

U.S. VOLUNTARY APPROACHES TO REDUCE FLUOROCARBON AND METHANE EMISSIONS

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Abstract: *The United States has taken aggressive steps to reduce emissions of methane and fluorocarbons. The U.S. may be unique in the world in the scope of its non-CO₂ programs, which are for the most part voluntary in nature. This paper describes U.S. policies and practices to reduce methane, HFCs, PFCs and SF₆ emissions. Information is provided on the strategic approach of these programs, their development and structure, and results to date. These programs illustrate the six elements of “best practices” in policies and measures: flexibility over time and space; public policy fit; cultural and institutional fit; economic fit; technological fit and accountability.*

Introduction

The United States focuses on reducing emissions of non-CO₂ greenhouse gases (NCGGs) because of their environmental significance and their economic attractiveness. These gases accounted for 18% of U.S. greenhouse gas emissions in 1990, and their share is expected to increase to 19% by 2010 under a “Business as Usual” case. As a result of voluntary action with industry, however, the emission growth rate will be substantially reduced.

The principal focus of U.S. activities on NCGGs is reducing emissions of methane and the high-GWP gases (HFCs, PFCs, and SF₆). Methane reductions are emphasized because of the cost-effectiveness of expanded methane collection and use and the near-term environmental benefits of reducing methane emissions. Due to its short atmospheric lifetime, near-term methane reductions can substantially mitigate the effects of global warming over the next several decades. The high-GWP gases are also an important focus of US efforts, primarily because of their potential for growth and the longevity of PFCs and SF₆ in the atmosphere. Since emissions of these gases are essentially irreversible, the United States has active programs to minimize emissions. The U.S. does not currently have extensive programs to reduce N₂O emissions, although various voluntary options are under consideration.

A review of U.S. experience in reducing these gases illustrates the breadth and scope of “best practices” in policies and measures.

U.S. Methane Programs

U.S. methane emissions totaled 180 mmtce (31 Tg) in 1997, a 6% increase over 1990 levels. Historic and projected emissions by source are shown in Table 1. The U.S. began to investigate opportunities to reduce methane emissions in 1990, and in 1993 introduced its first voluntary methane reduction program. Today, five voluntary programs are reducing methane emissions from the major U.S. sources (landfills, natural gas and oil systems, ruminant livestock, coalmines, and animal waste management systems). The special features and main elements of each program are described below:

Table 1: U.S. Business As Usual Methane Emissions, 1990 – 2010 (in mmtce)

Emission Source	1990	2000	2010
Landfills ⁺	64.8	51.4	52
Coal Mines	25.8	23.9	28
Natural Gas	32.9	35.6	37.9
Enteric Fermentation	35.7	35.2	36.6
Animal Waste Management	14.9	18.4	22.3
Other	9.2	11.2	13.2
Total	183.3	175.7	190

+ includes impact of the Landfill Rule.

The *Landfill Methane Outreach Program* works with all of the organizations involved in landfill gas-to-energy projects to remove barriers to project development, including landfill owner/operators, state and municipal government agencies, electric utilities and industrial companies (who may purchase the gas or electricity) and the landfill gas-to-energy industry. The program does not provide financial support to projects, but instead provides technical assistance for project development, as well as assistance on permitting and other issues. A variety of technical tools have been developed, including profiles of candidate landfill sites, and project development software. Since 1994, when the program began the number of U.S. landfill gas-to-energy projects has almost tripled, and there are currently almost 300 such projects in the United States.

The *Natural Gas STAR Program* works with natural gas companies to reduce methane emissions from all segments of the U.S. natural gas system (production, transmission, distribution, storage and processing). The program currently has over 70 corporate partners, who have signed Memoranda of Understanding with USEPA under which they agree to assess the applicability within their system of several “Best Management Practices (BMPs)” to reduce methane emissions. USEPA provides partners with technical and economic information on BMPs as well as over 50 additional gas saving practices that partners have reported. USEPA also creates opportunities for technology transfer within the industry through workshops and conferences, and provides partners with recognition for their environmental stewardship. Cumulative

methane reductions reported to the program through 1998 total 72 Bcf of gas (worth more than \$150 million at a price of \$2/mcf).

