



Australian Government

Department of the Environment and Energy

Emissions reduction options for synthetic greenhouse gases

Contributing to Australia's 2030 emissions reduction target

Regulation Impact Statement

April 2016

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Abbreviations and acronyms

B/C	benefit to cost ratio
CBA	cost-benefit analysis
CFC	chlorofluorocarbon
CH ₄	methane
CO ₂	carbon dioxide
CO ₂ -e	carbon dioxide equivalent
ERF	Emissions Reduction Fund
EU	European Union
GWP	global warming potential
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
HFO	hydrofluoro olefin
ISO	International Organization for Standardization
IWG	Interdepartmental Working Group
MAC	Mobile Air Conditioning
Montreal Protocol	<i>Montreal Protocol on Substances that Deplete the Ozone Layer</i>
Mt	metric tonne

N ₂ O	nitrous oxide
NPV	net present value
OBPR	Office of Best Practice Regulation
ODS	ozone depleting substance
OPSGGM	Ozone Protection and Synthetic Greenhouse Gas Management
PFC	perfluorocarbon
RAC	refrigeration and air conditioning
Rb	regulatory burden estimate
RBM	regulatory burden measurement
Rb/t	regulatory burden estimate per tonne
RIS	Regulation Impact Statement
SF ₆	sulfur hexafluoride
SGG	synthetic greenhouse gas
the Act	<i>Ozone Protection and Synthetic Greenhouse Gas Management Act 1986</i>
the Department	Department of the Environment and Energy
TWG	Technical Working Group
UNFCCC	United Nations Framework Convention on Climate Change

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Executive Summary

This Regulation Impact Statement (RIS) examines options to reduce emissions of hydrofluorocarbons (HFCs) by 85 per cent from 2016 levels by 2036. HFCs are a sub group of synthetic greenhouse gases (SGGs) contributing between 1–2 per cent of Australia's carbon equivalent emissions. The reduction of HFCs will contribute to the Australian Government's broader target to reduce greenhouse gas emissions by 26–28 per cent below 2005 levels by 2030. Current Australian consumption is 7.82 Mt CO₂-e (based on the average consumption between 2011 and 2013), and the objective is to reduce this by 85% to 1.17 Mt CO₂-e by 2036.

This RIS has been prepared by the Australian Government Department of the Environment and Energy (the Department) on behalf of the Commonwealth, in consultation with other Commonwealth Agencies and primary stakeholders. It follows the Office of Best Practice Regulation's *Australian Government Guide to Regulation* and builds on the Options Paper published by the Department in October 2015.

What is the Policy Problem?

In the lead up to the Paris United Nations Climate Conference in December 2015, the Government committed to reducing Australia's carbon emissions to 26–28 per cent below 2005 levels by 2030. As part of this announcement the Government committed to looking to fast track work to reduce domestic hydrofluorocarbon (a sub-group of SGGs) emissions specifically by 85 per cent from 2016 levels by 2036, in-line with the most ambitious phase-down proposals under the *Montreal Protocol on Substances that Deplete the Ozone Layer* (the Montreal Protocol).

Hydrofluorocarbons (HFCs) are a sub-group of SGGs which are greenhouse gases. HFCs have been specifically identified for possible policy action at the Montreal Protocol, to which Australia is a party, as they are powerful greenhouse gases. The Australian Government has identified them for possible earlier domestic action as they are widely used in the Australian economy by virtue of being the main gases used in the refrigeration, air conditioning and fire protection industries. HFCs constitute between 1–2 per cent of Australia's carbon-equivalent emissions. Current Australian consumption is 7.82 Mt CO₂-e in 2016, and the objective is to reduce this to 1.17 Mt CO₂-e by 2036.

Policy intervention in these sectors is expected to have a positive environmental impact due to their scope, covering residential to commercial buildings to the cold-food sector. In 2012 it was estimated there were more than 45 million individual pieces of equipment operating in Australia, with some 20,000 business involved in their sale, installation or maintenance. The refrigeration and air conditioning, and fire protection industries, the primary users of HFCs, have a history of successfully working with Government to reduce the use of environmentally damaging substances.

Nature and extent of the problem—Hydrofluorocarbons

Hydrofluorocarbons (HFCs) are SGGs, the manmade subset of greenhouse gases. Greenhouse gases insulate the Earth and prevent the sun's heat from escaping, meaning the Earth stays warm and enables life to exist and thrive. Many greenhouse gases occur naturally in the atmosphere, such as methane and

carbon dioxide. However the concentration of these gases has increased throughout the industrial era due to the burning of fossil fuels and changes in land use practices. The vast majority of the world's atmospheric scientists agree that the build up of anthropogenic greenhouse gases in the atmosphere is changing the planet's heat balance, which in turn is affecting global temperature and rainfall patterns.

HFCs are generally present in the atmosphere at low concentrations however they have a measurable impact on climate change because they typically have very high Global Warming Potential (GWP). GWP is a relative measure of how much heat a greenhouse gas traps in the atmosphere compared to a similar mass of carbon dioxide. Most commonly used SGGs have very high GWPs. The most common SGG used in Australia is HFC-134a, which has a GWP of 1430¹, meaning that it is 1430 times as potent in the atmosphere as carbon dioxide.

HFCs are used in a range of applications including refrigeration and air conditioning, fire protection, aerosols, electricity distribution, foams, medical and veterinary applications, smelting, solvents, niche processing applications (such as plasma etching and semi-conductor manufacture), and for laboratory and analytical purposes.

Health and Environmental Impacts

HFCs are either emissive in their designed use (e.g. fire extinguishers and aerosols) or inherently emissive in the equipment they are contained in (e.g. refrigeration and air conditioning systems will leak due to sudden equipment failure and or more slowly as pipe joints are weakened through mechanical vibrations). HFCs can be recovered from equipment when it reaches end of life. However, given the dispersed nature of applications using SGGs (i.e. it is used in small quantities in high numbers of equipment); the volume of SGGs recovered is generally low. Approximate recovery rates from different applications are included in the modelling supporting this RIS.

This means that it is assumed their full GWP will be released into the atmosphere over the course of their lifetime, contributing to global warming.

The prediction of future health impacts (from climate change) is a challenge because of the highly complex relationships that exist between humans and their environment. The links between a climate variable and a health impact can be very direct, such as physical injuries suffered during an extreme event or increases in respiratory symptoms during high temperature events. Other links are indirect and complex and require careful consideration of the chain of events that lead from climate variable to health impact².

HFC use in Australia

The prevalence in Australia of HFCs is a direct consequence of the global effort to reduce emissions of ozone depleting substances, which commenced in the 1990s. HFC are now the dominant gases used in the refrigeration and air conditioning sector, and constitute between 1–2 per cent of Australia's carbon-equivalent emissions. Direct spending in the refrigeration and air conditioning sector is equivalent to

1 All GWPs in this report are based on the IPCC's 4th Assessment report unless otherwise stated.

2 The Department of Health, WA, 2008 Report: Health impacts of climate change

0.7 per cent of Australia's gross domestic product. An overall expenditure figure of some \$26.2 billion was spent on equipment and services in 2012. Air conditioning is estimated to be installed in the majority of Australia's 8 million homes and in the majority of the 16 million registered road vehicles. Around 173,000 people are employed in more than 20,000 businesses operating in the sector.

A reduction of SGGs in this industry, due to its overall size and proportion of Australia's economy, means it is considered an opportunity for successful implementation of cost effective emissions reductions policies.

Regulation of HFC use in Australia

Australia regulates the manufacture, import, export, and domestic 'end-use' (handling, storage, transport) of HFCs and equipment containing these gases through import, export and end-use licensing systems under the Ozone Protection and Synthetic Greenhouse Gas Management (OPSGGM) Programme, established in 1989. HFCs were included in the OPSGGM Programme in 2003 following Australia's ratification of the United Nations Framework Convention on Climate Change.

The future of HFC use in Australia

While feedback from some stakeholders consulted disputes this view, the majority of stakeholders consider that Australia is a 'technology taker', notwithstanding that different technologies have been adapted from markets in Asia, Europe and North America to suit local conditions.

In the recent past, HFC use has been increasing as domestic air conditioning becomes more prevalent and the phase-out of HCFCs (hydrochlorofluorocarbons, a group of gases being phased out under the Montreal Protocol) nears completion. In the future, HFC use is expected to decline as alternative technologies become more cost-effective.

Why is Government action needed?

Carbon emissions are associated with a wide range of economic activities, such that private decisions of business and individuals are likely to increase emissions roughly in line with economic growth. If unpriced, the costs of those emissions are borne by the global community, rather than the person who makes the emission decision. The Government can use a range of policy instruments to ensure that Australia meets its emission reduction targets. The choice of instrument varies depending on the application or industry concerned. This RIS explores the most efficient and cost-effective policy instruments relevant to the applications and industries that use SGGs.

Objectives of Government action

The objectives of Government action are to implement cost effective policy options to reduce HFC emissions by 85 per cent by 2036.

Options for Government action

Emissions occur as a result of designed use, leakage and sub-standard decommissioning. There is a causal relationship between imports of bulk gas, imports of charged equipment and eventual emissions (as emissions are assumed at the point of production).

Therefore, options that (a) reduce imports of gas, whether bulk or in charged equipment, (b) prevent leakage in service, and (c) capture and destroy gas from charged equipment at end of life, could address the problem.

The following Options have been developed in discussions between the Department and industry stakeholders following these principles.

Option 1—No Additional Regulation

Option 1 (no additional regulation) represents the scenario in which government maintains current policy and there is an emphasis, through communication and education, on maximising the emissions reduction potential of current policies and practices.

Option 2—Legislated HFC phase-down (reduction of imports of bulk gases)

A legislated phase-down of bulk imports of HFCs would work to reduce emissions of HFCs through a decreasing total allowable amount that may be imported into Australia over a prescribed time period. The restriction on imports is administered through a quota system. Figure 1 shows the different reduction pathways.

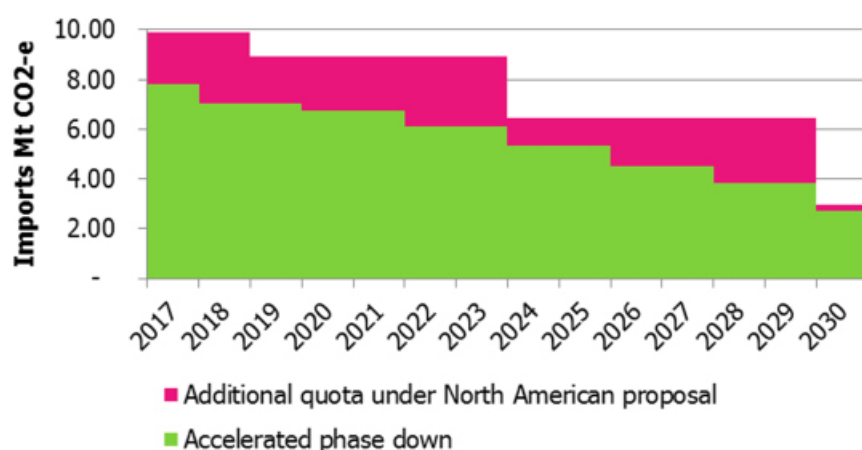
Option 2a—North American HFC phase-down proposal

Under this proposal, the phase-down leads to a gradual reduction from current levels to 15 per cent of current levels post 2036. The initial quota is at 90 per cent of the baseline in 2019, 65 per cent in 2024 and 30 per cent by 2030.

Option 2b—Accelerated alternative

The accelerated proposal considers stronger early reductions from current levels, smaller more frequent reductions in total quota and finally tapering to the same 15 per cent residual by 2036.

Figure 1: Greenhouse gas reduction pathways under HFC phase-down scenario



Option 3—Bans on HFC pre-charged equipment

Certain types of equipment are banned from import into Australia based on the GWP value of the gases they are pre-charged with and the availability of alternatives. Banning certain types of equipment is a direct way to move the market towards alternative and new technologies, as opposed to a phase-down which aims to do so through influencing the behaviour of manufacturers into decisions to move to new (and hopefully low GWP) alternatives.

Option 3a—Supermarket equipment bans

Ban supermarket equipment containing gas with GWP >2500 from 2020. This scenario has been developed around HFC-404a which, even though it represented only 3 per cent of bulk imports in 2013, by volume, its high GWP of 3800 means that it has a significant climate impact.

Option 3b—Mobile air conditioning bans

Bans on imports of mobile air conditioning equipment containing gas with GWP >150 and with a date of manufacture from 2017. This ban would see the Australian motor vehicle market maintain pace with international markets which have adopted similar policies, noting that motor vehicle air conditioning is seen as a single global platform by motor vehicle manufacturers.

Option 4—Domestic equipment controls

Mandatory equipment maintenance requirements could reduce emissions, both directly (through avoided leakage of SGGs) and indirectly via reductions in electricity use. This would reduce demand for bulk HFC, rather than limiting its availability (as in option 2).

Option 4a—Mandatory leak testing

Regular leak testing on all large equipment (remote and supermarket, medium to large air conditioning and large automotive systems).

The schedule of leak testing required follows Regulation (EU) No. 517/2014, and varies depending on the size of the gas charge in the equipment.

Option 4b—Mandatory maintenance

Regular maintenance on all large equipment (remote and supermarket, medium to large air conditioners and large automotive systems), in accordance with ISO 5149-4.

Maintenance would be required to be completed as per the schedule for leak testing and would cover energy performance aspects beyond refrigerants such as fans and filters.

Impact Analysis of Options

Summary of impact analysis

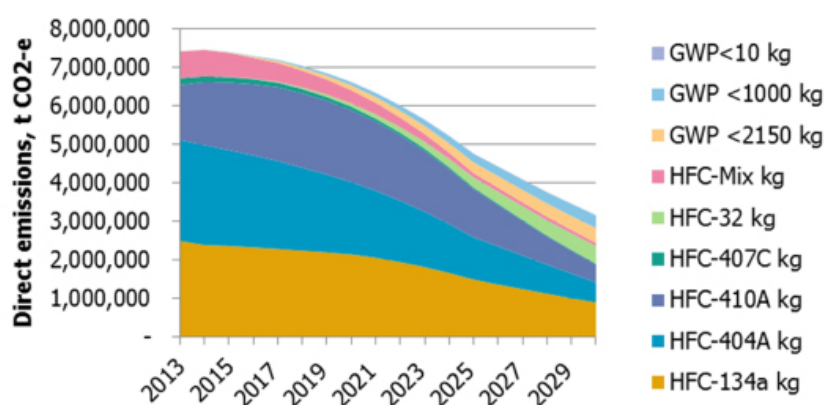
Each option was analysed to determine potential emissions reductions compared the base case of no additional policy intervention to the mechanisms in place under the OPSGGM Programme.

This was done through independent consultancies undertaken by Expert Group as part of the Environmental Impact Analysis of the Ozone Protection and Synthetic Greenhouse Gas Management Programme and Jacobs Consultancies as part of their cost-benefit analysis (CBA) by first establishing a business as usual scenario and using an industry model to make forward projections of consumption. Emissions from use and the bank of equipment and gas in Australia were then estimated based on this. Costs and benefits of the options have been quantified in a formal CBA and these are used to compare options with each other and determine their net benefit.

Option 1—No additional regulation

Even if no additional regulation is introduced, the quantities of Australia's HFC emissions are expected to decrease over the analysis period. Figure 2 shows the expected trajectory under the 'business as usual' scenario.

Figure 2: (also referred to in Section 5 as figure 8) Projected base case emissions, excluding HCFCs, Mt CO₂-e



Source: Expert Group source database

Figure 2 is based on the Expert Group reference scenario for 2016, it therefore uses a baseline of 7.31 Mt CO₂-e as opposed to the 7.82 Mt CO₂-e baseline accepted for this RIS. It has been used by Jacobs in the CBA to visually represent the reference scenario of expected trajectory of HFC emissions without policy intervention.³

This is because emissions of HFCs, in carbon dioxide equivalent (CO₂-e) terms, are expected to fall over time due in large part to improved containment, a more skilled workforce and changing technology driving an existing trend to adopt non-HFC refrigerants, with a predicted transition from high-GWP gases to lower or no-GWP alternatives.

