Climate Change Draft Scoping Plan

Measure Documentation Supplement

Pursuant to AB 32
The California Global Warming Solutions Act of 2006

Prepared by
the California Air Resources Board
for the State of California

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The purpose of this supplement is to document the assumptions and calculations Air Resources Board staff (ARB or staff) used as the basis for greenhouse gas (GHG) reduction measures in the Draft Scoping Plan Economic Evaluation. ARB developed the measures contained herein with technical help from other State agencies and the Climate Action Team subgroups. Where appropriate, updated assumptions or corrections to tabulated values in the Draft Scoping Plan and Appendices are noted using a delta symbol (Δ).

General assumptions common to categories of measures or sectors are listed under the major headings below. Unless otherwise noted, cost for a measure is the sum of the annualized capital cost and program maintenance costs. Annualized Capital Cost is defined as the product of the capital expenditure and the capital recovery amortized over a specified period of time at an annual discount rate of 5%. The capital recovery factor (CRF) is calculated using the formula:

$$Capital\_Recovery\_Factor = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where i is the discount rate (5%) and n is the life of the capital. A real discount rate of 5% is chosen to match the rate of return on an inflation adjusted 10-year treasury security. The expected life of the capital is estimated for each measure. The amortization period is related to the expected life of the capital or an estimate of the period over which GHG reductions are expected. For example, measures that use a 20-year capital life, the CRF is 0.08024 or approximately $0.08 annually for each dollar of capital expenditure. Each measure described specifies the estimated capital life and associated CRF.

Savings are generally calculated from reduced energy used as a result of efficiency or other measure. For most measures the savings value listed in the tables results from a reduction in fuel or electricity use or the net reduction associated with fuel switching. In the Draft Scoping Plan Appendices the "Net Annualized Cost" is calculated by subtracting the savings from the annualized cost. A negative cost value indicates the measure is expected to have net savings.

The values and assumptions documented here are preliminary and subject to change during the regulatory process.

Assumptions for Costs and Savings

Cost and Savings Calculation	
Capital cost	$357M
Estimated capital lifetime	20 years
20-year Capital Recovery Factor	0.08024
Annualized Capital cost 2020	$28.6M
Operating cost in 2020	$23.3M
Non-energy cost savings in 2020	$8.8
Electricity use	637,000 MWh
Value of electric use in 2020 (@ $86/MWh)	$55M
Natural gas reduction	33,400,000 MMBTU
Value of Natural Gas Savings (@ $7.94/MMBTU)	$265M
Total 2020 cost	$106.9M
Total 2020 savings	$274M
Net annualized cost (cost-savings)	-$167M

GHG Leak Reduction from Oil and Gas Transmission

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
GHG Leak Reduction from Oil and Gas Transmission	0.5-1.5	19	34.2	-15

Overview

This measure under evaluation addresses emissions from the transmission and distribution of natural gas throughout California. This measure would included: replacing older equipment (flanges, valves and fittings); substituting high bleed with low bleed pneumatic devices; installing vapor recovery devices; using emission monitoring equipment to detect leaks; installing more energy efficient equipment; switching to low carbon fuels to run the equipment; and improving practices for inspection and management.

Assumptions for GHG Reduction

Changing operating practices while taking compressors off-line achieves almost all of the estimated 0.9 $MMTCO_2E$ emissions reduction. Replacing just a handful of ICE pumps and compressors with electric motors achieves the remaining 0.1 $MMTCO_2E$ emissions reduction. These estimations will be refined as a more robust emission inventory is developed via an industry-wide survey and the control approaches of the measure identified

Assumptions for Costs and Savings

Cost and Savings Calculation	
Capital cost 2015	$28M
Lifetime	5 years
5-year Capital Recovery Factor	0.2310
Annualized capital cost 2020	$6.6M
Electricity cost	138,000 MWh
Value of electricity cost in 2020 (@$86/MWh)	$12M
Natural gas reduction	4,130,000 MMBTU
Value of natural gas savings (@ $7.94/MMBTU)	$33M
Operating cost 2020	$0.54M
Non-energy cost savings in 2020	$1.2M
Total 2020 cost	$19.0M
Total 2020 savings	$34.2M
Net annualized cost (cost-savings)	-$15

Industrial Boiler Efficiency

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Industrial Boiler Efficiency	0.5-1.5	22.9	150	-127

Overview

This measure under evaluation would require one or more of the following: annual tuning of all boilers, the installation of an oxygen trim system, and/or a non-condensing economizer to maximize boiler efficiency. A source could also replace an existing boiler with a new one that is equipped with these systems.

