KPMG

cutting through complexity

Cost Benefit Analysis:

Product Stewardship for Domestic Refrigerators and Air Conditioners at End-of-Life

Report prepared for the Department of the Environment

25 September 2014

Disclaimer

Inherent Limitations

This Report is solely for the purpose set out in the Introduction, Objectives and Scope Sections and for the Department of the Environment's information, and is not to be used for any other purpose or distributed to any other party without KPMG's prior written consent. The services provided in connection with this engagement comprise an advisory engagement, which is not subject to assurance or other standards issued by the Australian Auditing and Assurance Standards Board and, consequently no opinions or conclusions intended to convey assurance have been expressed.

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by, the Department of the Environment management and personnel consulted as part of the process.

KPMG have indicated within this report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

KPMG is under no obligation in any circumstance to update this report, in either oral or written form, for events occurring after the report has been issued in final form.

The findings in this report have been formed on the above basis.

Third Party Reliance

This report is solely for the purpose set out in the Scope Section and for the Department of the Environment's information, and is not to be used for any other purpose or distributed to any other party without KPMG's prior written consent.

This report has been prepared at the request of the Department of the Environment, in accordance with the Service Order SON458758 which was signed on 28 May 2014. Other than our responsibility to the Department of the Environment, neither KPMG nor any member or employee of KPMG undertakes responsibility arising in any way from reliance placed by a third party on this report. Any reliance placed is that party's sole responsibility.

Electronic Distribution of Reports

This KPMG report was produced solely for the use and benefit of the Department of the Environment and cannot be relied on or distributed, in whole or in part, in any format by any other party. The report is dated 25 September 2014 and KPMG accepts no liability for and has not undertaken work in respect of any event subsequent to that date which may affect the report.

Any redistribution of this report requires the prior written approval of KPMG and in any event is to be complete and unaltered version of the report and accompanied only by such other materials as KPMG may agree.

Responsibility for the security of any electronic distribution of this report remains the responsibility of Department of the Environment and KPMG accepts no liability if the report is or has been altered in any way by any person.

Contents

Glossary of Terms

Term	Description
BCR	Benefit Cost Ratio (BCR) is the ratio of the present value of total benefits to the present value of total costs.
CBA	Cost Benefit Analysis (CBA) is a method for organising information to aid decision making. CBA as two main features: • costs and benefits are expressed in monetary terms and hence are directly comparable; and • costs and benefits are valued in terms of the claims they make on and gains they provide to the community as a whole.
Disposal pathways	Describes different processes for disposing of whitegoods, each with different characteristics such as different tasks or actors.
Domestic RAC	Domestic RAC includes refrigerators (comprising upright refrigerators, bar refrigerators and wine refrigerators), freezers (comprising chest freezers, upright freezers and bar freezers) and air conditioners (comprising portable home air conditioners, split air conditioners, window air conditioners, dehumidifiers, evaporative coolers and ducted air conditioning systems).
Externality	An externality may be defined as any production or consumption process which ‘spills over’ such as that other parties receive a benefit for which they do not have to pay or incur a cost for which they are not automatically compensated. Externalities can be either positive (benefits) or negative (costs).
Ferrous metals	Any metal, including alloys, with appreciable iron content (e.g. steel).
IRR	Internal Rate of Return (IRR) is the discount rate at which the present value of benefits equals the present value of costs. This is the rate of return of benefits to costs.
Kerbside collection	Service provided, often by municipal or local authorities, to collect waste from households for the purpose of disposal. Also known as hard rubbish or verge collection.
LGA	Local Government Authorities (LGAs), commonly referred to as Councils.
Non-ferrous metals	Any metal, including alloys that do not contain appreciable amounts of iron.
NPV	Net Present Value (NPV) is the difference between the present value of total benefits and the present value of total costs.
ODS	Australia has legally binding obligations, under the Montreal Protocol on Substances that deplete the Ozone Layer, to phase out ozone depleting substances. Ozone depleting substances (ODS) were widely used in refrigerators, air conditioners, fire extinguishers, in dry cleaning, as solvents for cleaning, electronic equipment and as agricultural fumigants. Ozone depleting substances controlled by the Montreal Protocol include: • chlorofluorocarbons (CFCs) • halons

Term	Description
	• carbon tetrachloride (CCl_4), methyl chloroform (CH_3CCl_3) • hydrobromofluorocarbons (HBFCs) • hydrochlorofluorocarbons (HCFCs) • methyl bromide (CH3Br) • bromochloromethane (CH_2BrCl) There are other ozone depleting substances, but their import and manufacture are not legislated under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* as their impact on the ozone layer is insignificant.
Ozone Acts	The *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and related Acts protect the environment by reducing emissions of Ozone Depleting Substances (ODS) and Synthetic Greenhouse Gases (SGGs). The Ozone Acts include: *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* *Ozone Protection and Synthetic Greenhouse Gas (Import Levy) Act 1995* *Ozone Protection and Synthetic Greenhouse Gas (Manufacture Levy) Act 1995*
Product stewardship	An approach to reducing the environmental and other impacts of products by encouraging or requiring manufacturers, importers, distributors and other persons in the product chain to take responsibility for those products.
PV	Present Value (PV) is the discounted value of the cost or benefit.
RAC	Refrigeration and Air Conditioning (RAC) equipment, for the purpose of this paper includes refrigerators, air conditioners and freezers.
Refrigerant	A substance used in a refrigeration cycle which undergoes phase transitions from a liquid to a gas and back again in order to transfer heat.
Refrigeration	Process in which work is done to move heat from one location to another. Where the term refers to equipment it includes both refrigerators and freezers.
RRA	Refrigerant Reclaim Australia (RRA) is the product stewardship organisation for the Australian refrigerant industry.
SGG	Synthetic greenhouse gases (SGGs) are industrial substances used mainly as refrigerant gases in air conditioning and refrigeration equipment. They are also used for foam blowing, as propellants in specialty aerosol products and in the pharmaceutical, fire protection and electricity supply industries. The Australian Government is committed to reducing emissions of the SGGs listed under the Kyoto Protocol, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).
Scavenged	Uncontrolled collection and disposal of RAC equipment whereby parties collect from the kerbside and from other points in the disposal chain and sell directly to recyclers.
Shredder floc	Waste residue remaining after the shredding of vehicles, whitegoods or other appliances. Often largely comprised of plastics and rubber.

Executive Summary

Background

The Department of Environment (the 'Department') has commenced a project to explore the feasibility of a product stewardship approach for end-of-life domestic refrigeration and air conditioning (RAC) equipment across Australia.

The current treatment of RAC equipment at end-of-life has, and continues to create, a range of health and environmental impacts and loss of recoverable resources, resulting in a range of externalities whose costs are borne by businesses and society.

There are a number of potential approaches to reducing these impacts including improved compliance with existing schemes and the introduction of product stewardship options. The Department, in consultation with the RAC Industry Working Group, has developed preliminary options to underpin advice to the Commonwealth Government on the feasibility of a product stewardship approach. To assist with this process, the Department commissioned KPMG to undertake a cost benefit analysis (CBA) focussing on three product stewardship options identified by an industry working group.

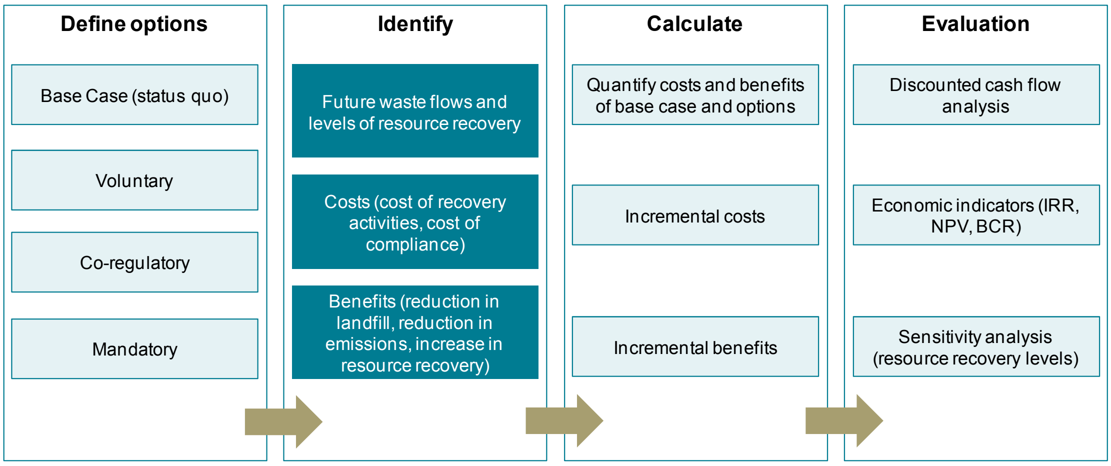
Approach

To assess the range of impacts associated with the product stewardship options under consideration, the evaluation employed the CBA framework, consistent with the relevant economic evaluation guidelines, including:

- guidelines for regulatory impact analysis published by the Office of Best Practice Regulation (OBPR), *The Australian Government Guide to Regulation;*
- the modified Business Cost Calculator (BCC) that calculates the compliance costs of regulatory proposals, administered by OBPR; and
- Commonwealth of Australia, *Handbook of Cost Benefit Analysis*, January 2006.

An overview of the CBA approach is illustrated in Figure 1 and described below.

Figure 1: Cost benefit analysis approach



Source: KPMG

The base case scenario and options considered in the analysis are outlined in Figure 2.

Figure 2: Product stewardship options for analysis

Base Case – Status Quo	• Voluntary retailer take-back programs and State Government run programs. • Some collection and destruction of refrigerant gases. • Collection of ferrous metals and some collection of non-ferrous metals.
Option 1 – Voluntary Scheme	• An administrator manages product stewardship arrangements on behalf of participants. • Participants are accredited to meet specific requirements. • Accreditation is voluntary and demonstrates an independent assessment.
Option 2 – Co-Regulatory Scheme	• Nationally consistent approach to collection and recycling of RAC equipment. • Liable parties required to be part of accredited product stewardship arrangement. • A regulatory impact statement would be required.
Option 3 – Mandatory Scheme	• Legislation specifying mandatory targets to be met by industry with penalties for non-compliance. • Regulations placed on importers and wholesalers. • Controls to ensure compliance at end-of-life.

Source: Department of the Environment and industry consultation

The product stewardship options included in the analysis aim to achieve a reduction in landfill, an increase in recovery of refrigerant gases and an increase in recovery of other resources for reuse. It is recognised that there may be a number of alternate means of achieving these outcomes. However, the focus of the analysis was on the product stewardship options developed by the industry working group in consultation with the Department of the Environment.

In undertaking the analysis, KPMG operated under a number of constraints. It is important to note these limitations when considering the study findings, including:

- The three options included in the analysis were designed by the industry working group in consultation with the Department of the Environment. These options, and the expected outcomes, are preliminary in nature and have not been tested in detail as a part of this analysis.

- Quantification of a number of the costs and benefits included in the analysis was based on information provided by the Department of the Environment or estimated through consultation with industry. Detailed testing of this information was not undertaken as a part of this analysis.
- Given the limited implementation of similar schemes elsewhere, the analysis relies on anecdotal evidence gathered through stakeholder consultation. Sensitivity analysis was undertaken to highlight the implications of variations in assumptions.

Identification and Quantification of Costs and Benefits

The identification and quantification of relevant costs and benefits included in the CBA are outlined in Table 2. Costs and benefits were identified and quantified based on anecdotal evidence provided by industry stakeholders and by the Department of the Environment.

Economic costs and benefits were quantified where market values were available, specifically:

- The costs of compliance were estimated by the Department of the Environment in consultation with the industry working group and include both costs to government and to industry. Costs are assumed to vary under each option depending on the specific requirements and level of compliance activity required. Compliance costs are expected to be lowest under a voluntary scheme (option 1) and highest under a mandatory scheme (option 3).
- Under each option, there is an increase in the number of refrigerators that are expected to be disposed of through retailer take back schemes. The cost of additional retailer take back activities was estimated based on consultation with industry representatives. Consultation suggests that costs of retailer take back schemes is approximately $40 per refrigerator, including transport, degassing and disposal costs.
- Under each option, there is expected to be an increase in plastics recovered from RAC equipment. Recovery of this material requires disassembly of RAC equipment. Industry consultation suggests that complete disassembly takes approximately one hour per RAC unit and costs between $20 and $30 per unit. For the purpose of the CBA, disassembly costs were assumed to be $20 per unit (in 2014 prices) reflecting the ability to achieve some economies of scale as the volume of equipment disassembled increases. The number of units disassembled was based on estimated recovery rates under each option. The assumed cost of disassembly remains constant in real terms, however there is potential that this could fall over time through economies of scale[1].

[1] The cost of disassembly is based on extensive research of the RAC equipment supply chain and consultation with industry stakeholders. Further detail is outlined in KPMG (2014). Some industry stakeholders indicated that the cost of disassembly could be up to $60 per unit. However, this cost includes the cost of degassing which is captured in the costs associated with the retailer take back scheme.

- Under each option, there is expected to be a reduction in the volume of waste diverted to landfill. Reducing the volume of waste to landfill avoids the economic costs associated with managing the waste and the environmental externalities created by landfill. For the purpose of the analysis, the cost of managing landfill was assumed to be $68 per tonne (in 2014 dollars). The environmental costs associated with landfill include methane gas emissions, leachate leakage and loss of amenity. For the purpose of the CBA, these costs were assumed to be $14 per tonne (in 2014 dollars). The economic and environmental costs of landfill were derived based on a review of recent literature and analysis of the cost of landfill in Australia[23].
- To achieve the reduction in volume of landfill additional disassembly of RAC equipment is undertaken and there is an increase in recovery of plastics under each option. The benefit associated with this increase in plastic recovery was quantified based on the market value for the recovered plastic. Consultation with industry suggests that the average value of plastic recovered would be approximately $550 per tonne.
- Under the mandatory scheme (option 3), the level of metal recovered from RAC equipment is assumed to increase slightly. The benefit associated with this increase in metal recovery was quantified based on the average value of recovered metal resources. These were derived from the previous KPMG report and are assumed to be:
    - $5,000 per tonne for copper;
    - $1,400 per tonne for aluminium; and
    - $140 per tonne for steel[4].
- Under each option, there is assumed to be an increase in the volume of refrigerant gas recovered from RAC equipment. The increase in refrigerant gas recovered results in a reduction in refrigerant gas emitted into the environment. There are a number of economic benefits associated with a reduction in refrigerant gas emissions including, the value of the emissions avoided, the health benefits of lower carbon emissions and the perceived value of lower emissions to society. Based on the independent Expert Panel reviewing the RET, the value of emissions are assumed to be equivalent to $9.50 per tonne of carbon.
- Under each option, there is expected to be an increase in the level of recycling. Willingness to pay captures society's value of increasing recycling activity and the resulting recovery of non-renewable resources and other non-market benefits. The willingness to pay for an increase in recycling of RAC equipment was assumed to be consistent with a recent analysis of the merits of a television and computer national recycling scheme ($0.50 per unit per

[2] BDA Group (2009) *The full cost of landfill disposal in Australia,* report prepared for the Department of the Environment Heritage and the Arts

[3] A landfill levy is charged for disposal of RAC equipment, however, this levy is used to cover the cost of waste management. For the purpose of the analysis, the landfill levy is treated as a transfer payment between parties and, therefore is not included.

[4] The value of resources recovered is based on extensive research of the RAC equipment supply chain and consultation with industry stakeholders. Further detail is outlined in KPMG (2014).

percentage point increase in recycling activity). Reflecting the uncertainty of the willingness to pay approach, results were presented both with and without these benefits.[5]

Key Findings

The key findings of the CBA are summarised in Table 1. Results are presented for the 10 years of the analysis in current years (2014) dollar values.

Table 1: Economic evaluation results (NPV @ 7% $m2014)

	PV$ million (2014 - 2024)		
	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Costs			
Cost of regulatory compliance – government	$1.0	$14.9	$22.7
Cost of regulatory compliance – industry	$2.0	$4.4	$14.3
Retailer take back scheme	$14.8	$14.8	$118.3
Cost of disassembly	$21.1	$63.4	$170.5
Total Costs	**$39.0**	**$97.6**	**$325.8**
Benefits			
Avoided landfill costs – waste management	$1.8	$3.5	$14.8
Avoided landfill costs – environmental	$0.4	$0.7	$3.0
Metal resource recovery	$0.0	$0.0	$30.6
Plastic resource recovery	$7.5	$22.6	$61.2
Refrigerant gas recovery (emissions reduction)	$1.3	$1.3	$9.1
Value of additional recycling	$0.6	$5.3	$52.0
Total Benefits	**$11.5**	**$33.5**	**$170.6**
Summary [a]			
NPV ($ million) – with WTP	-$27.4	-$64.1	-$155.2
NPV ($ million) – without WTP	-$28.0	-$69.4	-$207.2
BCR – with WTP	0.30	0.34	0.52
BCR – without WTP	0.28	0.29	0.36

a Results were presented with and without the willingness-to-pay (WTP) for additional recycling activity. This reflects the uncertainty associated with the WTP approach.

Source: KPMG analysis

Results are expressed in NPV terms of the 10 years of the analysis and include:

- The costs exceed the benefits under each option. The costs are largely driven by the costs of additional retailer take back and disassembly activity required to achieve the higher levels of material recovery under each option. These costs could potentially be reduced through

[5] PricewaterhouseCoopers and Hyder Consulting (2009), *Decision Regulatory Impact Statement Televisions and Computers*, report prepared for Environment Protection and Heritage Council.

economies of scale or through the establishment of a purpose specific third-party recovery scheme.

