WORKSHOP NOTES AND SUMMARY
Charting the Path Forward: Accounting for Renewables and the Environment
Thursday, 4 November 2004
Washington, DC

Convenors: Commission for Environmental Cooperation
US Environmental Protection Agency
World Resources Institute

Summary
Accounting for the environmental benefits associated with renewable power generation (e.g., avoided emissions) has been a topic of discussion by the Commission for Environmental Cooperation (CEC), the US Environmental Protection Agency (EPA), and the World Resources Institute (WRI) for the past several years. "*Charting the Path Forward: Accounting for Renewables and the Environment*" was the second workshop convened by the CEC and the US EPA to explore and discuss avoided emissions calculation methodologies. The meeting was designed to review and expand on several of the methodologies that were proposed during last year's "displaced emissions" workshop and take stock of recent methodology decisions by the Clean Development Mechanism methodology panel and the Canadian and Mexican governments. The goal was to facilitate a dialogue between electricity system operators, system modelers, governments, and key renewable energy stakeholders to "ground-truth" the assumptions of models and chart a course forward for exploring harmonizing approaches or agreeing on a suite of accepted methodologies.

The workshop provided the opportunity for renewable energy stakeholders to discuss their desired uses for this avoided emissions information. Having stakeholders outline their "end uses" and requirements was an important contribution toward helping policymakers and other stakeholders determine which avoided emissions calculation methodology or methodologies are the most appropriate to use. Key participants in this discussion included local and national policymakers, renewable energy certificate (REC)/greenhouse gas brokers, green power marketers, and corporate purchasers of RECs.

Modelers and electricity system operators tested leading "avoided emissions" calculation methodologies against a small set of case examples and assessed their relative technical and administrative strengths/drawbacks. Having electricity system modelers directly engaged with those responsible for managing the electric grid was a critical step for advancing the dialogue and for making progress towards practical recommendations regarding the emissions impact of grid-connected renewable energy. Applying methodologies against a similar set of case examples helped focus the workshop on addressing issues such as accuracy, availability of data, cost, transparency, and administrative "ease-of-use."

During the last two hours of the workshop, participants identified several points of agreement, the remaining technical issues to be resolved, and a series of next steps for developing a common framework for calculating the environmental benefits of renewable energy.

Opening session
The meeting organizers opened by articulating the goals of the day, namely, to review recent developments in the technical accounting for the air benefits associated with renewable power generation. There is general agreement that when renewable power enters the electricity grid, some other generating source (usually a fossil-fired generator) is not required to operate. There are environmental gains, especially avoided emissions, associated with the displacement of this fossil-fuel generated electricity. The meeting focused on how one should estimate/calculate the amount of these gains. Meeting organizers clarified that a number of other important issues, such as ownership of the environmental attributes, generation tracking systems, and emissions market design parameters were not the subject of the workshop although these are very important issues that should be addressed in the future.

Methodological summary
The next session provided a summary of methodologies that were reviewed in 2003, and provided a brief update on new avoided emissions calculation methodologies relevant to renewable energy projects. Bruce Biewald from Synapse Energy Economics provided an overview of the issues associated with various methodologies. He highlighted that although easy to calculate, system average emissions factors run the risk of being too inaccurate for purposes of emissions trading. More robust estimates are necessary and methods do exist to calculate these. For example, a system dispatch modeling approach is designed to provide a strong estimate of what happens to the dispatch of existing electricity generators when renewable energy enters the grid. This does not provide perfect information, but rather relies on a set of short-term assessments and is designed to be practical and appropriately accurate. There are issues that one must consider in reviewing modeling results because of real-life issues (e.g., transmission constraints) that disrupt the modeled economic or rational response of generators.

Bruce said that in the long term it is more difficult to determine what the capacity impact of renewable generation and energy efficiency is. Would there be a displacement of the need for future generation? If so, would this be the retirement of an older coal plant or the postponement/cancellation of a new natural gas peaking unit that was no longer required? The answer to these questions can be quite regionally- and locality-specific.

