IEEE POWER ENGINEERING SOCIETY
ENERGY DEVELOPMENT AND POWER GENERATING COMMITTEE
International Practices Subcommittee

PANEL SESSION: EXPERIENCE WITH COMPETITIVE SMALL-SCALE RENEWABLE PROJECTS THAT LIMIT GHG EMISSIONS

Sheraton Hotel; Room Cinema 1; July 16, 2003, 2:00 pm to 5:00 pm

EXTENDED FULL LENGTH PAPERS[#]

Chair: Jim McConnach, Chair CCWG, Ontario, Canada**:** jsmcconnach@ieee.org
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Track 5: Developments in Power Engineering Technologies

This Panel Session discussed Experience with Competitive Small-Scale Renewable Projects that Limit GHG Emissions. Eminent Panelists discussed and looked at the business case, review and approvals process, financing, CO2 and other environmental credits, technology description, and performance of projects. The panel covered success stories, hurdles, lessons learned and barriers encountered in the development and implementation of such projects.

Panelists and Presentation Titles:

1. John Warren, City of Toronto, Canada; "City of Toronto Integrated and Renewable Energy Perspective"
2. Dennis Fotinos, Enwave, Ontario, Canada; "Deep Water Cooling"
3. Richard T. D'Aquanni, Applied Resources Group Inc., USA; "The New England USA Experience with Competitive Small-scale Renewable Projects that Limit GHG Emissions"
4. Thomas Baumann, TEAM Operations Office, Natural Resources Canada; "TEAM's Experience with Renewable Power Technology Demonstration Projects"
5. Philipp Andres, Vestas - Canadian Wind Technology, Ontario, Canada; "Port Albert Wind Farms Ltd., Single Vestas V47-660kW Wind Turbine Installation"
6. Ivor da Cunha, Emerging Energy Technologies, Kinectrics Inc., Toronto, Ontario, Canada; Prepared Discussion: "Capitalizing on Renewable Energy through Distributed Generation"

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 J. S. McConnach, Chair, Climate Change Working Group (CCWG), Ontario, Canada; and T. J. Hammons, Chair of International Practices for Energy Development and Power Generation, University of Glasgow, UK.

Tom Hammons, and Jim McConnach moderated the Panel Session

[#] This document has been prepared and edited by Tom Hammons, Chair of International Practices for Energy Development and Power Generation, University of Glasgow, Glasgow G12 0PZ UK.

The first presentation was entitled: City of Toronto Integrated and Renewable Energy Perspective. John Warren, Director of Environmental Services in the Works and Emergency Services Department, City of Toronto, presented it.

The City of Toronto energy perspective currently includes: integrated energy as a concept crucial to Waterfront Revitalization; potential co-generation opportunities related to sewage treatment plant and landfill operations; working with other agencies groups and City decisions to establish wind turbines on the Waterfront; and an emerging cooperation with the private sector to investigate local applications for stationary fuel cells. These perspectives were discussed and evaluated.

John Warren, throughout his career, has linked environmental and sustainability issues to municipal practices, projects and policy making. In Ontario, he has worked for Proctor Redfern and the cities of Toronto, Hamilton, St. Catharines and Windsor. At Proctor Redfern he developed and implemented the first full service waste management contract in Ontario for the Region of Hamilton-Wentworth, including the construction and operation of the landfill and the operation and upgrading of the SWARU facility. In St. Catharines he brought in the first mechanical MRF facility in Ontario. Currently, he is responsible for departmental and corporate environmental strategy and planning, conducted through offices charged with air quality improvement, energy efficiency, soil and water quality and environmental planning and support.

The second presentation was about Toronto's Deep Water Cooling Project. It was prepared by Dennis Fotinos, Chief Executive Officer, Enwave District Energy Ltd., Toronto, Canada and was presented by Kevin T. Loughborough, Vice President – Major Projects at Enwave District Energy Limited

Deep Lake Water Cooling is based on a very simple physical property of water: water is heaviest at a temperature of 4° C, and is lighter at temperatures above and below this. As a result, any deep body of water will have a permanent layer of cold water (4°C) at a depth of 83 meters, called the "hypolimnion", and this layer is renewed every spring and fall as the surface is warmed and cooled with the seasons. When the surface hits this critical 4° C temperature, the water sinks, and adds to the existing cold layer. This layer can provide a permanent renewable source of totally natural cooling.

The Deep Lake Water Cooling project will involve the construction of three new HDPE intake pipes extending 5 kilometers into the lake from the City of Toronto's Island Filtration Plant and ultimately reaching a depth of 83 meters. When completed, it will be one of the most unique environmental and engineering achievements anywhere in the world. The project is estimated to cost about $175 million. It is anticipated that it will be completed by the spring of 2004. The project will eliminate over 40,000 tons of CO2 from Toronto's air shed annually, by dispensing with the need of CFC based chillers and the corresponding decrease in demand for coal fired electricity. Dennis Fotinos discussed the technology, environmental assessment, the distribution system, benefits to the owner/manager, and what the future holds.

Dennis Fotinos: is President and Chief Executive Officer of Enwave District Energy Limited- one of the largest district energy companies in North America. Prior to joining Enwave District Energy, Mr. Fotinos served as a member of Toronto's City and Metro Councils for almost nine years. As an elected official, Mr. Fotinos held numerous senior positions chairing both Standing Committees of Council and Special Purpose Task Forces that brought about important changes for the citizens of Toronto.

Mr. Fotinos has served on numerous Boards and is currently serving on the Board of Directors of the Canadian District Energy Association, the Geothermal Exchange Coalition, the Ontario Lung Association and the Chairman's Advisory Council for Habitat for Humanity, Toronto Chapter.

Kevin T. Loughborough has held the position of Vice President – Major Projects at Enwave District Energy Limited since January 2000. He joined Enwave in 1998 as Director of Engineering and Construction after 17 years with the Metropolitan Toronto Works Department. He represented the Metro Commissioner of Works on the Deep Lake Water Cooling Investigation Group. He authored the report to Metro Council that recommended authority be granted for Metropolitan Toronto to enter into an agreement with Enwave to develop the Deep Lake Water Cooling project which incorporates Toronto Water Supply infrastructure. He has directed the work of consultants designing the deep lake water cooling project and is now involved in the construction phase of the project working with the general and sub contractors.

The third presentation was entitled: The New England USA Experience with Competitive Small-scale Renewable Projects that Limit GHG Emissions. Richard T. D'Aquanni, President and Founder of Applied Resources Group Inc., USA, a 22 year old utility consulting and Systems Integration Corporation, presented it.

The two traditional methods of reducing power plant emissions by natural gas conversion and by installing emission control equipment will most likely fall short of Climate Change control expectations resulting in a greater dependence on clean electric generation from renewable energy technologies.

The first question the presenter addressed was whether this new renewable generation will take place on the supply or on the demand side of the customer meter. Examples of both were given along with the barriers and possible solutions that allow us to apply what we learn to maximize the future utilization of renewable energy for power production.

There are too many barriers to the viability of large renewable energy projects in urban areas such as the North East USA. The presenter discussed the numerous small-scale renewable energy projects that he believes, with the right infrastructure, can result in measurable GHG emission reductions.

Richard T. D'Aquanni studied estimation and control theory at Harvard University. He is a Senior Member of IEEE and is a registered professional engineer in Massachusetts and in California. Currently he is a consultant to the Massachusetts Renewable Energy Trust and to corporations that are studying and implementing renewable energy projects. Clients in 2003 include the Cambridge Savings Bank in Massachusetts, The Energy Counsel (TEC-RI) in Rhode Island and VESTAR, a CINERGY company, with projects in Connecticut.

The penultimate presentation discussed the Technology Early Action Measures Initiative's (TEAM)'s Experience with Renewable Power Technology Demonstration Projects, a $95 million government fund that includes 96 projects funded to date (1998-2003), creating a total investment of more than $945 million. The experience is a proving ground and stepping-stone to accelerate market acceptance of GHG mitigation technologies and build capacity to create verifiable GHG emission reductions. It was presented by Thomas Baumann, TEAM Operations Office, Natural Resources Canada.

The presentation began with an overview of how TEAM works, and a review of TEAM's renewable power projects. It focused on the evolution of GHG accountability in TEAM, including lessons learned and recommendations to proponents regarding measurement and reporting.

Based on TEAM's experiences developing and implementing various elements of GHG accountability, the presenter concluded that one must think multidisciplinary expertise (e.g. GHG, technical, environmental, auditing, etc.), think GHG verifiability (e.g. guiding principles of accuracy, completeness, transparency, etc.), build capacity for GHG projects (e.g. create network of experts, learn what to do and stay informed

because things change, have the tools to do it, etc., have a plan to address project and targets (e.g. CDM PDD, M&R plan, etc, and develop an approach to deal with confidentiality issues (e.g. NDAs, trusted partners, etc.)

Thomas Baumann is the Chief of Greenhouse Gas Measurement & Reporting for the Government of Canada's Climate Change Technology Early Action Measures (TEAM) Initiative. His main responsibilities include developing and implementing the System of Measurement and Reporting to TEAM (SMART) to evaluate the GHG performance claims of TEAM projects. He completed degrees in environmental economics and environmental engineering and was a consultant with The Delphi Group (1998-2001. He is engaged as a reviewer and contributor for GHG programs and protocol development.

The final presentation was entitled: "Port Albert Wind Farms Ltd., Single Vestas V47-660 kW Wind Turbine Installation". Philipp Andres, President, Port Albert Wind Farms Ltd., Ontario, Canada, made it.

Ontario has the potential to install 3,000-4,000 MW of wind energy capacity along the shoreline of the Great Lakes and with modern larger turbines of 2 MW and more, and tall hub heights, the agricultural land base further inland can also be developed in the near future. Success will largely depend on how serious various levels of government will be in tackling GHG emissions and recognizing the substantial contribution wind energy can make towards GHG reduction. This was evaluated.

Philipp Andres is Senior Vice President and General Manager of the Canadian subsidiary Vestas Canadian Wind Technology, Inc. and Vice President Business Development for the US subsidiary Vestas American Wind Technology, Inc. He is also the President of Port Albert Wind Farms Ltd., which is involved in the development of wind farms along the Lake Huron shoreline.

Mr Andres graduated from Sissach Agricultural college in Switzerland in 1976 and moved to Canada in 1979. He worked in the agricultural industry in the 1980s and managed a large scale alfalfa dehydration facility in the Kincardine area. This was followed by the installation of a small wind turbine and Ontario's first utility scale wind turbine (a 600 kW wind turbine installed adjacent to the Bruce Nuclear Power Facility). Later, Philipp worked with the German manufacturer Tacke Windtechnik (now GE Wind, a division of GE Power Systems) and since 1997 for the world's largest manufacturer of wind turbines, the Danish company Vestas Wind Systems A/S.

There was also a prepared discussion on "Capitalizing on Renewable Energy through Distributed Generation" by Ivor da Cunha. He is currently the Director of Business Development for Emerging Energy Technologies at Kinectrics Inc. in Toronto, Canada. His areas of experience include, distributed generation, energy policy and strategies, renewable energy, and emerging energy equipment.