- Under all options the costs are largely borne by industry and benefits flow to the community and the environment. Benefits also to industry through the value of materials recovered from RAC equipment including metals and plastics.
- The largest source of benefits under each option are those associated with increasing recovery RAC equipment materials including metals and plastics. The results of the analysis are highly sensitive to changes in unit value placed on recovery of metals, plastics and refrigerant gas.
- The BCR for the options are similar to those observed for the analysis of the costs and directly observable benefits of a national recycling scheme for televisions and computers[6].

A series of tests were undertaken to test the sensitivity of the results of the analysis. Findings of the sensitivity analysis include:

- Lower rates of participation and recovery results in lower costs under each option due to lower costs of regulatory compliance (lower levels of participation) and the reduction in recovery activities and associated costs of disassembly. The benefits under each option are also lower due to the lower level of recovery of plastics and refrigerant gas and higher level of landfill relative to the central assumptions.
- Higher rates of participation and recovery results in higher costs than under the central assumptions due to higher costs of regulatory compliance (higher levels of participation) and a higher rate of recovery of materials and associated costs. The benefits under each option are also higher, in particular the higher recovery of plastics (lower landfill).

Next Steps

The purpose of the CBA is to measure the economic, environmental and social costs and benefits of preliminary product stewardship options developed by the RAC Industry Working Group in consultation with the Department of the Environment. The analysis will be used to inform detailed option development including regulatory and non-regulatory factors. Following a government decision on whether to proceed with investigating product stewardship options, there are a number of steps required should the government decide to proceed:

- identification of priority options and further development;
- Regulatory Impact Statement of preferred option(s) and Government consideration;
- identification of implications of options and mitigation strategies; and
- product stewardship implementation.

[6] PwC and Hyder Consulting 2009, *Decision Regulatory Impact Statement: Televisions and Computers,* report prepared for the Environment Protection and Heritage Council, October.

1 Introduction

Product stewardship is an approach to managing the impacts of different products and materials. It acknowledges that those involved in producing, selling, using, and disposing of products have a shared responsibility to ensure that those products or materials are managed in a way that reduces their impact on the environment, human health and safety through their lifecycle.

The Department of the Environment (the 'Department') is currently exploring the feasibility of a product stewardship approach for end-of-life domestic refrigeration and air conditioning (RAC) equipment across Australia. Domestic RAC equipment comprises:

- refrigerators (comprising upright refrigerators, bar refrigerators, and wine refrigerators);
- freezers (comprising chest freezers, upright freezers, and bar freezers); and
- air conditioners (comprising portable home air conditioners, split air conditioners, window air conditioners, evaporative coolers, and ducted air conditioning systems)[7].

To assist in exploring this approach, RAC Industry Working Group, in consultation with the Department of Environment, has developed preliminary product stewardship options to underpin advice to the Commonwealth Government on the feasibility of further consideration of product stewardship. These options have been tested on refrigerators, freezers and air conditioners that will reach end-of-life between 2014 and 2024.

1.1 Objectives and Scope

The Department has commissioned KPMG to undertake a Cost Benefit Analysis (CBA) of three product stewardship options for domestic RAC equipment.

CBA is an economic appraisal tool that enables the measurement of the economic, environmental and social costs and benefits associated with a government action or intervention. There are two main features of CBA, being:

- quantification of costs and benefits in monetary terms to enable comparison and qualitative assessment of factors/impacts that cannot be readily quantified; and
- costs and benefits are considered in terms of the economy and society as a whole.

The economic analysis was undertaken in accordance with relevant government guidelines, namely:

- Guidelines for regulatory impact analysis published by the Office of Best Practice Regulation (OBPR), *The Australian Government Guide to Regulation;*
- The modified Business Cost Calculator (BCC) that calculates the compliance costs of regulatory proposals, administered by OBPR; and
- Commonwealth of Australia, *Handbook of Cost Benefit Analysis,* January 2006.

[7] It is noted that a number of air conditioners do not contain refrigerant gases.

1.2 Report Structure

The remainder of the report is structured as follows:

- Section 2 provides background on the Department's investigation of the feasibility of product stewardship options;
- Section 3 describes our approach to undertaking the CBA and defines the options for analysis;
- Section 4 identifies the costs and benefits of each option and quantification of these costs and benefits;
- Section 5 outlines the findings of the analysis; and
- Section 6 provides a summary of findings and outlines potential next steps.

2 Background

Domestic RAC equipment includes refrigerators, freezers and air conditioners with small refrigerant charges. Domestic RAC equipment can contain a range of materials including refrigerants, ferrous metals, non-ferrous metals, plastic, rubber, glass, oil and other materials. Australia currently has a national product stewardship scheme for management and disposal of refrigerant gases. This scheme is run by Refrigerant Reclaim Australia (RRA). The Department is investigating the feasibility of a product stewardship approach to manage the whole RAC equipment product at end-of-life including all materials such as any metals, plastics and refrigerant gases. In addition, the Department is undertaking a separate review of the Ozone Acts. The purpose of the Ozone Act review is to:

- identify opportunities to improve and streamline the operation of the Ozone Acts including reducing regulatory compliance costs for business and the community; and
- identify opportunities to reduce emissions of ozone depleting substances and synthetic greenhouse gases in line with international efforts.

As illustrated in Figure 2-1 and described below, the CBA forms part of a broader process of considering options and implications of product stewardship for domestic RAC equipment.

Figure 2-1: Product stewardship consideration approach

	Stage	Outcome
1	Analysis of the disposal of domestic RAC equipment at end-of-life in Australia (prepared by KPMG)	Understanding of disposal pathways, key stakeholders, and influencing factors such as legislation, costs and technology
2	Draft options paper prepared by the RAC Working Group with assistance from the Department	A series of preliminary options outlining potential approaches to product stewardship for domestic RAC equipment
3	Cost benefit analysis of preliminary options and approaches	Economic appraisal to measure the economic, environmental and social costs and benefits of each option
4	Provision of advice to government and its decision on whether to continue to explore options or to cease work	
5	Based on decision to proceed, identification of priority options and further options development	
6	Regulatory Impact Statement of preferred option(s) and Government consideration	Identification of implications of options and mitigation strategies
7	Product stewardship implementation	Product stewardship objectives achieved

Stage 1 – Analysis of the disposal of domestic RAC equipment

The Department commissioned KPMG to prepare an analysis of the flow and market share dynamics of domestic RAC equipment at end-of-life in Australia over the period 2014 to 2024. Specifically, the analysis considered:

- the stakeholders that participate in the RAC equipment disposal chain;
- the factors that influence stakeholder behaviour and actions in the disposal chain;
- the significant disposal pathways for RAC equipment;
- an understanding of the quantity of RAC items entering the disposal chain; and
- international best-practice for managed disposal of RAC equipment.

The findings of the analysis were used to inform the development of draft options for product stewardship.

Stage 2 – Draft options paper

In consultation with the Department, the RAC Working Group developed a number of preliminary product stewardship options and a draft options paper. These options are summarised in Figure 2-2 and outlined in further detail in Section 3.

Figure 2-2: Preliminary product stewardship options

Option 1 – Voluntary Scheme	An administrator manages product stewardship arrangements on behalf of participants. Participants are accredited to meet specific requirements. Accreditation is voluntary and demonstrates an independent assessment.
Option 2 – Co-Regulatory Scheme	A nationally consistent approach to collection and recycling of RAC equipment. Liable parties required to be part of accredited product stewardship arrangement. A regulatory impact statement would be required.
Option 3 – Mandatory Scheme	Legislation specifying mandatory targets to be met by industry with penalties for non-compliance. Regulations placed on importers and wholesalers. Controls to ensure compliance at end-of-life.

Source: Department of the Environment and industry consultation

Stage 3 – Cost benefit analysis

The Department has commissioned this report on the costs and benefits associated with three preliminary product stewardship options. The CBA considers each domestic RAC equipment product stewardship option from a whole of community perspective to determine the costs and benefits derived from each option in terms of increased resource recovery and reduced environmental and human health impacts. The purpose of the CBA is to assist the Department with further, more detailed, option development and to guide advice on whether to continue to pursue product stewardship options for RAC equipment.

Stage 4 – Government consideration

The Department will use the findings from Stages 1 to 3 to develop advice to government on product stewardship for RAC equipment. The government will consider whether the Department should continue to pursue product stewardship options. If the government decides not to continue the investigation of product stewardship for RAC equipment in Australia, the assessment of feasibility of options will cease.

Stages 5-7 – Option implementation

If the government decides to continue investigation of product stewardship for RAC equipment in Australia, more detailed analysis of options will be required. Once the priority options are identified, more detailed analysis will be required such as:

- analysis of the costs and benefits of the options;
- analysis of the regulatory impacts of the options;
- analysis of the distribution of costs and regulatory burden; and
- investigation of implementation of the product stewardship program.

3 Approach

This section outlines the approach employed to undertake the CBA including the:

- method of analysis; and
- specification of the base case and options considered.

3.1 Method of Analysis

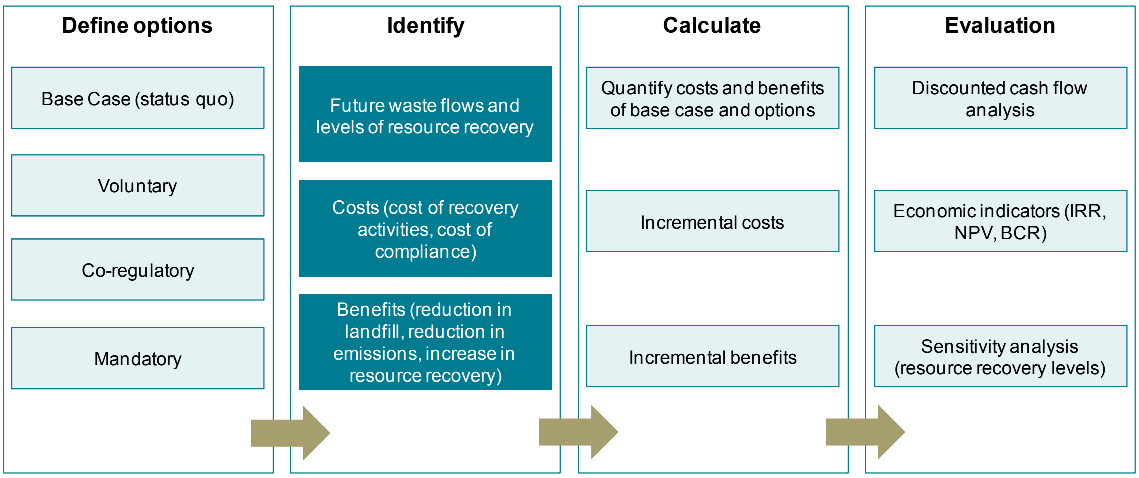
The approach to undertaking the CBA is consistent with relevant evaluation guidelines, including:

- Guidelines for regulatory impact analysis published by the Office of Best Practice Regulation (OBPR), *The Australian Government Guide to Regulation;*
- The modified Business Cost Calculator (BCC) that calculates the compliance costs of regulatory proposals, administered by OBPR; and
- Commonwealth of Australia, *Handbook of Cost Benefit Analysis*, January 2006.

The CBA considers each domestic RAC equipment product stewardship option from a whole of community perspective to determine the costs and benefits derived from each option in terms of increased resource recovery and reduced environmental and human health impacts. The evaluation is presented in terms of the net community gain (or loss) of administering each option to government, industry and society.

An overview of the approach to undertaking the CBA is illustrated in Figure 3-1.

Figure 3-1: Cost benefit analysis approach



Consistent with relevant guidelines and best practice, the approach to developing the CBA involved the following steps:

- articulation of the base case scenario (status quo) and policy options;

- identification of the relevant economic, social and environmental costs and benefits;
- quantification of the identified costs and benefits;
- qualitative description of costs and benefits that cannot be readily quantified;
- generation of the economic performance measures (such as net present value (NPV) and benefit cost ratio (BCR)) to:
    - compare and contrast quantified costs against the benefits over an appropriate timeframe
    - rank the economic returns expected across the proposed options; and
- undertake a sensitivity analysis to assess the sensitivity of performance measures to changes in key variables.

The performance measures described above are defined as follows:

- *NPV* – the difference between the present value of total benefits and the present value of total costs; and
- *BCR* – ratio of the present value of total benefits to the present value of total costs.

Options that yield a positive NPV indicate that the benefits outweigh the costs over the evaluation period. A BCR greater than one indicates that the option benefits exceed option costs over the evaluation period. A BCR less than one indicates that the option costs exceed the option benefits over the evaluation period.

Standard economic evaluation assumptions adopted for the analysis are outline in Table 3-1.

Table 3-1: Standard economic appraisal assumptions

Parameter	Value	Rationale
Discount rate	7 per cent	The discount rate converts costs and benefits that occur in different time periods to the present value (see price year) so they can be compared. The discount rate is aligned with the OBPR's guidelines for RIS and BCC. The OBPR recommends 7% as the default real discount rate for use with the Business Cost Calculator.
Price year	2014	The price year is the year in which the value of all costs and benefits will be expressed. All values will be discounted to the price year. Due to factors like inflation and the opportunity cost of investing, a dollar today is worth more than a dollar tomorrow, so future costs and benefits will be converted to an equivalent amount in the price year's dollars by applying the discount rate.
Evaluation period	10 years	The options will be evaluated in terms of the costs and benefits they will yield over a set evaluation period (2014 to 2024). The OBPR does not have a recommended timeframe for evaluation. The Regulatory Burden

Parameter	Value	Rationale
		Measurement Framework outlines a 10 year timeframe for calculating business compliance costs.

3.2 Base Case and Options for Analysis

The current treatment of RAC equipment at end-of-life has created a range of externalities that businesses and society pay for, including:

- human health impacts,
- environmental impacts, and
- loss of recoverable resources.

There are a number of potential approaches to reducing these impacts including improved compliance with existing schemes and the introduction of product stewardship options. As outlined in Section 1, the objective and scope of this report is to investigate the costs and benefits associated with three product stewardship options. The definition of the options were informed by:

- KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia,* report prepared for the Department of the Environment; and
- RAC Working Group 2014, *Feasibility of Product Stewardship for End-of-Life Domestic Refrigerators and Air Conditioners (Draft Options Paper)*, version 2, issued to KPMG in May 2014.

All options aim to achieve the following outcomes:

- a reduction in landfill;
- an increase in refrigerant recovery; and
- an increase in recovery of other resources.

Maintaining the status quo represents the base case and is required to enable identification and measurement of the incremental costs and benefits.

The following sections outlined the base case and options for analysis, including:

- a description of the option;
- an outline of the specific requirements of each option;
- the proposed management arrangements; and
- the outcomes achieved.

The base case and options focus on RAC equipment that will reach end-of-life between 2014 and 2024. The base case and options rely on analysis of historical sales data, forecast sales data, estimated life span and stock to forecast RAC equipment disposal rate and stock level on a yearly basis over the 10 year period. It is recognised that RAC equipment disposal and stock levels depend on the expected life span of the equipment. This life span can be impacted by a number of physical characteristics (e.g. quality of design and assembly) and behavioural influences (e.g. desire to upgrade and existence of market for second hand goods). It is recognised that the stock and disposal data that underpin the analysis was developed based partly on anecdotal evidence gathered through stakeholder consultation. Further detail regarding the limitations of these data are outlined in Appendix A.

It is recognised that the RAC industry is undergoing technological change which has altered the material composition of domestic RAC equipment since the early 1990s and will continue to evolve over the next decade. In particular, the industry is now manufacturing equipment with refrigerant gases with low GWPs and improved energy efficiency. This report has been limited to the stock of RAC equipment which is expected to reach end of life during 2014-2024. It is acknowledged that the stock of equipment reaching end of life after 2024 could be different.

Under all the options, including the base case, it is assumed that there is no carbon price. The repeal of the carbon price is expected to reduce the cost of new refrigerants which may cause a decline in the demand for "second hand" refrigerant gases. Subsequently, it is anticipated that the treatment of used refrigerant at end of life will change, with the relative proportion of refrigerant gases destroyed expected to increase and the proportion of refrigerant gases reused expected to reduce. This effect is consistent across all options, as such this will have no net impact on the relative proportion of gas recovered between options.

3.2.1 Base Case (Status Quo)

A clearly articulated base case is critical to effectively demonstrate the overall net incremental impact of the product stewardship options. The base case scenario for the CBA is based on the status quo of current management of RAC equipment at end-of-life in Australia. The base case was developed based on analysis of stakeholders involved in the RAC disposal chain, the impact of stakeholders on disposal practices and the impact of other factors such as regulations and supply chain costs. It also includes quantitative analysis of the amounts of RAC items entering the disposal chain from 2014 to 2024 (KPMG 2014). Data to inform the baseline was gathered by way of:

- research into the RAC equipment supply chain and the factors affecting sales, disposal rates, and choice of disposal pathway;
- extensive consultation with industry stakeholders in the retail, manufacturing, importing, regulation and choice of disposal pathway; and
- analysis of sales and lifespan data to determine disposal rates from 2014 to 2024.

Broadly the baseline includes:

- voluntary retailer take-back programs;
- State Government recycling programs;
- some collection and removal of refrigerant gases; and
- collection of ferrous metal and limited collection of non-ferrous.

There is currently no recovery of blowing agent from insulating foam in Australia. Accordingly, foam has not been considered in the analysis of the base case or the options.

The base case, as it relates to the different equipment types, is outlined below with a detailed description included in Appendix A.