Martin Tampier presented a summary of current initiatives worldwide that are developing "avoided emissions" calculation methodologies and which are outlined in his draft paper for the CEC, *North American and International Initiatives to Quantify Emission Reductions from On-Grid Renewable Electricity Facilities*. Several important initiatives include the Clean Development Mechanism, the WRI/WBCSD GHG Protocol (Project Standard), and the Canadian Offset System. He cited a growing tendency more complicated methodologies than grid average (e.g., movement toward approaches based on estimating dispatch impacts of renewable energy projects), a trend toward standardization of methodologies, and that the level of accuracy appears to be linked to its intended use.

WRI's Derik Broekhoff presented the WRI/WBCSD Greenhouse Gas Protocol process and explained that the generic corporate standard has extensive use globally, and that the GHG Protocol is now undertaking a project module that will provide guidance for "project-based" offsets (including grid-connected renewable power projects). A working group has been

established for the electricity sector and includes individuals with renewable energy project experience. The GHG Protocol's recommendations and process are reviewed extensively and the CEC and meeting participants will have the opportunity to provide comments into that process.

Many of the panelists suggested that workshop participants evaluate the various methodologies that will be discussed during the day against the following parameters:

- Relevance
- Completeness
- Transparency
- Consistency
- Accuracy
- Environmental conservativeness
- Practicality

The view from the market seeking to quantify environmental benefits

The third session of the day focused on the needs of the market—traders, marketers, government agencies, and energy end users who are applying the avoided emissions calculation methodologies to their projects and purchases. There was consensus that having a multitude of approaches (the current state of affairs) could put the market at risk in the future. The level of accuracy, however, may depend on the type of claim or pollution reduction that is being sought by the user. For example, Montgomery County's purchase of wind renewable energy certificates was predicated on a detailed accounting for the avoided NO_x emissions associated with the generation mix in the specific air-shed that influenced air quality in Montgomery County. They sought a label with exact documentation for each environmental attribute: when the energy was produced, from where it came, and a clear attestation that the renewable energy attributes had only been sold to them and not sold off to other buyers.

On the other hand, Evolution Markets, a broker of renewable energy certificates indicated that averages and estimates work fine for most of their market that wants to support renewable energy and does not require an exact accounting of how many tons of reductions of pollution their renewable purchase represented. However, Evolution Markets can foresee large companies wanting to purchase RECs as an emissions offset.

Community Energy provided a perspective from the green power or REC provider sector. It outlined an "avoided emissions methodology wish list" that included: (1) certification/recognition by air regulators, (2) regional emissions factors, (3) frequent and predictable updating, (4) publicly available and inexpensive to access (e.g., emissions factors for powerpools in the United States posted by the US EPA).

Large corporate buyers like DuPont, that want to reduce their carbon dioxide emissions, do want to have commonly accepted accounting principles in order to dispel uncertainty about what they are purchasing, help with evaluating their purchase opportunities, and facilitated corporate greenhouse gas emissions accounting (since they have facilities across the world).

The Government of Canada shared another example of an end user that is seeking to quantify offset reductions associated with renewable energy in a specific policy context—the Kyoto Protocol. In their case they are proposing a national emissions factor.

During the question/answer portion of this session, participants asked the following key questions: Should avoided emissions calculations for voluntary and mandatory markets be treated differently? What type of tracking requirements will be necessary? How might streamlined methodologies reduce costs associated with renewable energy project "credit" for avoided emissions? All participants agreed that the accounting system should be transparent, low cost, and the data/results made available on a relatively routine basis (and sooner, rather than later).

Modeling review

At this point, the meeting turned to a focused review of some methodologies that are being used in specific regions to estimate environmental benefits of renewable power generation.

