An Overview of greenhouse gas emissions verification Issues

Prepared for the Pew Center on Global Climate Change

by

Christopher P. Loreti

Scot A. Foster

Jane E. Obbagy

Arthur D. Little, Inc.
Cambridge, Massachusetts

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Foreword *Eileen Claussen, President, Pew Center on Global Climate Change*

The need for information on how to count, track, and verify greenhouse gas emissions has never been greater. Many of the world's nations are working toward international, national, and sub-national regimes for reducing emissions. These efforts have been accompanied by a growing number of corporate targets to reduce greenhouse gas emissions, as well as the emergence of a greenhouse gas trading market. To ensure that the numbers on which governments determine compliance, and on which companies stake their finances and reputations, are real, greenhouse gas emissions verification is critical.

In this Pew Center report, authors Christopher Loreti, Scot Foster, and Jane Obbagy of Arthur D. Little, Inc. describe the evolving approaches to corporate greenhouse gas emissions verification. They identify factors that drive verification activities and suggest a number of principles that organizations should consider when verifying greenhouse gas emissions, with an eye toward the experiences of the firms, governments, and non-governmental organizations that have been involved in verification activities.

This report builds on *An Overview of Greenhouse Gas Emissions Inventory Issues* which the Pew Center released last year, and which offered a set of principles for conducting greenhouse gas inventories. Both of these reports are part of the Solutions series, which is aimed at providing individuals and organizations with tools to evaluate and reduce their contributions to climate change.

The authors and the Pew Center would like to thank the companies featured in this report for sharing their experiences and perspectives, and acknowledge the members of the Center's Business Environmental Leadership Council, as well as Jean-Bernard Carrasco of the Australian Greenhouse Office, Nick Hughes of BP, and Janet Ranganathan of the World Resources Institute for their review and advice on a previous draft of this report.

Executive Summary

The growing number of companies that inventory greenhouse gas (GHG) emissions, implement emissions reductions projects and targets, and trade GHG emissions reductions has generated increasing interest in emissions verification. Stakeholders in the corporate, governmental, and non-governmental sectors recognize the need for complete, credible, and accurate information about GHG emissions and emissions reductions. To address this issue, some government bodies have developed standards for verifying GHG emissions for specific programs. More general approaches to verifying emissions are just beginning to evolve, however, as uniform approaches to inventorying and reporting GHG emissions are not yet fully established.

This paper describes the evolving approaches to corporate GHG emissions verification. The authors discuss the experiences of leading firms that inventory and verify GHG emissions, the approaches to verification embodied in various GHG programs sponsored by governments and non-governmental organizations, and the factors that drive verification. They also review general verification issues, including who should verify, what should be verified, and when verification should occur.

This paper builds on an earlier publication of the Pew Center on Global Climate Change, *An Overview of Greenhouse Gas Emissions Inventory Issues* (Loreti et al., 2000). Much of the content is the result of discussions with the Pew Center's Business Environmental Leadership Council, a survey of leading corporations on approaches to GHG emissions verification, a review of the current literature on corporate GHG emissions verification, discussions with representatives from governmental and non-governmental organizations involved in GHG emissions issues, and prior experience of Arthur D. Little, Inc. in environmental auditing and GHG verification.

Just as there are multiple purposes and methods for performing emissions inventories, there are a variety of reasons for verifying emissions inventories and a range of approaches to verification. However, the authors' review of the work to date on GHG emissions verification suggests several principles for any firm that conducts a GHG emissions inventory:

1. Conduct your inventory as if it is going to be verified, regardless of whether your organization is planning to verify it. Rigorous reporting, emissions estimation, and data management systems will facilitate any future verification. Indeed, these systems will make it possible to conduct third-party verification of today's emissions in the future should it become necessary, for example, to establish a baseline or obtain credit for early emissions reductions.

2. Be clear on the purpose of verification. Verification can be conducted for many reasons and the results of verification performed for one purpose may not be applicable to another. Be sure that all stakeholders who rely on the verification result will be satisfied with the scope and methods of the verification.

3. Choose your verifiers carefully. Be sure the individuals conducting the verification understand your organization, its type of business, and its emissions. The verifiers' knowledge and experience are more important than the type of organization they are from. If the verification is performed as part of an established GHG reporting or reduction program, be sure the verifiers you choose have the qualifications that that program requires.

4. Learn from your verification experience. Organizations will maximize the value of the verification if they use it to improve their inventory process, improve the reliability of reported information, and facilitate future verification. When hiring third-party verifiers, be sure that they provide specific recommendations for improving your organization's GHG inventory.

I. Introduction

The verification of greenhouse gas (GHG) emissions inventories and emissions reductions has become an area of increasing interest to stakeholders involved in the issue of climate change. As more organizations inventory and report on their GHG emissions and as more publicly commit to reducing them, the need to ensure the accuracy of reporting has become apparent. For firms involved in the trade or sale of GHG emissions reductions, third-party verification is necessary to establish the credibility of the reported reductions, and thus help to establish their value.[1]

Verification of GHG emissions is a field still in its infancy. Though a few firms have had their inventories verified and many, particularly in Europe, obtain third-party opinions on their environmental reporting, only a small fraction of firms that conduct GHG emissions inventories have had them undergo rigorous verification by independent third parties. This is not surprising since firms are rarely required to report or reduce their GHG emissions. Exceptions are firms involved in GHG emissions trading or in national or international emissions reduction projects, some of which require verification. In today's environment, in which most GHG emissions reporting and reduction is voluntary, questions about when verification is necessary, how it should be performed, and who should perform it are still being answered. Even in those cases where verification is required, suggested procedures for conducting verification have only recently been developed and a generally accepted methodology has yet to be adopted.

A. Purpose

The purpose of this paper is to provide an overview of GHG verification issues and to provide guidance to those individuals responsible for having their companies' emissions verified. The paper focuses on the verification of emissions and emissions reductions by corporations and non-commercial organizations, rather than the verification of national inventories conducted by governments or the verification of technologies that may reduce emissions. The authors provide background on the expectations of verification stakeholders, the range of current practices, and the direction GHG verification has taken in recent initiatives. The purpose of the paper is not, however, to produce a protocol on how GHG verification should be performed. Indeed, it is emphasized throughout the paper that during this dynamic period in the development of emissions verification methods, and with the variety of purposes for which verification may be performed, a single protocol would be inappropriate.

This paper builds on a related Pew Center publication, *An Overview of Greenhouse Gas Emissions Inventory Issues* (Loreti et al., 2000). Key recommendations of that paper of particular relevance here are the following:

- Understand the likely uses of the emissions inventory.
- Decide carefully which emissions to include by establishing meaningful boundaries.
- Maximize flexibility in how emissions are reported.
- Ensure transparency in the inventory process.

B. Scope

This paper addresses the types of corporate activities that may require verification. These activities include voluntary inventorying and reporting of GHG emissions, tracking progress in meeting corporate GHG emissions reduction targets, implementing specific emissions reductions projects, participating in international programs to reduce emissions, and emissions trading. Relatively little emphasis is placed on possible verification requirements under the Kyoto Protocol, as the specific requirements for verification would be developed only after the Protocol is ratified. Instead, the paper focuses on five major questions:

1. Who are the stakeholders in the verification process and what are their expectations? (Section II)
2. What approaches may be taken to verify emissions? (Section III)
3. What are the drivers for GHG emissions verification? (Section IV)
4. What key issues are associated with verification? (Section V)
5. What conclusions can be drawn from recent GHG verification experience? (Section VI)

C. Approach

This paper's discussion of emissions verification issues is based on the following information:

1. Discussions with the Pew Center on Global Climate Change's Business Environmental Leadership Council (BELC)[2] about the major verification questions the council members face;
2. A survey conducted by Arthur D. Little of the approaches leading companies are taking to verify greenhouse gases;
3. Review of the literature on GHG emissions verification;

4. Insights provided at a practitioners forum of the Pew Center on Global Climate Change on GHG emissions inventory and verification issues;

5. Discussions with individuals from corporations, state and federal governments, and non-governmental organizations (NGOs) involved in GHG emissions verification; and

6. The considerable experience of Arthur D. Little, Inc. in environmental auditing and GHG verification.

D. Terminology

Discussions of GHG verification often use differing terminology for what is essentially the same activity. What is called "verification" in one context may be referred to as "validation" in another or "auditing" in a third. This paper uses what the authors believe to be the most common terms for verification, consistent with those used by the World Bank and the Dutch government, among others:

- *Verification* is the assessment of the completeness and accuracy of reported GHG emissions or emissions reductions, as well as conformance with pre-established criteria. Third-party verification is performed by parties independent of the organization whose emissions are being verified. Self-verification is performed by the emitting organization.

- *Auditing* is often used synonymously with *verification* in the context of GHG emissions. *Verification* is the preferable term for many people, however, because *auditing* may imply a level of detail and rigor that may not be achievable with environmental information.

- *Validation* is the process of ensuring, before a project is implemented, that it will result in the claimed emissions reductions, that it contains adequate measures for monitoring and verification, and that it meets relevant program criteria.

- *Monitoring* is the continuous or periodic evaluation of the magnitude of emissions or emissions reductions.

- *Verifiable* (or *auditable*) information is adequately documented and readily traceable to its source so that its accuracy and completeness can be confirmed.

- *Certification* refers to the formal declaration of an independent body stating that claimed emissions or emissions reductions have been achieved.

- *Accreditation* refers to the process by which an authoritative body provides credentials to firms or individuals that conduct verification and certification activities, indicating that they have met a prescribed set of qualifications.

II. Stakeholders in the Verification Process

A. Stakeholders and their Expectations

GHG emissions verification involves a wide range of stakeholders, both internal and external to the emitting organization, each with somewhat different expectations. Who the stakeholders are and what they expect varies depending on what the organization hopes to achieve from verification. As with inventorying and reducing emissions, the voluntary nature of verification increases the range of stakeholder expectations. Verification stakeholders fall into seven main groups:

1. Company employees and management;
2. Shareholders and owners;
3. Customers;
4. Government agencies;
5. NGOs and the general public;
6. Verifiers; and
7. GHG emissions reduction trading partners and intermediaries.

Company employees and management are key verification stakeholders. Employees who conduct emissions inventories want to be sure the conclusions of the verification are accurate and appropriate, for it is their work that is being verified. Those responsible for reporting on GHG emissions want to ensure that the verification is done correctly so they can stand behind the numbers they report. Employees responsible for limiting or reducing emissions rely on verified emissions estimates as an indicator of their success in meeting their goals. Similarly, senior management has an interest in verification as a means of establishing the firm's credibility in its GHG reporting, particularly when that management must attest to the accuracy of the reported information.

Shareholders have become increasingly active on climate change issues. Shareholders at several companies have introduced resolutions requesting that management report GHG emissions and reductions[3] (Calvert Group, 1999). Though they do not specifically require verification, these resolutions indicate the desire of shareholders for comprehensive and accurate information. In addition to individual investors,

socially responsible mutual funds and the rating services they employ are interested in third-party verification of the corporate data on which they base their ratings. The desire for this information is not limited to individual or institutional investors. Many corporations that take a significant equity stake in another company include some or all of that company's emissions in their own inventory. These corporations depend on the accuracy of that company's emissions reporting when estimating their total emissions.

In the longer term, shareholders will be interested in the financial implications of GHG emissions. If firms are required to reduce their emissions or obtain offsets, then their emissions will be a financial liability. Conversely, if firms are able to sell GHG emissions credits, the firms will gain an asset. As these assets and liabilities become incorporated into firms' financial reporting, verification of their accuracy will become more important.

Customers also have a stake in verification of GHG emissions at the companies from which they purchase goods and services. Some companies use their environmental performance as a means of increasing market share. Those customers that base their purchasing decisions on environmental performance will want to know that their decisions are based on sound information. This is especially important for electricity consumers, who may be choosing their electricity supplier specifically to reduce their indirect GHG emissions. Verification is also critical to support company claims that a product is climate-neutral (resulting in no net GHG emissions over the product's life cycle), or that it is climate-friendly (resulting in less emissions than competing products).