Air conditioners

Under the current waste management model the householder or equipment owner pays for disposal of air conditioners through the services of a technician to remove and dispose of the unit. Technicians will remove the refrigerant and it is collected for reuse or sent to RRA for destruction (via a refrigerant wholesaler).

No retailer or wholesaler take-back programs were identified for end-of-life air conditioners, however, if the technician contracted to remove the unit works for a wholesaler or retailer, the unit is likely to be taken to a distribution centre where it is partially disassembled. Separated metal is sold to a scrap metal merchant or recycler and the remaining materials are sent to landfill. Alternatively, the unit is taken to a scrap metal merchant for disassembly prior to being sent to a metal recycler for shredding.

Industry consultation has indicated that approximately 90 per cent of air conditioners are estimated to be recovered through the pathway described. The estimated stocks and number of units of air conditioners disposed of at end-of-life are provided in Chart 3-1, values are based on the previous KPMG analysis[8].

The stock of domestic air conditioning units comprises:

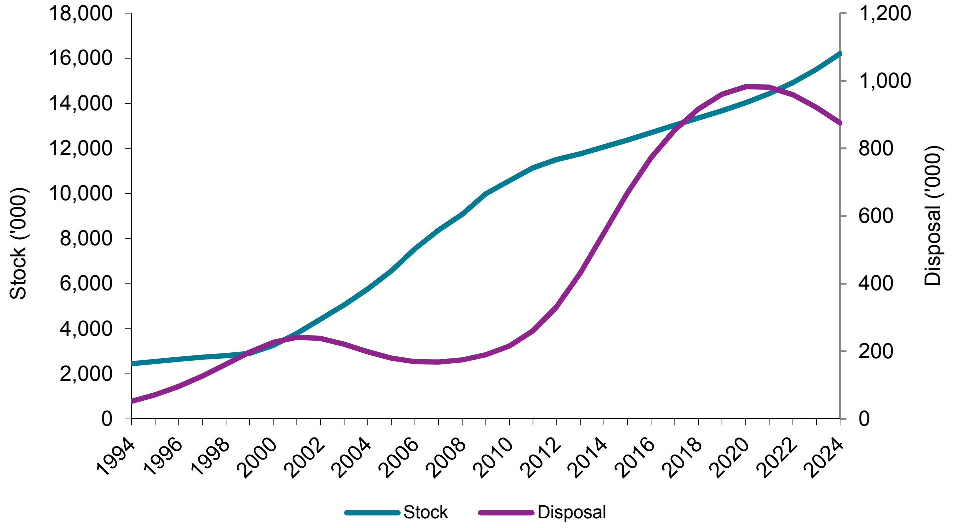
- 53 per cent split system units (not ducted);
- 19 per cent evaporative coolers;[9]
- 14 per cent window or wall units; and
- remainder are ducted split systems and portable air conditioners.[10]

[8] KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia*, report prepared for the Department of the Environment

[9] It is recognised that this equipment does not contain refrigerant.

[10] KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia*, report prepared for the Department of the Environment

Chart 3-1: Stock and disposals of domestic air conditioning equipment[a]



[a] Stock and disposals are based on sales data for each product category and the expected lifespan of each product. Detailed method of estimating stocks and disposals are outlined in KPMG (2014).

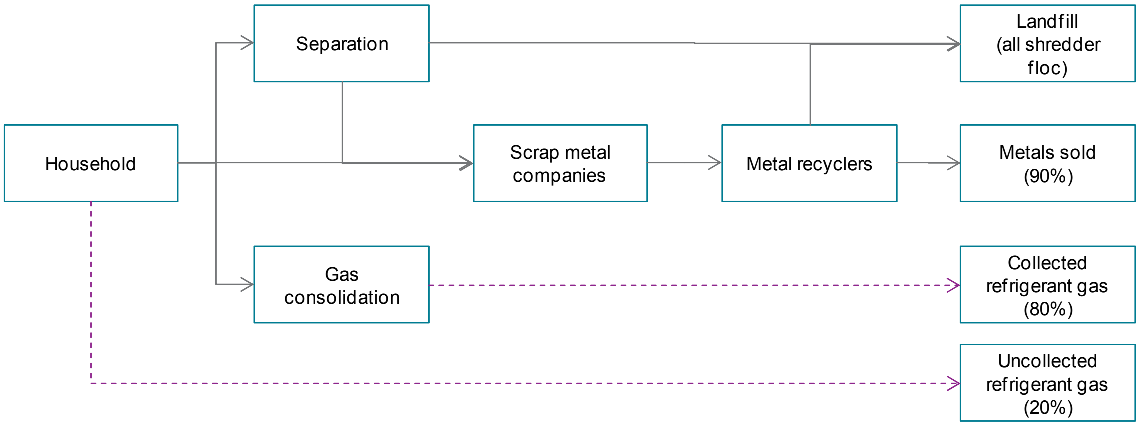
Source: KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia*, report prepared for the Department of the Environment.

Of the air conditioners recovered, industry stakeholders have estimated that the end-of-life waste material recovery and recycling rates include:

- approximately 80 per cent of the Ozone-Depleting Substance (ODS) or Synthetic Greenhouse Gases (SGG) refrigerant gas are recovered for reuse or for disposal by RRA;
- approximately 90 per cent of metals are recycled, comprising of 58.2 per cent steel, 12.7 per cent copper and 8.3 per cent aluminium; and
- other materials, such as plastics (which account for 12.4 per cent of air conditioning waste) and circuit boards are sent to landfill.

The recovery pathways for materials contained in air conditioners at end-of-life are summarised in Figure 3-2 and outlined in further detail in Appendix B.

Figure 3-2: Recovery pathways for air conditioners, base case



Source: KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia*, report prepared for the Department of the Environment.

Refrigerators

Under the current waste management model the householder or equipment owner pays for disposal through the services of a retailer (i.e. service fee) or local government authority (LGA) (i.e. council rates) to remove and dispose of the unit. Several retailers offer take-back services.

Industry consultation suggests that currently approximately 30 per cent of refrigerators are collected through retailer take-back schemes and 60 per cent are disposed of through kerb side collection. Consultation suggests that approximately half of the refrigerators left out for kerbside collection are scavenged and the other half are collected by local government[11].

Collected refrigerators are consolidated at waste transfer stations, retail distribution centres or scrap metal merchants. Refrigerant gas is then collected by some retailers and LGAs with an estimated refrigerant collection rate of between 30 and 40 per cent for all refrigerators. Refrigerators are then sent to or collected by metal recyclers where they are shredded and the metals are recovered for recycling. The waste shredder floc, consisting mainly of plastic, is sent to landfill[12].

Domestic refrigerators contain approximately 5 to 10 kg of insulating polyurethane foam. This foam in turn contains about 5 per cent by weight of blowing agent[13].

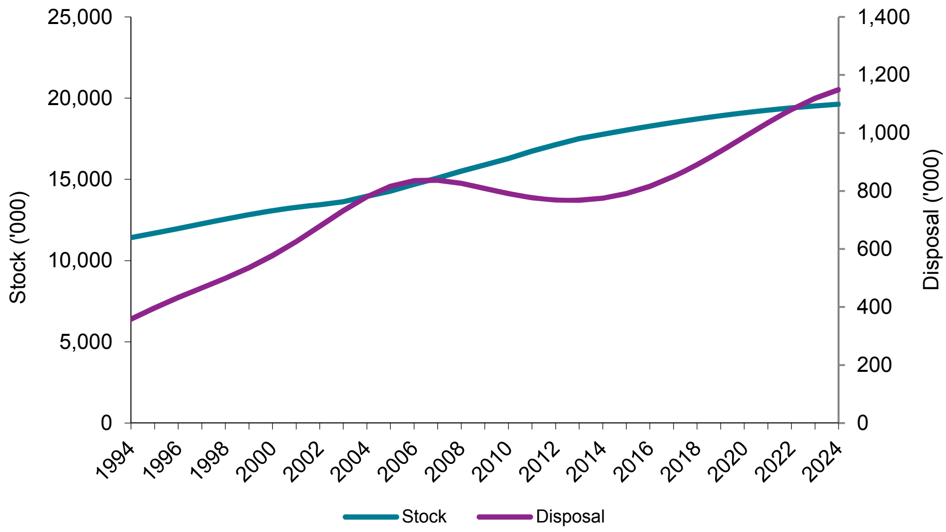
The estimated stocks and number of units of refrigerators disposed of at end-of- life are provided in Chart 3-2. For the stock of domestic refrigerators units:

- standalone freezers are in decline; and
- influenced by household growth as it is considered a saturated market[14].

---

[11] Based on consultation with industry.
[12] Based on consultation with industry.
[13] KPMG 2012, *Stage 1 Report – the Australian Foam Blowing and Foam Products Industry*, report prepared for the Department of the Environment
[14] *ibid.*

Chart 3-2: Stock and disposals of domestic refrigerators equipment [a]



a Stock and disposals are based on sales data for each product category and the expected lifespan of each product. Detailed method of estimating stocks and disposals are outlined in KPMG (2014).

Source: GfK Market Research and KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia,* report prepared for the Department of the Environment.

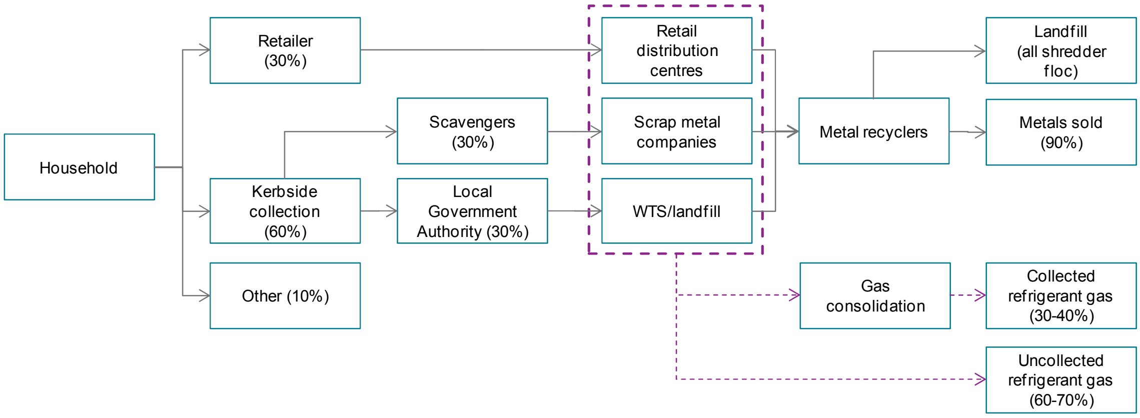
Of the refrigerators recovered, the end-of-life waste material recovery and recycling rates contain:

- approximately 60 to 100g of refrigerant gas for an average refrigerator at end-of-life;
- non-ferrous metals that are exported;
- ferrous metals that are sold (locally or exported); and
- waste shredder floc, consisting mainly of plastic, which is sent to landfill. Materials contain foam, plastic, coppers, lead and cadmium (from printed circuit boards) and oil[15].

Resource recovery pathways for refrigerators and freezers at end-of-life are illustrated in Figure 3-3 and outlined in further detail in Appendix B.

[15] The types of material recovered or disposed of from RAC equipment at end-of-life is based on available literature and stakeholder discussions.

Figure 3-3: Recovery pathways for refrigerators, base case



Source: KPMG 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia*, report prepared for the Department of the Environment.

3.2.2 Option 1 – Voluntary

The following table summarises option 1 as outlined in the draft options paper prepared by the RAC Industry Working Group in consultation with the Department, including the requirements, management, potential features and benefits and costs. The implications of this option on recovery of materials from refrigerators and air conditioners are illustrated in the diagrams that follow.

Table 3-2: Summary, option 1 – voluntary scheme

Description	Under a voluntary scheme an Administrator manages the product stewardship arrangement on behalf of participants to achieve a set of outcomes. Participants would be accredited and required to meet specific scheme requirements. Accreditation is voluntary and demonstrates that an organisation has been independently assessed.

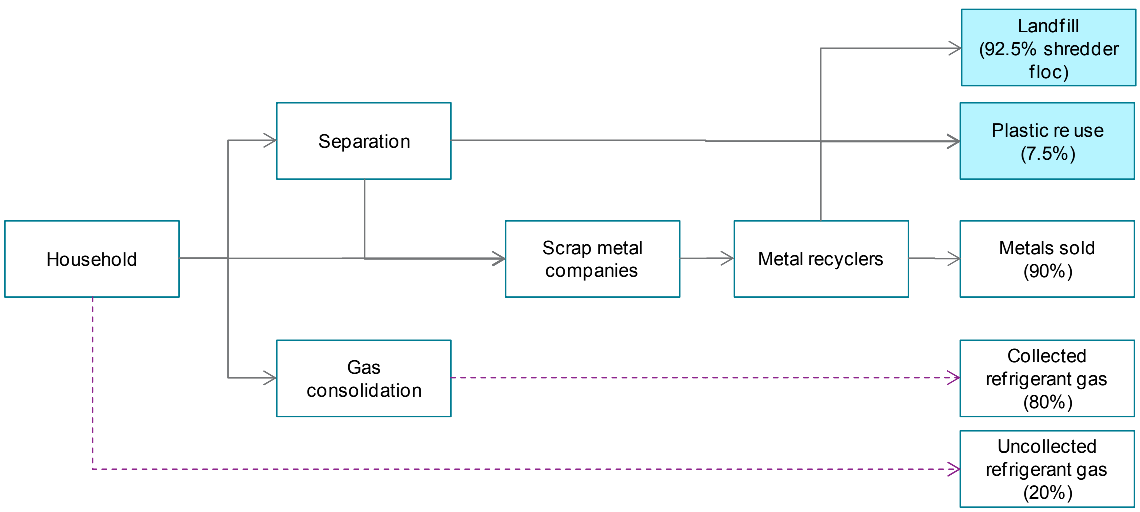
Requirements	Requirements of the voluntary scheme include:
	• An education campaign for consumers about the benefits of:
	  o using an accredited air conditioning installer; and
	  o appropriately disposing of RAC equipment.
	• An education campaign for metal recyclers to increase awareness of need for refrigerant recovery.
	• Accreditation and a logo to encourage a greater number of retailer take-back schemes to reduce the refrigerators put out for kerbside collection and thereby reducing the ability for scavengers to collect refrigerators.
	• A target to reduce the proportion of shredder floc from RAC equipment entering landfill (e.g. reduce the amount of shredder floc going to landfill by 15 per cent), funded by industry (e.g. manufacturers, importers, retailers).
	• Increasing the rebates paid to contractors for the return of ODS and SGG to RRA for destruction.

	• Encouraging LGAs to increase booked collections.
Management	Management arrangements required for a voluntary scheme include: • Collection of fees from importers/manufacturers which will fund recyclers for recycling RAC equipment. Accreditation and audit of participants and education campaigns. • Accredited retailer take back schemes. • Using a logo for consumer education and to identify accredited companies. • Local Governments sign up to have booked collections. • Reduction of hazardous substances in shredder floc
Outcomes	The expected outcomes of the voluntary scheme relative to the status quo include: • a 50 per cent industry participation in the scheme; • an increase in retailer take back schemes; • a reduction in the amount of shredder floc going to landfill; • an increase in the recovery of plastics through disassembly; • a reduction in scavenger collection of refrigerators for scrap metal; and • an increase in refrigerant gas recovered for destruction and/or reuse.

Source: RAC Working Group 2014, Feasibility of Product Stewardship for End-of-Life Domestic Refrigerators and Air Conditioners (Draft Options Paper), version 2, issued to KPMG in May 2014.

The expected impact of the voluntary scheme on recovery pathways for air conditioners at end-of-life is illustrated in Figure 3-4 and outlined in further detail in Appendix B.

Figure 3-4: Recovery pathways for air conditioners, option 1

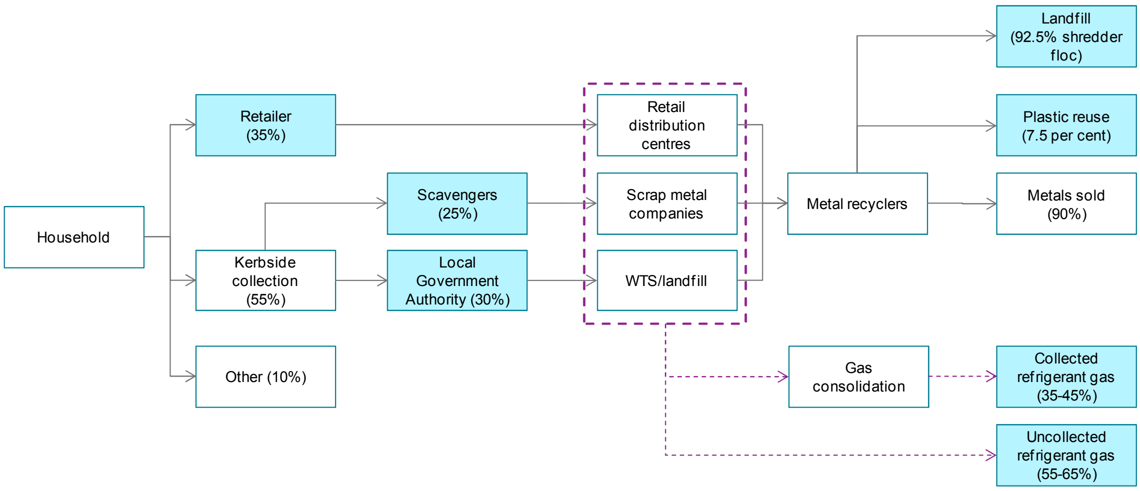


NOTE: Shaded boxes represent a shift from the status quo.