The *Coalbed Methane Outreach Program* works with underground coal mines to reduce methane emissions. The program provides technical assistance to mines to assess project feasibility, and has investigated and publicized several innovative technologies for using methane recovered during coal mining. Since 1994, the amount of methane recovered by U.S. coal mines has more than doubled, and the number of mines with recovery programs has increased from four in 1990 to 14 in 1998.

The *Ruminant Livestock Efficiency Program* is a joint USEPA-U.S. Department of Agriculture (USDA) program that works with livestock producers, particularly in the beef cattle sector, to improve animal productivity and thereby reduce methane emissions. The program encourages improved grazing management and feeding, as well as other productivity-enhancing practices. A number of feeding practices have been identified through the program, and a state-of-the art means of quantifying methane emissions has been developed.

The *AgSTAR Program* is another joint USEPA-USDA program, which is aimed at reducing methane emissions from animal waste management systems by encouraging the use of anaerobic digester technologies. Livestock producers, principally in the swine and dairy cattle industries, sign MOUs with USEPA under which they agree to assess the applicability of anaerobic digestion technologies at their facilities. USEPA provides technical assistance and technical tools to aid in the assessment and implementation of projects.

In addition to the voluntary programs, U.S. methane emissions are also reduced as a side benefit of some regulatory activities. Most significantly, in 1996 USEPA promulgated a regulation under the Clean Air Act that requires the largest landfills to collect and combust (i.e., flare or use) their landfill gas. The goal of this regulation is to reduce emissions of non-methane organic compounds, because of their contribution to tropospheric ozone formation (smog). The regulation will also result in substantial methane emission reductions, however. Recent estimates indicate that landfill emissions will be reduced by 35% in 2000 and 40% in 2010 due to the "Landfill Rule".

When the effect of the Landfill Rule and the voluntary programs are taken into account, the U.S. projects that methane emissions will be stabilized at or below 1990 levels through 2010, in spite of economic growth and increased activity by key emitting sectors. The current and projected impact of U.S. methane programs are summarized in Table 2, which shows that the voluntary programs are projected to reduce emissions by 13.5 mmtce (2.4 Tg) in 2000 and 20.3 mmtce (3.6 Tg) in 2010. The bulk of these reductions will come from additional activities in the landfill sector, and reduced coal mine and natural gas/oil system emissions.

**Table 2: Emission Reductions from Voluntary Methane Programs,
2000 and 2010 (in mmtce)**

	1990	2000	2010
Baseline Emissions ⁺	183.3	175.7	190
Voluntary Reductions	--	11.8	18
Net Emissions		162.9	172

+ includes impact of the Landfill Rule

U.S. High GWP Programs

As with methane, USEPA has focused on reducing emissions of high-GWP gases for several years. Two types of programs are being used to reduce emissions: regulatory and voluntary. Regulatory activities are carried out under Title VI of the Clean Air Act, which deals with the phase-out of chemicals that deplete the stratospheric ozone layer. Key provisions of Title VI require USEPA to assess the global warming potential of substitutes proposed for CFCs and HCFCs; enable EPA to ban certain substitutes if others with lower environmental impact including global warming potential are available; and prohibit venting of refrigerants during the servicing and disposal of air conditioning and refrigeration equipment. HFCs are critical replacements for some ODS uses (e.g. health and safety aerosol products, specialized fire protection and solvent cleaning, military applications). HFCs can also contribute to efforts to meet emission reduction targets in applications (e.g. foams, refrigeration and air conditioning) where HFCs have an energy efficiency advantage. Although emissions of ODS substitutes will increase over the next twenty years, EPA forecasts that emissions will be 55 mmtce lower by 2000 than under business-as-usual as a result of the regulatory activities with significant additional reductions expected by 2010.

