SL1: Short-Lived Climate Pollutants

Brief Summary:
This measure describes actions that the Air District will implement to reduce emissions of short-lived climate pollutants (SLCPs), also known as super-GHGs.

Purpose:
The purpose of this measure is to protect the climate by reducing emissions of super-GHGs. Reducing super-GHG emissions can help to restrain global warming in the near term, thereby complementing efforts to reduce CO_2 emissions over the long term.

Source Category:
The term "short-lived climate pollutant", or super-GHGs, refers to a diverse group of climate forcers[1] that have a relatively short lifetime in the atmosphere, but high global warming potential (GWP). GWP is a measure of how much heat a greenhouse gas traps in the atmosphere relative to CO_2 and can be expressed in either a 100-year or 20-year timeframe. A 100-year GWP works well for most of the proposed control measures in the 2017 Plan. However, for short-lived climate pollutant measures, it is more relevant and appropriate to use a shorter 20-year time horizon. Emission reductions expressed using a 20-year time frame highlight the much greater near-term benefit of actions to address short-lived climate pollutants that have a high GWP.

Super-GHGs addressed in this measure, with their GWP values[2], include:
- Methane (100-year GWP = 34; 20-year GWP = 86)
- Black carbon (BC) (100-year GWP = 900; 20-year GWP = 3,200)
- Fluorinated gases (F-gases) [3] (100-year GWP ranges from 140 to 23,900; 20 year-GWPs generally increase by a factor of 2-3)

Methane is the second leading GHG in the Bay Area inventory, after CO_2. Three source categories currently account for approximately 84 percent of total methane emissions in the Bay Area:
- Landfills: 53 percent
- Livestock: 16 percent
- Natural gas production and distribution: 15 percent

[1] A "climate forcer" is defined as any gas or particle that alters the Earth's energy balance by absorbing or reflecting solar radiation.
[2] GWP values are derived from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2013). See Chapter 8 of Working Group 1 report.
[3] In this document, we use the term "fluorinated gases" for this category of climate forcers to be consistent with terminology at the State level. The term "high GWP gases" is also sometimes used to describe this category of climate pollutant.

Recent studies indicate that current federal, state and regional methods for estimating methane emissions may be under-reporting methane by as much as 50 percent.[4] The Air District will pursue a Basin-wide Methane Strategy (see control measure SS16) to address methane emissions in the region. The strategy includes an effort to better quantify and characterize Bay Area methane emissions, as described in control measure SL3: Greenhouse Gas Monitoring and Measurement Network.

Black carbon, often referred to as soot, is a component of fine particulate matter. In addition to its effects in heating the climate, BC also has negative impacts on public health. Leading sources of BC emissions in the Bay Area include diesel engines and residential wood-burning. As climate change intensifies droughts in California, emissions of BC from wildfires are expected to increase. Some wildfires occur within Air District boundaries, but the Bay Area is also affected by wildfires in surrounding counties. Besides heating the climate, emissions of BC from wildfires impact public health in the Bay Area on an episodic basis.

Fluorinated gases are man-made compounds, many of which are potent climate forcers. Hydrofluorocarbons (HFCs) are the most prevalent F-gases in the Bay Area. HFCs are used in refrigeration and air conditioning systems in commercial, industrial, and residential applications, as well as air conditioning in motor vehicles.

Regulatory Context and Background:
Collectively, super-GHGs account for a significant portion of the total Bay Area GHG inventory, especially if global warming potential is measured over a twenty-year timeframe rather than 100 years. Because super-GHGs have a relatively short atmospheric lifetime, reducing SLCP emissions offers an effective means to reduce GHG emissions in the near term, while strategies to reduce emissions of longer-lived GHGs such as CO_2 are developed and implemented. In addition to directly reducing GHG emissions, near-term actions to decrease super-GHGs can slow climate feedback mechanisms in the Arctic and elsewhere (such as the release of CO_2 and methane caused by the thawing of permafrost) that would otherwise further accelerate global warming. According to the Air Resources Board (ARB), reducing emissions of super-GHGs on a global scale can:

- Cut global warming in half, by 0.6°C in 2050, and by 1.4°C in 2100.
- Reduce warming in the Arctic by two-thirds (0.7°C) by 2040.
- Reduce sea level rise by 25 percent.
- Increase chances of keeping average warming below 2°C to greater than 90 percent by 2050.