Option 1 is based on the business as usual reference scenario analysed in the cost-benefit analysis for comparison to Options 2, 3 and 4.

Option 2—Legislated HFC phase-down (reduction of imports of bulk gases)

³ Cost Benefit Analysis, Jacobs, 2015, pp 28

Option 2 has an overall net benefit, ranging from \$10 million to \$40 million, depending on how rapidly HFC is phased out.

Option 2a—North American HFC phase-down proposal

Option 2a is expected to result in emissions reduction of approximately 3.99 Mt CO₂-e over the period 2017–2036. Its benefits over the period 2016–2030 exceed its costs, with a net present value of \$40 million.

Regulatory burden estimated to be **\$4.19 million** per annum.

Option 2b—Accelerated alternative

Option 2b is expected to result in emissions reduction of approximately 9.15 Mt CO₂-e over the period 2017–2036. Its benefits over the period 2016–2030 exceed its costs, with a net present value of \$10 million.

Implementation of option 2a and 2b would be done so as to ensure that there are no anti-competitive impacts, such that all potential participants in Australia's HFC market have equal opportunity to access the limited amount of import quota.

Regulatory burden estimated to be **\$11.72 million** per annum.

Option 3—Bans on HFC pre-charged equipment

In terms of net benefit, Option 3 has mixed results.

Option 3a—Supermarket equipment bans

Option 3a is expected to result in emissions reduction of approximately 0.28 Mt CO₂-e over the period 2017–2036. While that achievement is very small, the benefits of this option clearly outweigh its costs, with a net benefit of \$4 million.

Regulatory burden estimated to be **\$0.05 million** per annum.

Option 3b—Mobile air conditioning bans

Option 3b is expected to result in emissions reduction of approximately 6.14 Mt CO₂-e over the period 2017–2036. However, its costs exceed its benefits, with a net present value of -\$182 million.

Regulatory burden estimated to be **\$31.57 million** per annum.

Option 4—Domestic equipment controls

These options achieve the largest emissions reductions, but they do so at very high cost and/or with higher risk.

Option 4a—Mandatory leak testing

Option 4b delivers large expected emissions reduction of approximately 21.63 Mt CO₂-e over the period 2017–2036. While, based on reasonable assumptions, the benefits of this option could exceed its costs, with a net present value of \$106 million; the ratio of benefits to cost is so marginal that the option presents a high risk of negative results.

Regulatory burden estimated to be **\$111.98 million** per annum

Option 4b—Mandatory maintenance

Option 4a is the option with the largest expected emissions reduction of approximately 70.19 Mt CO₂-e over the period 2017–2036. However, Option 4a imposes unacceptably high costs on the owners of charged equipment, such that costs exceed benefits with a net present value of -\$342 million.

Regulatory burden estimated to be **\$430.0 million** per annum

Summary of Emissions Reduction Pathways of Options 1, 2, 3 & 4

Figure 3 and Figure 4 depict the emissions reduction pathways of each option compared to Option 1. Figure 4 depicts the final years of projections to clearly show the difference between options. Option 3a is not shown as it overlaps with BAU such that they are not discernable for the purpose of this graph.

Figure 3: Direct (leakage) emissions against BAU 2017–2030

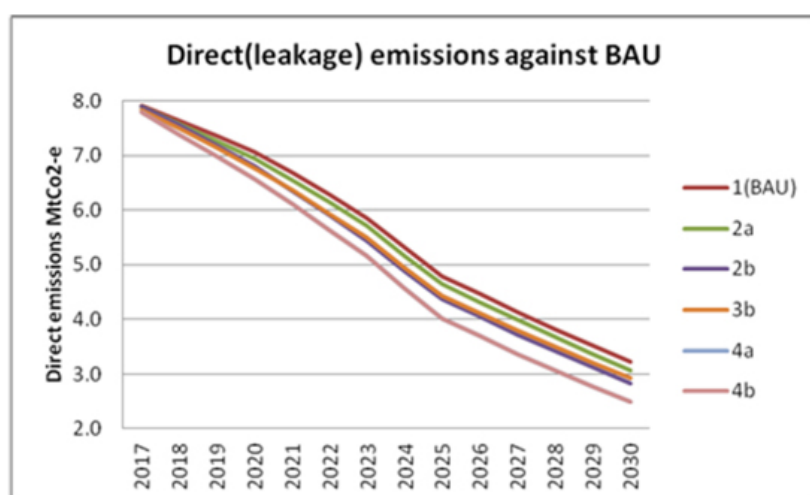
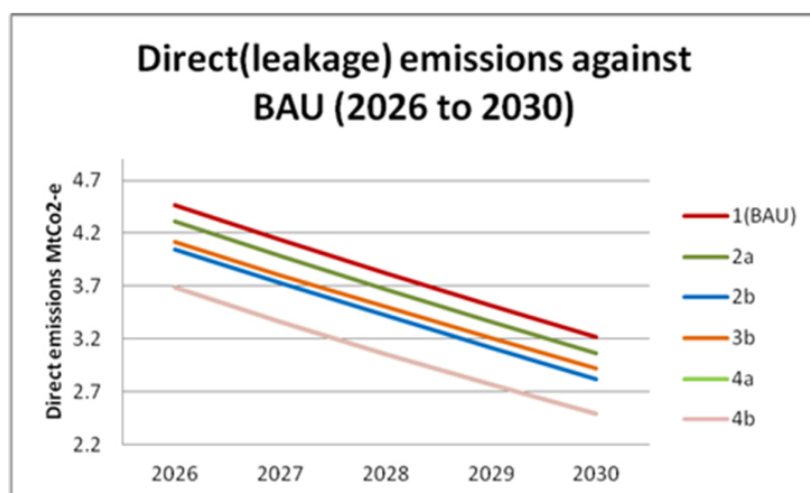


Figure 4: Direct (leakage) emissions against BAU 2026–2030



Consultation

Comprehensive consultation has been undertaken as part of wider consultation on the Review of the Ozone Protection and Synthetic Greenhouse Gas Management Programme. Consultation has included two public consultation periods, first on the Terms of Reference to the review, then the Options Paper; convening of a Technical Working Group as well as an Interdepartmental Working Group; and targeted consultation with stakeholders specifically relating to emissions reduction options.

38 submissions were received on the emission reduction options, covering the majority of sectors that use HFCS—importers, manufacturers, wholesalers, the refrigerated food industry, through to technicians installing and maintaining equipment. The majority supported the implementation of all options as a way to ensure maximum emission reduction and provide certainty for the industry. This is shown in the fact that 35 submissions supported Option 1, education and better enforcement of current policies, however 28 of these also supported additional policies, whether Option 2, 3 or 4. A minority of submissions preferred no additional policies be undertaken.

Best Option

The option with the highest net present value and that is robust under a range of assumptions is recommended for implementation to contribute to the Government's carbon emissions commitment.

This showed that option 2a (the HFC phase-down of bulk gas imports based on the North American amendment proposal) with a net present value of \$39.67 million, delivers a positive net benefit across a wide range of conditions and thus has a low level of risk.

Regulatory burden is estimated to be **\$4.19 million** per annum.

Implementation

Option 2a implementation will involve detailed design of both elements of the phase-down:

1) the HFC phase-down, including the baseline for total imports allowed, the step-down intervals and values, and

2) quota allocation, including to ensure that all potential importers, including new entrants, have a fair opportunity to obtain quota, for example by an open market auction.

It is further proposed that the policy be implemented outlining other review triggers such as reported detrimental impacts of the policy on Australian industry.

Other options found to have a positive net benefit will be assessed for potential implementation as part of the review of Option 2a implementation.

Review and evaluation

The recommended policy will be reviewed at five year intervals to determine the effectiveness of the policy. This will include consideration of:

- The pace of the phase-down.
- Other policy options to support the phase-down.

Overview of the Regulation Impact Statement

Report structure

The RIS is structured as follows:

[Section 1](#) provides the purpose and policy context for this RIS.

[Section 2](#) describes the problem that governments are seeking to address, and identifies current regulatory arrangements and core stakeholders.

[Section 3](#) establishes the principles and objectives of government action.

[Section 4](#) describes the policy options for consideration in this RIS.

[Section 5](#) outlines the impact analysis that has been undertaken, as well as the Regulatory Burden Measurement for each of the proposed options.

[Section 6](#) summarises consultation during the development of this RIS.

[Section 7](#) summarises the proposed implementation and review processes for the preferred policy option.

Section 1

Purpose

This Regulation Impact Statement (RIS) examines options to reduce emissions of hydrofluorocarbons (HFCs) by 85 per cent from 2016 levels by 2036. HFCs are a sub group of synthetic greenhouse gases (SGGs). Reducing emissions of HFCs will contribute to the Australian Government's broader target to reduce greenhouse gas emissions by 26–28 per cent below 2005 levels by 2030. In order to verify its recommendation, a cost-benefit analysis (CBA) has also been prepared to understand the performance of the options against a broader set of benefits. It is not the objective of this RIS to establish the net benefits of Australia's particular economy-wide emissions target.

The commitment to reducing HFC emissions as part of the broader 2030 target was informed by an Options Paper, outlining a CBA of HFC emission reduction options as part of the Review of the Ozone Protection and Synthetic Greenhouse Gas Management (OPSGGM) Programme. The Options Paper was published for public comment in October 2015.

The objectives of the Review, in train since May 2014, were to find opportunities for emissions reduction as well as efficiency and effectiveness gains within the OPSGGM Programme. The Options Paper summarised 18 months of in-depth analysis and two independent consultancies, including a CBA, exploring potential policies to reduce HFC emissions.

Recommendations on efficiency and effectiveness opportunities are outside the scope of this RIS. The preferred option outlined in this RIS has however been considered with the view of implementation alongside the efficiency and effectiveness recommendations stemming from the review to ensure the most robust implementation of the preferred option.

This RIS has been prepared by the Australian Government Department of the Environment and Energy (the Department) on behalf of the Commonwealth, in consultation with other Commonwealth Agencies and primary stakeholders. It follows the Office of Best Practice Regulation's (OBPR) *Australian Government Guide to Regulation* and builds on the Options Paper published by the Department in October 2015.

Section 2

What is the policy problem

In the lead up to the Paris United Nations Climate Conference in December 2015, the Government committed to reducing Australia's carbon emissions to 26–28 per cent below 2005 levels by 2030. Australia's target poses a challenge because total emissions are projected to increase without further policy action. Without taking account of abatement from the Government's emissions reduction policies, domestic emissions are projected to be 724 Mt CO₂-e₄ in 2029–2030, a 30 per cent increase on 1999–2000 levels.

The Government has indicated it will meet this target through a suite of targeted policies, including action to reduce the domestic use of HFCs. The Government has announced that "Australia will look to fast track work to reduce domestic HFC emissions by 85 per cent by 2036, in-line with the most ambitious phase-down proposals under the Montreal Protocol". This inclusion was informed by an options paper on the expected costs and benefits of HFC emission reduction policy options being explored for inclusion in the OPSGGM Programme, developed over the course of 18 months of in-depth analysis.

HFCs are SGGs used principally in refrigeration, air conditioning and fire protection applications and were introduced as substitutes ozone depleting substances (ODS), which have been phased out under the OPSGGM Programme. The refrigeration and air conditioning industry is the major industry, using over 80 per cent of all HFCs. HFCs are powerful greenhouse gases and are sometimes thousands of times more potent than carbon dioxide.

HFCs are being targeted for policy action as they comprise the vast majority of SGG emissions in Australia. Other synthetic greenhouse gases—perfluorocarbons (PFCs) and sulfur hexafluoride (SF₆)—constitute only a very small portion of emissions and are not considered in the RIS.

Modelling undertaken by Expert Group in the 2015 report: *Assessment of environmental impacts from the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*⁵, indicates there are currently a range of alternatives to SGGs gases in most applications, or that alternatives are in development and could soon be introduced to the Australian market. The implication is that, over time, the stock of equipment with high GWP will reduce and therefore emissions will reduce.

The transition to alternative chemicals has already started in major global markets and is now expanding the range of technology available to the Australian market. This includes legislation to reduce HFC emissions in the European Union (EU) through a phase-down and gas and equipment bans, and gas and equipment bans in the United States of America. These actions are encouraging global equipment manufacturers to transition to alternative gases.

4 Pg 6 Department of the Environment, Australia's emissions projections 2014–15 Report, March 2015 (<http://www.environment.gov.au/system/files/resources/f4bdfc0e-9a05-4c0b-bb04-e628ba4b12fd/files/australias-emissions-projections-2014-15.pdf>)

5 *Assessment of environmental impacts from the Ozone Protection and Synthetic Greenhouse Gas Management Act*, Peter Brodribb and Michael McCann 2014, Canberra. (<https://www.environment.gov.au/system/files/consultations/fe81135c-a55e-45b6-ae4b-ef02f1616ba2/files/ozone-acts-review-environmental-impact-analysis.pdf>)

The Expert Group model considers technology already present in the Australian market or available elsewhere in the world, and policy options to accelerate, or complement, the uptake of alternative technology at a pace that the Australian market can manage.

These industry sectors have been very responsive and successful in managing the environmental impacts of other similar chemicals. They have, in close relationship with the Government, successfully transitioned from the first generation of harmful gases, ODS gases, including the successful phase-out of chlorofluorocarbons (CFCs), and are currently in the tail-end of a phase-out of hydrochlorofluorocarbons (HCFCs). The emerging potential for low- GWP gases to cost-effectively replace SGGs represents an opportunity to make a contribution to the emission reduction target.

In consultation, major participants in these industry sectors have agreed that the proposed options are achievable.

Background

Nature and extent of the problem—Hydrofluorocarbons

Gases in the atmosphere, known as greenhouse gases, insulate the Earth. They prevent the sun's heat from escaping meaning the Earth stays warm and enables life to exist and thrive. Many greenhouse gases occur naturally in the atmosphere. Common greenhouse gases include methane (CH₄), nitrous oxide (N₂O) and carbon dioxide (CO₂). Other greenhouse gases include water vapour, fluorocarbon gases such as CFCs and HCFCs.

HFCs are type of SGG, which refers to man-made greenhouse gases. HFCs are generally present in the atmosphere at low concentrations however they have a measurable impact on climate change because they typically have very high Global Warming Potential (GWP). GWP is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of CO₂.

HFCs are used in a range of applications including refrigeration and air conditioning, fire protection, aerosols, electricity distribution, foams, medical and veterinary applications, smelting, solvents, niche processing applications (such as plasma etching and semi-conductor manufacture), and for laboratory and analytical purposes. HFCs are the common replacement for ODS. The prominence of HFCs represents an unintended consequence of the phase-out of ODS commencing in the late 1980s. While they have no ozone depleting potential, most commonly used SGGs have very high GWPs.

The most common HFCs used in Australia is HFC-134a, which has a GWP of 14306, meaning that it is 1430 times as potent in the atmosphere as CO₂. Other SGGs are even more powerful global warmers, with PFCs having GWPs between 7390–12,200 and SF₆ having a GWP of 22,800. Total SGG emissions accounted for around 1.9 per cent of Australia's annual net CO₂-e emissions (excluding emissions from land use, land use change and forestry) in 2013. By gas types, HFC emissions account for 1.8 per cent, PFCs for 0.04 per cent and SF₆ for 0.02 per cent of Australia's total annual emissions in 2013.

6 All GWPs in this report are based on the IPCC's 4th Assessment report unless otherwise stated.

Health and Environmental Impacts

HFCs are either emissive in their designed use (e.g. fire extinguishers and aerosols) or inherently emissive in the equipment they are contained in (e.g. refrigeration and air conditioning systems will leak due to sudden equipment failure and or more slowly as pipe joins are weakened through mechanical vibrations). A proportion of HFCs will be recovered and disposed of when equipment is serviced (replacing contaminated HFCs with pure HFCs) or when equipment is decommissioned at end of life.

Recovery rates are built into the emissions model supporting the OPSGGM Programme review. Australia's National Greenhouse Gas Inventory assumes annual emission rates from different classes of equipment based on standard Intergovernmental Panel on Climate Change emission rates, modified to Australia's circumstances where better data is available, and accounts for HFCs destroyed through product stewardship arrangements.