The Independent System Operator of New England (ISO NE) reports annual marginal emission rates for SO_2, NO_x, and CO_2. The marginal emissions rates are based on a model that can run a reference case and a marginal case for avoided electricity due to energy efficiency/demand side management or a decremental case for reneweable power generation (i.e., same number of electrons produced, but no/low emissions associated with the renewable energy). ISO NE has an "interregional electric market model" which is based on chronological load shape from the past year—essentially a retrospective, short-run marginal cost methodology. The model estimates the dispatch stack using actual historical data (e.g., power plant output, fuel costs). The ISO's goal is to get within 25 percent of the actual data from the past year. Jim Platts of ISO NE shared the results of recent year modeling for marginal CO_2, NO_x, and SO_2 emission rates and the results of modeling a wind farm and a landfill gas project.

Lawrence Berkeley National Laboratory (LBNL) discussed two ways in which renewable power facilities can impact emissions: (1) the operating margin, and (2) the build margin. Which margin renewables impact depends on the characteristics of the renewable generator. For instance, renewables that are intermittent (e.g., wind) will primarily have an impact on the operating margin. Renewables that are firm, baseload (e.g., geothermal) will impact the build margin. LBNL has two spreadsheet models for estimating avoided emissions. MAGPWR model is based on load duration curves that may be more appropriate for small projects only impacting the operating margin. MBASE produces annual or seasonal operating curves filled by the highest generating capacity plants first. This models the dispatch stack and can either be a capacity- or cost-based dispatch. MBASE allows users to also make the distinction of whether a plant is load-following or baseload. These are not time-of-day models and would not be appropriate for estimating exactly what happens with local pollution on an hourly basis. But the methodology is practical, achieving high accuracy in the case of the MAGPWR model and medium accuracy for MBASE. In the United States, the data are available and the calculations can be done on a spreadsheet, which makes the approach very accessible.

Geoff Keith of Synapse Energy Economics discussed how to estimate avoided electricity by using load curve analyses to determine marginal power generation. Geoff discussed how geography is an important parameter to consider due to transmission constraints, but that the system as a whole often needs to be analyzed. He also stated that different types of units are on the margin at different times and that in fact the dynamics of the system do not operate purely in terms of baseload and marginal units. For example, adding another baseload plant can impact

what is operating at the margin. Load-following units may not be impacted systematically and predictably because of system dynamics. His presentation suggested that load duration curve analysis, which stacks resources and generating units hourly, should be used to estimate what appeared on the margin at a particular time. The estimates would need to be reviewed in light of system constraints, emissions caps, and power import/export purchases across regions. In some regions, such as the West Coast, the transmission constraints and power sales/purchases may be very material to the results.

Beatriz del Valle Cardenas of ATPAE shared the methodology being used in Mexico. After evaluating a range of calculation methods (e.g., system average, operating margin, and various build margin options), ATPAE has settled on a "combined margin" (CM), in which 50% of the CM is the weighted average emissions factor for all thermoelectric plants. This is a simplified estimate of an operating margin (i.e., excluding the "must run" generation such as nuclear, hydro, and geothermal). The other 50% is the weighted average emissions factor of the five most recently built power plants; this serves as an estimate of a build margin. A CM is calculated for each of Mexico's four regional powerpools. This methodology is consistent with the recommendations that have been approved by the Meth Panel of the Clean Development Mechanism. These emissions factors are easy to use, easy to upgrade, replicable and publicly available. It is difficult to look at load/demand curves to determine hourly emissions factors based on the information the Energy Ministry has, but Mexico does provide peak, intermediate and base "block"/period emissions factors.

Jeff King of the Northwest Power and Conservation Council outlined how the Council uses a forward-looking system dispatch model (the Aurora Electric Market Model) to estimate avoided emissions due to renewable power generation. The model is a proprietary hourly dispatch electricity price and generation forecasting model. The model develops a base case by forecasting or making educated assumptions about electricity demand, fuel prices, and capacity additions over a long time period (e.g., 20 years). To determine the emissions impact of a renewable generator, the base case is changed to reflect the incremental renewable generation and the difference in emissions output per MWh relative to the base case is the marginal emissions factor. Jeff did a model run to determine the avoided CO_2 emissions per MWh of a 100-MW wind farm. In so doing, he identified several lessons about using forward-looking hourly dispatch models to calculate avoided emissions, including: (1) models can be temperamental, often producing unexpected results, (2) gathering data and doing the model runs can consume a lot of time, and (3) analysis of the results can be complex and time consuming.

