U.S. Department of Energy
Clean Energy Application Center
NORTHWEST

Promoting CHP, District Energy, and Waste Energy Recovery for the states of Alaska, Idaho, Montana, Oregon, and Washington

Selling Carbon Offsets from Your Clean Energy Project

Prepared by:
Carolyn J. Roos, Ph.D.
Washington State University
Extension Energy Program
P.O. Box 43165 • Olympia, WA 98504-3165
(360) 956-2004 • Fax (360) 236-2004 • TDD (360) 956-2218

October 2009

WSUEEP09-031

Cooperating agencies: Washington State University Extension Energy Program, U.S. Department of Energy, Alaska Energy Authority, Idaho Office of Energy Resources, Montana Department of Environmental Quality Energy Program, and Oregon Department of Energy

blank

About the Author

Carolyn Roos, Ph.D., is a mechanical engineer with the Washington State University Extension Energy Program. She provides technical support to the Northwest Clean Energy Application Center with a focus on clean heat and power (CHP), waste heat recovery, district heating, and biopower/gasification CHP applications. She has experience in building systems energy efficiency, mechanical design in hydroelectric facilities, solar thermal applications and provides technical assistance to commercial and industrial clients on energy system efficiency topics. Carolyn can be contacted by email at roosc@energy.wsu.edu.

Acknowledgements

This study was funded by the Northwest Clean Energy Application Center with support funding from the U.S. Department of Energy's Industrial Technologies Program and from the State of Washington.

Disclaimer

Contents

About the Author i
Acknowledgements i
Disclaimer i
Introduction 1
Key Points 2
About Clean Heat and Power 2
Who Buys Carbon Offsets? 3
Where Can Offset Projects Be Located? 4
How Are Carbon Offsets Measured? 5
How Are Carbon Offsets Quantified? 6
How Are Carbon Offsets Registered and Verified? 6
Can Carbon Offsets be Claimed for All Emission Reductions? 7
What Should Be Considered in Selecting a Standard? 8
How Does Climate Legislation Affect the Offset Market? 9
How Can You Create an Inventory of Your Emissions? 10
What Are Some Examples of Carbon Offset Projects? 11
Oregon State University Cogeneration -- Climate Trust of Oregon 11
Brubaker Farm Methane Digester -- NativeEnergy 12
How Are Emissions Reductions Calculated? 13
Emission Factors of Fossil Fuels 13
Emission Factors for Electricity Use 13
Baseline Calculation and Average Emission Factors 14
Energy Conservation Projects and the Operating Margin 15
Renewable Energy Projects and the "Build Margin" 16
Resources and Tools 17
News Sources 17
Overview and Summaries of Carbon Offsets 17
Emission Calculation Tools 18
Data Sources 18
Financial Analysis Tools 18
References 20

Introduction

Some energy efficiency and renewable energy projects can be made viable by selling "carbon offsets" or "carbon credits." A carbon offset is a tradable financial unit – similar to a stock share – representing a certain quantity of greenhouse gas emission reductions due to implementing a project. Carbon offsets from projects across the U.S. have been actively traded on voluntary markets since 2003 from a variety of project types including renewable energy, energy efficiency, methane-abatement, and forestry land projects.[1]

At its essence, carbon offsets are first created by implementing a project (such as an energy efficiency or renewable energy project implemented at a facility) that reduces greenhouse gas emissions. These offsets are sold by that facility into the market, typically through intermediaries, to buyers.

The demand for carbon offsets is created in two ways. First, carbon offsets can be sold on the over-the-counter retail market to buyers that have an interest in mitigating climate change. Second, most cap-and-trade systems – such as the Chicago Climate Exchange (CCX), the Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative (WCI), and the proposed U.S. cap-and-trade system – permit participants to meet a fraction of their obligation to limit emissions by purchasing carbon offsets from others.[2]

To have value, the carbon offsets you sell must be certified in accordance with rigorous standards that are accepted in carbon markets now and will be accepted by the proposed cap-and-trade systems. The price you can obtain in current markets depends on the standard you use. The Voluntary Carbon Standard (VCS) is the most popular and dominant standard in the U.S. Others are Green-e Climate (Green-e), the Chicago Climate Exchange (CCX), the California Climate Action Registry (CCAR), and the Clean Development Mechanism (CDM) Gold Standard. Information on market prices and trends for certified offsets can be found in New Energy Finance's *Voluntary Carbon Index*, published bimonthly at http://carbon.newenergyfinance.com/.

It is widely expected that federal climate legislation that includes emission caps will be enacted within the next few years. Even if not on the federal level, cap-and-trade systems that include carbon offsets are in effect or being developed in regions of the U.S. By increasing the demand for offsets, cap-and-trade systems that include them are an enormous boon to the carbon market. The larger the offsets allowed by a system, the greater it increases the demand for offsets. All the federal and regional cap-and-trade systems being considered in the U.S. (or, for the case of RGGI, now in effect) allow

[1] In 2007 voluntary offsets sold were comprised of 31% renewable energy, 18% energy efficiency, 16% methane-abatement, and 18% forestry land projects.