In summary, this means that it is assumed their full GWP will be released into the atmosphere over the course of their lifetime, contributing to global warming.

The prediction of future health impacts (from climate change) is a challenge because of the highly complex relationships that exist between humans and their environment. The links between a climate variable and a health impact can be very direct, such as physical injuries suffered during an extreme event or increases in respiratory symptoms during high temperature events. Other links are indirect and complex and require careful consideration of the chain of events that lead from climate variable to health impact⁷.

Australia's main HFC use—Refrigeration and air conditioning

As outlined in the Background, HFCs are used in a wide range of applications in the Australian economy. The main sector is refrigeration and air conditioning. *Cold Hard Facts 2: A study of the refrigeration and air conditioning industry in Australia*⁸ provides a detailed examination of the refrigeration and air conditioning industry in Australia. It provides information on the role of the industry and related industries and how they provide essential services within the Australian economy and how a reduction of HFC use in this industry, due to its overall size, can produce positive environmental impacts.

The report provides a snapshot of the vast scope and impact of the refrigeration and air conditioning sector on the Australian economy. The refrigerated cold food chain transports nearly \$30 billion worth of perishable food annually. There are more than 140 million square metres of air conditioned, commercial and other non-residential buildings in Australia. Air conditioning is installed in the majority of Australia's eight million homes and 16 million registered road vehicles. Nearly \$5.9 billion was spent purchasing and installing new equipment in 2012 with a further \$533 million spent on bulk refrigerant gas. An overall

7 The Department of Health, WA, 2008 Report: Health impacts of climate change

8 *Cold Hard Facts 2: A study of the refrigeration and air conditioning industry in Australia*—July 2013
<http://www.environment.gov.au/protection/ozone/publications/cold-hard-facts-2>

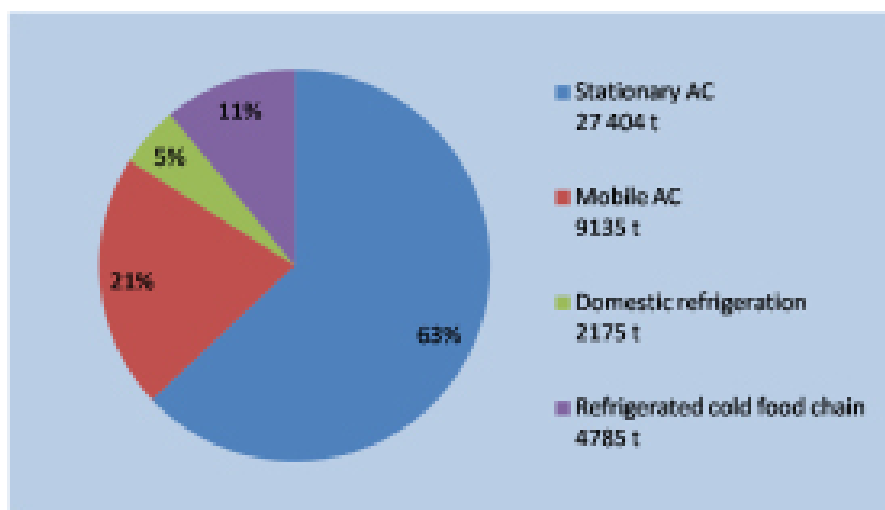
expenditure figure of some \$26.2 billion was spent on equipment and services in 2012 with the sector equating to direct spending of 0.7 per cent of Australia's gross domestic product.

The sector employs some 173,000 people in more than 20,000 businesses operating in the industry. These employees are earning approximately \$13.3 billion in wages and salaries per annum.

In terms of energy usage, refrigeration and air conditioning technology in all its forms is the single largest electricity consuming class of technology in Australia. There are more than 45 million individual pieces of equipment operating in Australia consuming more than an estimated 59,000 gigawatt hours of electricity in 2012, equivalent to more than 22 per cent of all electricity used in Australia that year. Equipment owners spent an estimated \$14 billion to pay for that electricity.

As a result of the huge quantity of electricity used and the significant stock of high-GWP refrigerant gases used, equipment is one of the largest single sources of greenhouse emissions in Australia. Total indirect greenhouse gas emissions resulting from the energy required to power systems is equivalent to more than 10 per cent of Australian greenhouse emissions.

Figure 5: Bank of refrigerants by major segment 2012 (total of 43,500 tonnes)



Source: CHF2 stock model

Regulation of HFC use in Australia

Australia regulates the manufacture, import, export, and domestic 'end-use' (handling, storage, transport) of SGGs and equipment containing these gases through import, export and end-use licensing systems under the OPSGGM Programme.

The OPSGGM Programme came into effect in 1989 and includes a suite of legislation (three Acts and three sets of Regulations⁹) and associated administrative policy. There are around 1200 import licences issued

⁹ *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
Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995
Ozone Protection and Synthetic Greenhouse Gas (Import Levy) Regulations 2004
Ozone Protection and Synthetic Greenhouse Gas (Manufacture Levy) Regulations 2004

and around 80,000 businesses and technicians licensed to trade in and handle ODS and HFCs in the refrigeration and air conditioning and fire protection industries.

As a result of a review of the OPSGGM Programme in 2001 amendments were made to the legislation in 2003 to include controls on HFCs and PFCs and an enabling power to introduce nationally consistent regulation of the sale, purchase, acquisition, disposal, storage, use handling and labelling of ODS, HFCs and PFCs. Critically, 2003 also saw the states and territories hand their power to regulate the end use of ODS and SGGs to the Commonwealth, resulting in a national scheme that is consistent across all jurisdictions. Prior to this there was little consistency between the schemes that had been administered separately by each jurisdiction, with Western Australia the only state with end use controls of HFCs.

The future of HFC use in Australia

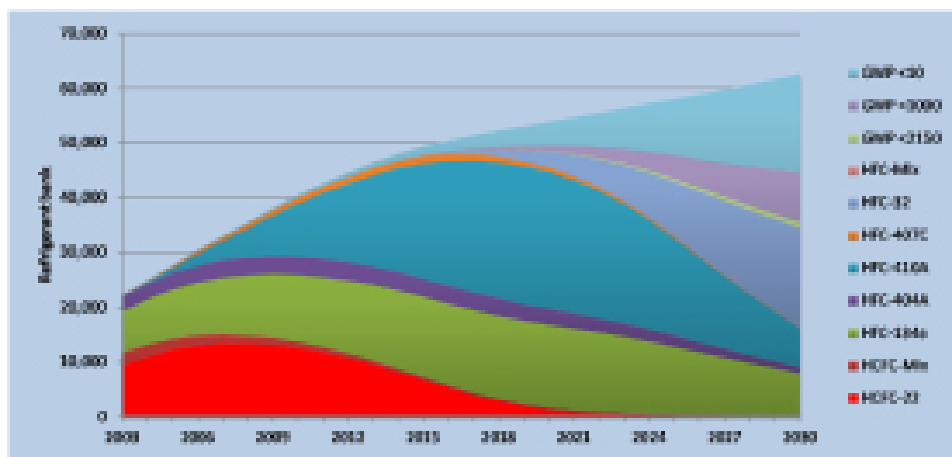
Australia is generally considered a 'technology taker', and different technologies have been adopted from markets in Asia, Europe and North America to suit local conditions.

Generally, HFC use is increasing as domestic air conditioning becomes more prevalent and the phase-out of HCFCs nears completion, while total emissions of these gases, in CO₂-e terms, are expected to fall over time. This is due in large part to improved containment, a more skilled workforce and changing technology, with a predicted transition from high-GWP HFCs to lower or no GWP alternatives. Figure 6 shows the potential refrigerant bank transition by gas species in Mt CO₂-e (IPCC Assessment Report 4—AR4).

The amount of lower GWP equipment currently entering the Australian market is relatively low, however it is increasing. For the immediate future equipment containing high GWP gases will continue to enter the Australian market, adding to the large bank of equipment already installed containing ODS and SGGs. This equipment bank requires management to reduce the emissions during life and at the end of life.

The largest sector of the existing charged-equipment bank is stationary air conditioning, while the largest annual service demand is in the mobile air conditioning sector.

Figure 6: Predicted refrigerant bank transition from 2013 to 2030 by gas species in Mt CO₂-e



Source: The data used to produce this graph was sourced by Expert Group from Departmental imports data, industry data and verified through consultation with fire protection industry representatives

Section 3

Why is Government action needed?

Carbon emissions are associated with a wide range of economic activities, such that private decisions of business and individuals are likely to increase emissions roughly in line with economic growth.

If unpriced, the costs of those emissions are borne by the global community, rather than the person who makes the emission decision.

Without the expected abatement from the Government's emissions reduction policies, Australia's overall emissions are projected to be 724 Mt CO₂-e₁₀ in 2029–2030, a 30 per cent increase on 1999–2000 levels.

The Government has a range of policy instruments available to ensure that Australia meets these commitments. For example, the Government could implement regulation for the import, manufacture or use of greenhouse gases or could provide incentives for households or businesses to purchase equipment that stops or minimises emissions. The choice of instrument varies depending on the application or industry concerned.

This RIS explores the most efficient policy instruments relevant to those applications and industries that use SGGs.

Objectives of Government action

The objectives of Government action are to:

- Implement cost effective policy options to reduce HFC emissions by 85 per cent by 2036.
- Ensure that any approach provides a net benefit to the community, while meeting the objectives of the Government's better regulation agenda by minimising the impact and costs to business/industry and individuals while meeting the first objective.

Section 4

Options for Government action

As outlined in the 'Health and Environmental Impact' section, emissions are a result of intended purpose, leakage and sub-standard decommissioning, meaning there is a causal relationship between imports of bulk gas, imports of charged equipment and eventual emissions (as emissions are assumed at the point of production).

Therefore, options that (a) reduce imports of gas, whether bulk or in charged equipment, (b) prevent leakage in service, and (c) capture & destroy gas from charged equipment at end of life, could address the problem.

The following Options have been developed in line with this methodology and are explored in depth in this section:

- Option 1—No additional regulation
- Option 2—Legislated HFC phase-down (reduction of imports of bulk gases)
 - Option 2a—North American HFC phase-down proposal
 - Option 2b—Accelerated alternative
- Option 3—Bans on HFC pre-charged equipment
 - Option 3a—Bans on commercial size supermarket equipment
 - Option 3b—Bans on mobile air conditioning equipment
- Option 4—Domestic equipment controls
 - Option 4a—Mandatory leak testing
 - Option 4b—Mandatory maintenance

Option 1 Overview—No additional regulation

Under this option no additional policies would be adopted to reduce HFCs. Rather a focus on strategic communication and education of the existing emissions reduction policies under the OPSGGM Programme would be undertaken to maximise their emission reduction potential.

Option 1 has been analysed by overlaying this emphasis on current policies onto the base case scenario developed for the cost benefit analysis for comparison with Options 2, 3 and 4. The underlying equipment stock and gas bank projections in the reference scenario were obtained from the source database developed by Expert Group. This database models significant technological change over the time period of analysis.

Option 2 Overview—Legislated HFC Phase-down (reduction of imports of bulk gases)

As outlined in Section 2, HFCs are the predominant SGGs used in Australia's economy by virtue of them being the most-used alternative to the phased-out ODS. A reduction in HFC emissions, through controls on bulk gas imports (meaning gas imported in a cylinder from which it must be transferred to be used) into the economy, is therefore considered a viable and likely cost effective method of achieving meaningful emissions reductions to contribute to Australia's broader 2030 targets.

A legislated phase-down of bulk imports of HFCs would work to reduce emissions of HFCs through a decreasing total allowable amount that may be imported into Australia over a prescribed time period. The restriction on imports is administered through a quota system. The phase-down targets all HFCs listed under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, meaning 100 per cent of the potential 1.8 per cent emissions that SGGs represent.

A restriction in the total quantity of gas in the economy is expected to induce the flow on effects of industry transition to alternative, and lower GWP gases. This method of reducing emissions through a restriction of total allowable imports has a successful track record globally, but specifically in Australia where this type of mechanism was effectively implemented to phase-out methyl bromide, CFCs, and currently HCFCs.

A phase-down of HFCs has been considered globally through the Montreal Protocol since 2009. While HFCs are traditionally monitored and managed through the UNFCCC and its Kyoto Protocol, it is generally accepted that the phase-out and phase-down mechanisms employed under the Montreal Protocol are the most effective way of reducing emissions of gases used in the types of industries and applications that HFCs are. Several phase-down designs have been developed and discussed at the Montreal Protocol level. This RIS looks at two versions of a phase-down design.

The first is the North American Amendment proposal submitted to the Montreal Protocol, considered the most ambitious of all phase-down proposals. The second is an accelerated alternative to the North American Amendment proposal. The greenhouse gas reduction pathways under each HFC phase-down scenario are defined according to different baseline definitions and total quantity step-down rates.

Option 2a—North American HFC phase-down proposal

Under the North American Amendment proposal, the baseline is 9.05 Mt CO₂-e, based on 100 per cent HFC consumption as well as 75 per cent of HCFC consumption between 2011 and 2013 (on the basis that HFCs largely replace HCFCs, the ODS currently being phased-out).

Under this proposal, the phase-down leads to a gradual reduction from current levels to 15 per cent of current levels post 2036. The initial quota is at 90 per cent of the baseline in 2019, 65 per cent in 2024 and 30 per cent by 2030.

Option 2b—Accelerated HFC phase-down

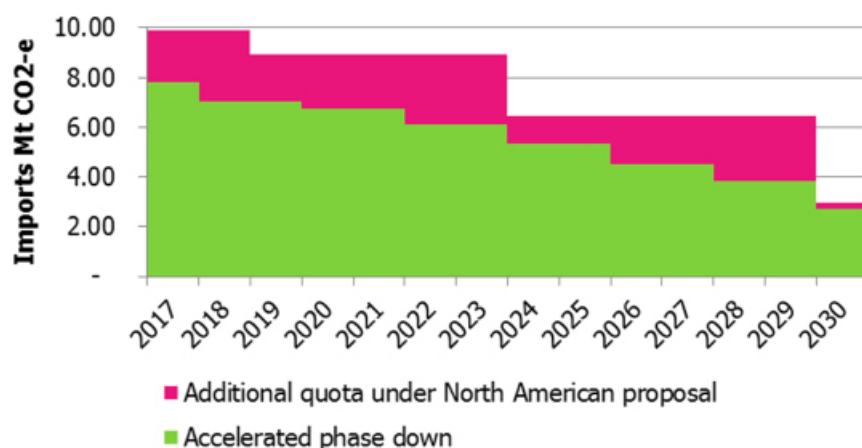
Under the Accelerated alternative, the baseline is lower at 7.82 Mt CO₂-e, based on the average consumption of HFCs between 2011 and 2013, and not accounting for HCFC imports.

The accelerated proposal considers stronger early reductions from current levels, smaller more frequent reductions in total quota and finally tapering to the same 15 per cent residual. Specifically, imports are

frozen at 100 per cent in 2017, reducing to 90 per cent in 2018, 86 per cent in 2020, 78 per cent in 2022, 68 per cent in 2024, 58 per cent in 2026, 49 per cent in 2028 and 35 per cent in 2030. This option allows less total imports over the phase-down period.

Figure 7 shows each HFC phase-down in terms of imports, expressed in millions of tonnes of CO₂-e gases.

Figure 7: Greenhouse gas reduction pathways under HFC phase-down scenario



Common characteristics

For purposes of a meaningful CBA comparison, **Options 2a** and **2b** have been analysed with the following common scenario characteristics:

- Base case is that import quotas for HFCs are not in place.
- Phase-down would include only bulk imports of HFCs (in transport cylinders or containers).
- Phase-down would include all HFCs listed under the Kyoto Protocol.
- It is assumed phase-down will be based on least cost low GWP gas alternatives being adopted. Safety and ease of handling are also important considerations in selecting gas alternatives. However, these decision criteria cannot be easily modelled.
- Implementation of a phase-down and quota allocation system would be through the existing licensing system under the OPSGGM legislation.
- Quota would be allocated through current licensing processes, similar to methods currently in use for the HCFC phase-out.
- Assume no changes to monitoring, compliance and enforcement.