In his January 2015 inaugural address, Governor Brown identified reducing SLCP emissions as one of five key pillars of the state's climate protection strategy. The ARB released a draft SLCP

[4] For example, a recent study by a team of Stanford University researchers published in the February 14, 2014 edition of *Science* found that leakage from natural gas pipelines may be a significant source of methane emissions. See http://www.nytimes.com/2014/02/14/us/study-finds-methane-leaks-negate-climate-benefits-of-natural-gas.html?_r=0

Reduction Strategy in April, 2016. Once the final SLCP Reduction Strategy has been reviewed and approved by the ARB Board, the Air District will take appropriate actions to help implement and support the statewide SLCP strategy. In September 2016, Governor Brown signed SB 1383, known as the Super Pollutant Reduction Act, which targets the following reductions in SLCPs to meet the State's long-term GHG reduction goals: 50 percent black carbon, 40 percent methane and 40 percent HFC gases in California by 2030.

Because of their high global warming potential and relatively short atmospheric lifetime, the various SLCPs are often grouped together as a single, separate category of climate pollutants. However, the SLCPs differ in terms of their sources, their projected emission trends, and the specific mechanism by which they contribute to global warming. Therefore, the emission reduction measures for each type of SLCP must be tailored to reflect its specific attributes.

The Air District has been working to reduce emissions of super-GHGs, in conjunction with federal, state, and local efforts to regulate these pollutants. The US EPA and the California ARB have both been pursuing measures to reduce methane emissions. The Air District already limits emissions from key sources of methane via regulation and/or permits from landfills (e.g., Regulation 8-34), composting operations, and natural gas production and distribution (e.g., Regulation 8-37). Additional Air District measures to further reduce methane emissions are described in the "Implementation Actions" section below.

Over the past 10-15 years, there has been great progress in reducing black carbon in response to (1) ARB regulations to reduce emissions from diesel engines, (2) Air District grant programs to reduce emissions from heavy-duty diesel vehicles and equipment, and (3) reductions in wood smoke as a result of the Air District's efforts to reduce wood-burning during winter months. Bay Area BC emissions are projected to continue decreasing through 2020. However, in the absence of additional policies and programs (beyond those already adopted), BC emissions are projected to begin increasing once again from 2020 through 2030 as the Bay Area economy grows and the number of diesel engines increases. Therefore, additional measures may be needed to prevent an increase in BC emissions and to protect public health from exposure to harmful particulate matter.

Emissions of F-gases are regulated at the international, national, and state level. At the global scale, in October 2016, international negotiators reached an important binding agreement, an amendment to the Montreal Protocol, to phase out the production and use of HFCs. In addition, some 50 nations, including the US as well as 50+ partner organizations, have joined the *Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants*. The Air District works to enforce State of California F-gas regulations in the Bay Area. For example, to promote compliance with the state regulation to reduce HFC emissions from commercial and industrial refrigeration systems, the Air District entered into a memorandum of understanding with ARB to ensure that regulated sources register their facilities with ARB and comply with program requirements. Although the State's regulation requires detected leaks to be fixed within 14 days, smaller systems that are subject to the regulation only have to perform leak inspections once a year. For leaks that go undetected in these and larger systems, it is possible a system could lose its entire charge of high-GWP refrigerant and still be in compliance if the leak is then fixed. Also, many systems have higher leak rates than the estimated average of 20-25 percent annually, leaving opportunities for better control of these emissions.

