IEEE POWER ENGINEERING SOCIETY
ENERGY DEVELOPMENT AND POWER GENERATION COMMITTEE

INTERNATIONAL PRACTICES SUBCOMMITTEE

PANEL SESSION: PRESENTATION & DISCUSSION OF DRAFT STANDARD FOR THE QUANTIFICATION OF CO2 EMISSION CREDITS

IEEE 2002 Summer Power Meeting, Chicago, July 23, 2002

Chairman: T. J. Hammons, Chair, International Practices for Energy Development and Power Generation, University of Glasgow, Glasgow, UK.
Co-Chairman: Jim McConnach, Castle Hill Engineering Services, Canada

The Panel Session presented and discussed the draft standard for the quantification of CO2 emission credits—IEEE Standards project 1595. Presentations included an overview of the document, the proposed approaches to evaluating different emission reduction technologies, and proposals for audit and certification of results.

Principal contributors included: Jim McConnach, Castle Hill Engineering Services, Ontario, Canada, who gave an overview of the draft Standard; Richard D'Aquanni, Applied Resources Group, USA, who reviewed quantifying the measurement and estimation uncertainties associated with GHG mitigation accounting; Scott Rouse, Ontario Power Generation, Canada talked about deriving emission credits from energy efficiency projects; Thomas Baumann, NRCan, Canada, who reviewed GHG reporting for Canada's Climate Change Technology Early Action Measures (TEAM); James R. Fancher, Consultant, who discussed primarily D'Aquanni's presentation on the calculation and/or monitoring of actual CO_2 emissions from fuel combustion systems; and Colin Beesley, Environment Strategy, Rolls-Royce, UK, who reported on experience of Rolls-Royce plc with the UK Emissions trading scheme.

Each Panelist spoke for approximately 20 minutes. Each presentation was discussed immediately following the respective presentation. There was a further opportunity for discussion of the presentations following the final presentation.

The Panel Session was organized by Tom Hammons, Chair, International Practices for Energy Development and Power Generation (University of Glasgow, UK) and Jim McConnach (Castle Hill Engineering Services, Canada). The Panel Session was moderated by Tom Hammons (University of Glasgow).

The presentations are summarized below:

1. OVERVIEW OF DRAFT STANDARD FOR THE QUANTIFICATION OF CO2 EMISSION CREDITS

Jim McConnach, SMIEEE, Castle Hill Engineering Services, Ontario, Canada.

A. INTRODUCTION

In August 2001, the IEEE Standards Board approved project P1595 to develop a "Standard for the Quantification of CO2 Emission Credits for Electrical Industry Processes". The project is sponsored by the IEEE Energy Development & Power Generation Committee and will be developed by the Working Group on Implementing Technology to Limit Climate Change (CCWG). A small task force (P1595TF) of about a dozen experts from across the industry and around the world has been formed to develop the Standard. The author is chair of CCWG and of P1595TF. The approved scope and purpose; the milestones schedule and some key issues of Standard project P1595 were presented at the IEEE 2002 Winter Power Meeting (WM2002) in New York (Ref 1).

Schedule and Progress

The P1595 milestone schedule and progress are summarized below:

- *Spring 2002:* "Strawman" first draft developed by Task Force. (This step was partially completed in the form of a number of presentations developed for the Chicago panel discussion)
- *July 2002:* Panel discussion of partial first draft at SM2002 Chicago. (Completed)
- *Fall 2002:* Second draft incorporating SM2002 panel feedback to be issued for review by CCWG. (It is hoped to issue this draft by the end of the year and to produce a final draft in the spring of 2003.)
- *July 2003:* Discussion of final draft at IEEE-PES 2003 General Meeting in Toronto. (It is planned to hold a CCWG meeting in Toronto to discuss the final draft.)
- *Fall 2003:* Target for 1st round balloting. (IEEE standards are subject to approval through an international review and balloting process.)
- *Fall 2004:* Target for issue of approved standard

This is an ambitious schedule for the development of a standard of this nature and complexity. However, given the status, pace of development and evolution of national, regional and international emission trading programs and mechanisms it is important to have the standard in place as soon as possible.

B. PRELIMINARY DRAFT OF KEY FEATURES OF STANDARD P1595

This section provides an overview of the draft Standard highlighting some of the main features. The draft outline including the basic premise and principles for the Standard is provided below in recommended IEEE-SA format to provide a glimpse of how the Standard is developing. However it must be stressed that this is still a very preliminary document.

Clause 1. Overview

1.1. Structure

This Standard is divided into four clauses. This first Clause provides the scope, purpose and background of the Standard. Clause 2 lists references to other standards, protocols, practices and guidelines that are useful in applying this Standard. Clause 3 provides definitions that are either not found in other standards, or have been modified for use with this Standard. Clause 4 establishes the basic principles, methodology and audit/review process for quantifying and verifying CO2 Emissions credits for use as a "common currency" in regional and global emissions trading.

The Standard also contains three Annexes. Annex 1 will provide examples of application of the Standard. Annex 2 will provide a listing of typical technologies for reducing CO2 emissions. Annex 3 will provide a listing of useful bibliographical references.

1.2. Scope

The Standard covers the measurement, quantification and verification of CO2 (or equivalent) reductions for emissions credits in the electricity supply and demand industry, as brought about by technology applications, innovations and improvements. It will cover "cradle to grave" project life cycles in all aspects of the industry. This includes fuel chain and processing, energy conversion systems (generation); emission control systems (pre and post combustion); delivery systems (transmission and distribution); and end uses (demand side management and conservation).

The "electricity industry" includes fuel supply and transformation; energy conversion (generation) and storage, including the construction and disposal of power plants; electricity delivery (transmission and distribution) including construction and disposal of delivery facilities; and the end uses of electricity including electrical equipment and appliances. It also includes the transportation sector to the extent that electro-technologies are used.

All six-greenhouse gases (GHG) of the Kyoto protocol are covered by the Standard, but greatest focus is given to CO2 due to its predominance in the electricity industry. The six GHGs are Carbon Dioxide (CO2); Methane (CH4); Nitrous Oxide (N2O); Hydro fluorocarbons (HFCs); Per fluorocarbons (PFCs); and Sulphurhexafluoride (SF6).

1.3. Purpose

With the emerging growth in regional and global programs for the trading of GHG emission reduction credits, there is a need for an internationally recognized means of grading emission reductions to ensure a "common currency" of emission credits.

The purpose of the Standard is to establish an internationally accepted basis for measuring, evaluating and quantifying the eligible, real, measurable, verifiable, and unique reduction in CO2 emissions attributable to a specific technology project for use in emissions trading systems. The Standard will help provide an answer to the generic question: "How can one country or jurisdiction to an emissions trade be assured and satisfied that it is getting real and true value for a purchased emission credit from another country or jurisdiction?"

1.4. Background

The Climate Change Debate

While there is still some room for scientific debate on the extent to which human activity is responsible for climate change, there is a large body of scientific opinion that this is the case and that it is being caused to a large extent by ever increasing levels of CO2 and other "Greenhouse Gases" (GHGs) in the earth's atmosphere. Certainly there is hard evidence and measured proof that CO2 concentrations are increasing. This is largely due to the burning of fossil fuels in our modern and heavily industrialized society. The electricity sector is responsible for about one third of global CO2 emissions. Therefore it makes good sense for the electricity industry to be part of the solution.

Prudence dictates that action should be taken now to reduce our dependence on fossil fuels. However this should not be done with blind faith. A "no regrets" policy seems the wisest - i.e. we should be doing things that make good sense for the economic and financial well being of society as well as for human health and a healthy environment, all of which contributes to the goals of sustainable development. For example the burning of fossil fuels is known to produce pollutants such as SOx; NOx; particulate; toxins etc, which are injurious to human health and the environment with huge "externality" costs. Therefore reducing dependence on fossil fuels will not only reduce CO2 emissions but will also benefit human health and the environment and reduce overall costs to society. Post September 11/01, reduced dependence on fossil fuels has definite benefits to the national security of many countries.

The enormous investment in the fossil fuels industry, the electricity sector and the transportation sector cannot be ignored and changing this huge infrastructure will take time and caution so that the economic and financial impacts are manageable. This can be achieved by aggressively adopting technology options which are economic and competitive in their own right such as energy and resource efficiency, competitive renewable energy forms such as wind; geothermal; fuel cells; bio-gas etc and small distributed generation technologies. One of the tools in the marketplace that can be used to accelerate the transition to a lower carbon economy is emission trading.

Emission Trading

The trading of GHG reduction credits in the marketplace is an effective "tool" not a technology option. This tool facilitates faster and less costly achievement of GHG reduction goals. It involves treating GHG emission credits like any other commodity in the global marketplace.

There are now a number of GHG emission trading programs in place or under development at the national and regional level. Noteworthy national programs in operation are those in the UK and Denmark. Programs are in development in Canada, the USA and the European Community. Internationally, the Kyoto protocol is attempting to get widespread agreement of industrialized nations to commit to targets for reduction of CO2 emissions relative to a 1990 baseline. The protocol contains three "flexibility mechanisms" to help countries generate reduction credits towards achieving their targets economically within the specified time frame. These are: -

- Joint Implementation (JI) projects between industrialized countries
- Clean Development Mechanism (CDM) projects by industrialized countries in developing nations; and
- International emission trading among the industrialized countries.

All of these programs and initiatives need standard rules to quantify, verify and certify emission reduction credits to work successfully.

Clause 2. References

This clause covers references to related standards and guidelines that are useful in applying this Standard. Some of the related standards, protocols and guidelines existing or under development as identified to date are:

- International Standards Organization (ISO): Has Life Cycle Assessment (LCA) standards in place (ISO/TS 14040 series) and a TC207-WG5 task force (CCTF) is developing a GHG measurement and verification protocol.
- UNFCCC/IPCC: Have established CO2 equivalent factors for other GHGs; CDM Rules for CDM projects are in place.
- USA-DOE: Federal Energy Management Program (FEMP) has established Measurement & Verification Guidelines for Federal Energy Projects, Sept. 2000.
- USA DOE: International Performance Measurement & Verification Protocol (IPMVP) Energy & Water Savings, March 2002.
- Lawrence Berkeley National Laboratory (LBNL): Has developed Guidelines for Monitoring, Evaluation, Reporting, Verification, and Certification of Energy Efficiency Projects for Climate Change Mitigation, March 1999.
- World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD): Have developed the Greenhouse Gas Protocol, A Corporate Accounting & Reporting Standard, September 2001, and are developing a GHG baseline protocol.
- OECD-IEA: Have developed Practical Baseline Recommendations for GHG Mitigation Projects in the Electric Sector, May 2002.
- The Canadian TEAM Initiative (Technology Early Action Measures): Has developed a series of Reports on its System of Measurement and Reporting (SMART) to TEAM, 2002. Part of the Canadian Climate Change Action Fund.
- California Climate Change Registry: Has developed a Baseline protocol.
- The Pembina Institute, Alberta: Has done a Life Cycle Value Assessment of a Wind Turbine, February 2000.

Others such as the IEC, the World Bank, etc., are still to be researched for related initiatives.

Clause 3. Definitions

This clause provides definitions that are either not found in other standards, or have been modified for use with this Standard. Examples may be “Monitoring”; “Measurement”; “Verification”; “Certification” “Baseline Conditions”; “Boundary Conditions”; Additionality; “Alternative Technology”; Generational Technology”; “Operating Margin”; “Build Margin”; “Statistically Significant”.

Clause 4. Quantifying and Verifying CO2 Emissions Credits

This clause is the main part of the standard and will provide basic principles and describe the methodologies and practices for the measurement, quantification, verification and certification of GHG emission reduction credits. The overall basic premise is to develop a performance-based standard for GHG mitigation and reduction projects.

4.1 Basic Principles for Qualification of Credits

For emission credits to qualify, reductions must:

- Be real; surplus; quantifiable; verifiable; and unique
- Be consistent with accepted practices
- Pass the "fungibility" test
- Pass verification and certification rules
- Be a true benefit to the environment and contribute to sustainable development
- Be well documented and auditable
- Comply with all laws, regulations and rules

4.2 Basic Principles for Methodology

The methodology must:

- Be consistent with best practice
- Be based on Life Cycle Assessment (LCA), where practicable
- Be credible, transparent and accurate
- Reflect local conditions and initiatives
- Be practical and cost effective
- Incorporate pros and cons
- Allow for the learning curve
- Be well documented and include a verification plan

4.3. Key Steps in the Methodology

While there will be specific methodologies for each technology option the general key steps to be followed will include:

1) Scoping to establish system boundaries, functions, material elements, inputs and outputs
2) Establish benchmark or baseline conditions
3) Evaluate project over full life-cycle, including all material elements, inputs and outputs
4) Comparison of project to baseline to get emission credit result
5) Perform verification checks
6) Fully document baseline, project, comparison and results
7) Random review and audit of selected projects

The above steps constitute a common currency approach that should fit most types of reductions projects, irrespective of technology, timing, lifetime, or emissions sources.