Discussion, areas of agreement, and remaining questions

Following the presentations, workshop participants discussed the implications of the different methodologies shared by panelists. Several areas of discussion included:

A. *Is an operating marginal emissions factor sufficiently attractive?* Participants quickly agreed that system average emissions factors are not sufficiently accurate for most of the purposes articulated by the end user panel. This is particularly the case if the avoided emissions calculations are going to materially impact financial transactions (e.g., to be used in emissions markets).

Participants were in favor of some form of marginal emissions rate being used. Load curve/dispatch stack analysis was generally interesting to workshop participants. There was concern that the dispatchers at the powerpool level would need to be engaged to provide information and/or analysis because this information is currently not public. The powerpool participants indicated that this was a service that could be provided, but that some of the underlying data could not be divulged for confidentiality reasons.

Workshop participants did not decide upon one method of calculating operating marginal emissions rates over another. A comparative analysis of different options would be helpful. Participants recognized that the key trade-off to be made between options would be "accuracy" versus "practicality." Complex models might lead to more accuracy but could be very expensive, rely on proprietary data, and not be very transparent to stakeholders.

B. *Should a build margin be used?* There was some debate about the merits of using a build margin as the basis for avoided emissions. Several issues/possible drawbacks were raised including:
   - Some estimates of build margins are based upon projections of power plant additions, some of which never come to fruition.
   - Some build margin estimates do not account for plant retirements. Instead of postponing or canceling new conventional power plants (e.g., natural gas plant), a new renewable power facility might actually hasten the retirement of an old existing plant (e.g., coal plant). The emissions factors between new build and retirement plants can differ widely.
   - As most panelists agreed, build margins reflect a longer-term impact of a new renewable power plant. Therefore, a build margin might make sense for projects that seek a constant, bankable "avoided emissions/MWh" figure that is used over a long time period (e.g., the 10–21 year time period under the Clean Development Mechanism). However, for applications that have more near-term application (e.g., a one-year REC purchase), the build margin impacts of a renewable power generator may not be relevant.
   - One question that was not resolved was whether the size, scale and distributed nature of renewable energy projects mean that their impact on build margins may be hard to identify. For instance, would 20 5-MW landfill gas projects scattered across Canada actually postpone or cancel the construction of a new 100-MW simple-cycle natural gas plant? In light of this, should there be a RE facility size threshold above which a build margin could be considered and below which an operating margin is used?

C. *What geographic scope is most appropriate?* Panelists and participants generally agreed that in light of how electricity systems function and where a renewable power generator would impact conventional generators, the *regional powerpool* is the most appropriate geographic scope for an "avoided emissions" factor. One question that was raised but not resolved was whether or not one should use an emissions factor for a region that can be smaller than a powerpool or that incorporates portions of several powerpools (e.g., an airshed).

D. *Should there be only one mutually agreed upon avoided emissions calculation methodology or several?* Most participants believed that it would be possible (and desirable) to agree on a *hierarchy* of approaches for calculating avoided emissions. The hierarchy could articulate, for instance, "if data x, y, and z are feasibly available, then use methodology 1", "if you only have data x, then use methodology 2", etc. The hierarchy could include an incentive mechanism that encourages users to utilize approaches that are likely to be more accurate but that may require more work or cost. For instance, a discount factor could be applied to the simple estimates that have a greater likelihood of being inaccurate.

