INTRODUCING THE GREEN POWER ANALYSIS TOOL

INSTALLMENT 4

BY DUNCAN AUSTIN

I. INTRODUCTION

Companies are increasingly interested in developing and procuring "green power"—energy derived from renewable sources such as wind, solar, landfill gas, and biomass. Companies are starting to explore green power sources for several different reasons. Some companies hope that purchasing or developing green power will enhance their reputation among key stakeholders who value environmental conservation. Similarly, green power can play a significant role in helping some companies meet their voluntary environmental commitments. Procuring green power can also be an effective way to pre-empt the impacts of emerging clean air and climate change regulations. In addition, green power can help lessen a company's exposure to the volatility of fossil fuel-based energy markets.

As corporate managers evaluate green power projects, they face a number of important questions. How much does green power cost relative to traditional energy sources? What does green power offer in terms of emissions reductions? How will the relative prices of green power and traditional energy sources change under future regulations? How much money might flow to green power purchasers or developers under existing and emerging emissions markets?

For the small but growing number of companies that have established voluntary environmental commitments ahead of formal regulations, there are additional questions. How much can green power options contribute to corporate environmental goals? What green power sources reduce emissions most cost-effectively? What combination of green power projects have to be implemented to achieve a corporate goal?

Unfortunately, many corporate managers lack the tools necessary to answer these questions. In working with large U.S. companies in the Green Power Market Development Group over the last two and a half years, World Resources Institute (WRI) has observed a number of barriers to addressing these issues. First, existing tools used to make energy procurement decisions are often focused exclusively on traditional factors such as cost and reliability and fail to account for the superior environmental attributes of green power sources, which either emit no pollutants or considerably

Accessing the Green Power Analysis Tool

This installment of the *Corporate Buyer's Guide to Green Power* introduces the Green Power Analysis Tool. The tool is a Microsoft Excel-based set of spreadsheets designed to help energy and environment managers make decisions about green power. WRI has developed this tool with the assistance of members of the Green Power Market Development Group. The tool is available for download free of charge at www.thegreenpowergroup.org/gpat. A support page of background information and useful web links is available at www.thegreenpowergroup.org/gpat/support.

The Green Power Analysis Tool permits corporate managers to analyze the economic and environmental attributes of one or more green power projects. Through an easy-to-use interface, users can research green power projects of interest and create tables and graphs that analyze green power projects either singly or in combination. The tool quantifies emissions reductions in CO_2, NO_x and SO_2 and the cost of achieving those reductions in dollars per ton. Users can input data about their own green power projects or learn more about green power markets by exploring several green power projects pre-installed into the tool.

less than conventional energy sources. These attributes may carry a monetary value under emerging regulations or internal corporate targets that conventional tools overlook. Second, decision-making for energy procurement and meeting environmental goals within a company often lies with different managers who pursue different goals with different metrics. Without the tools to integrate energy and environmental goals, companies that have established emissions reductions targets may miss out on cost-effective reductions. Third, there is no easy way for energy managers to come up to speed quickly on the characteristics and potential benefits of green power sources. There is often nowhere to turn for a quick "first cut" assessment of the viability of green power technologies to meet some part of a company's energy and environmental needs.

For these reasons, WRI has developed the Green Power Analysis Tool. The tool is a software program designed to help corporate managers evaluate green power projects and integrate energy and environment decision-making. The tool allows managers to analyze simultaneously the financial characteristics of green power projects and the contribution those projects make to clean air and climate change environmental goals. Amongst other things, the tool quantifies the reduced emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x) and sulfur dioxide (SO_2) associated with different green power projects and calculates the cost of achieving those reductions in standard metrics such as dollars per ton of emission avoided. The tool allows a more comprehensive assessment of green power options and a more robust comparison of green power and conventional generation sources than may be possible using existing energy procurement tools.

This installment of WRI's *Corporate Guide to Green Power Markets* accompanies the release of the Green Power Analysis Tool. *(See the Box on front cover for details on how to access the tool.)* This installment first identifies the business rationale for a Green Power Analysis Tool. It then describes how the tool is structured, and explains how corporate managers can input data on green power projects and corporate targets. Finally, the installment explains how managers can use the tool to analyze one or more green power projects and illustrates several of the tool's outputs.

II. THE BUSINESS RATIONALE FOR A GREEN POWER EVALUATION TOOL

While participating in the Green Power Market Development Group, the partner companies and WRI have jointly identified the need for an evaluation tool that allows corporate managers to assess simultaneously the economic and environmental aspects of green power projects. Companies are evaluating green power for several reasons. These include a desire to reap public relations benefits and an interest in finding energy sources that are less exposed to the volatile fossil fuel prices of recent years. However, the strongest incentives for companies to assess comprehensively green power's economic and environmental attributes come from two other factors:

1. emerging environmental regulations; and
2. increasing commitments from corporations to reduce their environmental footprint, irrespective of formal regulations.

The Corporate Guide to Green Power Markets

This publication is the fourth installment of the *Corporate Guide to Green Power Markets* series. Earlier installments of the *Corporate Guide* can be found online at **http://www.thegreenpowergroup.org/publications**. The first installment in the series provides an introduction to green power for corporate markets and the business case for green power. The second installment discusses corporate opportunities for using landfill gas as a green energy source. The third installment discusses how corporations can measure and record the climate benefits of green power through greenhouse gas inventories.

The *Corporate Guide* series is inspired by WRI's experience with the Green Power Market Development Group, a partnership that includes Alcoa Inc., Cargill Dow LLC, Delphi Corporation, The Dow Chemical Company, DuPont, General Motors, Kinko's, IBM, Interface, Johnson & Johnson, Pitney Bowes, and Staples.

Emerging Environmental Regulations

New regulatory programs are taking shape at both state and federal level that would extend the limits placed on several energy-sourced pollutants. The Administration's proposed Clear Skies Initiative aims to set national caps on NO_x, SO_2, and mercury emissions from power generation under a single framework.[1] Similar multipollutant approaches are being discussed in several states, including Massachusetts and New Hampshire. All else being equal, such programs could increase the attractiveness of green power options, which either emit no pollutants or considerably less than conventional alternatives.