4.4. Measurement and Verification

Key features of the measurement and verification of reduction credits:

- Units are metric tonnes of CO2 equivalent
- Metered values preferred where practical and cost effective
- Where values are calculated or estimated, the techniques must follow industry accepted rules and methodology
- Estimated values to be spot checked by metering where practical and cost effective
- Statistically significant results to be determined where appropriate, e.g., DSM programs.
- Metering equipment must be certified

- Full and accurate measurement and verification report to be prepared for each project

Where possible and cost effective, the preference will be for actual measurements to be taken to establish credits or verify calculations. Any measurements of energy savings or emissions reductions are to be done on certified metering equipment to internationally accepted standards. Therefore there will be a need for certification of meters, measurements and records.

GHG gases other than CO2 are to be equated to CO2 equivalent in accordance with guidelines developed by the Intergovernmental Panel on Climate Change (IPCC).

4.5. Review and Audit Process

Key Features of the review and audit process to certify results:

- Random selection of projects for audit
- Advance notification of audit projects
- Done by certified independent auditor
- Consistent with local conditions and rules
- Audit report well documented and open to public scrutiny

Review of selected projects (preferably at least one of each type) to be done by a **certified** independent auditor. ISO standards exist for certification of auditors.

All analysis, calculations, audit results etc to be open to public scrutiny

ANNEX 1: Examples and Case Studies

This annex to the standard will work through several complete examples, including baseline; reduction case; comparison to establish reduction result; and review and audit to certify the reduction credit. As experience and learning is gained with developing and implementing mitigation and reduction projects of all types in many jurisdictions, there should be ample case studies to draw on.

ANNEX 2: List of Typical CO2 Reduction Technologies

The following is a preliminary list of CO2 reduction technologies:

- Increased demand side efficiency, including hi-efficiency technologies; thermal envelope improvements; conservation; peak shifting; peak lopping; valley filling, etc.
- Increased supply side efficiency, including power conversion plant; station service; delivery (transmission and distribution), etc.
- Fuel transformation and fuel switching
- Fuel decarbonization or carbon removal from flue gas
- Carbon Sequestration
- Alternative generation technologies (renewables)
- Energy storage technologies
- Alternative power systems, e.g., Distributed Generation; Micro Grids
- Electric vehicles, fuel cells, hydrogen and hybrid technologies in the transportation sector.

ANNEX 3: Bibliography

This will be quite extensive, including references to many papers and books on CO2 reduction technologies. May include references to background papers, guidelines and protocols on Emission Trading and Emission Credits.

C. ISSUES

Progress with a number of key issues is summarized below. These are still open to further debate and/or developments as expected for such a complex and politically charged international standard.

- *Universality:* Compatibility with existing domestic trading programs will be important and the standard needs to recognize and provide the flexibility to encompass local rules
- *Grading:* The standard may need to recognize differing grades of credits (e.g. Grade A; Grade B; Grade C) depending upon their source and quality
- *Methodology:* Trade-offs between cost effectiveness and preferred methodologies such as full life cycle assessment and measured results will invariably be needed for practical reasons. This will be particularly important for smaller or dispersed projects, which are unable to bear the high cost burden of too arduous measurement and verification requirements
- *Accuracy and materiality criteria:* The level of accuracy desired is important for a performance-based standard. Materiality and accuracy thresholds are likely to be in the range of 1% to 10% of total depending upon the level of certainty and the cost of improved accuracy. Again trade-offs will be required, particularly for smaller projects or those of a dispersed nature such as DSM
- *Recognizing existing work:* There is a need to avoid re-inventing the wheel, as much work exists on aspects such as baseline conditions, boundary conditions and examples of project assessments and verification already done for a number of technologies. Advantage will be taken of existing standards and protocols where appropriate.

D. CONCLUSIONS

Reasonable progress has been made since the fall of 2001 in forming a Task Force and developing an outline and the basic premise and principles for many parts of the standard. However much work still needs to be done to further the learning curve on key sections such as methodology, measurement and verification (M&V), and certification. Also gathering information on examples and case studies will need the co-operation of project proponents. Funds and resources will be needed to take the document to the next level and further active participation by the industry is sought. Participation is open to all, even non-IEEE members. Please contact jsmcconnach@ieee.org to join the P1595TF or CCWG.

E. REFERENCES

[1]. IEEE Standard for Quantifying CO2 Emission Credits, Jim McConnach. Presented at IEEE PES 2002 WM, New York, January 28, 2002.

Reference Web-sites:

- IPCC www.ipcc.ch
- IETA www.ieta.org
- PEW Center, USA www.pewclimate.org
- DOE-FEMP www.eren.doe.gov/femp/
- Pembina Institute www.pembina.org
- IEA www.iea.org
- LBNL www.lbnl.gov
- WRI www.wri.org
- WBCSD www.wbcsd.ch
- California CC Registry www.climateregistry.org
- ISO www.iso.ch

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2. A PERFORMANCE-BASED ESTIMATION AND MEASUREMENT STANDARD TO QUANTIFY CO2 EMISSION CREDITS

Richard D'Aquanni, SMIEE, Applied Resources Group Inc, Brookline, Massachusetts, USA

A. INTRODUCTION

The P1595 International Standard addresses the measurement, quantification and verification of CO2 (or equivalent) reductions for emissions credits in the electricity supply and demand industry, as brought about by technology applications, innovations and improvements. It covers power plant fuel and conversion (generation); emission control systems (pre- and post-combustion); delivery systems (transmission and distribution); and end uses (demand side management and conservation including distributed generation).

With respect to the Structure of P1595, this presentation addresses Clause 4 of the P1595 Standard. It presents a first attempt at the basic principles and methodology for quantifying and verifying CO2 Emissions credits for use as a "common currency" in regional and global emissions trading.

This presentation also addresses two of the three Annexes that will make up P1595. Annex 1 provides examples of application of the Standard while Annex 2 provides a list of typical technologies for reducing CO2 emissions. The need to develop a list of proven strategies and technologies that reduce CO2 emissions is essential to P1595 in that a corresponding portfolio of measurement and verification (M&V) techniques must be developed to accommodate the technologies and strategies that will be employed to meet the minimum required accuracy standards set by the P1595 Task Force.

Anticipated barriers to development are identified and strategies to either avoid or break through the barriers are recommended. One recommendation is to adopt a Performance Based Standard that addresses the communication and integration barriers that multi culture participation and multi discipline integration requires, respectively. Another barrier is the combined analytical and empirical nature of the Standard with one approach being to apply Monte Carlo risk assessment techniques in developing accuracy goals that are both reasonable and affordable.

Finally, opportunities are identified and a plan recommended for the Task Force to engage. One opportunity is the Task Force's ability to hit the road running by tapping into the vast M&V knowledge and Best Practices that have been developed over many years. Another is the opportunity to carefully engage the resources of the worldwide metering manufactures, which through honest communication will see the benefit to them from their active participation in developing and advancing P1595.

B. PRINCIPLES

The principles to be followed in developing P1595 include:

- A focus on quantifying CO2 emission reductions from power plants as measured in tonnes of CO2 per year. Note that GHG gases other than CO2 are to be equated to CO2 equivalent in accordance with IPCC guidelines
- Be consistent with and build upon the best measurement and verification protocols that have been applied to DSM, ESCO Performance Contracts and Renewable Energy
- Utilization.
- Objectively engage appropriate electric meter technologies and software based estimation techniques to quantify CO2 emission credits.
- Identify enforceable regulatory incentives and programs but do not underestimate the marketplace
- Develop a Standard that complies with all laws, regulations and rules, is practical and cost effective to implement and that allows for indigenous conditions and initiatives
- Develop a Standard that is clearly documented and will hold up to an audit.
- Measurement, quantification, verification and certification of GHG emission reduction credit. Be a true benefit to the environment and contribute to sustainable development.

C. APPROACH TO DEVELOPING P1595

1. Challenges of P1595

The need to implement a Standard that is straight forward and affordable while thorough is necessary if the resulting Standard is expected to be followed in practice. This is made clear from the following:

- Whereas 10 % of the cost to implement electric energy conservation project can be assigned to the M&V role and tagged onto the total project cost without undermining a facility manager's ROI, demand and supply side renewable energy projects as well as fossil fuel emission reduction projects start out with a deficit so that any cost associated with M&V places an additional burden on the project and increases the need to assign a higher value to the mitigation of CO2.
- Given the sensitivity of sharing competitive information in an open market place require that the correlation between emissions and MWh generated is kept confidential. While this barrier can be resolved, e.g., Massachusetts in the US uses a GIS reporting system by APX to address its Renewable Portfolio Standard in a competitive marketplace.

2. Structure of P1595

P1595 must be able to set the standard for measuring and verifying the CO2 emission credits that result from a wide range of CO2 mitigation strategies. At minimum these strategies will include 1). the application of BACT to fossil-fueled power plants; 2). power plant fuel switching to "clean" or biomass fuels switching modifications; 3). on-site and behind the utility meter Distributed Generation (DG) consisting of renewable or CCGCT, 4). behind the meter conservation; 5). new central station renewable generation and "safe" nuclear power.

As a result of the diversity in technologies and in the scale of the CO2 credit tallied, a Performance Based Standard is recommended. Such a Standard will allow the user to choose the mix of techniques and hardware to meet or exceed the P1595 goal in a cost-effective manner.

The recommended next step is the layout of a template that allows the P1595 user to quickly match one or more mitigation strategies that they are responsible for to the M&V accuracy that they will need to achieve in order to satisfy P1595.

Table 1 is an early attempt at such a template where depending on the CO2 mitigation strategy deployed a minimum acceptable accuracy over a period of time is established. A later version might include rules that add flexibility by suggesting accuracies for combined mitigation techniques. Note that the scale in tonnes of CO2 that are expected to be reduced plays a factor in setting the accuracy so that project categories may be listed multiple times each having a unique Min-Max Tonnes of CO2 range. While the Period during which a project's CO_2 credits need to be verified is also a factor in arriving at a cost, there is a one to one match between Period and each Project Category.

Table 1. Prescriptive Table for Specifying Cost Sensitive CO2 Credit-Accuracy

Project Category	Min-Max Tonnes CO2	Accuracy	Period	Cost
Simple DSM (Indep HDD)	w1	x1	y1	z1
Complex DSM (CDD)	w2	x2	y2	z2
On-site renewable (Res PV)	w3	x3	y3	z3
IPP Renewable (Wind, Hydro)	w4	x4	y4	z4
IPP Renewable w emissions (Biomass, Geothermal)	w5	x5	y5	z5
Central Station BACT	w6	x6	y6	z6

The development of Table 1 is not trivial and will evolve over time based on an increasing understanding of project Categories that the Task Force designate as being credible and likely to be replicated. The mathematical approach recommended by the author to assist in developing the Table's Accuracy and Cost values is the Monte Carlo simulation technique. Applying this technique will allow Task Force staff to arrive at cost effective measurement strategies aimed at achieving a reasonable level of accuracy.

The Monte Carlo technique assigns probability distributions to the CO2 mitigation estimates derived from the M&V's analytical component, e.g., a simulation, a regression or a spreadsheet model and metering components. It allows for the realistic situation where combinations of M&V strategies are combined in the same GHG mitigation project. The Monte Carlo technique allows the user to change the distributions (smaller variance implies higher cost) and through controlled iterations will be used to establish the detailed values for accuracy in the Table.

With such a Table, the P1595 Standard user will then employ whatever software and hardware strategy they are comfortable with that simultaneously satisfies the accuracy requirements. The Case Studies to be included in the Standard will include Case Studies of M&V approaches that have worked for others. In addition, certain rules of thumb or tips will be passed on to the P1595 user to ease facilitation. Examples of these tips might include:

- The use of targeted short-term metering may be cost-effective in certain DSM and small DG CO2 mitigation approaches. Statistically sampled spot-checking may allow calculation of a persistent (long period) CO2 mitigation credit as opposed to more expensive long-term metering.
- While it may be cost prohibitive to verify savings of complicated technologies, HVAC Controls, Geothermal Heat Pumps, Fuel Cells, a user may engage a facility's Energy Management System (EMS) that in addition to contributing to a CO2 reduction may simultaneously be used to monitor it. In essence an EMS is often a utility revenue quality meter and can be used to meter a projects baseline kWh usage over a period of time and similarly can measure post mitigation conservation and thus related CO2 reductions.
- Given the scale of the CO2 challenge, metering buildings at their service entrance voltage, while not perfect, is more appropriate than engaging circuit sub-metering.

As a part of this process and in developing the Table, the Task Force will need to obtain up to date data regarding the performance and the cost of appropriate metering. In that the metering community will be a major beneficiary of P1595, it will be appropriate that the Task Force develop a "news release" that communicates the need for the meter companies to work with and support the Standard in order for it to develop in a controlled manner. This is presented in section E that discusses leveraging the marketplace.