E. *Should a central organization provide these emissions factors on a regular basis?* Participants were interested in having an independent third party provide emissions factors. For the US context, one option raised was to have the US EPA publish or post on its web site avoided emissions factors on a regular basis for all power pools. The data would be publicly available at low/no cost. The EPA could outsource the actual calculation of the factors to one or more independent firms. Some participants asked whether or not the power pools (ISOs) themselves should or would provide this information. Powerpool representatives asked in response why an ISO would conduct this analysis, given that they have no mandate or requirement currently to do so. This issue would need to be addressed. In some states there may be some emerging needs due to renewable portfolio standards compliance.

F. *How frequently should the data be provided?* Some participants suggested that the emissions factors be given for three- to five-year intervals. However, several people in the audience expressed concern that the data should not be more than a year old in order to ensure sufficient accuracy. As the marginal emissions factors of ISO NE indicate, emissions factors can change 5–15 percent over one or two years.

G. *Would the methodology used for estimating avoided CO_2 emissions be applicable to SO_2 and NO_x?* Panelists in the modelers/system operators session indicated that the approaches they presented would be applicable to all emissions. All of the models and approaches begin by looking at the impact of a renewable power facility on other power facilities in the regional grid. Based upon this physical impact on generating units, the approaches estimate the impact on resulting emissions. To the degree that the models take into consideration the presence (or lack of) emissions caps, the impact on all three emissions will be similarly affected. For example, a power plant ramping down to stay under an SO_2 cap will have a similar impact on its CO_2 emissions.

Several other issues that were raised during the meeting but that did not get discussed include:

- What role could "generation information systems" which are currently tracking renewable power generation and REC transactions in several US states/regions play in calculating avoided emissions?
- Is there a difference (and if so, what) between estimating emissions impacts in compliance markets and voluntary markets?
- How should the market and policymakers determine the "ownership" of avoided emissions and prevent "double-counting"?

- What role can Continuous Emissions Monitoring Systems (CEMS) data play?
- Can annual market reports from the ISOs serve as a sufficient data source?
- Should powerpool build margins be calculated on a case-by-case basis?

Next steps

Participants identified several possible next steps for developing a commonly agreed-upon approach to estimating the environmental benefits of renewable energy, including:

- Test various approaches to estimating marginal emissions rates (e.g., dispatch models, simple spreadsheet analyses) against real emissions data in a powerpool where the required information is relatively available (e.g., regulated market). This analysis would require a funder and organizer.

- Conduct a series of discussions with ISOs to determine:
  - What power plant generation and dispatch information they have
  - What could be made publicly available now ("as is")
  - What could be made publicly available if a third party (with whom the ISO has signed a confidentiality agreement) came in to analyze and then release aggregated data (preventing dispatch information on particular plants from being made public)
  - What remaining steps would need to be taken to provide sufficient data for determining marginal emissions rates

  Who would conduct this series of discussions with ISOs is yet to be determined.

- Over the next six months, the WRI/WBCSD Greenhouse Gas Protocol's Electricity Sub-sector Project Module will finalize its recommendations on which "avoided CO_2" emissions factors should be used for renewable energy and energy efficiency projects. Workshop participants are invited to provide input and serve as reviewers of the draft recommendations.

- The NAFTA CEC and US EPA will convene a follow-up workshop in six months (e.g., April/May 2005). During this event, participants will review the analyses and discussions completed between November [2004] and spring 2005 and agree upon a framework for avoided emissions calculations. Analyses to be shared include those being conducted for the EPA Climate Leaders initiative, the GHG Protocol Electricity Subsector Project Module, the Clean Development Mechanism, and others.

- This workshop focused on the specific issue of how to calculate the avoided emissions from grid-connected renewable power generation. Other issues were saved for later discussions. Going forward, some workshop participants may want to engage in dialogue to seek closure on some of the other issues. In particular, the US EPA could consider developing a series of discussions to address the issue of "ownership of emissions/emission reduction benefits" (e.g., emissions allowances, emissions credits) and the related issue of "emissions market design" (e.g., output-based allocations, renewable energy set-asides).