An increasingly common feature of clean air programs is reliance on emissions markets in which emissions allowances (or emissions reductions) are actively traded by the regulated entities. Sulfur dioxide has been traded under the Acid Rain Program since 1995,[2] while NO_x allowances are currently traded by nine states in the Northeast.[3] Additional NO_x trading programs are scheduled to begin in May 2003 in response to the U.S. Environmental Protection Agency's (EPA's) call for State Implementation Plans to address transport of ozone pollution across 19 states in the Midwest, Southeast, and Northeast.[4] These future programs may well include specific energy efficiency and renewable energy 'set-aside' provisions through which green power would be eligible for NO_x allowances.[5]

In addition to regulatory action on conventional pollutants, CO_2 and other greenhouse gases (GHGs) may be regulated in the near future. Although the federal government has so far avoided introducing GHG constraints, a number of states are beginning to address climate change in ways that affect energy markets.[6] Massachusetts and New Hampshire are both seeking to regulate CO_2 emissions from electric utilities as part of their proposed multipollutant strategies. Oregon has established the United States' first formal standard for CO_2 releases from new electricity generating facilities. Moreover, the emergence of voluntary emissions markets—most notably the Chicago Climate Exchange®—anticipates the more widespread development of market-based limits for GHGs.

Action to limit GHG emissions is also underway in other countries. The United Kingdom established an Emissions Trading Scheme in 2002,[7] while Denmark has had a mandatory CO_2 Emissions Trading Program for its electric utilities since 2000.[8] The European Union is currently drawing up plans for an E.U.-wide CO_2 trading market to commence in 2005. Such initiatives ensure that many multinational companies will soon be operating under GHG constraints if they are not already. Moreover, many feel that the United States—the world's largest emitter of GHGs—will eventually adopt a similar climate protection program.[9]

These policy developments should encourage managers to consider green power options more fully than they might have in the past. Most energy managers will want to know how new policies could change relative fuel prices and/or create potentially valuable revenue streams in the form of emissions reductions credits.

Corporate Commitments to Environmental Improvement

In addition to regulatory developments, many companies are responding to pressure from key stakeholders for them to improve their environmental performance. Even ahead of formal regulations, a growing number of companies are adopting voluntary and public emissions reductions targets, particularly for GHGs. As of June 2002, 38 major U.S. companies had committed to some degree of GHG or energy reduction.[10] *(See Table 1 for an overview of selected commitments.)*

Companies are setting environmental commitments and targets for several reasons. From an internal perspective, targets effectively force managers to identify and implement emissions reduction measures that can leave the company better positioned to meet new regulations. From an external perspective, setting voluntary environmental commitments is an important signal to a variety of stakeholders. Shareholders, for example, may be relieved to know that companies that they have invested in are taking steps to prepare for future GHG constraints and to avoid potential GHG liabilities. Similarly, customers and the general public may

Table 1 Selected Corporate Voluntary Targets

Company	Target Description	Baseline against which reductions will be measured
ABB	Reduce GHG emissions by 1% each year from 1998 through 2005.	Annual
Alcoa	• Reduce direct GHG emissions by 25% by 2010. • Reduce NO_x emissions by 30% by 2008. • Reduce SO_2 emissions by 60% by 2010.	1990 2000 2000
Baxter International	Reduce energy use and associated GHG emissions by 30% per unit of production value by 2005.	1996
DuPont	• Reduce GHG emissions by 65% by 2010. • Hold energy use constant. • Source 10% of worldwide energy from renewables by 2010.	1990 1990 —
Eastman Kodak	• Reduce energy use by 15% by 2004. • Reduce GHG emissions from electricity by 20% by 2004.	2000 2000
GM	Reduce CO_2 emissions from North American facilities by 10% by 2005.	2000
IBM	• Reduce CO_2 emissions by 4% annually from 2000 to 2005. • Reduce PFC emissions from semiconductor manufacturing by 10% by 2005.	Annual 2000
Johnson & Johnson	Reduce GHG emissions by 7% by 2010 with an interim goal of 4% by 2005.	1990
Nike	Reduce CO_2 emissions by 13% by 2005.	1998

Note: PFC: perfluorocarbon
Sources: Climate Change Activities in the United States, June 2002, Pew Center on Global Climate Change; *Corporate Greenhouse Gas Reduction Targets*, November 2001, Pew Center on Global Climate Change; company websites.

value a company's willingness to tackle environmental problems sooner rather than later.

The Role for a Green Power Evaluation Tool

In the face of these developments, corporate energy managers increasingly need to be looking not only at the traditional financial aspects of energy sources, but also at the environmental attributes, many of which can be monetized now or could be in the near future. Environmental pressures, in particular, raise a number of issues for companies.

First, by penalizing traditional energy sources or rewarding cleaner energy technologies, future regulations could change the relative prices of energy procurement options. Understanding what changes are likely and how they may affect corporate energy spending should be a key part of a company's overall energy procurement strategy. At a minimum, most companies will be interested in understanding how new regulations will alter the energy playing field. Specific questions that companies may have include the following:

- How will the costs of green power compare with those for traditional energy sources under emissions markets?
- In future emissions markets, what price per unit of avoided CO_2 (or NO_x or SO_2) is required to make green power sources competitive with traditional generation sources?
- How much are emissions reduced by using green power instead of traditional energy sources?

Companies may want to get ahead of other energy purchasers in securing access to cleaner energy sources that may prove to be less costly as rules change. Consequently, companies may wish to analyze the impact on energy costs of varying market prices for CO_2, NO_x, or SO_2, perhaps introduced at different points in time. While it is impossible to know what the future holds, exploring the impact of different possibilities allows companies to develop energy portfolios that are more robust in the face of regulatory uncertainty.

A growing number of companies have established voluntary commitments to reduce emissions of air pollutants and/or GHGs or to increase use of renewable energy sources. These companies may have further questions to address, including the following:

- Which green power sources offer the most cost-effective emissions reductions?
- To what degree can different green power sources contribute to corporate environmental goals?
- What combination of emissions reduction projects is required to achieve corporate environmental goals?