While some organizations are establishing CO2 emission inventories for their generation region (e.g., ISO or RTO), for states or for the US, CA and other countries, the P1595 Standard will address the verification of project oriented marginal reductions in CO2.

While P1595's project oriented accounting is independent of the geography, the P1595 Task Force must adopt a year as the starting point from which annual CO2 inventories are benchmarked. The Kyoto Protocol uses the year 1990 while more recent proposed legislation suggests the year 2000. In that historic data may be difficult to decipher and hence subject to opinion, the author recommends adopting 2000 or later as the baseline CO2 year.

Project Categories should list any program that is likely to be replicated. Some appear in ANNEX 1 in section G. This analysis will be based on the most recent information available on Government, Utility and Private Sector programs and initiatives.

While the need exists for the Task Force to fine tune the Project Categories, fine tuning the Types of Mitigation Measures will be much more difficult, but nevertheless must be addressed. See ANNEX 2, Section G for the latter.

D. DECISION TO ADOPT A PERFORMANCE BASED STANDARD

The International scope of P1595, the wide range of CO2 mitigation strategies and associated technologies and the diverse approaches to verifying credits are challenges that pointed to the need for a Performance Based Standard. In Chicago, the Implementing Technology to Limit Climate Change Working Group of the International Practices Sub Committee approved the Performance Based Standard recommended by the author. Note that the International Practices Sub Committee is under the IEEE Power Engineering Society's Energy Development and Power Generation Committee.

As suggested in Section C, the accuracy Table allows the P1595 Task Force to set a minimum requirement on the accuracy of the CO2 credit to be verified. This in turn allows the P1595 Standard user to choose from its portfolio of best practice metering and estimation options to satisfy P1595 in a comfortable and cost-effective manner.

Other Challenges that are addressed include the need to gather Best Practices examples of CO2 emission reduction credit programs as well as the M&V approaches that are used to verify their savings. While International participation in the Task Force has been achieved it will be very difficult to rank each program or sort between effective and non-effective programs, an example of the latter would include "Green Market" programs that are dependent on questionable utility funded subsidies.

The adoption of the Performance Based Standard at the Chicago IEEE PES Summer meeting is consistent with Best Practice and provides the public and private marketplace with the choice they expect and will use to leverage to achieve a CO2 emission credit verification across all nations.

E. LEVERAGING THE MARKETPLACE

The author believes that by addressing and avoiding conflict of interest issues, the development of an objective P1595 Standard can proceed along with the leveraging of the marketplace.

If the P1595 Task Force can communicate the logical and neutral role of the utility employee to nurture CO2 emission credits and their verification, then this may evolve into a new profit center for utility companies worldwide. Thus by leveraging of the utility marketplace and defining a role for the utility to support Green then the we may help reverse the trend where utilities are less involved in IEEE committees and standards developments. This communication may need to reach regulators as well as utilities.

If the development of P1595, via an IEEE pilot for new IEEE Standards, is implemented in a timely manner, then the Task Force will help remove some of the scrutiny that the IEEE Standards practice is under. We can learn from other recent attempt including the recent attempt to develop a speedy DG Interconnection Standard.

If the P1595 Task Force can tap into the IEEE's internal capabilities, e.g., the IEEE's Virtual Community's (VC) web site that could be more interactive if it included P1595's development, then a positive benefit to all parties will occur. In this instance it would include the Standard as well as the Continuing Education Department that operates the VC web site.

Participation from meter manufacturers, data base system integrators, meter consultants and others will assist P1595 by facilitating solutions. This support is within reach and the author believes can be leveraged once we communicate the benefits of PC1595 to the metering community. Opening the opportunity to participate to all the numerous meter manufacturers including ABB, Alstom, Eaton-Cutler Hammer, Electro Industries, GE, Invensys and Siemens will, if open and on a level playing field, avoid any conflict of Interest issues.

F. PRELIMINARY WORK ON ANNEX 1 and ANNEX 2

1. ANNEX 1: Examples and Case Studies of M&V of CO2 Emission Credits

This annex to the standard will work through several complete examples that illustrate techniques that are used to verify CO2 emissions as measured in tonnes. In the early stages these examples may include a mix of well-established Protocols, unproven methods or general examples. In time they will include examples of practical and cost effective value for the P1595 user to engage as they seek Credit from their mitigation efforts.

- International Standards Organization (ISO): Has Life Cycle Assessment (LCA) standards in place (ISO/TS 14040 series) and a TC207-WG5 task force (CCTF) is developing a GHG measurement and verification protocol.
- USA-EPA: Climate Leaders GHG Inventory Protocol: Core and Optional Modules under review address accounting guidance for GHG emission inventories.
- USA-DOE: Federal Energy Management Program (FEMP) has established Measurement & Verification Guidelines for Federal Energy Projects, Sept. 2000.
- USA DOE: International Performance Measurement & Verification Protocol (IPMVP) Energy & Water Savings, March 2002.
- Lawrence Berkeley National Laboratory (LBNL): Has developed Guidelines for Monitoring, Evaluation, Reporting, Verification, and Certification of Energy Efficiency Projects for Climate Change Mitigation, March 1999.
- World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD): Have developed the Greenhouse Gas Protocol, A Corporate Accounting & Reporting Standard, September 2001, and are developing a GHG baseline protocol.
- US State mandated Renewable Portfolio Standard programs and corresponding certification methods in approximately 13 states
- UK Volunteer Emission Trading System began in 2002, based on CO2 auction pricing
- Green Power system development & operation funded with pooled CO2 violator fees
- Sustainable Green Building (LEED) Program and verification process

The following examples illustrate the uncertainties that need to be addressed in typical mitigation scenarios that are being considered in P1595.

I. Milestone Uncertainties Associated with CO2 Emission Reductions

This section addresses the mismatch between expected GHG Reductions due to the expected commercialization of a reduction program and the actual date of commercialization when GHG emissions reductions actually begin.

The time span may be days, months or years. For many reasons a seemingly viable project may never get built. This uncertainty needs to be accounted at the front end prior to commissioning and transitioning to commercial operation. Once operating a project may cease to operate, a situation easily determined by observing its CO2 displacement output being reduced to zero.

The uncertainty associated with this assumed GHG reduction is controlled by tracking projects in their multiple stages of viability involving financing, equipment availability, insurance, community acceptance and related evidence of resource availability.

II. Capacity Uncertainties Associated with CO2 Emission Reductions

Once a project becomes commercial, the first uncertainty that should be addressed is the uncertainty associated with the quantity of CO2 reduction to be expected. A true up can be accomplished with preliminary data on the resource and the efficiency of the technology. This can be accomplished through spot metering of the site's resource and ambient conditions as well as efficiency calibration of the installed technology.

III. Operational Uncertainties Associated with CO2 Emission Reductions

Once operating, a project can be tracked with varying degrees of accuracy to quantify CO2 Emission Reductions over its operating life. The accuracy is a function of the combinations of meters and estimation techniques that depend on the CO2 reduction strategy/program employed. The following are addressed here.

Retrofit Demand Side Conservation Projects that displace MWh and that emit 0.00 lb/MWh of CO2

Examples include a Demand Side Management program verified by a Utility across many customers or members or by an Energy Service Company (ESCO) under a Guaranteed/shared savings contract that it secured with a large customer. Note that in addition to the CO2 reductions associated with the achieved savings, credits for an additional MWh must be accounted for used to displace CO2 emissions from the power plants that are operated as spinning reserve for reliability purposes and to overcome T&D losses now both avoided.

Metered Conservation

If all conservation measures are metered then the uncertainties in the amount conserved are related to the accuracy of the meters and the accuracy of the benchmark of energy use prior to the conservation program. Uncertainties based on established Verification programs such as those established by NAESCO, the US EPA Energy Star program or those adapted by State PUCs for DSM programs could be analyzed to determine the range of uncertainties over the time period of interest.

Estimated Conservation

If not metered, then in addition to the uncertainty in the a-priori benchmark, the uncertainty in the start time, end time and the dynamic amounts conserved based on the persistence of conservation measures will all add to uncertainties. In addition and on a positive note, added savings will occur due to replication of what may become examples of standard practice and based on the enforced adoption of new products having increased efficiency standards.

Customer Side Generation (On-site or behind the fence generation) displacing MWhs and that emit some lb/MWh of CO2

Examples include a Distributed Generation program by a utility across its customer/member territory to reinforce the grid or a project consisting of behind the meter generation that is implemented by an Energy Service Company (ESCo) or by a Energy Service Provider (ESP) under a Guaranteed/shared savings program or deregulated package, respectively across one or more large C/I customer aggregation. Note that again as in I A the CO2 reductions should account for an additional displacement of CO2 from the power plants that are operated as spinning reserve for reliability purposes and to overcome T&D losses.

Metered On-site Generator

It would be unusual for any generator, large or small, not to be metered. The type of meter and the reader of the meter will vary. An RTO/ISO in the US may monitor a generator above a minimum nameplate rating if supplying power into the grid or if a number of small units are aggregated to supply Green Power under a state/province RPS program. Most often an ESCO or ESP under contract with a customer/thermal host or a customer including universities, Biotech or Computer manufacturer campus will employ revenue quality MWh metering and possibly an interval meters. When a utility provides back-up support over its wires it may also institute metering, in part to compute its back-up fee. While an on-site generator may have a system that monitors emissions as required by a state/province authority, it is unlikely that emission monitoring will be available. More likely is the metering of generator fuel consumption such as natural gas, propane, wood chips, and others.

Estimated On-site Generator Performance

An estimate of MWh that overlap the emission record period -may be needed as will the emissions need to be estimated. Fuel use, percent heat recovered and heat rate as a function of ambient conditions are used to estimate the generator's emissions.

<u>Certified new construction of sustainable buildings that replace energy inefficient facilities and reduce CO2 emissions on the Demand side</u>

Various programs from the Energy Star Building to LEEDS address new electric buildings that have a smaller CO2 footprint than do conventional buildings built to code.

The difficulty here is the determining the higher electric use of the standard practice facilities that will be replaced by the sustainable facility.

<u>Certified renewable energy supply side power plants that emit 0.00 lb/MWh of CO2</u>

On the supply side this for or a field of PV arrays, a network of small, low head run of the river hydro facilities and wind energy farms. Shy of metering the MWh produced by a renewable technology the uncertainties that may be minimized include the estimated efficiency of the renewable technology; the quantity of the renewable fuel, i.e. wind speed, solar insolation, water flow rate, etc that are harnessed by the technology that are not likely measured; timing between the resource data base and ambient conditions or operating efficiency in error, etc.

Metered Generator Production

Measurement uncertainties associated with a pure solar, wind, wave or hydro renewable power plant's metered MWh output is directly related to the accuracy of the metering equipment.

Estimated Generator *Production*

In the absence of a meter, an estimation of MWh output may be based on the estimated/measured efficiency of the renewable technology and an estimated/measured record of the meteorological conditions within which the renewable technology operates.

<u>Certified renewable energy technologies that emit some lb/MWh of CO2</u>

Examples include a fuel cell farm, a methane fired turbine from a sludge or landfill field, perhaps a waste to energy plant, a variety of wood burning power plants and perhaps a geothermal power plant. A fuel cell example might be Fuel Cell Energy's Molten Carbonate DFC's in the range of (200 kW -30 MW, which according to the company states that their CO2 emission output is 765 lb per MWh of electrical output. Thus displacing 480 lb per MWh of CO2 if they operate in place of either a gas turbine or diesel engine.

Employment of Power Measurement and Continuous CO2 Emission Monitoring

In addition to the uncertainty associated with the Power Meter's measurement of MWh generated (see A.1), we now have the added uncertainty of estimating the CO2 emissions over the same time period and the uncertainty of synchronizing the two measurements.

Power Meter Unavailable

Similar to A.2 we add the uncertainty associated with the need to estimate the efficiency of the plant as well as the uncertainty of the renewable fuel resource supplied to the power plant.

Continuous CO2 Emissions Meter Unavailable

In addition to the uncertainty of the Power Meter we now have to estimate from spot metering or the chemistry of the fuel, the emissions vs. the renewable fuel supplied to the plant.

Neither *Power Meter nor Continuous CO2 Emissions Meter Available*

A combined uncertainty associated with the absence of all metered values.

<u>Certified BACT technologies that reduce lb/MWh of CO2 in Power plants that are being retrofit to extend life (Clean Air Act)</u>

Examples include a coal burner that is being retrofit with an ammonia based SCR technology, etc

Employment of Power Measurement and Continuous CO2 Emission Monitoring

In addition to the uncertainty associated with the Power Meter's measurement of MWh generated (see A.1), we now have the added uncertainty of estimating the CO2 emissions over the same time period and the uncertainty of synchronizing the two measurements.

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Neither *Power Meter nor Continuous CO2 Emissions Meter Available*

A combined uncertainty associated with the absence of all metered values.

2. *ANNEX 2: List of Typical CO2 Reduction Technologies and Programs*

This ANNEX to P1595 will present several examples of CO2 mitigation programs.
The three generic CO2 Mitigation Technologies and Programs examples that follow are believed by the author to be replicable based on their viability in the competitive marketplace and are verifiable, i.e., not so complex that a reasonable program couldn't be developed to verify credits within a reasonable budget.