Government agencies have a stake in GHG verification for a variety of reasons. Verification helps establish the credibility of government-sponsored GHG reporting systems and voluntary emissions reduction programs. Two examples of recently announced U.S. voluntary programs—the U.S. Environmental Protection Agency's (EPA) Climate Leaders program and the California Climate Action Registry—include provisions for GHG verification. The EPA program will require third-party verification for companies that wish to achieve its highest recognition level. The California program will require that participants submit certified emissions information in order to be eligible to receive the program's benefits. The Registry will adopt specific procedures and protocols detailing the certification required for each industry sector.

Voluntary emissions reduction programs, such as Activities Implemented Jointly (AIJ) under the United Nations Framework Convention on Climate Change (UNFCCC), often require participating companies to verify their reductions. This will also be true for Joint Implementation (JI) and Clean Development Mechanism (CDM) projects under the Kyoto Protocol. The World Bank has been a primary public sponsor of GHG verification for emissions reduction projects, and has been involved in emissions reduction projects in several countries. Currently, however, most voluntary programs, such as Canada's Climate Change Voluntary Challenge & Registry Inc., require that emissions reductions be verifiable, but not that they actually be verified.

NGOs, such as the World Wildlife Fund and Environmental Defense, need the reported emissions reductions of firms that participate in their voluntary initiatives to be reliable. The Natural Resources Defense Council is also concerned with the integrity of reported emissions reductions and with ensuring that voluntary reductions that earn any future credit are real. The Climate Neutral Network,[4] an NGO that certifies carbon-neutral products and enterprises, verifies GHG emissions and emissions offsets as part of its certification process.

Verifiers themselves have a direct stake in verification. As third parties responsible for performing verification, they have particular interests in the emissions protocols and verification approaches that form the basis for their work. Many verifiers are interested in standardizing approaches to verification, to allow for comparisons of both emissions estimates and verification results. In addition, potential requirements for the accreditation of verifiers under various programs will determine which firms or individuals may conduct third-party verification, and thus are important to verifiers.

GHG trading partners have a financial interest in verification. Verification may be considered part of the process of obtaining timely and accurate information about an asset a buyer is purchasing. Therefore, buyers typically require sellers to provide third-party verification of their reductions. For this reason, much of the GHG verification activity that has occurred to date has involved GHG trading partners. Even when the programs under which these trades have taken place do not require verification, the buyers have recognized the need for third-party verification and negotiated it as part of their contracts.

B. Stakeholder Expectations and the Purpose of Verification

The expectations for verification vary depending on what a firm intends to accomplish with its emissions information. If the firm tracks and reports its inventory only internally, and does not intend to obtain credit for voluntary reductions or to trade emissions reductions, then the need for rigorous verification—even the need for verification at all—is greatly reduced. (The firm may, however, wish to use verification as a means for improving its inventory process.) If the firm makes public commitments to reduce its emissions, then the expectations for verification are greater. If the firm intends to obtain some form of financial benefit for its emissions reductions (or assure that it will not be penalized for voluntarily reducing emissions), then expectations for verification are greater still. What the firm wishes to accomplish through tracking its GHG emissions—and thus the extent of its verification activities—depends on the attitudes of its management, and may change over time. (See Box 1.)

Box 1

Niagara Mohawk's Evolving Approach to Greenhouse Gas Verification

Niagara Mohawk Power Corporation's changing verification activities reflect the evolution of the company's climate change program. When the New York electricity and natural gas supplier began participating in the U.S. Department of Energy's voluntary 1605(b) reporting program,[5] Niagara Mohawk committed to public disclosure. The company thought it was important to have an independent third party—in this case, an environmental engineering consulting firm—review its methodology and assist in reporting for two reasons:

- First, the company was reporting on a complex variety of projects and related emissions, and it wanted greater assurance that a future outside reviewer would not find reason to criticize either its logic or its numbers.
- Second, even though reporting under the 1605(b) program is voluntary, a signed certification must be submitted with the report stating that the information is accurate to the best of the knowledge and belief of the person signing.

In 1996, the company began trading its GHG reductions. Many such commercial dealings are facilitated by an intermediary. A further level of external review by an environmental NGO was deemed necessary to enhance potential trading partners' confidence that the environmental community would accept the reported reductions. The company also believed that an NGO would be recognized as being more credible than an engineering firm alone when a formal trading program was instituted by government. Niagara Mohawk arranged for review by Environmental Resources Trust (ERT),[6] a private, non-profit organization. ERT maintains background documentation from Niagara Mohawk on reductions and related internal corporate activities and procedures. This information is available to prospective trading partners.

Through these layers of external review, Niagara Mohawk has learned better ways to refine emissions reduction calculations, identified calculational errors, and improved documentation regarding internal auditing and record-keeping. The company believes all three layers of review are important to the program. Governmental review of the company's 1605(b) reports promotes consistency with a large number of other reporters across the nation and allows easy public access. Input from engineering consultants provides greater accuracy in reporting and outside experience. NGO review adds a broader perspective not necessarily reflected by the other two levels. For example, an NGO could have an interest in the additionality[7] of emissions reductions, which the company may not have considered, or bring a fresh view to the measurement of fuel consumption, which company personnel or technical consultants might take for granted. For these reasons, Niagara Mohawk believes it probably would have profited from engaging an environmental NGO at the start of the company's internal global warming program.

The current voluntary approach to verification is likely to evolve as stakeholder expectations change. Many of the voluntary programs to report GHG emissions intentionally have not required verification in order to avoid discouraging potential participants with the costs of hiring third-party verifiers. These programs include the U.S. Department of Energy's (DOE) voluntary emissions reporting program under Section 1605(b) of the Energy Policy Act and the Northeast States for Coordinated Air Use Management's (NESCAUM) Greenhouse Gas Trading Demonstration Project.[8] Canada's Climate Change Voluntary Challenge & Registry Inc. program, Pilot Emission Reduction Trading Project (PERT),[9] and Greenhouse Gas Emission Reduction Trading Pilot (GERT)[10] do not require third-party verification for participation. GERT program rules, however, note that its Technical Committee may require independent, third-party verification of emissions reductions, though in practice it has not had to impose this requirement. Australia's Greenhouse Challenge program[11] does not require participants to obtain third-party verification, but they must agree to

allow verification at random by a mutually acceptable third party. The first round of verification under the Greenhouse Challenge program was funded by the Australian government in 2000, although these arrangements may be reviewed. (Australia's public funding of verification is unusual; in most cases program participants bear the cost.) As trading programs become better established and trades more common, and as proposals for gaining credit for voluntary early actions win acceptance, the need for, and methods of, verification will become more firmly established. Indeed, the recently launched United Kingdom Emissions Trading Scheme (UK-ETS)[12] requires third-party verification of emissions baselines and annual emissions.

III. Approaches to Greenhouse Gas Emissions Verification

Current activities related to GHG emissions verification fall into two main categories: verification of corporate-wide emissions inventories and verification of emissions reduction projects. The approaches used in these two activities are similar in many ways. Both examine the accuracy and completeness of reported emissions. Both typically include baseline emissions and emissions over a monitoring period. Corporate-wide emissions inventories require verification of a historic baseline if the firm has committed to tracking or reducing its emissions relative to a past year, such as 1990. Unless the company and the methods it employs for estimating or measuring emissions remain unchanged since this base year, the baseline emissions will need to be adjusted for any major changes to its structure and business that affect its GHG profile and for any changes in methods used to quantify emissions. Company changes may include major acquisitions and divestitures, changes in product mix, outsourcing, and transfer of assets. If changes in the company structure are not considered, using the base-year emissions of the original corporation as a benchmark would amount to comparing the emissions to those of a different company.

The baseline for an emissions reduction project also needs to be verified over the course of the project to ensure that it remains valid. The baseline assumed for a future year (what emissions would have been absent the project) is periodically verified after that year has passed to ensure that the predicted emissions reductions are achieved.[13]

Corporate-wide and project-level verifications also differ in several important respects. While verifying corporate-wide emissions estimates usually involves examining a subset of data, project-level verification may examine a much larger fraction or even all of the available data. This is due to differences in both the scale and the intent of the verification exercises. Corporate-level verification usually aims to provide an opinion about the accuracy and completeness of the inventory, while project-level verification may go a step further, recalculating and restating the reported emissions reductions if necessary. (As discussed later in this section, restating emissions reductions is included in some of the recently developed guidance on project-level verification.) Project-level verification must also include the verification of specific program requirements, which generally do not apply to corporate-wide inventories.

A. Verification Fundamentals

Verification refers to gathering data to identify and substantiate information in accordance with specific objectives, for example, to verify GHG emissions during the past year. Verification entails developing and implementing a strategy detailing the following:

- The scope of data being verified (e.g., GHG emissions from a company's worldwide operations);
- The types of data to gather (e.g., measured GHG emissions data, data on the level of activities that cause emissions, and emission factors for translating the activity data into GHG emissions); and
- The range of tests to be performed to confirm the validity of the information (e.g., recalculation of emissions estimates).

Verification activities typically focus on gathering three types of evidence—physical, documentary, and testimonial—by following steps outlined in a protocol developed for the verification. Because there are no generally accepted protocols for verifying corporate GHG emissions, verifiers typically develop their own, tailored to the company. Note, however, that most verification includes similar elements, discussed in Section III.B.

Physical evidence refers to something that can be seen or touched, such as fuel meters, emission monitors, or calibration equipment. Physical evidence is gathered by direct observation of equipment or processes, and is persuasive because it demonstrates that the entity being verified is in the practice of collecting relevant data.

Documentary evidence is written on paper or recorded electronically and includes operating procedures, log books, inspection sheets, invoices, and analytical results.

Testimonial evidence is gathered from interviews with technical, operating, administrative, or managerial personnel. It provides a context for understanding physical and documentary information, but its reliability depends on the knowledge of the interviewees.

The more data available, and the more rigorous the review, the more assurance verification will provide. (See Table 1.) Verification testing may include a wide variety of activities, such as retracing data to find omissions or transcription errors, re-computing emissions estimates to confirm engineering calculations, or reviewing documents attesting to an activity.

Table 1

Types of Verification Testing

Vouching	This test uncovers *errors* in reported data and involves following the paper trail back to the raw data. For example, reported quantities of purchased fuel oil used to calculate CO_2 emissions would be traced back to the accounts payable department to check invoices from the fuel supplier. This process verifies that all reported data are supported.
Re-computation	This test checks for the *accuracy* of arithmetic calculations. This would include, for example, recalculating the results of carbon dioxide and methane emissions from a flare, where emissions are unlikely to be measured.
Retracing Data	This test uncovers *omissions* in reported data and involves reviewing the original data records to ensure that all results are appropriately reported. For example, continuously monitored GHG emissions from multiple sources might be reviewed. The verifier would then verify that all the emissions sources were included in the inventory.
Confirmation	This test seeks *written* confirmation *from independent third parties.* This test may be used when an auditor cannot physically observe a condition, such as the calibration of a flow meter.

B. Greenhouse Gas Verification Approaches

GHG verification typically focuses on carbon dioxide (CO_2) and methane (CH_4), but may include any of the greenhouse gases listed in Table 2, depending on which emissions are included in the inventory.

These greenhouse gases include direct greenhouse gases, indirect greenhouse gases, and Montreal Protocol compounds. The *direct greenhouse gases* include the six compounds or families of compounds covered by the Kyoto Protocol. Globally, CO_2 and CH_4 are the two most important of these greenhouse gases, which is why they have been the focus of most verification work to date. For specific companies, however, the other direct greenhouse gases may be as important as CO_2 or CH_4.

Indirect greenhouse gases are sometimes included in GHG emissions inventories due to their role in forming ozone (another greenhouse gas) in the troposphere. While not typically included in the verification of GHG inventories, indirect greenhouse gases may be included in auditing or verifying conventional air pollutants, which are regulated by national laws such as the U.S. Clean Air Act.