In the U.S., high-GWP gases are also emitted by several other industries, including HCFC-22 production, primary aluminum smelting, semiconductor manufacture, electric power distribution, and magnesium smelting and die-casting. Beginning in 1993, EPA has implemented voluntary programs to reduce emissions from these sources. Companies joining the Partnerships evaluate the viability of pollution prevention techniques of process optimization, source reduction, substitute chemicals, recovery/recycling, and abatement. This information is used to set emission reduction goals based on cost-effective emission reduction strategies. EPA partners value the benefits voluntary programs offer: cost-effective pollution prevention, technological innovation and information sharing, flexibility and quick implementation, and positive company recognition. Reducing or preventing emissions of the high-GWP gases is important to the U.S. emission reduction strategy because of the potential high growth in emissions of these gases and the environmental benefits of avoiding a growing atmospheric concentration of long-lived anthropogenic chemicals.

The *Voluntary Aluminum Industrial Partnership* is an innovative pollution prevention program developed jointly by EPA and the U.S. primary aluminum industry. Participating companies

work to improve aluminum production efficiency while reducing PFC emissions. Ninety-four percent of U.S. production capacity and 11 of 12 U.S. manufacturers participate in the program. Each partner in the VAIP program signs a Memorandum of Understanding with EPA in which they agree to undertake technically feasible and cost-effective actions to reduce emissions. For its part, EPA has published a report on global efforts to reduce emissions, funded research into the factors that influence the generation of PFCs, and provides public recognition of the partners' efforts. Partners have cumulatively committed to reduce PFC emissions 45 percent from 1990 levels by the year 2000.

The PFC Emission Reduction Partnership for the Semiconductor Industry aims to reduce emissions of PFCs from semiconductor manufacturing. Companies joining the Partnership have agreed to work to reduce their emissions by considering the viability of pollution prevention techniques such as process optimization, source reduction, recovery/recycling, substitute chemicals and abatement. Semiconductor manufacturers began using small quantities of PFCs in the early 1990s and these chemicals have become critical to current manufacturing methods because they possess unique characteristics. Worldwide, semiconductor manufacturers are working through the World Semiconductor Council to reduce emissions cost-effectively. Manufacturers in Europe, Japan, Korea, Taiwan and the United States have pledged to reduce emissions by 10% from baseline by 2010. Despite high growth rates, this agreement ensures that this industry will not become a significant greenhouse gas emitter in the future.

The SF6 Emission Reduction Partnership for the Electric Power Systems was launched in 1999 and currently includes 57 electric utilities and local governments across the U.S. SF6 is used by this industry in a variety of applications, including that of dielectric insulating material in electrical transmission and distribution equipment such as circuit breakers. Electric power systems that join the Partnership must, within 18 months, establish an emission reduction goal reflecting technically and economically feasible opportunities within their company. They also agree to, within the constraints of economic and technical feasibility, estimate their emissions of SF6, establish a strategy for replacing older, leakier pieces of equipment, implement SF6 recycling, establish and apply proper handling techniques, and report annual emissions to EPA. EPA works as a clearinghouse for technical information, works to obtain commitments from all electric power system operators and will be sponsoring an international conference in 2000 on SF6 emission reductions.

The SF6 Emission Reduction Partnership for the Magnesium Industry works with primary and secondary producers of magnesium. SF6 is used by these industries as a protective covergas for the molten metal. Without such protection, molten magnesium readily vaporizes and burns when exposed to air. EPA launched its partnership with this industry in 1999 and is currently working with 12 U.S. companies. Initial focus will be on establishing baseline emission estimates, identification and implementation of good handling procedures, evaluation of emission control technologies and information sharing. EPA is also working with the International Magnesium Association to facilitate information sharing globally.