Assumptions for GHG Reduction

Assumptions:

- Estimated annual emissions based on draft Greenhouse Gas Inventory Forecast Estimates (February 6, 2008) 2020 projected emissions from natural gas: 24.19 $MMTCO_2E$
- Boiler efficiency measure applies to approximately 80% of the universe due to this natural gas usage
- Boiler Efficiency Measure accomplishes a 5% reduction in GHG emissions

$$(0.80)(24.19\ MMTCO_2E)(0.05) = 1.0\ MMTCO_2E \text{ reduction annually}$$

The Boiler Efficiency Measure requires the efficiency improvements summarized in the table below. Costs were estimated by determining the cost of each requirement and the approximate number of boilers that would need each type of the two retrofits or tuning.

Summary of Measure Requirements	
Applicability	Requirement
All permitted boilers	Annual tuning
Boilers rated at or over 10 MMBtu/hr	Retrofit with an oxygen trim system including parallel positioning and VFD
Boilers rated at or over 50 MMBtu/hr	Retrofit with a non-condensing economizer

Assumptions for Costs and Savings

- Total Capital Cost ($90,390,000)
    - The capital cost is derived from the cost of purchasing and installing equipment retrofits required by the measure multiplied by the approximate total number of installations. The total number of installations was estimated using engineering judgment, data from ARB's CEIDARS database, air district databases, and from information supplied by an industry sales representative and representatives of a consulting firm that administers a commercial and industrial boiler efficiency program.
- Annual Tuning requirement
    - Capital cost = $0.
- Retrofit of 10 MMBtu/hr boilers with oxygen trim, parallel positioning, VFD
- Equipment costs for retrofit assuming 600 boilers rated at or over 10 MMBtu/hr with oxygen trim, parallel positioning, and VFD ($96,000 per unit) = $57,600,000
- Note: Assumed 60% (600) of the 1000 boilers in CEIDARS inventory are not already equipped with oxygen trim, parallel positioning, and VFD and need the retrofit.
- Capital costs for retrofit of 105 boilers rated at or over 50 MMBtu/hr with a non-condensing economizer ($200,000 per unit) = $21,000,000
- Assumed 60% (105) of the 175 boilers in the State are not already equipped with a non-condensing economizer and need the retrofit. South Coast database shows there are 70 boilers in the District over 50 MMBtu/hr.
- Assuming South Coast has 40 percent of the inventory in the State, the total number of boilers over 50 MMBtu/hr in California is 70/0.4 = 175 boilers.
- Capital costs: $78,600,000
- Total installation costs (15 percent of capital costs) = $11,790,000
- Total capital and installation costs for boiler retrofits = $90,390,000
- Annual operating cost ($15,610,000)
- Annual maintenance costs for boiler retrofits (assumed to be 10 percent of capital costs) = $7,860,000
- Annual tuning costs for 3100 boilers ($2500 per unit) = $7,750,000
- Note: all the costs for the tuning requirement are considered to be an annual maintenance cost. The 2004 CEIDARS NO_x inventory showed approximately 3100 permitted natural gas boilers.
- Total annual operating costs (annual maintenance costs and annual tuning costs) = $15,610,000
- Lifetime Expenditures 2016 through 2020 ($168,440,000)
- $90,390,000 + (5 years)($15,610,000) = $168,440,000

- Cost Savings ($149,640,000)
- (There will also be an unknown electricity savings from the VFD.)
    - 1 $MMTCO_2E)(10^6$ metric ton/MMT)/(0.05306 metric tons CO_2/MMBtu) = 18,846,588 MMBtu natural gas annual savings
- Annual fuel cost savings ($7.94/MMBtu)(18,846,588 MMBtu) = $149,641,908
- Lifetime Cost Savings 2016 through 2020
- (5 years)($149,641,908) = $748,209,543

Summary Cost and Savings Calculation	
Total capital cost	$90.4M
Operating cost 2020	$16M
Estimated capital life	20 years
20-year CRF	0.08024
Annualized capital cost (capital x CRF)	$7.25M
Total cost in 2020	$22.86M
Natural gas savings	18,846,588 MMBTU
Value of Natural Gas Savings in 2020 (@ $7.94/MMBTU)	$149.7M
Net annualized cost (cost-savings)	-$127M

Stationary Internal Combustion Engine Electrification

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Stationary Internal Combustion Engine Electrification	0.1-0.5$^{\Delta}$	17.9	25	-7.1$^{\Delta}$

Overview

This measure under evaluation would affect owners and operators of engines in industrial and commercial operations rates at over 50 hp and used as primary power sources ("prime" engines). This measure would not affect internal combustion (IC) engines used for emergency power generation. This measure would include the replacement of IC engines with electric motors (electrification).