[2] "A 'cap' is a legal limit on the quantity of greenhouse gases our economy can emit each year. …'Trade' means that, by law, companies may swap among themselves the permission to emit greenhouse gases." (Durning 2009)

regulated entities to purchase offsets to a greater or lesser extent.[3] The enactment of a U.S. federal system in particular would create the largest offset market in the world by far.

Key Points

This publication will answer some questions about selling carbon offsets from your energy project. Key points include:

- Carbon offsets have been sold from projects located throughout the U.S.
- Carbon offsets have been sold from a variety of projects including renewable energy, energy efficiency, methane-abatement, and forestry land projects.
- Climate legislation now in development will significantly increase demand and deliver a huge stimulus to the carbon offset market in North America.
- To get started, contact an offset marketer or broker who can assist you in the process. After an initial screening, an energy analysis must be performed to estimate emissions reductions of your proposed project.
- Carbon offsets must be quantified, registered, certified and verified according to a rigorous standard. All of these steps take time, which must be considered in planning your project.
- Carbon offsets cannot be sold from all projects that reduce carbon emissions. Emission reductions must be demonstrated to be real, "additional," verifiable and enforceable. The project must be faced with one or more barriers that would have made it infeasible without revenues from carbon offsets.

About Clean Heat and Power

This factsheet is one in a series on Clean Heat and Power. Clean Heat and Power refers to clean, efficient local energy generation, including but not limited to combined heat and power, recycled energy, bioenergy, and other generation sources that lead to a demonstrable reduction in global greenhouse gas emissions. For more information refer to:

- The Northwest Clean Energy Application Center, http://www.chpcenternw.org/
- The U.S. Clean Heat and Power Association, http://www.uschpa.org

[3] If enacted, the federal cap-and-trade system passed in the U.S. House of Representatives and under consideration in the Senate would permit up to 30% of an entity's obligation to be obtained through carbon offsets in 2013, increasing to 66% by 2050. The Western Climate Initiative, which is scheduled to take effect in 2012, will allow its regulated entities to use carbon offsets to meet 49% of their required greenhouse gas (GHG) emissions reductions. RGGI, which covers the Northeast U.S. and took effect in 2008, allows its regulated entities to use carbon offsets to meet only 3% of their required GHG emissions reductions and tightly restricts the type of projects that can qualify.

Who Buys Carbon Offsets?

There are many businesses and organizations to which project developers can sell carbon offsets. Carbon offsets can be sold along the following avenues:

- To "credit aggregators"[4] or consolidators, such as Environmental Credit Corp.
- To over-the-counter offset retailers, such as NativeEnergy
- To non-profit organizations, such as The Climate Trust
- Through partnerships such as AgRefresh and the Pacific Northwest Direct Seed Association
- Directly to private companies such as Walmart, DuPont, and Morgan Stanley, who are voluntarily purchasing carbon credits
- To U.S. Native American tribes who have signed the Kyoto Protocol and purchase carbon offsets to meet their treaty requirements
- Directly on the Chicago Climate Exchange (large projects only)

Contact information for many offset marketers and brokers can be found at:

- Chicago Climate Exchange: www.chicagoclimateexchange.com/content.jsf?id=64 Marketers and brokers are listed under "Offset Aggregators"
- U.S. Department of Energy's list of greenhouse gas offset marketers: apps3.eere.energy.gov/greenpower/markets/carbon.shtml?page=2

[4] "Credit aggregators" are entities that buy credits from many projects and aggregate the credits into larger quantities for sale on the CCX. Refer to the CCX website for a definition of membership categories at http://www.chicagoclimateexchange.com/content.jsf?id=65.

Where Can Offset Projects Be Located?

Carbon offsets have been sold from projects located throughout the U.S. The geographical restrictions of carbon offsets must be distinguished from those of the "compliance" systems that may create them. For example, the Western Climate Initiative will only cap emissions of certain entities located in its partner states and provinces in North America.[5] However, while the regulated entities themselves are limited to a particular region, the offsets these entities are allowed to buy may come from projects located throughout the United States, Canada, and Mexico. In this way, this regional system contributes to markets across the continent.[6] Similarly, the federal cap-and-trade system now being considered in Congress would regulate emissions of certain entities located in the U.S., while offsets may be purchased from projects located around the world.[7]

[5] The Western Climate Initiative will release draft recommendations for public comment in October 2009, with final recommendations by the end of 2009. The WCI hopes to begin approving protocols in January 2010. U.S. partners are Washington, Oregon, California, Arizona, New Mexico, Utah, and Montana with Alaska, Nevada, Idaho, Wyoming, Colorado, and Kansas observing. In Canada, partners are British Columbia, Manitoba, Ontario, and Quebec, with Nova Scotia and Saskatchewan observing. In Mexico, Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas are observers. Refer to http://www.westernclimateinitiative.org/.

[6] Carbon offsets may be referred to as *voluntary* even if they are created from mandatory systems because the facility implementing the offset project voluntarily reduces their emissions in response to market demand. In addition, buyers may choose to either reduce their own emissions directly or to offset them by providing funding for others to reduce their emissions through the market.

[7] International offsets would be limited to some fraction of the total. In the House version 50% of the total offsets allowed could come from international projects.