Example CO2 reduction from "simple" conservation

One hundred incandescent light bulbs are replaced by 100 Compact Florescent Lamps (CFL) on January 1 2000 in a Boston Massachusetts USA hospital. In one year this retrofit project saved 2,000 kWh in the winter 1,250 kWh in the summer and 3,250 kWh in the spring and fall. Using a supply - demand multiplier of 1.1 and referring to the ISO-NE 2000 *NEPOOL Marginal Emission Rate Analysis* for 2000, we find that the Power

Plant's generation mix is estimated to produce approximately 0.73 tons of CO_2/MWh in the Winter, 0.75 tons in the Summer and 0.74 tons in the Spring and Fall.

Thus we conclude that this retrofit measure saved approximately 5.3 tons of CO_2 in 2002. Now if the start date was delayed by two weeks and if 10 % of the CFL's burned out in 9 months and were left in place or replaced with the original bulb and if lamps were used in the morning versus early evening the CO_2 credit would be different. While different, the big picture perspective tells us that this is good enough. If we extrapolate to 5,000 facilities however we might want to add more certainty and expand the M&V program to include spot metering of a statistically significant sample.

Example CO_2 reduction from substitution of renewable or a new and small nuclear power plant for CO_2 polluting plants

Now instead of light bulbs, we install 400 10 kW PV systems on houses or a 1,200 MW Nuclear Power Plant on a salt water inlet or a 100 MW wind farm on 200 acres on an exposed mountain ridge. Similar to light bulb retrofits, each power plant displaces CO_2. In the instance of the two central supply options there is a good chance that TOD MW production is well documented and available to be applied by accessing the ISO/RTO database.

1000 rooftop PV systems however may not be metered and may require: 1). revenue quality kWh metering or perhaps more appropriate, 2). an estimate of their site-specific kWh production based on its nameplate rating, its location/tilt and based on the weather station's record of daily hours of sunshine. As long as the MWh generation outputs are metered the error in quantifying the mitigated (avoided) CO_2 from the power pool for each of the 8760 hours in the year are limited to the accuracy of the meters and the correlation between an estimated CO_2 and each hours MW value.

Example CO_2 Reduction from Plants that do emit CO_2

Now to make matters more complicated a 20 MW wood burning Biomass plant is added to the Power Pool and a dirty Coal Burning Power plant is retrofit with BACT. While the MWh production of these two power plant should be readily available from the Power Pool, there is a simultaneous need to verify the reduction in CO_2 emissions attributed to the retrofit Coal plant and attributed to the substitution of the economic Biomass plant to the power Pool mix.

Given the confidentiality of individual power producers in a competitive market, we may depend on a system that correlates emissions to power plant generation without revealing competitive information. In New England this system is the Generation Information System (GIS) whereas in California it may in part be the Demand Reserves Partnership Program.

In addition to the correlation and meter errors associated with MWh production values, CO_2 emissions may be fluctuating faster than the metering can sample as the quality and the variations in moisture in coal and wood chips vary. Hence the accuracy and sampling rate of the CO_2 monitor becomes more important.

G. CONCLUSIONS

The development of the P1595 International Standard will not be easy. However, it can be and must be accomplished. In its absence there will be no business reason for CO_2 mitigation to occur in that a standard for the fair allocation of credits will not be available.

While the author addressed mitigation measures that impact CO_2 from power plants, he realizes that the complete package may have to include other creditable means of accounting for CO_2 emissions, namely sequestration and a reduction in CO_2 emissions in the transportation sector. While the author believes this task is beyond the scope of P1595, the author is hopeful that the structure that is developed in P1595 may help standardize the structure of all other CO_2 mitigation efforts.

Please contact rich@argpower.com if you have comments related to the above work.

ACKNOWLEDGEMENT

I would like to credit Jim McConnach and Tom Hammons for the impeccable timing of P1595. Without their fortitude to move this work along we would not be where we are today.

Richard T. D'Aquanni is a founder and President and Technical Director of Applied Resources Group Inc. (ARG), a 21 year old Energy Consulting and Systems Integration Company located in Brookline Massachusetts. Mr. D'Aquanni has undergraduate and graduate degrees in electrical engineering from Manhattan College and the University of Arizona and is a registered Electrical Engineer in Massachusetts and California.

At ARG, he coordinates engineering and software resources focused at applying automation solutions to facility utility problems. In addition to ARG's projects Mr. D'Aquanni consulted for McKinsey & Co, Haliburton Corp as well as to Utilities in the generation business in his role as the founder and Executive Director of the Non Utility Power Generation Association (NUGs).

He has assisted the Commonwealth of Massachusetts in performing a due-diligence on a biomass project resulting in a $ 700,000 grant. In 2002, ARG continues its work on Fuel Cells as a very reliable and clean source of facility power for the Cambridge savings Bank, located in Harvard Square Cambridge Massachusetts. Previously Rich assisted the Genetics Institute (GI) in facilitating their 5 MW cogeneration project and the Harvard School of Public Health and GI in assessing the utilization of Fuel Cell Technologies.

Richard D'Aquanni has conducted due diligence work involving the analysis and metering at a US/DOE shared-savings conservation project in Hawaii and utility DSM Programs in New England. He developed a business plan to advance the competitive position of the National Electrical Contractor's Association during utility deregulation.

He is a Senior Member of the IEEE and a Member of IEEE Power Engineering Society active in reliability, metering and renewable energy. Currently he is a member of the IEEE Working Group on Implementing Technology to Limit Climate Change and of the Task Force to develop a Standard for the Quantification of CO2 Emission Credits and the IEEE Power Systems Engineering working Group on System Design, the latter with emphasis on Quality of Service Indices and Calculations.

3. DERIVING EMISSION CREDITS FROM ENERGY EFFICIENCY PROJECTS

Scott Rouse, MIEEE, Ontario Power Generation Inc. Canada

ABSTRACT

Energy at Work is an internationally recognized program by both the Canadian and American federal governments. In 1999, *Energy at Work* was awarded the Canadian Energy Efficiency Award for Industry, and in 2002 it received the U.S. EPA Climate Protection Award.

Energy at Work creates over $90 Million in annual energy savings, reduces environmental emissions and enhances social equity. At the core of this 'triple bottom line' success are the valuable partnerships with internal and external stakeholders, leading to the development of cost-effective solutions and the elevation of *Energy at Work* to a leadership position in the field of energy efficiency. Partnerships have also allowed for the creation of emission reduction credits (ERCs) from several energy efficiency projects.

Through the efforts of the Emissions Trading team, a group of lighting and hydroelectric projects were submitted to the provincial process and approved, thus creating $2.2 Million in ERCs. Unfortunately, the experience was difficult; the process was longer and more arduous since there were no "standards" for creating ERCs from energy efficiency projects. Without the benefit of a "CO_2 Standard", the extra work needed in creating the ERCs became a significant barrier.

This experience prompted the author to join with others in working with the IEEE to help establish a "CO_2 Standard", see Task Force P1595, thereby reducing the number of obstacles encountered when pursuing the creation of ERCs from energy efficiency initiatives.

Energy Efficiency and Emission Trading details are available on the respective websites: www.Energy-Efficiency.com and www.PERT.org

KEYWORDS: Energy Efficiency; Generation Asset Optimization; Thermal Efficiency; Conversion Efficiency; Emission Reduction Credits; ERCs.

A. INTRODUCTION

1.1 *Energy at Work* Program

On April 1, 1999, the Ontario government divided Ontario Hydro into five separate companies, including Ontario Power Generation (OPG). OPG took over responsibility for generating electricity within the province. OPG also adopted the internal Energy Efficiency program implemented in 1994. During that year, Ontario Hydro identified itself as being the largest user of electrical power in the province. Ontario Hydro initiated a program to improve energy efficiency.

By 1995, the definition of energy efficiency grew beyond electricity consumption efficiency to include generation conversion process improvements and thermal efficiency improvements at nuclear, fossil and hydroelectric stations. The program evolved into the *Energy at Work* program. There have been energy efficiency targets every year since 1994.

The success of the *Energy at Work* program was recognized in 1999 and 2002 by being honored with the Canadian Office of Energy Efficiency and the U.S. EPA awards respectively. Details on the program are available from www.Energy-Efficiency.com

Looking to the future, the goal of the *Energy at Work* program is to reduce internal electricity consumption or increase energy productivity by 3% per year between 2002 and 2006. Since 1994, energy savings accomplished within OPG's three-generation groups (Nuclear, Hydroelectric and Fossil) total over 1,800 MWh/yr.

It is anticipated that the efforts of the *Energy at Work* program will continue to contribute to the 'triple bottom line' objectives:

- reduced costs;
- improved environmental performance;
- enhanced community contributions.

1.2 Benefits of an Emission Trading System

Traditional regulatory measures can be onerous for firms or organizations that have few, if any, cost effective opportunities to reduce their own emissions. Emission reduction credits (ERCs) are created when a company takes an initiative to reduce emissions that are not required by a regulator (see Attachment 1). Hence, the implementation of emission trading between companies, and countries, is intended to both complement existing legislation and help shape future legislation and commitments on emissions.

Emission trading is evolving within Ontario Power Generation, and has progressed into an effective tool for "monetizing" the environmental benefits accomplished by energy efficiency.

B. ENERGY EFFICIENCY AND EMISSION REDUCTION CREDITS (ERCs)

In 1997, the Pilot Emission Reduction Trading project (PERT) identified the potential to create ERCs from energy efficiency savings, when properly submitted and audited. The PERT project was an industry-led multi-stakeholder initiative, now taking the form of Clean Air Canada Inc.

For quite some time, energy efficiency has been recognized and accepted as an economic means of improving the profit position of a company. With the relatively recent introduction of emission trading, energy efficiency is now even more valuable, acting as the means to an end –- the reduction of environmental emissions with the potential for creating ERCs.

Ontario's electricity base load is met with nuclear and hydroelectric generation. Fossil fired stations (coal and oil) are the last generating units placed in service to meet peak demand and the first removed from service as system demand drops. In principle, energy efficiency initiatives reduce electricity demand, and therefore lower the generation required from fossil resources, avoiding the associated emissions.

Therefore, emission trading works to produce a "win-win-win" situation by uniting environmental, production and financial issues:

- emission reductions;
- production improvements and flexibility;
- cost reductions.

C. PROCESS FOR CREATING ERCs

Emission reduction credits are created when a source takes an action to reduce emissions below either the historic level of actual emissions or the level required by government regulations. In order to create ERCs, a company must follow a strict set of procedural guidelines and satisfy the following criteria:

- Real: An actual emission reduction has occurred due to a change in process/technology/operation.
- Quantifiable: Must be a reliable and quantifiable basis for calculating the amount of reduction
- Surplus: Must be in excess of any existing regulatory or voluntary commitments.
- Duration: The ERC can be either continuous or discrete, depending on the creation strategy. Permanent process changes create continuous ERCs, while reversible changes produce discrete ERCs.
- Verifiable: The onus of verification for ERCs is on the buyer. The proponent of the credit creation submits the ERC creation document to PERT.

For any project applying for the registration/creation of ERCs, it is audited to ensure the resulting emission reductions meet the above criteria. Ontario Power Generation's Emission Trading team determines if a selected energy efficiency project led to less fossil production. If the answer is 'yes', then the equivalent emission offset is calculated based on the time of year when the fossil units would be operating, etc. If the answer is 'no' then those projects are not tracked for emission savings.

Of the more than 300 energy efficiency projects implemented by the *Energy at Work* program over its eight-year history, only 50% have been successfully applied to create emission reduction credits on account of available documentation, type of project, time of year, etc.

Once approved internally, the proponent chooses a public forum to review its ERC claim. This involves submitting a creation document for public review to only one organization (e.g., Clean Air Canada Inc., NESCAUM, Environmental Resource Trust). Historically, energy efficiency projects created by *Energy at Work* have gone through the public forum known as PERT (now overseen by Clean Air Canada Inc.). PERT developed principles and program elements for creating, recognizing and trading ERCs. Composed of industry, government and environmental groups, the forum reviews the document and provides comments to the proponent. This input addresses where the creation is lacking in documentation or theory.

The proponent then clarifies the document and resubmits it to the entire PERT group. There is a commenting period on the strategy before the document is transposed to the registry. Once the document is listed on the registry, it is available for sale or use. Once used, the credits may undergo a third party audit.

The CO_2 trades have been subjected to a PERT review. Due diligence has also been undertaken for all trades. The result of the reviews reflects the quality of the ERCs, which determines the value of the credits and whether the deal goes forward.

The contracts for ERCs are no different than for any other traded commodity. Warranties, ownership, amount, and prices are identified. Final transactions are based on favorable reviews by PERT and a third party. The retention of documentation is also required.