Assumptions for GHG Reduction

In the Draft Scoping Plan ARB estimated the GHG emission reduction potential as approximately 0.1 to 1.0 $MMTCO_2E$. As ARB continued to evaluate this measure, it became apparent the high end of the range – 1 MMT, was unrealistic. Such a large reduction would require electrifying over two-thirds of the engines in this category by 2020. This level is not achievable due to both logistical difficulties (access to electrical service and/or required duty cycles) and high cost for engines that are not operated a high percentage of the time. To reflect this, ARB believes a more realistic range of potential reductions is 0.1 to 0.5.

Assumptions for Costs and Savings

Cost and Savings Calculation	
Total capital cost	$50.7M
Operating cost 2020	$14M
Estimated capital life	20 years
20-year CRF (@ 5% discount rate)	0.8024
Annualized capital cost (capital x CRF)	$4.1M
Total 2020 cost	$17.9M
Natural Gas Savings	7,670,600 MMBTU
Value of Natural Gas Savings in 2020 (@ $7.94/MMBTU	60.92
Diesel Savings in 2020	11.4 million gallons
Value of Diesel Savings 2020 (@ $3.685/gallon)	$41.9M
Increased electricity use in 2020	904,443 MWh
Cost of increased electricity (@ $86/MWh)	$77.9M
Net savings in fuel	25.04
Net annualized cost (cost-savings)	-$13M

Glass Plant Energy Efficiency—Equipment Efficiency and Use of Recycled Materials

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Glass Manufacturing Energy Efficiency	0.1-0.2	36.9	23.6	13^{Δ}

Overview

This measure under evaluation would increase the requirement for recycled glass (cullet) content and would require facilities to use the best technology to reduce GHG emissions or adopt energy efficient operation and maintenance procedures for manufacturing glass.

Assumptions for GHG Reduction

The GHG emissions reduction was based on the industry's increase in cullet use of 10% or more and the use of other potential energy efficiency measures which would result in 5 to 10% energy savings.

Assumptions for Costs and Savings

Cost and Savings Calculation	
Total capital cost	$15M
Estimated capital life	10 years
10-year CRF	0.1295
Annualized capital cost (capital x CRF)	$1.94M
2020 operating cost	$35M
2020 total annualized cost	$36.94M
Natural gas savings	281700 MMBTU
Value of natural gas savings (at $7.94/MMBTU)	$2.24M
Electricity savings	5979 MWh
Value of electricity savings (at $86/MWh)	$0.5M
Operational cost saving as a result of material	$20.8M
Total savings	$23.6M
Net annualized cost (cost-savings)	$13M

Off-Road Equipment

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Off-road Equipment	Up to 0.5	TBD	TBD	TBD

Overview

This measure targets a number of efficiency improvements in offroad equipment including solar-reflective paint and window glazing, reduced idling emissions, equipment electrification, and low friction engine oil. Staff is evaluating the potential GHG reductions and cost and savings from this measure.

Assumptions for GHG Reduction

TBD

Assumptions for Costs and Savings

TBD

Recycling and Waste

Landfill Methane Capture

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Landfill Methane Capture (Discrete Early Action)	1	52[19]	0	52

Overview

This measure would reduce methane emissions from municipal solid waste landfills by requiring owners and operators to install gas collection and control systems at smaller and other uncontrolled landfills. Additionally, all affected landfills will be required to satisfy enhanced methane monitoring requirements to ensure that their gas collection and control system is operating optimally and that fugitive emissions are minimized.

Assumptions for GHG Reduction

Staff estimates 0.8 $MMTCO_2E$ GHG emissions reduction from the approximately 53 landfills having greater than 450,000 tons of waste-in-place that may generate sufficient gas to support the installation of a gas collection and control system with a flare. Staff estimated an additional 0.2 $MMTCO_2E$ GHG emissions reduction from enhanced monitoring requirements to ensure that the landfill's gas collection and control system is operating optimally and that fugitive emissions are minimized. The total estimated reduction is 0.8+0.2 = 1 $MMTCO_2E$.

Assumptions for Costs and Savings

Staff estimated a capital cost of $3,438,000 and annual operating cost of $706,397 for the aforementioned 53 facilities. The lifetime of the gas collection and control systems is estimated at 15 years. The total estimated cost is approximately $1M per facility in 2020. Total industry costs, included those for landfills with existing gas collection and control systems, will be estimated in the staff report for the landfill methane control measure. The costs and emission reduction estimates presented here are preliminary estimates.

[19] In reviewing costs for the Landfill Methane Capture measure staff corrected the cost value in this documentation supplement. The cost value published in the Draft Scoping Plan Appendix of $1M is per landfill and not total.