Additionally, the regulation does not include comfort cooling systems (such as air conditioning units in office buildings), multi-family residences, hotels or other commercial, industrial or institutional spaces such as schools. F-gas emissions from these systems that occur during normal operation or maintenance are not reported and may be significant.

Implementation Actions:
Key Air District implementation actions to reduce emissions of super-GHGs are summarized below, with reference to control measures that address super-GHG emissions from several different economic sectors. For additional detail, see the control measures cited in parentheses.

Reduce methane emissions:
- Reduce methane emissions from landfills by amending Rule 8-34 to increase stringency of control and fugitive leak standards, and improve consistency with the State of California Landfill Methane Control Measure federal rules (see WA1).
- Reduce the amount of waste material entering landfills by expanding recycling and waste diversion (see WA4).
- Reduce the amount of waste material entering landfills by increasing the amount of organic material diverted to composting (see WA3).
- Develop model policies that can be employed by local agencies, such as adopting a zero waste ordinance, requiring large commercial and institutional facilities to use compost in their landscaping operations rather than employ artificial fertilizers, and requiring the recycling of construction and demolition materials in all commercial projects and public infrastructure projects (see WA3 and WA4).
- Promote the use of biogas recovery/anaerobic digester systems at Bay Area farms (see AG2).
- Work with the animal farming community to reduce methane emissions from enteric fermentation (see AG3).
- Collaborate with ARB and/or CPUC to develop a rule or rule amendments to reduce methane emissions from natural gas production, processing and storage operations (see SS13: Natural Gas and Crude Oil Production, Processing and Storage) and natural gas pipelines and processing operations (see SS15: Natural Gas Processing, Storage and Distribution).
- Reduce methane emissions from capped natural gas wells (see SS14).
- Continue to implement the amendments to Regulation 8-18, adopted in December 2015, to reduce emissions of methane and other organic gases from equipment leaks at oil refineries (see SS2: Equipment Leaks).

Reduce black carbon emissions:
- Continue and intensify Air District efforts to reduce residential wood-burning (see SS34: Wood Smoke).

- Implement programs to further reduce emissions from diesel-powered back-up generators (see SS32: Emergency Backup Generators).
- Provide grants and incentives to reduce emissions of particulate matter and BC from heavy-duty vehicles (see TR19: Medium- and Heavy-Duty Trucks).
- Continue to enforce ARB diesel regulations in the Bay Area communities most impacted by PM emissions.
- Monitor and support ARB efforts to promote more efficient drive trains in heavy-duty vehicles.
- Pursue strategies to reduce motor vehicle use, as described in various transportation measures, and to decarbonize the transportation sector by promoting alternative fuel vehicles, as described in TR14 (Cars and Light Trucks).

Reduce F-gas emissions:

- Continue to enforce ARB's regulation to reduce leaks from commercial and industrial refrigeration systems that use high-GWP refrigerants.
- Explore potential regulatory options to identify and reduce F-gas emissions in large refrigeration and/or air conditioning systems
- Incentivize leak detection and remediation in large refrigeration and air conditioning systems.
- Develop and promote best practices for leak avoidance, identification and remediation in refrigeration and air conditioning systems
- Incentivize early adoption of low-GWP refrigerants in commercial, industrial and residential refrigeration and air conditioning system retrofits and new installations, including a requirement that disposal of any replaced high-GWP refrigerant follow stringent practices.
- Support the adoption of more stringent regulations by ARB and/or US EPA, such as production phase-downs and sales restrictions of high-GWP refrigerants.
- Encourage better HFC disposal practices of high-global warming potential refrigerants.
- Develop or identify an existing model high-GWP refrigerant disposal ordinance and encourage local governments to adopt such an ordinance.
- Promote measures, such as the Air District's vehicle buy-back program described in control measure TR14 (Cars and Light Trucks), to accelerate turnover in the vehicle fleet of older model vehicles using high-GWPs in their air conditioning systems to vehicles that use low-GWP refrigerants.