When established in the market, ERCs may be created, registered and traded as a commodity, applicable toward certain regulatory or voluntary emission limits. In addition to monetary benefits, there is a direct reduction in impact on the environment through reduced use of resources and decreased emissions. Though not legally required to, Ontario Power Generation "retires" 10% of the credits it creates or purchases to ensure an ongoing environmental benefit.

D. ERCs CREATED FROM OPG'S ENERGY AT WORK

Until 1999, Ontario Power Generation has created emission reduction credits internally and purchased credits externally. These credits are submitted to and reviewed by PERT.

Below are two case studies of ERCs created by *Energy at Work* initiatives. The first project –- a lighting upgrade –- reduced the amount of electrical energy used in production, commonly referred to as electrical efficiency. The second project –- installation of more efficient runners and transformers –- increased the amount of electrical energy generated for a given amount of hydraulic energy input, commonly referred to as a conversion efficiency improvement. Although the projects were distinct, the experiences encountered throughout ERC process are similar. Lessons learned from each case study are provided.

Lighting Upgrades

The PERT review panel agreed to register ERCs for the energy savings achieved for 1997, 1998, and 1999 through various lighting improvements. The energy savings from 65 projects totaled 170,000 MWh by the end of 1999. The primary goal of the upgrades was better lighting and improved employee comfort; however, the project also resulted in reductions of environmental emissions. Greenhouse gas emissions from these projects are 450.3 tonnes (metric tons) for 1997, 409.2 tonnes for 1998 and 385.8 tonnes for 1999. The result is an approved emission reduction credit estimated at $800,000.

The ERC process started in March 2000 and went through three reviews. Approval and registration of the ERC was completed in 2001.

A key lesson was learned –- ensure verification of results.

Hydroelectric Improvements

Hydroelectric energy efficiency projects during 1998 and 1999 produced energy savings totaling over 467,000 MWh. The primary objective was greater reliability, however, the project also resulted in increased hydroelectric capacity, thus offsetting fossil requirements.

The result was the creation of an ERC worth $1.4 million. The ERC process started in January 2000 and went through one initial presentation and two reviews. Approval and registration of the ERC was completed in June 2001.

Several lessons were learned from this ERC process:

- proponent must ensure sufficient backup data is maintained;
- modeling must be consistent from one project to the next;
- in-service dates must be consistent with approved guidelines;
- be patient!

Unfortunately, the ERC process was a difficult experience; the process was longer and more arduous since there were no "standards" for creating ERCs from energy efficiency projects. Without the benefit of a "CO_2 standard", the extra time and effort needed in creating the ERCs became a significant barrier. It was this obstacle that prompted the author and others, in conjunction with the IEEE, to establish the "CO_2 standard".

E. FINDINGS

There are ample opportunities to achieve additional energy savings and generate greater emission credits. As energy efficiency and emissions trading continues to evolve, the practitioner must address a series of questions:

- How much is economically achievable?
- What is an accurate estimate of losses?

- What is an estimate of economically achievable savings?
- What is needed to maintain interest?

These questions can be addressed through different tactics. One 'piece of the puzzle' is the external search for new ideas by utilizing the synergies found within partnerships and organizations like the IEEE. Another is taking advantage of government-sponsored programs established to help private sector companies. Yet the most critical component needed for pursuing successful energy efficiency and emission trading is an established strategy. The "Energy Efficiency Best Practice Guide" accomplishes this by identifying seven criteria that are required for success.

The "Energy Efficiency Best Practice Guide" ensures a continuous improvement program is in place, thus helping to achieve energy savings and emission reduction credits well into the future.

F. CONCLUSIONS

Energy efficiency is a proven and cost-effective way to achieve the 'triple bottom line' results that today's advanced companies are pursuing: *economic performance* (increased productivity/ reduced costs), *environmental responsibility* (reduced emissions) and *community relations* (greater social equity and health).

Implementing energy efficiency can lead to another benefit –- the creation of emission reduction credits.

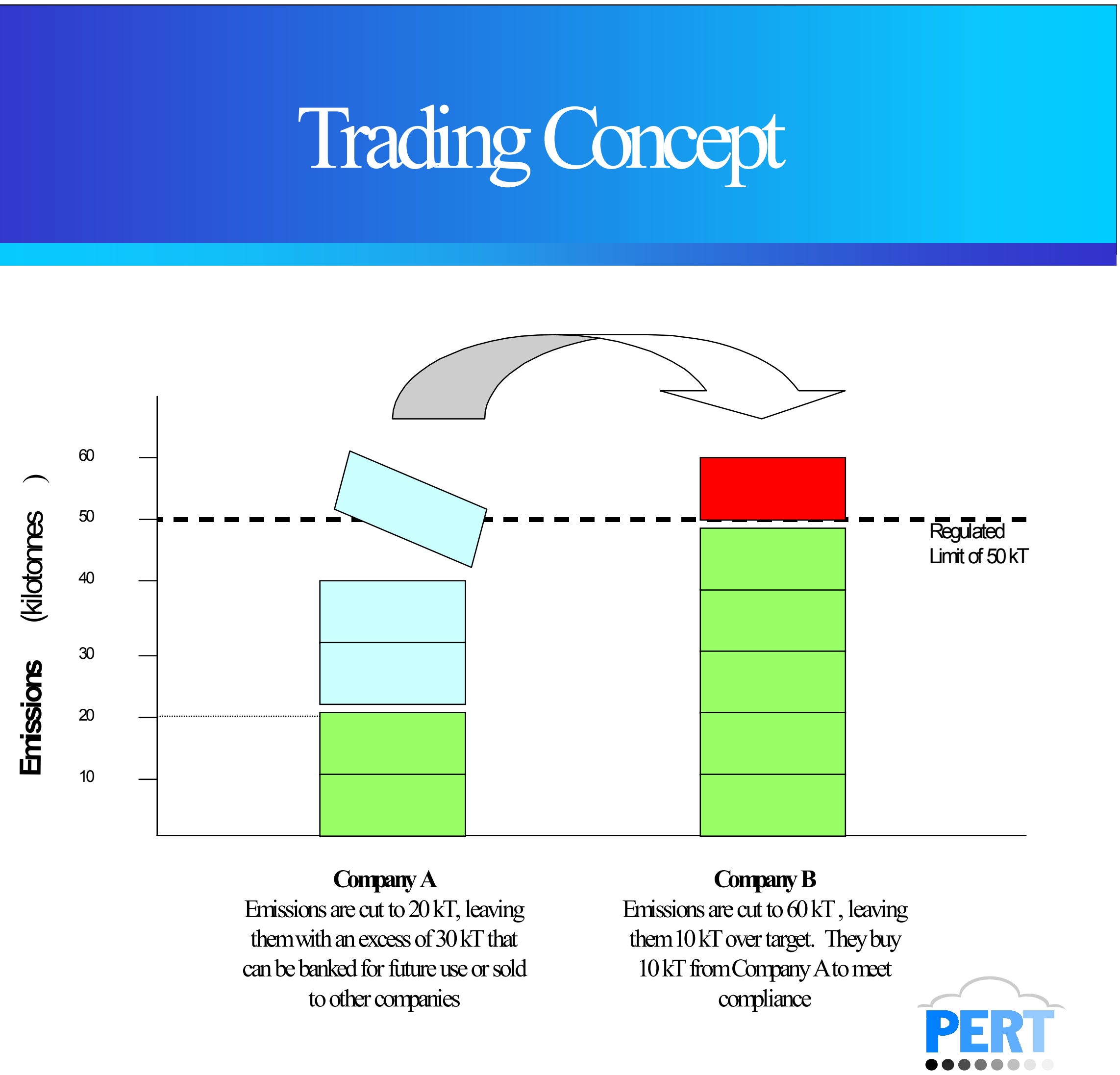
Ontario Power Generation's experience reveals first-hand the benefits of energy efficiency:

- Over 2.3 Billion kWh/year in energy savings;
- Over $90 Million saved per year;
- Over 2.6 Million metric tons in emission reductions.

The emerging emission trading system is improving the economics for projects by adding another source of revenue. Along with internal capital investments and government funding, funds resulting from the sale of ERCs can now make energy efficiency projects more "attractive".

Best of all – benefits go directly to the triple bottom line.

Attachment 1: ERC Trading Concept



Scott Rouse joined Ontario Hydro in 1982. He is now manager of the Energy Efficiency Department, Ontario Power Generation. The group helped the nuclear, fossil and hydroelectric business units save over 2 billion kWh /yr and now worth over $85 Million per year. Energy savings are converted to 2.4 million tonnes of emission savings - CO2, NOX and SOx. These emission benefits provide greater operation flexibility to the fossil fleet as well as increased revenue. Some of the earlier projects were used to create emission credits. He is a recipient of Canada's energy efficiency industrial tier one award. He has been in both the transmission and generation business units for the past 20 years. Rouse has authored papers for IEEE, CIGRE, and EPRI. He is a professional engineer in Ontario.

4. GHG REPORTING FOR THE GOVERNMENT OF CANADA'S CLIMATE CHANGE TECHNOLOGY EARLY ACTION MEASURES (TEAM) INITIATIVE – The System of Measurement and Reporting to TEAM (SMART)

Thomas Baumann, TEAM Operations Office, Climate Change Action Fund, Government of Canada

ABSTRACT

The System of Measurement and Reporting to TEAM (SMART) has been designed as a practical and cost-effective approach to establish the technical performance and GHG impacts of TEAM projects. Due to the early stage of development of greenhouse gas (GHG) verification activities (ex. rules, methodologies, etc.), this is a major challenge for most climate change programs. Furthermore, as most TEAM projects involve the development of innovative, late stage, pre-commercial technologies, it is often necessary to develop customized approaches for SMART reporting. The SMART combines 2 measurement and reporting (M&R)

approaches by addressing (i) technical performance (ex. data collection and analysis, SOPs, instrumentation, QA/QC plans, etc.) as well as (ii) GHG accounting (ex. boundaries, scope, benchmarks, methodologies, etc.). Fundamentally, GHG reductions result from (i) a reduction in activity and/or (ii) a reduction in GHG intensity of the activity (relative to the baseline activity on a per unit basis). The primary goal of the SMART is to determine the GHG impacts and advantages of the technology/project in terms of three metrics: (i) total GHG reductions; (ii) reductions in GHG intensity enabled by the core technology; and, (iii) annualized GHG reductions. The SMART framework consists of guidance and reporting templates to report: (i) overviews of the project and benchmark(s); (ii) project data and calculations; (iii) benchmark data and calculations; and, conclusions.

Note: The May 2002 version of the SMART was presented at the IEEE PES Summer Meeting in Chicago (July 2002). However, this overview is based on the September 2002 version of the SMART, and therefore, includes revisions resulting from the experience gained from the road testing of the SMART protocol.

This overview of the System of Measurement and Reporting to TEAM (SMART) includes the following sections:

Government of Canada and the Climate Change Action Fund

Immediately following the United Nations Framework Convention on Climate Change (www.unfccc.int) Third Conference of the Parties (COP3) in Kyoto, Japan, 1997, the Government of Canada created the Climate Change Action Fund (CCAF) (www.climatechange.gc.ca). This fund allocated $150 million over three years (1998-2001) to four main components:

- Technology Early Action Measures (TEAM), to support cost-effective technology projects that will lead to reductions in greenhouse gas emissions
- Public Education and Outreach, to inform and engage Canadians on climate change and to form partnerships with other governments, communities, the private sector, and other organizations in early action measures
- Science, Impacts and Adaptation, to improve knowledge of the climate system and to assess the impact of climate change on the regions of Canada and the options for adaptation
- Foundation Analysis, to support the sound analysis of options for implementing the Kyoto Protocol.

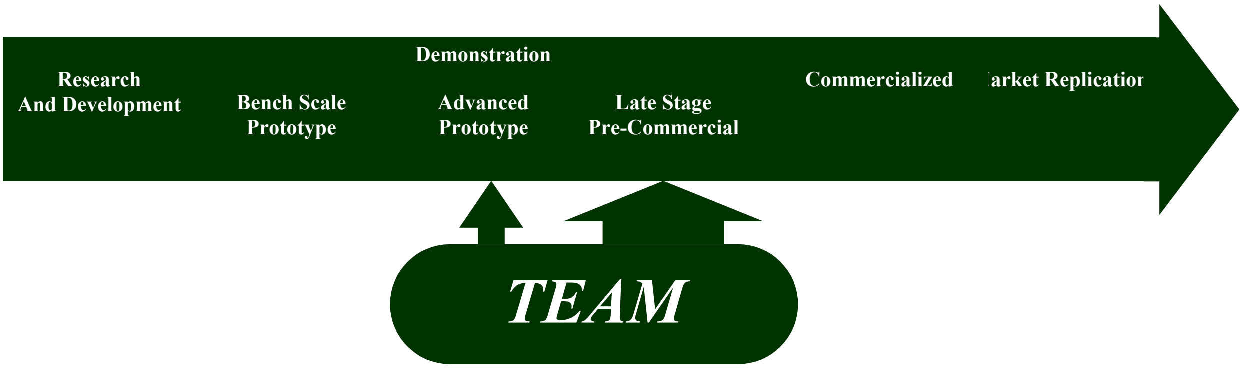
The CCAF was renewed for another 3-year mandate (2001-2004) with an additional $150 million. As well, the Action Plan 2000 climate change initiative was approved for a 5-year mandate (2001-2006) with $1.1 billion of funding.