Cost Calculation	
Capital cost	$3,438,000
Capital life	20 years
20 year CRF	0.08024
Annualized capital cost	$275,874
2020 Operating cost	$706,397
Total per facility cost	$982,271
Total cost (for 53 facilities)	$52M
Savings	$0
Net annualized cost (cost-savings)	$52M

High Global Warming Potential

Measure H-1: Motor Vehicle Air Conditioning Systems: Reduction of Refrigerant Emissions from Non-Professional Servicing (Discrete Early Action)

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Sales Restriction on Containers of Refrigerant	0.5	60	0	60^{Δ}
Alternative Proposal	0.25	3	0	3

Overview

This measure reduces GHG emissions from the non-professional servicing of motor vehicle air conditioning systems by do-it-yourself individuals. The basic structure and approach of this measure is essentially the same as that originally proposed in the Early Action Plan. There are two proposals currently undergoing consideration: a sales restriction (can ban) and an alternative approach. The alternative approach would include: 1) the installation of a self-sealing dispensing valve on all small containers of refrigerant, 2) the implementation of a mandatory container recycling and refrigerant recovery program, 3) improved labeling on all containers, and 4) the implementation of a consumer education program. Since this is a Discrete Early Action, the proposed regulation would become enforceable on January 1, 2010. The table above includes two rows, corresponding to the two approaches that were considered by Staff. The Draft Scoping Plan Appendix C includes only the original estimate associated with the Staff recommendation, the Alternative Proposal. The numbers above are refinements based on the most recent information emerging from the public process.

Assumptions for GHG Reduction

The total annual emission reduction from the "Can Ban" amounts to approximately 0.47 $MMTCO_2E$ and is principally due to the prohibition of sales and the significantly reduced do-it-yourself practice in California.

The alternative approach is estimated to achieve a reduction of approximately 0.25 $MMTCO_2E$ in 2020 resulting from the recovery of the unused refrigerant in the containers and an increased consumer awareness of an optimum charging techniques arising from the improved labeling and the education program.

Assumptions for Costs and Savings

Under the "Can Ban," there would be no costs or charges imposed on the small can industry to comply with the ban, but there would be complete loss of revenues which would amount to $25 million in California. Under the small can ban, consumer costs would be affected by the difference between the cost of professional repairs and the cost of DIY recharges. The cost to consumers would increase by $74 million annually.

The industry has estimated that the installation of self-sealing valves and the implementation of the recycling program would result in a cost increase of one dollar per container. At 1.6 million cans per year the increased consumer cost is $1.6 million. Assuming a 95% can return rate and a $10 deposit per can, the 5% of unclaimed deposits amounts to $0.8 million per year and will be an additional cost to the consumers. Total increased cost to the consumer is thus ~$3 million per year.

Measure H-2: SF_6 Limits in Non-Utility and Non-Semiconductor Applications (Discrete Early Action)

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
SF6 Liming in Non-Utility and Non-Semiconductor Applications (Discrete Early Action)	0.3	0.22	0.14	$<0.1^{\Delta}$

Overview

This measure reduces sulfur hexafluoride emissions from non-utility and non-semiconductor-related applications. This includes, but is not limited to, magnesium casting, tracer gas uses, and recreational uses such as magic tricks.

Assumptions for GHG Reduction

ARB estimated a range of estimates for other uses (non-semiconductor, non-utility, and non-magnesium) is 0.13 – 0.34 (ARB 2008). Alternatives are available and a phase-out is possible for magnesium casting, tracer uses, and recreational uses. A reduction is not possible for medical uses. Alternatives are 98+ percent effective for magnesium casting and range from 50-90+ percent for tracer uses (EPA 2006). Recreational uses would either be eliminated or alternatives would have a near 100% reduction (ARB 2008). Based on alternative effectiveness, reductions from magnesium would be 0.99 $MMTCO_2E$. For other applications, an effectiveness of 90% was used to estimate reductions up to 0.2 $MMTCO_2E$. In total, reductions are estimated at 0.3 $MMTCO_2E$.

Assumptions for Costs and Savings

Due to a lack of data for other sectors, ARB was only able to calculate costs for the magnesium sector. The estimate will still be reasonable since alternatives to sulfur hexafluoride are generally either less expensive per pound or per use (less alternative needed per use) and other uses in this measure do not have capital costs since they do not require significant infrastructure changes.

For the magnesium sector, there are two sets of costs associated with alternate gases: upfront and annual costs. Based on Canadian data, upfront costs could run up to $573,000, which is annualized to approximately $94,000 after conversion to 2007 dollars and annualized using a 10 year lifetime (Environment Canada, 1998). The annual costs, based on the same Canadian study, are approximately $126,000 for training.

There could be an associated cost savings since one alternative is less expensive than sulfur hexafluoride. Based on U.S. EPA, the cost savings will be $140,000 in 2007 dollars.