Method for quota allocation

Quota is auctioned to the highest bidder

An alternative method for quota was considered, but is not recommended, due to the distributional impacts and the risk of possibly reducing competition, as discussed in *Section 7: Implementation*. Under the alternative method, quota is allocated through a hybrid grandfathered/non-grandfathered allocation system (split 90/10). This would be designed as follows:

- The grandfathered portion would be allocated free of charge to existing players in the market based on their share of historical imports, similar to the current approach for allocating HCFC quota.
- There are currently around 30 bulk importers who would be eligible for grandfathered quota.
- The non-grandfathered quota would be available to any applicant, and also allocated free of charge. An application and assessment process would need to be established in the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (the Act). For the purposes of modelling, it is estimated that five new entities would lodge an application for non-grandfathered quota for each quota period, although the European experience indicates a higher number of applications may be received.
- Quota would be allocated every two years, valid for a two year period.

Option 3 Overview—Bans on imports of HFC pre-charged equipment

Bans on imports of specified equipment are considered to be another potentially effective mechanism to cost effectively reduce SGG emissions. Under this policy option, certain types of equipment are banned from import into Australia based on the GWP value of the gases they are pre-charged with and where alternatives are commercially available. Banning certain types of equipment is a direct way to move the market towards alternative and new technologies, as opposed to a phase-down which aims to do so through influencing the behaviour of manufacturers into decisions to move to new (and hopefully low GWP) alternatives.

Overview of Option 3a—supermarket equipment bans

Bans of supermarket equipment containing gas with GWP >2500 from 2020. This scenario has been developed around HFC-404a which, even though it represented only 3 per cent of bulk imports in 2013, its high GWP of 3800 means that it has a significant climate impact. This option was developed for the purpose of this RIS based on an early assessment of its potential to achieve direct emissions reductions of up to 0.28 Mt CO₂-e between 2017 and 2036.

- There are presently 215 importers of equipment containing HFC-404A.

Overview of Option 3b—mobile air conditioning bans

Bans on imports of mobile air conditioning (MAC) equipment containing gas with GWP >150 and with a date of manufacture from 2017. This ban would see the Australian motor vehicle market maintain pace with international markets which have adopted similar policies, noting that motor vehicle air conditioning is seen as a single global platform by motor vehicle manufacturers.

- There are presently 265 importers of automotive air conditioning equipment.

Option 4 Overview—Domestic equipment controls

The third option that has been developed and assessed for cost-effectiveness is controls on equipment installed in the Australian economy through mandatory maintenance. Mandatory equipment maintenance

requirements could reduce emissions, both directly (through avoided leakage of HFCs) and indirectly via reductions in electricity use.

Two alternative forms of equipment control are discussed, each with varying levels of stringency with respect to management of leaks: (i) simple leak testing (including repair) and (ii) maintenance (which includes leak testing as well as a range of preventative measures to prevent leaks from occurring and enhance system performance).

Overview of Option 4a—Mandatory leak testing

Regular leak testing on all large equipment (remote and supermarket, medium to large air conditioning and large automotive systems).

The schedule of leak testing required follows Regulation (EU) No. 517/2014, and varies depending on the size of the gas charge in the equipment.

Overview of Option 4b—Mandatory maintenance

Regular maintenance on all large equipment (remote and supermarkets, medium to large air conditioners and large automotive systems), in accordance with ISO 5149-4.

Maintenance would be required to be completed as per the schedule for leak testing and would cover energy performance aspects beyond refrigerants such as fans and filters.

Section 5

Impact analysis of each option

This section describes the methodology and key assumptions underpinning the impact analysis; and the application of a sensitivity analysis to measures, as applicable.

The results of the CBA are summarised using two main metrics:

- Net present value (NPV), which is the present value of benefits delivered by the policy less the present value of costs incurred. It measures the expected benefit (or cost) to society of implementing each scenario; and
- Benefit Cost Ratio (B/C), which is the ratio of the present value of benefits to present value of costs.

The Department commissioned Jacobs Environmental Consultancies and Services to undertake the modelling. The modelling is substantially informed by *Cold Hard Facts 2: A study of the refrigeration and air conditioning industry in Australia*, a report commissioned by the Department in 2013. The modelling report draws attention to the high level of uncertainty around the estimated costs and benefits it presents in relation to the maintenance and leak testing options, noting that, “In many cases, the available data from which to estimate costs and benefits was scarce and assumptions had to be made.”¹¹

Cost-Benefit Analysis—General Framework

The CBA involves a comparison of costs and benefits against a reference scenario which represents a business as usual outcome. The timeframe of the CBA is from 2016 to 2030 (the ‘study period’) . This timeframe was selected to align with the emissions estimates that have already been modelled by Expert Group for the Department. Because many of the costs may be incurred up-front and benefits such as avoided greenhouse gas emissions and energy savings would be realised after this evaluation period, it is likely that the CBA will understate benefits.

The discount rate used is 7 per cent. The CBA is conducted in line with the recent guidelines published by the OBPR¹² and is consistent with the Regulatory Burden Measure to estimate compliance costs. Unless specified otherwise, all modeling is undertaken in real terms, in 2015 dollars. Sensitivity analysis of key variables appears as the end of this *Impacts* section.

Cost-Benefit Analysis—Reference Scenario

A reference scenario was developed for comparison with each of the proposed policy scenarios. The underlying equipment stock and gas bank projections in the reference scenario were obtained from the source database

¹¹ Cost Benefit Analysis of Ozone Depleting and Synthetic Greenhouse Gas Reduction Policies, August 2015, Jacobs Australia Pty Limited for the Department of The Environment, Pg 9 (<https://www.environment.gov.au/system/files/consultations/fe81135c-a55e-45b6-ae4b-ef02f1616ba2/files/ozone-acts-review-cost-benefit-analysis.pdf>)

¹² <http://www.cuttingredtape.gov.au/handbook/australian-government-guide-regulation>

developed by Expert Group. The source database models significant technological change over the time period of analysis.

Given the range of options being examined, the reference scenario needed to provide annual estimates of various items from the source database. In addition, projections were required for gas prices, maintenance and leak testing activity, and end use licences issued for refrigeration and air conditioning and fire protection equipment. Each of these variables is projected between 2015 and 2030, based on available evidence and reasonable assumptions.

Cost-Benefit Analysis—Assumptions and methodology¹³

This section describes the assumptions and methodology underlying calculation of the cost and benefit in each scenario. In all cases costs and benefits are compared to the reference scenario to deduce net benefit of each scenario.

Costs and benefits data

Costs and benefits were classified in the following categories:

- **Costs of abatement.** These are likely to reduce under most scenarios which either reduce the amount of leakage of HFCs or reduce the GWP of HFCs. The CBA model applies a \$14/tonne abatement price in 2014 which rises by 3 per cent every year to \$22/tonne in 2030. This reflects the increasing cost of achieving emission reductions over time, using a starting cost consistent with the cost of emission reductions achieved under round 1 of the Emission Reductions Fund (\$13.95/tonne)¹⁴.
- **Energy costs.** These are likely to reduce for most scenarios. Energy reduction occurs when HFC leakage is reduced (i.e. improving the efficiency of the equipment) and can also occur when standard gas options are replaced with certain alternatives in new equipment. Energy costs are likely to increase if regulation is removed. These costs will be incurred by equipment owners. The CBA model calculates electricity cost savings by applying baseline energy costs across nine different equipment types (ranging from \$100–\$65,550 per year), nominating changes to energy costs for two equipment types (refrigerated remote and supermarket) based on the improved efficiency associated with low GWP alternatives. Jacobs used their own energy market model for retail electricity prices, which has been developed using a range of price drivers including carbon prices, fuel costs, unit inefficiencies and capital costs of new plant. Specifically, the electricity cost in the CBA model moves from \$22.24/MWh in 2016 to \$25.43 in 2030 for residential, and from \$12.83/MWh to \$14.70 for large commercial.
- **Capital costs.** Where equipment is replaced at the end of life with low GWP alternatives, capital costs could increase if equipment is more expensive when designed for certain types of low GWP gases. For example, equipment that uses CO₂ is typically more expensive because the properties of the gas create additional pressurisation requirements. These costs will be incurred by the refrigeration and air conditioning and/or fire protection industries, and be passed on to equipment owners. The CBA model applies base year capital costs

¹³ Cost Benefit Analysis, Jacobs, 2015, pp 28 (<https://www.environment.gov.au/system/files/consultations/fe81135c-a55e-45b6-ae4b-ef02f1616ba2/files/ozone-acts-review-cost-benefit-analysis.pdf>)

¹⁴ Note that the CBA model uses the current average cost of abatement of 1 tonne of carbon, not the conventional social cost of carbon emissions (i.e. the marginal damage cost of a tonne of carbon).

for nine different equipment types that range from \$1000 for domestic refrigeration to \$488,000 for supermarket RCFC. Small and large MAC was expected to become more expensive in the move to low GWP alternatives, with a respective 5 per cent and 10 per cent capital cost increase reflected in the CBA model.

- **Maintenance costs.** In the case of scenarios in which equipment is replaced at the end of life with low GWP alternatives, maintenance costs could increase as a result of changes to flammability and thermodynamic properties. In the case of scenarios which increase leak detection and maintenance from business as usual, these costs will include additional time costs of equipment handlers. Maintenance costs will be incurred by the refrigeration and air conditioning and/or fire protection industries and will be passed on to equipment owners. The CBA model applies base year maintenance costs for nine different equipment types that range from \$10 for domestic refrigeration to \$14,640 for supermarket RCFC. The maintenance regimes for small and large MAC equipment is expected to become more expensive, with a respective 9 per cent and 14 per cent maintenance cost increase reflected in the CBA model.
- **Gas costs.** Reducing the quota of HFCs that are imported into the country will increase prices and see a corresponding increase in demand for an alternative. These costs will be incurred by the refrigeration and air conditioning and/or fire protection industries, and will be passed on to equipment owners. If leakage increases under reduced regulation, these costs could also rise. However, the CBA assumes that HFC gas prices will not change because the nature of the phase-down is such that it allows the market to choose where the phase down can most efficiently be undertaken. This approach was undertaken because it simplifies the modelling and makes the results more transparent and explainable. Two species of HFC alternatives for which a price change is modelled in the CBA are 'HFO1234yf' (which changes from \$150/kg in 2016 to \$26.9/kg in 2030) and 'HFO New Blends' which changes from \$50/kg in 2016 to \$30/kg in 2030.
- **Administration costs.** For the purpose of this analysis, these costs describe regular ongoing costs which underpin management, monitoring, reporting, and control under each scenario. Administration costs are presently incurred by the Australian Government and refrigeration and air conditioning and fire protection industry licensees. Depending on the scenario under consideration, the distribution of administration costs could change between the Australian Government, the State and Territory governments, and refrigeration and air conditioning and fire protection licensees. The CBA assumes that the value of a bulk importer's and equipment owner's time is \$50/hr.
- **Transitional costs.** Transitional costs are incurred prior to, or in the first few years of any scenario, and cover the cost of stakeholder adjustment to each scenario's conditions relative to current conditions. Increased transaction costs for equipment owners are expected as they will likely have to undertake research to determine the most appropriate low GWP alternative. The CBA model assumes that the 21 existing bulk importers and 5 new entrants would each require eight hours to understand the change in regulations, plan for which gases to import and liaise with key customers. The 17,241 refrigerant traders were assumed to require an additional four hours each to understand the phase down and begin identifying alternative gases to promote to customers.

Impact analysis Option 1—No additional regulation

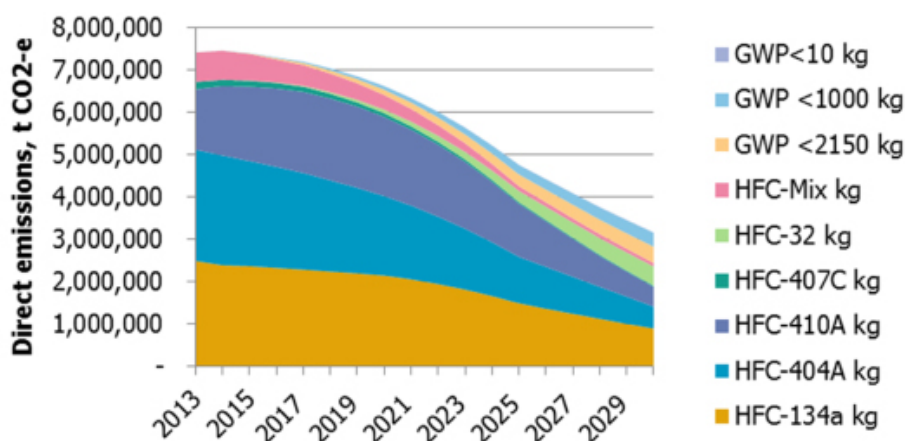
Option 1 represents the scenario where no new policy intervention is undertaken and there is an emphasis on uptake of existing policies through education. This scenario was modelled as the reference scenario for Options 2, 3 and 4. Figure 8 displays the reference scenario. It has the following features:

- A steady decline in ODS imports consistent with the legislated phase-out of these substances under the Montreal Protocol and the accelerated phase-out in Australia, continuing impacting on the transition to alternatives, including HFCs.
- A gradual decline in the volumes of high GWP HFC imports, despite growth in the stock of equipment such as small and medium air conditioning charged with HFC-410A.
- Growth of low GWP import substances (CO₂, hydrofluoro-olefins (HFO) and HFO blends, hydrocarbons) in equipment post 2018.
- A high degree of diversification in the use of refrigerant gases, especially in the supermarket industry, with projected sales mixes including a range of hydrocarbons, CO₂, HFCs, HFOs and blends.

The international situation for HFCs is likely to change. The United States of America, Canada and Mexico have put forward the North American Amendment proposal to the Montreal Protocol which, if adopted, would introduce a global HFC phase-down. The amendment proposal is supported by recent agreements between USA and China, and between the G-20 group of countries. In addition the European Union has introduced a HFC phase-down from 2015. The Parties to the Montreal Protocol agreed in November 2015 to work to agreeing a HFC phase-down in 2016.

The reference scenario concludes that emissions are likely to decline over the projections period without further policy intervention, however potential future changes such as these introduce a high degree of uncertainty around the estimates.

Figure 8: Projected emissions, base case, excluding HCFCs, Mt CO₂-e



Source: Expert Group source database

Impact on stakeholders

Option 1 represents an uncertain future for Australian industry that use HFCs in any capacity, this ranges from importers, manufacturers, wholesalers to the building industry and the cold food industry, through to technicians installing and maintaining the equipment.

As Australia is a technology taker, a scenario in which the import of HFCs is not formally regulated opens the Australian industry up to outcomes of policy decisions made by other countries without any known 'stop point'. Stakeholders have voiced concern that in this scenario, Australia could become the global 'dumping ground' of old technology. As other countries regulate to move their industries to newer technologies,

Australia could in this scenario become a likely target for manufacturers sending their old technology equipment which they cannot sell in regulated markets.

The rate of change in this scenario is unpredictable, with a likely initial influx of old technology, delay in transition to new technologies, and a build up of this old technology in the Australian economy—further delaying a transition and extending the requirement for higher emitting gases to service old equipment.

Likely expected impacts on the main groups of stakeholders include:

Importers, manufacturers, wholesalers

- In the context of global regulation, the expectation that future Australian governments are likely to regulate HFCs may reduce investment certainty.
- Cost impacts from inability to plan their business model and required stock levels with any certainty.
- Induces flow on effects from importers through to wholesalers.

Building and cold food industries

- Likely cost impacts from not being able to choose equipment for installation with certainty relating to their quality and likely longevity.
- Likely cost impacts from increased price of maintenance due both to old technology (increasing frequency of maintenance required) and cost of labour (increasing due to flow on impacts to technicians in wider range of required training and occupational risks).

Technicians

- Inability to plan their business model adequately with uncertainty around training and regulatory requirements for gases they may work with.
- Increased health and safety risks due to highly diversified range of gases in the market. If not adequately trained in the handling of all possibilities, risks rise.
- Cost impacts of minimising these risks through additional training and research.

Consumers

- Similar impacts are expected to those to the building and cold food industries, as consumer goods are likely to track in the same direction as commercial goods.