Overview of Technology Early Action Measures (TEAM) Initiative and How TEAM Works

In 1998, The Technology Early Action Measures (TEAM) Initiative component was provided $60 million and a mandate to engage the private sector and other governments in undertaking projects that would develop and deploy innovative technologies that can have significant impact on GHG emissions. In 2001, the TEAM initiative was extended by 3 years (to 2004) with an additional $35 million. Further information on TEAM's Phase II Business Plan and Management Framework is available at www.team.gc.ca. TEAM's project portfolio includes 87 projects funded to date (1998-2002) and a total investment of more than $915 million.

To achieve the greatest results, TEAM assigned top priority to projects that demonstrated significant financial partnering with a number of interested parties, such as the private sector, provinces, municipalities, international agencies and other national governments. Rather than develop a new project management infrastructure, TEAM acts as a "top-up" investment fund to existing federal government technology advancement programs. Each project must be approved by one of these delivery programs, in keeping with the terms and conditions of that program, and then presented to TEAM by the program manager if it has potential for significant impact on GHG emissions. TEAM may provide up to 75% of the total government contributions to the project, while the delivery programs provide the balance, including management of the federal government's participation in the project.

TEAM's mission is to invest in technology deployment and late stage development in support of early action to reduce GHG emissions, nationally and internationally, while sustaining economic and social development.



Purpose and Benefits of the System of Measurement and Reporting to TEAM (SMART)

In order to establish and maintain a high level of credibility of all TEAM projects, the TEAM Operations Office (TOO) was mandated to provide a GHG measurement and reporting (M&R) system and to guide proponents and government managers with the objective to accelerate market acceptance of these innovative technologies. The System of Measurement And Reporting to TEAM (SMART) was designed as a practical and cost-effective approach, based on extensive consultation with experts and initiatives, in Canada and internationally. Due to the early stage of GHG M&R and verification activities (ex. rules, methodologies, etc.), this is a major challenge for most climate change programs. Furthermore, as most TEAM projects involve the development of innovative, late stage, pre-commercial technologies, it is often necessary to develop customized approaches for SMART reporting. The SMART combines 2 M&R approaches by addressing (i) technical performance (ex. data collection and analysis, SOPs, instrumentation, QA/QC plans, etc.) as well as (ii) GHG accounting (ex. boundaries, scope, benchmarks, methodologies, etc.). Each SMART report clearly indicates the technical performance as well as the GHG impacts and advantages of the TEAM-supported technology to offer customers, investors and the public with the due diligence to ensure that these solutions are real opportunities.

As well, the SMART offers many benefits to both project proponents and government programs. Companies benefit by establishing credibility, gaining experience and know-how, showing leadership, building competitive advantage, maintaining constructive government and public relations, and developing a network of partners and relationships to be prepared to participate in future climate change initiatives. The Government of Canada benefits in the confidence and knowledge that its investments have real-world results that are fiscally responsible, build capacity in the private sector, and reduce risks associated with climate change.

SMART Chronology

1998 ➔ TEAM Business Plan & Management Framework requires verification plan and report on technical performance & GHG impacts of projects.
1999-2002 ➔ SMART protocol developed; May 2002 version presented at IEEE in Chicago; September 2002 version used in this overview paper.
2002 (January-September) ➔ SMART protocol road-tested with 8 projects and finalized.
2002-2005 ➔ SMART contracting and reporting.

SMART Objectives

The key objectives for the SMART and the approaches to address these objectives include:

Credibility and Accountability:

- Follow Best Practices, Be Practical & Produce Useful Results, Use Consistent Approach, Be Transparent & Accurate, Indicate Environmental Co/Dis-Benefits

Cost-Effectiveness:

- Budget < $30K Cdn or $20K USD, Utilize Best Practices (don't reinvent the wheel), Custom and Flexible Protocol, Use TEAM Project Final Technical Report, Allow Self-Reporting (if proponent has been pre-qualified to do the SMART)

Building Capacity:

- Credibility and Leadership, Learning and Experience, Competitive Advantage, Marketing & Technology Sales, Basis for GHG Reduction Crediting, Government & Public Relations

Working Together:

- Canada's Greenhouse Gas Verification Center
- Canada's Clean Development Mechanism and Joint Implementation Office
- Voluntary Challenge & Registry
- Partners for Climate Protection (Federation of Canadian Municipalities)
- Baseline Protection Initiative (Office of Energy Efficiency)
- Pilot Emission Removals, Reductions & Learnings Initiative
- US EPA Greenhouse Gas Technology Verification Center
- Environmental Technology Verification Canada
- World Resources Institute & World Business Council for Sustainable Development
- International Organization for Standardization (ISO)

SMART Guiding Principles

The following principles should be used as general guidance to complete the SMART.

Accuracy

Accuracy is the relative measure of the exactness of relevant measures. This should enable estimates to be neither over nor under their true values, as far as can be judged, and that uncertainties are reduced as far as practical.

Best practices

Best practices refer to performance equal to or better than recognized standards and methodologies.

Completeness

The approach and results should consider the full extent of performance and impacts during the lifecycle of all materially significant elements (ex. technologies, activities, unit processes) of the benchmark and project systems, including all relevant GHGs and related issues such as "leakage".

Comparability

The approach and results to consider GHG sources and sinks between the benchmark system and the project system should be comparable. Equivalent functions, as well as comparable functional units and reference units, should be defined and used.

Consistency

The same approach, level of rigor and detail of analyses that are applied to the benchmark and project systems, elements, inputs/outputs, and issues should be used in the SMART, as well as among different SMARTs.

Cost-efficiency

The costs and effort to complete the SMART (ex. document, measure, calculate, report, etc.) should be prioritized to attempt to achieve the maximum results, according to the guiding principles presented here, within the budget allocated to complete the SMART.

Practicability

Practicability attempts to balance the effort to adhere to the guiding principles with simple, reasonable, and cost-effective approaches to achieve credible, and valuable, results that reflect actual conditions.

Reliability

The approach and results of the SMART should be able to easily and reliably reproduced and verified by other parties.

Transparency

The data, documentation, measurement, assumptions, calculations, methodologies, reporting, etc. in the SMART should be explicitly presented in order to be easily understood.

Verifiability

To be verifiable, the data, documentation, measurement, assumptions, calculations, methodologies, reporting, etc. in the SMART should adhere to the guiding principles and methodological guidance of the SMART.

Systems Approach in the SMART

A systems approach may be used to achieve a more complete accounting of the environmental impacts of activities, especially as a comparison between options and often within a decision-making process. The

SMART uses a systems approach, whereby GHG sources and sinks are tracked during the life cycle from "cradle-to-grave". The life cycle approach considers for the broadest possible boundary of consideration. This means that GHGs are identified and tracked from their origins in the atmosphere or the earth (or from anthropogenic origins (ex. landfills) that represent end-points of the economy as if the GHG precursors were returned to the earth). GHGs or their precursors are then tracked through the system of various activities (ex. production, transportation, installation, operation, utilization, decommissioning) to their ultimate destiny (ex. release again to the atmosphere or sequestration). Using this flexible approach permits the SMART to set its reporting focus, as appropriate, at either a relatively narrow scope, such as a project involving engine modifications, or a relatively wide scope, such as the lifecycle for biodiesel (ex. fuel cycle, operation cycle, etc.).

Non-Crediting Status of the SMART

As a Government of Canada initiative, TEAM does not issue or certify "credits" for GHG emission reductions, avoidance or sequestration, nor is it a forum for trading in such credits. However, the TEAM reporting procedures have been designed to collect and analyze data in a transparent fashion so that this information will have maximum credibility if it is used by the proponent as part of a submission to a credit-trading program.

General Limitations of the SMART

The SMART is intended to take a "snapshot" of the GHG claims at the completion of a TEAM funded project. Although TEAM assists in the preparation and reviews the SMART reports, TEAM does not intend to verify the information through additional, independent review. TEAM uses the SMART results to evaluate its investment efficacy and to inform the Government of Canada on GHG mitigation technology project activities. In any other context, the information contained in the SMART should be used with caution. There is no subsequent monitoring of the information contained in the SMART. Due to resource limitations (ex. funds, time, etc.), the SMART is not intended to be a completed verification of the technical and GHG claims of a TEAM funded project. However, based on the guiding principles and methodological guidance of the SMART, it is intended to provide a verifiable evaluation of the technical and GHG claims of a TEAM funded project.

Although TEAM requires environmental issues (other than GHGs) to be identified and reported in the SMART, the level of reporting is not intended to be comprehensive. While the environmental issues identified and reported in the SMART are perceived to be of potential importance for the overall evaluation of the technology, the SMART does not include an assessment of their relative or absolute importance. Therefore, users of the SMART are advised to undertake additional investigation and analysis relating to environmental issues.

General Challenges & Approaches/Solutions for the SMART

The following table provides an overview of the approaches and solutions to resolve the challenges that are inherent to the design and implementation of the SMART.

- Innovative Pre-commercial Technologies and Commercial Confidentiality
- Customize SMART, Allow Self-Reporting (company = the experts)
- Keep Costs Down
- Flexible Protocol, Leverage TEAM Project Technical Reports
- Consistency with Other Climate Change Initiatives
- Balance Common Features and Maintain Collaboration
- Proponent Resistance & Steep Learning Curve
- SMART Funding (Carrot), Project Funding Hold-back (Stick), Education, Persistence
- Administration & Logistics
- Establish and Manage New Government Contracting System for Pre-qualified Contractors

SMART Metrics

1) Fundamentally, GHG reductions result from (i) a reduction in activity and/or (ii) a reduction in GHG intensity of the activity (relative to the baseline activity on a per unit basis). The primary goal of the SMART is to determine the GHG impacts and advantages of the technology/project in terms of three metrics:
2) Estimate the total GHG emission reductions (ex. tonnes of CO_2e) for the actual TEAM project. Total GHG emission reductions are estimated as the difference between emissions from the Project System and the Benchmark System. This metric provides a measurement of the project's impact versus the business-as-usual benchmark that would have occurred in the absence of the project;
3) Estimate the GHG intensity gain per unit (ex. tonnes of CO_2e per unit energy, mass, or activity). The GHG intensity gain is estimated as the difference, on a unit basis, between the GHG intensity of the Project relative to the GHG intensity of the Benchmark System. This metric provides a measure of the specific GHG advantage of the project's core technology (ex. kg of CO_2e per L of biodiesel); and,
4) Estimate the annualized GHG intensity gain per unit of technology/project (ex. tonnes of CO_2e per unit technology per year). The annualized GHG intensity gain is estimated as the difference, on an annualized unit of the technology or project, between the GHG intensity of the Project relative to the GHG intensity of the Benchmark. This metric provides a measure of the specific GHG advantage of the project's core technology per year (ex. a 30kW micro turbine with CHP operating at 80% capacity is estimated to reduce ### tonnes of CO_2e per year relative to a specific benchmark).

Overview of the SMART Framework

The SMART framework consists of 3 general steps:

1) Provide overviews of the project and benchmark(s), including benchmark selection
2) Determine boundaries, scope elements, and report data in SMART templates & attachments
3) Calculate GHG metrics, discuss significant issues, and provide recommendations in the SMART Report

The following table presents an overview of the SMART reporting templates and key sections.

Project Overview	Project Data	Benchmark Overview	Benchmark Data	Conclusion
Project Description	Element Overviews	Benchmark Selection	Element Overviews	Element Summary
Technology Description	Element Inputs	Benchmark Factors	Element Inputs	SMART Metrics
Proponent Description	Element Outputs	Comparability	Element Outputs	Environmental Issues
Project Functions	GHG Emissions		GHG Emissions	Human Resource Issues
Technical Documents	Environmental Issues		Environmental Issues	Health & Safety Issues
Proponent Contacts				Limitations
SMART Contractors				Discussion
Government Manager				Recommendations and Next Steps
				Figures

The project overview template is designed to provide general information about the project (ex. project site and conditions, activities, figures, duration, level of activity, etc.), the technology (ex. fundamentals, figures, etc.), the proponent (ex. roles and responsibilities), and contact information.

The benchmark overview template is designed to provide general information about benchmarks, as well as the rationale for benchmark selection (ex. type of benchmark, regulatory factors, strengths, weaknesses, etc.). Types of benchmarks could include generational (ex. from an earlier model to an advanced design) or alternative (ex. next best, multi-project, industry standard/benchmark, historical, existing system to be replaced, etc.).