Compounds covered by the Montreal Protocol are also greenhouse gases.[14] The production and use of these compounds—chlorofluorocarbons, hydrochlorofluorocarbons, halons, carbon tetrachloride, and 1,1,1-trichloroethane— are being phased out because they destroy stratospheric ozone. They may be included in GHG verification because they are sometimes included in GHG reporting schemes, although to date, they generally have not been verified as GHG emissions.

Table 2

Greenhouse Gases That May Be Included in Verification

Greenhouse Gas	
Name	**Abbreviation**
Direct Greenhouse Gases	
Carbon Dioxide	CO_2
Methane	CH_4
Nitrous Oxide	N_2O
Hydrofluorocarbons	HFCs
Perfluorocarbons	PFCs
Sulfur Hexafluoride	SF_6
Indirect Greenhouse Gases	
Nitrogen Oxides	NO_x
Carbon Monoxide	CO
Non-Methane Volatile Organic Compounds	NMVOCs
Montreal Protocol Compounds	
Chlorofluorocarbons	CFCs
Hydrochlorofluorocarbons	HCFCs
Halons[15]	N/A
Carbon Tetrachloride	CCl_4
1,1,1-Trichloroethane	1,1,1-TCA

Currently there is no single, established approach to GHG verification, although guidance has been provided for certain programs. (See Section IV.) Finding the right approach to verification is largely influenced by the necessary degree of accuracy and credibility. Companies selling GHG emissions reductions require greater accuracy and credibility than companies seeking merely to understand and report on their GHG emissions.

Although a standardized approach to GHG verification has not been established, verification typically includes:

- Evaluating the data management systems for inventorying GHG emissions;
- Confirming the appropriateness of the GHG emissions inventory; and
- Confirming emissions estimates and reductions.

1. Evaluating the Data Management Systems for Inventorying Greenhouse Gas Emissions

The initial step in verifying a corporate-wide inventory is to understand and evaluate how the firm collects and aggregates data from its facilities. This includes reviewing controls that are in place to ensure the completeness and accuracy of the collected data, and to account for changes in the structure of the company.

This initial step is important in identifying where the greatest risk of misstatement of emissions may be occurring and where the efforts of the verifiers should focus. For example, a firm may lack processes to ensure that emissions from particular types of sources are accurately and completely charaterized. If

these sources are believed to be significant to the firm's operations, then emissions from these sources will be reviewed in greater detail during the verification as compared to minor sources or sources where adequate controls on the data are in place.

2. Confirming the Appropriateness of the Greenhouse Gas Emissions Inventory

The next step is to confirm that the inventory reflects actual operations to ensure that it covers all material sources of GHG emissions. This entails reviewing and confirming the sources included in the inventory by facility type (e.g., refinery, chemical plant, manufacturing site) and the types of gases these facilities emit. The boundaries of the inventory must be carefully considered. If the inventory includes indirect emissions from purchased electricity, for example, estimates of emissions from the power plants used to supply the electricity must be reviewed. If indirect emissions from purchased electricity are not included, the rationale for their exclusion should also be reviewed.

This step typically involves interviewing facility engineers; touring operations to verify that all material processes, equipment, and sources of emissions are included; and reviewing process information to confirm the types of greenhouse gases emitted.

3. Confirming Emissions Estimates and Reductions

Approaches for confirming emissions estimates and reductions include reviewing emissions estimates, confirming that an established emissions reporting protocol has been followed, confirming engineering calculations, and measuring actual emissions. An important part of this review is to ensure that the emissions quantification has been conducted consistently throughout the organization and over time. Consistency within the organization allows comparisons to be made between different parts of the organization and consistency over times allows increases or decreases in emissions to be identified, even if the underlying emissions estimation methods have limited precision.

Approaches to confirming emissions estimates and reductions are described below. The most rigorous verification strategies both examine calculations and measure actual emissions. In practice, however, it is unusual to measure actual emissions during verification unless specific questions have been raised previously.

a. Confirmation of Emissions Estimates. This confirms that the methods used for estimating GHG emissions are sound and consistent with established methodologies and data. Table 3 lists the types of information that are typically reviewed. Undertaking this form of verification for GHG emissions from process and fugitive sources[16] requires detailed knowledge of the characteristics of equipment generating GHG emissions, information about equipment operating hours and efficiency, and maintenance prac-

tices to ensure the equipment is functioning as intended and designed. For combustion-related emissions, it requires knowledge about CO_2 emissions from different fuel types as well as the potential need to consider emissions of other greenhouse gases, such as methane emissions resulting from incomplete combustion in flares used in oil production.

Confirmation of emissions estimates involves:

- Analyzing the quantities of fuel consumed and the appropriateness of the emission factors used to convert the amount of fuel consumed to the amount of greenhouse gases emitted;
- Confirming the GHG emissions from process equipment generating greenhouse gases, considering contingencies regarding the design and operation of the equipment; and
- Examining the calculation of emissions from indirect and fugitive emissions sources.

This type of verification involves detailed interviews with process engineers and maintenance personnel, and detailed review of operating records and process and equipment design specifications.

Table 3

Typical Information to Review in Verifying Emissions Estimates

Emissions Categories	Informational Requirements
Combustion	• Fuel type • Quantity of fuel consumed • Greenhouse gases emitted (CO_2 and possibly other gases) • Combustion efficiency • Emission factors for each greenhouse gas
Process	• Emissions source • Hours of operation or quantity of output • Uncontrolled GHG emissions (and emission factors) • Control equipment efficiency • Net emissions per hour of operation or unit of output
Fugitive Emissions	• Stream compositions • Leak test results or maintenance practices • Types of equipment and equipment counts • Emissions history
Emissions from Purchased Electricity	• Generating sources • Greenhouse gases emitted as a function of kilowatt-hours generated • Transmission and distribution losses • Kilowatt-hours consumed

b. Measurement of GHG Emissions. Measuring GHG emissions is quite rigorous and involves all three types of information gathering—physical, documentary, and testimonial. It requires a detailed analysis of GHG sources, review of source characteristics to determine the frequency and length of monitoring required to obtain representative data, use of monitoring equipment suitable to obtain representative data, and calibration of the monitoring instrumentation to validate the accuracy of the data gathered.

Direct measurement of emissions as part of a verification exercise is unusual, but would be more likely for process emissions than for combustion emissions because the fixed relationship between fuel consumption and CO_2 emissions does not apply.[17] More typically, verifiers would comment on the adequacy of emissions estimation or measurement methods and the need to improve them in order to verify the results.

Most guidance on verification has been developed for the specific programs discussed in Section IV. While limited, there is some published general guidance on GHG verification beyond that developed for these programs. Though focused more on monitoring, *The Monitoring, Evaluation, and Verification of Climate Change Mitigation Projects: Discussion of Issues and Methodologies and Review of Existing Protocols and Guidelines* (Vine and Sathaye, 1997) and the *International Performance Measurement and Verification Protocol: Concepts and Options for Determining Energy Savings* (DOE, 2000) also address verification. The latter publication provides comprehensive information on measuring the effectiveness of energy efficiency projects, an area closely related to measuring GHG emissions reductions. Its previous edition was used as the starting point for the World Bank's Illumex project to verify GHG emissions reductions associated with energy efficiency measures in Mexico.

While most verification guidance has come from government agencies, some commercial firms have published their approaches. For example, SGS Forestry has published information on its approach to verifying emissions reductions from forestry offset projects (Moura-Costa et al., 2000). (See Box 3.)

IV. Drivers of Greenhouse Gas Emissions Verification

Companies choose to have their GHG emissions verified for a variety of reasons, including the following:

- To assure others that the firm is reporting its emissions accurately and meeting any announced GHG emissions reduction targets;
- To include GHG emissions among the company's reported and verified environmental indicators;
- To demonstrate the results of specific emissions reduction projects; and
- To meet actual or anticipated requirements for trading GHG emissions reductions.

Firms considering verification need to have a clear understanding of what they want to accomplish and be sure that the verification process is designed to meet those goals.

A. Reporting Corporate Greenhouse Gas Emissions and Reductions

An increasing number of firms report their corporate GHG emissions; many have their reported emissions verified. In some cases, this is part of verifying their broader environmental reporting. In others, the focus is specifically on GHG emissions. The public announcement of GHG emissions reduction targets also motivates firms to perform third-party verification. Many firms that have not announced emissions reduction targets but report emissions externally have also had their emissions verified to ensure the credibility of their reported data.

A dozen firms that inventory GHG emissions agreed to participate in a survey for this paper. Table 4 summarizes the information they provided about the verification of their corporate GHG reporting. For convenience, the companies have been classified in three groups: power and gas, oil, and others. There are not, however, notable differences among the groups in their approaches to verification. In each group, some companies used external, third-party verifiers, some companies relied on internal verification, and some companies believed that verification was unnecessary.

Table 4

Verification of Corporate GHG Emissions Inventories

Company	Type of Verification, Years	Reason for Verifying or not Verifying	Reporting of GHG Emissions	Reporting of Verification Results
Power and Gas Companies				
American Electric Power	Self (corporate reporting), Third-party (1605(b) reduction reporting)	Determine the legitimacy of claimed emissions reductions reported under the 1605 (b) program	Biennial Environmental Performance Report (on web site)	For internal review, records available for review on site by EPA auditors
Enron	Third-party, 1999	Ensure against significant gaps or mistakes; add validity to numbers	Considering publishing results in annual report (on web site)	Considering publishing results in annual report (on web site)
Ontario Power Generation (OPG)	Third-party, 1998, 1999 for OPG's *Towards Sustainable Development;* data submission for Environmental Commitment and Responsibility Report (CEA ECR) randomly verified by third party, most recently in 2000	Demonstrate commitment to credible and verifiable reporting of environmental performance	OPG's *Towards Sustainable Development* (on web site), OPG Greenhouse Action Plan, Canadian Electricity Association's CEA ECR	Published as a letter from the verifiers in the annual environmental report, *Towards Sustainable Development*
PG&E Corporation	Self (partial, high-level review)	No final decision yet	Limited GHG emissions and reductions data in Annual Environmental Report	Not applicable
Wisconsin Electric Power Co.	Third-party, 1999	Anticipate the development of emissions trading regimes and a national emissions registry	Not yet publicized, considering annual environmental report and web site	Not yet publicized, considering annual environmental report and web site
Oil Companies				
British Petroleum (BP)	Third-party, 1990, 1998, 2000	Assure data quality to support emissions trading; demonstrate progress toward company emissions reduction target	On BP web site and in external report	On BP web site, in external report, and in papers and conferences
Shell	Third-party, 1996-present, annually	Provide accountability to and greater engagement with stakeholders; assure accuracy and reliability in reporting and build stakeholder confidence; improve ability to monitor and manage business	*Shell Report*, web site, individual operating unit or country reports (available externally)	Results of the verification are published as a letter from the verifiers in the annual *Shell Report*, available on Shell's web site. Each operating unit of the company receives a "Memorandum of Verification" with details on improving the process, which is not published.
Sunoco	Not considered necessary	Inventory results are used as internal performance indicators; they are treated as approximations and are not used where verification would be required	In Sunoco's annual environmental report, on its web site, and reported to CERES	Not applicable

continued on next page

Table 4, continued

Company	Type of Verification, Years	Reason for Verifying or not Verifying	Reporting of GHG Emissions	Reporting of Verification Results
Other Companies				
Alcoa	Third-party verification of total emissions in Australia and Norway and government verification of PFC emissions reductions in Australia, United States, Canada, and Norway, 1990, 2000, 2001	Too early in the process for external verification of corporate inventory, lack of uniform worldwide rules for verification	At present, for internal use only. Publicly announced 1990 baseline in April, 2001 and commitment to achieve a 25 percent reduction from baseline by 2010	For internal use and for reporting to government agencies that require third-party verification.
IBM	Third-party, 1990, 1999 (every other year thereafter)	Requirement for World Wildlife Fund's Climate Savers Program	Externally through annual environmental report (CO_2 from energy use)	To be determined
Intel	None	Request for third-party verification has only come recently from a few stakeholders; key stakeholders trust Intel's accountability and transparency, eliminating much pressure for verification	Internally as a review of progress towards meeting emissions reduction goals, externally as part of an industry agreement with EPA, also supply data to various investment and profiling organizations	Not applicable
Rohm and Haas	None	Question of verification has not been raised	To date, used internally only (CO_2 emissions data)	Not applicable

There is greater variability in how GHG emissions data are reported publicly and, if the data are verified, whether the results of the verification are publicized. Generally, firms that have their emissions externally verified publish emissions information or are considering doing so. Verification is not considered necessary for publicly reporting emissions, however. Sunoco, for example, believes verification is unnecessary for its uses of GHG data. Intel has felt little stakeholder pressure for verification given the level of trust it believes it has established with them and the transparent nature of its reports.