Option 2—Legislated HFC phase-down (reduction of imports of bulk gases)

Option 2a—North American HFC phase-down proposal

Option 2b—Accelerated HFC phase-down

The key impact from implementation of Option 2 as a whole, whether through the specific mechanisms of Options 2a or 2b, is to reduce the amount of bulk HFC available to potential users in a predictable way. This scarcity effect may be felt in the form of higher prices, or the expectation of higher future prices for HFC.

Either option is expected to lead to market adaptation through reducing supply of existing gases and exploration of alternative options. This includes importing equipment that uses lower GWP gases so that equipment could be serviced into the future. At end of life, existing systems would be replaced with equipment that uses lower GWP gases.

Anticipated benefits (Options 2a and 2b)

- Option 2a is expected to result in emissions reduction of approximately 3.99 Mt CO₂-e over the period 2017–2036.
- Option 2b is expected to result in emissions reduction of approximately 9.15 Mt CO₂-e over the period 2017–2036.
- Improved energy efficiency an indirect consequence of the use of alternative gas in new equipment and/or as a direct consequence of reducing leakage. Option 2a and 2b are estimated to save owners \$31.8 million in energy costs over the study period.
- Encourage replacement of equipment with low GWP alternatives, particularly after 2020. May encourage retrofit of certain systems with lower GWP alternatives that can be used as direct drop-in alternatives. This is considered especially likely in the supermarket sector.

Anticipated costs (Options 2a and 2b)

- Industry will need to adapt their business model to a quota or rationing system where none exists now—although as noted in the HFC consumption study¹⁵, this is unlikely to be a cost until at least 2020 based on current import/consumption projections. Option 2a and 2b are estimated to cost \$0.8 million in transitional costs over the study period.
- Owners of equipment charged with HFCs may experience higher costs to replace gas lost due to leakage. This may occur if demand for HFCs exceeds available supply, pushing prices up. Option 2a and 2b are estimated to cost owners \$3.8 million and \$27.9 million respectively, in additional gas costs over the study period.
- Equipment owners are not expected to replace their HFC equipment earlier than usual as the phase-down is gradual; it is unlikely to force early equipment retirement.
- Some equipment purchasers would purchase more expensive non-HFC equipment as a result of the scarcity of HFC. The major substitute gas is HFO-1234yf, and this gas is more expensive than HFC, but the price differential is projected to decline over the period to 2030. Option 2a and 2b are estimated to cost *residential* purchasers \$4.7 million and \$7.3 million, respectively, in capital costs over the study period. Option 2a and 2b are estimated to cost *business* purchasers \$2.9 million in capital costs over the study period.
- Higher maintenance costs in some instances¹⁶ where replacement gases have higher flammability, toxicity or require higher operating pressure. Option 2a and 2b are estimated to cost residential purchasers \$18.0 million and \$46.2 million, respectively, in maintenance costs over the study period.

¹⁵ Expert Group (2015), Assessment of Environmental Impacts from the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*, draft report to the Department of the Environment, February 2015. (<https://www.environment.gov.au/system/files/consultations/fe81135c-a55e-45b6-ae4b-ef02f1616ba2/files/ozone-acts-review-environmental-impact-analysis.pdf>)

¹⁶ Expert views around change in maintenance costs under use of different refrigerants are varied. To maintain consistency in the use of data around change in capital, maintenance, and energy costs, we have opted to take data from a single source that (generally) describes increased maintenance costs. There may be some instances however where maintenance costs do not change or may even reduce because the

- Australian Government to design and implement a phase-down process including baseline, schedule and quotas acceptable to industry.

Impacts on affected stakeholders

While many modelled costs are incurred by the RAC industry, gas importers and traders bear the ultimate incidence of costs associated with an HFC phase-down are most likely to fall primarily on users and consumers of refrigeration and air conditioning services. While the purchase price of HFC charged equipment will not be directly impacted, due to the exemption of charged equipment from the quota system, we assume that generally equipment suppliers will gradually move away from HFC charged equipment as the servicing of that equipment is projected to become increasingly difficult or expensive.

For example, if a car manufacturer currently chooses to install HFO air conditioning units in lieu of HFC units (the current standard), the retail price of the car is likely to reflect the additional cost of HFO which is \$60 for a full gas charge, compared with \$11 for HFC charge. In addition, the capital cost of the HFO car air conditioning unit itself is approximately \$50 more expensive than the HFC version it replaces.¹⁷ The HFO cost premiums are expected to get progressively smaller in the future as technological innovation and economies of scale drive down the price.

Consumers of RAC services are estimated to incur most of the costs over the analysis period, and these costs are much higher in the case of the Accelerated Proposal due to its earlier, faster adoption of expensive alternative gases and equipment that requires more costly maintenance than HFC equipment. See Table 1 for a summary of distributional impacts.

Under the Regulatory Burden Measurement Framework, regulatory burden is estimated at \$4.19 million (option 2a) for the North American Proposal and \$11.72 million (option 2b) for the Accelerated Proposal.

Table 1: Stakeholder impacts (2016–30)

Stakeholder group	Substitution Costs (\$ million, NPV)	
	Option 2a North American Proposal	Option 2b Accelerated Proposal
End users (business) and consumers of RAC services	30.2	85.2
Australian Government	2.6	2.6
Total substitution costs	32.8	87.7

In addition to the costs faced by those users and consumers who will substitute out of HFC, many in this group will continue to use HFC including those who own older equipment and those who elected to keep

equipment design has incorporated improved engineering and safety measures to counter any increased hazard.

¹⁷ Additional cost details can be found in Jacobs Report page 22, Table 4.3. (<https://www.environment.gov.au/system/files/consultations/fe81135c-a55e-45b6-ae4b-ef02f1616ba2/files/ozone-acts-review-cost-benefit-analysis.pdf>)

buying HFC equipment. For this group, there is likely to be higher costs associated with recharging their equipment with HFC if it leaks, for example (70% of bulk HFC imports are used for leak replacement¹⁸). Higher costs are a direct result of the scarcity created by the phase-down. These costs are extremely difficult to predict, but indicative values are provided below. These are not costs in the traditional sense, rather they are likely to be transfers to the Australian Government via the bulk HFC quota auction mechanism. These estimates are based on a simple model in which:

- The current level of demand for refrigerants sets the reference quantity, in terms of megatonnes CO₂-e per year, and this demand is assumed to decline at a rate which averages 5% every year, reflecting the projections of future HFC use by the Expert Group.
- The difference between the amount of permitted bulk HFC import under the phase down schedules and the reference quantity for that period gives the quantity change as a percentage
- The price elasticity of demand gives the impact of this quantity change on price. Direct evidence of the elasticity for substitutable gases could not be obtained so proxy information was obtained from a study of substitutable fuel sources, which indicates that demand for HFC is likely to be 'reasonably elastic', with a value of approximately -1.2. Given the high degree of uncertainty around this estimate, a wide range of sensitivity has been tested, at slightly inelastic (-0.8) and very elastic (-1.6), to provide a sense of scale. See Table 2 below.

Table 2: Estimated transfer costs for stakeholder group—users and consumers of RAC services

Own price elasticity	Transfers 2016–2030 (\$ million, NPV)	
	Option 2a North American Proposal	Option 2b Accelerated Proposal
0.8	\$100	\$341
1.2	\$66	\$228
1.6	\$50	\$171

Under the recommended scenario, this transfer would be revenue to the Australian Government. Under the alternative implementation scenario, in which quota is allocated under a 'grandfathering' method, this transfer would be income to the holders of quota rights.

In any case, these transfer estimates should be considered to be indicative only, as they are based on a range of assumptions that cannot be easily validated, such as the future demand schedule.

Competition impacts and distributional impacts

The recommended method for allocation of HFC import quota is via a periodic open-market auction, or equivalent process that ensures that all firms (incumbent, new entrant) have an equal opportunity to obtain the HFC quantities they desire. Should demand exceed supply at the time of any auction, this system should ensure that the quota goes to the party who values it most.

¹⁸ Cold Hard Facts 2: <http://www.environment.gov.au/protection/ozone/publications/cold-hard-facts-2>

Alternative allocation method

Another method is to allocate most of the quota, free of charge, to existing importers. This alternative allocation method is not recommended but, if it is adopted, the RIS recommends that it be subject to special review arrangements at appropriate intervals.

There are currently around 30 importers of HFCs in the Australian market, with this figure holding more or less steady over the comparable time period of the HCFC phase-out beginning in the mid 1990s. Of these, two importers represent 50 per cent of the total market with this break down of the market also relatively steady over the same time period. The allocation of quota to these incumbent firms presents a barrier to new entrants, which is not faced by the incumbent importers, thus limiting the number or types of businesses that may import HFC in the future.

The alternative allocation method has the potential to exclude new entrants from any markets in which HFC is a possible input in the short term, so provision would be made for new entrants to apply for a portion of the 5–10 per cent of quota set aside for this group. Future demand for HFC cannot be predicted and may be more or less than this amount in any given quota period. Any uncertainty for new entrants about their ability to access HFC quota when they need it necessarily raises the costs of entry, such as by making capital more difficult to secure.

Competition would be protected by ensuring that quota holders are not restricted from re-selling their quota or gas on the domestic market. Markets are complex and the HFC phase-down option operates at the simplest level, by limiting the quantity of gas imported. Once imported, gas might be used by the importer (downstream production) or resold to other parties to incorporate in products or consume in other processes. If there is inadequate gas to meet the requirements of all potential domestic users, at the pre-quota price, then the domestic price for HFC will have to rise until demand and supply are again equal. Holders of grandfathered quota will also face a choice: use the gas, or resell it at the (possibly higher) domestic price. This freedom to resell means that, if the relevant markets are perfectly efficient, then any firm that wants to use HFC will be assured that they can secure supply, and that prices are likely to be higher than the import price. In this way, the downstream markets remain competitive even if imports are tied up by incumbents. In fact, the opportunity cost for a quota holder to continue to participate in downstream markets will increase as the opportunity for arbitrage profits increases. While this involves a transfer of wealth from consumers to quota holders, innovation in the market is protected.

Thus, grandfathering quota under the alternative allocation method increases the cost of exit from the import market, but may encourage exit from downstream markets (for those importers who were vertically integrated) since firms that hold quota rights face an incentive to continue to import, to retain the option value of being able to exploit potential rents generated by regulatory scarcity, which may be valuable in perpetuity.

The distributional impacts of grandfathering may be small as substitute technologies become cost-effective, or they could be large. For example, with HFC imports at 8Mt of CO₂-e (equivalent to 5.6 million kg of HFC-134a) which presently trades for the world price of AUD\$26 per kg, the value of a year's imports is in the

order of \$145 million. Given a supply elasticity of zero (under the quota), a (for example) 10 per cent increase in price is conceivable and would transfer wealth of around \$15 million from consumers to quota holders annually. Transfers are conventionally excluded from a cost-benefit analysis but indicative modelling has been described above in Table 2.

The recommended allocation method, involving the open auction of all quota, would put incumbents and new entrants on an equal competitive footing at all stages of the import-distribution-consumption chain. This option, however, is untested whereas the grandfathering approach was used in the phase-out of ODS in Australia, and is being used for the phase-down of HFCs currently underway in Europe. The auction method also involves a financial transfer (depending on demand) from industry to government which is likely to be similar in size to the arbitrage profits described above and in Table 2.

While elements of the proposal do not promote competition, any adverse impact is limited to the import stage of the market, with downstream markets able to remain competitive, and the extent of competition impact is reduced by provisions to set aside up to 10 per cent of quota for new entrants. Based on these factors, it is possible that the allocation mechanisms of the proposed regulation would not impose significant costs on consumers additional to the costs imposed by limiting HFC supply *per se* (these default costs are fully captured in the form of higher prices by the regulatory burden measurement framework and by the cost-benefit analysis discussed in Section 6).

If the alternative allocation method was used, then strategies to protect against the risks to competition and distributional impacts must be considered within the review mechanism. Specifically, a review should be conducted at five year intervals and will include consideration of the quota allocation, including whether scarcity rents are being observed and appropriately managed

Cost-Benefit Analysis

The cost-benefit analysis is provided in Table 3. The table shows that the HFC phase-down would provide a positive net benefit under each proposal between 2016 and 2030.

The differences arise from a greater modelled level of end of life equipment replacement under the Accelerated alternative, particularly small mobile air conditioning requiring higher expenditure on refrigerant gases. However, if other parts of the industry choose to increase maintenance, the pressure to reduce imports in the automotive industry may reduce, and it could be cost effective to undertake the Accelerated alternative in this circumstance.

See summary Table 3 and additional detail in Jacobs report page 34–39.

Table 3: Cost-benefit analysis of HFC phase-down scenario, \$000s

	Unit	Accelerated alternative phase-down		North American amendment phase-down	
		NPV, 2016–2020	NPV, 2016–2030	NPV, 2016–2020	NPV, 2016–2030
Net Benefits	\$000s	-3652	10,491	5712	39,667

		Unit	Accelerated alternative phase-down		North American amendment phase-down	
			NPV, 2016–2020	NPV, 2016–2030	NPV, 2016–2020	NPV, 2016–2030
Benefits						
Carbon saving	Direct (leakage)	\$000s	6528	44,155	3671	17,711
	Direct (reclaim and re-use)	\$000s	8351	19,358	8455	20,044
	Indirect	\$000s	725	2930	725	2930
Energy saving	Residential	\$000s	5974	19,243	5974	19,243
	Business	\$000s	2855	12,541	2855	12,541
Total Benefits		\$000s	24,473	98,228	21,680	72,470
Costs						
Refrigerant gas costs	RAC industry—leakage replacement	\$000s	7682	27,940	1284	3780
Incremental capital cost	Residential households	\$000s	7291	7291	4745	4745
	Business	\$000s	2889	2889	2889	2889
Maintenance cost	Equipment owners	\$000s	7458	46,188	4244	17,958
Transitional cost	Industry	\$000s	831	831	831	831
	Australian Government	\$000s	1662	1662	1662	1662
Administrative cost	Industry	\$000s	31	40	31	40
	Australian Government	\$000s	282	897	282	897
Total costs		\$000s	28,125	87,738	15,968	32,802
Benefit to cost ratio		Ratio	0.9	1.1	1.4	2.2

Source: Jacobs' analysis. Note that the net benefit may be much higher if the scenario was based on increased maintenance and leak reduction strategies

Impact analysis Option 3—Bans on pre-charged HFC Equipment

Option 3a—Supermarket equipment bans

Option 3b—Mobile air conditioning bans

The key impact from implementation of Option 3 as a whole, whether through the specific mechanisms of Options 3a or 3b, is to reduce the amount of HFC in pre-charged equipment available to potential users in a predictable way. This scarcity effect may be felt in the form of higher prices, or the expectation of higher future prices for HFC.

Either option is expected to lead to market adaptation through reducing supply of existing technology and exploration of alternative options. This includes importing equipment that uses lower GWP gases so that equipment could be serviced into the future.

Impact of Option 3a—Supermarket equipment bans

Bans of supermarket equipment containing gas with GWP >2500 from 2020.

The sales mix of new supermarket equipment in 2020 is diverse, with only ten per cent of all new equipment sold containing HFC-404A. By 2024, no new supermarket equipment is expected to be sold using HFC-404A, with a total of 92 pieces of equipment expected to be sold between 2020 and 2024 (6 per cent of total sales over the period).

This suggests there are a range of cost-effective alternatives on the market. Systems based on alternative gases are likely to have similar capital and maintenance costs, and can reduce energy costs by up to 5.8 per cent, hence a strong incentive for supermarkets to consider other options already exists.

The CBA indicates a positive net benefit for the ban on supermarket equipment.

Impacts of Option 3b—Mobile air conditioning bans

Bans on imports of mobile air conditioning equipment containing gas with GWP >150 and with a date of manufacture from 2017.

Preliminary modelling of potential future use trends indicates the most likely alternative gas for mobile air conditioning equipment is HFO-1234yf as a replacement for HFC-134a.

Under this assumption, the most significant costs include capital and maintenance costs, which outweigh benefits in avoided emissions. The increased capital and maintenance costs occur because mobile air conditioning systems using HFO-1234yf are more expensive to produce (thus potentially increasing the purchase price of a vehicle) and more expensive to maintain.

