Technology Market Summit
May 14, 2012

Case Study Primer for Participant Discussion: Fenceline Air Quality Monitoring

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Introduction

The U.S. Environmental Protection Agency is committed to exploring environmental technology opportunities that cooperatively engage the investment, business, technology, government, nonprofit and academic communities. EPA's roadmap, Technology Innovation for Environmental and Economic Progress[1], outlines EPA's vision:

> *The EPA will promote innovation that eliminates or significantly reduces the use of toxic substances and exposure to pollutants in the environment and that also promotes growth of the American economy. Building upon the EPA's history of scientific and technological expertise, the Agency will seek out prospective technological advances that have the greatest potential to achieve multiple environmental goals. Consistent with its statutory and regulatory authorities, the EPA will partner with a diverse set of new and existing stakeholders to speed the design, development and deployment of the next generation of environmental technologies, creating a cleaner environment and a stronger economy for our nation and the world.*

The Technology Market Summit on May 14, 2012 supports EPA's vision by bringing together representatives of diverse sectors to come up with ideas and actions to support a cleaner environment, new technology markets, and new jobs. The Summit is designed to yield specific, short and long term steps that government, business, nonprofit and academic communities can take to facilitate private investment in sustainable environmental technologies.

The Summit provides participants with the opportunity to engage in dialogue on one of three case studies: fenceline air quality monitoring, the automotive supply chain, and biodigesters and biogas.

This primer serves as a foundation and guide for discussions on fenceline air quality monitoring. The investment community, technical experts, government officials, and technology firms, all of whom have been specifically invited to this meeting, each have perspectives that can lead to possible solutions through innovative business and investment models.

One way to promote long-term environmental protection in a cost-effective manner is to encourage the acceptance and use of technologies to provide timely information on fugitive emissions from industrial facilities. Improved monitoring can help facilities manage exposure to environmental pollution by workers and residents living adjacent to a facility. Enhanced monitoring can also help manage and control a company's product losses. Real-time sensing also has the potential to reduce facility operating costs by allowing for rapid responses to leaks that are often the source of fugitive emissions.

Fenceline Monitoring

Background

The term "fenceline monitoring" refers to the measurement of air pollution at industrial facilities and site remediation boundaries. The techniques and instruments for fenceline monitoring can also be used inside of facility boundaries to monitor air pollutant levels near key process units.

[1] Technology Innovation for Environmental and Economic Progress: An EPA Roadmap, available at http://www.epa.gov/envirofinance/innovation.html.

Fenceline monitoring has been used to provide information about fugitive emissions at various industrial facilities. By better understanding emissions, facilities can potentially reduce community and worker exposures to air pollution. In addition, facilities can realize cost savings through improved monitoring and management of product loss. These advantages can also enhance community relations and corporate reputation.

There are two broad categories of emissions from facilities: stack emissions and fugitive emissions.

- **Stack emissions** refer to air pollutant emissions from point sources, such as industrial stacks, and can be accurately monitored through continuous emissions monitoring systems (CEMS) or stack tests. Emission limits can be enforced based on the monitoring results.

  Methods to assess stack emissions have been the focus of decades of research. For example, the EPA has promulgated National Ambient Air Quality Standards (NAAQs) for six "criteria" air pollutants (e.g., ozone and fine particulate matter ($PM_{2.5}$)), which have fostered a domestic market for CEMS that target these compounds. Although significant research challenges remain, these source types, along with the hazardous air pollutants (HAPs), are relatively well-understood, and the regulatory framework is mature. Many, but not all, industrial stacks have CEMS or ports for emissions testing.

- **Fugitive emissions**, also termed "uncontrolled process emissions," are "those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally-equivalent opening"[2]. Compared to stack emissions, understanding of fugitive emissions is less developed. Pollutants associated with fugitive emissions may be criteria pollutants or toxic air pollutants emitted from industrial processes and material handling operations.

  Fugitive gaseous emissions come from leaking pressurized equipment, storage tanks, wastewater treatment units, and various other unintended or irregular releases. Fugitive particulate matter emissions come from industrial operations such as iron and steel manufacturing, raw material storage and handling, maintenance of control equipment and various earth-moving and remediation activities. Specific sources of fugitive emissions can be difficult to identify.

  Unlike stack emissions, it is difficult to estimate, permit, and enforce fugitive emission limits because: 1) there can be numerous fugitive emission points within a single plant; 2) emissions can emanate from large areas and change locations; 3) emissions may be intermittent and can depend on variable processes and environmental factors such as wind speed and direction; 4) they are frequently unique to a specific plant or site such that it would be difficult to set an industry-wide rule; and, 5) fugitive emissions monitors and the necessary models for estimating their emissions are not readily available, except for a few dozen chemical compounds.

Advantages of Fenceline Monitoring

Fenceline monitoring can provide many benefits to industrial managers, their employees and their neighbors. Benefits, especially gained through real-time data, include:

- Greatly increased knowledge of emissions, inventories and population exposure by more accurately identifying the actual source of pollution;

[2] 40 C.F.R. 52.21(e)(20) *Fugitive emissions*

- Potential to reduce local exposures to air pollutants, of special importance to environmental justice communities;
- Enhanced worker safety through rapid detection of dangerous leaks;
- Cost savings realized through reduced product loss, and
- Improved public relations, operational efficiencies and emissions verifications in future trading strategies.