How Are Carbon Offsets Measured?

Carbon offsets are commonly measured in either metric tons (tCO_2e) or short tons ($stCO_2e$) of carbon dioxide-equivalent.[8] The phrase "carbon dioxide-equivalent" (CO_2e) refers to the fact that carbon dioxide is just one of several greenhouse gases. To simplify measurement, the global warming potentials of the others are compared to that of carbon dioxide. If your project avoids methane emissions, for example, these methane emission reductions must be converted to the equivalent carbon dioxide emissions. Methane is 23 times more potent as a greenhouse gas than carbon dioxide. Therefore, one ton of methane emissions reduction is equivalent to 23 tons of carbon dioxide-equivalent reduction.

The Intergovernmental Panel on Climate Change (IPCC) is recognized as the authority on the global warming potential of greenhouse gases. IPCC data on the equivalent carbon dioxide emissions of thirteen greenhouse gases is available at http://www.climatetrust.org/conversion_metrics.html.

[8] The Chicago Climate Exchange trades in Carbon Financial Instruments (CFI), which represents 100 tCO_{2e}. Many voluntary retail markets trade in Verified Emissions Reductions (VERs), which represents 1 tCO_{2e}. RGGI and the U.S. Environmental Protection Agency use short tons CO_{2e}, while the WCI uses metric tons. One metric ton equals 1.102 short tons.

How Are Carbon Offsets Quantified?

In determining the carbon offsets of your proposed project, its emissions reductions must be compared to an accurate and realistic baseline that reflects what greenhouse gas emissions would have been in the absence of your project. After an initial screening, an energy analysis and/or emissions abatement analysis will be required to establish your baseline emissions and determine the emissions reductions of your proposed project.

How emissions are quantified from these studies is determined by the standard you will be using. In the meantime, you can arrive at a preliminary estimate of your emissions reductions and your baseline using the information provided below in the section "How Are Emissions Reductions Calculated." As explained in that section, the emissions associated with fossil fuel use are much simpler to quantify than the emissions associated with electricity use. References where you can find data for both are given in that section.

How Are Carbon Offsets Registered and Verified?

Trading in carbon offsets will require registering your project, quantifying carbon emission reductions, and certifying and verifying the reductions by an independent third party or certification program – all of which takes time. Typically you will be responsible for performing a feasibility study, but an offset retailer, marketer, or broker will often guide you through the process and assist in an initial screening or preliminary analysis to help you determine if a more in-depth feasibility study is warranted. The details of your trading contract, including the point at which you begin receiving income, are negotiated between you and the buyer of the carbon offsets.

Can Carbon Offsets be Claimed for All Emission Reductions?

Not all GHG emissions reductions will qualify as carbon offsets. First, strict criteria must be met to ensure the quality of the offsets. In addition, the demand for offsets in the market place is still small compared to the potential supply, and offsets from certain types of projects may find markets while others don't. While the market is growing rapidly, it is expected that demand will remain small until federal cap-and-trade systems that include offsets are enacted. In the meantime, the rejection rate of offset projects in general is still high.

Issues impacting a project's eligibility and economics include:

Additionality: For emissions reductions to be eligible as offsets, it must be demonstrated that the project faced one or more barriers that would have made it infeasible without revenues from carbon offsets. In addition, the project cannot already be widely employed in a field or mandated by any regulation. This is known as the "additionality" criteria. That is, the project must be "additional" to what would have happened anyway. Barriers can be financial, technological or institutional. An example of an institutional barrier is reluctance to implement a project that has uncertain returns or that is not within the company's normal purview.

Double Counting: For certain projects the environmental benefits associated with greenhouse gas reductions can be sold in at least three ways. For example, electricity generated from renewable sources may be sold as "green power," may earn renewable energy credits (RECs), or may earn carbon offsets. If you are already claiming RECs for your project or are selling green power, you usually will not also be able to sell carbon offsets. Exceptions are projects that legitimately have two environmental benefits, such as dairy anaerobic digester and landfill gas projects that generate electricity. In these cases, avoided methane emission from the landfill or the dairy's manure collection pond may earn carbon offsets. At the same time, the renewable electricity generated may earn RECs or may be sold as green power.

Ownership: There are cases where your project may reduce greenhouse gases but someone else owns the offsets. If your project receives funding from another source, your agreement with the funder should stipulate who owns any carbon offsets or renewable energy credits that it may generate.

Project Type: Project type (for example, energy efficiency versus renewable energy) influences sales price, price stability, and the demand for your potential offsets. Also, many retailers and marketers focus on certain types of projects.

What Should Be Considered in Selecting a Standard?

It is very important that your offset project follows standards that are accepted in the current market and will be approved under the regional and federal climate legislation currently in development. At this time, standards used by the CCAR and RGGI have been essentially pre-approved by the proposed federal cap-and-trade legislation. The VCS and CCX are lobbying for pre-approval, but even if they are not pre-approved, the bill has provisions for approval as long as certain criteria are met. In any case, to ensure recognition, the standard used by your project should be based on internationally recognized protocols and standards, such as the United Nation's Clean Development Mechanism and the International Organization for Standardization (ISO). As an example of how a standard incorporates such protocols and international standards, visit the website of the Voluntary Carbon Standard at www.v-c-s.org.