Anticipated benefits (Options 3a and 3b)

- Option 3a is expected to result in emissions reduction of approximately 0.28 Mt CO₂-e over the period 2017–2036.
- Option 3b is expected to result in emissions reduction of approximately 6.14 Mt CO₂-e over the period 2017–2036.
- Introduction of more energy efficient technology, which will reduce energy costs by up to 5.8 per cent.

Anticipated costs (Options 3a and 3b)

- Incremental capital costs for new equipment of \$39.1 million for option 3b only. Under option 3a there are already a range of cost-effective alternatives for supermarket equipment on the market. In addition, only 10 per cent of supermarket equipment sold currently contains HFC404A. In contrast, small and large MAC have a 5–10 per cent higher price for low GWP alternatives.
- Refrigerant gas costs of \$98.3M for 3b only.
- Maintenance costs of \$0.4M for 3a and \$82.8M for 3b.

Impacts on affected stakeholders

The ultimate incidence of costs associated with an HFC equipment ban are most likely to fall on importers (currently 265 importers of MAC equipment) and equipment owners, and likely to be passed onto consumers. The bans will be applied at point of import, and therefore do not cause regulatory burden for end users of equipment. However, there is expected to be additional capital and maintenance cost to equipment purchasers, as a direct result of no longer being able to purchase equipment containing certain gases.

Under the Regulatory Burden Measurement framework, annual regulatory burden is estimated at \$0.05 million (option 3a) for supermarket equipment and \$31.57 million (option 3b) for mobile air conditioners.

For example, as the most appropriate alternative for HFC134a in MAC is HFO1234y vehicle owners will likely move to equipment that uses this species. For Large MAC that contains HFO1234y, the projected 10 per cent increase in capital cost will move the price from \$7000 to \$7700.

Table 4 for a summary of distributional impacts.

Table 4: Stakeholder impacts (2016–30)

Stakeholder group	Substitution Costs (\$ million, NPV)	
	Option 3a Supermarket Equipment Bans	Option 3b Mobile Air Conditioning Equipment
Equipment/vehicle owners	0.41	220.18
Federal Government	1.81	2.41
Total substitution costs	2.21	222.59

Cost-Benefit Analysis results

On balance, the costs of banning equipment containing HFC far outweigh the benefits, except in the case of supermarket equipment where the long term benefit is significant.

See summary Table 5 and additional detail in Jacobs report.

Table 5: Cost-benefit analysis for equipment bans

		Unit	Supermarket equipment from 2020		MAC equipment from 2017		Both categories	
			NPV, 2016–2020	NPV, 2016–2030	NPV, 2016–2020	NPV, 2016–2030	NPV, 2016–2020	NPV, 2016–2030
Net Benefits—Equipment bans		\$000 s	-296	3834	-103,353	-181,704	-103,649	-177,870
Benefits								
Carbon Costs	Direct—leakage	\$000 s	547	1645	8745	40,866	9292	42,531
	Indirect	\$000 s	10	490			10	490
Energy Costs	All end users	\$000 s	84	3788			84	3788
Refrigerant gas cost	RAC industry	\$000 s	51	129			51	129
Total Benefits		\$000 s	692	6051	8745	40,866	9437	46,937
Costs								
Incremental capital cost	Equipment owners	\$000 s	0	0	39,089	39,089	39,089	39,089
Refrigerant gas cost	Equipment owners	\$000 s			39,951	98,316	39,951	98,316
Maintenance cost	RAC industry	\$000 s	10	412	31,472	82,774	31,482	83,186
Transitional cost	Australian Government	\$000 s	978	978	1207	1207	2185	2185
Administrative cost	Australian Government	\$000 s	0	826	378	1204	378	2031
Total costs		\$000 s	988	2217	112,098	222,590	113,086	224,807
Benefit to cost ratio		ratio	0.7	2.7	0.1	0.2	0.1	0.2

Impact analysis—Option 4—Equipment controls

Option 4a—Mandatory leak testing

Option 4b—Mandatory maintenance

The key impact from implementation of Option 4 as a whole, whether through the specific mechanisms of Options 4a or 4b, is to reduce HFC emissions over the life of equipment through extending the life of equipment, and reducing leaks over that lifetime.

Impacts of Option 4a—Mandatory leak testing

The leak testing reference scenario was developed based on an assumption of 50 per cent of required maintenance being undertaken in business as usual conditions. Evidence from the European Union suggests that most sectors in 2011 were compliant with the leak testing requirements of the previous F-Gas regulations. However compliance was less likely for smaller supermarkets and private commercial applications. For smaller companies leak testing tends to be done in response to identified equipment problems or as specified in the maintenance contract.¹⁹ The analysis assumes that all equipment types are currently tested manually, not using automatic systems.

This approach may over estimate the cost to business if automatic leak testing is already being adopted by businesses. Similarly, the benefits may be overstated if the source database used for analysis assumes a lower level of reference leak testing than that specified in the CBA. Jacobs has recommended further work to verify leak testing levels and subsequent emissions impacts to strengthen the assumptions in the analysis.

Impacts of Option 4b—Mandatory maintenance

The maintenance option is an extension to the leakage reduction option. Maintenance would be scheduled according to the same timetable as leak testing, occurring in the same technician call-out to maximise efficiency. Maintenance however, also includes activities such as regular inspection, cleaning and possible replacement of air filters, regular inspection and clearing of the surfaces of condensers, evaporators, fans, blades and fan guards, and improved containment practices on equipment connections, hoses, pipes and accessories, and such activities will improve energy efficiency and provide energy savings benefits to participants.

It is assumed that maintenance requirements would be implemented from 2017, and would apply to large pieces of equipment, specifically supermarket, medium and large air conditioners and large automotive systems.

Anticipated benefits (Options 4a and 4b)

- Option 4a is expected to result in emissions reduction of approximately 70.19 Mt CO₂-e over the period 2017–2036.
- Option 4b is expected to result in emissions reduction of approximately 21.63 Mt CO₂-e over the period 2017–2036.
- Reduced energy consumption and therefore energy costs for equipment owner of up to 1 per cent reduction for 4a (representing a \$384.7M saving) and 8.5 per cent on 4b for a \$3128.0M saving between 2016–2030.

¹⁹ Schwarz, W. et al (2011), Preparatory study for a review of Regulation (EC) No. 842/2006 on certain fluorinated greenhouse gases, Final report to European Commission, September 2011. (http://ec.europa.eu/clima/policies/f-gas/docs/2011_study_en.pdf)

- Reduced cost for equipment owners for bulk SGG as a result of lower leak rates resulting in \$80.20M savings in gas costs between 2016–2030 for 4a and \$80.29M savings in gas costs between 2016–2030 for 4b.

Anticipated costs (Options 4a and 4b)

- Increased maintenance costs, of \$2636.9M for option 4b only, for implementation of extensive maintenance regime. Leak detection costs of \$679.7M for both options, including for the purchase of automatic leak detection equipment. Administrative costs of \$209.7M for both options,
- Transitional costs to equipment owners (including on education around compliance requirements for equipment owners) of \$41.0M for both options.

Impacts on affected stakeholders

The major cost burden associated with the maintenance and leak testing option fall with equipment owners, with a particular focus on maintenance costs. For example, under Option 4a, larger pieces of MAC equipment will be required to install an automatic leak detection system and conduct a check of the system every six months. This is anticipated to cost \$1500 to purchase and install automatic leak detection, and the yearly system test is expected to be included within one of the six-monthly manual leak tests that are currently undertaken. This option also includes obligations for education in order for technicians to familiarise themselves with the new equipment, and for additional record-keeping requirements.

Option 4(b) places significant obligations for equipment/vehicle owners. Specifically, this will involve all of the leak testing obligations with the addition of the activities described above in (i.e. more regular inspections, cleaning and replacement of air filters, etc). The level of maintenance expected across the 10 different equipment types ranges from between 2.5 to 10 hours per item of equipment, per year.

Under the Regulatory Burden Measurement Framework, regulatory burden is estimated at \$111.98 million (option 4a) for mandatory leak testing and \$430.05 million (option 4b) for mandatory maintenance.

See Table 6 for a summary of distributional impacts.

Table 6: Stakeholder impacts (2016–30)

Stakeholder group	Substitution Costs (\$ million, NPV)	
	Option 4a Mandatory Leak Testing	Option 4b Mandatory Maintenance
Equipment/vehicle owners	930.49	3567.46
Federal Government	6.57	6.57
Total substitution costs	937.07	3574.03

Cost-Benefit Analysis Results—Mandatory leak testing

Table 7 summarises the CBA results.

More information can be found in the Jacobs report on pages 40 to 43.

Table 7: Cost-benefit analysis for leak detection scenario

		Unit	NPV, 2016–2020	NPV, 2016–2030
Net Benefits—Leak testing		\$000s	-188,183	-341,937
Benefits				
Carbon Costs	Direct	\$000s	14,928	82,414
	Indirect	\$000s	16,306	47,804
Energy Costs	All end users	\$000s	139,987	384,712
Refrigerant Costs	All end users	\$000s	13,536	80,202
Total Benefits		\$000s	184,756	595,132
Costs				
Leak testing cost	Equipment owners	\$000s	251,978	679,727
Transitional cost	Equipment owners	\$000s	41,039	41,039
	Australian Government	\$000s	2830	2830
Administrative cost	Equipment owners	\$000s	76,234	209,731
	Australian Government	\$000s	858	3742
Total costs		\$000s	372,939	937,070
Benefit to cost ratio		ratio	0.5	0.6

Source: Jacobs' analysis

Cost-Benefit Analysis Results—Mandatory maintenance

Table 8 summarises the CBA results.

More information can be found in the Jacobs report on pages 43 to 45.

Table 8: Cost-benefit analysis for maintenance scenario

		Unit	NPV, 2016–2020	NPV, 2016–2030
Net Benefits—Maintenance		\$000s	-36,528	105,506
Benefits				
Carbon Costs	Direct	\$000s	14,977	82,505
	Indirect		132,237	388,737
Energy Costs	All end users	\$000s	1,135,262	3,128,005

		Unit	NPV, 2016–2020	NPV, 2016–2030
Refrigerant Costs	All end users	\$000s	13,577	80,291
Total Benefits		\$000s	1,296,053	3,679,537
Maintenance cost	Equipment owners	\$000s	959,642	2,636,961
Leak detection cost	Equipment owners	\$000s	251,978	679,727
Transitional cost	Equipment owners	\$000s	41,039	41,039
	Australian Government	\$000s	2830	2830
Administrative cost	Equipment owners	\$000s	76,234	209,731
	Australian Government	\$000s	858	3742
Total costs		\$000s	1,332,582	3,574,031
Benefit to cost ratio		ratio	0.97	1.03

Source: Jacobs' analysis

Regulatory burden of each option

The Regulatory Burden Measurement (RBM) framework²⁰ provides an estimate of the regulatory impacts (costs or savings) for business, community organisations and individuals (BCI) using an activity-based costing methodology. RBM values are calculated as a simple average of costs to BCI over the first 10-year period (2017 to 2026 inclusive) of the regulations being proposed in the options set out in Section 4.

Of relevance to the options in this RIS, the RBM framework identifies 2 major categories of costs that should be included in calculating regulatory burden:

- Administrative compliance costs—costs that are primarily driven by the need to demonstrate compliance with the regulation, such as learning about the regulation, seeking permission from government, filling in forms or providing certain information to government.
- Substantive compliance costs—costs incurred to deliver the regulated outcomes being sought. These costs may include the capital costs of equipment/technology upgrades as well as operational costs from process changes or additional staff training.

The RBM focuses on the costs to industry that would not otherwise be incurred. Business as usual costs—being those arising from existing legislation or actions that industry would undertake regardless of government intervention—are excluded from the calculation.

²⁰ Additional information about the framework can be found on www.cuttingredtape.gov.au

General characteristics of the options in this RIS

All options costed have modest amounts of *administrative* costs including the need for stakeholders to learn about their new obligations and manage their transition (all options) to register for HFC import quota auctions and pay auction amounts (option 2), and to keep records about their use of technicians for maintenance and leak testing (option 4).

The major source of regulatory burden for all options is the *substantive* cost of reducing HFC use.

Substantive costs includes:

- paying higher prices for non-HFC refrigerant gases (“*Refrigerant gas cost*” in the CBA results tables in Section 5).
 - Relevant to Option 2.
 - paying higher prices for the purchase of equipment that does not use HFC (“*Incremental capital cost*” in the CBA results tables in Section 5). Relevant to Option 2 and 3.
- any difference in the cost of maintaining non-HFC equipment which people choose to use compared with HFC equipment (“*Maintenance cost*” in the CBA results tables in Section 5).
 - Relevant to Option 2, 3 and 4.
- the cost of purchasing additional equipment, such as automatic leak detection modules (“*Leak testing cost*” in the CBA results tables in Section 5).
 - Relevant to Option 4.
- The cost of engaging technicians to perform maintenance and tests required by the policy (“*Maintenance cost*” and part of “*Leak testing cost*” in the CBA results tables in Section 5).
 - Relevant to Option 4.

Costs that are excluded, under the RBM framework, include:

- Financial transfers to the Australian Government, such as any amounts paid in an auction for HFC import quota.

RBM framework—Results

Option 2—HFC phase-down (bulk gases)

2a—North American Montreal Protocol Amendment Proposal

Regulatory burden estimated to be **\$4.19 million** per annum.

2b—Accelerated Alternative

Regulatory burden estimated to be **\$11.72 million** per annum.

Option 3—HFC pre-charged equipment ban

3a—Supermarket equipment bans

Regulatory burden estimated to be **\$0.05 million** per annum.

3b—Mobile air conditioning bans

Regulatory burden estimated to be **\$31.57 million** per annum.

Option 4—Equipment controls

4a—Mandatory leak testing

Regulatory burden estimated to be **\$111.98 million** per annum

4b—Mandatory maintenance

Regulatory burden estimated to be **\$430.0 million** per annum

Summary of impact analysis

Table 9: Summary of impact analysis of emission reduction options over period 2016-2030

Summary of Impact Analysis* 2016–2030					Summary of regulatory burden 2017–26	
	Costs NPV	Benefits NPV	Net benefit NPV	Benefit to cost ratio	Regulatory burden estimate (Rb)	Direct CO ₂ -e abatement projected (cumulative over 10 years)
	\$m	\$m	\$m	(B/C)	\$m (annual average)	million tonnes
Option 2a—HFC Phase-down of bulk gas import (North American proposal)	32.80	72.47	39.67	2.2	4.19	2.94
Option 2b—HFC Phase-down of bulk gas import (Accelerated)	87.74	98.23	10.49	1.1	11.72	4.65
Option 3a—HFC- charged equipment ban (Supermarket equipment)	2.23	6.05	3.83	2.7	0.05	0.16
Option 3b—HFC- charged equipment ban (Mobile air conditioning)	222.59	40.87	-181.70	0.2	31.57	2.86
Option 4a— Mandatory leak testing	937.07	595.13	-341.94	0.6	111.98	8.78
Option 4b— Mandatory maintenance	3574.03	3679.54	105.51	1.0	430.05	32.47
*Benefits were determined using recently observed carbon abatement prices, rather than a measure of the social cost of carbon emissions. In the model, this gives a conservative (low) value of avoided emissions.						

Summary of Emissions Reduction Pathways of Options 1, 2, 3 & 4

Figure 3 and Figure 4 depict the emissions reduction pathways of each option compared to Option 1. Figure 4 depicts the final years of projections to clearly show the difference between options. Option 3a is not shown as it overlaps with BAU such that they are not discernable for the purpose of this graph.