Each presentation is summarized below:

1. CITY OF TORONTO INTEGRATED AND RENEWABLE ENERGY PERSPECTIVE

John Warren, Director Environmental Services, City of Toronto, Canada

SUMMARY

The City of Toronto energy perspective currently includes as part of its focus particular efforts with respect to energy efficiency and related standards; Integrated Energy as a concept crucial to Waterfront Revitalization; potential co-generation opportunities related to sewage treatment plant and landfill operations; working with other agencies groups and City decisions to establish wind turbines on the Waterfront; and an emerging cooperation with the private sector to investigate local applications for stationary fuel cells.

Significant initiatives such as the Better Buildings Partnership (BBP) and research and development of enhanced energy efficiency standards are currently proceeding through the mandate of the City's Energy Efficiency Office.

The Toronto Waterfront Revitalization Corporation, with the City, and its federal and provincial government partners, is proceeding with the further development and business case analysis for the Integrated Energy Concept for the Central Toronto Waterfront. This concept combines high or ultra high energy efficiency standards with energy supply technologies that will reduce the greenhouse gas emissions and other pollutants associated with energy generation, such as deep lake water cooling, co-generation/district heating, solar and wind power. It will also provide security of energy supply to the Waterfront and Toronto through local energy production.

Successful implementation of the Integrated Energy Concept is dependent upon application of the Comprehensive Coordinated Infrastructure Approach. This means that infrastructure for energy, water and wastewater, transportation transit, waste management and telecommunications/information technology should be integrated into a package for its planning, development and implementation. The intent of the approach is to plan strategically on the basis of a 25 to 30 year build out period, emphasize comprehensive thinking and coordination, integrate energy infrastructure and soil and groundwater remediation into infrastructure planning, and focus on potential area-wide approaches, phasing and sequencing.

The success of the Integrated Energy Concept and the Comprehensive Coordinated Infrastructure Approach is dependent upon the application of a Waterfront environmental assessment process that meets federal and provincial requirements, and a Coordinated Public Consultation Process.

The City currently has one Waterfront wind turbine established by the Toronto Renewable Energy Cooperative (TREC), and has significant experience to share now with respect to municipal planning approvals considerations, federal environmental assessment and the community response to such proposals. The City is also engaged in initial investigations with the private sector to develop pilot projects for the establishment of local stationary fuel cell applications.

A current concern for the City is the potential impact of Ontario electricity re-regulation on energy efficiency initiatives and Demand Side Management, and alternative energy sources.

John Warren holds a Bachelor's Degree in Civil Engineering from the University of Manchester Institute of Science and Technology and a Master's Degree in Civil Engineering from the University of Windsor. He is a registered Professional Engineer in Ontario, a member of the British Institution of Civil Engineers, New Zealand Institute of Professional Engineers and is a Chartered Engineer registered by the British Engineering

Council. Throughout his career, he has linked environmental and sustainability issues to municipal practises, projects and policy making.

John has worked as a municipal engineer in both the private and public sectors in New Zealand and Ontario. In New Zealand he was responsible for the design, construction and operation of an innovative water treatment plant that included engineering measures to address the effects of sea level rise due to climate change.

In Ontario, he has worked for Proctor Redfern and the cities of Toronto, Hamilton, St. Catharines and Windsor. At Proctor Redfern John developed and implemented the first full service waste management contract in Ontario for the Region of Hamilton-Wentworth, including the construction and operation of the landfill and the operation and upgrading of the SWARU facility. In St. Catharines he brought in the first mechanical MRF facility in Ontario.

As Director of Environmental Services in the Works and Emergency Services Department of the City of Toronto, John is responsible for departmental and corporate environmental strategy and planning, conducted through offices charged with air quality improvement, energy efficiency, soil and water quality and environmental planning and support.

John is a voting member of the City of Toronto Sustainability Roundtable and its Waterfront Work Group. He is also the Works representative on the City of Toronto Waterfront Reference Group, responsible for City oversight of the Toronto Waterfront Revitalization. He is the City representative on the Steering Committee for Sustainability Toronto, a community university research alliance engaged in specific projects to move the City towards a sustainable future, and provided an advisory role to the Canadian Secretariat for the World Summit on Sustainable Development in 2002.

2. DEEP LAKE WATER COOLING

Dennis Fotinos, CEO, Enwave District Energy Ltd., Toronto, Canada

1. Introduction

As we enter the new millennium, our expectations with respect to ease and comfort become more and more refined, and former luxuries become necessities. Air conditioning is now taken for granted, and its use has steadily expanded: to our cars, our homes, and our offices and this has led to serious side effects. Electrical brown-outs due to larger air conditioning loads are now a regular complement to heat waves in parts of North America. CFC's used in chillers are blamed for destroying the ozone layer and coal generating stations used for electrical peaking are blamed for global warming and acid rain.

Currently, comfort has a steep environmental price and, with the ever-increasing frequency of electricity supply shortages in Ontario, escalating financial costs are not far behind. Peak electricity prices during the hottest days will hit unprecedented levels as supply tries to keep up with increased demand caused by global warming and economic growth. We are in a vicious spiral, which threatens how we all live and how we do business. However, with a commitment to renewable energy sources and improved conservation and efficiency measures the clock can be turned back.

Toronto is particularly fortunate in this regard because several renewable energy projects are being developed. The largest of these and, arguable the most innovative, is Enwave's Deep Lake Water Cooling (DLWC) project. Prominent environmentalists like Robert F. Kennedy Jr. have come to extol the benefits of this project, which will eliminate over 40,000 tons of CO2 from Toronto's air shed annually. Elimination of CFC based chillers and the corresponding decrease in demand for coal fired electricity, will mean that environmentally friendly cooling derived from Lake Ontario will be akin to removing 8,000 vehicles from Toronto's streets; it will displace enough coal fired electricity to light over 3,000 homes for one year. Finally, for cost conscious property managers, it will ultimately provide them with a mechanism to hedge against electricity price volatility and inevitable brownouts in the future. Like other renewable energy projects, DLWC can be the environmental and economic solution that property managers and City planners are looking for.

2. The Technology

Simple and elegant, Deep Lake Water Cooling is a technology whose time has come. It makes business sense and also has huge environmental benefits, because it uses 75% less electrical energy than conventional electric chillers.

Deep Lake Water Cooling is based on a very simple physical property of water: water is heaviest at a temperature of 4° C, and is lighter at temperatures above and below this. As a result, any deep body of water will have a permanent layer of cold (4°C) water at a depth of 83 meters, called the "hypolimnion", and this layer is renewed every spring and fall as the surface is warmed and cooled with the seasons: when the surface hits this critical 4° C temperature, it sinks, and adds to the existing cold layer. This layer can provide a permanent renewable source of totally natural cooling.

Lake Ontario is deep enough to have this layer of cold water, and scientists have concluded that it is renewable at a withdrawal rate of up to 10,000 cubic meters per second. The Deep Lake Water Cooling project being built by Enwave District Energy (formerly the Toronto District Heating Corporation) will draw about 5 cubic meters per second, giving a safety factor of about 200,000 %.

The Deep Lake Water Cooling project will involve the construction of three new HDPE intake pipes extending 5 kilometers into the lake from the City of Toronto's Island Filtration Plant and ultimately

reaching a depth of 83 meters. Colder, cleaner, algae-free water will then make its way through the City's filtration system and ultimately to the John Street Pumping Station where a series of large heat exchangers will accomplish the heat transfer that will supply environmentally friendly chilled water to Enwave's customers. When completed, it will be one of the most unique environmental and engineering achievements anywhere in the world. The project is estimated to cost about $175 million, and is expected to be completed by the spring of 2004.

3. History in Toronto

The physical principles of Deep Lake Water Cooling have been known for quite some time, and in the early 1980's research was carried out on Project Freecool, which involved cooling all of downtown Toronto with a lake water project with a capacity of 300,000 tons and a cost in the range of more than $600 million. That project unfortunately never saw the light of day, largely due to its massive scale, but the seed had been planted. The current project is smaller, at 52,000 tons of cooling (183 MW- enough to cool 21 million square feet of commercial office space), and has the added efficiency of using the existing City infrastructure and water system. This creative breakthrough has made the project bankable and thus economically feasible.

4. Environmental Assessment

An environmental assessment was carried out for the Deep Lake Water Cooling project in early 1998, with public meetings and a very thorough series of studies thermal characteristics, water quality, aquatic habitat, and other potential impacts on the natural environment. The Enwave project passed with flying colours and in record time. All environmental groups support this project as very beneficial to the environment.

5. The Distribution System

The Deep Lake Water Cooling project will be part of a district energy system covering the south part of downtown Toronto – from Toronto harbour into the heart of downtown Toronto. The definitive characteristic of district energy is that it replaces the heating and cooling plants in individual buildings with a central energy plant and a network of distribution pipes. In this case, the "central plant" will be Lake Ontario, and the energy will be provided by Nature, although the cold natural water will be stabilized and backed up by steam-driven chillers, which have already been installed and are currently cooling the Air Canada Centre, Steam Whistle Brewery, the telecom hub at 151 Front Street, One University and the Toronto Convention Centre.

Benefits to the Owner/ManagerThe chilled water provided by Enwave will be superior to the in-house chilled water product for a number of reasons:

- It will be more reliable. Enwave has a 20-year record of 100% reliability in its district heating business, and it will maintain the same level of performance in its cooling business.
- The owner will be able to reallocate the capital from an in-house plant to its core business and generate a superior return.
- The building manager can forget about the CFC problem, which is likely to become much more serious over the next few years. Situations could develop where existing cooling plants will simply have to shut down.
- Unsightly and expensive cooling towers can be removed or avoided altogether.
- Building owners may be eligible for CO2 credits should this regime be adopted by government.

- The building manager will have some extra space to rent after the in-house plant is shut down.
- The building will acquire a "green" image, which, may act as a differentiator to justify increased rents.
- DLWC will exceed by more than 100% the proposed City of Toronto building energy efficiency standards for cooling and other energy use.

6. Enwave's Deep Lake Water Cooling: the Product of the Future

In summary, the Deep Lake Water Cooling project has it all: it makes business sense, it is environmentally responsible, and it will be reliable. Customer contracts are being negotiated right now and several new landmark buildings are expected to join Enwave's expanding cooling network over the next few months.

Dennis Fotinos: was named President and Chief Executive Officer of Enwave District Energy Limited in March. 2001, one of the largest district energy companies in North America. This appointment came just over one year after first joining the company as Executive Vice President, Business Development where he implemented the marketing strategy that completed the transformation from non-profit to private sector corporation.

In his new role, Mr. Fotinos is positioning the company to expand its market share by focusing on core competencies to meet the changing needs of customers. He is overseeing the development of the company's signature Deep Lake Water Cooling Project and he has accelerated the process to find alternative fuel sources to reduce Enwave's steam production costs. These two initiatives will make Enwave the market leader in the generation of environmentally friendly heating and cooling energy in Toronto's downtown core.