Specifically, the federal climate bills state that projects that are established after January 1, 2009 and "which otherwise meet all other criteria can apply to the Administrator for consideration for early offset credit." Therefore it is very important that your project meet all the necessary criteria. In general terms, the criteria are that the project:

- Has developed methodologies through a public consultation or peer-reviewed process,
- Has publicly published standards that ensure emission reductions are real, additional, verifiable and enforceable,
- Requires that all credit issues are registered in a publicly accessible registry with individual serial numbers for each ton, and
- There is no conflict of interest between the offset project representative and the registry.

Climate change legislation is rapidly evolving. To stay abreast, refer to the "Resources and Tools: News Sources" at the end of this guide.

How Does Climate Legislation Affect the Offset Market?

Climate policy is now under consideration or being implemented at the state, regional and federal levels. Most observers believe that federal climate legislation will be enacted in the near term. By mandating emissions reductions and allowing a percentage of reductions to be met by offsets, climate legislation that is now in development will significantly increase demand and therefore promises to deliver a huge stimulus to the carbon offset market in North America.

At the federal level, the Waxman-Markey bill or the "American Clean Energy and Security Act" (ACES) passed in the U.S. House of Representatives in June 2009. A Senate version of the climate bill, the "Clean Energy Jobs and America's Power Act," was introduced at the end of September 2009. The Senate version left ACES substantially unchanged, except for a few important "tweaks."[9] To summarize the proposed legislation, beginning in 2012 both versions would create a greenhouse gas emissions cap-and-trade system that allows U.S. companies to meet part of their emissions reductions obligations by purchasing offsets. The percentage of offsets allowed will vary each year. In 2013, 30% of an entity's emissions reduction obligation could be met by offsets. By 2050, this increases to 66%. If enacted, this would create the world's single largest carbon market by far.[10] Importantly, the legislation is intended to promote early action by recognizing the carbon offsets of projects implemented prior to enactment. Once the cap-and-trade system begins, eligible carbon offsets from projects implemented prior to enactment, or "early actors," would be traded in for compliance credits under the cap-and-trade system.

At the regional level, the Western Climate Initiative will include significant access to offsets, allowing 49% of an entity's required emissions reductions to be met by offsets and allowances from other recognized GHG emissions trading systems. RGGI also includes offsets, but offsets can be used to meet only 3.3% of required emissions reductions and the types of projects that can qualify are tightly restricted. Even so, the volume of offsets sold on RGGI already almost equals offsets traded through the European Union's trading system. Note that state and regional climate legislation will continue to be relevant despite the pending federal legislation because the newly released Senate version would allow states to maintain their own cap-and-trade plans through 2017 in the event that a national cap-and-trade system is delayed.

---

[9] The Senate version has a more aggressive 2020 emissions reduction target: 20% below 2005 levels vs. the 17% reduction targeted by the House bill. The bill also preserves the ability for the U.S. Environmental Protection Agency (EPA) to separately regulate emissions from greenhouse gases where necessary under the Clean Air Act. The bill also reduces the portion of the economy covered by the emissions cap, moving methane emissions from coal mines, landfills and oil and natural gas distribution facilities (e.g. pipelines) outside of the cap. Instead, these emissions sources are included in the expanded list of eligible sources of domestic offsets. The ratio of domestic to international offsets is also increased, although the total of 2 billion tons of offsets is maintained.

[10] The EPA predicts that the supply of carbon offsets will be much less than the allowed percentage. So the demand for offsets will increase dramatically.

How Can You Create an Inventory of Your Emissions?

Cap-and-trade systems will require facilities to reduce their emissions from an established baseline. Many of the GHG emissions trading programs now in development will be based on standards and data developed by the Climate Registry. Therefore, registration on the Climate Registry is important in ensuring you will receive potential benefit from your emissions reductions and in ensuring that a fair baseline for your carbon emitting activities is established.

The Climate Registry Information System (CRIS) is available at www.theclimateregistry.org.

What Are Some Examples of Carbon Offset Projects?

Two examples of projects selling carbon offsets are the combined heat and power (CHP) project at Oregon State University and the anaerobic digester project at the Brubaker farm in Pennsylvania.

Oregon State University Cogeneration -- Climate Trust of Oregon

A combined heat and power (cogeneration) system is currently under construction at Oregon State University (OSU). This system will generate electricity with a natural gas turbine-generator and use heat recovered from the turbine to heat the campus.

The new CHP plant will replace an antiquated steam plant whose equipment and infrastructure has been installed over the last 50 to 100 years. Two of the five boilers in the existing plant are not operable and the remaining three cannot meet the peak winter steam demand. The old steam plant system operates at only about 43% efficiency. Carbon offsets and other financial incentives helped make up the difference in cost between simply replacing the boilers versus installing a CHP system with its higher capital cost but greater efficiency and lower operating costs.