As they begin to verify GHG emissions, firms increasingly have to decide whether to publish the verification results. Table 4 shows that GHG verification is relatively new to many companies, and how to report the results is still under consideration. For those firms that verify periodic environmental (or sustainability) reporting, verification opinions are typically included as an attachment to the report, just as an auditor's opinion is made part of an annual financial report.

BP reports and verifies its GHG inventory and reduction program more publicly than most companies. (See Box 2.) It relies on verification to enhance the credibility of its commitment to its GHG emissions reduction target, and to provide a sound basis for its internal emissions trading program. BP uses a team of third-party reviewers from consulting, verification, and financial auditing firms, and its own staff.

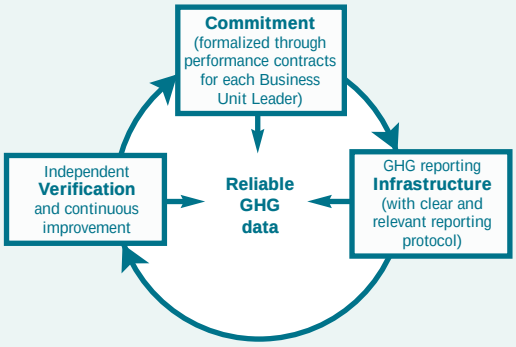
Box 2

Achieving Reliable Greenhouse Gas Data: BP's Verification Experience

BP has operations in over 100 countries. These operations are organized into 150 separate business units (BUs). As a group, they emit approximately 80 million tonnes of carbon dioxide and methane per year (as CO_2-equivalents).

BP has committed to a 10 percent reduction in greenhouse gases from a 1990 baseline by 2010. To assist in making these reductions cost-effectively, BP operates a group-wide emissions trading system, applying emissions caps to each Business Unit. The targets and emissions caps apply to "direct emissions" (i.e., those from BP operations) and account for emissions from all operations in which BP has an equity interest (reported pro rata based on BP's equity share in the operation).

BP recognizes that both the credibility of its GHG commitments and effective functioning of its internal trading system depend on its ability to report data that are reliable, consistent, and comparable. This in turn requires a sound infrastructure for collecting and reporting the data, as well as effective independent data verification, as shown in the figure to the right.



In 1999, BP started groundbreaking work on GHG verification with a consortium of external auditors, KPMG,[18] DNV,[19] and ICF.[20] Working together, these companies offered experiences and skills drawn from both financial and environmental sectors, pooling resources from process engineering, environmental management systems, and financial auditing backgrounds.

In the first year of the project, the auditors sought to verify BP's 1990 and 1998 reported emissions, using 1990 as the baseline year and 1998 data to establish Business Units' trading allocations.

The audit process focused on assessing compliance with the BP GHG reporting protocol and providing assurance that there were adequate controls over data management to enable GHG emissions to be reported without material misstatement. To minimize transaction costs, a "risk-based" audit approach was applied, with the auditors targeting activities and operations where there was greatest risk of material error in the data.

The first round of audits resulted in several improvements to the GHG reporting protocol, eradicating many sources of "variability" through clearer definition of boundaries and improved guidance to the Business Units:

- *Improved definition of boundaries,* i.e. what is included and excluded from the GHG inventories at a Business Unit level (e.g. how to treat emissions from contracted services).
- *Improved guidance on the calculation of "equity share"* of emissions, reducing the variability in approaches to equity definition that were apparent in different parts of the business.
- *Additional guidance on the calculation of methane emissions,* a significant contribution to BP's total GHG releases.

It was also apparent from the first round of audits that there were inherent errors in the 1990 reported data that were very difficult to address given the absence of raw data. This issue is likely to be common to organizations trying to establish 1990 baselines.

In a second round of audits in 2000, BP paid greater attention to gaining assurance from data management systems to provide increased confidence in the reported data. This was an important transition that kept the costs and resource requirements of auditing to a minimum. Improving the consistency of data presentation from individual BUs also reduced time and resource demands. Here, the benefits of embedding GHG management into the Business Unit's ISO 14001 Environmental Management Systems[21] became apparent.

The second round of audits, completed in March 2001, confirmed that material reporting errors in the BP group data had been addressed, allowing BP to demonstrate real GHG reductions to the external world and to evolve its emissions trading system with high confidence in the underlying data.

B. Voluntary Government Programs for Reporting Greenhouse Gas Emissions

The participation of corporations and other organizations in voluntary government programs to report GHG emissions and reductions is another driver of verification. These programs, which provide a public means for documenting emissions and reductions, have taken a variety of approaches to verification, ranging from relying on self-verification by the reporting party to requiring independent, third-party verification funded by the reporting organization. (See Section VI for a discussion of options on who conducts the verification.) Table 5 illustrates how several national and state programs address verification.

The differences illustrated in Table 5 reflect the balance the programs have reached between maximizing participation—which for all of the listed programs is voluntary—and ensuring the accuracy of reported emissions and reductions. To promote participation, none of the national programs requires external verification except Australia's Greenhouse Challenge, which requires participants to agree to allow third-party verification of their reports. The party performing the verification must be acceptable to the participant, and in 2000, for the first round of verification, each verification was arranged and paid for by the government,

Table 5

Verification in Voluntary Reporting Programs

Program	Type of Verification Required			Comments
	Self	3rd party	Government	
National GHG Reporting Programs				
Australian Greenhouse Challenge		X		Verification is performed by third-party contractors funded by the government and following government guidance
Canada's Climate Change Voluntary Challenge & Registry Inc.	X			Inventory must be verifiable to achieve highest "Gold" reporting standard, but does not have to be verified by a third party
U.S. DOE 1605(b) Program				No explicit verification requirement. Submittals require certification of accuracy by individual submitting data; DOE reviews arithmetic and consistency of submittals
U.S. EPA Climate Leaders	X	X		Program is under development and is expected to have two tiers of recognition; highest tier will require independent third- party verification
Developing State Programs				
California Climate Action Registry		X		Act establishing registry requires third-party verification of information reported each year at the expense of the registrant; California Energy Commission will qualify organizations to perform verification (CA, 2000)
Maine Greenhouse Gas Registry				Proposed rules yet to be developed
New Hampshire Voluntary Greenhouse Gas Reductions Registry		X	X	Proposed rules allow registrant to contract with third-party verifier before registration or allow New Hampshire Department of Environmental Services to conduct verification after registration
Texas Greenhouse Gas Reduction Registry				Proposed rules yet to be developed
Wisconsin Voluntary Emissions Reduction Registry				Proposed rules do not require verification, but allow the verification to be registered along with reductions if the registrant wishes

which selected from a set of pre-approved contractors. This approach eliminated cost as a disincentive for the participants to have their inventories externally verified and allowed them to maximize resources put toward GHG abatement and reporting.

Canada's Climate Change Voluntary Challenge & Registry Inc.[22] takes an incentive approach to third-party verification (VCR, 1999). To promote completeness and accuracy in reporting, the program has established a "Champion Reporting System" in which participants may be awarded "Bronze," "Silver," or "Gold" status depending on the rigor of their reporting. While none of these levels actually requires verification, Gold status requires a verifiable emissions inventory for the current year.

The U.S. EPA's Climate Leaders program, which is under development, also uses recognition level as an incentive to promote third-party verification. Unlike the Canadian VCR program, however, the highest recognition level would require independent third-party verification (EPA, 2001). For companies not looking for the highest level of recognition, third-party verification would be voluntary. All Climate Leaders companies will be required to use a standard GHG reporting protocol, however, which will be based on that developed by the GHG Protocol Initiative.[23]

State registries under development in the United States reflect a greater range of verification options than the national programs. While none of the rules on the emerging state programs are yet final, their differing directions are clear. Approaches range from Wisconsin's, which allows for verification but does not require it (WI, 2001), to California's, which requires rigorous certification of all results by third parties, with spot check verification by the state. New Hampshire's draft regulations take a middle approach (NH, 2001). The draft rules require verification, but allow registrants a choice between (1) contracting with an independent third party before registering the emissions reductions, or (2) allowing the state to conduct the verification at the state's expense.

In addition to providing a basis for when verification is required, voluntary registry programs have also been a source of guidance on how verification should be performed. The Australian Greenhouse Challenge program has accumulated the most experience in this regard. In March 2000, it published verification and reporting guidelines (AGO, 2000), which include the following elements:

- Site meeting and tour;
- Review of selected GHG-related systems;
- Verification of baseline and current inventories, and abatement project reports;
- Site and system confirmations; and
- Summary report and closing meeting.

The Australian Greenhouse Office (AGO) also prepared a reporting template to ensure consistency among the reports prepared by the verifiers it employs.

The AGO verification process involves visits to the head office and to one or more selected sites (for organizations with more than one site in Australia). Generally one to two days are spent at the head office, and one at each site. The AGO has found that for the purpose of the Greenhouse Challenge program, this number of visits to participant sites is sufficient. However, it makes clear to participants that the verification is related only to the accuracy of GHG reporting under the Greenhouse Challenge program, and is unlikely to be of sufficient depth or rigor to give the participants credit for early action, baseline protection, or tradable credits for emissions reductions if such schemes were to be developed in Australia (Carrasco, 2000).

While not as well developed as the Australian verification materials, the emerging U.S. state registry programs also contain guidance on verification. The California Registry, for example, requires that any reporting entity report all statewide emissions, and national and international reporting is encouraged. The integrity of the baseline as operations move in and out of state will be tracked. No project-only reporting is acceptable. All data and records must be maintained transparently to allow ex-post certification. Certification must be conducted by a third party that can sign an opinion letter for which it can be held financially accountable.

New Hampshire's proposed regulations for its emissions reductions registry require the following:

- Checking that the voluntary emissions reductions are quantifiable through application of guidance documents issued by the State of New Hampshire, the U.S. EPA, the U.S. DOE, or application of other proposed methods approved by the State; testing of emissions performed in accordance with state regulations; or continuous emissions monitoring;[24]
- Checking that the calculation of the emissions reductions is mathematically correct; and
- Confirming through on-site inspection that the emissions reductions have occurred.

For third-party verification, the proposed New Hampshire regulations also require documenting the verification by affidavit.

The California and proposed New Hampshire approaches to verification are consistent in that they require third-party verification. Since the New Hampshire program focuses on reductions of emissions from specific sources and the California program requires statewide emissions to be reported, the nature of the verification activities will differ, however. The New Hampshire regulations, for example, contain the explicit requirement that the emissions reduction sites be visited; the California regulations do not.

These two state registries are intentionally more rigorous than the U.S. DOE's 1605(b) program. Both state programs are intended to ensure as much as possible that voluntary reductions will be recognized under any future regulatory programs—federal programs in New Hampshire's case, and international, federal, or state programs in California's.

C. Voluntary Emissions Reductions Programs of Non-Governmental Organizations

Recently, NGOs have established voluntary emissions reduction agreements with several companies. Through its Climate Savers program, the World Wildlife Fund has signed separate agreements with IBM, Polaroid, and Johnson & Johnson to reduce CO_2 emissions through energy efficiency measures and fuel-switching. Climate Savers requires participants to obtain independent third-party verification of emissions reductions every other year. Companies are free to choose the verifier, but the estimates of emissions reductions must be consistent with the GHG Protocol Initiative (Eaton, 2001).