Prior to joining Enwave District Energy, Mr. Fotinos served as a member of Toronto's City and Metro Councils for almost nine years. As an elected official, Mr. Fotinos held numerous senior positions chairing both Standing Committees of Council and Special Purpose Task Forces that brought about important changes for the citizens of Toronto.

Mr. Fotinos was educated at the University of Toronto where he received a Bachelor of Arts Degree in Political Science and International Relations and he is currently completing an MBA from the Kellogg School of Management/Schulich School of Business combined program.

Mr. Fotinos has served on numerous Boards and is currently serving on the Board of Directors of the Canadian District Energy Association, the Geothermal Exchange Coalition, the Ontario Lung Association and the Chairman's Advisory Council for Habitat for Humanity, Toronto Chapter.

Kevin T. Loughborough has held the position of Vice President – Major Projects at Enwave District Energy Limited since January 2000. A licensed Professional Engineer in the Province of Ontario, he graduated from Queen's University at Kingston with an Honours Bachelor of Science degree in Civil Engineering from the Faculty of Applied Science. He joined Enwave in 1998 as Director of Engineering and Construction after 17 years with the Metropolitan Toronto Works Department. Prior to that he worked with leading consulting engineering firms on municipal infrastructure projects. At Metro Works he gained specialized knowledge of water and wastewater engineering and an intimate knowledge of Metro water infrastructure and was closely involved in the development of the Metropolitan Toronto Carbon Dioxide Reduction Plan. Carbon Dioxide Emissions trading was considered as a means to facilitate the plan. He was a member of the interagency air quality committee that looked at setting new standards for air emissions from power plants and the transportation sector with specific attention to fine particulate emissions. He was a member of the blue ribbon committee that facilitated the introduction of the Drive Clean program in Ontario. He co-authored a comprehensive study of the potential for District Energy in Metropolitan Toronto. The

study looked at combined heat and power and deep lake water-cooling as means to substantially increase the efficiency of energy use in Toronto. He represented the Metro Commissioner of Works on the Deep Lake Water Cooling Investigation Group. The Group included representatives of Metro Toronto, the City of Toronto, Ontario Ministry of Environment, Ontario Ministry of Housing, Toronto Hydro and Federal Department of Natural Resources. He authored the report to Metro Council that recommended authority be granted for Metropolitan Toronto to enter into an agreement with Enwave to develop the Deep Lake Water Cooling project which incorporates Toronto Water Supply infrastructure. He has directed the work of consultants designing the deep lake water cooling project and is now involved in the construction phase of the project working with the general and sub contractors.

3. THE NEW ENGLAND USA EXPERIENCE WITH COMPETITIVE SMALL-SCALE RENEWABLE ENERGY PROJECTS THAT LIMIT GHG EMISSIONS

Richard T. D'Aquanni, PE, SMIEEE, Applied Resources Group Inc., Brookline, Massachusetts, USA

1. Introduction

While not necessarily the most cost-effective method, the increased production of electricity by renewable energy resources will result in the reduction in use of fossil fueled power plants and hence reduce world-wide emissions. In addition to resulting in the reduction of power plant emissions, renewable energy resources including wind, solar, geothermal, tidal, small hydro and bio-fueled generators are important for power supply diversity, and to increase, with limitations based on their specific intermittent operation, the reliability of customer operations throughout the US.

In the northeast region of the US the need for renewable energy resources are reinforced by: (i) a decline in the export of clean natural gas to the US from Canada due to falling production and an increase in Canadian demand; (ii) the number of mid-west US utility's to side step the US EPA's New Source Review legislation which would have otherwise ordered coal fired plant owners to invest in new emission controls when undertaking major renovations; and (iii) a need for customer installed back-up power to achieve "Internet Age" reliability by reinforcing the "Industrial Age" electric utility grid.

Two critical questions that need to be answered include the expected forms of the renewable energy to evolve and whether these forms will be sustainable? The form of the renewable energy resource includes the scale of the generator, often a function as to whether it is on the supply or demand side of a customer's electric meter. Compared to supply side renewable energy installations, demand or behind-the-meter renewable energy installations have the advantages of avoiding T&D losses and requiring proportionally less system reserves. Put simply, this implies that between 1.2 and 1.3 MW of supply side renewable energy technologies are needed to achieve the same smokestack emission reductions as installing a 1 MW behind-the-meter renewable energy generator.

Renewable energy has been successfully applied to serve remote and isolated telecommunication loads. World-wide applications include the on-site replacement of diesel for water pumping and rural electrification generation in remote locations. In the developed and densely populated areas it is appropriate to apply renewable energy to serve critical loads that are served by a failing grids. In the northeast these include IT, Telecom and any other critical load defined as those that require but fall short of receiving six 9s reliable power. Examples include the application of solar PV and fuel cell technologies to replace batteries in utility and IT/telecom installations.

The challenge of large supply-side renewable energy installations is their significant cost disadvantage compared to the lower cost and reliable performance of conventional fossil fueled generation. Likewise, the challenge of implementing behind-the-meter renewable energy technologies is their poor economic payback compared to electric utility rates. Specifically, even in states where Net Metering is legislated and where the size of a generator exceeds the off-peak load of a facility, the life cycle cost of a renewable energy project is more expensive than the avoided costs associated with generation and delivery. While advances in factory automation and improvements in efficiencies continue to improve the economics of renewable energy technologies and state and federal incentives help homeowners and businesses buy down installation costs, unsubsidized grid connected renewable energy projects continue to be uneconomical.

Examples of sustainable supply-side strategies include Green Power, Green Pricing and Renewable Portfolio Standard (RPS) programs that leverage certifiable Renewable Energy Credits (REC) using appropriate Wind, Bio-mass and Landfill Gas generation projects. Green Power programs include those by third party marketers that offer customers options in deregulated states where customers can choose their suppliers. Green pricing programs are those offered by utilities to their customers whether or not their state allows customers a choice.

RPS programs that have been mandated by state legislators in Massachusetts, Connecticut, Maine and other States require that increasing percentages of the load served by each Load Serving Entity (LSE) must be supplied by renewable energy resources. While increasing the renewable energy supply, this requirement should not undermine the need to select sites where the renewable resource is abundant and where projects are not opposed by vocal residents. In addition, there are other financial incentives that benefit the developer and subsequently the customer, referred to as Certificates, that allow the renewable energy generator to trade or to retire their attributes to others that go beyond their ability to produce electric energy used to operate lights and appliances.

The Renewable Energy Certificates (REC) and Tradable Renewable Certificates (TRC), also referred to as Green tags, green tickets and T-RECs, are sold separately from the electric energy commodity. The RECs have attributes which once certified can be traded across grids where electricity may have difficulty flowing. Their attributes include their clean, non-polluting and social features. Once verified they can be used to reinforce project development through consumer confidence in committing to a renewable power plant developer that issues them.

In that Certificates have value, there is a need to verify their value, their authenticity and track their ownership and the date when they're retired. The need to define a reasonably priced quantification method for verifying GHG emission reductions due to renewable generators, as well for verifying energy conservation and fossil fueled power plant emission reduction control projects, is precisely the intent of IEEE P1595, the International Standard under development to Quantify GHG Emission Credits. IEEE P1595 will be discussed later.

2. Appropriate and Sustainable Renewable Energy Projects

In addition to matching renewable energy power plants to a region's indigenous energy resources, market potential and social climate, the scale of a renewable energy generator is directly related to its location, i.e. on the supply or demand side of a customer's meter. Supply side generators can range from 10 to 200 MW while demand side generators might fall in the 3 to 500 kW range.

Given the current initiatives being facilitated in the northeast region of the US, it is difficult to forecast whether renewable energy generation will proliferate on one or both sides of the customer's meter. While both are in progress, numerous barriers, incentives and sustainable solutions add chaos to the development process.

The viability and sustained operational availability of renewable energy power projects are not to be taken for granted if we have committed to achieve concrete emission reductions. In today's risk adverse climate, renewable power plant financing is a lengthy process riddled with barriers. Examples include the uncertainties associated with a large scale 20 MW bio-mass plant using a gasification process which must comply with a poorly defined regulations, e.g. requiring an unproven low emission bio-mass conversion process, a risky investment even in good financial times.

Wind power generation in the form of farms are also risky investments, both from a wind resource perspective and from the social perspective when vocal and sometimes political Not In My Back Yard (NIMBY) proponents participate. Very few untapped landfill gas projects exist and a litigious landscape

waits the small hydro developer where the protection of fish is an issue. In the North East, one glimmer of hope exists where expansion of existing renewable generators are permitted to be included in the new renewable energy mix. In these vintage plant status situations, new renewable generation is defined by exceeding a base-line, established by the renewable plant's historic generation. Existing wood burning power plants that can operate at a higher Capacity Factor are examples of this more liberal definition of a new renewable resource under some RPS legislation.

3. Chicken and Egg or Supply-Demand Paradigm

Aside from the RPS that exists in the New England states of Massachusetts, Maine and Connecticut where a growing percentage of a power supplier's product is required to be derived from new renewable resources, another dilemma is the absence of infrastructure to match green buying cooperatives to green power suppliers. While one or two suppliers will meet the needs of a few customers the need for aggregations of green purchasers is apparent. While liberal funding has been awarded to such green aggregators in RI and MA, these mostly non-profits have failed to achieve their stated goal. In part this is do to the finite green marketplace but mostly do to their inability to engage a system that can manage conditional suppliers and purchasers as they opt in and out of the Green Power dance.

Fortunately some infrastructure is and more will soon be in-place in New England. Specifically the www.nepoolgis.com system has been developed by APX to assign emission Certificates including Renewable Energy Certificates (REC) to every generator that is dispatched in New England. In addition, each state with an RPS, i.e. Massachusetts, Connecticut and Maine, will also require reporting to insure that the correct percentage of load of each Load Serving Entity is complying with its RPS obligations. This system, similar to the Texas/ERCOT system, will oversea market trades within the region.

In addition and to the benefit of renewable plant developers in the ISO-NE region, the Massachusetts Renewable Energy Trust has introduced a competitive financial mechanism to guarantee the purchase of RECs at a uniform price over a 10 – 15 year period. This Partnership benefits new renewable suppliers in New England and purchasers of Green Power in Massachusetts. In addition to this attempt to minimize the uncertainty in the value of a REC, other barriers to large scale renewable energy supply projects in New England include the ending of PURPA contracts, protection of fish, retiring or exhaustion of landfills and NIMBY issues.

One barrier that the IEEE is addressing is the development of an International Standard to Quantify the GHG Emission Credit under IEEE P1595. To be discussed later the measurement, verification and certification to be defined by P1595 lies at the heart of insuring that the Certificates, e.g. RECs or TRCs, have value as the market grows from one region to multiple regions and from countries to continents.