Bringing together financial and environmental data is highly relevant for companies that have undertaken a voluntary commitment to reduce emissions. Such companies will have a clear incentive to achieve their environmental goal at the lowest overall cost or with greatest overall savings. Consequently, managers will need to identify what combination of options—including but not limited to green power projects or purchases—can attain the corporate goal for lowest overall cost.

In addition, a company that has taken on a voluntary commitment may find that responsibility for meeting the commitment lies with an environmental manager who is quite distant from energy procurement decisions that could impact the commitment. In such cases, decision-making can improve with the use of an analytical tool that combines the financial information required by the energy manager and the emissions information required by the environmental manager.

The Green Power Analysis Tool also serves a general informational need. For many companies, the novelty of renewable technologies and certain green power purchasing options may discourage further exploration and the setting of voluntary targets. There is no obvious first place to turn to do a quick initial assessment of the feasibility of green power projects and to ascertain some of the less evident benefits such as the associated environmental gains. A tool that allows energy managers to quickly grasp some of the key economic and emissions reduction characteristics of green power projects should be a significant aid to corporations considering green power for the first time.

III. INTRODUCING THE GREEN POWER ANALYSIS TOOL

To assist managers in addressing these questions, WRI has developed the Green Power Analysis Tool—a spreadsheet-based software tool. The tool analyzes financial and environmental aspects of green power projects and provides quantitative outputs in a series of tables and charts. The tool can analyze a single green power project, assess a portfolio of projects simultaneously, and compare green power projects with other emissions reductions strategies. The tool makes use of the latest information on energy-sourced emissions as compiled in EPA's Emissions and Generation Resource Integrated Database (E-GRID).[11] E-GRID is a comprehensive source of information on the environmental characteristics of electricity generation throughout the United States.

The Green Power Analysis Tool can accommodate the various different green power options available to companies. It can handle on-site technologies such as solar photovoltaics (PVs) and fuel cells, as well as off-site technologies such as wind and geothermal. It can accommodate the many green power technologies that generate electricity as well as the direct use of landfill gas (LFG) for heat and/or steam applications. The tool also handles the different ways in which companies might procure green power, including a company's own development of

Who Should Use the Green Power Analysis Tool?

The Green Power Analysis Tool is designed primarily for corporate energy managers and environment managers, and for their counterparts at the facility level. A number of other audiences might also find the tool useful. Large non-corporate energy buyers (e.g., hospitals, governments, and schools) could use the tool for the same reasons as corporate buyers. For green power suppliers, developers, and marketers, the tool provides a useful way to "step into the shoes" of potential customers, which could inform planning and marketing efforts. The tool may also prove useful for managers of electric utilities, federal and state environment and energy officials, and environmental groups.

green power, direct purchase of green power from a third-party developer, or procurement of renewable energy certificates (also known as "green tags").

The following explains the elements of the tool, using tables and graphs that appear in the program.

The Structure of The Green Power Analysis Tool

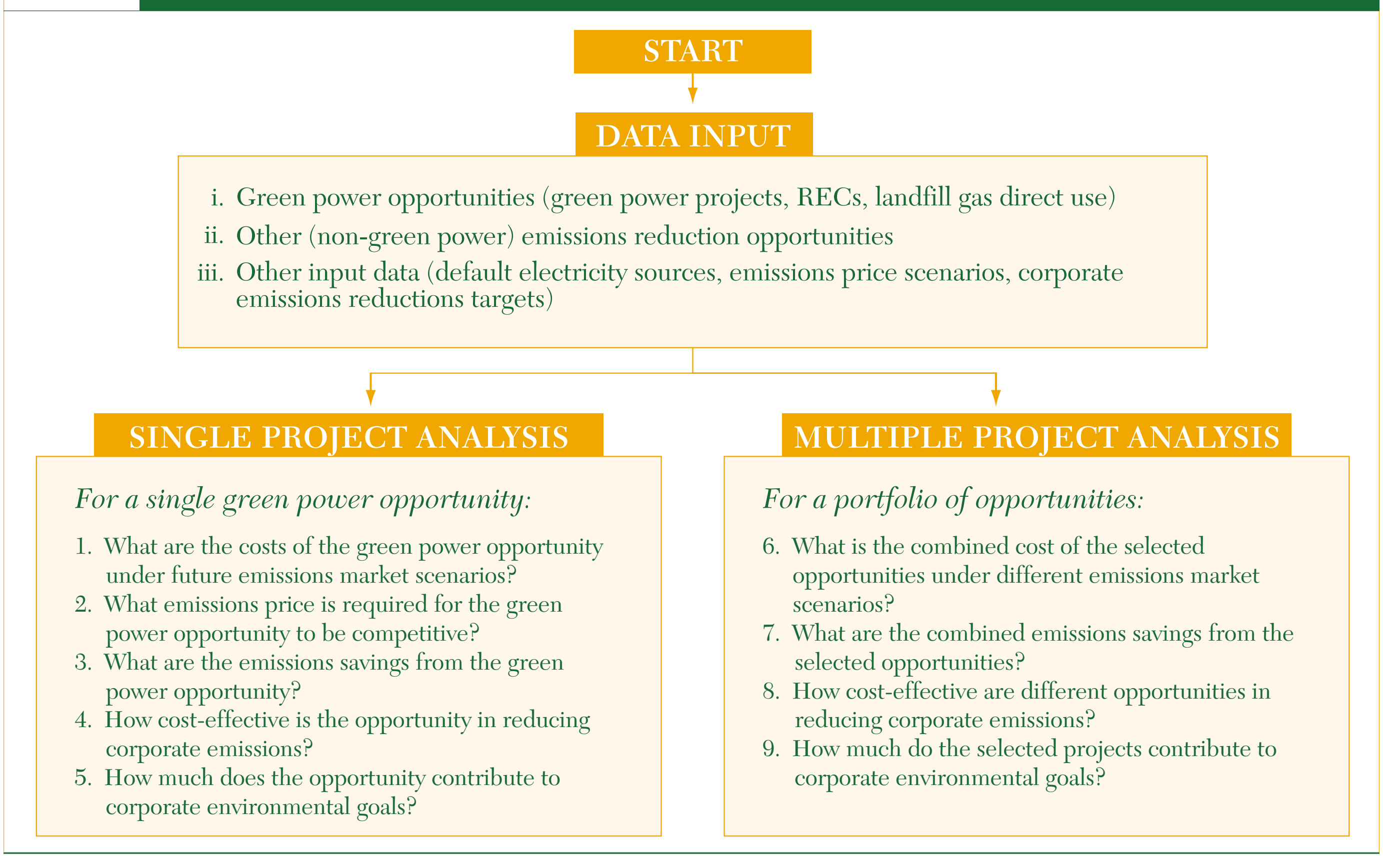
Figure 1 outlines the tool's overall workflow. The first step is to enter data into the Data Input section, which requests information required to evaluate green power projects and other emissions reduction opportunities. To help users get started, the tool provides a pre-installed database of several green power projects and information on default electricity sources and non-green power projects. Once downloaded, the program is fully functional without the need for any initial data input. Users who wish to get a feel for the application or who wish to develop their understanding of the economics of green power can use information on these projects as a starting point. Though information on green power projects is informed by actual projects that members of the Group have evaluated, for proprietary reasons the pre-installed project information is illustrative only.