The project data template and the benchmark data template are designed to report specific information about the project elements and benchmark elements. The first section on each template reports all of the elements within the boundaries and applies standard scoping criteria to prioritize the relevant significant elements to be reported in the SMART. The following sections report the inputs and outputs (ex. type of input or output, GHG emission estimation method, uncertainty, etc.) for each element included in the scope of study. Examples of GHG emission estimation methods include mass and energy balance, emission factor, sampling, monitoring, etc.

The final sections on each template present the GHG information for each element, as well as overviews of the significant environmental issues.

The scoping criteria applied in the SMART to prioritize the reporting efforts include the following key questions:

- Is the element different between the Benchmark and the Project? (yes or no)
- Is the element related to a GHG source or GHG sink? (yes or no, if yes indicate the type of GHG source or sink according to IPCC classifications energy (fuel combustion, fugitive emissions), industrial processes, solvent and other product use, agriculture, land-use change & forestry, waste, other)
- Is the element materially significant to include it in scope of study? (yes or no, if no provide an explanation such as it contributes to less than 5% of total GHG emissions of the system (refer to the guidance template for more information)
- Is the availability of data of the element appropriate to include it in scope of study? (yes or no, if no provide an explanation)

The conclusion template presents a summary of the GHG intensity of each element reported in the SMART, as well as the SMART Metrics (ex. reduction in GHG intensity, total GHG reductions for the project, annual GHG reductions). The following sections discuss significant issues relating to the environment, human resources and health & safety, as well as limitations and assumptions (ex. relating to the technology/project, benchmark, GHG methodologies, SMART process, etc.). The final sections provide conclusions (ex. findings, sensitivity analysis, etc.), recommendations (ex. to improve credibility of evaluation, etc.), and next steps (ex. gap analysis to link proponent from TEAM/SMART to another initiative or project, etc.).

Overview of TEAM Projects Related to the Electricity Sector

Approximately one-third of all TEAM projects are directly related to the electricity sector. The following table presents a list of the number and types of TEAM projects related to different areas of the electricity sector.

Project Sector	Number of Projects
Solar Energy	3
Bio-Energy	2
Wind Energy	3
Small Hydro	6
Fuel Cell & Hydrogen	11
Electric Vehicles	1
Energy Efficiency	3
Total	28

Case Study: Brief Overview of the Montreal 2000 – Electric Vehicle Project

(www.ve-montreal2000.com)

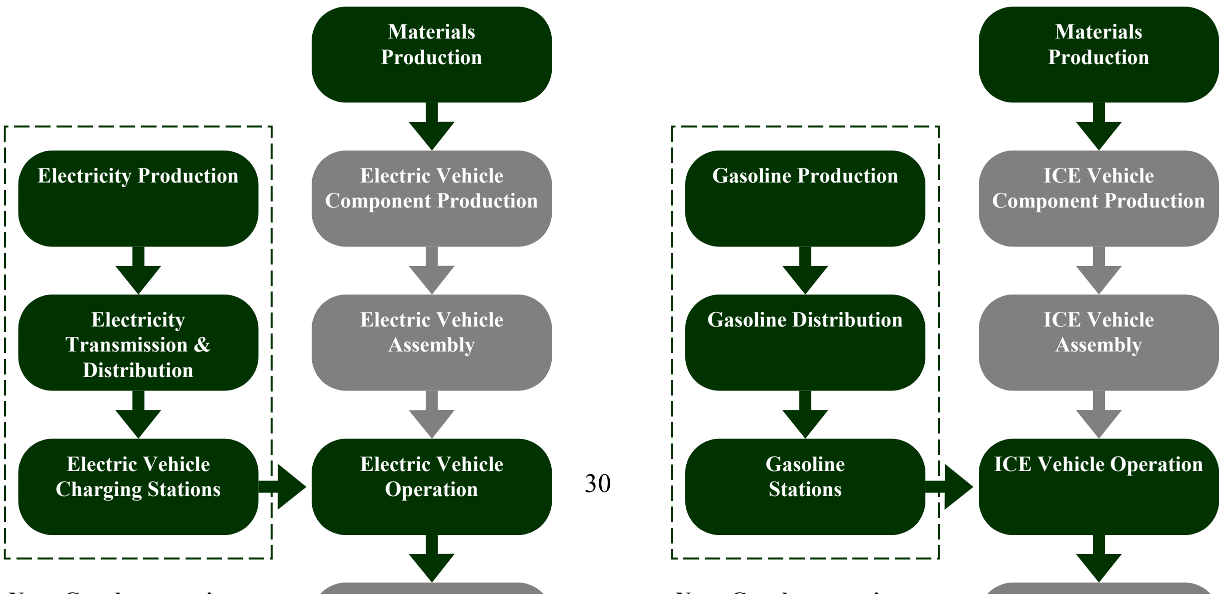
In the province of Quebec, road transportation is responsible for over 40% of greenhouse gas emissions. Like most major cities, Montreal has been grappling with the problem of urban smog caused by gaseous pollutants such as oxides of nitrogen (NOx), volatile organic compounds (VOCs), etc. Vehicles powered by fossil fuel are mainly responsible for this situation.

The purpose of the Montreal 2000 - Electric Vehicle Project was to facilitate the introduction of the first light electric vehicles (EVs) in Canada, specifically in the Greater Montreal region. The project was intended for organizations operating institutional and commercial vehicle fleets. The Montreal 2000 - Electric Vehicle Project was divided in three components: Scientific Study Program, User Support Program and Communications Program. The Montreal 2000 EV project involved the demonstration of 24 EVs (4 different types) and 30 charging stations in and around Montreal, Canada.

Overview of Montreal 2000 Project Participants and Electric Vehicles

Participants	Electric Vehicles
Bell Canada	2 Ford Rangers
Department of National Defense	1 Solectria CitiVan
Environment Canada	1 Solectria Force
Hydro-Quebec	8 Ford Rangers 1 Solectria Force 1 Ford TH!NK city
Les Services électriques Blanchette	1 Ford Ranger
Ministère des Transports du Québec	2 Ford Rangers
Canada Post	1 Solectria (conversion)
Transport Canada	1 Solectria Force 1 Ford Ranger
City of Montreal	2 Ford Rangers
Ministère des Transports du Québec	2 Ford TH!NK city
Total	24

Boundaries and Scope of Reporting in the SMART for the Montreal 2000 EV Project and Benchmark (Gasoline Internal Combustion Engine (ICE) Vehicles)



Activities upstream from the electric vehicle operation were aggregated to simplify reporting (based on element specific information). Transmission and distribution losses (5% and 2.5%, respectively) were reported, however, SF_6 emissions were not reported because data was not available for Canada (as well, based on US estimates SF_6 emissions were estimated to be insignificant). EV charging station losses were also reported (2.5%).

Activities upstream from the operation of the gasoline internal combustion engine (ICE) aggregated to simplify reporting (based on element specific information).

Overview of M&R

The M&R parameters for EV Performance that were assessed during the project include: energy consumption, usage (range, seasonal variation, driver attitudes, etc.), traction energy, regenerative braking energy, DC and AC charging, static loss, intensity of current entering/exiting batteries, voltage of batteries, vehicle speed, exterior temperature, and EV reliability. The M&R parameters for the EV charging station performance that were assessed include charging frequency and losses. Various data collection systems were used including on-board logs, on-board data systems and surveys.

The benchmark is being assessed in the SMART using standard references (ex. Intergovernmental Panel on Climate Change (IPCC), Environment Canada, etc.) for emission factors and methodologies for ICEV operation and upstream gasoline production and distribution. Upstream activities from vehicle production (ex. materials production) are being assessed using life cycle engineering databases.

Summary and Next Steps for the SMART

The experience with the SMART road test will be used to refine the SMART protocol for application to the remaining ~80 TEAM projects during next 2+ years. TEAM is establishing the necessary administrative infrastructure to contract pre-qualified contractors to complete the SMART reports.

By focusing on basic M&R principles and following a logical approach, the SMART protocol has proven to be easily customized in terms of breadth and depth of GHG reporting. On that basis, as well as TEAM's commitment of continued collaboration, the SMART has been adapted, or is being adapted, by other climate change initiatives.

Thomas Baumann is the Project Verification Officer for the Government of Canada's Climate Change Technology Early Action Measures (TEAM) Initiative, a $100 million government fund that includes 83 projects funded to date (1998-2002) with a total investment of more than $700 million. His main responsibilities within TEAM include (i) screening GHG reduction estimates of TEAM project proposals and (ii) developing and implementing the System of Measurement And Reporting to TEAM (SMART) at the conclusion of TEAM projects. Mr. Baumann holds degrees in environmental economics and environmental engineering.

5. PREPARED DISCUSSION ON DRAFT STANDARD FOR THE QUANTIFICATION OF CO2 EMISSION CREDITS

James R. Fancher, Consultant

My comments address primarily Mr. D'Aquanni's presentation as to the calculation and/or monitoring of actual CO_2 emissions from fuel combustion systems.

In fuel combustion systems, stack instrumentation can, in principle, detect the <u>concentration</u> of a gas, including CO_2; however, because such locations usually present a rather hostile environment, it may be difficult, especially with sensitive equipment, to maintain the accuracy of such monitoring over a long period. The real difficulty with such measurement, however, is that to convert concentrations to physical emission quantities, one needs mass flow information, and mass flow is very difficult to quantify in large systems. (Internal combustion engines may be an exception to this rule.) Such an approach is almost certain to have a very large error band.

In contrast, there are well developed, standardized techniques for fuel analysis, which are repeatable with quite good agreement. In some fuel contracts, split sampling is done routinely to serve as evidence that specifications are met. In general, carbon content can be resolved via such analyses within plus or minus 5% for coal, and probably within a narrower band for liquid or gaseous fuels. Moreover, the physical quantity of fuel is easily measured (and indeed is a basic economic parameter, i.e., quantity of fuel times delivered unit price equals cost of fuel consumed, adjusted if necessary for spillage or other losses), so that the generating entity always knows how much fuel it has used. Since the "ultimate analysis" of fuel identifies the total amount of carbon, and since efficient generation converts nearly all of the carbon to CO_2, the weight of CO_2 emitted can be calculated with very good precision—the primary source of error being the analytical one, as described above. The only other variable one might wish to quantify is the time over which the emission takes place, i.e., over what interval the fuel was used. Unit characteristics have almost no effect on the quantity of CO_2 emissions.

When one is accounting for the emission from a group of generating units, or an entire system, the problem is complicated by the continuously changing mix of different sources of generation; obviously, more gas and less coal will result in lower carbon emissions, and the presence or absence of nuclear, hydro, renewables, etc. can shift the system emissions substantially, even if averaged over periods approaching a year. One would certainly prefer NOT to use a "plug number", even if derived through sophisticated modeling, for such emission calculations. It is actually quite feasible to determine the emissions for a system on a near-real-time basis: The inputs are the fuel analyses for each unit (inputted manually, and updated each time a sample is run); and the fuel flow rate for each unit (in practice, this would be derived from the instantaneous megawatt output and the heat rate; in fact, if a heat rate curve showing fuel efficiency as a function of load is available for a unit, this function could be built into the calculation). The instantaneous CO_2 emission rates could then be determined for each unit and summed for the entire system. These instantaneous emission rates could be integrated over time to get the physical quantities emitted from the system in any desired interval. Some of the data inputs to this system are obviously proprietary, and because of the potential for competitors to derive useful information from unit-by-unit emission data, most operational entities would probably prefer to issue the results for their systems as a whole, over a sufficient interval to make disaggregation difficult. Nonetheless, independent audit could be facilitated by the record-keeping capability of a computer-based installation such as this. Such an installation would also permit "environmental dispatch" if that becomes an objective for a particular system or control area.

Obviously, this proposal is somewhat simplified, and automated recording would probably be uneconomical for small systems, isolated units, industrial boilers and the like. Even in those cases, however, working from the fuel analysis and fuel usage will likely provide greater accuracy and simpler determination of emissions than any kind of metering of CO_2 concentrations.

One important footnote is necessary: For emissions other than CO_2, the problem is more complex: In particular, very little of the NO_x emitted from combustion systems is dependent on fuel nitrogen; most of the

N_2 is supplied by combustion air, and the combustion conditions determine how much is oxidized. Such emissions may therefore vary considerably with load changes, operating temperatures, weather conditions and other factors. For sulfur oxides, there may be significant sulfur residues trapped in the ash, so that assuming total conversion of fuel sulfur may overstate the emissions. We generally assume that hydrocarbon emissions, including emissions of pure carbon (soot), are negligible—efficient operation of units, which is an implicit goal of generating entities, seeks to squeeze the maximum energy from the fuel, implying complete combustion--, but this may not be the case for Diesel generation, nor for older combustion technologies [small stokers, for instance, particularly if burning mixed or wet fuels, such as municipal or industrial wastes, bagasse, shredded tires, wood chips or the like], and start-up or upset conditions may also disturb this relationship for some combustion systems.

None of the above is intended to detract from otherwise excellent papers, but simply to clarify the best method of determining CO_2 emissions.