4. Small is Beautiful

While MW sized wind generators will sprout up and produce wholesale electricity on ridges and along coasts around the world, there is good reason to believe that the significant amount of renewable energy development will result from low profile, easy to site, behind-the-meter generators. This is particularly true in the densely populated northeast USA where siting near to population centers is a concern. While frustrating to the wind or tidal farm developer, this is good news in that 1 MW of installed renewable energy on the demand side of a meter is able to reduce the same emissions as would a 1.2 to 1.3.MW supply side renewable energy project.

In the near term these behind-the-meter renewable technologies are advancing due to subsidies from the various "Clean Energy funds that exist. These include PV clusters and sustainable (LEED) building

grants as well as fuel cell and biomass initiatives. Unfortunately with poor payback periods they are unlikely to transform the marketplace before the Systems Benefit funding that supports them is either pulled into State coffers or dries up. One strategy that States have learned by doing is to assist project developers to leverage the full Federal Performance Tax Credit by awarding fewer buy down grants and more performance based awards. Not only does this provide more financial incentive to projects but is expected to increase the operational availability of viable projects.

The sustainable community is becoming a larger factor due to interest in voluntary organizations such as the *International Cities for Climate Protection program.* Such organizations facilitate appropriate and more sustainable renewable energy applications that promote the timely application of high visibility technologies, including solar. In Massachusetts, communities exist in the Berkshires, on Cape Cod and even in urban areas including Boston, Brookline, Cambridge and Somerville.

It is encouraging to observe the recent inclusion of renewable energy projects in current Performance Contract programs by Energy Savings Company (ESCO). These are becoming more routine as a means of differentiating the products of a company from others, especially in US Federal Energy Management Commission (FERC) programs that address Federal facilities.

In addition, a major thrust is beginning to take shape within the utility marketplace. Whether bundled or not, the DISCO side of the electric business is always looking out for products that bring them closer to their customers especially as DSM activities wane. Green Pricing that typically leverages wind farms in the mid west is rearing its head in New England with utilities such as National Grid proposing to work with small non-profits that are aggregating behind-the-meter solar PV, small landfill gas projects and small wind energy installations. In rural areas this will include bio-mass fueled cogeneration including fuel cells.

As regulators advance Performance Based Rates Incentives and other regulatory strategies to reward utilities for their customer quality of service, i.e. for delivering quality power in a reliable manner, rather than for delivering more kWhs, there will be a level playing field for the DISCO to introduce DG, including renewable, into customer owned facilities. One example is to engage hydrogen or bio-fueled fuel cells in small sizes that can be operated efficiently to reduce a facility's electric and thermal load, the latter utilizing waste heat extraction. Through the replacement of a larger supply of conventional grid power with less demand side clean power, facility managers will reduce supply side emissions and provide their facility with a back-up power source that improves their reliability.

Similar to the utility, the majority of customers must see value in the installation of a renewable energy installation. Such value may result from helping the environment but it must include savings and possible mitigation of costly damage to their home or business. One measure of benefit to the owner of a renewable energy generator is the Total Cost of Operating its Facilities. The discussion follows:

5. Total Cost of Operating Facilities

Multiple revenue streams are important to the customer who operates 1 or 1,000 facilities. The sum of the revenue streams can be described in many ways, one using the customer's Total Cost of Operation (TCO) metric as described by the following illustration and equation:

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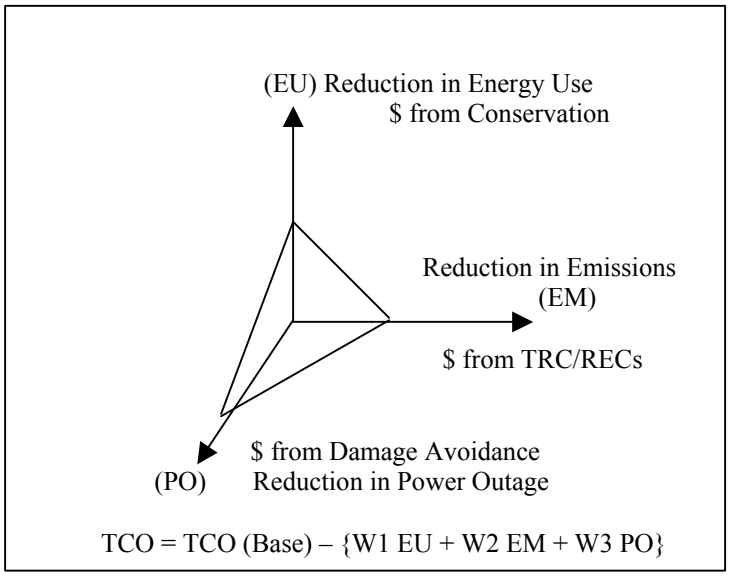


TCO = (Unit cost of utility supply + delivery) x (Facility load) + (O&M) material and labor costs + Environmental related damage costs + Utility quality related damage costs + Utility reliability related damage costs.

Similar to DSM projects, behind-the-meter renewable energy projects will be installed at homes, businesses and institutions in the 3 kW to 500 kW range. The author is assisting in the facilitation of a number of such projects that are valued for their conserving, environmental and damage avoidance revenue streams. Case Studies are presented in the Appendix.

6. Small is Challenging

Similar to the supply side renewable power plant project, the substantially smaller demand side renewable projects is not without its challenges. Experience has shown that the success in leveraging the dispersed renewable energy resource into emission reduction credits is dependent on the existence of an economic infrastructure to track many small and dispersed emission levels. These systems include small wind turbines, solar PV, bio-fueled IC, micro-turbines and fuel cell generators.

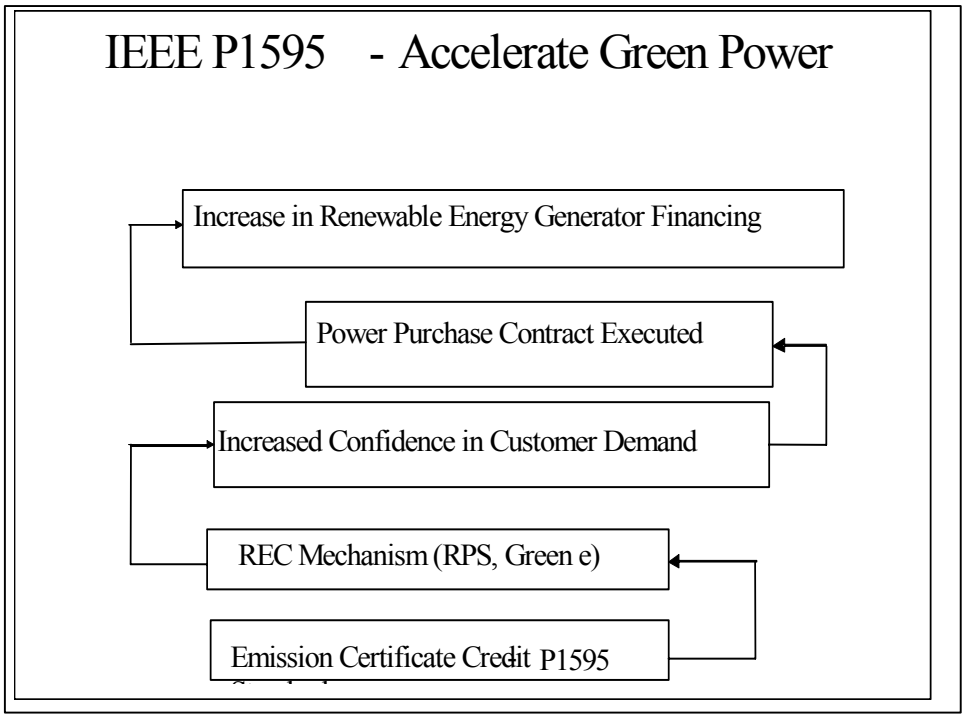
The motivation to track the performance of demand-side renewable energy does not exist. The contractor who installs a small renewable energy generator is paid to install the system in line with building codes. Without a vested interest in a project the contractor is paid immediately after completing a satisfactory installation. If the need exists, the owner must track the system's performance. Estimating performance based on baseline comparisons, resource intensity maps, spot metering and contractor maintenance invoices may be sufficiently accurate to avoid the need for a second utility meters.

The motivation to install a meter on a small generator at increased cost does not exist. Unlike the energy production of wind farms, bio-mass, geothermal, small hydro and the isolated solar central power plant that require meters for dispatching by regional power pool operators, small demand-side systems do not require any metering. Typically the go or no-go payback calculation used to justify small generators are based on a site specific estimate of its annual energy production not. In-fact, demand-side generator installations often take advantage of Net Metering laws that save money by eliminating the power production meter, the very meter that would be used to most easily quantify the output of the small generator.

Recent events will result in the integration of meters with the installation of the small renewable generator. Specifically in Massachusetts, Connecticut and soon other states a component of a system benefit award to a small renewable project must be in-part based on its metered and verified energy output. Similar to the US Federal Performance Tax Credits, such awards will require performance records based on a revenue grade meter. In addition to individual meters, a system to recognize and account for behind-the-meter renewable power is under development in Massachusetts. The replication of this tracking system will be guaranteed if it proves to be cost-effective.

Without a tracking system but with access to meters, the reporting frequency also needs to be intelligently addressed. Specifically, a revenue meter can record and report production over hourly, daily or monthly averages. While traditional monthly read metering does not permit matching the ability of renewable generators to displace hour to hour or day to day emissions, existing and affordable metering and wireless communication technologies will allow this. There is a need to weigh the cost of arriving at estimates of performance based on valid metrics and mature hardware reliability data or based on the use of performance measurements either from meters or other sources.

7. IEEE P1595



The need to establish a reasonably priced quantification standard to accurately verify GHG emission reductions resulting from renewable generators, energy efficiency and conservation and fossil fueled power plant emission reduction control projects, is the intent of IEEE P1595. The electric sector specific IEEE P1595 will establish the international standards to quantify project specific GHG emission credits that other protocols and other standards will depend upon, (illustrated below). These include the International Standards Organization (ISO) as it addresses its GHG Protocols in ISO 14064 and the World Resource Institute/World Business Council of Sustainable Design through its General Guidance in GHG Corporate and Project Modules. This also includes the American Association of Issuing Bodies (AAIB) that is being proposed to develop the standards to track RECs and TRCs across regional boundaries that are issued by others, e.g. NEPOOLGIS for RPS in NE, ERCOT for TX RPS and various Green Pricing utility partners.