Source: Department of the Environment and industry consultation

The expected impact of the voluntary scheme on recovery pathways for refrigerators and freezers at end-of-life is illustrated in Figure 3-5 and outlined in further detail in Appendix B.

Figure 3-5: Recovery pathways for refrigerators, option 1



NOTE: Shaded boxes represent a shift from the status quo.

Source: Department of the Environment and industry consultation

3.2.3 Option 2 – Co-regulatory

The following table summarises option 2 as outlined in the draft options paper prepared by the RAC Industry Working Group in consultation with the Department, including the requirements, management, potential features and benefits and costs.

Table 3-3: Summary, option 2 – co-regulatory scheme

Description	A co-regulatory approach would provide a nationally consistent approach to the collection and recycling of domestic RAC equipment. Liable parties would be required to be a part of an approved product stewardship arrangement. A regulatory impact statement would need to be undertaken. The co-regulatory scheme includes the requirements of the voluntary scheme and a number of additional requirements (outlined below).
Requirements	Requirements as per the voluntary scheme including: • An education campaign for consumers about the benefits of: o using an accredited air conditioning installer; and o appropriately disposing of RAC equipment. • An education campaign for metal recyclers to increase awareness of the need for refrigerant recovery. • Accreditation and a logo to encourage a greater number of retailer take back schemes, to reduce the refrigerators put out for kerb side collection and thereby reducing the ability for scavengers to collect refrigerators.

<table>
<tr><td></td><td>

A target to reduce the proportion of shredder floc from RAC equipment entering landfill (e.g. reduce the amount of shredder floc going to landfill by 15 per cent), funded by industry (e.g. manufacturers, importers, retailers).
Increasing the rebates paid to contractors for the return of ODS and SGG to RRA for destruction.
Encouraging LGAs to increase booked collections.

Additional requirements, including:

A clear set of established requirements for liable entities, such as importers, manufactures, accredited retailers, accredited LGAs, accredited recyclers.
Importers and manufacturers charged a levy through which they discharge their responsibilities (e.g. pay a recycler to dismantle rather than shred).
A target to reduce the proportion of shredder floc from RAC equipment entering landfill (15 and 30 per cent), funded by industry (e.g. manufacturers, and importers).
Education and training regarding: how to treat end-of-life RAC equipment and penalties for non-compliance.

</td></tr>
<tr><td>Management</td><td>
Management of a co-regulatory scheme would comprise:

enforcement product stewardship program by Commonwealth Government;
powers to the Regulator that permits:

the assessment and approval of product stewardship arrangements to meet requirements on behalf of liable parties;
monitoring of liable party arrangements to ensure compliance;
the ability to enforce the legislation through escalating sanctions; and

consideration of regional versus non metropolitan areas.

</td></tr>
<tr><td>Outcomes</td><td>
The expected outcomes of the co-regulatory approach relative to the status quo include:

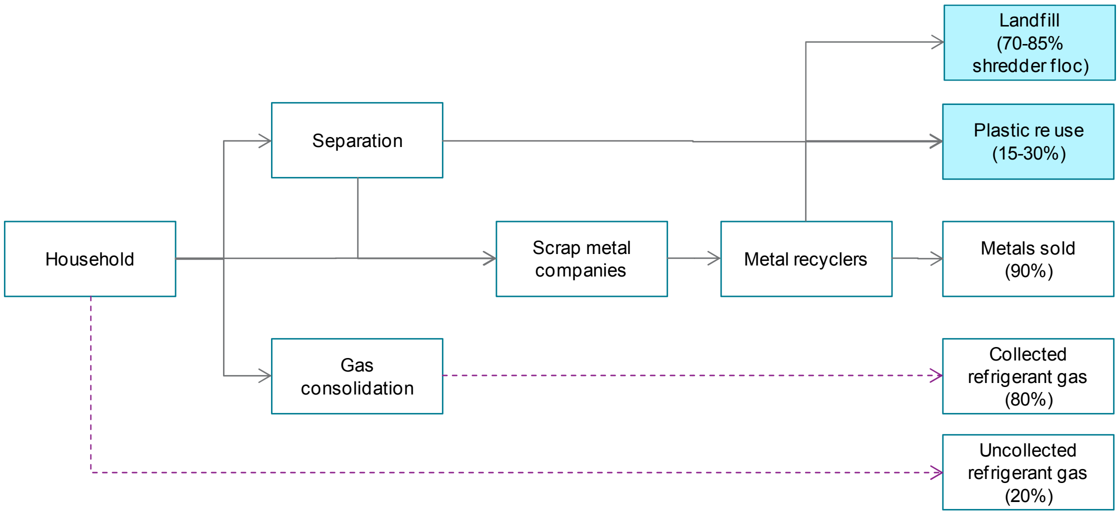
an increase in retailer take back schemes;
a reduction in scavenger collection of refrigerators for scrap metal;
a reduction in the amount of shredder floc going to landfill;
an increase in the recovery of plastics due to disassembly; and
an increase in refrigerant gas recovered for destruction and/or reuse.

</td></tr>
</table>

Source: RAC Working Group 2014, Feasibility of Product Stewardship for End-of-Life Domestic Refrigerators and Air Conditioners (Draft Options Paper), version 2, issued to KPMG in May 2014.

The resource recovery pathways for equipment at end-of-life under a co-regulatory scheme are outlined in Figure 3-6 and Figure 3-7 and outlined in further detail in Appendix B.

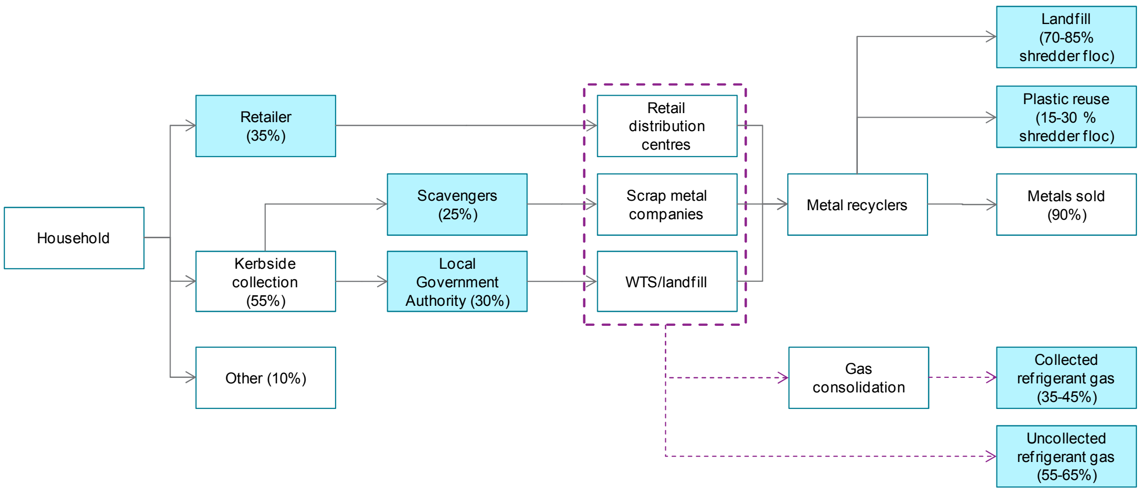
Figure 3-6: Recovery pathways for air conditioners, option 2



NOTE: Shaded boxes represent a shift from the status quo.

Source: Department of the Environment and industry consultation

Figure 3-7: Recovery pathways for refrigerators, option 2



NOTE: Shaded boxes represent a shift from the status quo.

Source: Department of the Environment and industry consultation

3.2.4 Option 3 - Mandatory

The following table summarises option 3 as outlined in the draft options paper prepared by the RAC Industry Working Group in consultation with the Department, including the requirements, management, potential features and benefits and costs.

Table 3-4: Summary, option 3 – mandatory scheme

Description	The mandatory scheme involves legislation specifying mandatory targets which must be met by industry and will allow for civil penalties or infringement notices for non-compliance. Regulations will be placed on the importers and manufactures (i.e. the point in the supply chain where the number of stakeholders is minimised). However controls are in place to ensure that stakeholder at the end-of-life are conducting themselves in accordance with the requirements of the legislation. The mandatory scheme includes the requirements of the voluntary and co-regulator schemes and a number of additional requirements (outlined below).

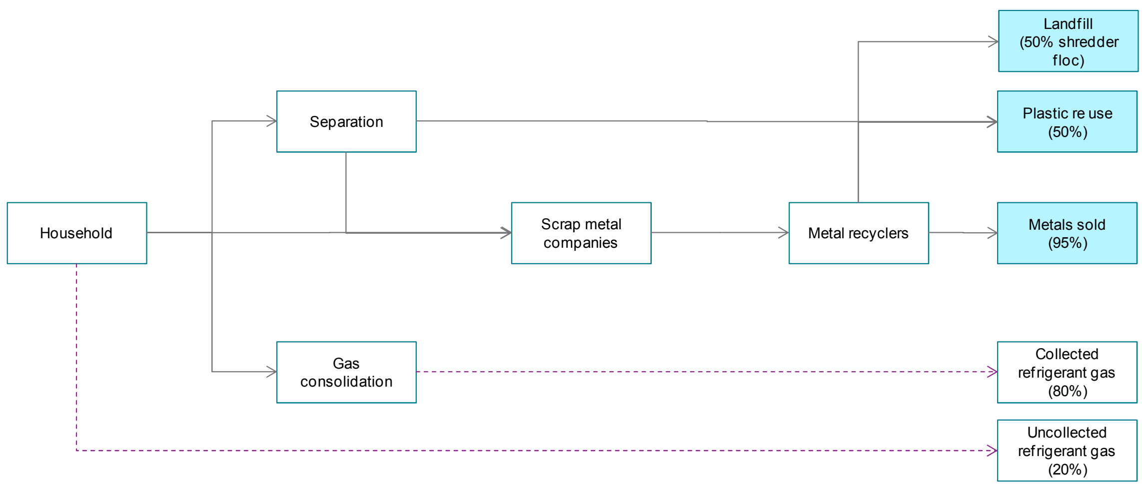
Requirements	Requirements as per the voluntary scheme including:
	• An education campaign for consumers about the benefits of:
	  o using an accredited air conditioning installer; and
	  o appropriately disposing of RAC equipment.
	• An education campaign for metal recyclers to increase awareness of need for refrigerant recovery.
	• Accreditation and a logo to encourage a greater number of retailer take back schemes, to reduce the refrigerators put out for kerb side collection and thereby reducing the ability for scavengers to collect refrigerators.
	• A target to reduce the proportion of shredder floc from RAC equipment entering landfill (e.g. reduce the amount of shredder floc going to landfill by 15 per cent), funded by industry (e.g. manufacturers, importers, retailers).
	• Increasing the rebates paid to contractors for the return of ODS and SGG to RRA for destruction.
	• Encouraging LGAs to increase booked collections.
	
	Additional requirements, including:
	• A target to reduce the proportion of shredder floc from RAC equipment entering landfill by 70 per cent, funded by industry (e.g. manufacturers, importers, retailers).
	• Labelling and packaging to indicate the presence of hazardous substances, required disposal methods and take back programs.
	• Communication and handling of RAC equipment at end-of-life such as council or metal recyclers to de-gas equipment and disassemble before shredding.
	• Labelling and packaging to indicate the presence of hazardous substances, required disposal methods and take back programs.
	• Coverage is for all domestic RAC equipment to be dismantled and there is a ban on domestic RAC equipment going into landfill.

	• Every retailer must offer a take back scheme. • LGAs offer on-call collections (capped at two per year).
Management	• Regulate the design of domestic RAC equipment to comply with European Standards and to ban specific materials. • Regulate the retailer take back schemes. • Impose a ban on end-of-life domestic RAC equipment entering landfill.
Outcomes	The expected outcomes of the mandatory scheme relative to the status quo include: • an increase in retailer take back schemes; • a reduction in LGA collection of refrigerators; • a reduction in scavenger collection of refrigerators for scrap metal; • a reduction in the amount of shredder floc going to landfill; • an increase in the recovery of plastics due to disassembly; • an increase in the volume of metals sold; and • an increase in refrigerant gas recovered for destruction and/or reuse.

Source: RAC Working Group 2014, Feasibility of Product Stewardship for End-of-Life Domestic Refrigerators and Air Conditioners (Draft Options Paper), version 2, issued to KPMG in May 2014.

The implications of this option on recovery of materials from refrigerators and air conditioners are illustrated in the diagrams that follow and outlined in further detail in Appendix B.

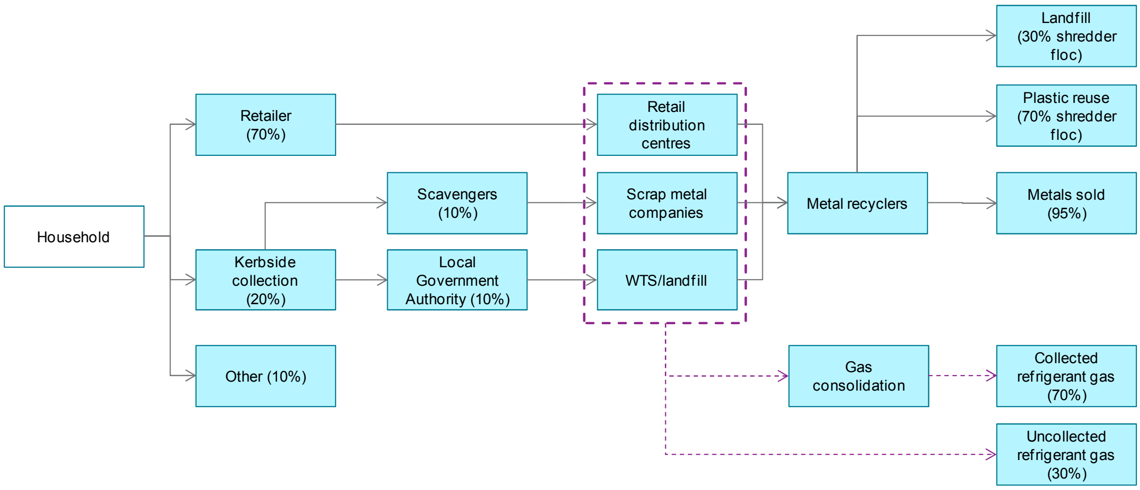
Figure 3-8: Recovery pathways for air conditioners, option 3



NOTE: Shaded boxes represent a shift from the status quo.

Source: Department of the Environment and industry consultation

Figure 3-9: Recovery pathways for refrigerators, option 3



NOTE: Shaded boxes represent a shift from the status quo.

Source: Department of the Environment and industry consultation

4 Identification and Quantification of Costs and Benefits

Table 4-1 identifies the costs and benefits used in the economic appraisal. Economic costs and benefits were quantified where market values were available. Other economic costs and benefits were discussed qualitatively.

Table 4-1: Costs and benefits of product stewardship options

Cost/Benefit	Description	Bearer/ Beneficiary	Quantified	Source of information
Costs:				
Cost of regulatory compliance	Under each of the proposed schemes there will be a cost associated with ensuring compliance with the scheme. Costs will include establishment of the accreditation system and ongoing monitoring. The costs of compliance vary depending on the specific requirements of the option and the number of participants.	Government, Industry	Yes	Department of the Environment Industry Consultation
Cost of additional recovery activities (e.g. retailer take back schemes)	As the disposal of RAC equipment becomes more regulated, the proportion of materials recovered for recycling increases. There is a cost associated with recovering refrigerant gas, metals and plastics including costs associated with transportation, disassembly and degassing.	Industry	Yes	Industry Consultation
Benefits:				
Reduction in landfill and associated waste management costs and environmental externalities.	The proposed product stewardship options aim to reduce the volume of waste sent to landfill. This reduction ranges from 7.5 per cent under the voluntary scheme to 70 per cent under the mandatory scheme. There are significant savings associated with a reduction in waste management costs and environmental externalities as the volume to landfill reduces.	Industry, Environment, Community	Yes	BDA Group (2009), *The full cost of landfill disposal in Australia*, report prepared for the Department of the Environment Heritage and the Arts
Increase in resource re-use (metals and plastics)	As the overall objective of the product stewardship options promote an increase in the controlled collection of RAC	Industry, Environment, Community	Yes	Industry Consultation Rawtec (2012), *Study on South Australian Plastics*

Cost/Benefit	Description	Bearer/ Beneficiary	Quantified	Source of information
	equipment, more of the equipment can be disassembled and therefore more resources recovered for re-use.			*Packaging Resource Recovery Sector*, report prepared for Zero Waste SA.
Increase in refrigerant gas recovery	As the schemes promote an increase in the controlled collection of RAC equipment, more refrigerant gas will be able to be recovered. This is particularly applicable for refrigerators as the current recovery of gas from air conditioners is relatively high. The increase in refrigerant recovery is expected to result in an increase in payments of rebates. This is treated as a transfer payment for the purpose of the analysis.	Industry, Environment, Community	Yes	Department of the Environment
Community willingness to pay for recycling activities	Value the community places on recovering non-renewable resources. These benefits include the community's valuation for recycling to manage recovery of material, perceived health and environmental risk.	Community	Yes[16]	PricewaterhouseCoopers and Hyder Consulting (2009), *Decision Regulatory Impact Statement: Televisions and Computers*, report prepared for Environment Protection and Heritage Council
Health benefits of reduced emissions	There are a number of health implications associated with emissions and their detrimental environmental effects. A reduction in emissions has the potential to reduce these adverse health outcomes.	Community	No	

[16] Based on advice from the Department of the Environment, the societal value of a reduction in emissions was assumed to be included in the value placed on the benefit of the increase in refrigerant recovery.