If a change is made in the manufacturing process for certain industries, the caster must go through a requalification process. These costs are not currently included in the analysis but could be significant.

Measure H-3: High GWP Reduction in Semiconductor Manufacturing (Discrete Early Action)

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
High GWP Reduction in Semiconductor Manufacturing (Discrete Early Action)	0.15	2.6	0	2.6^{Δ}

Overview

This measure targets a reduction in emissions of several high global warming potential gases uses in the semiconductor manufacturing industry. Reductions are expected from process optimization, alternative chemistries and abatement technologies. This measure is currently in the regulatory process.

Assumptions for GHG Reduction

The proposed measure is designed to achieve at least a 50% reduction in emissions of high GWP gases from the semiconductor manufacturing industry. ARB recently conducted an industry survey of GHG emissions from more than 100 semiconductor and related devices facilities. This bottom-up accounting revealed approximately 0.3 $MMTCO_2E$ of emissions in 2006. Staff is proposing to target an emissions reduction of 0.15.

Assumptions for Costs and Savings

The cost of the proposed measure is based on the assumption that abatement technologies are used for compliance. The $2.6 million total annualized cost estimate ($3.3 million in 2007 dollars) was derived from a June 2001 U.S. EPA report[20]. This value included the capital, operating and maintenance costs as a single figure for etch abatement systems. The annualized cost is calculated assuming $23.4 million in capital costs, a 5% discount rate, and a 9 year life for the abatement systems.

Measure H-4: Limit High GWP Use in Consumer Products (Discrete Early Action)

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Limit High GWP Use in Consumer Products (Discrete Early Action)	0.25	0.06	0.23	<0.1

Overview

The objective of this measure is to reduce the use of high GWP compounds in consumer products when alternatives are available. To achieve these reductions, consumer product formulations would need to be changed to reduce or eliminate the use of high GWP compounds.

Assumptions for GHG Reduction

The potential reductions for this measure for 2020 were estimated based on the perceived opportunities for reductions of GHG emissions from specific categories of Consumer Products. Emissions of GHG from the specific Consumer Products were determined from formal surveys of manufacturer's sales and formulation data that were conducted for the 2001, 2003 and 2006 sales years. Further, in June 2008, the Board approved a measure to reduce the GHG emissions from Pressurized Gas Dusters. This measure achieved approximately 0.20 $MMTCO_2E$ in 2020. It is anticipated that the remainder of the emission reduction goal could be achieved by adopting GHG standards for other categories of Consumer Products in future rulemakings.

Assumptions for Costs and Savings

The estimated costs attributed to this measure were based on previous consumer products regulations affecting similar categories of products from which emission reductions were anticipated to occur. Specifically, for the Pressurized Gas Dusters, it was estimated that the total costs of the regulation will be approximately $450,000 over ten years or $45,000 a

[20] U.S. EPA June 2001, U.S. High Global Warming Potential (High GWP) Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions, Chapter 6 Cost and Emission Reduction Analysis of PFC, HFC, and SF_6 Emissions from the Semiconductor Manufacturing in the United States, pg. 6-6, June 2001.

year.[21] Additional costs to manufacturers and consumers will likely occur for additional categories that are regulated for GHG emissions.

Measure H-5: High GWP Reduction from Mobile Sources

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Low GWP Refrigerants for New Motor Vehicle Air Conditioning Systems	2.5	20.86^{Δ}	0	16
Air Conditioner Refrigerant Leak Test During Vehicle Smog Check	0.5		TBD	TBD
Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers	<0.1		TBD	TBD
Enforcement of Federal Ban on Refrigerant Release During Servicing or Dismantling of Motor Vehicle Air Conditioning Systems	0.07 – 0.3		TBD	TBD

Low GWP Refrigerants for New Motor Vehicle Air Conditioning Systems

Overview

This measure would reduce greenhouse gas emissions by replacing high GWP refrigerants used in California's MVACs with lower GWP alternatives that also represent better lifecycle climate performance than the current refrigerant. This measure is meant to initially cover those classes of vehicles not included in the AB 1493 (Pavley) regulation: heavy duty and off-road vehicles. The principal benefit of this measure is the reduction of the GWP impact of refrigerant releases through direct and indirect emissions. The measure is fundamentally the same and as proposed in the Early Action Plan.

Assumptions for GHG Reduction

An estimate of the statewide emission inventory is under development for MVAC refrigerants in 2020. Anticipated reductions for 2020 are expected to be 0.7 $MMTCO_2E$ for light duty vehicles and 1.8 $MMTCO_2E$ for heavy duty vehicles for a total of 2.5 $MMTCO_2E$ for a universal phase out of HFC-134a in new and in-use MVACs in California. These projections were based on the current estimated annual leakage rate of R-134a for light duty vehicles and heavy duty trucks. These estimations will be refined as a more robust emission

[21] See "Initial Statement of Reasons for Proposed Amendments to the California Consumer Products Regulation, May 9, 2008. http://www.arb.ca.gov/regact/2008/cp2008/cp2008.htm.

inventory is developed and the likely replacement refrigerants are selected and the split in the market is predicted.