Table 3: Estimated Emission Reductions from Voluntary High GWP Programs, 2000 and 2010 (in mmtce)

	1990	2000	2010
Baseline Emissions	23	32.5	45.9
Voluntary Reductions+		8.5	29.1
Net Emissions		24	16.8

+ includes voluntary efforts by HCFC-22 producers to reduce HFC-23 emissions

U.S. Voluntary Programs Illustrate Best Practice

The U.S. voluntary programs for methane and high GWP gases have been highly successful in partnering with industry to reduce emissions of these potent greenhouse gases. For the affected industries, NCGG use and/or emissions tend to be fundamental to current business practices, and determining the technical opportunities and economic benefits of options to reduce emissions is critical to program development. In the United States, voluntary programs are developed after extensive research and consultation with industry.

The methane and high GWP programs are being applied throughout the United States and are serving as a model for other countries. Within the U.S., care has been taken to identify uniquely regional barriers to methane recovery projects where they exist and to ensure that appropriate programmatic responses are developed. Each program is customized to the specific needs of its industry. In addition, the barriers to methane recovery projects are systematically reassessed.

Each high GWP voluntary program is also customized to the specific needs of its industry. These programs are successfully reducing emissions and guiding chemical and equipment suppliers and industry to low- or no-emitting production methods. The USEPA voluntary partnership for semiconductors catalyzed similar programs in Japan, Europe, Korea and Taiwan, and contributed to setting a voluntary global PFC emission reduction target by the World Semiconductor Council. The U.S. HFC refrigerant recycling program has global recognition and being used as a model in a number of countries. Cost-effective process optimization methods to reduce PFCs from aluminum smelting are readily transferable.

1. What are the criteria used to characterize the best practice policies and measures?

The United States focuses on reducing emissions of methane, HFCs, PFCs and SF6 because of their environmental significance and their economic attractiveness. These gases accounted for 18% of U.S. greenhouse gas emissions in 1990, and their share is expected to increase to 19% by 2010 under a “Business as Usual” case.

In 1998, the voluntary methane programs worked with more than 200 companies, 500 farms, 29 state, and 22 local communities in reducing emissions of methane by over 5.4 mmtce. In

addition, the U.S. methane programs are expected to offset future growth and result in stabilized methane emissions at 1990 levels through 2010, at a profit.

The high GWP gas programs have reduced US emissions by 63 mmtce since 1990, and are projected to reduce emissions significantly more by the year 2010. Without action, business as usual emissions of high GWP gases are projected to grow rapidly. High growth industries such as semiconductors, expansion of HFC and PFC use as CFC and halon substitutes, and difficult technical challenges of finding substitutes all contribute to potential rapid growth in emissions. Working directly with industry helps quickly foster relevant scientific and technological research and supports the development of innovative operating practices and technologies.

2. Basic guidelines for selection of best practices

Flexibility over time Program strategies need to be re-evaluated and updated frequently. Successful voluntary programs provide state-of-the-art information to partners that encourage emission reduction activities. Changing market conditions, new technologies, and regulatory and policy developments are among the factors that can affect these industries and their assessment of the technical and economic feasibility of various emission reduction options. The tools and activities that have been provided previously may not be the most important or effective for the future. USEPA assesses program strategies on an annual basis and modifies strategies and activities as needed.

Public policy fit The Landfill Methane Outreach Program has changed significantly over the years. Since promulgation of the U.S. “Landfill Rule”, the program no longer targets large landfills because they are required under the regulation to collect and combust their gas. In addition, the landfill program closely tracks electric restructuring activities across the U.S. and modifies its activities to keep pace with these developments.

The United States is committed to making substantial cost-effective national emission reduction choices that protect both the ozone layer and climate without compromising other environmental, health and safety concerns. HFCs, and to a lesser extent PFCs, have emerged as important to the successful transition out of ozone depleting gases. Consequently, the U.S. is working aggressively to avoid unnecessary emissions of greenhouse gases while restoring the stratospheric ozone layer. The USEPA has banned the extremely damaging practice of venting all CFC and replacement refrigerants. To further enhance the environmental benefits of no venting, mandatory recovery and recycling of air conditioning refrigerants has been in place since 1995. Regulations to require recovery and recycling of all other refrigerants have been proposed.