In October 2000, Environmental Defense announced its Partnership for Climate Action with seven major corporations: BP, Shell International, DuPont, Suncor Energy, Ontario Power Generation, Alcan, and Pechiney. Since then, Entergy has also joined. The primary purpose of the partnership is to champion market-based mechanisms as a means of achieving early GHG emissions reductions. In joining the partnership, companies agree to publicly declare a limit on GHG emissions from their respective global operations, and to measure, track, and publicly report their GHG emissions performance. Companies agree to adopt best practices in GHG measurement and accounting, and to document and report on their reporting methods. They are not required to have their emissions externally verified (Wade, 2001), but most do employ some form of third-party verification. Table 4 and Boxes 2 and 4 describe the verification activities of BP, Shell, Suncor, and Ontario Power Generation.

D. Product Certification

Product certification—notably for "green" electricity,[25] the environmental attributes of green electricity ("green tags"[26]), and carbon-neutral products—requires verification. In the United States, the best-known organization certifying green electricity is Green-e, established by the non-profit Center for Resource Solutions (CRS)[27] to certify green electricity in states whose electricity markets have been deregulated. A companion program of CRS, the Green Pricing Accreditation Program, operates in states where electricity markets are regulated. Canada's Environmental Choice (EcoLogo™) provides certification in Canada, and several commercial firms do so in Europe. Wisconsin Electric has had its electricity certified under the Green Pricing Accreditation Program, while Ontario Power Generation has received green power certification under the EcoLogo™ program.

Green-e allows non-renewable electricity to account for up to half of the certified electricity product, but imposes restrictions on its sources. The non-renewable portion of the electricity mix must have lower emissions of air pollutants and greenhouse gases than those of the traditional electricity supplier. The Green-e program requires that the company receiving the certification annually employ an independent certified public accountant or certified internal auditor to verify that the non-renewable portion of the certified electricity meets its emissions requirements.

Certification of climate-neutral products also involves verification. Over its lifetime, a climate-neutral product has no net GHG emissions. This is accomplished by designing the product to minimize emissions through its lifecycle, and acquiring GHG offsets for emissions that cannot be eliminated, for example through emissions trading. Alternatively, companies may have their operations certified as climate-neutral by reducing and offsetting the emissions from their operations.

The Climate Neutral Network is one of the best-known (and the only U.S.-based) organization performing Climate Neutral certification.[28] Companies including Interface Inc., Shaklee US, and the Saunders Hotel Group have received climate-neutral certification for their products or operations. The Climate Neutral Network does not require companies that wish to have their products or operations certified to hire independent third-party verifiers, though some companies do. Instead, the organization establishes a review panel staffed by at least four members of the Network's Environmental Advisory Panel. The panel verifies the GHG emissions, reductions, and offsets.[29]

E. International Greenhouse Gas Emissions Reduction and Sequestration Projects

Much of today's third-party GHG verification is driven by the participation—or potential participation—in international projects for reducing GHG emissions under the UNFCCC and the Kyoto Protocol. In prospective Joint Implementation (JI) projects, an entity in one developed (Annex 1) country purchases emissions reduction credits from projects in another developed country. Under the Clean Development Mechanism (CDM), emissions reduction projects are established in developing countries. Since JI and CDM projects are part of the as-yet-unratified[30] Kyoto Protocol, the rules for these programs have not been developed. However, companies involved in projects that may qualify for JI or CDM do so under rules—including rules for verification—established by national governments for pilot projects under various national Activities Implemented Jointly (AIJ) projects of the UNFCCC.

Power companies have been active in JI and CDM-type projects. Table 6 lists projects of those companies that participated in the survey for this paper. Projects must be acceptable to the host country as well as the country of the sponsoring organization. Requirements for third-party verification vary by country, however. Projects to be included in the U.S. Initiative on Joint Implementation are required to contain provisions for external verification (USIJI, 1994), for example, but Canadian projects are not.

A key component of verification is ensuring that these projects meet the relevant program criteria and achieve their reported emissions reductions. Box 3 describes the importance of validating program criteria and verifying emissions reductions for a forestry offset project in Costa Rica. In this case, the firm conducting the verification would be the same as the one that initially validated the project. Some programs, such as the World Bank's Prototype Carbon Fund (described below), would prohibit such an arrangement. However, most programs do not prohibit the same firm being both the validator and verifier.[31]

Table 6

Verification of International GHG Emissions Reduction and Sequestration Projects

Company	Type of Emissions Reduction Project(s)	Initial Project Validation	Type of Verification
American Electric Power	• Noel Kempff Mercado Climate Action Project: avoided deforestation • Guaraqueçaba Environmental Protection Area: reforestation and avoided deforestation • UtiliTree Carbon Company: domestic and international carbon management programs including reduced impact logging and carbon sequestration	Noel Kempff and UtiliTree projects reviewed and approved under USIJI program	Monitoring and verification plan for Noel Kempff was developed with the assistance of Winrock International; similar plans used at other sites
Ontario Power Generation	AIJ (in association with six other electric companies): • Indonesia: basic electricity supply to 4000 citizens in remote areas using renewable resources • Jordan: technical assistance and equipment for efficiency improvements and emissions reductions for fossil fuel power generation units • Zimbabwe: micro-hydro generating station addition to an existing irrigation dam for rural electrification	AIJ projects registered with AIJ bodies in Canada, France, Germany, Italy, and Japan	As required by countries where projects registered; annual progress report to Canada's CDM/JI Office (third-party verification not required)
PG&E Corporation	Sabah Malaysia: sequestration/forestry, potential CDM project	Application submitted to USIJI Program, awaiting host country approval	Field verification conducted every five years by third party consisting of two auditors, one selected by PG&E, one by project developer; project-specific protocol used
Wisconsin Electric Power Co.	• Repowering project in the Czech Republic • Forestry sequestration in Belize	Approved by USIJI	Annual verification of repowering project by representatives of the Czech government; annual verification of sequestration project by Winrock International; project-specific protocols used in each case.

The most challenging criteria to verify involve those for CDM projects:

- The project must be acceptable to the government of the host country.
- Emissions reductions must be real, quantifiable, and verifiable. A project that leads to greater emissions outside the host country would not represent a real reduction.
- Emissions reductions must be additional to those that would have occurred had the project not been implemented, a concept referred to as "additionality."[32]
- The project must promote sustainable development—environmentally, socially, and economically—in the host country.

Box 3

Validation of the Costa Rican Protected Areas Project

SGS Forestry, a part of the SGS Group, the world's largest inspection, verification, and testing company, worked with the Costa Rican Government to evaluate the carbon sequestration potential of its conservation reserves for the Costa Rican Protected Areas Project (PAP). The goal of this effort was to ensure that the project would comply with requirements for CDM projects under the Kyoto Protocol.

Due to the lack of an internationally recognized standard against which to assess potential CDM projects, SGS Forestry[33] and Ecosecurities Ltd.[34] prepared a set of Eligibility Criteria, which describe the conditions that CDM projects may have to fulfill. There are four criteria, three of which are drawn specifically from the text of the relevant articles in the Kyoto Protocol. The fourth criterion relates to capacity of the implementing organization.

1. *Acceptability.* The project was shown to comply with national land use and development policies, national and sub-national legislation, and stakeholder expectations though the signing of a Memorandum of Understanding between the host and non-host countries.
2. *Additionality.* The project, emissions savings, and financing were demonstrated to be additional to what would have happened otherwise. Additionality was demonstrated based on two satellite images showing deforestation between 1979 and 1992. The rate of deforestation was then discounted depending on the type of land ownership, with state lands considered to be more secure than NGO lands and NGO lands more secure than private lands.
3. *Externalities.* The project was evaluated for (i) the potential for its benefits to be lost, and (ii) negative environmental and social impacts. Non-GHG externalities including social and environmental performance were evaluated based on established Forest Stewardship Council Principles and Criteria.
4. *Capacity.* The project was demonstrated to deliver the expected benefits because it was to be implemented by the National Parks Authority, which already has a good track record in managing existing areas and is aided by a stable political climate.

SGS also conducted a risk and uncertainty assessment. Risks important to forestry projects include technical failure (e.g., poor silvicultural practice), natural disasters (e.g., fire), local or national socio-political issues such as indigenous peoples' or local peoples' land rights, and, in severe cases, civil unrest. The original prediction that 1.6 million tonnes of carbon would remain sequestered over 20 years was reduced to an "almost risk-free" prediction of 1 million tonnes.

While working on the project one particular challenge arose. There is no standard definition of a "carbon offset." In particular, there is no guidance on how long a tonne of carbon must be retained before it counts as an emissions offset. This definition will have great significance for forestry projects because it will determine how project managers handle harvesting cycles. In the Costa Rican PAP, the offset time frame was 20 years (the project life), but SGS would expect the forests to remain after that.

To date, the expected project offsets have not been verified. While project activities such as the transfer of lands, demarcation of boundaries, and fire control measures have begun, project offsets have not yet been sold. If the offsets are sold and SGS is asked to verify the offsets, it will:

- Check the transfer of lands to ensure they have become conservation reserves;
- Check the demarcation of park boundaries (maps, field visits, fly over);
- Check satellite images (if available) to assess deforestation within and outside the park boundaries to confirm baseline assumptions;
- Visit neighboring communities to see if they have been involved in fire control, education programs, etc.;
- Inspect the resources and conditions within the National Parks Authority, which must have resources to monitor the project; and
- Assess ongoing compliance with the eligibility criteria listed above.

After completing the verification, SGS would issue Certified Tradable Offsets (CTOs). CTOs, which have been created by the Costa Rican government, represent one tonne of carbon sequestered by Costa Rican forests. SGS Forestry expects that once it has been accredited to issue Certified Emission Reduction Units (CERUs) under the CDM, CTOs issued after 2000 could be transferred into CERUs because the CDM will recognize and allow banking of certified emissions reductions only beginning in 2000. Because of this restriction, CTOs generated before 2000 could not be converted to CERUs under the CDM, but would still be valid for meeting voluntary commitments.

Companies considering participating in JI- or CDM-type projects should recognize that they may require verification throughout the course of the company's involvement with the project.

F. Greenhouse Gas Emissions Trading

Emissions trading is commonly employed for conventionally regulated air pollutants such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Trading allows companies that would find it expensive to reduce emissions to purchase emissions reduction credits from another firm that has reduced its emissions more than required. The selling firm benefits financially; the acquiring firm benefits by meeting its emissions reductions requirements in a less costly way. Because conventional pollutants are traded in order to meet regulatory requirements, regulatory programs that allow trading rigorously monitor and verify emissions to ensure that the excess emissions reductions are actually achieved and accurately reported.

Trading of GHG emissions is in its infancy. With few exceptions, company emissions of greenhouse gases are unregulated, and trading is not used for compliance purposes. Companies like Suncor, Ontario Power Generation, and TransAlta are, however, purchasing GHG emissions reductions to meet their publicly announced commitments to limit their GHG emissions. (See Box 4.)

Nearly all GHG trades have occurred as bilateral contracts between a single buyer and a single seller. As such, verification of reductions has been negotiated as part of the contract. Buyers typically insist that sellers provide third-party verification of the emissions reductions, and may retain their own verifiers for the same purpose. As each transaction is unique, and no verification standards have been established, the protocols for the verification of these reductions vary depending on the nature of the reduction and the firm conducting the verification.

Brokers involved in GHG trades have played a limited role in verification. Since liability for the reductions rests with the seller, rather than the broker, emissions brokers like Natsource provide advice and guidance to firms that may wish to list emissions reductions, but do not develop or use their own verification protocols (Edwards, 2001). Similarly, CO2e.com, a web-based trading system for greenhouse gases, provides some screening criteria to prospective sellers, but leaves the buyer and seller to negotiate verification (Arner, 2001).

