

# EVALUATION OF A VARIETY OF F-GAS EMISSION REDUCTION STRATEGIES

## I. OBJECTIVE

This project identifies the optimal policy or combination of policies needed to achieve targeted 2030 and 2050 reductions of fluorinated gas (F-gas) emissions in California. The optimal design of an F-gas fee program, including distribution of fee revenues, will be specified in light of comparable regulatory experience. Emission reduction strategies other than fees will also be evaluated and compared according to their cost-effectiveness, feasibility, economic efficiency and distributional effects, and interaction with other emission control programs. Project results will inform the design of ARB's medium and long-term F-gas emission control programs.

## II. BACKGROUND

High global warming potential (high-GWP) gases contribute to global warming at a level hundreds to thousands of times greater than carbon dioxide. A majority of future high-GWP emissions in California will be comprised of F-gases, which are used primarily in refrigeration, air conditioning, insulation and pesticide applications. Emissions of high-GWP F-gases are four percent of today's statewide GHG inventory, but they are the fastest-growing GHG source in California because F-gases are replacing ozone-depleting substances (ODS substances) in response to Montreal Protocol mandates. ARB Scoping Plan control programs already target high-GWP emissions, but even with these regulations in place, annual F-gas emissions in California are projected to increase by about 40 percent (from 18 to 25 MMTCO<sub>2</sub>e) between 2012 and 2020, and more than double by 2050, to 43 MMTCO<sub>2</sub>e.

High-GWP emissions from refrigeration, air conditioning and foam insulation are fugitive emissions due to leakage or inappropriate disposal. Other sources, such as inhalers, aerosol propellants, medical sterilants, industrial solvents, semiconductor manufacturing, and pesticides, are emissive by design. Control programs must address both types of emission sources.

The diversity of F-gas emission sources, a dearth of cost-effective, low-GWP alternatives, and the difficulty of enforcement in end-user sectors all pose challenges to future emission reduction programs.

## III. SCOPE OF WORK

To ensure that future F-gas control programs achieve reductions in the most reliable, cost-effective and economically efficient manner, relevant regulatory experience will be reviewed and its lessons applied to a systematic comparative analysis of potential F-gas emission reduction strategies. Study goals will be accomplished in four phases: information collection; fee program analysis; optimal policy analysis and the final report. Interim deliverables will mark the completion of each of the first three phases.

## **A. Information Collection**

Investigators will review and summarize peer-reviewed literature and other information relevant to primary study goals, organized around three broad themes: characterization of the F-gas sector; F-gas technology assessment; and control policy design insights from related regulatory experience.

***F-gas sector characterization*** will cover the properties, sources and uses of F-gases. Market size, segmentation and structure of California's F-gas market will be covered, as will pricing, sales and emissions inventory (historical and projected). Drivers of demand for F-gases will be identified and abatement opportunities through 2050 will be quantified in the form of a marginal abatement cost curve.

***F-Gas Technology Assessment*** will review the most recent information on potential low-GWP replacement technologies for both F-gases and F-gas-using products and systems. Emerging technologies for leak detection and management, as well as recovery/destruction of F-gas "banks" will be included.

***Regulatory Policy Design*** will extract policy design insights from relevant GHG and high-GWP regulatory programs including market-based compliance systems, performance standards, fee, refund-deposit, voluntary and incentive programs. Feasibility, enforceability and potential economic impacts of design features will be considered.

**Interim Deliverable:** Summary of findings, with abatement cost estimates.

## **B. F-gas Fee Program Analysis**

Investigators will systematically evaluate options for both F-gas fee design and application of fee revenues.

***F-gas Fee Design*** -- Compare potential approaches to an F-gas fee program in California by systematically assessing their advantages, disadvantages and likely environmental and economic impacts. Draw on experience with fee-based and other high-GWP control programs to estimate the price elasticity of demand for F-gases and F-gas-intensive products/services. Specify the parameters of the optimal fee program design, including: point of regulation; fee basis, form and level; implementation mechanism; formula; and means for adjustment. Estimate fee collection revenues and costs.

***Uses of F-gas Fee Revenues*** -- Assuming a California F-gas fee program as designed above, investigators will assess the advantages and disadvantages of various approaches to distributing collected funds, while achieving targeted emission reductions. Potential applications of funds should include: "Fee & Dividend"; emission abatement; mitigation;

incentive; research; demonstration; commercialization; and training programs. Investigators will prioritize potential uses of funds.

Both F-gas fee collection and distribution program options should be evaluated by multiple criteria, including:

- Estimated emission reductions and co-benefits;
- Cost, cost-effectiveness;
- Feasibility;
- Economic impacts and their distribution;
- Enforceability and the potential for leakage;
- Interaction with other (state, federal, international) regulatory programs.

**Interim Deliverable:** F-gas Fee Program Analysis findings and recommendations.

### **C. F-Gas Emission Reduction Optimal Policy Analysis**

Evaluate an inclusive menu of policy options, including sector-specific prohibitions, cap & trade variants, performance standards, deposit-refund schemes, targeted abatement and mitigation programs, as well as the fee program options specified in Part B, above. Applying transparent criteria and assumptions, investigators will systematically compare F-gas emission reduction policy options to identify the policy or combination of policies that offers the optimal approach to achieving targeted 2030 and 2050 F-gas emission reductions. ARB staff will be consulted regarding legal authority or constraints. The optimal regulatory design and two “next-best” alternative control programs will be identified. Policy options will be clearly defined and evaluated using multiple criteria, including, but not limited to:

- Net environmental impacts;
- Reliability and verifiability of reductions;
- Co-benefits, including health impacts;
- Cost and cost-effectiveness;
- Administrative and technological feasibility;
- Economic impacts and their distribution;
- Enforceability and the potential for emissions/economic leakage;
- Interaction with other regulatory programs and jurisdictions.

**Interim Deliverable:** F-gas Policy Scenario Analysis Findings

### **D. Final Report & Recommendations**

The final report will integrate and summarize the findings and interim deliverables of the first three study activities. It will include a detailed presentation of the short-listed regulatory program designs and estimated impacts. A summary matrix will be included.

#### **IV. DELIVERABLES**

- Quarterly progress reports and conference calls;
- Draft final report;
- Peer-reviewed publication(s), as appropriate;
- Final report and research seminar in Sacramento;
- All data and analyses generated through the course of this project;
- Additional deliverables to be determined in consultation with ARB staff.

#### **V. TIMELINE AND BUDGET**

It is anticipated this project will be completed in 24 months from the start date. This allows 18 months for completion of all work through delivery of a draft final report. The last 6 months are for review of the draft final report by ARB staff and the Research Screening Committee (RSC), modification of the report by the contractor in response to ARB staff and RSC comments, and delivery of a revised final report and data files to the ARB. The estimated budget for this project is \$300,000.