Whether with their own information or the pre-installed data, users can perform detailed analysis on a single project in the Single Project Analysis stream or a broader analysis on a portfolio of projects in the Multiple Project Analysis stream. The Multiple Project analysis allows users to evaluate the combined effect of implementing several projects together, as well as to compare projects against each other. The following describes each section in turn.

Data Input

Though the tool has some pre-installed data, it will prove most useful once users begin to customize

Figure 1 Overview of the Green Power Analysis Tool's Workflow



it with data for particular projects of interest and with information about their own corporate goals. Users can customize the tool by inputting and storing data in five categories:

1. green power opportunities;
2. other (non-green power) emissions reduction opportunities;
3. other input data

These are described in more detail below.

1. Green Power Opportunities

Users can input information on the costs and environmental attributes of one or more green power opportunities in which they are interested. The tool is flexible enough to handle both (a) projects for which only cursory cost data are available and (b) projects for which more detailed information on the cost structure is known. This allows users to analyze projects in a quick, first-cut manner before going into more detail if a project merits further consideration. In addition, the ability to input detailed cost information also allows the tool to serve as a high-level pro forma worksheet against which to check quotes from renewables suppliers.

Similarly, the tool allows users to enter different information depending on whether they intend (a) to develop or directly purchase green power or (b) to procure renewable energy certificates. In addition, though most green power projects are electricity-based, the tool also allows users to enter information on LFG direct-use projects.

2. Other (Non-green Power) Emissions Reduction Opportunities

Green power is just one strategy companies can use to reduce their emissions. In addition, corporations can invest in energy efficiency projects that will both reduce pollution and save on energy usage. Companies can also buy emission reductions from external sources, either from a number of offset providers, such as Natsource and Trexler & Associates, or through bilateral trade of emissions between companies.

Users can enter information on other (non-green power) projects that could reduce CO_2 or air pollutants. By inputting summary information on the magnitude and cost of emissions reductions of such projects, users can evaluate a full spectrum of reduction options that may be available to a company. Essentially, the tool provides a platform to compare different types of emissions reduction projects—green power and non-green power—that may contribute to corporate goals or cost reduction efforts under new regulations.

(Users should note that the Green Power Analysis Tool has thus far been developed primarily to analyze green power projects. Though non-green power projects can be input into the tool and analyzed, the input interface for these projects is less extensive and may require separate calculations to be performed outside of the program. In addition, while non-green power projects can be fully analyzed in the Multiple Project Analysis section of the tool, some of the calculations in the Single Project Analysis section are not designed to evaluate non-green power projects.)

3. Other Input Data

Default Electricity Sources

Much of the analysis in the tool is done by comparing green power opportunities against the default electricity sources that would be displaced. For green power projects, the user interface requests information on both the future costs and the emissions profile of the default electricity source. In most cases, the default electricity source will consist of conventional electricity generation that the company currently procures. However for direct-use landfill gas projects, the default energy source will likely be a direct fuel supply such as natural gas, oil, or coal. The net costs and emissions reductions of a new green power project are then calculated by comparing to the costs and emissions associated with the default electricity source.

The emissions benefits of a particular green power project are sensitive to the emissions baseline against which it is measured. For example, a wind project that displaces electricity generation from a coal-fired power plant will reduce more emissions than an identical wind project that displaces power from a natural gas-fired power plant.

In practice, determining which electricity source—and which associated emissions—are displaced by the introduction of a green power project is a highly complex issue. The commingling of electrons on the grid makes it almost impossible for a company to know the specific source of their electricity.[12] Consequently, measures of displaced emissions tend to be based on the average emissions profiles of generation sources that feed power to relevant parts of the electricity grid. However, even this presents problems. For example, what is the appropriate level at which to take an average: the utility level, the Power Control Area (PCA) level, or the national level? The utility level seems most intuitive, but many utilities are small and effectively rely on other generation sources to supply power to their customers for some or all of the time. In addition, utilities frequently buy or divest generating assets, making the associated emissions profile something of a moving reference to measure against. On the other hand, while using a nationally averaged emissions profile across all generation sources in the country creates a more stable reference, it raises a conceptual problem. A wind farm installed in Ohio will likely offset a lot more emissions—by displacing the predominant coal generation in that region—than a wind farm in Washington where the emissions associated with electricity generation are lower because of the large share of hydropower in that region's energy mix. Using a national average fails to capture these differences.

There are other issues as well. In calculating the emissions avoided by a new wind farm, should a manager use *average* emissions rates or *marginal* emissions rates (i.e., emissions associated with the specific generating source that would be backed down as the wind turbines started to generate power)? There is also a timescale problem. For a wind project with a 10-year lifespan, should one assume that the emissions displaced in the first year are the same as the emissions displaced in the last year, given that the underlying generation sources are likely to change (i.e., with addition of new plants and retirement of older plants)?

Unfortunately, there is no universal standard for measuring avoided emissions. In the absence of such a standard, the Green Power Analysis Tool aims to be flexible and allows users to analyze emissions reductions by selecting different levels of default electricity source as specified in the E-GRID database.