Emission Reductions:
The potential emission reductions for many of the implementation actions described above are discussed in specific control measures which those implementation actions proposed for the agriculture, energy, stationary source, and waste sectors. The implementation actions related to F-gases are not duplicative of other control measures and their estimated emission reductions are discussed here. Total emission reductions of F-gases from this control measure are estimated to be 13,200 MT CO2e per year, on a 20-year timeframe, and 6,600 MT CO2e on a 100-year timeframe in 2020. In 2030, reductions are estimated to be 57,200 MT C02e per year, on a 20-year timeframe and 28,600 MT CO2e per year, on a 100-year time frame.

Pollutants*	2020	2030
CO_{2e}	6,600	28,600

**CO_{2e} is reported in metric tons/year (100 yr GWP) in this table*

Emission Reduction Methodology:
Reductions of F-gas emissions for this control measure focus on the impacts of providing incentives for early adoption of low-GWP refrigerants in commercial and industrial refrigeration systems. These reductions are considered additional to State and federal policies. Emission reductions for this measure were calculated based on ARB's proposed Short-Lived Climate Pollutant Reduction Strategy released in April 2016. ARB estimates 2 $MMTCO_2e$ reductions (20 year GWP) could be achieved statewide through a $20 million investment. This dollar per ton cost effectiveness was multiplied by 0.20 to account for the District's portion of the State's population. A typical leak rate of 15-20 percent for large commercial refrigeration systems was assumed.

Exposure Reduction:
Decreasing emissions of black carbon will reduce population exposure to soot and thus help to reduce the wide-ranging health effects related to fine PM and the cancer risk associated with exposure to diesel PM.

Emission Reduction Trade-offs:
Some technologies that reduce PM emissions from vehicles may slightly decrease fuel efficiency. In these cases, it is possible that emissions of CO_2 may slightly increase.

Cost:
The potential costs for many implementation actions described above are discussed in the specific control measures proposed for the agriculture, energy, stationary source, and waste sectors.

The cost/benefit data provided in the table below illustrates that prior regulatory actions at the State level associated with reducing emissions of F-gases associated with refrigerants appear to be cost effective (data is from ARB's Refrigerant Management Program). However, potential Air District regulatory and/or programmatic activities are unknown at this time and therefore a cost/benefit analysis will be performed when and if specific regulatory actions are identified for the Bay Area.

Annual costs	Facilities with small systems (50-200 lbs. high GWP refrigerant)	Facilities with medium systems (200 – 2,000 lbs.)	Facilities with large systems (>2,000 lbs.)
Total gross cost	$651	$2,770	$5,410
Refrigerant savings	$637	$2,740	$14,130
Total net annual cost	$14	$30	$8,720 (savings)

Co-benefits:
Decreasing emissions of black carbon will protect public health by reducing population exposure to fine PM. Mitigating leaks of F-gases in refrigeration and air conditioning increases the efficiency of the system and offsets the cost of mitigation.

Issues/Impediments:
None identified at this time.

Source:

1. Air Resources Board. *Proposed Short-Lived Climate Pollutant Reduction Strategy*. April 2016
2. Air Resources Board. *Initial Statement of Reasons for Proposed Regulation for the Management of High Global Warming Potential Refrigerants for Stationary Sources Appendix C: Economic Estimates*. October 23, 2009.

SL2: Guidance for Local Planners

Brief Summary:
The Air District will develop guidance to help local agencies address short-lived climate pollutants (SLCPs), or super-GHGs, in their climate action plans and programs.

Purpose:
The purpose of this measure is to encourage local agencies to include actions to reduce super-GHG emissions in their climate plans and programs.