Assumptions for Costs and Savings

Only capital costs were considered in this cost estimate. Additional staff analysis is needed to determine operating costs, cost savings, and economic impacts. The life of potentially new air conditioning systems is expected to be the same as current systems. Capital costs for the introduction of new refrigerants in the California fleet were estimated to be on the order of $150 million by 2020 based on assumptions that changes begin to phase in around 2013. This estimate is based on a European incremental cost per vehicle of $23 to $28 (at an average exchange rate for the following mentioned year) per LDV in 2003 with a six percent annual increase in cost. The estimate includes several vehicle categories: light duty vehicles, heavy duty vehicles, and off-road vehicles. The detailed information for the intermediate years needs to be determined. Actual costs for maintenance will vary depending on the low GWP refrigerant selected. Significant additional analysis is needed to enable and improve cost and performance estimates of the various alternative technologies.

Air Conditioner Refrigerant Lead Test During Vehicle Smog Check

Overview

As originally conceived, the proposed measure may add a refrigerant leak check to the "pass" criteria for the California vehicular inspection and maintenance (I/M) program, Smog Check, for all vehicles that undergo the test. However, additional staff analysis indicates new issues associated with the technical feasibility of the measure that were not originally considered. Thus, further technical assessment is needed. If put in place, all vehicles that pass Smog Check would have motor vehicle air conditioning (MVAC) systems that either leak at or below natural leak rates (to be determined in the measure) or are empty and precluded from further use unless the identified excessive leak is repaired. Inspections of MVACs would be conducted by the Smog Check technician with a portable refrigerant "sniffer" that detects HFC leakage or other means to be determined in the measure. Protocols would be developed for the test, including use of equipment and identification of threshold values to establish repair criteria. Vehicle owners who choose not to repair a leaky MVAC can pass I/M by agreeing to have the remaining refrigerant recovered and their MVAC rendered inoperable.

Assumptions for GHG Reduction

The potential for annual reductions are thus estimated to be from 0.95 $MMTCO_2E$/year as a standalone measure, to 0.48 $MMTCO_2E$/year when considered as an addition to other measures. The estimates are preliminary; realistic values could range from one half to twice the estimates provided. The estimates are based on the following:

- The program would begin in 2011
- All vehicles will use HFC-134a (GWP=1300) in 2011.

Annual sales of R-134a refrigerant in California are assumed to be emitted into the atmosphere annually due to service losses and due to leaking vehicles. These sales are approximately 1.9 $MMTCO_2E$ per year.

To determine order of magnitude estimates, it assumed that implementation of an MVAC test and repair requirement would reduce leaks and service losses by 50% to an annual leak rate of 0.95 $MMTCO_2E$/ year. (More detailed analyses of the potential reductions are currently underway).

Refrigerant entering the state as OEM charge is not included in the emission rate; and refrigerant captured at end of life is not subtracted from the emission rate. (More detailed analyses of the potential reductions are currently underway).

Reductions obtained by implementation of this measure might overlap with reductions obtained by other MVAC related measures. To determine order of magnitude estimates, it is assumed that 50% of the MVAC direct emissions will already have been mitigated by other measures, reducing the potential reduction from 0.95 $MMTCO_2E$/year to 0.48 $MMTCO_2E$/year. (More detailed analyses of the potential reductions are currently underway).

Assumptions for Costs and Savings

Each Smog Check station would have to spend about $200~$300 for each hand-held HFC detector. This assumes the hand-held detector approach proves to be the correct approach. Station owners or technicians would have to pay up to $280 per person to train the Smog Check technicians. The initial cost to Smog Check station owners and technicians would be $2M (Instrument costs) + $4M (Training costs) = $6M. These are one time start up costs. Continuing annual costs are not considered because they are assumed to be covered by increases in the consumer price of a smog check.

Due to the increased time required by technicians to test MVAC systems, the consumer price of a Smog Check is expected to increase by an amount that has yet to be determined.

Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers

Overview

The purpose of this measure is to mitigate any impacts from releases, either intended or accidental, of refrigerant from decommissioned refrigerated shipping containers. Refrigerated shipping containers may accumulate in major ports and that the refrigeration systems on these containers may leak high-GWP refrigerants such as HFC-134a. In particular, the refrigerant remaining in the decommissioned containers, the leakage from these containers, and refrigerant disposal as the containers approach end-of-life (EOL).