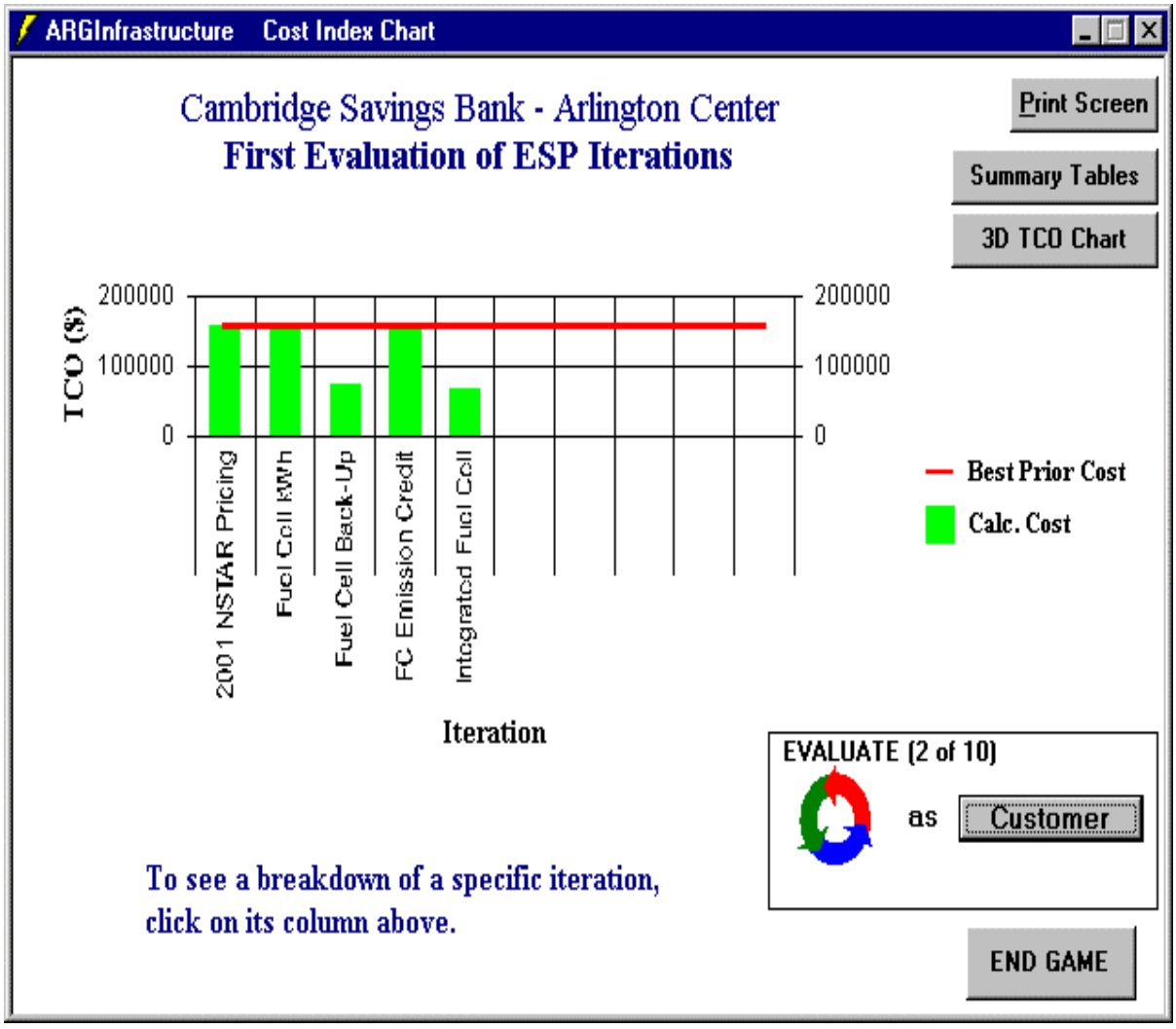
[Refer to the IEEE PES GM2003 Proceeding Paper No: 03GM 0558 Summary which this Summary has expanded].

8. Appendix

8.1 Example behind-the-meter renewable energy project Case Studies:

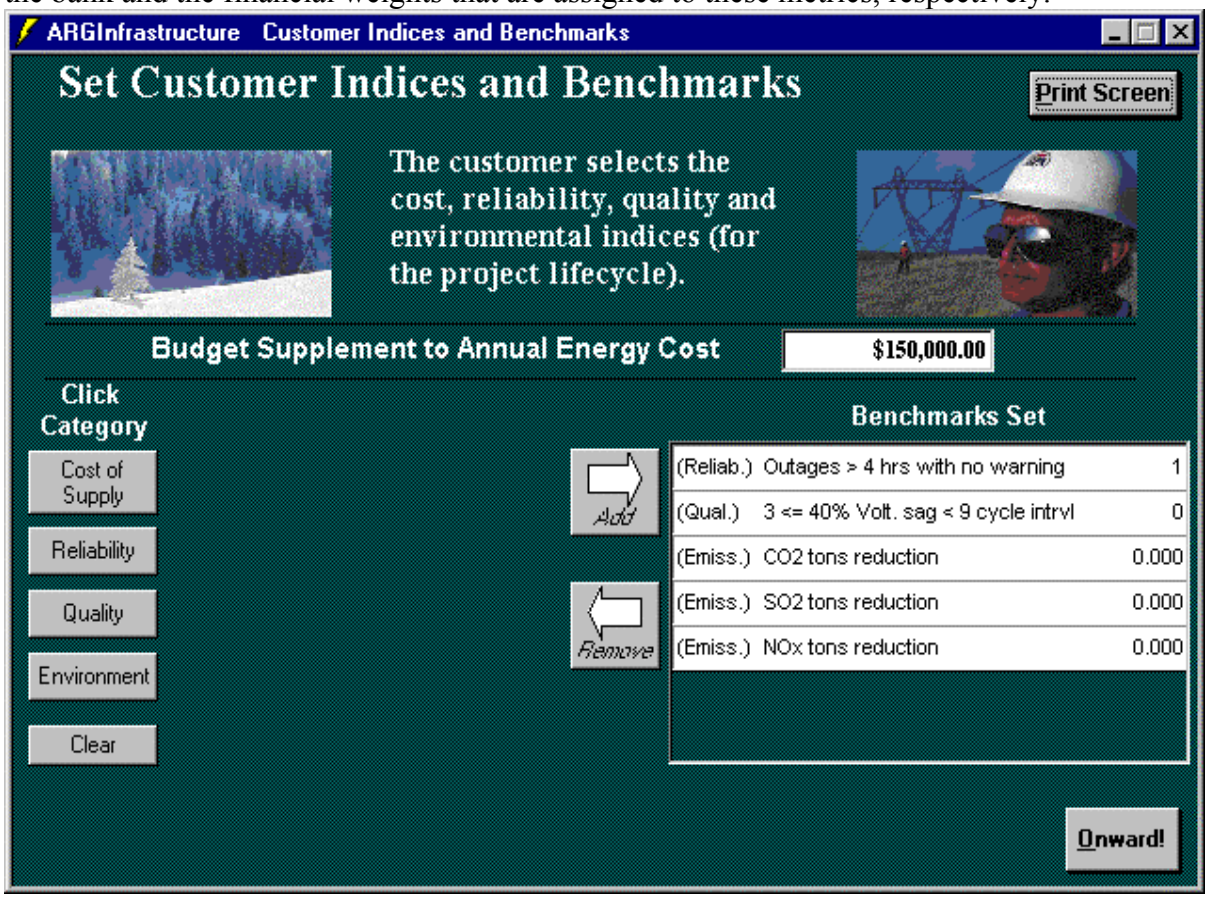
A 5 kW project where a hydrogen based fuel cell addresses the critical IT and Telecom loads of a commercial customer and three solar photovoltaic (PV) projects for the Town of Hamden Connecticut where VESTAR has taken the lead as an environmentally conscious Energy Services Performance Contractor arrangement.

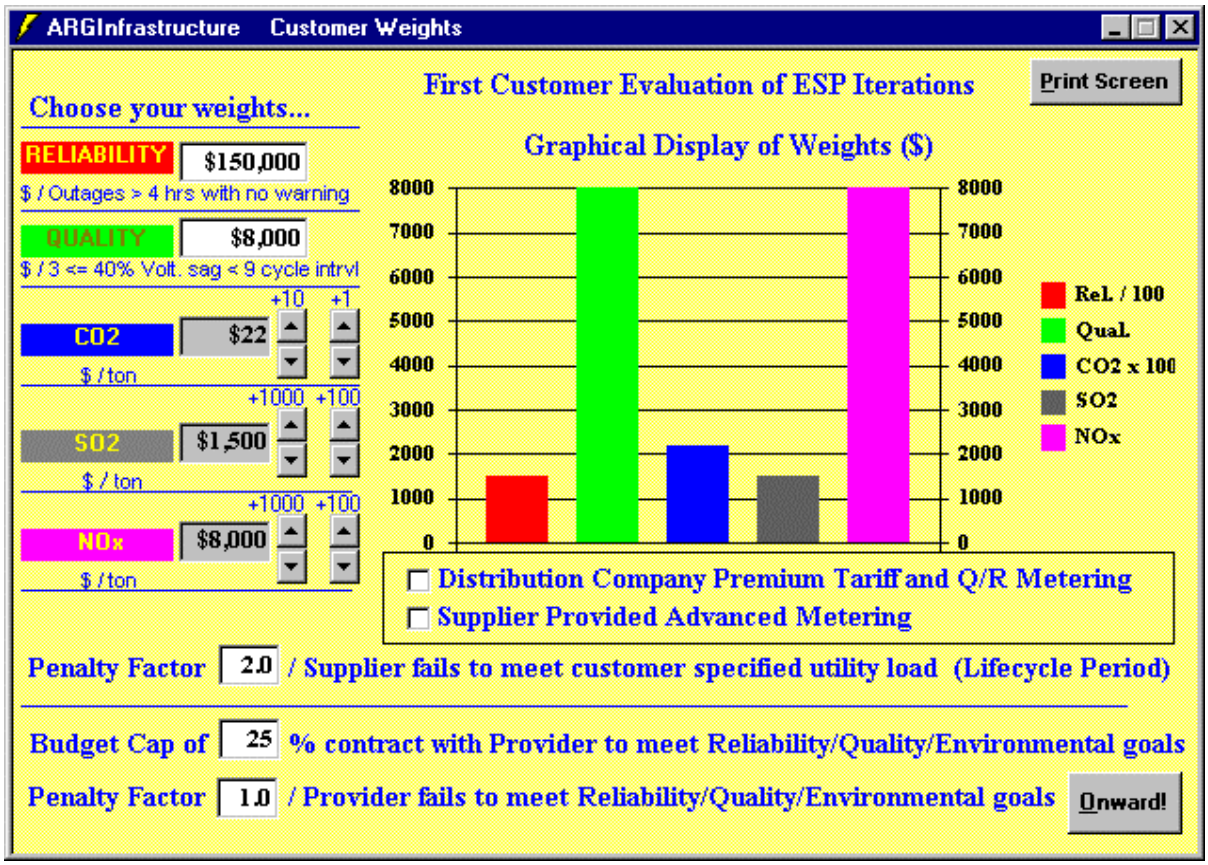
The screens from ***ARGInfrastructure*** illustrate these projects and serve as Case Studies that may be distributed in the form as "best practices" to be replicated. A few follow:

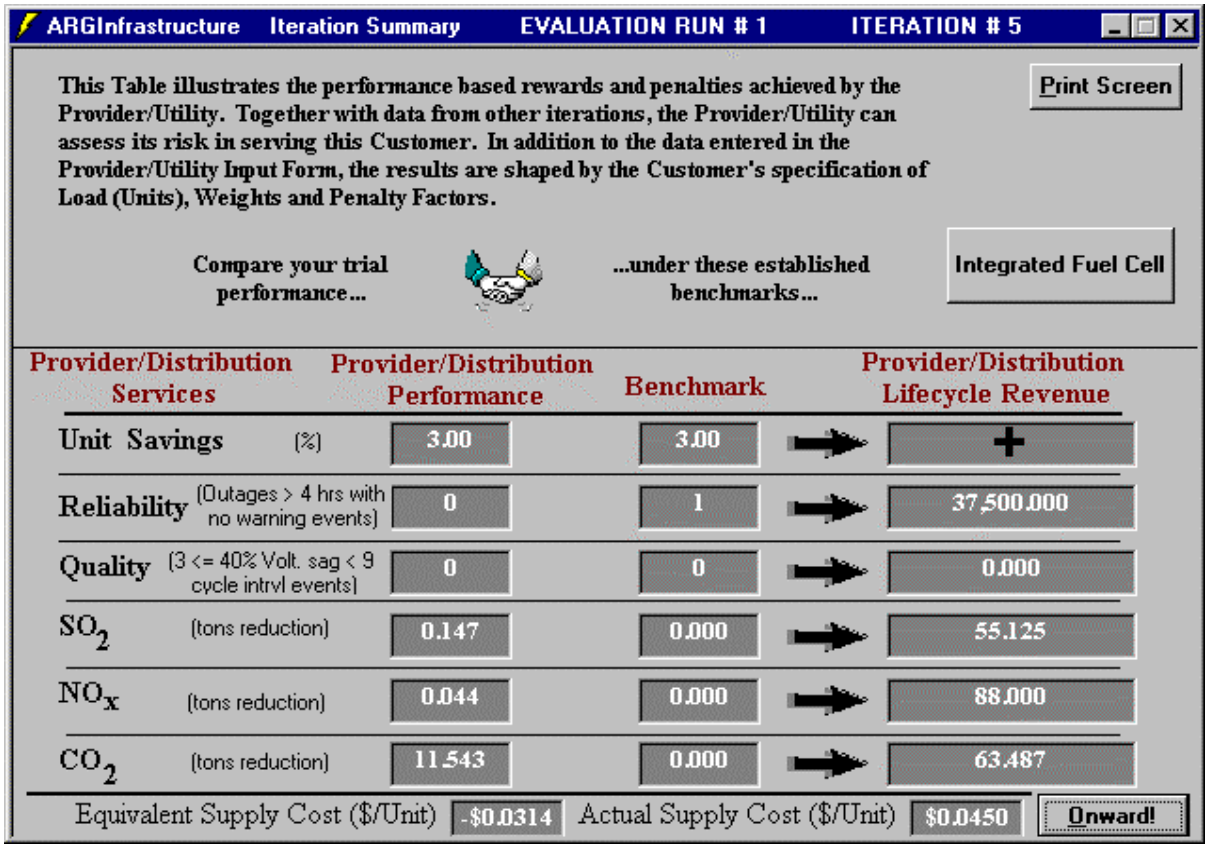


This screen is a snapshot of the *ARGIfrastructure* simulation representing the Total Cost of Operation benefit of applying a 5 kW PEM fuel cell to the critical IT and Telecom loads at a small bank in Cambridge Massachusetts. While savings and emissions are important and the latter when tallied with other projects will be substantial, the primary customer benefit results from avoiding damage at this bank.

The two slides on the following page illustrate the Indices and benchmarks considered important to the bank and the financial weights that are assigned to these metrics, respectively.




ARGInfrastructure Customer Weights
First Customer Evaluation of ESP Iterations
Print Screen
Choose your weights...
RELIABILITY
$150,000
$ / Outages > 4 hrs with no warning
QUALITY
$8,000
$ / 3 <= 40% Volt. sag < 9 cycle intrvl
+10 +1
CO2
$22
$ / ton
+1000 +100
SO2
$1,500
$ / ton
+1000 +100
NOx
$8,000
$ / ton
Graphical Display of Weights ($)
8000
7000
6000
5000
4000
3000
2000
1000
0
ReL / 100
Qual
CO2 x 100
SO2
NOx
Distribution Company Premium Tariff and Q/R Metering
Supplier Provided Advanced Metering
Penalty Factor 2.0 / Supplier fails to meet customer specified utility load (Lifecycle Period)
Budget Cap of 25 % contract with Provider to meet Reliability/Quality/Environmental goals
Penalty Factor 1.0 / Provider fails to meet Reliability/Quality/Environmental goals
Onward!



The above screen captured from the *ARGInfrastructure* simulation for the bank illustrates the positive value of conservation associated with the installation of a fuel cell that shaved 3 % of the banks large base load as well as the $ 37,500 annual savings resulting from avoiding damage and the approximate $ 200 in the value (REC) from emission reductions. Note that a $ value was not associated with the 3 % conservation savings that was achieved in that *ARGInfrastructure* treats the project as one where a performance contractor finances the project over 5 years and realizes a positive (+) cash flow by capturing all of the conservation. The emission reductions achieved are illustrated below:

Annual lbs/MWh of Emission Reductions (2000)

	SO2	NOx	CO2
ISO-NE * ----------	6.2	1.9	1488.1
Fuel Cell ** --------	0	0.03	1000
Reduction (lbs/MWh)	6.2	1.87	488.05
Demand Reduction (tons)*** -	0.1222	0.0369	9.6195
Supply Reduction In tons****	0.1466	0.0442	11.5434

* Based on NEPOOL 2000 Marginal Emission Report
** Based on DEP Emission Allowances and MA Climate Action Plan for Fuel Cells
*** Fuel Cell behind the meter Annual Production (39.42 MWh @ 90 % Availability)
**** Assume a 1.2 Multiplier for T&D Losses & Spinning Reserve Generation

8.2 VESTAR – Town of Hamden Connecticut Solar PV project Case Studies follow:

PV--- Estimated Emission Reduction savings for two of the three Solar Photovoltaic (PV) projects approved by the Connecticut Clean Energy Fund and grid connected result in:

UTILITY	ENERGY DISPLACED	ANNUAL GREENHOUSE GAS REDUCTIC	
Electricity	**8,640 kWh**	**Carbon Dioxide**	**12,857.0 lbs**
		Sulfur Dioxide	**53.6 lbs**
		Nitrous Oxides	**16.4 lbs**

Note that in Addition to the behind-the-meter conservation benefit resulting from PV, the emission reduction attributes add additional value as a qualified “renewable” energy resource in CT, ME and MA under each states’ Renewable Portfolio Standard (RPS). These are discussed later.

FC--- Estimated Emission Reduction savings for the two of the three grid connected continuous operation Fuel Cell (FC) projects proposed to the CT CEF would result in:

UTILITY	ENERGY DISPLACED	ANNUAL GREENHOUSE GAS REDUCTIC	
Electricity	**1,658,200 kWh**	**Carbon Dioxide ***	**809,304 lbs**
		Sulfur Dioxide	**10,281 lbs**
		Nitrous Oxides **	**3,100 lbs**

* 488.05 lbs/MWh for reformed gas FC ** 1.87 lbs/MWh for reformed gas FC

Unlike PV, FC's that are fueled by fossil fuels do not qualify under RPS programs as renewable resources. A third proposed project fueled by Praxair hydrogen would have qualified but as a back-up source, it would have displaced a small load.

Multiplier---Similar to behind-the-meter conservation, it is prudent to apply a 1.3 multiplier times the demand side emission reduction resulting from PV and FC projects to reflect the equivalent supply side (smokestack) reduction. This factor accounts for average T&D losses of 9%, power plant efficiency losses of 5% and spinning reserve margins to maintain reliability (ICAP) of 20% as reported by the USA EIA across the US.

While this multiplier will be favorable and realistic to include in the IEEE International Standard to Quantify GHG Emission Credits its inclusion in NE State regulations has not yet been decided. The author has introduced this multiplier to the Massachusetts DEP who are developing the NOx set aside credits for DSM and behind-the-meter renewable projects. The final regulations and reasoning behind including or excluding this multiplier has been delayed to the Fall of 2003. If not applied in Massachusetts and not in NY then CT may also exclude this1.3 T&D losses and Spinning reserve multiplier.

The facilitation of renewable energy projects that produce electricity avoid fossil fueled power plant emissions and GHG's, i.e. SO2, NOx and CO2 have the potential to obtain credit via tradable Renewable Energy Certificates (REC).

Renewable generators are defined Renewable Portfolio Standard (RPS) regulations passed by each State, e.g. MA, ME and CT and in many other US states. Solar PV and Wind generators would always be included followed by Bio-Mass and then Hydro, Tidal and IC engines fueled by bio or landfill gas or hydrogen created through electrolysis using a renewable resource.

The ATX is a world wide California based exchange that developed and operates a Generation Information System (GIS) for ISO-NE. The function of this www.nepoolgis.com system is to account for emission tags that specify the emissions of each electric power plant, both large and small, that are dispatched or operating in NE. The large Power Plants are generally NEPOOL members but non-NEPOOL power plants will join and if renewable be provide a certificate that is valuable to a Load Serving Entity (LSE) in a NE state where a percent of the energy they provide to customer aggregations must be from renewable sources. Beyond the RPS obligation, Green Pricing and retail branding programs may add value to utility customers that purchase RECs from Green Suppliers.

[See recent arguments for Cap and Trade from Emission Marketing Association, International Emissions Trading Association and the note from the Secretariat of the Committee on Sustainable Energy of the UN Economic Commission for Europe on May 26-28 2003 (Fourteenth session)].

In Massachusetts where the RPS is in effect, the DTE certified Load Serving Entities (LSE) include NSTAR, National Grid, WMECo and FG&E and aggregators such as HEFA, Constellation, Select Energy, Tratebel, etc. The LSE needs to acquire new renewable resources or pay a penalty to comply with the Massachusetts' RPS and hence will buy renewable certificates in the ISO-NE market place. The monetary value of the certificate is a function of its quality which in turn is a function of the State's regulations where it is verified and administered.

The value of a MWh certificate from a renewable energy plant located in Massachusetts have recently traded in the range of $ 20 to $ 30 per MWh where the less rigorously certified renewable power plants in CT have had values in the range of $ 5 to $ 10 per MWh. While the MA RPS has been in effect since July 1, 2002 it was said that the CT RPS is scheduled to be effective (SB733/File No. 428) after July 1, 2003. Regarding the economic value of RPS Certificates the expected 8.5-9 MWh generation from the two Hamden PV projects, i.e. Government Center and Pumping Station generate an additional upper limit of $55.00 per MWh or $ 468 to $ 495 per year of revenue. While the maximum value is $ 7,200.00 on average, the value of the RPS renewable certificate over the 15 year contract period is expected to be closer to $ 3,600.00. In certain situations renewable projects may qualify for a competitively bid MTC Green Power partnership guarantee which will fix the REC to a reasonable and uniform value over a 15 year period.