Economic fit The methane and high GWP voluntary programs reduce greenhouse gases by promoting cost-effective, low emission technologies and practices. The programs drive investment, deliver cost savings and enhance economic activity. Many of the investments resulting from the partnership programs have 10- to 15-year lifetimes, and key benefits for the next decade will result from investment decisions being made now.

Technological fit Given the diversity of industries, emission sources, and technical options, a single type of program will not be appropriate to deal with the array of NCGG emissions. What works with the coal industry will not work with the aluminum industry, for example, and program structure must reflect this. In the United States, each voluntary program is unique in terms of its structure, its strategy, and the tools it provides.

Accountability To be accepted voluntary programs must also meet the expectations of the public and the needs of government. The credibility of any voluntary program will ultimately determine whether a voluntary initiative can be sustained or used to complement or supplant regulations. Commitment to a goal is an element of all USEPA voluntary climate partnerships. Dependable measurement techniques and verifiable reporting methods to account for emission reductions are other hallmarks of the U.S. methane and high GWP voluntary programs.

3. What are the barriers addressed by the best practices?

USEPA has designed its voluntary programs to overcome barriers with the long-term goal of transforming production processes and products to low emission.

Lack of awareness about what emission reductions can be achieved, resulting benefits, and the products, which are capable of delivering these benefits. Partnership programs successfully leverage investments in low emission technologies by providing partners with information, motivation and tools to help them achieve emission reduction goals.

Government program managers need extensive expertise in their program areas. In order for voluntary programs to add value to industry and encourage emission reductions that would not have happened otherwise, program managers must understand the full array of technical, economic, and policy issues affecting the desired emission reduction activities. In the early stages of program development in the U.S., it frequently appeared that there were few available technically and economically attractive reduction opportunities. Over time, however, program managers working closely with their industry counterparts were able to identify the opportunities that currently form the foundation of the voluntary programs. Having dedicated technical staff working with industry has been fundamental to USEPA's success with its voluntary programs.

Ongoing communication with industry is essential for program design and implementation. Ultimately, the success of the NCGG programs depends on industry voluntarily implementing new technologies or practices to reduce emissions. The only way the government can facilitate this process is if the industry is involved in and supportive of the programs. All of USEPA's voluntary NCGG programs were developed through discussion and negotiation with industry. They thus meet both USEPA's goal of environmental protection and industry's desire to minimize emissions while maintaining economic growth and competitiveness.

4. What is the interaction of best practice policies and measures with other policies?

These programs have additional benefits beyond those associated with reducing greenhouse gas emissions. Use of wasted methane displaces fossil fuel consumption. Combustion of landfill gas reduces emissions of other non-methane volatile organic compounds (VOCs) that contribute to tropospheric ozone formation, as well as reducing odor and gas migration problems at landfills. Methane recovery from manure management can improve the quality of the manure management system, thereby reducing odor and water quality problems associated with animal waste. And methane recovery at coalmines can improve mine safety by reducing explosive hazards.

The United States is committed to making cost-effective national emission reduction choices that protect both the ozone layer and climate without compromising other environmental, health and safety concerns. Due to long-atmospheric lifetimes (several thousand years) of PFCs and SF₆, the greenhouse effects of emissions are essentially irreversible. Avoiding emissions will help protect human health and the environment if additional, unanticipated effects result from the accumulation of high GWP gases into the atmosphere.

Volunteer programs are also necessary where the products produced with high GWP gases are themselves necessary for climate protection. For example, it would be counterproductive to limit total PFC emissions from semiconductor manufacture if shortages of semiconductors made it impossible to telecommute or to use computer controlled energy-saving devices.

Conclusion

Voluntary programs are a successful part of the U.S. mix of strategic tools to lower greenhouse gas emissions. Voluntary programs promoting cost-effective greenhouse gas reductions capitalize on technological creativity and help expand markets for low- or no- emitting equipment and alternative process chemicals.

These effective programs exhibit the key characteristics of “best practices”. They offer useful models for adaptation by other countries to achieve important greenhouse gas emission reductions mindful of each country’s unique national circumstances.