At the new CHP plant, electricity will be generated by a 5.5 megawatt combustion turbine-generator fired by natural gas and a 1.1 megawatt back pressure steam turbine. A heat recovery steam generator with duct burners recovers heat from the turbine to produce steam for campus heat. The overall efficiency of the new plant is expected to be 72%. The system will be operated such that it "follows" the thermal needs of the campus. That is, the turbine-generator will be operated to meet the heating needs of the campus. For this particular case, "thermal following" will result in about half of the electrical needs of the campus being generated onsite. Following the thermal loads rather than operating the plant to meet all of its electrical needs results in the highest overall efficiency and hence is generally the most cost effective way of operating CHP plants. Over the course of the year, about 90% of campus heating needs will be met by the CHP system with auxiliary boilers providing the balance.

The project reduces carbon dioxide emissions because 50% of its electrical needs are met using modern fuel-efficient CHP technology rather than by purchasing grid-based electricity, which is generated less efficiently by the electric utility. OSU guarantees that the project will provide at least 338,790 metric tons of offsets over a 20-year project life. This represents a 38% reduction in greenhouse gas emissions.

The Climate Trust of Oregon (The Climate Trust) is providing offset funding in two disbursements, the second of which will be delivered to OSU upon delivery of proof of commercial operation of the power facility. The Climate Trust used a financial barriers test to assess whether offset funding was essential for project implementation. Funding from The Climate Trust was matched one-for-one with bonds from the State of Oregon.

Brubaker Farm Methane Digester -- NativeEnergy

The Brubaker family farm in Mount Joy, Pennsylvania, completed construction of an anaerobic digester in April 2008. The digester produces methane from manure from the farm's 700 dairy cows and generates more than 4,000 kilowatt-hours of electricity per day. The farm only uses a small portion of the electricity generated and sells the excess back to their local electric company. In addition, excess heat from the electric generator engine is used to heat the farm buildings, reducing the farm's fossil fuel use.

The Brubaker farm receives income from both carbon offsets associated with methane abatement and renewable energy credits (RECs) associated with the renewable electricity they generate. Offsets and RECs are purchased by NativeEnergy (www.nativeenergy.com). Anaerobic digesters avoid methane emissions by capturing methane that would otherwise be released to the atmosphere from open anaerobic manure storage lagoons. The captured methane is then burned to generate electricity and heat.

The Brubaker farm also received funding from the State of Pennsylvania in 2005 and the U.S. Department of Agriculture in 2007. Without this financial assistance and the income from offsets and RECs, the digester would have taken about 10 years to pay back.

Owner Michael Brubaker explained, "We were fortunate to receive the two grants. However, we were still concerned about the risk involved in the $367,000 remaining in the project. Our farm would be similar to many farms in that it is land rich, cash poor. Factoring that amount of money into the cash flow drastically affected profitability. When we learned of the potential revenues from the REC and carbon credits, we felt it was the final piece of the puzzle that was needed to go ahead with the project. This final portion of the funding is exactly what was needed to ensure a quicker payback and better rate of return without putting an excessive burden of debt on the rest of the farm."

How Are Emissions Reductions Calculated?

In addition to the energy used and saved onsite at your facility, the emissions associated with delivering that energy to your site must be considered in quantifying your carbon footprint and your emissions reductions. Emission factors, available in the references discussed below, enable the emissions associated with delivered energy to be quantified.

It is important to note that the specifics of quantifying your emissions will be determined by the standard you are using (for example, the VCS, Green-e, CCX or CDM.) The intermediary you are working with will assist you in quantifying your emissions accordingly. This section provides background to help you understand the process.

Note that it is generally recommended to quantify emissions conservatively. So if emission factors from two sources conflict, the safest approach is to take the smaller of the two when calculating emissions reductions. This does run the risk of ruling out projects that might be viable if the larger of the two turns out to be acceptable.

Emission Factors of Fossil Fuels

The most widely accepted reference on emission factors associated with combustion of fossil fuels is the Intergovernmental Panel on Climate Change (IPCC). These factors are summarized on the Climate Trust's webpage at http://www.climatetrust.org/conversion_metrics.html. For example, the combustion of natural gas produces 117 lbs of CO_2 per MMBtu.

In addition, there are emissions associated with extraction, processing and delivering the fuel to your site. For natural gas, only 91% of the energy value of the gas at the well gets delivered to the customer.[11] These losses contribute another 12 lbs of CO_2 per MMBtu of natural gas consumed on site. This brings the emission factor associated with delivered natural gas to 129 lb of CO_2 per MMBtu.

Emission Factors for Electricity Use

Emission factors for electricity relate the greenhouse gases created in generating the electricity to the electricity consumed onsite. In the U.S. the units of emissions factors for electricity are often expressed in pounds of a particular greenhouse gas per megawatt-hour used (e.g. lb CO_2 per MWh). The U.S. EPA has catalogued emissions factors for carbon dioxide, methane and nitrous oxide on their eGRID system, which is available at http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

Emissions associated with electricity use vary from region to region depending on the types of power plants that predominate in that region. Regions that depend more highly on

[11] Refer to "Validation of Direct Natural Gas Use to Reduce CO2 Emissions" by the Gas Technology Institute, available at http://www.ingaa.org/cms/28/8776.aspx

coal than on natural gas or hydropower, for example, have greater emissions associated with each kilowatt-hour (kWh) of electricity consumed. Emission factors of electricity also may vary over the years due to a changing generation mix.