While Massachusetts is working on a Climate Change plan that will provide credit for reduction of GHG including CO2, the nine State Registry of companies that would undergo verification of their CO2 reductions suggested by NY's Governor Pataki would likely be legislated by these states in 2006. In the mean time, Towns or their Energy Service Providers could participate in auctions, e.g. Ontario Hydro's recent RFP and acquisition, or in Non Governmental Exchanges such as the Chicago Climate Exchanges where CO2 and the other 5 GHGs are being traded. The quantity would depend on the ability of the Town or its ESP to accumulate a significant number of RECs from conservation and renewable energy project MWh Negawatt reductions. The present auctioned value of CO2 while rock bottom at $ 1.00 per tonne (one metric tonne is approximately equal to 1.2 ton) would likely increase exponentially as RPS kicks in throughout North America. In August 2003 the Province of Ontario Canada introduced an RPS model that will likely spread to all of Canada, one of the countries that has adopted the Kyoto Protocol.

The CT DEP is also working on a CO2 credit that will be tradable but this is likely to occur after 2005. This is likely to resemble the Massachusetts regulations by Jane Swift in April 2001 which allow fossil fueled power plants to

achieve emission reductions through demand side conservation and renewable energy development. In the mean time the CT DEP is conducting workshops that keep DEP abreast of CO2 initiatives.

While the three gases selected (CO2, NOx and SO2) are the most likely to result in sources of revenue, five others are considered relevant in the GHG mix by agencies such as World Resource Institute (WRI), the Intergovernmental Panel on Climate Change (IPCC) and others. These include Methane (CH4) which results from drilling for gas, landfills and the burning of biomass fuels, Sulphur Hexafluoride (SF6) which results from electric T&D as well as from industrial processes such as aluminum smelting and magnesium casting, Hydrofluorocarbons (HFCs) which results from their use as a substitute to CFCs in refrigerant and industrial processes and Perfluorocarbons (PFCs) which results from electric T&D as well as from industrial processes such as aluminum smelting and magnesium casting.

The annual value of 5,865,785 lbs of CO2 savings due to conservation and PV at $ 1.00 per tonne based on the Hydro Ontario RFP would result in a 15 year revenue stream of approximately $ 40,000.00. In the future, 2008 – 2012, CO2 is expected to range between $ 10 to $ 15/tonne in value.

Rich D'Aquanni is the President and Founder of Applied Resources Group Inc., a 22 year old utility consulting and Systems Integration Corporation.

Mr. D'Aquanni, has a BS and MS in Electrical Engineering with a specialty in controls from Manhattan College and the University of Arizona, respectively and studied estimation and control theory at Harvard University. He is a Senior member of the IEEE and is a registered professional engineer in Massachusetts and in California.

Rich has the unique experience of facilitating renewable energy as a utility planner, a national consultant, a regulatory stake-holder and as an engineer who has performed due diligence on, as well as designed and built, renewable energy generation projects. Projects have involved wind, PV, small hydro, bio-mass and fuel cell technologies.

Currently he is a consultant to the Massachusetts Renewable Energy Trust and to corporations that are studying and implementing renewable energy projects. Clients in 2003 include the Cambridge Savings Bank in Massachusetts, The Energy Counsel (TEC-RI) in Rhode Island and VESTAR, a CINERGY company, with projects in Connecticut.

4. TEAM'S EXPERIENCE WITH RENEWABLE POWER TECHNOLOGY DEMONSTRATION PROJECTS: A PROVING-GROUND AND STEPPING-STONE TO ACCELERATE MARKET ACCEPTANCE OF GHG MITIGATION TECHNOLOGIES AND BUILD CAPACITY TO CREATE VERIFIABLE GHG EMISSION REDUCTIONS

Thomas Baumann, Chief of Greenhouse Gas Measurement & Reporting for the Government of Canada's Climate Change Technology Early Action Measures (TEAM), Ottawa, Canada

1. Introduction

The presentation will start with an overview of TEAM (Technology Early Action Measures Initiative), how TEAM works, and TEAM's renewable power projects. The presentation will focus on the evolution of GHG accountability in TEAM, including lessons learned and recommendations to proponents regarding measurement and reporting.

2. Overview of TEAM and How it Works

The Technology Early Action Measures (TEAM) Initiative is a $95 million government Climate Change fund that includes 96 projects funded to date (1998-2003) with a total investment of more than $945 million. TEAM's mission is "technology deployment and late stage development in support of early action to reduce GHG emissions, both nationally and internationally." TEAM is not a mechanism to create GHG emission reductions credits, rather TEAM serves as a proving ground and stepping stone (e.g. to prove technologies, to build capacity, etc.) to accelerate market acceptance of GHG mitigation technologies and projects. TEAM invests through existing government programs, leveraging internal resources (e.g. experts, funds, facilities) and the government-company relationships. TEAM funded projects are managed by the government programs that partner with the proponents. Further details about the proposal review process was provided during the panel discussion.

2.1 Overview of TEAM Renewable Power Technology Demonstration Projects

To date (1998-2003), TEAM has funded a total of 19 renewable power projects. Most of these TEAM projects are located in Canada (13), yet there are also projects located in Asia, South America, Africa and Eastern Europe. The following table presents an overview of the projects:

Renewable Power Sector	Number of Projects	Total Investment ($ millions)	TEAM Investment ($ millions)
Solar	5	$114.1	$9.2
Small Hydro	5	$39.9	$2.8
Wind	5	$10.1	$4.3
Landfill	2	$4.0	$1.8
Biomass	1	$4.0	$0.7
Cross-cutting	1	$3.2	$0.8
Total	19	$175.5	$19.6

Further background descriptions of the projects (e.g. objectives, applications, size, performance, etc.) was also be presented at the panel discussion.

2.2 Evolution of TEAM GHG Accountability

TEAM is a proving ground for both technology development and GHG measurement and reporting. Within the TEAM Business Plan and Management Framework, TEAM is committed to report the performance and impacts of TEAM funded projects. When TEAM entered round 1 of government climate change funding (1998-2001), there was a general lack of guidance (i.e. no rules, ongoing initiatives) and supply/network of experts (i.e. not much demand and also costly to do) for GHG reporting, especially for GHG mitigation technology projects (i.e. rather than inventories and projects).

Recognizing the objectives/limitations of TEAM, establishing performance metrics ("measures of success") and reporting objectives was an important task for evaluation, consistency with other GHG programs, as well as communication. TEAM responded with funding, networks, guidance, staff, etc. to develop and implement its GHG reporting for TEAM projects. For example, TEAM:

- Funds up to $30,000 per project for GHG reporting,
- Coordinates with GHG programs and experts such as Canada's CDM/JI Office, in order to help companies move to the next step, and
- Designed the SMART (System of Measurement And Reporting to TEAM) to be a "better, faster, cheaper" GHG reporting approach that would be practical and cost-effective and provide a clear and accurate evaluation of the technical performance and impacts of TEAM funded projects.

The SMART process is subsequent to, and builds on, the information provided in the project measurement & reporting (M&R) plan and final technical report for each TEAM project. Further information about the development of TEAM's GHG accountability was provided in the panel discussion.

2.3 Lessons Learned and Experiences with GHG Accountability of TEAM Projects

Although many early TEAM projects are deemed "successful" by the proponent and/or government representative, due diligence reveals a lack of adequate technical and project information for a credible GHG report of performance and impacts (Verifiability – Show me the evidence). This is an indication that a properly designed and implemented GHG project requires a combination of expertise, including:

- Technical (e.g. operation, measurement techniques, etc.)
- GHG (e.g. boundaries, baselines, emission factors, etc.)
- Environmental (e.g. impacts, regulations, etc.)
- Auditing (e.g. transparency, substantiation, etc.).

Ongoing challenges and issues for GHG measurement & reporting include:

- GHG reporting is still new – need to do it faster, better, cheaper
- Need more information (e.g. verifiable baseline conditions) and case studies
- Consistency and best practices – which one to use, what's next?
- Building capacity of project proponents, government representatives, contractors.

However, TEAM has engaged several projects and has success with M&R plans and GHG reporting, for example, planning and reporting costs are relatively low (e.g. about $3k and $20k, respectively) while verifiability is increasing. Given a convincing case (e.g. seeing the evidence, understanding the benefits, etc.), more and more companies are willing to go the extra step required to create verifiable GHG emission reductions. Collaboration among reporting approaches is important to maintain consistency and enhance acceptance by all parties. Many TEAM projects have proven technologies (e.g. substantiation, replication, etc.) and taken the next step to other climate change programs (e.g. CDM studies, credits, etc.). Further details of TEAM's successes and challenges was provided during the panel discussion.

3. Recommendations and Next Steps – GHG Measurement and Reporting Issues

Based on TEAM's experiences developing and implementing various elements of GHG accountability:

- Think multidisciplinary expertise (e.g. GHG, technical, environmental, auditing, etc.)
- Think GHG verifiability (e.g. guiding principles of accuracy, completeness, transparency, etc.)
- Build capacity for GHG projects (e.g. create network of experts, learn what to do and stay informed because things change, have the tools to do it, etc.)
- Have a plan to address project and targets (e.g. CDM PDD, M&R plan, etc.)
- Develop an approach to deal with confidentiality issues (e.g. NDAs, trusted partners, etc.).

Thomas Baumann is the Chief of Greenhouse Gas Measurement and Reporting for the Government of Canada's Climate Change Technology Early Action Measures (TEAM) Initiative, a $95 million government fund that includes 96 projects funded to date (1998-2003), creating a total investment of more than $945 million. His main responsibilities include developing and implementing the System of Measurement And Reporting to TEAM (SMART) to evaluate the GHG performance claims of TEAM projects. Baumann started working with the Government of Canada in 1992 at Statistics Canada and then Environment Canada. Before rejoining the federal government in 2001 with the TEAM Operations Office (situated within Natural Resources Canada), he completed degrees in environmental economics and environmental engineering and was a consultant with The Delphi Group (1998-2001). He is also actively engaged as a reviewer and contributor for GHG programs and protocol development, including IEEE P1595 CCWG, WRI-WBCSD project protocol, ISO WG5 CAC-cc, PERRL (Canada's Pilot Emission Reductions and Removals Learnings Initative), and others.

5. PORT ALBERT WIND FARMS LTD. SINGLE VESTAS V47-660 KW WIND TURBINE INSTALLATION

Philipp Andres, President, Port Albert Wind Farms Ltd., Ontario, Canada

SUMMARY

As a result of deregulation of the Ontario Electricity Market, in the spring of 2001 David Thompson (my partner) and myself decided to take the first step to make our dream become a reality to install a wind farm along the Lake Huron Shoreline.

We decided to install a single Vestas V47-660 kW wind turbine near the village of Port Albert within about 4 km of the Lake Huron Shoreline. I have taken wind measurements in the area as far back as 1992 and we were confident that the area had an economically viable wind resource which with the right incentives could be developed.

In the fall of 2001 the wind turbine was installed on leased property after a public meeting was held to gain the support of the local community and a building permit was obtained.

Public support for the project was very strong and we received only encouragement to proceed with the project.

In early December of 2001 the project was commissioned and we started to feed the power into the Hydro One grid.

