Greenhouse Gas Emissions Quantification and Verification Strategies Workshop

Measurement and Monitoring Technology Challenges

June 2-3, 2010

Scripps Institution of Oceanography, La Jolla, CA

Workshop Scope

Breakout Session	Session Chair
Power Generation – Point Sources	Eric Holdsworth, Edison Electric Institute
Industrial Generation – Point and Non-point Sources	Ed Rightor, The Dow Chemical Company
Distributed/Localized Sources and Sinks	John Miranowski, Iowa State University
Regional and International Emissions	Ralph Keeling, Scripps Institution of Oceanography
Carbon Markets	Daniel Schrag, Harvard University

Industrial Generation – Point and Non-Point Sources

The industrial sector consumes over one-third of the world's energy, approximately 150 exajoules (EJ) in 2007 – an increase of about 65% since 1971. Industrial emissions represent 36% of global carbon dioxide (CO2) from fossil fuels. The Intergovernmental Panel on Climate Change (IPCC) and other sources such as the U.S. Energy Information Administration (EIA) have predicted that industrial energy use and CO2 emissions will continue to increase over the next two decades (about 2% per year through 2030). Certain activities are particularly energy-intensive, including metals industries, such as iron, steel, and aluminum; petroleum refining; chemicals; fertilizers; glass; pulp and paper; and mineral products, such as cement, lime, and soda ash. Less energy-intensive industries include the manufacture or assembly of automobiles, appliances, electronics, food and beverages, and other products. In addition to combustion-related emissions, industry is responsible for several process-related greenhouse gas emissions from sources such as aluminum production, cement manufacture, ammonia, and lime manufacture. Process-related emissions (including both CO2 and other gases) account for approximately five percent of GHG emissions from all sources in the United States. (MEF 2009)

Mandatory Reporting of Greenhouse Gases (GHGs) Rules issued in 2009 will impose substantial requirements on various entities to report greenhouse gas emissions. These regulations also include requirements relative to the measurement, sampling, testing and calculations for estimating GHG emissions. Legislation is also now under consideration favoring cap and trade and other approaches. Any type of approach that places an economic value on GHG emissions will also require consistent, fair and accurate measurement systems. Measurement and monitoring of industrial emissions could be a challenge for many industries. While some are already utilizing continuous emissions monitoring systems (CEMS), other estimation methods are frequently used. Options may include direct measurement, simulations, standard emission factors or other calculations based on data from fuel or raw material use. The uncertainties involved with these methods are not well established. For others, data collection requirements may overlap with, or fail to align with, the existing GHG data collection program, creating reports that may not be consistent with previously reported GHG data. There is also debate on how indirect emissions will be assessed.

This session will explore challenges associated with measurement and monitoring of GHG emission from industrial facilities. Of particular interest are the principal GHGs covered in regulation and pending legislation, including carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorocarbons, and other fluorinated gases, from sources to include combustion, processes, and gaseous leaks.

- What are some of the potentially most viable strategies for quantification and verification of industrial GHGs? What is the tradeoff between accuracy, precision, and economics?
- How would we summarize GHG estimation methods used in these industrial segments today?
- What are the key principles of a measurement system that may be used in some type of GHG market system and should this market be different for direct, process, and indirect emissions?
- How will process emissions (decarbonization of limestone, etc.), direct emissions associated with energy consumption, and indirect emissions (purchased steam, power, etc.) be quantified and reported and how will industrial companies need to interact on this topic?
- What are the most critical technology barriers to be addressed in developing and adopting strategies for GHGs quantification and verification?
- What are the most critical non-technology (energy, economic, environmental, and societal) barriers to be addressed in developing and adopting strategies for GHGs quantification and verification?
- What are the key measurement issues that need to be resolved?
- Going forward, what is the priority R&D or other actions that should be pursued to support effective development and adoption of key strategies?

MEF 2009. Technology Action Plan: Industrial Sector Energy Efficiency, Major Economies Forum on Energy and Climate. http://www.majoreconomiesforum.org/the-global-partnership/

Power Plants – Point and Non-Point Sources

In 2008, emissions from fossil fuel combustion used for electric power generation amounted to 42% of the U.S. carbon dioxide emissions inventory. Therefore, reliable accounting of this portion of the U.S. inventory is essential to any emissions reduction and verification activity. The vast majority of the electric power sector's GHG emissions come from the stacks at plants. Title IV of the CAAA has required utilities to measure CO2 with CEMS since 2003 for Phase I units and 2005 for Phase 2 units. There are alternative CEMS systems allowed for Low Mass Emitters (LMEs), who can base their measurements on fuel flow, but those are alternative CEMS systems subject to all the QA/QC and missing data protocols as the CEMS that are based on measured stack concentrations and flows. The new Mandatory GHG Reporting Rule issued by EPA requires electric utilities that have CEMS (even the LMEs) to use that data for reporting GHGs. For entities that have not installed CEMs can estimate their emissions based on fuel use data. In developing the mandatory reporting rule, EPA recognized the reporting done to date by the electric power sector under section 821 of the Clean Air Act acid rain reporting program, terming the information reported by utilities under that program "quality data." One issue is that the broader the scope of reporting, the greater the cost for the reporting entity, and the more inter-mingled the data becomes among reporting sources.]In this breakout session, issues will be identified which might impede future implementation of either market-based and/or regulatory approaches to emissions reductions in this sector. In addition, key issues related to current measurement systems used in stacks and possible future technology needs will be discussed. Key questions include the scope of required reporting and the minimum level of uncertainty in quantification necessary for viable implementation of a market-driven system and/or effective and fair regulation.