4.1 Costs

Quantification of the costs under each option required development of a series of assumptions. These assumptions and the costs under each option are outlined in the following sections.

4.1.1 Cost of regulatory compliance

Costs of compliance were estimated by the Department of the Environment and through consultation with industry and include both costs to government and industry. The detailed components of the costs of compliance are outlined in Appendix C. It should be noted that if a decision were made to pursue regulatory options, the estimated costs of compliance would be investigated in more detail through the preparation of a regulatory impact statement.

The total present value of costs associated with compliance under each option over the 10 years of the analysis are outlined in Table 4-2 and described below. Annual estimates of compliance costs are outlined in Appendix D.

Table 4-2: Costs of compliance ($ million PV @ 7%) [a]

Option	$ million PV @ 7% (2014-2024)	
	Costs to Government	Costs to Industry
Option 1 – Voluntary Scheme	$1.0	$2.0
Option 2 – Co-Regulatory Approach	$14.9	$4.4
Option 3 – Mandatory Scheme	$22.7	$14.3

a Detailed costs under each option are outlined in Appendix C. Year-by-year analysis of compliance costs is outlined in Appendix D.

Source: Department of the Environment, industry consultation and KPMG analysis.

Under the voluntary scheme (option 1), the costs to government include funding for an independent chair, facilitation of workshops, consultancies and other costs. These costs are expected to be concentrated in the first two years of the scheme to assist in facilitating the establishment of the scheme. The costs to industry include costs associated with establishing voluntary accreditation such as application and assessment costs. In addition, there are a number of ongoing costs such as surveying and monitoring of scheme participants.

Under the co-regulatory scheme (option 2), there are a number of implementation costs for government, including:

- regulatory impact statement related consultation;
- regulatory impact statement related decision costs;
- stakeholder consultation costs;
- travel and training costs;
- IT system support;

- cost of lodgement with the Federal Register of Legislative Instruments (FRLI);
- legal advice; and
- staff to support the implementation.

Ongoing costs associated with the co-regulatory scheme include litigation costs, IT support, FRLI, legal costs, compliance officer costs and staff costs. The cost to industry include contract negotiation costs for the estimated 29 liable parties, logo development for the scheme, establishment costs, and ongoing costs of auditing the participants.[17]

The costs to government under the mandatory scheme are similar to the co-regulatory option although with higher upfront staffing and consultancy costs. The costs to industry under the mandatory option involve the initial cost of licensing for the 754 liable parties[18]. It is estimated that each licence holder would spend approximately 100 minutes applying for a licence. Industry costs include audit costs of $2,060 per liable party with 10 per cent of liable parties audited each year.

4.1.2 Cost of additional retailer take back activities

Retailer take back activities involve collection of end-of-life refrigerator equipment when a new refrigerator is delivered (i.e. new for old replacement). Generally, these old refrigerators are stored at the retailer's distribution centres, degassed and sent to scrap metal yards or shredders.

Equipment disposals through retailer take back schemes under each option is outlined in Table 4-3 and outlined in further detail in Appendix B.

Table 4-3: Disposals through retailer take back schemes

Option	Proportion of all Equipment Disposals
Base Case (Status Quo)	30 per cent
Option 1 – Voluntary Scheme	35 per cent
Option 2 – Co-Regulatory Approach	35 per cent
Option 3 – Mandatory Scheme	70 per cent

Source: Department of the Environment and industry consultation

Industry consultation suggests that there are a number of potential costs associated with retailer take back activities, including:

- cost of collection of equipment from household (estimated to be approximately $15-30 per unit);
- cost of degassing equipment (estimated to be approximately $15-30 per unit); and

[17] The number of liable parties under the co-regulatory option is assumed to be 29. This represents an approximate threshold of 2,000 pieces of equipment per year.
[18] Under the mandatory option, the number of liable parties is assumed to be 754. This represents an estimate of the number of licence holders who imported domestic RAC equipment averaged over a three year period.

- cost of transporting equipment to metal recycler or shredder (estimated to be $15-30 per unit).

There are potentially some economies of scale associated with higher volumes of equipment. There is some degree of uncertainty regarding the incidence of transport costs associated with retailer take-back schemes. It is expected that the cost of transport would be incurred under the base case and each option. Accordingly, the incremental cost of retailer take back activities under each option was assumed to be equivalent to the cost of collecting and degassing equipment (assumed to be $40 per unit in total). It is recognised that this potentially understates the overall costs where additional transport activity is required. Further detail on the retailer take back scheme assumptions are provided in Appendix C.

Consultation indicated that costs would likely be higher in regional areas where the rate of unit disposals is lower and distance to points of disposal are further[19]. Sensitivity analysis was undertaken to test the impact of changes in retailer take back scheme cost assumptions on the overall results of the analysis.

The costs associated with retailer take back schemes under each option, relative to the base case, over the 10 years of the analysis are outlined in Table 4-4. Annual costs are provided in Appendix D.

Table 4-4: Costs of retailer take back schemes ($ million PV @ 7%) [a]

Option	$ million PV @ 7% (2014-2024) Costs of Increased Retailer Take Back Scheme Recovery
Option 1 – Voluntary Scheme	$14.8
Option 2 – Co-Regulatory Approach	$14.8
Option 3 – Mandatory Scheme	$118.3

a It is important to note that the costs of retailer take back activities is based on information provided through consultation with industry. Detailed testing of these costs has not being undertaken as a part of this analysis.

Source: Department of the Environment, industry consultation and KPMG analysis

The costs associated with recovery through retailer take back schemes is significantly higher under the mandatory scheme. This is due to the higher rate of disposals through retailer schemes as outlined in Table 4-3 due to the regulation of retailer take back schemes. There is potential that the average cost per unit could decrease due to economies of scale as the number of units recovered increases.

There are no retailer take back schemes for air conditioners. Accordingly, all retailer take back schemes are associated with the recovery of refrigerators and freezers at end of life.

[19] Based on industry consultation as outlined in KPMG (2014)

4.1.3 Costs of disassembly

Reducing the volume of RAC equipment waste to landfill requires disassembly of the unit to recover plastics and other materials. Consultation with industry suggests that complete disassemble takes about one hour per RAC unit and costs between $20 and $30 per unit[20]. For the purpose of the analysis, the cost of disassembly was assumed to be $20 per unit. Consultation with industry suggest there may be some scope for these costs to decrease as recycling levels increase through economies of scale. This cost efficiency is reflected in the cost per unit being consistent with the lower bound of industry expectations. The proportion of units disassembled and cost of disassembly under each option over the 10 years of the analysis is outlined Table 4-5. Annual estimates of the costs of disassembly are outlined in Appendix D.

Table 4-5: RAC equipment units disassembled ($ million PV @ 7%) [a, b]

Option	$ million PV @ 7% (2014-2024)	
	RAC equipment disassembled	Cost of disassembly
Base Case (Status Quo)	0 per cent	$0.0
Option 1 – Voluntary Scheme	7.5 per cent	$21.1
Option 2 – Co-Regulatory Approach	22.5 per cent	$63.4
Option 3 – Mandatory Scheme	70 per cent	$170.5

a Based on the estimated recovery of plastics under each option as outlined in Section 3.

b It is important to note that the costs of disassembly is based on information provided through consultation with industry. Detailed testing of these costs has not being undertaken as a part of this analysis.

Source: Department of the Environment, industry consultation and KPMG analysis

The costs of disassembly are highest under the mandatory scheme (option 3). This is consistent with the activity required to achieve the significant reduction in RAC equipment materials sent to landfill. The total costs of disassembly are higher for refrigerators and freezers than for air conditioners. This reflects the larger volume of refrigerators and freezers reaching end of life over the period of analysis (2014 to 2024).

4.2 Benefits

The benefits that have been identified to occur as a result of the options are:

- avoided landfill costs (including direct costs and externality costs);
- value of the additional resources recovered from RAC equipment;
- the value of the refrigerant gas recovered;
- society's intrinsic value of a reduction in GHG emissions (consumer surplus from reduced emissions); and

[20] KPMG (2014)

- health benefits from reduced emissions.

The options could potentially have positive impacts on employment creation (e.g. due to additional recycling activity). However, these impacts are not generally included in a CBA framework.

4.2.1 Reduction in landfill

The impact of the options on the share of RAC equipment waste diverted to landfill is outlined in Table 4-6 and outlined in further detail in Appendix B.

Reducing the volume of waste diverted to landfill avoids the costs associated with managing this waste, including:

- costs of land;
- costs of on-site gas recovery and flaring;
- fencing and security;
- capping and landscaping;
- operational costs (e.g. fuel, labour and materials); and
- cost of rehabilitation and aftercare.

Table 4-6: Landfill reduction under product stewardship options

Option	Reduction in landfill relative to base case	
	Refrigerators	Air Conditioners
Option 1 – Voluntary Scheme	7.5 per cent	7.5 per cent
Option 2 – Co-Regulatory Approach	15 to 30 per cent [a]	15 to 30 per cent [a]
Option 3 – Mandatory Scheme	70 per cent	50 per cent

[a] Analysis was undertaken based on the mid-point (22.5 per cent) and sensitivity analysis undertaken for high and low values.

Source: Department of the Environment and industry consultation

A review of the costs of landfill disposal in Australia was undertaken by BDA Group in 2009. The estimated costs of landfills for small, medium and large landfills in Australia are outlined in Table 4-7.

Table 4-7: Estimated cost of landfill ($ per tonne)

Cost	Cost of landfill ($ per tonne)		
	Small (<10,000t)	**Medium (10,000 to 100,000t)**	**Large (>100,000t)**
Land	5	3	2
Approvals/site development	10	6	4
Best practice liner	13	8	5
Leachate collection	6	4	3
Gas recovery	6	4	3
Amenity management	1	1	1
Operations	34	20	14
Capping and remediation	10	8	4
Post-closure maintenance	15	9	6
Total	**100**	**60**	**40**

Source: BDA Group (2009) *The full cost of landfill disposal in Australia,* report prepared for the Department of the Environment Heritage and the Arts

A large volume of RAC equipment would likely be disposed of in large urban landfills. However, recycling rates are potentially lower in regional areas as retailer and local government schemes are likely to be less accessible. Accordingly, a large volume of RAC equipment will also be disposed of in small and medium landfills. Accordingly, for the purpose of the analysis the estimate for medium sized landfills ($60/tonne) was adopted to model the economic benefits of diverted landfill waste. This 2009 estimate was inflated to 2014 dollars ($68/tonne) based on the Consumer Price Index (CPI).

In addition to the economic costs of landfill, there are a number of environmental costs associated with waste diversion to landfill, including:

- greenhouse gas emissions;
- other gas emissions;
- leachate leakage; and
- loss of amenity.

Estimates of the environmental costs of landfill vary significantly ranging from $1 to $24 per tonne (in 2009 dollars)[21]. For the purpose of the analysis, the mid-point was adopted as the assumed environmental cost of landfill ($14 per tonne in 2014).

The benefits of avoided landfill under each option, relative to the base case over the 10 years of the analysis, are outlined in Table 4-8. Care must be taken in interpreting these costs as the

[21] BDA Group (2009) *The full cost of landfill disposal in Australia,* report prepared for the Department of the Environment Heritage and the Arts

parameters used to measure landfill waste management costs and environmental externalities are not specific to RAC equipment waste.

Consistent with the reduction in disposal of RAC equipment materials outlined in Table 4-6, the avoided waste management costs and environmental externalities of landfill are highest under the mandatory scheme (option 3). Under all options, the avoided landfill costs are higher for refrigerators and freezers than for air conditioners. This is consistent with the higher volume of refrigerators and freezers reaching end of life over the period of analysis (2014 to 2024).

Table 4-8: Avoided landfill costs (PV @ 7% $ million)

Option	PV @ 7% $ million (2014 to 2024)	
	Avoided Waste Management Costs	Avoided Environmental Externalities
Option 1 – Voluntary Scheme	$1.8	$0.4
Option 2 – Co-Regulatory Approach	$3.5	$0.7
Option 3 – Mandatory Scheme	$14.8	$3.0

Source: KPMG analysis

4.2.2 Increase in resource reuse

The expected level of metals recovery from RAC equipment at end-of-life is outlined in Table 4-9 and outlined in further detail in Appendix B. The rate of metal recovery remains consistent with the status quo under each option except the mandatory scheme. Under the mandatory scheme, the level of metal recovery is expected to be higher as a result of the increase in retailer take back schemes.

Table 4-9: Metal resource recovery rates

Option	Metal Resource Recovery Rate	
	Refrigerators	Air Conditioners
Base Case (Status Quo)	90 per cent	90 per cent
Option 1 – Voluntary Scheme	90 per cent	90 per cent
Option 2 – Co-Regulatory Approach	90 per cent	90 per cent
Option 3 – Mandatory Scheme	95 per cent	95 per cent

Source: Department of the Environment and industry consultation

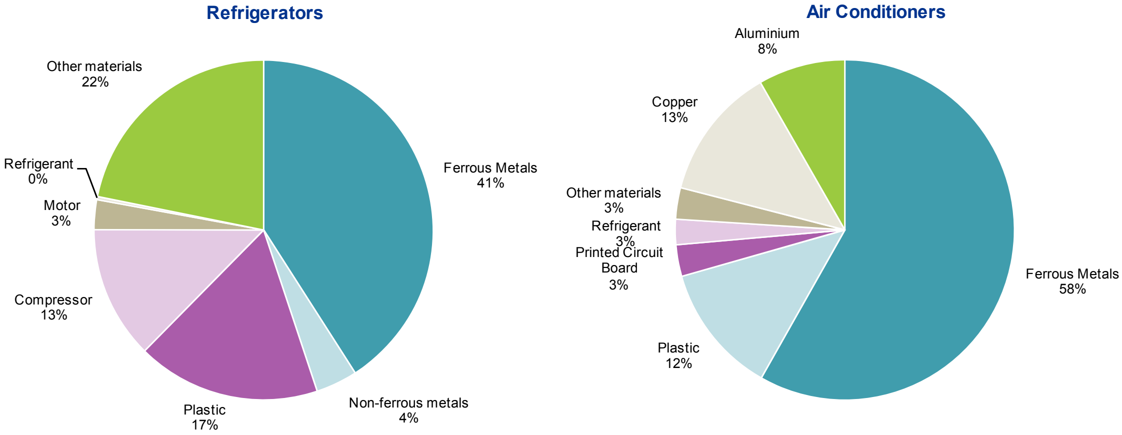
Based on industry consultation, the average value of metal resources recovered is assumed to be:

- $5,000 per tonne for copper;
- $1,400 per tonne for aluminium; and

- $140 per tonne for steel[22].

The material composition of RAC equipment is illustrated in Chart 4-1.

Chart 4-1: Material composition of RAC equipment



Source: Department of the Environment, industry consultation and KPMG (2014).

The net benefits associated with metal recovery were estimated based on the composition of RAC equipment, the average value of recovered metal resources and the volume of disposals each year (outlined in Appendix A). The net benefit over the 10 years of the analysis under each option is outlined in Table 4-10. Annual benefits are outlined in Appendix D.

Table 4-10: Metal resource recovery benefits (PV @ 7% $ million) [a]

Option	PV @ 7% $ million (2014 to 2024) Metal Resource Recovery Benefits
Option 1 – Voluntary Scheme	$0.0
Option 2 – Co-Regulatory Approach	$0.0
Option 3 – Mandatory Scheme	$30.6

[a] It is important to note that the value of metal resources is based on information provided through consultation with industry. Detailed testing of these costs has not being undertaken as a part of this analysis.

Source: Department of the Environment, industry consultation and KPMG analysis

As described in Section 2 and outlined in Table 4-9, the metal recovery rate only increases under the mandatory scheme (option 3). Accordingly, there are no incremental benefits of metal resource recovery under options 1 and 2. The incremental benefit of increasing metal recovery from RAC equipment at end-of-life from 90 per cent to 95 per cent is estimated to be $30.6 million (in present value terms). Consistent with the materials composition, the value of metals recovered is higher for air conditioners than for refrigerators and freezers.

[22] Based on consultation with industry as outlined in KPMG (2014).

Additional disassembly of RAC equipment under the options is also expected to result in an increase in recovery of other materials, including plastics. As outlined in Chart 4-1, plastics comprise 17 per cent of materials in refrigerators and 12 per cent of air conditioners. Plastics recovered can potentially be reused to manufacture new products. The value of plastic recovered varies depending on the type of plastic, the degree of separation and the level of contamination. A recent analysis of plastic recycling indicates that the current international market price for sorted and bundled scrap plastic materials is between $500 and $1,000 per tonne[23]. Consultation with industry suggests that the average price received for recovered plastics is $550 per tonne. For the purpose of the CBA and consistent with industry consultation, the value of recovered plastics was assumed to be $550 per tonne.

The net benefits associated with plastic recovery are estimated based on the composition of RAC equipment, the proportion of material recovered (based on the rate of landfill disposal), the average value of recovered plastic resources and the volume of disposals each year (outlined in Appendix A). The net benefit over the 10 years of the analysis under each option is outlined in Table 4-11. Annual benefits are outlined in Appendix D.

Table 4-11: Plastic resource recovery benefits (PV @ 7% $ million)[a]

Option	PV @ 7% $ million (2014 to 2024) Plastic Resource Recovery Benefits
Option 1 – Voluntary Scheme	$7.5
Option 2 – Co-Regulatory Approach	$22.6
Option 3 – Mandatory Scheme	$61.2

a It is important to note that the value of plastic recovered is based on information provided through consultation with industry. Detailed testing of these costs has not being undertaken as a part of this analysis.