In selecting average emissions rates for default electricity sources, users can choose from a database that includes the 120 separate PCAs, the 50 states, the 27 E-GRID-defined national subregions or the 12 North American Electric Reliability Council subregions. The tool also allows users to input their own specific default emissions if they have more detailed knowledge about the environmental profile of their existing electricity mix.

Emissions Price Scenarios

Future regulatory systems may increasingly use market-based approaches in which companies can buy and sell emissions allowances (or emissions reductions) at a market-clearing price. Regulated markets for NO_x and SO_2 already exist, while voluntary markets for CO_2 and other GHGs are just emerging.

As companies explore the implications of emissions markets, some have developed working rules of thumb for how to value emissions reductions. Royal Dutch Shell, for example, has instituted an internal budgeting policy that requires planners to place a shadow value on the CO_2 emissions associated with proposed projects. Many more companies are interested in testing the sensitivity of green power project costs to a range of different future emissions prices.

To allow companies to assess the viability of projects under different emissions price scenarios, users can input a number of different trajectories for emissions prices between now and 2025. Price trajectories can be entered for CO_2 or GHGs (in metric tons of CO_2 equivalent) and for NO_x and SO_2. Users can create trajectories by specifying four different parameters:

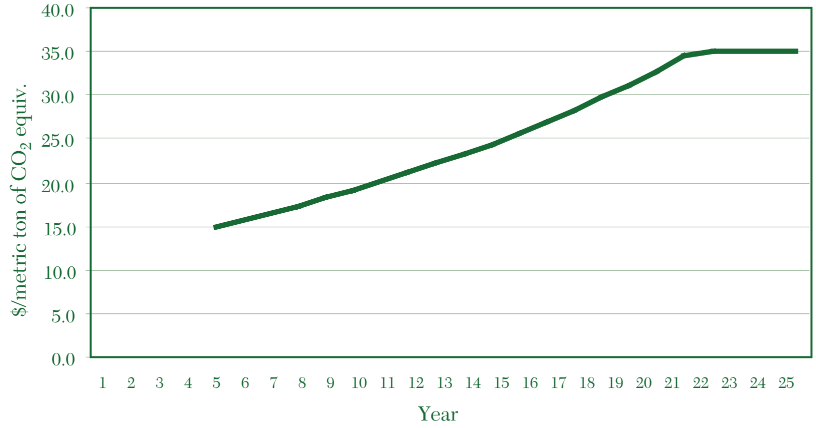
- starting year (between years 1 and 25)
- starting price
- annual rate of change in price
- price ceiling (i.e. price that cannot be exceeded)

Users can also visualize the impact of parameter changes by referring to the relevant trajectory graph. *(See Figure 2 for an example of input parameters and a graph for a CO_2 price trajectory.)* In addition, to aid users who are new to thinking about emissions prices, the Green Power Analysis Tool includes a small number of preinstalled price trajectories based on past market data and economic modeling forecasts.

Figure 2 **Specifying a Future Price Trajectory for CO_2 Emissions**

Carbon Dioxide (CO_2) Price Trajectory

Starting Year		5
Starting Price	\$/metric ton of CO_2 equiv.	\$ 15
Growth Rate	percent increase per year	5%
Ceiling Price	\$/metric ton of CO_2 equiv.	\$ 35



Corporate Emissions Reductions Targets

To allow the Green Power Analysis Tool to measure a company's progress towards an emissions target, users can input information about the details of a corporate target. Besides differing in terms of overall level of commitment, company targets established to date also differ structurally. Some companies have expressed environmental goals in terms of reductions in greenhouse gases (e.g., CO_2 or methane) and/or air pollutants (e.g., NO_x or SO_2), while others have aimed for general reductions in energy use or increased use of renewables as a proxy for environmental improvement. Some companies have set targets in absolute terms (i.e., a fixed number of pounds or metric tons), while others have opted for relative improvements that measure emissions reductions relative to some measure of business activity (e.g., pounds of CO_2 per unit of output). In addition, some companies are concerned only with the levels attained in a final target year, while other companies have multi-year targets that place emphasis on progress made in interim years. Finally, some companies have multiple goals. *(See Table 1 for an overview of selected corporate voluntary targets.)* The Green Power Analysis Tool is designed to be flexible enough to accommodate most of the target structures that have been adopted to date.

These data input options allow the user to customize the tool. Users can also adjust the discount rate throughout the tool to ensure that the analysis is consistent with other analysis done within the company. In addition to information preinstalled in the tool, a set of web links on the Green Power Market Development Group website will allow users to identify relevant information, such as recent prices of emissions. These links will be maintained over time. The information will be available at www.thegreeenpowergroup.org/gpat/support.

Project Analysis

After entering their information, corporate managers will want to perform different types of analyses. First, a corporate manager may want to explore in detail the specific economic and environmental characteristics of a single green power project. The tool can provide quantitative analyses to help managers address a number of questions at the level of the individual project.

Second, corporate managers may be interested in assessing the combined contribution of a portfolio of projects, perhaps undertaken over different time periods. The tool provides answers to a series of questions relevant for evaluating combinations of projects. In this second cluster of analyses, a user can both compare individual projects against each other and calculate the combined impact of implementing more than one project.

To illustrate some of the tool's capabilities and analytical outputs, the descriptions and figures below make use of the following fictitious example. ACME is a large U.S. manufacturing corporation that is a major purchaser of electricity. The company has started its search for green power projects by looking at a wind farm in Texas.

ACME is considering signing a power purchase agreement to take the power from a new 5 megawatt (MW) wind farm that would provide 16,206 MWh of electricity annually for 10 years. ACME has contracted with the wind power generator to secure the power at a flat delivered cost of 5.1 cents per kilowatt hour (¢/kWh) for the life of the project. The contract also passes all claims to the environmental benefits to ACME.

The wind-derived electricity would displace some of the electricity currently provided by a utility in the ERCOT ISO. ACME forecasts that the price of electricity from the utility will rise at 0.5 percent per year over the next 10 years from its current level of 4.6 ¢/kWh. ACME's energy manager has chosen to base his environmental analysis against the average emissions profile of the entire ERCOT ISO.

A Key Assumption: Ownership of Environmental Attributes

An important assumption made throughout the Green Power Analysis Tool is that the user owns all of the emissions reductions associated with a green power project. For projects that a company develops itself, this should not be in question. Similarly, green tags confer explicit ownership of emissions reductions associated with a green power project to the purchaser even if the purchaser is not receiving the underlying power.