A third complicating factor is that emission factors also may vary depending on the type of your particular project. "Average" emission factors are typically used for quantifying your carbon footprint and establishing your baseline. But to calculate emissions reductions associated with energy efficiency projects, it is common to use emission factors associated with the electricity generated at the "operating margin," as will be explained below. Factors for renewable energy projects may use some combination of factors for average generation and generation at the "operating margin" and "build margin," also explained below.

Baseline Calculation and Average Emission Factors

Electricity supplied by utilities in a region is typically generated from a mix of several energy sources, such as natural gas, coal, hydropower, nuclear, and wind. In addition, even if operating on the same fuel, different power plants will have different efficiencies depending on factors such as the type of plant (e.g. combined cycle natural gas versus simple cycle) and its age. As well, the number of hours of operation over the course of the year differs from plant to plant. The emissions factors for average generation of a region reflect the mix of energy sources, the efficiency of the various power plants and their respective hours of operation to arrive at the pounds of carbon dioxide generated per megawatt-hour on an annual average.

Emission factors for average generation for 20 regions of the country are available on the U.S. EPA's eGrid system at http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_GHGOutputRates.pdf. For average emission factors, use data in the column titled "Annual output emission rates." For example, the emissions factor used to calculate average emissions for a project located in the Northwest U.S. (i.e. the Northwest Power Pool or NWPP) is 902 lb CO_2 per MWh.

For Washington State, information on the fuel mix of individual utilities is available on the Washington State Department of Commerce's "Fuel Mix Disclosure" website at http://www.commerce.wa.gov/site/539/default.aspx.

Electricity emission factors are available on a statewide basis from the U.S. Energy Information Administration on their webpage **"**Voluntary Reporting of Greenhouse Gases Program: Average Electricity Factors by State and Region" at http://www.eia.doe.gov/oiaf/1605/ee-factors.html. Note this data is based on voluntary reporting from utility and non-utility electric generators. Not all generators may be included. A footnote to the data cautions, "Reporters should use these state- and regional-level factors only if utility-specific or power pool-specific emission factors are not available."

Energy Conservation Projects and the Operating Margin

When electricity is conserved, the electrical generation that is reduced in a region is generally not from the sources that are cheaper to *operate*, such as hydro, nuclear or wind, but the power generated by more expensive sources such as natural gas or coal. The plants that are brought on only for peak loads and will be turned off first if enough energy is conserved are referred to as being at the "operating margin." In considering the emissions reductions due to energy conservation, it is the emissions associated with this marginal generation that are typically used. This is important because operating margin emissions are much greater than average emissions in regions such as the Northwest U.S. that depend on hydropower for a large percentage of their generation. Note that, while we can expect the electric system to become more and more renewable, this may not affect the operating margin much as long as natural gas or coal power plants remain at the operating margin.

Operating margin emission factors in the U.S. are available on the U.S. EPA's eGrid system at http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_GHGOutputRates.pdf. In using eGrid tables, the data in the column titled "Annual non-baseload output emission rates" provide the operating margin factors.[12] For example, the operating margin emission factor given by eGRID for the NWPP is 1,333 lb CO_2 per MWh.

In the Northwest U.S., emissions factors have also been examined by the Northwest Power and Conservation Council (NWPCC) and these might be used rather than the U.S. EPA eGrid data. The NWPCC found in 2006 that the generation resources at the operating margin in the Pacific Northwest power system consisted of natural gas combined cycle gas turbine (CCGT) power plants for most hours of the year and coal plants for most of the remainder. Based on this finding, on average over the course of the year, the operating margin emission factor they found was 800 lbs CO_2 per MWh.[13] Refer to the *Marginal Carbon Dioxide Production Rates of the Northwest Power System* available on the NWPCC's website at http://www.nwcouncil.org/Library/2008/2008-08.pdf.

Unfortunately the U.S. EPA's eGRID data and the NWPCC's data differ dramatically. Using the NWPCC's data would result in a more conservative estimate of emissions than either the average factor or operating margin factor given by eGRID.

[12] It is noted on the eGRID table of emission factors that annual non-baseload emission rates should not be used to establish a carbon footprint but can be used to estimate GHG emissions from reductions in electricity.
[13] Note that NWPCC's values differ from those found in eGrid but are consistent with their finding that the marginal resources in this region are primarily CCGTs with some coal plants, considering that CCGTs have efficiencies up to 58%.

Renewable Energy Projects and the "Build Margin"

Renewable energy projects may impact both the operation of existing power plants and the construction of new power plants. The impact of both is by some quantified in terms of a "combined margin," which considers both the operating margin discussed above and the "build margin."

The concept of the "build margin" is very similar to the concept of the "operating margin." New renewable energy projects contribute to avoiding new utility power plants. In any particular region, the mix of power plants that are planned for construction by utilities in the near future will vary. For example, one region may be planning to add coal and wind plants, while another may be planning predominantly natural gas plants. Emissions factors associated with renewable energy projects will therefore reflect the mix of planned generation capacity to the extent that it impacts adding new generation capacity.