Types of monitoring technologies and their applications

Point monitors can measure air in real-time or collect air samples using a canister, cartridge, or filter for laboratory analysis at a later date. Point monitors can collect particulate matter as well as gases. For collected samples, there may be a several week delay to obtain laboratory results that identify specific organic compounds and toxic metals.

Near real-time volatile organic compound (VOC) results may be achieved with an automated gas chromatograph (auto-GC) system. This type of station is expensive to construct and maintain. Auto-GC stations tend to be established at long-term fixed urban center sites and may not realistically be applied in a fenceline setting.

Some point monitors are available for field screening that are relatively inexpensive (less than $5,000/each), easy to operate, very portable, and highly time-resolved. Such hand-held monitors can assess, for example, overall VOC or hydrogen sulfide levels and monitor "dust" (i.e., coarse and total particulates) in industrial settings, but have not been widely tested for permanent fenceline monitoring applications.

Some more expensive point monitors, usually based on optical spectroscopic techniques, possess high precision and time resolution and are suitable for fixed or mobile monitoring applications.

Open-path monitors project a beam of ultraviolet or infrared light over distances ranging from 50 meters to a kilometer. As gases pass through the beam of light, they are identified by their unique absorption of the light.

Some 20 years ago, manufacturers of open-path monitors marketed their instruments as fenceline “sentries” and “first alert” devices to warn facilities of gaseous emissions crossing their borders. However, the market never developed for these technologies because, in part, the instruments are complex and relatively expensive. However, it is possible to develop lower cost open path technologies. EPA’s “Deep UV Optical Sensor” is inexpensive and simple to operate. Although very sensitive to numerous HAPs, the limitation of this sensor is that it

cannot identify specific compounds. One intended use of the instrument is for process unit "fenceline" monitoring to trigger leak detection and repair (LDAR) surveys, where low cost, simplified operation, and sensitivity are more important than compound identification.

In addition to capital investment in instruments, the market is sensitive to expense drivers such as labor, calibration standards and processes, service maintenance, and data processing costs. In particular, and in contrast to in-stack CEMS, fenceline measurement data requires expert interpretation because wind has a major effect on the measurement results.

Fenceline monitors include point monitors and open-path monitors. Fenceline monitoring tools can be applied in any location to provide useful data, such as at the facility's boundaries or by a facility to monitor internal process units. Mobile measurement techniques that provide a geospatial picture of emissions are also forms of fenceline monitoring.

Regulatory Environment

Contemporary permitting and enforcement of fugitive emission sources are still based on emission estimates (which often rely on outdated monitoring methods) and management practices (assumed to be strong), not on measured emissions.

Presently, there are 53 federal LDAR regulations covering industries ranging from chemical manufacturing to hazardous waste storage.[3] The LDAR regulations are intended to limit the extent of fugitive emissions by periodically requiring facilities to manually measure and repair gaseous leaks from valves, flanges, pumps, closed-vent systems, and other sources of leaks. LDAR methods are extremely labor-intensive and require facilities to keep detailed records on every piece of regulated equipment, which may number in the hundreds of thousands for a large plant.

Fenceline monitoring has the potential to supplement and simplify a facility's compliance with federal LDAR rules. Many of the LDAR regulations provide an avenue for facilities to propose alternative monitoring plans (also described as "an alternative means of emissions limitation"), which could include proposals to reduce periodic LDAR surveys in favor of surveys triggered by plume detection at the process unit boundary. Leak surveys may be done when a fugitive emissions problem is known to exist. Furthermore, appropriate placement of real-time monitors can isolate the general area of the plume, reducing the time it would take to find the leaking equipment.

The EPA also recognizes that fenceline monitoring may be useful for other regulations of industrial facilities, providing data on whether concentrations of particular pollutants are exceeded and providing greater information to surrounding neighborhoods about emissions and potential risks. Industry-wide monitoring requirements that support streamlined reporting and flexibility for industry could pave the way for a larger fenceline monitoring technology market.

[3] U.S. Environmental Protection Agency. Leak Detection and Repair, A Best Practices Guide (EPA-305-D-07-001). Accessible at <http://www.epa.gov/compliance/resources/publications/assistance/ldarguide.pdf>.

Challenges for Adoption of Fenceline Monitoring

Market-based Issues

Market-based challenges for adopting fenceline monitoring include:

- The benefits of fenceline monitoring can be realized only through technology advancements and cost effectiveness. Presently, the technology is expensive because a significant market has not existed to drive research and development. Both capital costs and operating costs can be very high for elaborate fenceline monitoring systems. From the user standpoint, the decision to install a fenceline monitoring system is based on projected capital and operating costs and whether the perceived benefits of the system exceed these costs.

- In order to encourage investment in research and development and guarantee the existence of a market, industry needs assurance that regulations will be in place for the long term.