Government GHG trading programs, while just emerging, are addressing the issue of verification. In 2000, the State of New Jersey added greenhouse gases to the compounds covered by its Open Market Emission Trading (OMET) program (NJ, 2000). This program defines rules for generating, registering, transferring, verifying, using, and voluntarily retiring credits. The same rules apply for each pollutant, although there are no provisions for "using" GHG credits to achieve regulatory compliance. Because verification is

Box 4

Suncor's Verification Approach

Suncor has developed a comprehensive climate change action plan that includes managing its own emissions, developing alternative and renewable energy, using GHG offset mechanisms, helping to educate and engage the public and its employees, and measuring and reporting on its progress. Fundamental to the success of this strategy is a robust and rigorous system to quantify and verify GHG emissions reductions—both from its own operations and from offset projects considered for inclusion in its portfolio. Verification efforts are driven by Suncor's need to ensure the transparency and credibility of its efforts with a wide range of stakeholders (shareholders, communities, governments, customers, interest groups, the general public), and to assure its shareholders that it is managing climate change risks appropriately.

Each of Suncor's businesses has developed an "accounting methodology" document to quantify its emissions. This document outlines how GHG emissions are calculated within that part of Suncor. Environmental Resources Trust reviews the methodologies used to generate Suncor's GHG emissions estimates. In selecting a verifier, Suncor looked for organizations that were prepared to work collaboratively to develop creative solutions to environmental issues. Using a non-profit, Suncor was able to draw upon:

- Unique expertise in the design of emissions trading programs;
- An orientation to leverage the transactions to derive further environmental benefits; and
- Credibility based on internationally recognized expertise.

At present, Suncor does not conduct an annual, in-depth verification of its corporate GHG emissions. GHG emissions are now being verified as one of several selected indicators that Suncor includes in its annual sustainability report. In addition, as a one-time activity, Suncor has retained a third party to compare its GHG reporting practices with a range of emerging guidelines and to compare actual company reporting practice with the company's internal accounting methodology.

Suncor also conducts verification of GHG offset projects in which it participates, such as the Rio Bravo sequestration project in Costa Rica. Such projects are being implemented on behalf of shareholders who want assurances that the GHG benefits are being achieved and that the projects will be positioned for future government recognition. Offset projects also must be technically sound and have the credibility necessary to attain formal recognition. Suncor's approach to offsets is to become involved only in projects that have a rigorous and internationally credible verification strategy. It looks for the following elements:

- Validity and accuracy of measurement methodology;
- Cost of verification process;
- Credibility of verification entity;
- Host country endorsement; and
- Corporate learning benefits.

Suncor has recognized the necessity of verifying GHG emissions reduction projects from which it purchases or may receive credit for emissions reductions. The company also sees verification as being an increasingly important part of its corporate performance reporting generally, including performance on such environmental indicators as GHG emissions.

required only when the credits are used in New Jersey and not when they are generated, transferred (sold), or retired, OMET verification is not required for GHG credits.

However, verification of GHG emissions may occur under OMET and a notice of any verification is registered along with the credit. The same rules apply for verification of greenhouse gases as for verifying nitrogen oxides and volatile organic compounds:

- Credits generated within the State of New Jersey must be verified by either a professional engineer or certified public accountant licensed under New Jersey regulations.
- Credits generated outside of the State of New Jersey must be verified by, or in accordance with the procedures of, the other state, and the air pollution control agencies of the two states must have a written agreement in place that expressly allows credit verification in the other state to be recognized in New Jersey.
- The verifier may be hired by the generator, but must meet specific tests of independence from the generator.

While the New Jersey regulations do not spell out the precise steps the verifier must take, they do specify four findings the verifier must make in order for the credit to be verified:

- The credit generation notice must contain all of the required information, supporting documentation, and certification required under the regulation and the applicable quantification protocol for the pollutant.
- The credit generation notice must appear on its face to be true, accurate, and complete.
- All calculations must be performed as required under New Jersey regulations in accordance with a quantification protocol that also meets the state's requirements.
- The credit generation notice must establish that the credits are based on real and surplus emissions reductions that satisfy the state's requirements for the generation of credits.

The state is preparing guidance on quantification protocols used to generate GHG credits, which would then be used for verification (NJ, 2000b). The generator must develop the protocol, however.

Development of the UK-ETS for greenhouse gases is leading to development of guidance on how to calculate and verify emissions reductions. Companies that participate in this voluntary scheme will have a target for reducing GHG emissions. They may buy and sell emission allowances throughout the year, provided that at the end of the year they have sufficient allowances to cover their emissions target. Because the

targets apply to the entire company's emissions (or entire industrial sectors within a company), the protocol and verification guidance is focused on emissions from entire operations, rather than on specific emissions reduction projects.

The consultation document developed for the UK-ETS expresses the government's belief that robust procedures for verification are essential to a credible trading scheme (DETR, 2000). Recognizing the need to minimize the administrative burden (if not the cost) to the companies that volunteer to participate, the government has suggested a two-tier approach to verification: annual third-party verification of submitted data and other information to demonstrate compliance with trading scheme requirements, and more thorough periodic checks to assess the basis for the emissions data and related information.

Neither the emissions calculation protocol nor the verification guidance has been published in final form, though the program requires that company emissions be verified annually. An Emissions Trading Group[35] working group has proposed basing verification on BP's GHG emissions verification procedure and on International Standards Organization (ISO) guidance for environmental management systems, ISO 14001 (ETG, 2001). (ISO has not yet developed guidance for verifying emissions inventories.) The verification audits would consist of four elements:

- Strategic analysis to understand the organization's operations, emissions, and evaluation of GHG sources, and the areas to be the focus of the audit;
- Process and evaluation analysis to understand high-risk processes and the organization's effectiveness in managing identified risks;
- Additional audit testing and reporting to complete the audit and evaluation of risk control methods; and
- End-of-the-year review.

G. National and International Solicitations for Greenhouse Gas Emissions Reductions

Programs of the Dutch Government and the World Bank to promote GHG emissions reduction projects and foster emissions trading are another driver for GHG verification. The Ministry of Economic Affairs of the Netherlands has developed verification guidelines for JI projects developed under the Dutch government's Emission Reduction Unit Procurement Tender (ERU-PT) (MEA, 2000). ERU-PT is a public offer of the Dutch government to purchase GHG emissions reduction units generated by projects in Annex 1 countries that approve the transfer of ERUs to the Netherlands. To date, Bulgaria, Romania, and Slovakia have done so.

Instead of purchasing emissions reductions, the World Bank invests in projects to reduce GHG emissions through its Prototype Carbon Fund. The fund was established with contributions from governments and private companies to experiment with creating an emissions reductions market. The fund invests in cleaner technologies in developing countries and countries with economies in transition to reduce GHG emissions. These emissions reductions will be independently verified and certified and then transferred to the fund's contributors as emissions reduction certificates rather than cash. As part of this program, the fund has developed guidelines for verifying GHG emissions reduction projects (PCF, 2000).

Table 7 lists the approaches to verification required by ERU-PT and the Prototype Carbon Fund. The key elements of the verification guidance are similar—periodic verification of the reported emissions and reductions by qualified third parties—though they differ somewhat in the specific qualifications required of the verifiers. Also, the Dutch program is directed specifically at JI projects, while the Prototype Carbon Fund includes potential CDM projects.

These programs are still too young to assess their success and whether they will serve as models for other similar programs. If they are successful, the guidance developed for them will likely see more widespread use.

Table 7

Elements of Published GHG Verification Guidance

Verification Guidance and Scope	Key Elements of Verification	Requirements for Verifiers
Ministry of Economic Affairs of the Netherlands: Guidelines for Joint Implementation Projects	• Planning and coordination with project organization for verification and any on-site assessment • Review of project considering verifiability of claimed emissions reductions; proper control, monitoring, and measurement of key factors influencing reductions; assessment of whether the baseline study, project design documents, and monitoring plan are still valid; conformity with program guidance on baseline studies, monitoring, and reporting; conformity of the monitoring report with the project's monitoring plan; transparency and verifiability of monitoring report; and accuracy and transparency of calculations • Verification report and conclusions • Corrective action request (if necessary) • Verification decision (certification)	Among numerous other requirements, firms must: • Be accredited for the certification of environmental management systems based on ISO 14001 • Employ as verifiers personnel with a minimum of four years of relevant, full-time professional experience and formal training related to GHG issues and verification
World Bank Prototype Carbon Fund (PCF)	• Conducted at regular, possibly annual, intervals • Includes visit to project before operation begins to review baseline and the appropriateness of the monitoring plan, to audit compliance with the agreed monitoring plan, and to consult with and/or train monitoring personnel as necessary • At regular intervals, review continued compliance with agreed procedures for monitoring, audit the physical measurements and statistical data collected during the verification period, assess whether project continues to meet all project criteria, check calculations of baseline and project emissions, and examine the calculation of emissions reductions including any corrections for leakage • At the request of the PCF, review project assumptions, particularly related to emissions baseline and leakage; alert project participants to risks that may jeopardize the project's success	• Normally be an environmental auditing and certification company with accreditation under a publicly recognized accreditation scheme • Must not be the firm that conducted the initial validation of the project

V. Verification Issues

The verification of GHG emissions raises several issues not typically faced by environmental or financial auditors. These issues relate to the timing and scope of the activities being verified and to the general absence of regulatory or industry standards against which verification may be performed.

A. Who Conducts the Verification?

A range of possibilities exists for who conducts the verification, including independent third parties, government entities, and the emitters (in the case of self-verification). At present, nearly all verification is done by independent third parties or through self-verification. Governments have shown relatively little interest in verifying corporate GHG emissions.[36]

There are several attributes that firms should look for in selecting verifiers. These attributes include experience in verification, auditing, or compliance monitoring; training; knowledge of GHG issues; knowledge of the relevant sector or industry; and independence. Firms that self-verify cannot achieve complete independence, and the greatest advantage to third-party verification is the ability to provide an unbiased view.

The need for third-party verification is driven by a company's internal and external stakeholders. For firms that have concluded that complete independence is needed or that they lack the necessary skills internally, third-party reviews often bring a breadth and depth of knowledge and skills that cannot be found within an organization. The external expertise and problem-solving abilities of a third party may make the verification process more cost-effective than self-verification. Independence generally promotes the full disclosure of information by individuals within an organization, and provides a higher degree of credibility with stakeholders. Companies that use third-party verification will find themselves in a better position in negotiations with business partners and governments than their self-verifying counterparts.

Organizations that wish to retain independent third parties to conduct their verification have a range of verifiers to choose from, including accounting firms, certification firms, engineering firms, environmental consultants, and NGOs.

Different companies have taken different approaches to selecting verifiers. In some cases, a combination of firms has been used to conduct verification. (See Box 2.) It is important that the individuals conducting the verification understand the type of business and processes they are reviewing and have

experience and expertise in the areas covered by the verification audit. For this reason, the AGO qualifies specific individuals within a firm, rather than the firm itself, to conduct verification.

IBM, like other companies, is using more than one organization to conduct its emissions verification. For PFC emissions reductions, it works with the U.S. EPA. Through the World Wildlife Fund's Climate Savers Program, IBM has engaged the Center for Energy and Climate Solutions[37] to conduct the third-party review of its CO_2 emissions reduction estimates, as well as its energy use and conservation efforts.

As the interest in monetizing emissions reductions increases and a more structured and reliable trading system develops, the need for the same degree of independence and credibility currently provided by financial auditing will increase for the accounting of GHG emissions. Pressure for third-party verification can be expected to increase from those involved in direct trades, the trading markets themselves, mergers and acquisitions, and government GHG reduction programs.

Firms participating in public programs to report or reduce their GHG emissions will want to pay close attention to program requirements for verifiers. Various public sector programs have established guidelines for who should perform GHG verification. These include guidance established for the AGO, the Dutch ERU-PT program, and the UK-ETS program, as well as existing and proposed regulations in New Jersey and New Hampshire. These programs vary widely regarding the certification of verifiers. Reflecting the greater interest in environmental management systems in Europe than in North America, the Dutch Program requires that the verifiers be accredited for certification of environmental management systems based on ISO's Environmental Management Standard (ISO 14001). The UK-ETS has proposed that verifiers "need to be accredited as having the appropriate range of competencies and skills similar to existing verifiers/certifiers of environmental management systems" (DETR, 2000). In contrast, the Australian Greenhouse Challenge program does not require that verifiers be certified in environmental management systems (although it is listed as an advantage in its selection criteria for verifiers).