In Washington State, natural gas-fired power plants account for over 80 percent of the new generation. The remaining new generation is a mix of wind, biomass, and diesel generators. Refer to the Washington State Department of Commerce's "Frequently Asked Questions: Electricity" available at http://www.commerce.wa.gov/_CTED/documents/ID_2657_Publications.pdf.

Resources and Tools

News Sources

Note that climate legislation is rapidly evolving so it is important to always check the dates of news stories. Anything more than a few months old on federal climate legislation in particular may already be out of date until the House and Senate versions are reconciled and the legislation passes into law, assuming it does. Websites that offer breaking news and summaries of climate legislation include:

- Carbon Control News, http://carboncontrolnews.com/. A subscription is required, except for news overviews.
- New Carbon Finance (Carbon Markets division), http://carbon.newenergyfinance.com/
- Point Carbon, http://www.pointcarbon.com/
- Scott Deatherage's blog at http://lawandenvironment.typepad.com/newcarboncycle/federal_legislation/. Scott Deatherage is a partner in the Environmental Law Practice Group at Thompson & Knight, L.L.P. in Dallas, Texas, and head of the firm's Climate Change and Renewable Energy Practice Group.
- Stockholm Environment Institute, www.sei-us.org
- World Resources Institute, www.wri.org

Overview and Summaries of Carbon Offsets

The following references provide summaries on the topic of carbon offsets in general.

- Broekhoff, Derik, World Resources Institute, "Voluntary Carbon Offsets – Getting What You Pay For," Testimony before the House Select Committee on Energy Independence and Global Warming, U.S. House of Representatives, July 18, 2007.

- Climate Lab website, "Voluntary Carbon Offsets" climatelab.org/Voluntary_Carbon_Offsets.

- Hamilton, Katherine, Milo Sjardin, Thomas Marcello, and Gordon Xu. *Forging a Frontier: State of the Voluntary Carbon Markets 2008*, A Report by Ecosystem Marketplace and New Carbon Finance, May 2008, www.ecosystemmarketplace.com/documents/cms_documents/2008_StateofVoluntaryCarbonMarket2.pdf

- Kollmuss, Anja, Michael Lazarus, Carrie Lee, and Clifford Polycarp. *A Review of Offset Programs: Trading Systems, Funds, Protocols, Standards and Retailers*, Stockholm Environment Institute, October 2008, www.sei-us.org/climate-and-energy/SEIOffsetReview08.pdf.

Emission Calculation Tools

- Climate Registry Information System (CRIS), www.theclimateregistry.org.
  - An online demonstration of how to use CRIS is available at http://www.theclimateregistry.org/downloads/demo/CRIS%20Demo_skin.swf.
  - A guide for facility users on getting started on CRIS is available at http://cris.theclimateregistry.org/eats/tcr/index.cfm?fuseaction=home.help&clearfuseattribs=true
  - A summary of The Climate Registry's verification process is available at http://www.theclimateregistry.org/resources/verification/verification-process-overview/

- Greenhouse Gas Protocol, Calculation Tools http://www.ghgprotocol.org/calculation-tools

Data Sources

- Intergovernmental Panel on Climate Change, http://www.ipcc.ch

- Northwest Power and Conservation Council, *Marginal Carbon Dioxide Production Rates of the Northwest Power System*, June 13, 2008, (electricity emission factors for the Northwest United States), http://www.nwcouncil.org/Library/2008/2008-08.pdf

- The Climate Trust, "Conversion Metrics" webpage http://www.climatetrust.org/conversion_metrics.html

- U.S. Environmental Protection Agency, eGRID webpage, (electricity emission factors for eGRID subregions of the United States), http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

- Washington State Department of Commerce's "Fuel Mix Disclosure" webpage http://www.commerce.wa.gov/site/539/default.aspx.

- U.S. Energy Information Administration on their webpage **"**Voluntary Reporting of Greenhouse Gases Program: Average Electricity Factors by State and Region" at http://www.eia.doe.gov/oiaf/1605/ee-factors.html.

Financial Analysis Tools

Software tools for financial analysis of energy projects will more and more include revenue streams from carbon credits, renewable energy credits, production incentives, tax credits, and other incentives for projects that reduce greenhouse gas emissions. Two tools that currently include such revenue streams include:

- *RETScreen Clean Energy Project Analysis Software*. This software was developed by Natural Resources Canada and is available free-of-charge from www.retscreen.net. *RETScreen* is used to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of combined heat and power, renewable energy and energy efficiency projects.

- *RELCOST Financial*. This Microsoft Excel spreadsheet template, developed by the Washington State University Extension Energy Program, can be used for evaluating the financial viability of energy projects. It includes a variety of factors key to project success such as the minimum power sales price, carbon offset price, the optimum mix of equity and capital to attract investors, and financial incentives. Available from www.energy.wsu.edu.

References

"American Clean Energy and Security Act of 2009 (Engrossed as Agreed to or Passed by House)," Library of Congress, THOMAS website (http://thomas.loc.gov).
See also: "Text of H.R. 2454: American Clean Energy and Security Act of 2009," GovTrack.us, http://www.govtrack.us/congress/billtext.xpd?bill=h111-2454.