Source Category:
The term "short-lived climate pollutants", or super-GHGs, refers to a diverse group of climate forcers[1] that have a relatively short lifetime in the atmosphere, but have high global warming potential (GWP).[2] Super-GHGs addressed by this control measure include:

- Methane
- Black carbon (BC)
- Fluorinated gases (F-gases)

Methane is the second leading GHG in the Bay Area inventory, after CO_2. Three source categories currently account for 90 percent of total methane emissions in the Bay Area:

- Landfills: 50 percent
- Animal waste: 27 percent
- Natural gas production and distribution: 13 percent

Leading sources of BC emissions in the Bay Area include diesel engines and residential wood-burning.

Hydrofluorocarbons (HFCs) are the most prevalent of the fluorinated gases in the Bay Area. HFCs are used in refrigeration and air conditioning systems in commercial, industrial, and residential applications, as well as air conditioning in motor vehicles.

Regulatory Context and Background:
As described in control measure SL1, super-GHGs account for a significant portion of the total Bay Area greenhouse gas (GHG) inventory. Current and proposed regulatory measures to reduce super-GHG emissions are also described in SL1. Because super-GHGs have a relatively short atmospheric lifetime, reducing super-GHG emissions offers an effective means to reduce GHG emissions in the near term, while strategies to reduce emissions of longer-lived GHGs such as carbon dioxide (CO_2) are developed and implemented. In addition to directly reducing GHG

[1] A "**climate forcer**" is defined as any gas or particle that alters the Earth's energy balance by absorbing or reflecting solar radiation.
[2] In this document, we use the term "short-lived climate pollutants" for this category of climate forcers in order to be consistent with terminology at the State level. However, the term "high GWP gases" might be more accurate to describe this category since most fluorinated gases have long lifespans in the atmosphere, as discussed below.

emissions, near-term actions to decrease super-GHG emissions can slow climate feedback mechanisms in the Arctic and elsewhere (for example, the release of CO_2 and methane caused by the thawing of permafrost) that would otherwise further accelerate global warming. According to the Air Resources Board (ARB), reducing emissions of super-GHGs on a global scale can:

- Cut global warming in half, by $0.6^{o}C$ in 2050, and by $1.4^{o}C$ in 2100.
- Reduce warming in the Arctic by two-thirds ($0.7^{o}C$) by 2040.
- Reduce sea level rise by 25 percent.
- Increase chances of keeping average warming below $2^{o}C$ to greater than 90 percent by 2050.

In his January 2015 inaugural address, Governor Brown identified reducing SLCP emissions as one of six key pillars of the state's climate protection strategy. The ARB released a draft statewide SLCP Reduction Strategy in April 2016. The draft statewide SLCP strategy identifies a number of potential opportunities for local actions to reduce super-GHG emissions. ARB staff is currently preparing a final version of the strategy for review and approval by the ARB board.

Many local agencies in the Bay Area play an important role in reducing emissions of GHGs by implementing policies that complement state and regional programs. Some local agencies already address super-GHGs in their climate action plans, primarily via measures that would help to reduce methane emissions from landfills, water treatment, or agriculture. In addition, several local climate action plans include measure to address F-gases. For example, the Marin County climate action plan includes a measure to implement best management practices to reduce F-gas emissions from the use and disposal of refrigerants. The City of Livermore climate action plan includes several potential measures to reduce emissions of F-gases, and the City of El Cerrito climate action plan calls for developing a local policy to reduce emissions of F-gas refrigerants to the lowest achievable and practical levels.

To date, however, most of the 60+ local climate action plans adopted by Bay Area cities and counties primarily focus on reducing emissions of CO_2. Local governments can potentially increase the scope and effectiveness of their climate action plans by adding super-GHGs to their local GHG inventories and including measure to reduce super-GHGs in their climate action strategies.

Implementation Actions:

The Air District will encourage local agencies to help reduce emissions of super-GHGs in the Bay Area by:

- Providing information to local agencies to describe the current and projected emissions of super-GHGs and their contribution to the overall regional GHG inventory.
- Explaining why reducing super-GHG emissions can be an important element of a comprehensive local
  climate action plan and providing technical assistance to develop or update climate action plans to address super-GHGs.
- Suggesting potential policies or measures that local agencies can implement to reduce super-GHG emissions (see examples of potential actions described below).