The World Bank's Prototype Carbon Fund states that verifiers should normally be environmental auditing and certification companies with accreditation under any publicly recognized accreditation scheme (PCF, 2000), though it does not specify any particular scheme. New Jersey regulations for verification under its OMET emissions trading program explicitly require that verifiers be certified financial auditors or engineers (NJ, 2000). Proposed regulations for New Hampshire's voluntary registry require that third-party verifiers have at least five years of experience in conducting compliance testing of air emissions (NH, 2001).

Firms that have rigorous, verifiable emissions inventory programs and that have not been pressured by stakeholders may choose not to retain third-party verifiers. Many firms believe that self-verification

meets their short-term needs. United Technologies, for example, has been involved in self-verification based on an honor system, with the recognition that third-party verification may be desirable as the process matures and standards become broadly accepted.

Self-verification offers the most feasible, practical, and cost-effective alternative for many firms in the early stages of inventorying emissions. Companies generally have the most detailed information available concerning their own emissions and can thus verify them much more cost-effectively than a third party can. Systems of self-reporting increase the possibility of mistakes or misrepresentation, however. In any self-verification, there may be incentives for bias. The process will lack credibility if it is closed to public view. Transparency in both the process of reporting emissions and in conducting the verification is key for self-verification to succeed.

As companies look toward setting future GHG reduction targets, participating in internal or external carbon trading programs, or investing in JI- or CDM-type projects, self-verification will generally not be sufficient. Program criteria or contractual requirements will require external verification in many cases. When third-party verification is not an explicit requirement, NGOs, government bodies, and other stakeholders will push at least for the verifiability of inventories, if not for actual verification by third parties.

B. What To Verify: Inventory Protocols and Verification Standards

The absence of widely accepted protocols for conducting GHG inventories and verification increases the complexity and cost of verification. While efforts are underway to standardize the emissions estimation and reporting process through measures such as the GHG Protocol Initiative, most organizations currently report emissions in their own way (unless they follow specific national guidance as in Australia).[38] Therefore, the reporting procedures being verified will vary by company. This situation is analogous to environmental compliance auditing, which examines conformance with internal company policies and procedures and applicable government regulations. However, broad national (or international) standards that form the basis for building company policies and procedures for inventorying and reporting GHG emissions are lacking. The lack of such standards does not preclude verification, and, as with other forms of environmental reporting, a single, uniform reporting standard may never exist. More uniform reporting standards could make verification results more widely understood and accepted.

The standards for conducting verification also remain unresolved. Scott (2000) reports wide variability in the scope and quality of verification statements, ranging from those based merely on the review of a company's environmental report to those that describe the verification methodology, attest to the accuracy and completeness of the reported information, and provide recommendations for improvement. Before selecting a firm for verification, companies are advised to gain a clear understanding of what the verifiers

will do and to review the verification statements of a range of firms. The best statements will clearly state their methodology, views on the accuracy and completeness of the inventory, and recommendations for improvement (Scott, 2000).

Not only will statements vary, but the depth of verification may differ as well. Verifiers may choose to:

- Review records in the corporate headquarters or on site;
- Review all company facilities or a selected few; or
- Rely on standard estimation or measurement techniques, or independently assess the relevance and reliability of these techniques.

Some firms, notably BP and Texaco, have concluded that corporate-wide verification focused solely on GHG emissions from significant portions of their operations is necessary. Others, such as Shell, have incorporated verification of their GHG emissions into verification of their environmental reporting with more limited on-site activities. Others have relied on outside firms to review their procedures and calculations without conducting on-site visits.

Most firms have not considered it necessary to assess the applicability of standard estimation techniques or to conduct field tests. However, such assessment can be valuable. American Electric Power, for example, found that continuous emissions monitoring, following procedures established under EPA regulations, tended to overstate their emissions (Loreti et al., 2000).

Another issue faced by organizations undergoing verification is that of the relative emphasis to be placed on environmental management systems as compared to GHG-related data. The recent experience of a number of verifiers working under the Australia Greenhouse Challenge program was that over-emphasis on a firm's environmental management systems and internal processes may have added unnecessary time and cost to the verification and distracted from the focus on the key verification issues of whether the emissions data reported were accurate and how they were obtained (AGO, 2001). For this reason, the AGO has suggested that future verification should have increased focus on the actual data, although the verifiers should continue to offer suggestions to improve the data gathering and reporting processes.

A recent initiative to provide guidance on verification issues is highlighted in the *Government of Canada Action Plan 2000 on Climate Change* (Canada, 2000). The plan includes a government commitment to establish a "Greenhouse Gas Verification Centre" to "accredit the verification of industry actions." The center, which is currently being set up, will serve as a clearinghouse and provide technical advice, support services, and engineering guidance on emissions measurements, estimation, and verification methodologies and protocols.

The Global Reporting Initiative (GRI),[39] while concerned with sustainability (and hence environmental) reporting, is revising its guidance on verification. The initiative's *Sustainability Reporting Guidelines* (GRI, 2000) do not require third-party verification, but contain some general guidance. GRI has established a Verification Working Group to help standardize verification methodologies and confirm the legitimacy of verifiers. The group also serves as a forum for parties interested in verification, and as a source of guidance on the overarching principles of verification.

C. When To Verify

Firms and governments have varied on the question of when verification of GHG emissions should occur. In some programs, for example those in Canada, the approach is to defer verification until the firm can obtain some clear benefit. Under GERT, firms are not required to verify their emissions reductions in order to register them. However, if the reductions are sold, the buyer will almost certainly require them to be verified. A similar approach is taken under Canada's baseline protection program in which firms register their baseline emissions to obtain credit in the future for any voluntary emissions reductions they make before regulations are imposed. Because of uncertainties about future regulatory requirements and the cost of conducting verification now, verification is not required when the baseline is registered. Firms should understand, however, that verification of the registered baseline might be required in the future.

For firms that currently conduct GHG emissions inventories but have chosen not to verify them, it is essential that they maximize the verifiability of their inventories. Therefore, if someone wishes to verify the company's emissions in the future, the procedures for conducting the inventory will be available, as will documentation of data on which the inventory is based.

Firms that are not required to verify GHG emissions through voluntary programs in which they participate, but chose to do so anyway, have greater freedom in choosing when verification is performed. If the firm has only recently begun conducting a corporate GHG inventory, it may make sense to conduct the inventory without external verification for several years to learn how to do it and to improve the inventory process.

Verification should be seen as a means of continuing the process of improving the accuracy and completeness of the inventory. Thus, once the firm has established an inventory process and wishes to improve it—or if there are specific shortcomings it is unable to resolve—the time would be right for external verification. One exception to waiting is for firms that already have other environmental data verified. In this case, relatively little additional effort may be needed to include greenhouse gases in the verification. Doing so will avoid questions about why greenhouse gases were omitted from the set of verified environmental parameters.

D. Cost of Verification

The cost of third-party GHG emissions verification varies widely. While it is impossible to provide any precise numbers due to the wide range of possible scopes and reluctance of companies to share such information, the cost of corporate verification typically ranges from $5000 to $500,000. The cost depends on the size of the company, the number of sites visited, the size of the verification team that visits each facility, and the depth of its investigations. Large, multinational corporations conducting verification by visiting multiple sites can expect their costs to be at the upper end of (or even beyond) this range. Firms that are able to incorporate GHG verification into their existing environmental auditing or verification programs will spend much less.

The cost of third-party verification of emissions reductions needs to be considered in relation to the value obtained from those reductions. With GHG emissions reductions currently trading for as little as one to five dollars per ton of CO_2, the cost of the verification can amount to a significant fraction of the value of the GHG reduction. This is a particular problem for small projects, whose verification and other transaction costs are proportionately greater than those of large projects.

E. Materiality

Materiality refers to the significance of the difference between reported data and actual results obtained by a verifier or auditor. In financial reporting, a material (or significant) misstatement is sometimes taken to be a difference of more than 5 percent between a reported and audited value (though this is not an absolute standard). Even a rough materiality standard does not exist for reporting of GHG emissions or other environmental data, which inherently have more variability than financial data. Therefore, verifiers have applied different standards of materiality in their GHG emissions verification. In its first round of verification, the Australian Greenhouse Challenge (AGO, 2001) established an acceptable margin of error of ±10 percent for reporting progress in meeting emissions reduction targets. Their verifiers found that in many cases a 5 percent margin of error could be achieved for most energy-related sources but that for some sources and sectors, a greater margin of error was needed. The AGO is reviewing the appropriateness of using the 10 percent margin of error in future verification under the Greenhouse Challenge Program.[40]

BP has used a stricter standard of materiality than that used in the first round of Australian Greenhouse Challenge verifications. For GHG verification, a misstatement of 5 percent of total company emissions is considered to be material (BP, 2001). After completing audits of 1998 and 1990 data, the verifiers were unable to state that the BP Group data were free from material misstatement. However, after improvements to the inventory protocol and a focussed effort on improving data quality, recent audits have shown that the latest reported data (year 2000) meet the required standard and are free from material misstatement.

As more companies set corporate targets for GHG emissions reductions, and as more voluntary registries develop for reporting corporate-wide emissions, the importance of materiality will increase. For firms that set targets ranging from stabilization (no increase in emissions) to reductions of up to 10 percent of their baseline, the materiality threshold may equal or exceed the goal for emissions reductions. This will inevitably lead to questions about whether the target is being met or whether the reported reductions result from a lack of precision in the data.

F. Verifying the Baseline

Most organizations that conduct GHG emissions inventories establish a baseline from which to track trends in emissions or to measure progress in reducing emissions. Often, 1990 emissions are used as the basis of comparison. If an organization commits to capping or reducing its emissions relative to some past base year, then the verification of its progress toward this goal requires that both the baseline and current levels of emissions be verified. (See Box 2 for a discussion of BP's experience in verifying its baseline.)

A key problem that arises when verifying past emissions is the lack of data. Since most organizations have not inventoried their GHG emissions until relatively recently, their ability to estimate their baseline emissions for past years largely depends on the adequacy of their record-keeping systems. If historic fuel consumption records are available, for example, they could be used to estimate baseline CO_2 emissions. For greenhouse gases from other sources, however, estimation of past emissions would be more difficult. Even if a firm has data on the activity level that causes the emissions (e.g., the amount of gas flared in an upstream oil operations), it may not have historical data relevant to the selection of the emission factors for the activity (for example, the flaring efficiency in the base year[41]).

Further complicating the establishment of an emissions baseline is the dynamic nature of modern organizations. Due to organic growth, acquisitions, and divestitures, the firm for which the retrospective baseline is being verified could be quite different from the firm that originally committed to limiting its emissions and performing the verification. If the baseline has been adjusted to eliminate emissions from divested assets or to include emissions from acquired assets, the verifiers must confirm emissions from assets of a different company or eliminate that part of the emissions from the divested assets.

G. Verifying Indirect Emissions

Conducting GHG emissions inventories requires drawing boundaries around a firm's sources. Loreti et al. (2000) recommend that companies include in their inventories emissions over which they have significant control. This includes indirect emissions associated with the electricity they purchase.[42]

Verifying indirect emissions raises the issue of data access. Presumably, the organization whose emissions are being verified will have information on the amount of electricity it consumes, but it is less likely to have specific information on the carbon intensity of this electricity. Such information could be obtained from the electric utility serving the organization—at least on an average basis—though it is uncertain whether the utility would allow verifiers to check the basis for the data they supply. If the utility hires its own third-party verifier to check on its emissions, this problem will be greatly reduced.

Line losses between generating units and electricity purchasers will further complicate verification of indirect emissions. The utility is likely to supply average figures, which may or may not reflect the actual losses that occur in supplying electricity to the facility of interest. Establishing the actual losses would likely be beyond the scope of the verification. An assessment of the uncertainty this creates would be appropriate for the inventory verification.