Broekhoff, Derik, World Resources Institute, "Voluntary Carbon Offsets – Getting What You Pay For," Testimony before the House Select Committee on Energy Independence and Global Warming, U.S. House of Representatives, July 18, 2007, http://pdf.wri.org/20070718_broekhoff_testimony.pdf.

Carbon Positive, "US carbon bill a boon for world offsets market," 8 July 2009 (updated July 24, 2009, Revised assessment of early action credits), http://www.carbonpositive.net/viewarticle.aspx?articleID=1596.

"Clean Energy Jobs and American Power Act," (bill introduced September 30, 2009, by U.S. Senator John Kerry on behalf of himself and Senator Barbara Boxer), 111th Congress, 1st Session, http://kerry.senate.gov/cleanenergyjobsandamericanpower/pdf/bill.pdf.

Da Rosa, Jeremy, "Co-generation plant receives endorsement," *The Daily Barometer*, Oregon State University, March 13, 2006, http://barometer.orst.edu/home/.

Durning, Alan, "Cap and Trade 101: A Federal Climate Policy Primer," *Sightline Institute*, July 2009, http://www.sightline.org/research/energy/res_pubs/cap-and-trade-101/Cap-Trade_online.pdf.

Gas Technology Institute, *Validation of Direct Natural Gas Use to Reduce CO_2 Emissions, Final Report*, June 26, 2009, http://www.ingaa.org/cms/28/8776.aspx

Hamilton, Katherine, Milo Sjardin, Thomas Marcello, and Gordon Xu, *Forging a Frontier: State of the Voluntary Carbon Markets 2008*, A Report by Ecosystem Marketplace and New Carbon Finance, May 2008, www.ecosystemmarketplace.com/documents/cms_documents/2008_StateofVoluntaryCarbonMarket2.pdf.

Jenkins, Jesse, "Anatomy of a Bill: Key Features of Kerry-Boxer Senate Climate Bill," *The Energy Collective*, September 30, 2009, http://theenergycollective.com/TheEnergyCollective/48931.

Kollmuss, Anja, Michael Lazarus, Carrie Lee, and Clifford Polycarp, *A Review of Offset Programs: Trading Systems, Funds, Protocols, Standards and Retailers*, Stockholm Environment Institute, October 2008, www.sei-us.org/climate-and-energy/SEIOffsetReview08.pdf.

Marshall, Christa, and Jessica Leber, "Senate Draft of Climate Legislation Makes Unofficial Debut," *New York Times*, September 30, 2009, http://www.nytimes.com/cwire/2009/09/30/30climatewire-senate-draft-of-climate-legislation-makes-un-61701.html.

Northwest Power and Conservation Council, *Marginal Carbon Dioxide Production Rates of the Northwest Power System*, June 13, 2008, http://www.nwcouncil.org/Library/2008/2008-08.pdf.

"Senate Climate Bill Preserves Ability of States to Adopt Emission Rules," *Carbon Control News*, October 1, 2009, http://carboncontrolnews.com/.

"Senate Proposals May Foreshadow Battle Over Carbon-Offset Standards," *Carbon Control News*, October 5, 2009, http://carboncontrolnews.com/.

Shapiro, Allison, "Can U.S. Plan Entice Polluters into Early Reduction of Greenhouse Gas Emissions?" *GreenBiz.com*, July 31, 2009, http://www.climatebiz.com/blog/2009/07/31/can-us-plan-entice-polluters-early-reduction-greenhouse-gas-emissions.

Shupp, Charlene M., "Brubaker Farms Celebrates the Launch of 'Cow Power,'" *Lancaster Farming*, April 18, 2008, http://www.lancasterfarming.com/node/1210.

Voluntary Carbon Standard 2007.1, 18 November 2008, http://www.v-c-s.org/docs/Voluntary%20Carbon%20Standard%202007_1.pdf.

"Voluntary Carbon Standard Memorandum to the California Air Resources Board, Re: Comments on CARB Public Meeting Presentation: Criteria for Compliance Offsets in a Cap-and-Trade Program," May 21, 2009, http://www.arb.ca.gov/cc/capandtrade/meetings/042809am/apr281pcvolcst.pdf.

Voluntary Carbon Standard Program Guidelines, 19 November 2008, http://www.v-c-s.org/docs/Program%20Guidelines%202007.pdf.

Western Climate Initiative, "Design Recommendations for the WCI Regional Cap-and-Trade Program," September 23, 2008, available at http://www.westernclimateinitiative.org/document-archives/wci-design-recommendations.

World Resources Institute, *Options for Addressing Early Action Greenhouse Gas Reductions and Offsets in U.S. Federal Cap-and-Trade Policy*, Alexia Kelly and Nicholas Biano with Contributions from John Larsen, August 2009, http://www.wri.org/publication/options-for-early-action-greenhouse-gas-reductions.

World Resources Institute, *WRI Summary of H.R. 2454, the American Clean Energy and Security Act (Waxman-Markey)* by John Larsen, Alexia Kelly and Robert Hellmayr, July 31, 2009, http://pdf.wri.org/wri_summary_of_aces_0731.pdf.