Assumptions for GHG Reduction

It is essential that a needs assessment be performed to get an accurate estimate the annual amount of refrigerants that are available for recovery from decommissioned refrigerated shipping containers. It has been estimated that shipping container activity could double by 2020. If it is assumed that this applies to the decommissioned refrigerated shipping containers as well, then the bank becomes 160,000 to 320,000 $MTCO_2E$ based on staff

analysis. This estimate represents the upper bound for the possible reduction potential of this mitigation.

Assumptions for Costs and Savings

Very little information on costs and economic impacts is known today about this proposed measure. As part of measure development, an assessment will be performed in order to get a better understanding of the number of refrigerated shipping containers decommissioned each year, the amount of refrigerant remaining, whether there is refrigerant recovery, and the costs associated with the recovery and recycling processes for the remaining refrigerant.

Enforcement of Federal Ban on Refrigerant Release During Servicing or Dismantling of Motor Vehicle Air Conditioning Systems

Overview

An existing federal regulation (40 CFR 82.154) bans the release to the atmosphere of high-GWP refrigerant substance at the end-of-life or during equipment servicing. The current degree of compliance with 40 CFR 82.154 is poorly documented but under review. The goal of this non-regulatory strategy is improved compliance with this regulation prohibiting the venting of certain types of refrigerant, including HFCs, to the atmosphere when MVACs equipment is serviced or dismantled. Venting is avoided by recovering refrigerants with specialized equipment before dismantling or servicing. The recovered refrigerant can be re-used by the owner or transferred to re-processors approved by U.S. EPA for proper disposal.

The anticipated approach would emphasize enhanced enforcement of existing federal requirements for recovery via audits of activities and documentation. ARB will be involved in implementing the measure. The appropriate offices of the U.S. EPA, and the local air districts where dismantling activity is taking place will also participate in developing and enforcing the measure. The Department of Motor Vehicles and the Bureau of Automotive Repair will be involved because vehicle scrapping facilities are under their jurisdiction.

Assumptions for GHG Reduction

Reductions from dismantling operations could be expressed as a baseline emission rate times the fraction that is practically recoverable times a goal for fraction of vehicle dismantlers who would be prompted to comply with the federal regulation. None of these values is well known at present.

A rough approximation of the potential reductions from dismantling (as presented in the March 2006 Climate Action Team Report and usable until a better alternative is developed) is 0.1 to 0.6 $MMTCO_2E$ per year in 2010 (assuming the program will be in effect then) and 0.07 to 0.3 $MMTCO_2E$ per year in 2020.

Assumptions for Costs and Savings

Some dismantlers may not have the latest compliant hardware for recovering refrigerants or any equipment at all. Each dismantler who must purchase the equipment would have to spend approximately $3000 to $5000 per unit. The number of units needed would depend on

the size of the operation (vehicle throughput). However, this would be an expense that the dismantler has so far avoided only through failure to comply with the existing federal regulation. Thus, this is not a cost burden associated with the proposed strategy.

The same statements apply to obtaining certification for technicians who use the recovery equipment, but with minimal anticipated costs. Training for the U.S. EPA's certification program is offered by various commercial schools. In addition, the Mobile Air Conditioning Society offers free training (a downloadable pamphlet) and a nominal exam fee, so the expense for operator certification should be minimal.

There are costs for storage of recovered refrigerant, record-keeping, and the operators' labor. Again, however, these are expenses already obliged by the federal regulation.

Recovered HFC may have some salvage value, but it is slight.

Measure H-6: High GWP Reduction from Stationary Sources

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
High GWP Recycling and Deposit Program	6.3	1.0	3.6	-2.6^{Δ}
Specifications for Commercial and Industrial Refrigeration	4.0	1.24	0.66	1^{Δ}
Foam Recovery and Destruction Program	1.0	94.8	0	95
SF_6 Leak Reduction and Recycling in Electrical Applications	0.1	0.3	0.4	-0.1
Alternative Suppressants in Fire Protection Systems	0.1	2	0.2	2
Residential Refrigeration Early Retirement Program	0.1	18.9	24.8	-6

Stationary Equipment Refrigerant Management Program

The high-GWP Stationary Equipment Refrigerant Management Program integrates two AB 32 early action measures: High-GWP Recycling and Deposit Program and Specifications for New Commercial and Industrial Refrigeration Systems. These two measures, discussed below, target different areas of the refrigerant value chain for stationary equipment. The Stationary Equipment Refrigerant Management Program approaches the challenge of high-GWP gases management in a more holistic manner integrating all sectors of the value chain.