Source: Department of the Environment, industry consultation, Rawtec (2012) and KPMG analysis

Consistent with the level of recovery of materials, the benefits associated with recovery of plastics is highest under the mandatory scheme (option 3). As expected, given the materials composition, the value of plastic recovered is higher for refrigerators and freezers than for air conditioners.

4.2.3 Increase in refrigerant recovery

The rate of recovery of refrigerant gas under each of the product stewardship options is outlined in Table 4-12 and outlined in further detail in Appendix B.

There is a legal requirement that gas used for servicing new or existing equipment must meet the specifications for new refrigerant set out by ARI 700-2004 *Specification for Fluorocarbon Refrigerants*. Consultation with industry suggests that the current level of refrigerant gas reuse is uncertain. Additionally, the product stewardship options do not include specific incentives to influence the levels of refrigerant gas reuse. Accordingly, the benefit associated with refrigerant gas reuse is not quantified in the analysis.

---

[23] Rawtec (2012), *Study on South Australian Plastics Packaging Resource Recovery Sector*, report prepared for Zero Waste SA, March

Table 4-12: Refrigerant gas recovery rates

Option	Refrigerant Gas Recovery Rate	
	Refrigerators	Air Conditioners
Base Case (Status Quo)	30-40 per cent	80 per cent
Option 1 – Voluntary Scheme	35-45 per cent	80 per cent
Option 2 – Co-Regulatory Approach	35-45 per cent	80 per cent
Option 3 – Mandatory Scheme	70 per cent	80 per cent

NOTE: Where ranges are reported the mid-point was used for the analysis and high and low ranges were included in sensitivity analysis.

Source: Department of the Environment

There are two primary benefits associated with refrigerant gas recovery:

- a reduction in refrigerant gas related environmental emissions; and
- reuse of refrigerant gas in existing RAC equipment.

The benefit of a reduction in refrigerant gas related emissions was quantified based on the international price placed on environmental emissions. Quantifying the benefit of reduced environmental emissions is based on the following:

- assumptions regarding the type of refrigerant gases that will be released over the period of analysis;
- application of the appropriate global warming potential measure; and
- application of a value of the GHG emissions to the atmosphere.

The most common refrigerant gas types have been used to calculate the environmental impact. For refrigerators, R134a has been used as it is the most common refrigerant used in domestic refrigerators during the period of analysis, accounting for 93 per cent of all stock. For air conditioners, R22 has been used as it is the most common refrigerant in domestic air conditioners during the period of analysis. Other refrigerant gases will also be found in end-of-life domestic RAC, during the period 2014-2024, however, they have been excluded from analysis[24].

Both R22 and R134a have high global warming potentials (GWP) which represents their global warming impact relative to carbon dioxide (CO_2). The GWP of the refrigerant gases are assumed to be:

- 1,810 for R22; and

[24] Expert Group 2013, *Cold Hard Facts 2: A study of the refrigeration and air conditioning industry in Australia,* report prepared for the Department of the Environment.

- 1,430 for R134a.[25]

The GWP values are calculated using the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) GWP values which Australia currently uses to report its United Nations Framework Convention on Climate Change (UNFCCC) commitments.

Global warming caused by substances such as refrigerants potentially has a number of global environmental consequences, including:

- sea-level rises;
- ocean acidification;
- change in rainfall patterns; and
- increased risk of natural disaster (including storms and droughts).[26]

In Australia, potential consequences of climate change include:

- temperature increases with more hot days and less cool days;
- an increase in the number of extreme fire weather days in southern Australia;
- higher incidence of drought in southern Australia;
- sea-level rise;
- higher intensity of tropical cyclones; and
- greater intensity and frequency of extreme rainfall days[27].

As outlined in Table 4-13, there are a number of approaches to quantifying the cost of carbon emissions.

Table 4-13: Approaches to quantifying the cost of carbon emissions

Approach	Description
Social Cost of Carbon	The full global cost of an incremental unit of carbon (or equivalent amount of other greenhouse gases) summing to the full global cost of the damages imposed over the whole of its time in the atmosphere. The social cost of carbon provides an indication of the amount society should be willing to pay now to avoid future damage caused by carbon emission.
Market Price of Carbon	The value of carbon emission rights to those in the market given the constraints on supply of these rights to emit imposed by current policy.
Marginal Abatement Cost	The cost of reducing emissions (rather than the damage imposed by creating emissions).

25 Intergovernmental Panel on Climate Change 2007, *IPCC Fourth Assessment Report: Climate Change 2007 (AR4).*
26 The Committee for Economic Development in Australia. 2014, *The Economics of Climate Change*, June.
27 CSIRO 2014, *State of the Climate 2014,* accessed at http://www.csiro.au/Outcomes/Climate/Understanding/State-of-the-Climate-2014.aspx, 1 July 2014. p.15.

Under certain assumptions, the three measures of the cost of carbon are consistent at the margin. The market price and marginal abatement cost would be expected to be broadly equal if the carbon market covers all emissions and is competitive. From an economic optimisation perspective, the optimal carbon concentration level is where the social cost of carbon is equal to the marginal abatement cost required to achieve this level. If the marginal abatement cost is below the social cost of carbon, it is cost effective to abate further. If the marginal abatement cost is above the social cost of carbon, lower abatement targets could be considered.

Based on advice from the Department of the Environment, the value of GHG emissions assumed for the analysis is equivalent to the shadow carbon price modelled for the Independent Expert Panel reviewing the RET scheme [28]. The shadow carbon price is based on the spot market price for European permits and is approximately $9.50 per tonne of carbon, escalating at 3 per cent in real terms[29]. The shadow carbon price was applied to the expected refrigerant gas recovery rates under each option and the assumed global warming potential outlined above.

The benefits of reduced environmental emissions from refrigerant gases over the 10 years of the analysis are outlined in Table 4-14. Annual benefit estimates are outlined in Appendix D.

Table 4-14: Refrigerant gas recovery emission reduction benefits (PV @ 7% $ million)

Option	**PV @ 7% $ million (2014-2024)** **Reduced environmental emissions**
Option 1 – Voluntary Scheme	$1.3
Option 2 – Co-Regulatory Approach	$1.3
Option 3 – Mandatory Scheme	$9.1

Source: Department of the Environment, industry consultation, Acil Allen 2014, *RET Review Workshop Preliminary Modelling Results,* prepared for the RET Review Panel and KPMG analysis.

Consistent with the higher level of refrigerant gas recovery, the emission reduction benefits are highest under the mandatory scheme (option 3). There is no change in the level of recovery from air conditioners, accordingly, all emission reduction benefits relate to an increase in recovery of refrigerant from freezers and refrigerators.

ODS including HCFCs are directly implicated in the depletion of the ozone layer. These gases deplete the ozone layer by releasing chlorine and bromine atoms into the stratosphere, which destroy ozone molecules. ODS also contribute to varying extents to the enhanced greenhouse effect and global warming.

Refrigerant gases containing ODS, deplete the ozone layer and increase the level of ultraviolet (UV) radiation at the surface of the Earth. The increased level of UV radiation can damage ecosystems and increase human diseases, with the extent of the impact dependant on the level of UV exposure, resulting in:

- skin cancers;
- cataracts;

[28] Australian Government 2014, *Review of the Renewable Energy Target,* https://retreview.dpmc.gov.au/
[29] Acil Allen 2014, *RET Review Workshop Preliminary Modelling Results,* prepared for the RET Review Panel.

- a weakening of the immune system; and
- detrimental effects to crops, wild plants and aquatic life[30].

All ODS produced are assumed to be released under the Montreal Protocol and the environmental and health impacts managed globally through the phase down of ODS manufacture and use, and the eventual phase out of ODS. The Montreal Protocol sets binding progressive phase out obligations for all the major ozone depleting substances, including CFCs, halons and less damaging transitional chemicals such as HCFCs. ODS are widely used in refrigerators, air conditioners, fire extinguishers, in dry cleaning, as solvents for cleaning, electronic equipment and as agricultural fumigants. Domestic RAC equipment currently sold in Australia no longer contain ODS, however ODS remains in the current stock of RAC equipment reaching end-of-life over the period of analysis (i.e. 2014 to 2024). As a result, ODS are not included in the CBA.

4.2.3.1 Health benefits of reduction in emissions

There are a number of potential health benefits and associated economic savings that may be achieved as a result of reduction in refrigerant gas emissions. These benefits include:

- improvements in health and life expectancy;
- fewer days away from work or with restricted activity;
- fewer medical consultations;
- fewer hospital admissions;
- reduced use of medication; and
- increased productivity.

Based on advice from the Department of the Environment, health benefits were assumed to be captured in the shadow price of carbon and are included in the benefits outlined in Table 4-14.

4.2.3.2 Willingness to pay

Willingness to pay captures society's value of increasing recycling activity and the resulting recovery of non-renewable resources and other non-market benefits from increasing recycling levels (e.g. consumer surplus from increased recycling). There is limited information available on the consumers' willingness to pay to recycle RAC equipment or refrigerant. There are, however, a number of studies that suggest that people are willing to pay for an increase in recycling activity. A recent analysis of the merit of a television and computer national recycling scheme included a

[30] Aucamp, P. J. and Björn, L. O., 2010, *Questions and Answers about the Environmental Effects of the Ozone Layer Depletion and Climate Change: 2010 Update*, prepared for the United Nations Environmental Programme on Environmental Effects Assessment Panel: 2010 , date: accessed 25/6/14, http://ozone.unep.org/Assessment_Panels/EEAP/eeap-report2010-FAQ.pdf

willingness to pay benefit of $0.50 per unit per percentage point increase in recycling activity. This assumption was adopted for the purpose of this analysis[31].

The willingness to pay benefits associated with the increase in recycling under each option is outlined in Table 4-15. Annual willingness to pay benefits are outlined in Appendix D.

Table 4-15: Willingness to pay benefits (PV @ 7% $million)

Option	**PV @ 7% $ million (2014-2024)** **Willingness to pay for recycling**
Option 1 – Voluntary Scheme	$0.6
Option 2 – Co-Regulatory Approach	$5.3
Option 3 – Mandatory Scheme	$52.0

Source: PricewaterhouseCoopers and Hyder Consulting (2009), *Decision Regulatory Impact Statement: Televisions and Computers*, report prepared for Environment Protection and Heritage Council and KPMG analysis.

Consistent with the higher level of recycling, the willingness to pay benefit is highest under the mandatory option (option 3). Consistent with the larger volume of equipment reaching end of life over the period of analysis (2014 to 2024), the willingness to pay benefit is larger for refrigerators and freezers than for air conditioners.

[31] PricewaterhouseCoopers and Hyder Consulting (2009), *Decision Regulatory Impact Statement: Televisions and Computers*, report prepared for Environment Protection and Heritage Council

5 Assessment of Net Benefit and Sensitivity Analysis

The following section outlines the results of the analysis, including:

- an assessment of net benefits;
- an analysis of the distribution of the costs and benefits under each option; and
- a sensitivity analysis of key assumptions.

5.1 Assessment of Net Benefit

The product stewardship options were compared with the base case using a discounted cash flow technique with a real discount rate of 7 per cent in accordance with relevant guidelines. The results of the economic evaluation are summarised in Table 5-1. Reflecting the uncertainty regarding the WTP approach, overall results are presented with and without WTP benefits included.

The NPV provides an indication of the option that provides the greatest net benefit for the whole of society. The BCR is a useful measure when faced with budget constraints as it provides an indication of efficiency of expenditure.

Table 5-1: Economic evaluation results (PV @ 7% $million 2014)

	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Costs			
Cost of regulatory compliance – government	$1.0	$14.9	$22.7
Cost of regulatory compliance – industry	$2.0	$4.4	$14.3
Retailer take back scheme	$14.8	$14.8	$118.3
Cost of disassembly	$21.1	$63.4	$170.5
Total Costs	**$39.0**	**$97.6**	**$325.8**
Benefits			
Avoided landfill costs – waste management	$1.8	$3.5	$14.8
Avoided landfill costs – environmental	$0.4	$0.7	$3.0
Metal resource recovery	$0.0	$0.0	$30.6
Plastic resource recovery	$7.5	$22.6	$61.2
Refrigerant gas recovery (emissions reduction)	$1.3	$1.3	$9.1
Willingness to pay for additional recycling	$0.6	$5.3	$52.0
Total Benefits	**$11.5**	**$33.5**	**$170.6**
Summary			
NPV ($ million) – with WTP	-$28.0	-$69.4	-$207.2

	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
NPV ($ million) – without WTP	-$28.5	-$74.7	-$259.2
BCR – with WTP	0.28	0.29	0.36
BCR – without WTP	0.27	0.23	0.20

NOTE: Totals may not sum due to rounding. All values are incremental to the base case.

Source: KPMG analysis based on sources outlined in previous section.

Under each option, the costs outweigh the benefits relative to the base case (status quo). The main drivers of the higher costs are those associated with additional retailer take back activities and disassembly of RAC equipment. The benefits under each option are largely driven by the level of resource recovery under each option, the associated reduction in landfill related costs and the value of the resources themselves. The willingness to pay benefits are also significant, particularly under the mandatory scheme. The distribution of the costs and benefits under each option are outlined in further detail in the following section.

Further, the results for each option were compared with a recent analysis of a recycling scheme in Australia. Comparison shows that the BCR for the options are similar to those observed for the analysis of the costs and directly observable benefits of a national recycling scheme for televisions and computers[32].

5.2 Distributional Analysis

The following sections outline the flow costs and benefits to different groups under each option.

5.2.1 Option 1 – Voluntary Scheme

The distribution of costs and benefits under a voluntary scheme are outlined in Table 5-2.

Under option 1, the largest costs are those associated with additional disassembly activity. As outlined in the previous section, disassembly is required to recover materials from RAC equipment and reduce the volume of shredder floc sent to landfill. Disassembly costs represent 54 per cent of the total costs under option 1 and are based on an average cost of disassembly of $20 per unit

Additional retailer take back activities account for 39 per cent of the total costs under option 1.Economies of scale could potentially be achieved in the retailer take back process. For example, the scale of recovery may warrant establishment of a third-party purpose specific service.

Costs of regulatory compliance represent 8 per cent of total costs and are largely borne by industry.

The value of plastics recovered under option 1 account for 66 per cent of the total benefits. Under option 1, benefits associated with lower emissions account for 11 per cent of the total benefits.

[32] PwC and Hyder Consulting 2009, *Decision Regulatory Impact Statement: Televisions and Computers,* report prepared for the Environment Protection and Heritage Council, October.

These benefits flow to the community and the environment in the form of avoided carbon emissions and the associated climate impacts.

In addition to the environmental benefits associated with avoided emissions, option 1 also results in a reduction in landfill related environmental externalities. These benefits represent 3 per cent of the total benefits. Savings in waste management costs, associated with lower landfill disposal, are estimated to represent 18 per cent of the total benefits under option 1.

Table 5-2: Distribution of costs and benefits, option 1 (PV @ 7% $million 2014)

	Bearer / Beneficiary	Cost/Benefit ($m)	Share of total (%)
Costs			
Cost of regulatory compliance – government	Government	$1.0	3%
Cost of regulatory compliance – industry	Industry (importers)	$2.0	5%
Retailer take back scheme	Industry (retailers)	$14.8	38%
Cost of disassembly	Industry	$21.1	54%
Total costs		**$39.0**	**100%**
Benefits			
Avoided landfill costs – waste management	Landfill operators (Local Government)	$1.8	15%
Avoided landfill costs – environmental	Environment	$0.4	3%
Metal resource recovery	Industry	$0.0	0%
Plastic resource recovery	Industry	$7.5	66%
Refrigerant gas recovery (emissions reduction)	Environment, Community	$1.3	11%
Value of additional recycling	Community	$0.6	5%
Total benefits		**$11.5**	**100%**

Source: KPMG analysis

5.2.2 Option 2 – Co-Regulatory Approach

The distribution of the costs and benefits under the co-regulatory approach is outlined in Table 5-3.

Similar to option 1, the costs of disassembly are the largest cost under the co-regulatory approach. Given the large volume of RAC equipment being disassembled under this option, efficiencies may be able to be achieved through development of specialist facilities.

Retailers are estimated to bear 15 per cent of the total costs as a result of an increase in retailer take back activity. Efficiencies and lower costs may be able to be achieved through the establishment of a third-party scheme.

Compliance costs are estimated to be 20 per cent of the total costs with the majority of these costs borne by government.

The value of plastic resources recovered account for 68 per cent of the total benefits. The remaining benefits are those associated with avoided landfill including reduced waste management costs (10 per cent of total benefits) and reduced landfill related environmental externalities (2 per cent of total costs) and environmental and community benefits associated with the increase in refrigerant gas recovery (4 per cent of total benefits). The community's willingness to pay for increased recycling levels represent 16 per cent of total benefits.

Table 5-3: Distribution of costs and benefits, option 2 (PV @ 7% $million 2014)

	Bearer / Beneficiary	Cost/Benefit ($m)	Share of total (%)
Costs			
Cost of regulatory compliance – government	Government	$14.9	15%
Cost of regulatory compliance – industry	Industry (importers)	$4.4	5%
Retailer take back scheme	Industry (retailers)	$14.8	15%
Cost of disassembly	Industry	$63.4	65%
Total costs		**$97.6**	**100%**
Benefits			
Avoided landfill costs – waste management	Landfill operators (Local Government)	$3.5	10%
Avoided landfill costs – environmental	Environment	$0.7	2%
Metal resource recovery	Industry	$0.0	0%
Plastic resource recovery	Industry	$22.6	68%
Refrigerant gas recovery (emissions reduction)	Environment, Community	$1.3	4%
Value of additional recycling	Community	$5.3	16%
Total benefits		**$33.5**	**100%**

Source: KPMG analysis

5.2.3 Option 3 – Mandatory Scheme

The distribution of the costs and benefits under the mandatory scheme is outlined in Table 5-4.