However, for power purchased from a third party such as a green power developer or power marketer, companies will need to ensure that they are the legitimate owners of the emissions reductions and also that they are the sole owners (i.e., that the developer is not also laying claim to the same emissions reductions). If regulatory systems establish the renewable developer as the default recipient of allowances, a company seeking ownership of the emissions reductions will have to secure them by contracting with the developer.

Single Project Analysis

Using this feature, a specific green power project can be analyzed. Once a green power project and a default electricity source are selected from the Single Project Analysis menu, the tool answers the following key questions about the project in a series of separate worksheets:

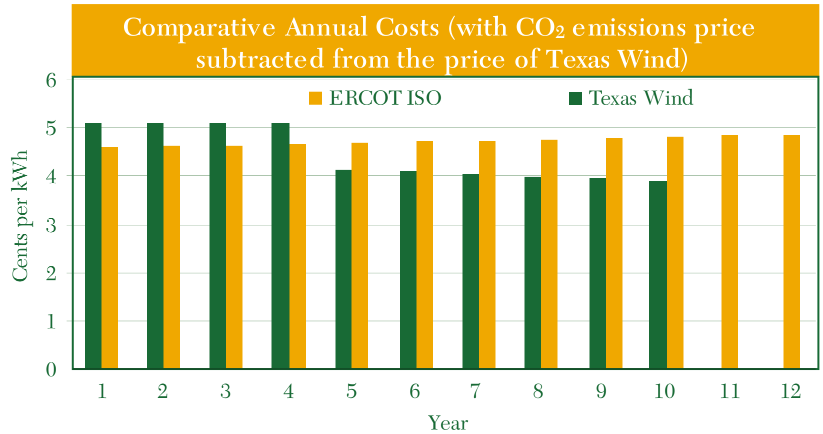
What are the costs of the green power opportunity under future emissions market scenarios?

One of the first things managers will probably want to assess is the relative costs of green power and conventional energy sources under different scenarios for future regulations and emissions markets. The Green Power Analysis Tool shows corporate managers the impact of future emissions markets on the relative costs of green power and default electricity sources, by assuming that new emissions markets create prices for emissions allowances (or emissions reductions). *(See Figure 3.)* Users can test sensitivity to emissions markets implemented for one or more of the three main emissions categories: CO_2 (and other GHGs), NO_x and SO_2. The analysis is based on the emissions price trajectories created on the Emissions Price Scenarios input page described above.

In addition, the structure of a future emissions market may be unknown. For example, in a "downstream" emissions market, green power generators or green power end users could earn excess emissions allowances or credits for emissions avoided, thereby lowering the net cost of green power. An alternative approach would create a comparable incentive by incorporating the environmental costs associated with traditional fuels into the "upstream" price of the fuel, thereby increasing the net cost of traditional energy sources. If these alternative approaches are equivalent in terms of overall emissions limits, they would generate the same price differential between green and traditional power sources, but have different implications for absolute prices of the two energy sources. Consequently, the main graph on this worksheet can be alternately set to show the yearly net costs of green power and the default electricity source assuming either that green power costs will be offset by emissions values (shown) or that default electricity costs will be increased by emissions values.

Figure 3

SAMPLE OUTPUT FROM THE GREEN POWER ANALYSIS TOOL:
What are the Costs of the Green Power Opportunity under Future Emissions Market Scenarios?



Summary of Life of Project Costs

NPV of Texas Wind costs:	$ 5,586,374
NPV of equivalent ERCOT ISO costs:	$ 5,133,693
Without accounting for CO_2 emissions values, choosing Texas Wind to displace ERCOT ISO leads to net costs of:	$ 452,681
NPV of selected CO_2 emissions values:	$ 567,921
Choosing Texas Wind to displace ERCOT ISO leads to net savings of:	$ 115,241

ACME's manager is interested in testing the sensitivity of the Texas Wind project to a particular CO_2 price trajectory. He has previously entered a price trajectory *(see Figure 2)* in which CO_2 prices appear in Year 5 at a forecast price of $15 per metric ton of CO_2 equivalent growing at a rate of 5 percent per year, but not exceeding $35 per metric ton of CO_2 equivalent. Under that price trajectory, the Green Power Analysis Tool calculates that the green power project could earn emissions reduction credits equal to $567,921 in net present value (NPV) terms. *(See Figure 3.)* With this additional revenue stream, the Texas Wind project saves ACME $115,241 compared to a business-as-usual scenario in which the company continues to use its default electricity source. In addition, the manager can review the annual stream of costs of the green power and default electricity projects. In this case, a regulatory policy that is structured to lower the net cost of green power shows the absolute price of green power starting at 5.1 ¢/kWh and slowly falling to 3.9 ¢/kWh in Year 10.

What emissions price is required for the green power opportunity to be competitive?

Managers may also want to examine the sensitivity of a green power project to future emissions prices from a different perspective by analyzing what emissions price needs to emerge for the green power project to be as competitive as the default electricity source. The Green Power Analysis Tool can determine what emissions price (the break-even price) for any one of the three gases will be required over the course of a green power project for the project to be competitive with existing electricity sources. The tool generates several metrics to accommodate different possible cost structures of the energy sources being compared. *(See Figure 4.)*

The graph in Figure 4 shows the value for the selected emissions type (CO_2 in this case) that would be required each year for the costs of the green power project to equal the costs of the default electricity source in that year. This information is then condensed into a single summary

Figure 4

Sample Output from the Green Power Analysis Tool:
What Emissions Price is Required for the Green Power Opportunity to be Competitive?

Calculating Constant CO_2 Emissions Price Needed for "Break-Even" of Texas Wind Project

NPV of Texas Wind costs:		$ 5,586,374
NPV of equivalent ERCOT ISO costs:		$ 5,133,693
Implied NPV required from future CO_2 equivalent prices for Texas Wind to be as competitive as ERCOT ISO:		$ 452,681
Levelized emissions price required for 'break-even' over life of Texas Wind project:	$/metric ton of CO_2 equivalent	$ 6.47

statistic—the break-even price that would be required in each year of the project for the green power opportunity to be competitive with the default electricity source.