- Using current emission monitoring technologies, what is the level of accuracy that can be substantiated? What are the measurement barriers that may impede this realization, and are there means to overcome or work around such barriers? Are there other technical barriers that should be considered? How can the experience of the power sector be transferred to other sectors?
- Are current consensus standards governing this type of GHG monitoring adequate to support possible future market-based and/or regulatory approaches to emissions reductions in this sector?
- [What is the impact on companies, markets and accurate reporting of the inclusion of a requirement to report indirect emissions? For example, how would a reporting system capture and accurately report reductions from efficiency improvements for a large energy use customer? What if these reductions occurred partly or entirely as the result of a utility-based program?]
- What are likely new technologies that will become available in the next 5 years with potential to improve the performance of these monitoring systems?
- How does the capability to quantify emissions in this sector compare with those of other sectors?

Distributed/Localized Sources and Sinks

Going forward, virtually all economic analysis of climate policy concludes that forestry and agriculture-related projects that enhance the uptake of carbon by trees, plants and soils, as well as other projects undertaken off-system (either locally, regionally, nationally or internationally)—known as offsets—will play a critical role in helping covered entities (and therefore nations) meet their reduction targets in the context of market-based reduction approaches (and possibly under certain regulatory approaches as well). In this breakout session, we will consider issues critical to the proper quantification of carbon emissions and offsets that are managed through human activities (not naturally occurring). Many of these carbon offsets occur over extended geographical regions for which currently used point measurement capabilities fail to provide adequate assessment. Of importance in this sector is the need to quantify emissions of the three principal greenhouse gases (CO_2, methane, and nitrous oxide), which result from agricultural operations, landfills, coal mining, and oil and gas extraction. Because reliable quantification of carbon offsets plays a critical role in proposed approaches for emissions reduction strategies, consistency in determination of these inventory sources and sinks is essential.

- A broad range of measurement approaches, having varying performance capabilities, is used in this sector. Do current measurement methodologies used to estimate carbon inventories attributed to distributed/localized sources and sinks have the quantification capabilities needed to harmonize them with point source emissions? If not, what are the priorities for development of new or improved measurement technologies and standards? [EIA 1605(b) reporting program]
- Are new consensus standards needed to support the assessments of GHG additions/removals associated with area sources/sinks?
- What methodologies are needed to compare the ensemble of results from area assessments to global observations? Are the measurement uncertainties of these dissimilar measurement approaches sufficiently comparable?

- Are the measurement uncertainties realized for area sources/sinks sufficiently comparable to those found in inventories from other sectors, to adequately support regulatory needs or market confidence in market-based emissions reduction approaches?

Regional and International Emissions

Changes in the world's climate and the influence of human activity on our planet are of great interest to all citizens of the World. Increasingly, world leaders are faced with important, climate-driven decisions with profound economic implications, and they wish to rely on accurate scientific observations of the state of the global environment and atmosphere. The global atmospheric observation community will likely be called upon to supply scientifically substantiated information on this subject. This need for observations of increased accuracy and complexity will be needed. These will likely place stringent demands on the accuracy and reliability of global observation systems and their comparability. In this breakout session, we will consider the measurement obstacles facing the global atmospheric observation community, and the challenges of melding information provided by satellite and ground-based observations.

- What are the key measurement issues in climate science, Numerical Weather Prediction (NWP) modeling and earth observation where there is a requirement for improved underpinning metrology?
- Are current global observations conducted in different countries equivalent? If not, are there measurements and standards issues preventing them from being part of a single global data pool?
- What are the key differences in data from ground-based sources versus satellite observations, and what are the implications for estimating climatic impacts [e.g., satellite vs. ground-based temperature data, the urban heat-island bias, the location of measuring stations, etc.]?
- What are the challenges that arise in linking ground-based sources with satellite observations?
- What are the controversies surrounding predictions of future hurricane activity because of human-induced climate change?

Carbon Market Emissions Issues

Emissions trading (i.e., cap and trade) is currently used in some countries to control greenhouse gases (GHGs) or other emissions by providing economic incentives for achieving emission reductions. Although no federal GHG cap and trade program exists in the U.S. todayi, legislation is under consideration that could establish carbon trading, although the requirements of resulting regulation and policy are still highly uncertain.

Some of the key issues for carbon markets include the following:

- Establishment of a carbon price in light of uncertain regulation, policy and leadership;
- Diversity of carbon reduction instruments allowed (e.g. REDD) and their quality;
- Establishing that carbon is truly reduced, and whether the reduction is permanent or additional (where applicable);
- Integrating measurements across disparate segments, methodologies, and length scales;
- Measuring whether a country is meeting or has met compliance and/or reduction targets; and
- Establishing consistent nomenclature (e.g. verification, control, certification, etc).

The last three issues outlined above will be the primary focus of this breakout session. In particular, this includes the accuracy of GHG emissions quantification required to successfully support a U.S. carbon trading system, why certain accuracy levels are important, and the current methods of use

(and flaws or uncertainties). In addition, discussions will focus on what is needed to close the potential gaps (e.g., R&D). Other factors that will potentially impact trading schemes or must be addressed to ensure confidence in a U.S. carbon market will also be discussed (3rd party verification, etc.).

For trading of carbon between countries, GHG inventories must be consistent, with equivalent units and measurement techniques. Depending on local legislation, GHG measurements may require additional checks and verification by government or third party auditors. Voluntary programs have also established various methods for GHG quantification. Some standards are now widely recognized and accepted as a designation of credibility. Examples include: the Voluntary Gold Standard; the GHG Protocol for Project Accounting; and the Climate, Community and Biodiversity Project Design Standards.

[i] The Regional Greeenhouse Gas Initiative (RGGI), covering ten Northeastern and Mid-Atlantic states, is the first mandatory, market-based effort in the United States to reduce greenhouse gas emissions. RGGI requires utility sector sources to reduce CO_2 emissions by 10 percent by 2018.