Associated with the higher recovery rates under the mandatory scheme, the costs associated with retailer take back schemes and disassembly are almost 90 per cent of the total costs. As discussed previously, there is potential that these costs could be reduced through economies of scale. The remaining costs are those associated with regulatory compliance and are borne by both government (6 per cent) and industry (4 per cent).

The benefits associated with resource recovery (metals and plastics) account for over half of the total benefits. The community's willingness to pay for higher recycling represents 30 per cent of the total benefits. Avoided landfill waste management and externality costs represent 9 per cent of the total benefits. The remaining benefits are those associated with recovery of refrigerant gases (5 per cent).

Table 5-4: Distribution of costs and benefits, Option 3 (PV @ 7% $million 2014)

	Bearer / Beneficiary	Cost/Benefit ($m)	Share of total (%)
Costs			
Cost of regulatory compliance – government	Government	$22.7	6%
Cost of regulatory compliance – industry	Industry (importers)	$14.3	4%
Retailer take back scheme	Industry (retailers)	$118.3	36%
Cost of disassembly	Industry	$170.5	52%
Total costs		**$325.8**	**100%**
Benefits			
Avoided landfill costs – waste management	Landfill operators (Local Government)	$14.8	9%
Avoided landfill costs – environmental	Environment	$3.0	2%
Metal resource recovery	Environment, Community	$30.6	18%
Plastic resource recovery	Environment, Community	$61.2	36%
Refrigerant gas recovery (emissions reduction)	Community	$9.1	5%
Value of additional recycling	Community	$52.0	30%
Total benefits		**$121.7**	**100%**

Source: KPMG analysis

5.3 Sensitivity Analysis

A series of sensitivity testing was undertaken to highlight the sensitivity of results to changes in key assumptions, including:

- discount rate;
- level of compliance/participation and associated recovery rates;
- costs associated with compliance and additional recovery activity; and
- benefits associated with avoided landfill and resource and refrigerant recovery.

5.3.1 Discount rate

Sensitivity analysis was undertaken to highlight the effect of changes in the discount rate on the results of the analysis. The results of the sensitivity analysis are presented in Table 5-5.

Table 5-5: Sensitivity analysis results- discount rate (NPV $million 2014)

	NPV $ million		
	Option 1 – Voluntary Scheme	**Option 2 – Co-Regulatory Approach**	**Option 3 – Mandatory Scheme**
Discount Rate = 7% (Central Assumption)			
NPV ($ million)	-$27.4	-$64.1	-$155.2
BCR	0.30	0.34	0.52
Discount Rate = 4%			
NPV ($ million)	-$31.4	-$72.8	-$176.7
BCR	0.30	0.35	0.53
Discount Rate = 10%			
NPV ($ million)	-$24.3	-$57.0	-$137.8
BCR	0.29	0.34	0.52

NOTE: Totals may not sum due to rounding. All values are incremental to the base case.

Source: KPMG analysis

The results of the analysis are less favourable with a lower discount rate. This is expected in this analysis given that the incremental costs under each option outweigh the benefits.

5.3.2 Level of participation and recovery

Two sets of sensitivity results are presented below representing low and high assumptions regarding selected parameters. The assumptions under each sensitivity analysis are outlined in Table 5-6.

Table 5-6: Sensitivity analysis assumptions

	Base Case (status quo)	**Option 1 – Voluntary Scheme**	**Option 2 – Co-Regulatory Approach**	**Option 3 – Mandatory Scheme**
Central Assumption				
Waste diverted to landfill – refrigerators	100 per cent	92.5 per cent	77.5 per cent	30 per cent
Waste diverted to landfill – air conditioners	100 per cent	92.5 per cent	77.5 per cent	50 per cent
Recovery of refrigerant gases - refrigerator	35 per cent	40 per cent	40 per cent	70 per cent
Recovery of refrigerant gases – air conditioners	80 per cent	80 per cent	80 per cent	80 per cent
Level of compliance and associated cost	-	15 participants	29 liable parties	754 licence holders

	Base Case (status quo)	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Low participation and recovery				
Waste diverted to landfill – refrigerators	100 per cent	95 per cent	85 per cent	40 per cent
Waste diverted to landfill – air conditioners	100 per cent	95 per cent	85 per cent	60 per cent
Recovery of refrigerant gases - refrigerator	35 per cent	35 per cent	35 per cent	65 per cent
Recovery of refrigerant gases – air conditioners	80 per cent	80 per cent	80 per cent	80 per cent
Level of compliance and associated cost	-	10 per cent lower (13 participants)	10 per cent lower (26 liable parties)	10 per cent lower (679 licence holders)
High participation and recovery				
Waste diverted to landfill – refrigerators	100 per cent	90 per cent	70 per cent	20 per cent
Waste diverted to landfill – air conditioners	100 per cent	90 per cent	70 per cent	40 per cent
Recovery of refrigerant gases – refrigerator	35 per cent	45 per cent	45 per cent	75 per cent
Recovery of refrigerant gases – air conditioners	80 per cent	85 per cent	85 per cent	85 per cent
Level of compliance and associated cost	-	10 per cent higher (17 participants)	10 per cent higher (32 liable parties)	10 per cent higher (829 liable parties)

The results under the sensitivity analysis are outlined in Table 5-7. The results of the sensitivity analysis include the willingness to pay benefits.

Table 5-7: Sensitivity analysis results- participation and recovery (NPV @ 7% $million 2014)

	NPV @ 7% $ million		
	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Central Assumption			
Total Costs ($ million)	**$39.0**	**$97.6**	**$325.8**
Total Benefits ($ million)	**$11.5**	**$33.5**	**$170.6**
NPV ($ million)	-$27.4	-$64.1	-$155.2

	NPV @ 7% $ million		
	Option 1 – Voluntary Scheme	**Option 2 – Co-Regulatory Approach**	**Option 3 – Mandatory Scheme**
BCR	0.30	0.34	0.52
Low participation and recovery			
Total Costs ($ million)	**$29.8**	**$70.0**	**$275.7**
Total Benefits ($ million)	**$5.7**	**$17.4**	**$121.1**
NPV ($ million)	-$24.0	-$52.6	-$154.6
BCR	0.19	0.25	0.44
High participation and recovery			
Total Costs ($ million)	**$41.7**	**$105.9**	**$323.5**
Total Benefits ($ million)	**$27.5**	**$53.7**	**$167.2**
NPV ($ million)	-$14.3	-$52.2	-$156.4
BCR	0.66	0.51	0.52

NOTE: Totals may not sum due to rounding. All values are incremental to the base case.

Source: KPMG analysis

Under the lower rates of participation and recovery, costs under each option are lower due to lower costs of regulatory compliance (lower levels of participation) and the reduction in recovery activities and associated costs of disassembly. The benefits under each option are also lower due to the lower level of recovery of plastics and refrigerant gas and higher level of landfill relative to the central assumptions.

Under the higher rates of participation and recovery, the costs under each option are higher than under the central assumptions due to higher costs of regulatory compliance (higher levels of participation) and a high rate of recovery of materials and associated costs. The benefits under each option are also higher, in particular the higher recovery of plastics (lower landfill).

5.3.3 Costs associated with compliance and recovery activities

Sensitivity analysis was undertaken to highlight the effect of changes in costs under each option. The results of the analysis are summarised in Table 5-8.

Table 5-8: Sensitivity analysis results- costs (NPV @ 7% $million 2014)

	Option 1 – Voluntary Scheme	**Option 2 – Co-Regulatory Approach**	**Option 3 – Mandatory Scheme**
Central Assumption			
Total Costs ($ million)	$39.0	$97.6	$325.8
Total Benefits ($ million)	$11.5	$33.5	$170.6
NPV ($ million)	-$27.4	-$64.1	-$155.2

	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
BCR	0.30	0.34	0.52
Lower costs (-15 per cent)			
Total Costs ($ million)	$33.1	$82.9	$276.9
Total Benefits ($ million)	$11.5	$33.5	$170.6
NPV ($ million)	-$21.6	-$49.5	-$106.3
BCR	0.35	0.40	0.62
Higher costs (+15 per cent)			
Total Costs ($ million)	$44.8	$112.2	$374.6
Total Benefits ($ million)	$11.5	$33.5	$170.6
NPV ($ million)	-$33.3	-$78.7	-$204.1
BCR	0.26	0.30	0.46

NOTE: Totals may not sum due to rounding. All values are incremental to the base case.

Source: KPMG analysis

Sensitivity analysis highlights that despite a 15 per cent reduction in total costs, the costs of each option still outweigh the relative benefits.

5.3.4 Benefits associated with avoided landfill and resource and refrigerant recovery

Sensitivity analysis was undertaken to highlight the effect of a change in the benefits under each option. The results of the analysis are outlined in Table 5-9.

As expected, an increase in benefits under each option increases the NPV and BCR. However, costs under each option still outweigh the benefits.

Table 5-9: Sensitivity analysis results- benefits (NPV @ 7% $million 2014)

	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Central Assumption			
Total Costs ($ million)	$39.0	$97.6	$325.8
Total Benefits ($ million)	$11.5	$33.5	$170.6
NPV ($ million)	-$27.4	-$64.1	-$155.2
BCR	0.30	0.34	0.52
Lower benefits (-15 per cent)			
Total Costs ($ million)	$39.0	$97.6	$325.8
Total Benefits ($ million)	$9.8	$28.4	$145.0

	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
NPV ($ million)	-$29.2	-$69.1	-$180.8
BCR	0.25	0.29	0.45
Higher benefits (+15 per cent)			
Total Costs ($ million)	$39.0	$97.6	$325.8
Total Benefits ($ million)	$13.2	$38.5	$196.2
NPV ($ million)	-$25.7	-$59.1	-$129.6
BCR	0.34	0.39	0.60

NOTE: Totals may not sum due to rounding. All values are incremental to the base case.

Source: KPMG analysis

6 Summary and Next Steps

The following section provides a summary of findings of the analysis and outlines the potential next steps.

6.1 Summary of Results

Analysis of costs and benefits and their distribution found that:

- The costs exceed the benefits under each option. The costs are largely driven by the costs of additional retailer take back and disassembly activity required to achieve the higher levels of material recovery under each option. These costs could potentially be reduced through economies of scale or through the establishment of a purpose specific third-party recovery scheme.
- Under all options the costs are borne by industry and government and benefits flow to the community, industry and the environment.
- The largest source of benefit under each option are those associated with increasing recovery of materials.
- Given the increases in refrigerant gas recovery under each option, the viability of the options are potentially largely sensitive to the value placed on the recovery of these gases (and associated avoided emissions).

6.2 Next Steps

As outlined in Section 1, the CBA forms part of a broader process of investigating options for treatment of domestic RAC equipment at end-of-life. The purpose of the CBA is to measure the economic, environmental and social costs and benefits of preliminary product stewardship options developed by industry and the Department of the Environment. The analysis will be used to inform advice to government on the feasibility of product stewardship approaches for end-of-life RAC. Following consideration by government on whether to proceed with investigating product stewardship options, there are a number of steps required:

- identification of priority options and further development;
- regulatory Impact Statement of preferred option(s) and Government consideration;
- identification of implications of options and mitigation strategies; and
- product stewardship implementation.

In addition to investigating product stewardship options, the Department is undertaking a separate review of the Ozone Acts. The purpose of the Ozone Act review is to:

- identify opportunities to improve and streamline the operation of the Ozone Acts including reducing regulatory compliance costs for business and the community; and

- identify opportunities to reduce emissions of ozone depleting substances and synthetic greenhouse gases in line with international efforts.

Appendix A – Base Case Assumptions

The definition of the base case that forms the basis of the CBA is formed on the following:

- The draft options paper, prepared by the RAC Working Group, 2014, *Feasibility of Product Stewardship for End-of-Life Domestic Refrigerators and Air Conditioners*, version 2, issued by KPMG on 29 May 2014, (the 'options paper')
- The KPMG, 2014, *End-of-life domestic refrigeration and air conditioning equipment in Australia*, prepared for the Department of the Environment (the 'RAC EOL report')
- The KPMG Model Assumptions report, *Cost Benefit Analysis for Domestic RAC Equipment at End-of- Life*, prepared for the Department of the Environment and presented at the RAC CBA industry workshop held on 13 June 2014
- The findings of the RAC CBA industry workshop held on 13 June 2014.

The base case was formed from the Draft Options Paper and the RAC EOL report. This base case was presented to and discussed with the industry working group at the workshop, held on 13 June 2014. A number of concerns about the base case were raised in the workshop, and were subsequently addressed and incorporated in the final base case included in the CBA.

The following sections outline the specific assumptions included in the base case, including:

- The life span of the RAC equipment;
- The treatment of industry trends; and
- Material composition and treatment of RAC equipment at EOL.

Life span of the RAC equipment

The period under investigation (the analysis period, 2014 – 2024) looks at the waste composition of RAC equipment at end-of-life. This is a function of the rate at which domestic RAC equipment enters the household (stock) and the life span of the stock.

Based on the RAC EOL report (KPMG, 2014), the average life span of RAC equipment is 10 to 21 years, or a mean time of between 14 to 18 years, see Appendix Table A1. Hence, stock is assumed to commence exiting a household around 10 to 21 years after purchase.

Appendix Table A1: Parameters of the life span functions for each RAC category

	Refrigerators	Freezers	Air conditioners
Distribution	Beta		Normal
Lifespan	10 – 25 years	13 – 25 years	10 – 21 years
Mean time in stock	17 years	18 years	14 years

	Refrigerators	Freezers	Air conditioners
Source(s)	Commonwealth Government, *Major Appliances Material Project*, 2001 ABS 4602.2, 2011 Stakeholder interviews	Commonwealth Government, *Major Appliances Material Project*, 2001 Stakeholder interviews	Energy Efficient Strategies, *Status of Air Conditioners in Australia*, 2006 Expert Group, *Cold Hard Facts 2*, 2013 Energy Strategies, *ODS and SGGs in Australia*, 2008

Source: Appendix C, Table 9, the RAC EOL report (KPMG, 2014)

Treatment of industry trends

Several concerns were raised in the options paper about the composition of waste materials for end-of-life domestic RAC equipment that formed presented in the RAC EOL report.

Several questions were raised at the workshop in regards to the proposed material composition of RAC equipment at EOL that will be applied in the cost benefit analysis (CBA) over the period of analysis, from 2014 – 2024.

These were raised and discussed at the workshop and resolved as outlined in the following table:

Appendix Table A2: Composition of waste materials

Industry trends	Consideration
Refrigerant Gases	
Transitioning to low GWP alternatives	Industry is transitioning to low global warming potential (GWP) alternatives, which will be accelerated by the phase down of hydrofluorocarbons (HFCs) in Europe and potentially North America. The replacement of SGGs with refrigerant gases with a low GWP will reduce the quantity of SGGs refrigerant gases, and hence quantities that are recovered. While this will impact the use of refrigerants in Australia, changing the type and GWP of refrigerant gases.
Decommissioning practices	A proportion of the refrigerant charge in air conditioners maybe lost prior to decommissioning. Rate of refrigerant recovery may be lower due to behavioural practices when decommissioning. The MA Report assumes an 80% recovery rate of air conditioning refrigerant gases. Consultation with industry working group advised that the estimated refrigerant gas recovery rate when the technician is involved, are difficult to determine, hence it is proposed that a sensitivity analysis is undertaken to reflect this uncertainty.
Rebate	A query was raised at the workshop in relation to the impact increasing the refrigerant gas recovery rebate may have on EOL recovery rates of refrigerant gases. The effect of changing the rebate may increase the recovery and destruction of gases. However, it is unlikely that the rebate will impact volume of refrigerant that is recovered for reuse by technicians. For the purpose of the CBA, the RRA funded rebate is treated as a transfer payment between government and industry and is not included in the analysis.

Carbon price	The carbon price is treated consistently across all the options, including the base case. The Australian Government repealed the carbon price with effect 1 July 2014 and the impact of the repeal is expected to be consistent across options. The repeal of the carbon price is expected to reduce the cost of new refrigerants which may cause a decline in the demand for "second hand" refrigerant gases. Subsequently, the relative proportion of refrigerant gases that are destroyed will increase and the portion of refrigerant gases reused will reduce. As such this will have nil impact on the relative proportion of gas recovered between options. The effect of this could be a reduction in the reuse and recovery of refrigerant gases, however overall, this would have no net impact on the incremental costs or benefits of the options. For the purpose of the analysis the CBA assumes the carbon price does not apply as the current status quo.
Affected by global refrigerant prices	The following assumption taken from the RAC EOL report (KPMG, 2014) will need to be adjusted: *"Based on estimated refrigerant recovery rates per unit at end-of-life (40% for refrigerators and freezers and 80% for split air conditioners), refer to report section 2.1, Table 1: Estimated refrigerant recovery rates for RAC equipment"* Workshop advised there is no significant impact. Therefore no change to the base case in the RAC EOL
Leakage rates lower	A proportion of the refrigerant charge in air conditioners maybe lost prior to decommissioning. The RAC EOL report (KPMG, 2014) takes into account initial charge and leakage rates by assuming the quantity of refrigerant that remains at end of life as outlined in Appendix C. Therefore no change to the base case in the RAC EOL.
Insulating foam	
Quantities of foam	Foam blowing agent may contain ODS, SGG or pentane. Blowing agent is released when waste foam is shredded. The 2005 MEPS has resulted in an increase in the thickness of the insulating foam: • 15 year old air conditioner is likely to have an energy efficiency rating of 2 • A new air conditioner is likely to have a rating of 7. A query was raised regarding the foam content in refrigerants and the following were suggested as being appropriate (KPMG, 2013): • Content of foam 5 % to 10% by volume • Type of foam blowing agent due to changes to pentane in the late 1992 – 1994. The values applied in the RAC EOL materials report aligns with the values raised in the workshop. Therefore no change is required to the proposed base case.
Hazardous Materials	
Phase out of heavy metals	The European Union Directive is expected to influence the refrigerator and freezer waste stream in Australia. A phase out of heavy metals under the European Union RoHS Directive that took effect on 1 July 2006. This will create a gradual decline of heavy metals in the RAC waste stream by 2024. Analysis assumes the effect of the European Union RoHS Directive will be a reduction in hazardous materials, hence no changes required to the waste material composition. Therefore no change is required to the proposed base case.