The table in Figure 4 indicates how this is calculated. In our example, ACME finds that the NPV of the 10-year Texas Wind project is $5,586,374 compared to the NPV of $5,133,693 from buying an equivalent quantity of electricity from the default electricity source over the same time period. Consequently, for Texas Wind to be competitive, ACME needs a revenue stream from future emissions credits equivalent to $452, 681 in NPV terms (i.e., the difference between the NPVs of the green power project cost stream and the baseline electricity cost stream). Because many different emissions price trajectories could elicit this present value dollar amount, the tool then works out what the equivalent *constant* price of emissions would have to be throughout the project's lifetime to make up the difference. If the discount rate is 10 percent, a levelized emissions price of $6.47 per metric ton of CO_2 equivalent will generate the needed $452,681.

What are the emissions savings from the green power opportunity?

Many managers will also be interested in the absolute emissions quantities that could be avoided by green power projects. The tool calculates the emissions savings from a green power project, expressing results as both pounds of emissions avoided per megawatt hour (MWh) and as metric tons of emissions avoided per year.

By switching some of its electricity needs from its local utility in the ERCOT area to the Texas Wind project, ACME avoids 10,346 metric tons of CO_2 equivalent, 16 tons of NO_x, and 22 tons of SO_2 per year. Over the life of the project, the total savings are 103,456 metric tons of CO_2 equivalent, 165 tons of NO_x, and 215 tons of SO_2 (not illustrated).

How cost-effective is the green power opportunity in reducing corporate emissions?

Many managers at companies that face emissions targets will want to know how cost-effective a green power project is in reducing emissions. The tool provides this information for individual green power projects by computing the implied dollar value per ton of emission avoided for any of the three main gases: CO_2, NO_x and SO_2.

Again, in order to account for changing costs over the life of a project, this calculation is based on the NPVs of the cost streams for the green power and default electricity sources. ACME finds that buying electricity from the Texas Wind project imposes an additional cost of $452,681 and leads to emissions reductions of 103,456 metric tons of CO_2. Consequently, the project reduces carbon emissions at a cost of $4.38 per metric ton of CO_2 avoided (not illustrated).

How much does the green power opportunity contribute to meeting corporate environmental goals?

Companies that have established emissions reduction goals will want to know how much the green power project in question contributes to meeting those goals. The tool measures the contribution of an individual green power project in different ways depending on the details of the corporate target that the user has previously entered.

ACME has committed to reducing its CO_2 emissions 10 percent by 2010 relative to 2000 levels. The tool allows ACME managers to calculate and display (both numerically and graphically) how much the Texas Wind project will contribute to achieving this goal (not illustrated).

Multiple Project Analysis

In the final section of the tool, the user can explore the financial and environmental implications of multiple projects simultaneously. These projects are not limited to green power, but can include other types of emissions reduction projects such as energy efficiency investments or purchase of emissions offsets from third parties.

To conduct analysis on multiple emissions reductions opportunities, the manager must first select the projects of interest. For each project, the manager must also specify which default electricity source each individual project is to be compared against. This allows users to be able to measure the relative environmental benefits of implementing the same project at alternative locations. For example, the installation of a solar photovoltaic array may be possible at different company facilities where displaced electricity sources (e.g., utilities) would be different. For some projects (e.g., renewable energy certificates) the emissions savings are independent of a default electricity source. Consequently, when selecting certain projects for analysis, the Green Power Analysis Tool disables the default electricity source.

As with the single project analysis outputs, the tool provides answers to a sequence of questions, many of which mirror those described above. The questions include the following:

What is the combined cost of the selected opportunities under future emissions market scenarios?

Corporate managers may want to test the sensitivity of a portfolio of projects to future emissions price trajectories. The relevant worksheet summarizes the costs for the selected projects both individually and together. Managers can test the sensitivity of overall costs by applying one or more of the price trajectories for CO_2, NO_x, or SO_2 previously specified in the data input section of the tool.

What are the combined emissions savings from the selected opportunities?

Managers may also want to know the aggregate quantity of emissions avoided by pursuing more than one project. The tool calculates the total emissions avoided by the projects (singly and together) for the full lifetime of the projects. The tool also graphs the annual emissions avoided showing the contribution of different projects.

How cost-effective are different opportunities in reducing corporate emissions?

In order to set priorities, companies have an obvious interest in assessing which projects achieve emissions reductions at the lowest cost. To assist with this process, the tool ranks the selected projects in terms of cost-effectiveness, allowing users to see which projects should be implemented first. The tool creates two graphs to help managers prioritize projects and determine how many projects to implement. One graph shows the marginal cost of attaining different levels of overall emissions reduction (the “marginal abatement cost curve”). A second graph shows the total cost to the company of achieving different levels of emissions reductions.

Figure 5

Sample Output from the Green Power Analysis Tool:
How Cost-effective are Different Opportunities in Reducing Corporate Emissions?