The power was initially sold to Ontario Power Generation (OPG) into the interim market until the wholesale electricity market opened in May of 2002. Since that time the power has been sold at spot market rates to Hydro One but without selling the associated environmental attributes to the utility.

We initially partnered with Grey Bruce Renewable Energy Cooperative to market the green attributes of the project to its members. Uptake was relatively slow since the coop had no full time staff and relied solely on volunteers to "spread the word" about the availability of green power for its members. It was then decided to bank the green attributes until a suitable buyer could be found.

The turbine was installed as a CRCE (Canadian Renewable Conservation Expense) machine where 100% of the cost of the wind turbine installation could be expensed in the year of installation. The purpose of CRCE is to provide similar tax treatment for the wind energy industry as what the oil and gas industry enjoys in expensing their exploration activities.

One is eligible under CRCE provided the proponent intends to use the turbine as a test turbine to verify the wind resource with actual production from a single turbine with the intent to expand the site to a full fledged wind farm.

Based on the production data gained, Port Albert Wind Farms (PAWF) intends to expand the site in a number of phases to a large-scale wind farm.

In January 2002, the Ontario government launched Canada's first emissions trading program, designed to help further reduce emissions of NOx and SO2. The system provides a financial incentive for emitters to invest in more reductions than they would otherwise under regulation alone. One of the features of the Ontario program is the so-called "Set-Aside Allowance". It allows energy conservation and renewable energy projects to create allowances and sell them through the trading system. PAWF was the first project to make a claim under this provision

The Province of Ontario has allocated emission allowances to OPG of 35 and 153.5 kilo tonnes (kT) of NO and SO2 respectively for the year 2002. A portion of those allowances (1 kT of NOX and 4 kT of SO2) have been set aside for use by renewable energy and energy conservation projects. Such projects displace the production of fossil-on-margin electricity, and therefore aid in reducing emissions.

These projects can claim a portion of the set-aside and sell the allowances to OPG. Any unclaimed portion of the Set-Aside is remitted back to OPG at the end of the year

PAWF registered 1 ton of NOx and 3 tons of SO2 under that program for avoided emissions between January and the end of July 2002. Unfortunately GHGs are currently not captured under the Ontario's emission trading program. With the ratification of the Kyoto Protocol by Canada it is however hoped that Ontario's cap and trade system could be expanded to include GHGs. This would be a logic next step since emitters will have already all the necessary monitoring equipment in place for NOx and SO2 and with a small additional investment CO2 concentrations could be measured alongside these other 2 pollutants.

The set aside could then be expanded to include GHGs and thereby further enhancing the value of zero emission generation such as wind energy and water power.

The province of Ontario has signaled with a number of initiatives that it wishes to support the further development of renewable energy projects. It has passed regulations to provide for a 10 year property tax holiday for wind energy projects similar to the water power tax exemptions and provided other tax concessions such as accelerated write offs of the capital investment in a wind farm and streamlined permitting procedures where the limit for an environmental screening was raised from 2 MW to 100 MW for wind energy projects.

On the Federal level the Federal Government has announced the WPPI (wind power production incentive) which currently provides 1 c/kWh in support payments for qualifying projects built between April 1, 2003 and March 31, 2006. There are several restrictions associated with this program with the most important ones being a limitation of 300 MW per province in qualifying projects and limitations put on the total program spending of $260 million. The limitations and the payout are currently under review and it is the sincere hope of the author that the Federal Government will heed the advice of the wind energy industry and significantly enhance the program as a cost effective means to significantly reduce GHG emissions in Canada and assist in meeting Canada's commitment under the Kyoto Protocol. Our industry is estimating a cost of between $8-10 per ton of CO^2 which is very competitive in the comparison to other policy options available.

Ontario has the potential to install 3-4,000 MW of wind energy capacity along the shoreline of the Great Lakes and with modern larger turbines (2 MW +) and tall hub heights the agricultural land base further inland can also be developed in the near future.

Success will largely depend on how serious the various levels of government will get in tackling GHG emissions and recognizing the substantial contribution wind energy can make towards GHG reduction.

Philipp Andres was born and educated in Switzerland. He graduated from Sissach Agricultural college in Switzerland in 1976 and moved to Canada in 1979.

He worked in the agricultural industry in the 1980s and managed a large scale alfalfa dehydration facility in the Kincardine area. It is during that time that wind energy development sparked his interest and he started to conduct wind measurements along the Lake Huron Shoreline. Later, this was followed by the installation of a small wind turbine and Ontario's first utility scale wind turbine (a 600 kW wind turbine installed adjacent to the Bruce Nuclear Power Facility). Since that time Philipp has worked in the wind energy industry full time. First with the German manufacturer Tacke Windtechnik (now GE Wind, a division of GE Power Systems) and since 1997 for the world's largest manufacturer of wind turbines, the Danish company Vestas Wind Systems A/S.

He currently holds the titles of Senior Vice President and General Manager of the Canadian subsidiary Vestas Canadian Wind Technology, Inc. and the title Vice President Business Development for the US subsidiary Vestas American Wind Technology, Inc.

During his term with Vestas he has grown sales in the North American market in 2001 to in excess of USD 300 million installing more than 700 MW of new capacity.

He is also the President of Port Albert Wind Farms Ltd., a company involved in the development of wind farms along the shore line of Lake Huron.

6. CAPITALIZING ON RENEWABLE ENERGY THROUGH DISTRIBUTED GENERATION (PREPARED DISCUSSION)

Ivor da Cunha**,** Director, Business Development – Emerging Energy Technologies, Kinectrics Inc., Toronto, Canada

Distributed Energy Resources (DER), are modular, decentralized power plants, located close to an end use location. The confluence of deregulated markets, technology advances, venture capital and need for energy security have all contributed the uptake of DER. This technology can provide continuous electric power, backup power, or supplemental power during times of peak demand. DER integrated power systems can include effective means of energy storage and delivery as well as power-generating technologies. Distributed energy systems are poised to help to meet increased demand, reduce peak operating costs and improve reliability of the electric power generation system. Coupling DER systems with energy efficiency measures and good energy management practices can make them even more effective.

During the previous five years, the principal DER applications have encompassed emergency power and peak shaving, supply of critical loads and combined cooling heat and power. Niche applications have included resources recovery from flare and landfill gas, as well as power generated from renewable sources such as bioenergy, solar and wind.

Operators of DER technologies have several key advantages such as improved energy security, supply risk reduction, energy diversification, and overall system efficiency. Traditional utilities and local distribution companies benefit from DER technologies through lower transmission and distribution (T&D) costs, reduced line losses and speed to market. Society can benefit through deferrals for new T&D infrastructure, environmental benefits and possible combined heat and power demand management.

There are a plethora of DER technologies to address the specific requirements of an end user. Many technologies are commercialized, while others are in the pre-commercial pipeline.

Microturbines are combustion turbines that are electricity-producing devices that operate at high temperatures. These tend to be small combustion turbines with outputs of 25 to 400 kilowatts (kW). Microturbine systems can be 22 to 30 per cent efficient, and emissions, in particular NOx emissions, are much lower than those of conventional turbines or reciprocating engines. The “Achilles heel” of a microturbine has typically been the associated gas supply compressor. These compressors have contributed to parasitic efficiency losses along with lower run times; however, manufacturers are making strides to improve the reliability of gas supply compressors. Difficulties have also been encountered with landfill gas applications through the impingement of certain artificial chemicals present in landfill gas. Although microturbines typically cost around US$1,000/kW, next generation systems are expected to be even lower through volume production.

In fuel cells, power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode and separating the two by an electrolyte. The byproducts are usually only heat, water and carbon dioxide. Fuels cells are highly efficient, quiet, and can be stacked to produce a usable voltage and power output and to match the client’s specific power needs. Fuel cells are integrated with an inverter to convert direct current to alternating current; in some cases, waste heat can be used for a site’s thermal energy requirements.

Geothermal heating and cooling systems (GSHP) can be used with different residential, commercial and industrial buildings. Using the steady underground temperatures of the earth, GSHP warm air during the heating season and cool it during the cooling season. This technology can also be used to heat water. Geothermal heat pumps for commercial buildings can significantly reduce energy

consumption and peak demand, thereby dampening electricity price volatility.

Uninterruptible power supply (UPS) systems may be the best known and most widely used energy storage media for DER applications. UPS systems provide high quality and high reliability power to facilities that cannot tolerate even brief outages. In addition to batteries, flywheels, superconducting technologies, ultracapacitors and supercooled electromagnets are also possible storage devices.

Hybrid systems consist of two or more types of distinct DER technologies. The separate units are integrated into packaged hybrid systems that can improve the array of energy services provided to customers. Several different concepts are being developed. For example, one hybrid concept involves the integration of fuel cells and gas turbines.

Renewable DER technologies are firmly established in the marketplace. Photovoltaics (PV) average capital costs, which have fallen 50 per cent since 1991, range from $5 to $10 per watt. Wind turbines convert the kinetic energy of the wind into electricity. Most wind machines have two or three blades mounted on a rotor connected to an electric generator that is typically 0.5 to one MW in capacity. Larger turbines are now entering the commercial marketplace. Next generation biomass technologies now being evaluated include several types of biomass gasifiers, producing gas for direct use in a turbine that drives a generator.

As the evolution of DER technologies continues, combined heat and power (CHP) continues to play a role in the overall economic performance. Future CHP systems could achieve greater than 85 per cent fuel utilization efficiency in industrial, commercial and residential applications.

What does the future hold for DER? The business models are still evolving, as is the marketplace. Scandals (Enron) and crises (California, Alberta, Ontario) in the energy marketplace have only exacerbated the situation. The boundaries between traditional utilities and end users are blurred. The ramifications of Kyoto have caused many to rethink their overall energy game plans with respect to DER from renewable energy sources. There is an emergence of intelligent distributed generation networks or smart networks. Security concerns are leading towards smart self-healing networks of DER that would survive national security incidents.

Overall, DER provides consumers with supply choice, and in many cases a “buy or make” option. Consumers are executing strategies encompassing financial risk management, energy purchases from utilities and self-generation through DER. A business competitive advantage can be garnered from the successful understanding and deployment of distributed energy resources.

Ivor da Cunha has developed expertise in energy management field providing through progressive experience in the electrical, natural gas, nuclear and process industry sectors. He is currently the Director of Business Development for Emerging Energy Technologies at Kinectrics Inc. in Toronto, Canada. His areas of experience include, distributed generation, energy policy and strategies, renewable energy, and emerging energy equipment. Ivor has also undertaken energy technology assessments, competitive intelligence benchmarking, strategic planning, and energy performance contracting. His international experience has included projects in China, Korea, Romania and South America.. Ivor da Cunha graduated from the Royal Military College of Canada, in Chemical Engineering specialization in fuels, materials and energy systems. He is also an MBA graduate from Queen’s University specializing in industrial marketing and business strategy. In 2002, he contributed professionally to the development of Canada’s national fuel cell roadmap. He is a registered Professional Engineer in the Province of Ontario, and a member of Canada’s National Energy Roundtable Working Group.

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