Plastics	
Increased volume of plastics	The volume of plastic in RAC equipment has and is expected to continue to increase relative to metal. The value of resources which can be recovered from EOL, may become uneconomical for metal recyclers. The RAC EOL report (KPMG, 2014) has assumed that the material composition of the RAC equipment is static (i.e. no change to the material composition over time). Workshop advised that the assumption regarding increasing the plastic content is appropriate.

Material composition and treatment of RAC equipment at EOL

The bank of RAC equipment that will reach EOL and enter the disposal chain is based on the material composition of equipment purchased 10 to 25 years prior. The current market trends affecting the composition of the RAC equipment purchased today, will commence entering the waste stream after 2024. Hence, the waste material composition of RAC equipment over the analysis period is based on existing stock.

Under the status quo scenario it is assumed the majority of RAC equipment finds its way to the metal recyclers where it is shredded, forming plastic floc and shredded metal. The metal is recycled, shredder floc is sent to landfill and a proportion of refrigerant gases are collected.

There is no significant disassembly of RAC equipment. Where this may occur, it is predominately for split or ducted air conditioning units which have appreciable scrap metal value, and hence incentive for separation. Scrap metal merchants are more likely to receive and on-sell separated metals from RAC equipment. It is not cost effective to manually disassemble refrigerators.

Along the disposal pathway the recovery rates of refrigerant gases varies, for air conditioners recovery is high, but lower for domestic refrigerators and freezers at end-of-life.

Shredded metals

Shredded metal comprises mainly ferrous metal (iron and steel), non-ferrous metals (mainly copper and aluminium) comprise only 1% to 2% of shredded metal. Most scrap metal is exported to China and South East Asia, but some recycled steel is used in the Victorian and New South Wales steel mills (the RAC EOL report, KPMG, 2014).

Shredder floc

There are no significant exports of shredded plastic waste or floc, as they have no saleable value. All shredder floc is currently disposed of to landfill. Shredding of polyurethane foam will release blowing agents into the atmosphere, including fluorinated compounds in older appliances.

Refrigerants gases

It is estimated 30% – 40% of the refrigerant gases collected from EOL refrigerators are collected (KPMG, 2014). Recovery rates are significantly affected by the activities of “scavenger” parties collecting RAC equipment from the kerbside and other points in the disposal chain. They sell directly to metal recycles. No recovery of refrigerant gases is assumed when scavengers are involved (KPMG, 2014). Recovery rates for air conditioners are much greater. A licensed service technician is generally involved in installation, they collect refrigerant from the obsolete unit.

Technicians remove the refrigerant charge more than 80 per cent of the time when they are replacing an air conditioner. The refrigerant is then sent to Refrigerant Reclaim Australia (RRA) for destruction (via a refrigerant wholesaler) or is collected for reuse.

Foam blowing agent

Domestic refrigerators contain approximately 5 to 10 kg of insulating polyurethane foam, about 5% by weight of blowing agent (the RAC EOL report, KPMG, 2014). It is likely the blowing agent is released on shredding due to the increase in surface area, heat of shredding, and the breakdown of the encapsulating metal or plastic structure of the appliance (the RAC EOL report, KPMG, 2014). 2013). Insulating foam will be collected as a part of shredder floc (the RAC EOL report, KPMG, 2014).

Refrigerators manufactured prior to 1995 are likely to contain chlorofluorocarbons (CFCs) as blowing agents. These compounds have since been phased out and replaced to some extent by hydrochlorofluorocarbons (HCFCs) and later by hydrofluorocarbons (HFCs). The higher cost of these gases and the phase out of HCFCs has led to the widespread use of hydrocarbons such as pentane.

Appendix B – Recovery Pathways

Appendix Table B 1: Recovery pathway, air conditioners

	Base Case (status quo)	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Landfill	100 per cent	92.5 per cent	70-85 per cent	50 per cent
Plastic Re-use	0 per cent	7.5 per cent	15-30 per cent	50 per cent
Metals Sold	90 per cent	90 per cent	90 per cent	90 per cent
Collected Refrigerant	80 per cent	80 per cent	80 per cent	80 per cent

Source: Department of the Environment

Appendix Table B 2: Recovery pathway, refrigerators

	Base Case (status quo)	Option 1 – Voluntary Scheme	Option 2 – Co-Regulatory Approach	Option 3 – Mandatory Scheme
Retailer	30 per cent	35 per cent	35 per cent	70 per cent
Kerbside/Booked Collections	60 per cent	55 per cent	55 per cent	20 per cent
- Scavengers	30 per cent	25 per cent	25 per cent	10 per cent
- Local Councils	30 per cent	30 per cent	30 per cent	10 per cent
Other	10 per cent	10 per cent	10 per cent	10 per cent
Landfill	100 per cent	92.5 per cent	70-85 per cent	30 per cent
Plastic Re-use	0 per cent	7.5 per cent	15-30 per cent	70 per cent
Metals Sold	90 per cent	90 per cent	90 per cent	90 per cent
Collected Refrigerant	30-40 per cent	35-45 per cent	35-45 per cent	70 per cent

Source: Department of the Environment

Appendix C – Assumptions and Parameter Values

Compliance Costs

Appendix Table C 1: Government costs of compliance ($2014), Option 1

Description	Type of cost	Cost per annum
Independent chair	Initial (2 years)	$75,000
Workshop fees	Initial (2 years)	$16,128
Consultancy	Initial (2 years)	$57,000
Travel	Initial (2 years)	$3,930
Staff cost (EL1 – 1 FTE)	Initial (2 years)	$158,000
Staff cost (EL2 – 1 FTE)	Initial (2 years)	$194,000

Source: Department of the Environment

Appendix Table C 2: Industry costs of compliance ($2014), Option 1

Description	Type of cost	Cost per annum
Project manager	Ongoing	$150,000
Application for voluntary accreditation under the *Product Stewardship Act*		
Independent financial viability assessment	Initial (1year)	$20,000
Consultant to prepare application for voluntary accreditation	Initial (1year)	$40,000
Application fee	Initial (1year)	$26,600
Scheme activities		
Secretariat and survey costs	Ongoing	$24,000
Conference costs	Ongoing	$5,000
Staff overhead costs	Ongoing	$3,100
Workshops	Ongoing	$3,000
Auditing of participants	Ongoing	$30,900
Travel	Ongoing	$10,480
Logo development and trademark certification	Initial (1year)	$5,800
Communications	Ongoing	$15,700

Source: Department of the Environment

Appendix Table C 3: Government costs of compliance ($2014), Option 2

Description	Type of cost	Cost per annum
Travel	Initial (3 years)	$12,000
Training	Initial (1 year)	$28,980
Consultation (RIS)	Initial (1 year)	$170,000
Decision (RIS)	Initial (1 year)	$250,000
Consultancies	Initial (1 year)	$200,000
Stakeholder consultation	Initial (1 year)	$126,000
IT systems	Initial (1 year)	$180,000
FRLI lodgement	Initial (1 year)	$5,000
Specialist legal advice	Initial (1 year)	$55,000
Staff Cost (EL1 – 4 FTEs)	Initial (3 years)	$632,000
Staff Cost (EL2 – 1 FTE)	Initial (3 years)	$194,000
Staff Cost (APS 6 – 1 FTE)	Initial (3 years)	$131,000
Staff Cost (APS 5 – 1 FTE)	Initial (3 years)	$115,000
Litigation costs	Ongoing	$50,000
IT system development	Ongoing	$180,000
FRLI	Ongoing	$5,000
Specialist legal advice	Ongoing	$55,000
Compliance officers	Ongoing	$405,000
Staff cost (EL1 – 1 FTE)	Ongoing	$158,000
Staff cost (EL2 – 0.5 FTE)	Ongoing	$97,000
Staff cost (APS 6 – 2 FTEs)	Ongoing	$262,000
Staff cost (APS 5 – 1 FTE)	Ongoing	$115,000

Source: Department of the Environment

Appendix Table C 4: Industry costs of compliance ($2014), Option 2

Description	Type of cost	Cost per annum
Logo development	Initial (1 year)	$5,800
Contract negotiation	Initial (1 year)	$2,000 per participant $58,000 (total)
Website	Initial (1 year)	$17,000
Legal	Initial (1 year)	$20,000
Conference cost	Ongoing	$5,000
Workshop	Ongoing	$3,000
Auditing of participants	Ongoing	$2,060 per participant $30,900 total
Travel	Ongoing	$10,480
Communication	Ongoing	$15,700
Reporting	Ongoing	$1,500 per participant $43,500 total
Website maintenance	Ongoing	$6,000
Database management	Ongoing	$15,000
Insurance	Ongoing	$5,000
Other	Ongoing	$20,000
Staff cost – CEO	Ongoing	$150,000
Staff cost – Marketing and education	Ongoing	$75,000
Staff cost – Administration	Ongoing	$50,000
Staff cost – Operations	Ongoing	$90,000
Staff costs – On costs	Ongoing	$3,100

Source: Department of the Environment and industry consultation

Appendix Table C 5: Government costs of compliance ($2014), Option 3

Description	Type of cost	Cost per annum
Travel	Initial (3 years)	$12,000
Training	Initial (1 year)	$28,980
Consultation (RIS)	Initial (1 year)	$170,000
Decision (RIS)	Initial (1 year)	$250,000
Consultancies	Initial (1 year)	$500,000
Stakeholder consultation	Initial (1 year)	$126,000
IT systems	Initial (1 year)	$180,000
FRLI lodgement	Initial (1 year)	$5,000
Specialist legal advice	Initial (1 year)	$55,000
Staff Cost (EL1 – 4 FTEs)	Initial (3 years)	$632,000
Staff Cost (EL2 – 1 FTE)	Initial (3 years)	$194,000
Staff Cost (APS 6 – 3 FTE)	Initial (3 years)	$393,000
Staff Cost (APS 5 – 1 FTE)	Initial (3 years)	$115,000
Litigation costs	Ongoing	$200,000
IT system development	Ongoing	$180,000
FRLI	Ongoing	$5,000
Specialist legal advice	Ongoing	$55,000
Compliance officers	Ongoing	$810,000
Staff cost (EL1 – 2 FTE)	Ongoing	$316,000
Staff cost (EL2 – 0.5 FTE)	Ongoing	$97,000
Staff cost (APS 6 – 3 FTEs)	Ongoing	$393,000
Staff cost (APS 5 – 1 FTE)	Ongoing	$115,000

Source: Department of the Environment

Appendix Table C 6: Industry costs of compliance ($2014), Option 3

Description	Type of cost	Cost per annum
Logo development	Initial (1 year)	$5,800
Licence cost	Initial (1 year)	$89 per participant $66,855 (total)
Website	Initial (1 year)	$17,000
Legal	Initial (1 year)	$20,000
Conference cost	Ongoing	$5,000
Workshop	Ongoing	$3,000
Auditing of participants	Ongoing	$2,060 per participant $155,324 total
Travel	Ongoing	$10,480
Communication	Ongoing	$15,700
Reporting	Ongoing	$1,500 per participant $1,131,000 total
Website maintenance	Ongoing	$6,000
Database management	Ongoing	$30,000
Insurance	Ongoing	$5,000
Other	Ongoing	$20,000
Staff cost – CEO	Ongoing	$150,000
Staff cost – Marketing and education	Ongoing	$75,000
Staff cost – Administration	Ongoing	$50,000
Staff cost – Operations	Ongoing	$90,000
Staff costs – On costs	Ongoing	$3,100

Source: Department of the Environment and industry consultation

Retailer take back activity

Appendix Table C 7: Retailer take back scheme costs ($2014)

Description	Cost per unit
Cost of collecting equipment from household	$20
Cost of degassing equipment	$20
Total cost per unit	**$40**

Source: KPMG (2014) and industry consultation

Appendix Table C 8: Retailer take back scheme costs [a]

Option	Equipment recovered	Refrigerators recovered (2014)	Refrigerators recovered (2014)	Air conditioners recovered (2014)	Air conditioners recovered (2014)
Base Case	0 per cent	232,497	344,590	164,894	262,624
Option 1	7 per cent	271,247	402,021	192,376	306,395
Option 2	22.5 per cent	271,247	402,021	192,376	306,395
Option 3	70 per cent	542,493	804,042	384,752	612,790

[a] Based on the estimated recovery by retailers under each option and RAC equipment disposals outlined in Section 3.

Source: Department of the Environment, industry consultation and KPMG analysis

Disassembly

Appendix Table C 9: Disassemble scheme costs [a]

Option	Equipment disassembled	Refrigerators disassembled (2014)	Refrigerators disassembled (2014)	Air conditioners disassembled (2014)	Air conditioners disassembled (2014)
Base Case	0 per cent	-	-	-	-
Option 1	7 per cent	54,249	80,404	38,475	61,279
Option 2	22.5 per cent	174,373	258,442	123,670	196,968
Option 3	70 per cent	542,493	804,042	384,752	612,790

[a] Based on the estimated recovery of plastics under each option and RAC equipment disposals outlined in Section 3.

Source: Department of the Environment, industry consultation and KPMG analysis

Appendix D – Summary of Costs and Benefits by Year

Appendix Table D 1: Costs and benefits, Option 1 ($ million 2014)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Costs											
Cost of regulatory compliance – government	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cost of regulatory compliance – industry	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Retailer take back scheme	1.5	1.6	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.2	2.3
Cost of disassembly	2.0	2.2	2.4	2.6	2.7	2.8	3.0	3.0	3.1	3.1	3.0
Total Costs	**4.4**	**4.5**	**4.3**	**4.5**	**4.7**	**5.0**	**5.2**	**5.3**	**5.5**	**5.5**	**5.6**
Benefits											
Avoided landfill costs – waste management	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Avoided landfill costs – environmental	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
Metal resource recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Refrigerant gas recovery (emissions reduction)	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Plastic resource recovery	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1
Value of additional recycling (WTP)	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Benefits	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.5**	**1.6**	**1.6**	**1.7**	**1.7**	**1.7**

Source: KPMG analysis

Appendix Table D 2: Costs and benefits, Option 2 ($ million 2014)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Costs											
Cost of regulatory compliance – government	3.4	2.5	2.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Cost of regulatory compliance – industry	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Retailer take back scheme	1.5	1.6	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.2	2.3
Cost of disassembly	6.0	6.6	7.1	7.7	8.1	8.5	8.9	9.1	9.2	9.2	9.1
Total Costs	**11.6**	**11.2**	**11.9**	**11.2**	**11.8**	**12.3**	**12.7**	**13.0**	**13.2**	**13.3**	**13.3**
Benefits											
Avoided landfill costs – waste management	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Avoided landfill costs – environmental	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Metal resource recovery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Refrigerant gas recovery (emissions reduction)	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Plastic resource recovery	2.1	2.4	2.6	2.8	2.9	3.1	3.2	3.2	3.3	3.2	3.2
Value of additional recycling (WTP)	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9
Total Benefits	**2.6**	**2.9**	**3.2**	**3.4**	**3.6**	**3.8**	**3.9**	**4.0**	**4.1**	**4.1**	**4.0**

Source: KPMG analysis

Appendix Table D 3: Costs and benefits, Option 3 ($ million 2014)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Costs											
Cost of regulatory compliance – government	3.4	2.5	2.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Cost of regulatory compliance – industry	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Retailer take back scheme	12.4	12.7	13.1	13.6	14.3	15.0	15.8	16.6	17.3	17.9	18.4
Cost of disassembly	16.3	17.8	19.2	20.4	21.6	22.7	23.6	24.3	24.7	24.9	24.8
Total Costs	**34.0**	**34.7**	**36.5**	**37.1**	**39.0**	**40.8**	**42.5**	**43.9**	**45.1**	**45.9**	**46.3**
Benefits											
Avoided landfill costs – waste management	1.4	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.2
Avoided landfill costs – environmental	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Metal resource recovery	2.6	3.1	3.5	3.9	4.1	4.3	4.4	4.5	4.4	4.2	4.0
Refrigerant gas recovery (emissions reduction)	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.5	1.6
Plastic resource recovery	5.9	6.4	6.9	7.4	7.8	8.2	8.5	8.7	8.8	8.8	8.8
Value of additional recycling (WTP)	4.5	4.9	5.3	5.8	6.3	6.8	7.3	7.8	8.3	8.7	9.0
Total Benefits	**11.0**	**12.2**	**13.4**	**14.4**	**15.3**	**16.0**	**16.6**	**17.0**	**17.2**	**17.2**	**17.0**

Source: KPMG analysis