- Investing in technologies other than fenceline monitors that have a higher rate of return or a faster profit turnaround may be more attractive to investors and technology developers.

Technological Issues

Technology issues for fenceline monitoring include:

- CEMS are available for stack emissions, but it may be impractical to install CEMS on any but the largest of stacks. There may be a number of stacks without CEMS that must be considered as possible emissions sources impacting fenceline and local community monitors.

- Fast, inexpensive, and easily deployable monitors are needed to fill the niche between screening-level sensors (e.g, passive diffusion tubes and badges) and higher-cost fenceline monitoring approaches (e.g. auto-GC and high-end open-path systems). There are important trade-offs to be considered. Screening monitors are portable and easy to use, but they tend to have detection limits above ambient or fenceline concentrations and may not identify specific HAPs. Auto-GC results are high-quality and near real-time but are less portable and have significant equipment and labor costs.

- One fenceline approach may be to deploy multiple real-time micro-detectors around facility fence lines that are linked wirelessly to data collection and reporting systems. This category of sensors is emerging quickly. Recently, the EPA hosted a two-day workshop with researchers and developers of such instruments and has begun conversations with inventors who are working on micro-sensors and applications under the general heading of "Sensor/Apps." EPA sees this category of sensors filling in the gap between screening-level sensors and the more expensive instruments that have dominated the market.

Financial Issues

At this point, there are only a few possibilities for financing fenceline monitoring sensors, due to the limited market size:

1. Technology developer financing: In essence, this type of financing involves the developer/vendor building a device and then, in turn, providing some type of financial terms to the end user/purchaser.

2. Rentals: If the end user rents the equipment, it can be returned to the original equipment manufacturer after the rental term. In some cases, the rent which is paid might actually be applied to the purchase of the equipment, after the rental term is finished.

3. Leases: Leasing is like renting but frequently gives the lessee the ability to buy the equipment at the end of the lease as well as affording certain tax benefits to the end user. There are two types of leases – operating and capital leases.

    - Operating Leases – the owner transfers the right to use the equipment during the lease term only. Once the term is completed, the lessee returns the equipment. Since the lessee has no risk of ownership, the equipment expense is treated as an operating expense.

    - Capital Leases – the lessee has some of the risks of ownership and consequently some of the benefits. The equipment is recognized as an asset of the lessee's company and a liability. The lessee deducts the depreciation of the equipment as well as the interest element of the lease payments each year.

4. Purchases: Sometimes when a purchase is made outright, the company which is selling the equipment can arrange a loan on that equipment. If the company selling the equipment has a large enough asset base, it might arrange the loan directly. If not, it might find a third party (a bank or finance company) to help finance the purchase (often called asset-based lending).

The EPA provides many resources for financing environmental projects, including grants. They include:

- Environmental Finance Center Network: Environmental goals cannot be met without financing, which is essential to implementing state and local programs. Knowledge about how to fund these programs is often limited, especially at the local level. EPA sponsors Environmental Finance Centers at universities around the nation. They provide state and local officials and small businesses with advisory services; education, publications, and training; technical assistance; and analyses on financing alternatives.

- *Guidebook of Financial Tools: Paying for Sustainable Environmental Systems*: The EPA publishes a guide, currently in the process of being updated, that describes tools covering a wide range of approaches that are available to assist public and private sector parties in finding the most appropriate ways to finance their environmental protection needs.

- Performance Partnership Grants (PPGs): With PPGs, states and tribes can reduce administrative costs through streamlined paperwork and accounting procedures; direct EPA grant funds to priority environmental problems or program needs; and try multi-media approaches and initiatives that are difficult to fund under traditional categorical grants.

- Pollution prevention (P2) grants: The website located at http://www.epa.gov/p2/pubs/grants/index.htm#p2 provides information on matching funds to

state and tribal programs to support P2 activities across all environmental media and to develop state P2 programs.

- State Innovation Grant Program: This program provides funds and technical assistance to state environmental agencies to improve permit compliance and integrate voluntary stewardship approaches.

Finding Solutions

Some solutions can be embraced by both the private sector and regulators to improve environmental information and benefits, while also providing social and economic benefits to the private sector.

- EPA could work with the private sector to establish new monitoring methods transparently, to ensure a cost-effective regulatory environment.

- Government and private sector partners can focus on technological certainty, innovation and emerging technologies.

- EPA and other regulators can create long-term certainty in the investment community by:

    - Articulating regulations clearly and ensuring that they will be in force for a period of time sufficient to create/maintain value of equipment;
    - Reducing reporting burden while collecting better data;
    - Encouraging facilities to show they are operating within their permit limits and increasing certainty about which emissions are contributing to an ambient problem; and
    - Encouraging State and local agency flexibility and experimentation.

Appendix – Acronym List

Auto-GC ..... automated gas chromatograph
CEMS ..... continuous emissions monitoring systems
EPA ..... U.S. Environmental Protection Agency
HAP ..... hazardous air pollutant
LDAR ..... leak detection and repair
NAAQS ..... National Ambient Air Quality Standard
P2 ..... pollution prevention
PPG ..... performance partnership grant
VOC ..... volatile organic compound

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