- Tracking progress in adoption of super-GHG reduction measures in local plans via its database that catalogs local GHG policies.

Examples of potential actions that local agencies can take to reduce super-GHG emissions are described below.

Methane reductions:

- Reduce methane emission from landfills by diverting food waste and organic materials from the waste stream (see WA2).
- Work with the farming community to promote practices and projects that reduce methane from agriculture, such as promoting dairy digesters (see measures AG1 and AG2).

Black carbon reductions:

- Promote the use of alternative fuel vehicles in local fleets and communities in order to reduce emissions of black carbon from diesel engines.
- Promote the use of the cleanest available construction equipment in local projects, promote the use of clean construction equipment as a CEQA mitigation measure, and monitor project implementation to ensure compliance with clean equipment requirements.
- Support the Air District's efforts to reduce residential wood-burning.
- Consider collaborating with land management and fire agencies to promote land use and forestry practices that reduce the chance of large-scale wildfires.

F-gas reductions:

- Take action to minimize F-gas emissions from use and/or disposal of air conditioning systems, motor vehicles, refrigeration units, and other sources.

Emission Reductions:
No emission reduction estimates have been quantified for this measure.

Exposure Reduction:
Decreasing emissions of black carbon will reduce population exposure to soot and thus help to reduce the wide-ranging health effects related to fine PM and the cancer risk associated with exposure to diesel PM.

Emission Reduction Trade-offs:
None identified.

Cost:
No significant costs associated with this measure are identified at this time.

Co-benefits:

Decreasing emissions of black carbon will protect public health by reducing population exposure to fine PM.

Issues/Impediments:
No significant issues or impediments are identified at this time.

Source:

1. Air Resources Board. *Draft Short-Lived Climate Pollutant Reduction Strategy*. April 2016

SL3: Greenhouse Gas Monitoring and Measurement Network

Brief Summary:
This measure facilitates the Air District's continued efforts to operate a fixed site greenhouse gas (GHG) monitoring network across the San Francisco Bay Area.

Purpose:
This control measure will increase the Air District's knowledge of methane and other GHG emission sources in the Bay Area by identifying emission 'hotspots', facilitate verifying and validating the Air District's regional methane emissions inventory, and to ultimately evaluate the efficacy of policy measures and regulatory actions adopted and implemented by the Air District.

Source Category:
This measure is related to information gathering and is not specific to any particular source category.

Regulatory Context & Background:
The Air District traditionally estimates emissions for the regional GHG inventory using a bottom-up methodology. In this approach, emission factors (e.g. the amount of methane emitted per unit of biomass burned), based on accepted studies and practices, are combined with activity data (e.g. population density, fuel consumed) to generate source-specific emissions estimates. This approach is consistent with how the Air Resources Board (ARB) and the U.S. Environmental Protection Agency (EPA) develop statewide and national GHG inventories, respectively. As methane measurement technologies have improved over the last decade, there is increased interest within the scientific community to verify and validate the estimates in the bottom-up inventories using a variety of top-down observational techniques that depend on direct measurement of methane concentrations in the atmosphere. Recent literature suggests that traditional bottom-up methods of generating emission inventories in California may be significantly under-estimating actual emissions of methane (Wunch et al., 2009; Hsu et al., 2010; Wennberg et al., 2012; Peischl et al., 2013; Jeong et al., 2014). In a recent study that utilizes methane data collected over the last two decades from several Air District monitoring stations (Fairley and Fischer, 2015), the authors conclude that the resulting methane emissions are 1.5 to 2 times greater than the Air District's bottom-up inventory estimates. With this control measure, the Air District intends to resolve this data gap through source-specific measurements of methane throughout the Bay Area.