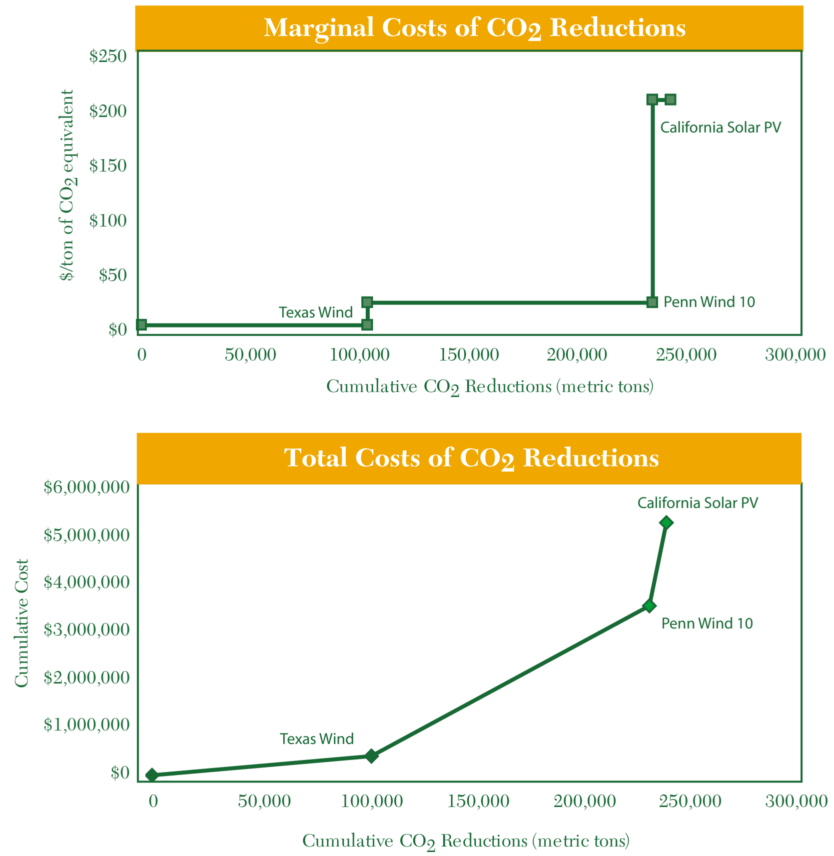


Figure 5 illustrates the results from ACME's analysis of three green power opportunities: One solar photovoltaic and two wind projects. Among the three options, Texas Wind is the most cost-effective in achieving emissions reductions while Penn Wind 10 avoids the largest amount of emissions.

How much do the selected opportunities contribute to corporate environmental goals?

As with the single project analysis, managers may be interested in assessing how far a group of projects goes to meeting the corporate target. The final worksheet summarizes the aggregate contribution of the selected projects to the corporate target specified by the user. The user can gauge progress toward both a simple end-year target and the annual progress if the target specifies interim year or annual targets.

IV. CONCLUSION

One hindrance to the uptake of green power has been the lack of sufficient analytical tools that can compare traditional and green power sources on an equal basis. Traditional cost-focused metrics almost always overlook green power's environmental benefits, some of which may be monetized now or in the near future. Also inhibiting a proper evaluation of green power by companies is the frequent division of energy and environmental management responsibilities within a company. Even though energy procurement strategies are central to the realization of both environmental and energy goals, a common framework may not exist through which two different types of manager can achieve their goals. Finally, the complex nature of green power technologies—and the relatively small role green power has played in energy markets to date—has made it easy for busy energy managers to overlook green power as a viable procurement strategy.

WRI has developed the Green Power Analysis Tool to overcome these barriers. By capturing the absolute quantities of emissions reductions, and the potential monetary value of those reductions, it should be easier to compare traditional and green power sources in a more comprehensive way. Doing so also provides a common set of metrics that allows energy and environment teams to recognize and understand the trade-offs between their overlapping goals and responsibilities. Furthermore, a tool like this should greatly reduce the start-up time for energy managers looking to understand some of the characteristics and benefits of green power in more detail.

ACKNOWLEDGMENTS

The author thanks Kevin Baumert, Amy Cassara, Craig Hanson, Jennifer Layke, Jay McAllister, and Amy Sprague of WRI for kindly reviewing early drafts of this installment. The author thanks Quayle Hodek, Rick Morgan, and Chandra Shah for their insightful comments. In addition, Buddy Hay and other corporate members of the Green Power Market Development Group made numerous helpful contributions and suggestions. The author thanks Matthew Markoff for his invaluable assistance in developing the software tool that accompanies this installment. The author is also grateful to Maggie Powell and Martha Schultz for their help in producing this installment.

WRI would like to thank those who currently support the Green Power Market Development Group including The Pew Charitable Trusts, The Energy Foundation, the Oak Foundation, and the Spencer T. and Ann W. Olin Foundation. WRI also would like to thank all of the Group's collaborators and the many suppliers and developers with whom we have engaged. The author alone is responsible for the views and opinions expressed in this installment.

NOTES

1. See http://www.epa.gov/air/clearskies/basic.html.
2. See http://www.epa.gov/airmarkets/arp/index.html.
3. See http://www.epa.gov/airmarkt/otc/overview.html.
4. See http://www.epa.gov/airmarkets/fednox/index.html.
5. See http://www.epa.gov/appdstar/state_local_govnt/state_outreach/
6. Rabe, Barry, "Greenhouse and Statehouse: The Evolving State Government Role in Climate Change" November, 2002, Pew Center on Global Climate Change.
7. See http://www.defra.gov.uk/environment/climatechange/trading/
8. See http://www.ens.dk/sw1084.asp
9. In January 2003, Senators McCain and Lieberman introduced a bill (S.139) proposing a nationwide trading program for GHGs to cover sectors representing 85 percent of the United States' overall GHG emissions.
10. Climate Change Activities in the United States, June 2002, Pew Center on Global Climate Change.
11. See http://www.epa.gov/airmarkets/egrid/. The tool uses E-GRID2002 data, version 1.0, based on data from the year 2000.
12. Of course, this should not be a problem for direct use of landfill gas, which will replace a measurable quantity of natural gas, oil, or coal that the company is already purchasing.

The World Resources Institute is an environmental think tank that goes beyond research to create practical ways to protect the Earth and improve people's lives. Our mission is to move human society to live in ways that protect Earth's environment for current and future generations.

Our program meets global challenges by using knowledge to catalyze public and private action:

- *To reverse damage to ecosystems.* We protect the capacity of ecosystems to sustain life and prosperity.
- *To expand participation in environmental decisions.* We collaborate with partners worldwide to increase people's access to information and influence over decisions about natural resources.
- *To avert dangerous climate change.* We promote public and private action to ensure a safe climate and sound world economy.
- *To increase prosperity while improving the environment.* We challenge the private sector to grow by improving environmental and community well-being.

In all of its policy research and work with institutions, WRI tries to build bridges between ideas and actions, meshing the insights of scientific research, economic and institutional analyses, and practical experience with the need for open and participatory decision-making.

For over a decade, WRI's Sustainable Enterprise Program has harnessed the power of business to create profitable solutions to environment and development challenges. WRI is the only organization that brings together corporations, entrepreneurs, investors, and business schools to accelerate change in business practices. The program improves people's lives and the environment by helping business leaders and new markets thrive.

World
Resources
Institute

ISBN 1-56973-549-2