James R. Fancher was awarded a B.S. degree in Electrical Engineering, Iowa State University, 1956, and a M.B.A. degree, University of Chicago, 1963. He has been a P.E. in Illinois since 1968.

He retired from Commonwealth Edison Co. (now a unit of Exelon Corporation) in December 1992, after approximately 30 years service. His assignments for Commonwealth Edison include: Assistant to the Manager of Quality Assurance, 13 years; Fuel Agent (directing purchases of coal and petroleum fuels for generation, and, for part of the time, purchases of nuclear fuel and services), 3 years; Director of Air Quality / Environmental Engineer, 7 years; staff assistant in various executive offices, total of 2-1/2 years; engineering assignments in distribution, field engineering, substation and generating station design, etc., 6 years; other miscellaneous assignments and training. He taught company-sponsored classes in electronics and in engineering economics; served on corporate-level committees and task forces in environmental, nuclear research and development, emergency preparedness, and public relations areas; testified on behalf of the company in several contractual lawsuits, one court proceeding for injunctive relief, and numerous administrative hearings before regulatory bodies including the Illinois Commerce Commission, Illinois Pollution Control Board, and Atomic Safety and Licensing Boards. As a direct result of his work in the environmental area, the Illinois Supreme Court in 1974 remanded the statewide Sulfur Dioxide emissions regulations to the Illinois Pollution Control Board for further consideration of the projected economic impact of those regulations.

Previous to his tenure at Commonwealth Edison, Fancher was employed for six years as an electronic circuit designer, specializing in design of HF, VHF and UHF radio transmitters, receivers, power supplies and auxiliaries, and also facsimile transmitting and receiving equipment. From 1997-1999, he was a part-time consultant providing quality assurance services to a small engineering firm which primarily supplied nuclear-related engineering services.

6. GUIDE TO UK EMISSIONS TRADING SCHEME

Colin Beesley, Head of Environmental Strategy, Rolls Royce, Derby, UK

A brief report on the experience of Rolls-Royce Plc with the UK Emissions Trading Scheme (ETS) is given below. The report reflects a personal view rather than the approved company position. A summary of the UK ETS is provided at the end of the report.

The first point is that the UK ETS has to be seen in the context of other greenhouse gas emissions initiatives that are in place or emerging which have a direct effect on UK businesses.

The most important of these is the Climate Change Levy (CCL) that in effect is an approximate 15% tax on the use of energy by business. Certain energy intensive industry sectors have entered into agreements with the UK Government whereby they receive an 80% rebate from the CCL in exchange for specific emissions reduction targets (e.g. 15% CO2 reduction per tonne of product over 10 years). For competitive reasons, these agreements are through trade associations, covering sectors, rather than with individual companies.

UK businesses organizations, principally the Confederation of British Industry (CBI) and the Advisory Committee on Business and the Environment (ACBE) argued for an emissions trading scheme to help businesses meet their emissions reduction obligations in the most cost-efficient manner. The UK emissions trading scheme that emerged is a complex one, based on the objective of trading in an absolute cap regime with traders with specific reduction targets.

Rolls Royce has a negotiated agreement through the Society of British Aerospace Companies (SBAC) for a very small proportion of its energy use, which qualifies for such an agreement (the Integrated Pollution Prevention and Control (IPPC) regulations), but because they were not considered to be "energy intensive" their CCL agreement is on an absolute emissions reduction basis. The vast majority of their energy use is not included in this agreement, so they pay 100% CCL on this, the net effect is a cost of £2-3m p.a.

To ensure there were enough players in the UK ETS and there were sellers as well as buyers, and to allow those with negotiated specific agreements to participate, an incentive scheme was included in the UK ETS. Incentives, on a £/tonne of CO2 equivalent, were auctioned in exchange for businesses taking on an absolute emissions reduction target. The baseline was set as a three-year average and emissions reduction over the 2002-2006 period, effectively giving a diminishing emissions allowance, which cannot be exceeded in each of 5 successive years. This auction took place in March 2002 and resulted in a price of £53.26/tonne of CO2e. Rolls Royce successfully bid for a very modest amount. The complex and stringent penalty clauses in the ETS agreement meant that Rolls Royce took a very conservative position. Rolls Royce only bid for emissions reductions that they were very confident they would be able to achieve over a very uncertain 5-year horizon. They have so far not traded any of their emissions allowance. Early trading has been hampered by the need for emissions baselines to be externally verified, a process which has taken longer to complete than was anticipated. It is understood that some early trades took place at the £5-6/tonne level, and that recently this price has been rising to over £10, due to the shortage of sellers allowed to trade, due to the slowness in verification.

Rolls Royce's main incentive for joining this scheme was to gain experience of this strategically important financial mechanism for the reduction of greenhouse gases. They consider that emissions trading could be a very influential factor in the markets in which all of their businesses operate in the years to come.

A particular concern is the compatibility of the current UK ETS with the EU scheme that has been proposed and is likely to supersede the UK scheme.

SUMMARY – UK EMISSIONS TRADING SCHEME

The following summary is extracted from the document entitled “A Summary Guide to the UK Emissions Trading Scheme” issued by the UK Department for Environment, Food and Rural Affairs (DEFRA).

The UK emissions trading scheme is a new policy initiative which forms part of the UK Climate Change Programme. Emissions trading is an approach designed to allow greenhouse gas emission reductions to be made in the most economically efficient manner. Emissions trading is already being developed internationally – it is a central part of the Kyoto Protocol, and the European Commission has proposed that EU-wide trading at company level should start in 2005. The UK Government has set up a UK emissions trading scheme that started in the Spring 2002. This allows UK business and other organizations to get early experience of emissions trading. It is the world's first economy-wide greenhouse gas trading system.

How does it Work?

An emissions trading scheme is a way of setting an overall target covering a group of organizations, and then letting those participants decide in a flexible way how to achieve their own target. Because greenhouse gases have the same environmental impact regardless of where they enter the atmosphere, it doesn't matter how much individual organizations emit, as long as the overall target is met. Participants can either: *meet* their target by reducing their own emissions; reduce their emissions *below* their target and sell or bank the excess emissions allowances; or let their emissions remain *above* their target, and buy emissions allowances from other participants.

The best strategy will depend on the price of allowances in the market compared to the costs of making emission reductions. Across the whole scheme, those with lower cost emission reduction opportunities will tend to sell allowances to those with higher cost options thus reducing the overall cost of delivering the environmental benefits. The wider the participation in the scheme the greater these cost reductions are likely to be.

Who can Participate?

The UK emissions trading scheme is a voluntary scheme that started in April 2002. There are four main ways in which participants may enter:

(i) The Government has agreed to provide a financial incentive for organizations that agree to take on voluntary targets for a five-year period 2002-2006. Up to £215 million has been made available, equivalent to £30 million per year after tax. Participating organizations will be required to make absolute reductions in emissions against a 1998-2000 baseline. The targets and the level of incentive payment will be set through a competitive bidding process. Each participant was able to bid in absolute levels of emission reduction at prices set through an auction held in January 2002. The Government is aiming to obtain the maximum level of reductions for the incentive money. Organizations successfully bidding in the auction have to deliver five equal annual emission reductions to qualify for their incentive payments.

(ii) Companies which already have emission or energy targets set through the Climate Change Agreements will be able to use the trading scheme either to help meet their target or to sell any over-achievement if they can do better than their target. Many of the targets set through the Climate Change Agreements are efficiency targets – i.e., relative rather than absolute emission caps – so trading by these companies will be subject to certain restrictions. A "gateway" will control the flow of allowances from this sector into the rest of the trading scheme.

(iii) Organizations are able to undertake emission-reduction projects and sell the resulting credits into the scheme. Other participants to meet their targets can then use these credits. A project must be additional to emission reductions that would have been delivered under business as usual.

(iv) Anyone who does not want to enter the scheme on the basis of an emissions target or an emissions reduction project can simply open an account in the registry to buy and sell allowances.

Who can apply for the Financial Incentive?

The incentive is available to most businesses and other organizations that are responsible for greenhouse gas emissions within the UK, although some emission sources are not eligible. Ineligible sources include emissions already covered by a Climate Change Agreement and those from electricity generation for usage off-site. Some additional restrictions are set out in the framework document for the scheme. It is possible for a participant to take on a target based on emissions from one or more other organizations. An energy services company, for example, could join the scheme by taking a single target covering emissions from a number of client sites.

Reporting Emissions

A participant's emissions include both direct emissions – such as those from fossil fuel combustion or other industrial processes – and indirect emissions associated with energy usage. In this way all measures that reduce energy use or emissions will contribute towards delivering the target reductions. Each participant needs to measure and report their initial (baseline) emissions and their annual emissions according to the Government's reporting guidelines. All reported emissions are subject to independent third-party verification.

Allocating Allowances and Credits

Organizations, which received the financial incentive, have emission targets covering each annual compliance period. Organizations are allocated emissions allowances equal to this target each year, provided they have been in compliance in the previous year. For the first year of the scheme, organizations received allowances for the compliance period January to December 2002 in April 2002. For subsequent years, allocation of at least some allowances may be made earlier than this. At the end of each compliance year, organizations have a three-month reconciliation period to compile their verified emissions report and to undertake any further trading necessary to meet their target. By the end of this period each participant will have demonstrated to the Government that it has sufficient allowances to cover all of its emissions. This form of emissions trading is called “cap and trade”.

Companies that entered the scheme through the Climate Change Agreements do not receive allowances up front. At the end of each “milestone year” in which they have targets (every second year starting from 2002) they will receive allowances if they have beaten their target, or they will be able to buy additional allowances if they have not achieved their target. This form of emissions trading is called “baseline and credit”. Emission reduction projects only receive credits after the emission reductions have been verified. The rules for projects are being developed separately to those covering the rest of the scheme but the Government hopes to allow projects to start as soon as possible after the trading scheme is up and running.

Trading Allowances

All allowance holdings are recorded on a computerized registry. All target-holders have a compliance account in the registry for their allowances issued by Government. Following each compliance period the Government will check the total holdings in each compliance account and all allowances needed to cover emissions over the preceding year. There is no restriction on banking up to 2007. Participants with absolute emissions targets are able to bank any over-achievement of their own target into the Kyoto Protocol commitment period starting in 2008.

Trading emission allowances is no different from trading any other commodity. Anyone who holds an account in the registry will be allowed to buy and sell allowances. Participants in the scheme are able to trade directly between themselves or through third party brokers.

Compliance

If a trading scheme is to deliver the expected environmental benefit there must be a robust compliance mechanism to ensure that it is always preferable for participants to buy allowances rather than miss their targets. The scheme is equipped with penalties that are sufficiently strong to ensure it operates effectively but are not disproportionate for a voluntary scheme. A participant must be able to demonstrate that it is in compliance in order to receive an incentive payment and a full allocation of allowances the following year.

What is needed to join the Scheme?

There were several stages leading up to the start of the scheme: August 2001: Framework document and reporting guidelines published; August 2001 to Pre-registration period to prepare bids for financial December 2001: incentive; January 2002: Registration and auction to allocate incentive money; April 2002: Scheme started. Anyone that applied for the financial incentive had been ready to take part in the auction in January 2002. To do this they needed information on their baseline emissions over the period 1998-2000, and on the expected cost of emission reductions below this baseline. Before they started to calculate their baseline data they needed to ensure that they were eligible to participate in the scheme. They also needed to have a list of all the emission sources that they brought into the scheme, compiled in line with guidance in the framework document and approved by Government.

Organizations who were interested in participation contacted the Government during the pre-registration period to confirm the details of their application and to get their list of emissions sources approved. In addition, if an organization wanted to bring emissions not covered by the Government's reporting guidelines into the scheme then it had to ensure that a suitable protocol to measure and report these emissions was developed and approved.

Although there was no obligation to have baseline data fully verified in time for the auction, a participant entering the scheme via the financial incentive route needed to submit verified baseline data before it could receive its first allowance allocation. The Government therefore recommended that organizations started to engage an independent verifier to confirm their baseline emissions data as soon as possible. A list of potential verifiers was provided by the United Kingdom Accreditation Service (www.ukas.co.uk).

Companies in Climate Change Agreements did not need to take part in the registration process described above. Their first step was to open an account in the registry anytime after the registry opened in April 2002. They then were free to start buying allowances. Any allowances placed in this account contributed towards their targets. If they beat their target, they need to have their performance verified at the end of the milestone periods before any allowances will be issued into their account. The rules for emission reduction projects are still being developed. When these rules are in place project owners will be able to start the process of gaining approval for their proposals.

Any other participants who wished to buy or sell allowances in the scheme are free to open an account in the registry anytime after April 2002.

Information about the Scheme

Additional information can be found in the framework document and the reporting guidelines. Alternatively, general enquiries may be made to: UK Emissions Trading Scheme, Global Atmosphere Division, Department for Environment, Food and Rural Affairs (DEFRA), 3/F3 Ashdown House, 123 Victoria Street, London SW1E 6DE, UK, Tel: +44 20 7944 5933, Email: ets@defra.gsi.gov.uk

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