H. Verifying Life-Cycle Emissions

Verification of emissions over a product's life cycle raises issues beyond those faced by organizations verifying emissions from their operations. These issues expand on those for indirect emissions discussed in Section VI G. Emissions from purchased electricity used in manufacturing are one component of a life-cycle emissions inventory, so the issues associated with energy imports also apply to conducting a life-cycle assessment. The issue of indirect emissions is further complicated in a life-cycle assessment by the need to determine emissions associated with the other inputs to a product's manufacture (raw materials), the use of the product, and its disposal. There is further uncertainty and complexity when the emissions associated with these parts of the life cycle occur overseas. Confidently verifying emissions over the entire life cycle requires the cooperation of many parties.

To calculate a project's net emissions reduction, it is necessary to assess the emissions over the entire project life cycle. In evaluating projects to reduce GHG emissions based on the substitution of raw materials, for example, emissions from the production of the raw materials and their effects on disposal or recycling of the finished product should be considered. Furthermore, the reporting boundaries of the project should be drawn broadly enough to prevent leakage (the shifting of emissions outside of the reporting boundary). For example, replacing steel in automobiles with aluminum to reduce weight and thus fuel consumption and GHG emissions requires looking at the change in emissions resulting from manufacturing and recycling aluminum compared to steel, as well as to the changes in the vehicle emissions.

VI. Conclusions

Procedures for verifying GHG emissions are in an even earlier stage of development than procedures for conducting emissions inventories. Nevertheless, the limited verification experience to date suggests a number of principles companies and other organizations should follow when verifying their emissions and emissions reductions:

1. *Conduct your emissions inventory as if it is going to be verified.* For organizations that do plan to have their emissions verified by third parties, establishing rigorous reporting, emissions estimation, and data retention and management systems will facilitate the work of verifiers and provide increased confidence in reported emissions. For organizations that do not see a current need to verify, having these systems in place will make it possible to conduct third-party verification of current emissions in the future, should it become necessary.

2. *Be clear on the purpose of the verification.* Verification is conducted for various reasons and the results of verification performed for one purpose may not be applicable to another. Verification of emissions reductions reported in an annual environmental report is unlikely to satisfy a trading partner to whom you are trying to sell emissions reductions, for example. Be sure that all stakeholders who rely on the verification will be satisfied with the scope and methods of the verification.

3. *Choose verifiers carefully.* Recognizing that a range of verification approaches exists, be sure that the verifiers you select have qualifications and experience in the appropriate areas. The individuals verifying your inventory should understand your organization, its type of business, and its emissions. The verifiers' knowledge and experience are more important than the organization they are from. If the verification is being performed as part of an established GHG reporting or reduction program, choose verifiers who have the qualifications that that program requires.

4. *Learn from your verification experience.* Organizations will maximize the value of their GHG verification if they use it to improve their GHG emissions inventory process. Most organizations are still gaining experience in conducting inventories. Applying the results of the verification to future inventories will improve the reliability of the reported information and facilitate future verification. When hiring third-party verifiers, ask that specific recommendations for improving your organization's GHG inventory be included in their findings.

Endnotes

1. In “emissions trading,” the polluter reduces more emissions than required and then sells the excess reductions to another party who wishes to acquire them. Rather than emissions, what is really being traded (or purchased) are emissions reductions.

2. The Business Environmental Leadership Council (BELC) of the Pew Center on Global Climate Change is a group of leading companies worldwide that are responding to the challenges posed by global climate change. The BELC explores how companies can contribute to solutions at home and abroad through their own products, practices, and technologies.

3. ExxonMobil, GM, Ford, Cinergy, Goodyear, Duke Power, CSX, Southern Co., Chevron, Texaco, and Allegheny Energy have been the targets of shareholder resolutions related to GHG emissions.

4. The Climate Neutral Network is an alliance of companies and other organizations committed to developing products and enterprises that eliminate their impacts on the earth's climate. The organization encourages and supports companies in developing a new marketplace in which climate-neutral products and services can be offered competitively to a range of interested buyers. The group defines climate-neutral products and services as those "determined to have little or no effect on the Earth's climate."

5. The Voluntary Reporting of Greenhouse Gases Program, created under Section 1605(b) of the Energy Policy Act of 1992 (EPACT), affords an opportunity for any company, organization, or individual to establish a public record of emissions, reductions, or sequestration achievements in a national database. The program is administered by the U.S. Department of Energy.

6. ERT is a nonprofit organization founded in 1996 with the assistance of the Environmental Defense Fund (EDF) to promote, support, and conduct pioneering transactions, such as the sale and purchase of pollution reductions, that produce net environmental benefits.

7. I.e., the requirement that emissions reductions be in addition to those that would otherwise occur.

8. The NESCAUM Greenhouse Gas Trading Demonstration Project is a voluntary program aimed at elucidating issues surrounding a cap and trade approach to reducing GHG emissions.

9. The Pilot Emission Reduction Trading Project is an industry-led, multi-stakeholder environmental initiative in Canada. PERT evaluates emissions trading as a tool to assist in reducing smog, air pollution, and GHG emissions in the Windsor-Quebec corridor.

10. The Greenhouse Gas Emission Reduction Trading Pilot is designed to test the effectiveness of emissions trading for greenhouse gases in Canada. The pilot is a partnership between the Canadian federal government, several provinces, industry, labor, and environmental groups.

11. Australia’s Greenhouse Challenge Program was established as a voluntary program that now includes over 500 organizations, representing a broad industrial and government cross section. It targets approximately 55 percent of Australia’s industrial emissions (and currently covers about 50 percent of the target). Participating organizations agree to submit annual reports on emissions and progress in implementing action plans designed to abate emissions.

12. The UK Emissions Trading Scheme is a voluntary program established by the British government. The program is open to companies operating in the UK. Companies agree to binding emissions limits and then engage in trading with other program participants to ensure that these limits are met in the most cost-effective way.

13. If the project aimed to reduce emissions by switching a boiler from coal to natural gas, for example, the baseline would be checked to ensure that the amount of coal that was predicted to have been displaced by the gas actually was displaced. If the demand on the boiler were less than what had originally been predicted, then the emissions reductions would also be less.

14. The warming effect of compounds covered by the Montreal Protocol is offset to varying degrees by the cooling effect caused by their destruction of stratospheric ozone. As ozone in the stratosphere has a natural greenhouse effect, the magnitude of this effect is reduced as the stratospheric ozone is destroyed.

15. Halon is a DuPont trade name for a group of bromofluorocarbons, which are used almost exclusively in fire protection systems.

16. Fugitive emissions are emissions that do not pass through a stack, chimney, or vent, such as emissions from leaking valves, pumps, or sampling connections.

17. Because the carbon in fossil fuels is converted to CO_2 during combustion, if the type of fuel is known, emissions can be calculated based on the quantity of fuel combusted and its carbon content, without the need for direct measurement of emissions.

18. KPMG is a provider of assurance, tax, legal, consulting, and financial advisory services.

19. Det Norske Veritas (DNV) is a provider of safety and reliability services, where classification, certification, verification, and advisory services are key activities.

20. ICF Consulting provides services and products to help optimize energy resources, meet environmental challenges, foster economic and community development, and enhance transportation policy and projects.

21. The International Standards Organization (ISO) 14001 Management Standard is a standard for environmental management systems, which has been adopted by many companies.

22. VCR Inc. is a nonprofit partnership between industry and governments across Canada. VCR's mission is to provide the means for promoting, assessing, and recognizing the effectiveness of the voluntary approach in addressing climate change.

23. The GHG Protocol Initiative is an open, international, multi-stakeholder collaboration to design, disseminate, and promote the use of an international corporate protocol for reporting business GHG emissions. The core operations module of the protocol has been released in draft form and has recently undergone testing.

24. Continuous emissions monitoring systems (CEMs) continuously measure and record pollutant concentrations in an exhaust gas and the flow rate of that gas. These systems calculate the emission rate of the pollutant. The best-known application of CEMs is in the measurement of emissions from power plants.

25. Green electricity is generated in whole or part from renewable resources, such as wind, solar, and geothermal energy.

26. Green tags represent the environmental attributes of electricity generated from renewable energy sources. By splitting the attributes from the electricity, the supplier is able to sell the electricity at competitive rates, while realizing additional revenues from buyers of the environmental attributes.

27. The Center for Resource Solutions (CRS) is a nonprofit organization based in San Francisco dedicated to promoting renewable energy and economic and environmental sustainability.

28. It is expected that the Australian government will soon launch a product certification program similar to the Climate Neutral program. This Greenhouse Certification program will require companies participating to have their products'

emissions inventories and offsetting emissions reductions credits independently verified—using verifiers selected by companies from a government-approved panel and paid for at the companies' own expense. The Australian Greenhouse Office will undertake random audits of any verification to ensure consistency and accuracy.

29. Members of the Environmental Advisory Panel are volunteers. As more firms seek Climate Neutral certification, the Climate Neutral Network expects that it will rely on independent third parties to conduct the verification, while the network assumes more of an oversight role (Hall, 2001).

30. As of this writing, the Kyoto Protocol has been ratified by relatively few countries and has not taken effect.

31. This may be explained by the fact that if the validator is independent of the organization promoting the project, there is no inherent conflict of interest. Indeed, it could be argued that the firm that validates the project at the start would be better able to conduct future verification.

32. Those companies involved in emissions reduction projects under the UNFCCC and Kyoto Protocol must consider additionality in setting their baselines. Both of these programs require that the emissions reductions be additional to those that would otherwise occur. To avoid these problems, simplified means of establishing baselines to evaluate additionality have been proposed. Some of the primary methods being discussed include the following:

- *Benchmarking*, under which host countries would establish default emissions rates for the different sectors, subsectors, or regions;
- *Technology matrix*, under which a number of pre-defined default technologies would be used as baseline technologies for a defined region and a specified time; and
- *Top down baseline*, under which project baselines would be derived by the host government from a more aggregate baseline (e.g., a country might allocate project baselines from its national baseline, with reductions below the baseline being considered additional) (Center for Clean Air Policy, 1999).

33. Validation and Verification of GHG Projects is now one of several services offered under the SGS Climate Change Program. SGS Forestry no longer exists as an entity.

34. EcoSecurities Ltd. is an environmental finance company specializing in advising on strategy regarding global warming issues.

35. The Emissions Trading Group is the steering group for the United Kingdom Emissions Trading Scheme (UK-ETS).

36. Although the Australian government is heavily involved in inventory verification under its Greenhouse Challenge Program—designing the program, training the verifiers, and attending a sample of the verification audits—the actual verification work is done by third-party contractors. The proposed regulations for the State of New Hampshire's GHG registry are unusual in envisaging a direct role for government employees in conducting the verification.

37. The nonprofit Center for Energy and Climate Solutions provides businesses with tools and strategies that reduce energy costs and GHG emissions while increasing profits and productivity.

38. Several resources are available that provide guidance on measuring and estimating GHG emissions, many of which are listed in *An Overview of Greenhouse Gas Emissions Inventory Issues* (Loreti et al., 2000). Much less guidance is available on how to establish boundaries around the inventory and how and when baseline adjustments are necessary.

39. The Global Reporting Initiative (GRI) was established in late 1997 to develop globally applicable guidelines for reporting on corporate economic, environmental, and social performance. Convened by the Coalition for Environmentally Responsible Economies (a U.S. coalition of environmental, investor, and advocacy groups working together for a sustainable future) in partnership with the United Nations Environment Program (UNEP), the GRI incorporates the

active participation of corporations, NGOs, accountancy organizations, business associations, and other stakeholders from around the world. The GRI guidelines will eventually be available to any business, government, or NGO.

40. Multiple thresholds which would vary by type of emission sources, and an absolute threshold (i.e., X tons of emissions) will be examined.

41. While methane emissions from the combustion of fossil fuels in boilers, furnaces, and engines are typically negligible compared to CO_2 emissions, methane releases from flares can be significant. Therefore, it important to know the flare efficiency to be able to accurately estimate emissions.

42. For firms participating in the Australian Greenhouse Challenge program, inclusion of indirect emissions from purchased energy is required, and review of these emissions is part of the government-sponsored verification program. The UK-ETS also includes emissions from purchased electricity in its GHG reporting protocol.

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