Figure 3: Direct (leakage) emissions against BAU 2017–2030

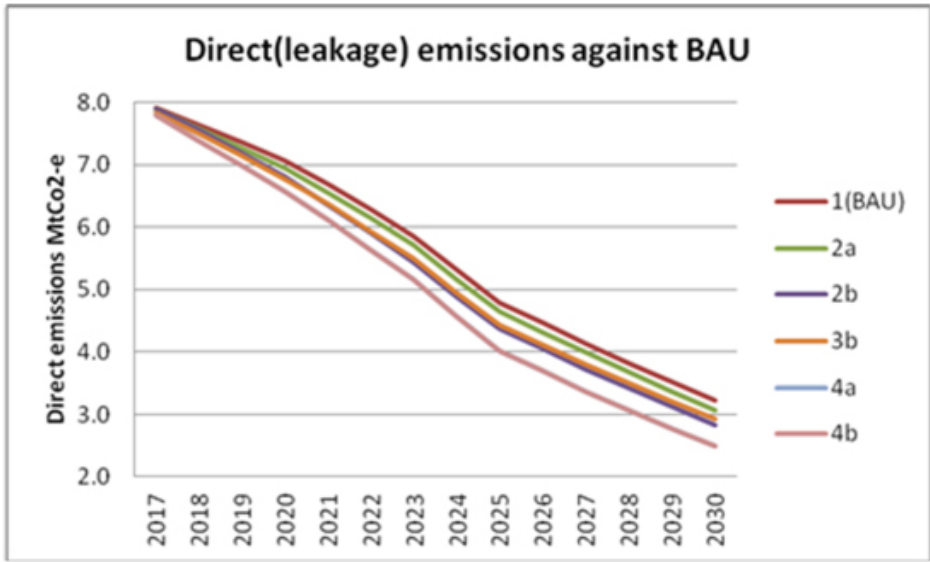
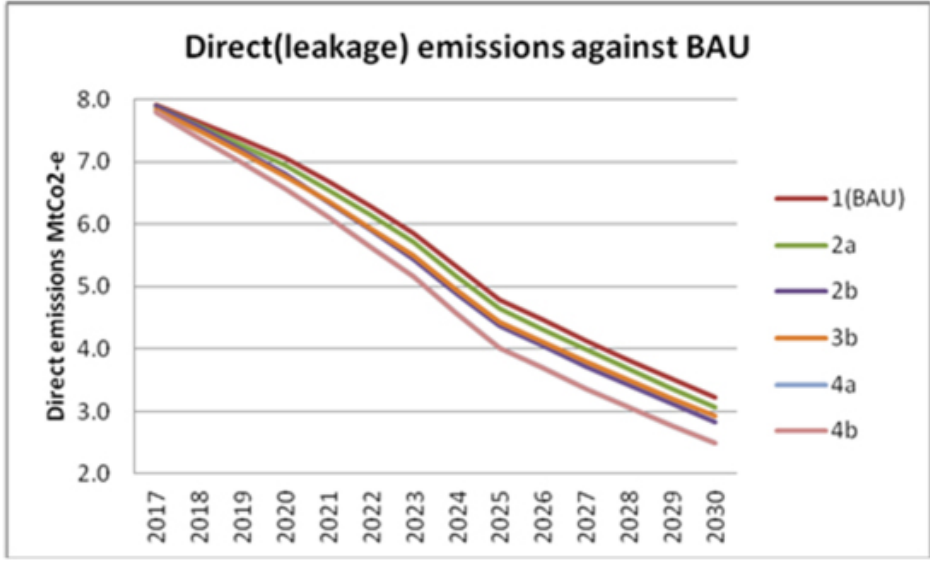


Figure 4: Direct (leakage) emissions against BAU 2026–2030



Cost-Benefit Analysis—Sensitivity analysis

A number of parameters were found to be material to the outcome of the various cost benefit analyses. This section outlines each parameter considered and forming the sensitivity analysis. The NPV has only been calculated for scenarios in which the parameter is material.

Discount Rate

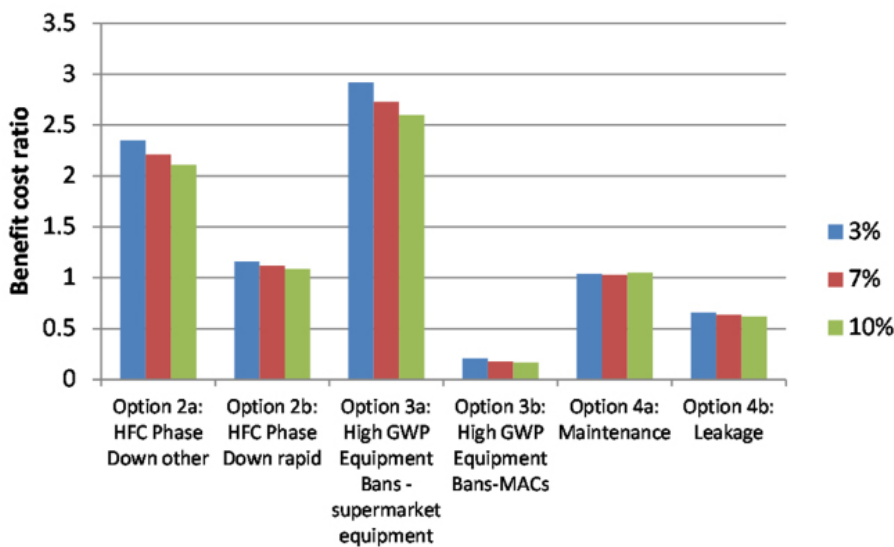
Table 10 and Figure 9: Benefit cost ratio under a selection of discount rates display the net benefit and benefit cost ratios under discount rates of 3 per cent, 7 per cent and 10 per cent respectively. In all cases the sign of the net benefit is not affected by the discount rate, leaving overall conclusions around the analysis unaffected.

Table 10: Net present value under a selection of discount rates, \$M

Discount rate	3%	7%	10%
Scenario			
HFC Phase-down North American amendment	57	40	31
HFC Phase-down Accelerated Alternative	19	10	6
High GWP Equipment Bans—supermarket equipment	6	4	3
High GWP Equipment Bans—mobile air conditioning	-220	-182	-159
Maintenance	186	106	67
Leak testing	-433	-342	-292

Source: Jacobs' analysis

Figure 9: Benefit cost ratio under a selection of discount rates



Source: Jacobs' analysis

Carbon price

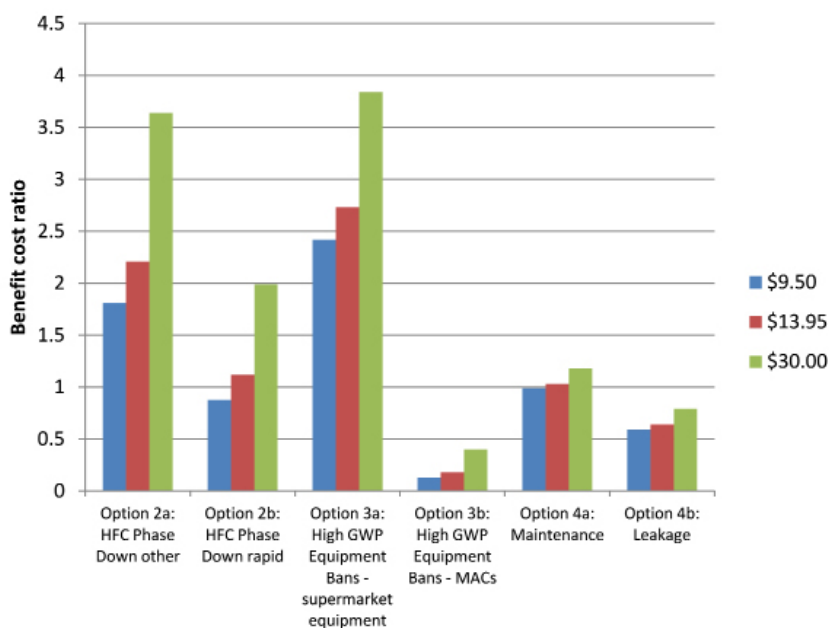
As noted above, the central analysis assumes that the carbon price starts at \$13.95, and gradually rises annually to a maximum of \$22 in 2030, Table 11 and Figure 10 display the net benefit and benefit cost ratios under starting carbon prices of \$9.50, \$13.95 and \$30 respectively. In most cases the sign of the net benefit is not affected by the carbon price, leaving overall conclusions around the analysis unaffected. Though there is some potential for a negative net benefit with very low carbon price values under the accelerated alternative HFC phase-down and the maintenance option.

Table 11: Net present value under a selection of starting carbon prices, \$M

Carbon price	\$9.50	\$13.95	\$30
Scenario			
HFC Phase-down North American amendment	27	40	86
HFC Phase-down Accelerated Alternative	-11	10	87
High GWP Equipment Bans—supermarket equipment	3	4	6
High GWP Equipment Bans—mobile air conditioning	-195	-182	-135
Maintenance	-45	106	648
Leak testing	-383	-342	-192

Source: Jacobs' analysis

Figure 10: Benefit cost ratio under a selection of carbon prices



Source: Jacobs' analysis

Maintenance costs

Table 12 displays the net benefit and benefit cost ratios with and without adjustments for increased maintenance cost when end of life equipment is replaced with a low GWP alternative, for those scenarios where this is relevant. The results show that, while maintenance costs are material to the analysis, their level does not significantly affect the outcome.

Table 12: Net present value under a selection of maintenance cost assumptions, \$M

Maintenance assumption	No increase to equipment maintenance cost under alternative gas	Current assumptions	Double current maintenance assumptions
Scenario			
Accelerated phase-down	57	10	-36
North American amendment phase-down	58	40	22
High GWP Equipment Bans—mobile air conditioning	-99	-182	-264

Source: Jacobs' analysis

Capital costs

Table 13 displays the net benefit and benefit cost ratios with and without adjustments for increased capital cost when end of life equipment is replaced with a low GWP alternative, for those scenarios where this is relevant. The results show that capital costs are material to the analysis, but the outcome is not materially affected.

Table 13: Net present value under a selection of capital cost assumptions

Scenario	No increase to capital costs assumed for Equipment using alternative gases	Current assumptions	Double the increase to capital costs assumed for alternative gases
North American amendment phase-down	47	40	32
Accelerated phase-down	21	10	0.3
High GWP Equipment Bans—mobile air conditioning	-143	-182	-221

Source: Jacobs' analysis

Gas costs

Table 14 displays the net benefit and benefit cost ratios with different gas cost assumptions for HFO-1234yf. The results show that even though capital costs are material to the analysis the conclusions do not generally change with different gas prices. Gas prices at the higher end of the range may yield a negative cost benefit under the accelerated phase-down scenario.

Table 14: Net present value under a selection of gas cost assumptions, \$M

Cost of HFO-1234yf	Assume HFO-1234yf drops to \$80/kg by 2020	Current assumptions	Current assumption: HFO-1234yf remains at \$150/kg to 2020
Scenario			
North American amendment phase-down	41	40	38
Accelerated phase-down	25	10	-0.5
High GWP Equipment Bans—mobile air conditioning	-146	-181	-209
Maintenance	104	106	106
Leak testing	-343	-342	-341

Source: Jacobs' analysis

Maintenance frequency under the maintenance and leak detection scenarios

Given the uncertainty around the true amount of maintenance currently being conducted on refrigeration and air conditioning equipment, sensitivity analysis was conducted on this variable to examine how changes in the amount of maintenance might impact on the costs and benefits of the maintenance scenario examined.

As the benefits of the maintenance scenario (reduced emissions, electricity and gas costs) were defined by the outputs of the source model, these do not change in response to a change in maintenance frequency. Expert Group do not include a baseline level of maintenance in the source model to determine their estimate of emissions and electricity reductions; this means that it is not possible to compare costs and benefits on an equal basis. This is a significant limitation of the analysis.

To assist in decision-making, Jacobs varied the baseline maintenance frequency (percentage of equipment currently being maintained in accordance with the proposed maintenance schedule, defined by EU Regulation 517/2014). As Table 15 below demonstrates, the higher the percentage of equipment currently being maintained, the lower the additional cost to implement maintenance requirements. Consequently, the net benefit is higher under an assumption of high existing levels of maintenance. The table also demonstrates that the results are highly sensitive to this assumption.

Table 15: Effect of varying maintenance assumptions

		Assumed percentage of equipment currently maintained in accordance with schedule defined in EU Regulation 517/2014		
		30%	50% (baseline scenario)	80%
Benefits	\$M	3.7	3.7	3.7

		Assumed percentage of equipment currently maintained in accordance with schedule defined in EU Regulation 517/2014		
		30%	50% (baseline scenario)	80%
Costs	\$M	4.5	3.6	2.1
NPV, 2016–2030	\$M	-0.8	0.1	1.6
Benefit cost ratio		0.8	1.0	1.7

Table 16: Effect of varying leak detection assumptions

		Assumed percentage of equipment currently leak tested in accordance with schedule defined in EU Regulation 517/2014		
		30%	50% (baseline scenario)	80%
Benefits	\$M	0.6	0.6	0.6
Costs	\$M	1.2	0.9	0.5
NPV, 2016–2030	\$M	-0.6	-0.3	0.1
Benefit cost ratio		0.5	0.6	1.1

Section 6

Consultation

Extensive consultation has been conducted in relation to the emissions reduction options outlined in this RIS as part of consultation undertaken for the review of the OPSGGM Programme, in train since May 2014. This has been undertaken throughout the various stages of the review; on the Terms of Reference outlining the objectives of the review and throughout the policy review and measure development, including the development of the cost-benefit analysis.

This has ensured that all likely impacts to business, the community and government arising from the implementation of the recommended emissions reduction and efficiency and effectiveness measures were identified and mitigated as much as possible in the development of final policy options.

Consultation has been undertaken in several ways:

Terms of Reference Public Consultation Period

The review of the OPSGGM Programme, including the emissions reduction options considered in this RIS, was announced by then Minister for the Environment, the Hon Greg Hunt MP on 24 May 2014. With the announcement the Minister released the Terms of Reference to the review for public consultation. The purpose of the public consultation was to seek input on opportunities to improve the OPSGGM Programme and achieve the emissions reduction and efficiency and effectiveness objectives of the review.

The public consultation period ended on 18 July 2014.

Twenty eight submissions were received and 24 of those published on the Department's website (four submissions were treated as confidential at the request of submitters). A summary of this consultation period can be found at the Department's website at:

<http://www.environment.gov.au/protection/ozone/legislation/ozone-acts-review>

Technical Working Group

A Technical Working Group (TWG) was established to advise the Department during the review of the OPSGGM Programme. The TWG is made up of 12 representative bodies reflecting the major industries regulated by the OPSGGM legislation. Membership consists of the:

- Air conditioning and Mechanical Contractors' Association (AMCA)
- Air conditioning and Refrigeration Equipment Manufacturers Association (AREMA)
- Australian Industry Group (AIG)
- Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH)
- Australian Refrigeration Association (ARA)
- Fire Protection Association Australia (FPAA)
- Plastics and Chemicals Industries Association (PACIA)

- Refrigerants Australia (RA)
- Refrigerant Reclaim Australia (RRA)
- Automotive Air Conditioning, Electrical and Cooling Technicians of Australia (VASA)
- Victorian Automotive Chamber of Commerce (VACC)
- Refrigerants Australia also represented methyl bromide uses.

The TWG met eight times between May 2014 and September 2015. TWG meetings focussed on analysis of issues and measures for reform raised in public submissions, and input into the environmental impact and cost-benefit analysis supporting this RIS. The Department used the TWG to confirm that the intent behind public submissions had been interpreted correctly, and issues were being analysed in line with those intentions.

Non-Technical Working Group engagement

The Department also consulted individually with smaller sub-sections of the TWG specifically in relation to the emissions reduction options outlined in this RIS, including the design of the phase-down of HFCs and quota allocation.

Interdepartmental Working Group

An Interdepartmental Working Group (IWG) was established to ensure the review fulfilled Australian Government requirements and to provide input on possible areas of reform in line with the objectives of the review. The IWG consisted of:

- Australian Customs and Border Protection Service (now Department of Immigration and Border Protection)
- Department of Defence
- Department of Agriculture and Water Resources
- Department of Employment
- Safe Work Australia
- Department of Finance
- Attorney-General's Department
- Department of Health
- The Treasury
- Department of Industry, Innovation and Science
- Department of the Prime Minister and Cabinet
- Department of Foreign Affairs and Trade, and
- Civil Aviation Safety Authority.

The Department also engaged with these agencies separately on specific issues throughout the Review.

Options Paper Public Consultation Period

Following the receipt of public submissions on the Terms of Reference, an extensive policy review was undertaken of all aspects of the OPSGGM Programme. This culminated in the release of the OPSGGM Programme Review Options Paper on 6 October 2015. The paper outlined the measures identified within each area of the OPSGGM Programme with opportunities to either include new mechanisms, or improve existing mechanisms to achieve the objectives of the review.