The first phase of this program focused on setting up a long-term GHG monitoring network at four sites. One of the four sites is located north and generally upwind of the urban core at Bodega Bay along the Pacific Coast. This site receives clean marine inflow from the west-northwest and hence provides a regional background level of ambient methane. The other three sites are strategically located at exit points for Bay Area wind paths that contain concentration enhancements generated from Bay Area GHG sources added to the prevailing background concentrations. These stations are at San Martin, which is located south and generally downwind of the San Jose metropolitan area; at Patterson Pass, which is at the cross section of the eastern edge of the Bay Area with California's Central Valley; and at Bethel Island at the mouth of the Sacramento-San Joaquin Delta. At all sites, carbon dioxide and methane are being measured continuously, along with carbon monoxide (acting as a source tracer for combustion emissions) and other air pollutants.

The second phase of the program will include use of a van to serve as a mobile GHG measurement platform, equipped with state-of-the-art instruments capable of measuring not only methane, carbon dioxide and carbon monoxide, but also nitrous oxide (N_2O), isotopic methane and the hydrocarbon tracer ethane. There are a variety of local stationary GHG sources in the Bay Area including landfills, wastewater treatment plants, dairies, oil refineries, natural gas cogeneration plants, gas pipelines etc. Measurements of concentrations of GHGs conducted upwind and downwind of such sources will be combined with short-range measurement techniques and an atmospheric dispersion model to verify source emission rates. The isotopic information will aid in source attribution. These measurements from local sources will allow verification and validation of the Air District's regional GHG emissions inventory for the Bay Area.

Implementation Actions:

- Continue development of a GHG monitoring plan for the Bay Area that includes strategic selection of measurement locations, selection of relevant measurement technologies and procurement of appropriate GHG instrumentation, calibration gas standards and sampling logistics.
- Operate and maintain the fixed-site GHG monitoring network.
- Report monitoring data on the Air District's website for access by the public and scientific community alike.
- Utilize an ultraportable methane analyzer to detect emissions hotspots in the Bay Area.
- Analyze date from fixed-site network data to develop future source-specific investigation plans.
- Fabricate and equip the Air District's mobile measurement van with high resolution instrumentation, meteorological devices, and related equipment for localized GHG measurements.
- Collaborate with the scientific community to use different methods to estimate regional methane emissions for the Bay Area utilizing top-down observations, estimate methane mass emission rates from individual sources and facilities, and develop spatially resolved maps of methane emissions.

Emission Reductions:

This control measure will inform policy, program and rule development efforts targeted at methane emission reductions.

Emission Reduction Methodology:

This control measure will not directly reduce emissions.

Exposure Reduction:
This control measure will not directly impact emission exposure.

Emission Reduction Trade-Offs:
This control measure will not directly impact emissions.

Cost:
To date, approximately $600,000 has been invested in the GHG monitoring network. The majority of this amount (~ $570,000) has been spent on procuring eight sophisticated and top-of–the-line GHG instruments that will be the core of the GHG stationary and mobile network. Existing Air District staff operate and maintain the equipment and evaluate the data collected.

Co-Benefits:
In addition to improving the Air District's methane emissions estimates, the GHG monitoring and measurement network also includes CO_2 measurements at the fixed-site locations, and both CO_2 and N_2O aboard the mobile platform. There is significant uncertainty in ARB's bottom-up N_2O emissions inventory especially in the transportation sector (Guha et al., 2015) that needs to be investigated through top-down studies. The N_2O measurement capability is a powerful tool to better understand the Bay Area's N_2O emission sources. Additionally, the methane measurement infrastructure will attract potential collaborators in academic and research institutions, building knowledge which will be critical to the implementation of other control measures in the 2016 Plan.

Issues/Impediments:
Methane source identification and attribution becomes more robust when accompanied by simultaneous measurement of source markers e.g. volatile organic compounds like ethane (to detect methane from fugitive oil and gas sources) and methanol (to detect methane from dairy and livestock sources). Adding additional measurement capability to the GHG mobile platform would require additional financial resources.

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