The incremental annual emission reduction in 2020 based on the 2020 BAU emissions is: 6.6 $MMTCO_2E$ x 20% = 1.3 $MMTCO_2E$

The total emission reduction for 2020 would be:

Total 2019 emission reductions of 5.0 $MMTCO_2E$ + 1.3 $MMTCO_2E$ = 6.3 $MMTCO_2E$

Assumptions for Costs and Savings

Labor and capital costs for monitoring and leak repair and equipment replacement vary for air-conditioning versus refrigeration equipment.

The assumptions for cost and cost savings are as follows:

Monitoring Costs	**Cost per Year / Installation**
General Cost for Monitoring	$100
Monitoring Equipment	$2,500

Leak Repair Costs		
	Air Conditioning	**Refrigeration**
Labor	$2,000	$3,000
Parts & Refrigerants	$500	$8,000
Replacement	$20,000	$500,000

Facility Inventory		
	Air Conditioning	**Refrigeration**
Total Number of Systems	86,000	10,000
Assumes 10,000 facilities have both air condition and refrigeration.		

Specifications for Commercial and Industrial Refrigeration

Overview

The primary analysis to estimate possible direct emissions reductions was to assume new refrigeration systems installed would use secondary loop refrigeration technology, or technologies that meet the same performance standards as secondary loop technology. Additionally, ARMINES' also reviewed the energy savings impact of technical options being applied in all installations, e.g., floating head pressure controls and closed display cases.

Assumptions for GHG Reduction

Although commercial and industrial refrigeration inventory research remains in progress, ARB's refrigeration and air-conditioning (RAC) contractor, ARMINES', preliminary work (available at: http://www.arb.ca.gov/cc/commref/armines_report_03_625.pdf) suggests that the Total Equivalent Warming Impact (TEWI) of current direct expansion refrigeration systems commonly used is 0.0307 $MMTCO_2E$ (approximately two to three times that of a secondary loop system).

Based on literature review it is assumed that 250 new commercial refrigeration systems will be installed in California in the 2012 through 2020 time period – approximately 30 per year

Measure: Methane Capture at Large Dairies

Overview

This is a voluntary measure to encourage the installation of methane digesters to capture methane emissions from the decomposition of solid and liquid waste at large dairies. The methane could be used as an alternative to natural gas in combustion, power production, or as a transportation fuel.

Assumptions for GHG Reduction

Manure Management Emission Reduction Assumptions (dairies with 1,000 head or more)

1,781,799 Head	Total California Herd
6.55 Million Metric Tons	Uncontrolled GHG emissions from California Herd
1,392,888 Head	Total SJVAPCD Herd*
78%	SJVAPCD percentage of total California Herd
330,028 Affected Head	Assumes 73% of dairy cows at dairies with 1,000+ head will already be feeding digesters through voluntary action.
1,223,854 Head	Dairy cows, heifers, calves, and bulls at dairies with 1,000+ head not feeding an existing digester
3.676 tonnes CO2e/head	Includes CH4 and N2O
1.2 Million Metric Tons	Uncontrolled emissions from 330,028 head
86%	Control
1.0 Million Metric Tons	Reductions from 330,028 head
330	Dairies with 1,000 or more dairy cows, heifers, calves, and bulls not already feeding a digeser
1,628	Total dairies in California (2006 CDFA data)

*: Includes all cows in Kern County

Assumptions for Costs and Savings

Staff estimates an operating cost of $33M and an annualized cost for installation of digesters at $123M for this measure based on an average capital cost of $3.9M per digester. No savings is assumed. However, the cost for this voluntary measure is not included in the economic modeling as the reduction is not required as part of the AB 32 GHG emissions reduction program.

Cost and Savings Calculation	
Cost per digester	$3.9M
# of large dairies (with more than 100 head)	330
Capital cost	$1,280M
Capital life	15 years
15-year CRF	0.09634
Annualized capital cost 2020 (capital cost x CRF)	$123.3M
Operating cost 2020 ($100k)	$33M
Total cost 2020	$156M

Forests

GHG Reduction Measure	Potential 2020 Reductions $MMTCO_2E$	Annualized Cost ($Millions)	Savings ($Millions)	Net Annualized Cost ($Millions) [Cost-Savings]
Sustainable Forest Target	5	50	0	50

Measure: Sustainable Forest Target

Overview

Reductions from this target will be achieved through conservation, forest management, reforestation, afforestation urban forestry and fuels management projects. The forest net flux, that is the balance between uptake and emissions, is currently -5 $MMTCO_2E$.

Assumptions for GHG Reduction

A target reduction of 5 $MMTCO_2E$ is required forest sector to maintain the current net flux based on inventory projections.

Assumptions for Costs and Savings

Staff estimates a net cost of $50M to achieve a 5 $MMTCO_2E$ reduction based on the current voluntary offset price of approximately $10 per $MTCO_2E$.