The paper was supported by a Technical Analysis Report containing a detailed analysis of each measure, as well as two independent research consultancies undertaken as part of the review. The first was the *Assessment of Environmental Impacts from the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* by Expert Group. The second was a Cost-benefit analysis by Jacobs Environmental Consultancies and Services which specifically considered the options outlined in this RIS.

The public consultation period ended on 16 November 2015. Fifty seven submissions were received and 45 of those published on the Department's website (12 submissions were treated as confidential at the request of submitters). A summary of this consultation period can be found at the Department's website at: <http://www.environment.gov.au/protection/ozone/legislation/opsggm-review>

Outcomes of Consultation

The main theme that emerged through the consultation process was an overall level of support for the OPSGGM Programme and the options and measures developed to achieve the objectives of Government action as outlined in this RIS, as well as the broader objectives of the Review.

39 submissions received as part of consultation on the Option Paper discussed one or more of the emissions reduction options analysed in this RIS. Table 17 provides a summary of all submissions received on the Options Paper and shows which commented on the emissions reduction options.

A shaded box indicates that the submission canvassed the option, a tick indicates that clear support was given, a 'cross' indicates that the option was clearly not supported. This table is an extract out of the full table covering all submissions received on the Options Paper, available at the Department's website at the link outlined above.

Feedback on Option 1: No additional regulation

35 submissions addressed the option of no further regulation, of these 7 were specifically supportive. These stakeholders voiced the option of increasing compliance and enforcement action and raising existing levies to act as incentives for better handling of equipment, thereby leading to emissions reduction.

It is worth noting that of these 35, 29 also supported the adoption of at least one other measure, with 28 supporting Option 2, 12 supporting Option 3, and 18 supporting Option 4.

Feedback on Option 2: HFC Phase-down

39 submissions specifically addressed the phase-down. In general, industry stakeholders support a HFC phase-down. Refrigerants Australia (RA), representing the main HFC importers and distributors, and the Air Conditioning and Refrigeration Equipment Manufacturers Association (AREMA), representing major HFC equipment manufacturers, support a faster phase-down.

The quota approach is supported by most current importers, with slight differences in opinion on how quota should be allocated.

Feedback on Option 3: Equipment bans

36 submission specifically addressed equipment bans, 12 clearly supported bans, 3 were against.

Stakeholder's views are mixed, with representative bodies of larger importers resisting early bans. There was some support for bans on HFC equipment as a complementary policy to a phase-down of HFCs however an equal amount of support was voiced for limiting the total of gas allowed (through a phase-down) and allowing manufacturers to make technology decisions based on this.

Feedback on Option 4: Maintenance

35 submissions specifically addressed the maintenance options, 18 clearly supported, 1 was against.

Those who support Option 4 commented that it was likely to achieve greater emissions reductions and also spread the regulatory burden and responsibilities to equipment owners.

In addition to comments on the emission reduction options specifically, 23 submissions, covering almost the full spectrum of stakeholders who provided comments including representative groups of the natural refrigerant sector recommended the legislation be broadened to include all refrigerants. This was suggested to include those not listed under the Montreal Protocol and Kyoto Protocol, meaning the majority have low to no global warming potential. This is on the basis of addressing safety concerns and to some extent reduced energy related emissions.

Stakeholder feedback throughout the RIS process has influenced the policy design of each option, particularly in respect of the design of implementation of the preferred option to minimise negative impacts on the regulated community while achieving the highest possible environmental benefit, as described in the Implementation section.

Table 17: Summary of stakeholder feedback

		6.1 Further reduce emissions of SGGS				
		Option 1 No additional regulation	Option 2 Phase- down of HFCs	Option 3 HFC equipment ban	Option 4 Maintenance and leak testing	Broaden coverage of the scheme to regulate indirect emissions, consider energy efficiency, account for diversity in the industry, the movement towards alternatives and associated issues such as gas quality, Workplace Health and Safety and product stewardship—Through various measures (for eg. regulating more gases/activities, training, links to other legislation/schemes, standards, codes of practice, labelling)
Legend: Shaded means measure is canvassed—a tick means generally supported—X means generally not supported						
SUBMISSION						

			6.1 Further reduce emissions of SGGS			
		Option 1 No additional regulation	Option 2 Phase-down of HFCs	Option 3 HFC equipment ban	Option 4 Maintenance and leak testing	Broaden coverage of the scheme to regulate indirect emissions, consider energy efficiency, account for diversity in the industry, the movement towards alternatives and associated issues such as gas quality, Workplace Health and Safety and product stewardship— Through various measures (for eg. regulating more gases/activities, training, links to other legislation/schemes, standards, codes of practice, labelling)
Legend: Shaded means measure is canvassed—a tick means generally supported—X means generally not supported						
1	CONFIDENTIAL		✓			
2	CONFIDENTIAL		✓			
3	CONFIDENTIAL					
4	CONFIDENTIAL					
5	CONFIDENTIAL					
6	CONFIDENTIAL					
7	CONFIDENTIAL		✓	✓	✓	
8	CONFIDENTIAL		✓	X	X	
9	CONFIDENTIAL					
10	CONFIDENTIAL					
11	CONFIDENTIAL					
12	CONFIDENTIAL		✓			
13	AIRAH—Australian Institute of Refrigeration and Air Conditioning and Heating	✓	✓	✓	✓	Mandatory recording and logging of refrigerant use throughout the supply chain; introducing mandatory training updates for new skills
14	AMCA—Air Conditioning and Mechanical Contractors Association of Australia	✓	✓			
15	AMROBA—Aviation Maintenance Repair Overhaul Business Association Inc					
16	ARC—Australian Refrigeration Council				✓	
17	AREMA—Air-conditioning and Refrigeration Equipment Manufacturers Association of Australia	✓	✓	X	Yes. Mandatory for owners of large equipment	Increase support for Refrigerant Reclaim Australia for improved recovery of end of life gases.

		6.1 Further reduce emissions of SGGS				
		Option 1 No additional regulation	Option 2 Phase- down of HFCs	Option 3 HFC equipment ban	Option 4 Maintenance and leak testing	Broaden coverage of the scheme to regulate indirect emissions, consider energy efficiency, account for diversity in the industry, the movement towards alternatives and associated issues such as gas quality, Workplace Health and Safety and product stewardship— Through various measures (for eg. regulating more gases/activities, training, links to other legislation/schemes, standards, codes of practice, labelling)
Legend: Shaded means measure is canvassed—a tick means generally supported—X means generally not supported						
18	ARKEMA—Chemicals company		✓			
19	ARMA—Australian Refrigeration Mechanics Association	✓	✓	✓		
20	AUSGRID—electricity infrastructure company					
21	Australian Refrigeration Association	✓	✓		✓	
22	BOC—Bulk Importer		✓	✓	✓	
23	Canon—Manufacturer					
24	Climate Institute					
25	Department of Agriculture					
26	Environmental Investigation Agency		✓	✓	✓	
27	E-Oz Energy Skills Australia					
28	FCAI—Federal Chamber of Automotive Industries			X		
29	Fire Protection—Industry Association Joint Statement		✓		✓	
30	Fire Protection Association of Australia		✓		✓	
31	Fire Protection Industry Board		✓		✓	
32	Griffith Hack IP Amplified—SUPPORT ARA's submission		✓			
33	Honeywell—Bulk importer		✓	✓		
34	Kidde Aerospace—fire protection and safety		✓		✓	

		6.1 Further reduce emissions of SGGS				
		Option 1 No additional regulation	Option 2 Phase- down of HFCs	Option 3 HFC equipment ban	Option 4 Maintenance and leak testing	Broaden coverage of the scheme to regulate indirect emissions, consider energy efficiency, account for diversity in the industry, the movement towards alternatives and associated issues such as gas quality, Workplace Health and Safety and product stewardship— Through various measures (for eg. regulating more gases/activities, training, links to other legislation/schemes, standards, codes of practice, labelling)
Legend: Shaded means measure is canvassed—a tick means generally supported—X means generally not supported						
	systems for commercial and military aviation and for commercial and military ground vehicle applications.					
35	Lateral Fire Design	✓	✓		✓	
36	LPG Fire Australia Pty Ltd		✓	✓	✓	
37	Mitsubishi—Manufacturer					
38	Mr Tony Bittman—Private citizen					
39	National Fire Solutions		✓	✓	✓	
40	NFIA—National Fire Industry Association					
41	NSW Environment Protection Agency					
42	Plantic Technologies Ltd					
43	Powerlink Queensland					
44	RACCA—Refrigeration and Air Conditioning Contractors of Australia				✓	
45	Refrigerant Reclaim Australia		✓	✓	✓	
46	Refrigerants Australia	✓	✓			
47	Scantec—Manufacturer					
48	Shecco		✓	✓	✓	
49	The Chemours Company		✓			
50	Truck Industry Council					
51	True Food International		✓	✓		
52	TYCO		✓		✓	

			6.1 Further reduce emissions of SGGS			
		Option 1 No additional regulation	Option 2 Phase- down of HFCs	Option 3 HFC equipment ban	Option 4 Maintenance and leak testing	Broaden coverage of the scheme to regulate indirect emissions, consider energy efficiency, account for diversity in the industry, the movement towards alternatives and associated issues such as gas quality, Workplace Health and Safety and product stewardship— Through various measures (for eg. regulating more gases/activities, training, links to other legislation/schemes, standards, codes of practice, labelling)
Legend: Shaded means measure is canvassed—a tick means generally supported—X means generally not supported						
53	UTC Building & Industrial Systems		✓	✓	✓	
54	VACC—Victorian Automobile Chamber of Commerce					
55	VASA—Automotive Air conditioning, Electrical and Cooling Technicians of Australasia		✓			
56	Wilhelmsen Ships—Global maritime industry group					
57	Xatech International					

Section 7

What is the best option from those you have considered?

The option with the highest net present value and that is robust under a range of assumptions is recommended for implementation to contribute to the Government's carbon emissions commitment.

Based on the analysis outlined in this RIS, the recommendation is to adopt:

- Option 2a—HFC phase-down (bulk gases) – North American Montreal Protocol Amendment Proposal

This option has a net present value of \$39.67 million and is designed to achieve SGG emissions by accelerating an existing trend away from HFC in favour of alternative refrigerants.

Regulatory burden is estimated to be **\$4.19 million** per annum.

Implementation of preferred option

Option 2a—HFC phase-down (bulk gases) – North American Montreal Protocol Amendment Proposal

Design of phase-down

The phase-down will be implemented with the following characteristics:

Phase-down design

- The years 2011 to 2013 will be used to calculate the baseline from which the phase-down quantities will be determined. This will include total HFC consumption and 75 per cent of HCFC consumption for the same period.
- The phase-down will relate to new HFC only.
- The HFC phase-down will apply to bulk gas only and not pre-charged equipment.
- Provisions will be made for specific exemptions such as for feedstock use, destruction and essential uses. These exemptions will be in line with Montreal Protocol requirements and there will be provisions for these exemptions to be periodically reassessed.
- Provisions will be made to review the phase-down after five years of implementation.

Establishing an Auction

The recommended method for allocation of HFC import quota is via a periodic open-market auction, or equivalent process that ensures that all firms (incumbent, new entrant) have an equal opportunity to obtain the HFC quantities they desire. Should demand exceed supply at the time of any auction, this system should ensure that the quota goes to the party who values it most.

Other options with a positive net benefit based on the RIS analysis will be assessed for potential implementation at a later date, as part of the periodic review of the best option.

Implementation processes

The implementation would have two stages, the first to implement new policies through requisite legislative amendment as soon as practicable, taking effect no later than 1 January 2018.

The second stage is to assess the appropriateness of implementing additional policies that are included in this RIS. The second stage is intended to be conducted following the review of the Preferred Option, further described in the Review Section, and is not discussed in detail in this RIS.

The first stage has five main aspects.

- Development of requisite legislative amendments, including amendments to applicable Regulations, to enact the preferred option to implement a phase-down of HFCs per the North American Amendment proposal.
- It is intended that these be undertaken as soon as practicable with the aim of the phase-down of HFCs commencing on 1 January 2018.
- Development of administrative policy to support the implementation of the phase-down.
- Development of complementary administrative and IT systems to ensure the effective implementation of the phase-down.
- Development of a targeted communications and education strategy to support the effective implementation of the phase-down and encourage an overall higher uptake of policies that will result in emissions reductions.

The implementation of the preferred Option is intended to be undertaken in conjunction with efficiency and effectiveness measures recommended as part of the broader review of the OPSGGM Programme, outlined in a separate recommendations paper. These efficiency and effectiveness measures are intended to be implemented as soon as possible, and by mid-2017 where changes to the Act are not required to allow adequate time for both Government and affected stakeholders to prepare for the changes.

Staging this aspect of the implementation of the recommendations from the review of the OPSGGM Programme prior to the major policy change, the phase-down of HFCs, taking effect from 1 January 2018 would allow for this new policy to be implemented into a newly robust OPSGGM Programme.

Implementation Risks

Implementation is to be achieved within the existing regulatory framework, which is well-known to industry, so the risks of non-compliance with the recommended Option are low.

Market Impacts

It is planned that the phase-down trajectory will be at a pace where the emergence of substitutes suppresses any excess demand for HFC. Nevertheless, key risks include the risk that the value of HFC, once imported to Australia by quota holders, rises as a result of the scarcity created by the policy (*arbitrage*

risk). This arbitrage risk, if realised, could generate substantial levels of auction revenue to the Australian Government.

If the alternative allocation method described on page [39–40] above is adopted then the arbitrage risk could generate substantial unearned income to quota holders. This risk would require careful management, such as by instituting compulsory reporting to the Department of all transactions (including between related parties) of quota or of HFC gases. The information, including date, counterparty identities, volume and value would be published on the Department's website.

Under the alternative allocation method, the arbitrage risk also leads to HFC ballots being over-subscribed by speculators and to administrative risks, which are mitigated by existing Australian Government anti-corruption arrangements. It will also be supported by periodic review in which the acceptability of observed levels of arbitrage earnings will be specifically addressed.

Environmental Risks

The preferred option will restrict a class of HFCs listed under the Kyoto Protocol. If innovation leads to adoption of a chemical outside this class, the chemical will be permitted, even if its global warming potential is as high, or higher than, HFC. This is highly unlikely as chemical manufacturers and equipment manufacturers are unlikely to invest in a new technology where future controls are possible. The evolution of ODS is an example where no new substances have emerged since the Montreal Protocol was agreed in 1987. Nevertheless, efforts to predict technological developments over a 20 year timeframe are difficult, so future reviews will need to monitor developments in this regard.

Furthermore, the exemption of pre-charged equipment could lead to growth in the amount of HFC being imported *in products*, rather than in bulk form. Related to this possibility, Australian businesses may experience a decline in their competitiveness relative to pre-charged equipment.

This potential flow on effect will be assessed as part of the periodic review of the policy.

Health and Safety Risks

The preferred option limits the availability of a gas which has characteristics well known by technicians. Some substitute gases may pose a danger to technicians and/or to occupants of buildings containing refrigeration or air conditioning equipment if they are handled and installed in an unsafe manner and in equipment not designed to house them.

The Department will develop a plan to use the End User Licensing system to deploy education and enforcement strategies to mitigate those risks, also noting that existing International Safety Standards already apply to this equipment. This potential flow on effect will also be assessed as part of the periodic review of the policy.

Funding

This RIS does not explore funding options for implementation of the preferred Option. However, a range of funding options for resourcing could be considered, including utilising the cost recovery arrangements of the OPSGGM Programme.

Review

It is proposed that the efficacy of the preferred Option be reviewed in 2023, five years after the intended commencement date of the policy, 1 January 2018.

This would allow the phase-down to be operational for two full consecutive two-year quota allocation periods, with the review undertaken mid-way through the third quota period. This would allow assessment of the effectiveness of the policy and its design in meeting Government objectives.

It is further proposed that the policy be implemented outlining other review triggers such as reported detrimental impacts of the policy on Australian industry, including competition aspects.

A timeline of key milestones and government action items for implementation and review will be developed pending a final decision on the preferred Option.

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