Hydropower and the Environmental Commodities Markets in the U.S.

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ABSTRACT
The United States is currently one of the many countries across the globe which continues to work towards implementing mechanisms focused on mitigating anthropogenic carbon emissions. In the U.S., markets and the market-like instruments which are employed within them, known most commonly as carbon offsets and renewable energy certificates (RECs), are the tools which encourage the development of renewable energy and reduce carbon emissions. These market-based incentives have the potential to significantly endorse or impede hydropower, dependent upon the potential interaction of science and politics.

The implications of the voluntary and compliance markets on alternative and renewable energy affect both the future development of power plants, as well as the management of existing facilities. Case studies demonstrating the financial impacts of these markets on hydropower projects are presented, which highlight the regulatory requirements in place for hydropower and other renewable power plants. The paper concludes with a discussion of what the future may hold for the environmental commodities markets and the role of the hydropower industry within them.

Introduction

In the spring of 1979, the United States Department of Energy issued a report on global climate change which warned, “It is the sense of the scientific community that carbon dioxide from unrestrained combustion of fossil fuels potentially is the most important environmental issue facing mankind.” Three decades later, the United States and countries across the world are implementing mechanisms to mitigate anthropogenic carbon emissions. To date, this has been accomplished in the United States through the use of markets and market-like instruments, known most commonly as carbon offsets and renewable energy certificates (RECs). These market-based incentives have the potential to significantly endorse or impede hydropower, dependent upon the interaction of science and politics.

This paper reviews recent activity in both the REC and carbon offset markets, highlighting the involvement of the hydropower industry. The rising of public concern over climate change, a new administration, and difficult economic times have created a unique set of opportunities and challenges for all industries, including hydropower. The surge activity in environmental commodities markets to date demonstrates the value of hydropower remaining an established renewable resource, both publically and politically.

U.S. Renewable Energy Certificate Trading

A renewable energy certificate -- sometimes referred to as a renewable resource credit, a green certificate, a green tag, or a tradable renewable certificate -- represents 1 megawatt-hour (MWh) of electricity from a renewable energy resource. Renewable energy certificates, or RECs, represent the environmental, social, and other non-power qualities of renewable electricity generation. They can be sold separately from the underlying physical electricity associated with a renewable resource. By separating out the non-power attributes of renewable energy, RECs can be bought and sold over a geographic area that is larger than the grid it serves.

Renewable electricity generators produce two distinct products: physical electricity and RECs. The non-power (environmental) benefits of using renewable energy are represented by RECs -- RECs do not represent the energy itself. If the physical electricity and the associated RECs are sold to separate buyers, the electricity is no longer considered “renewable.”

The goal of a renewable energy certificate program is to provide an incentive for renewable energy through a market-driven production subsidy. In the REC market, there exists both a voluntary and a compliance scheme for purchasing and trading commodities. The voluntary market serves consumers who make conscious decisions to purchase RECs, so as to offset their own energy usage. The compliance market is formed by regulations that promote the use of renewable energy. At the time of writing, there is not a federal mandate for renewable energy. However, most States have developed Renewable Portfolio Standards (RPS), which form the basis of the existing compliance market for RECs. **Figure 1** shows the States which, as of January 2009, have mandatory (green) or voluntary (blue) RPSs.

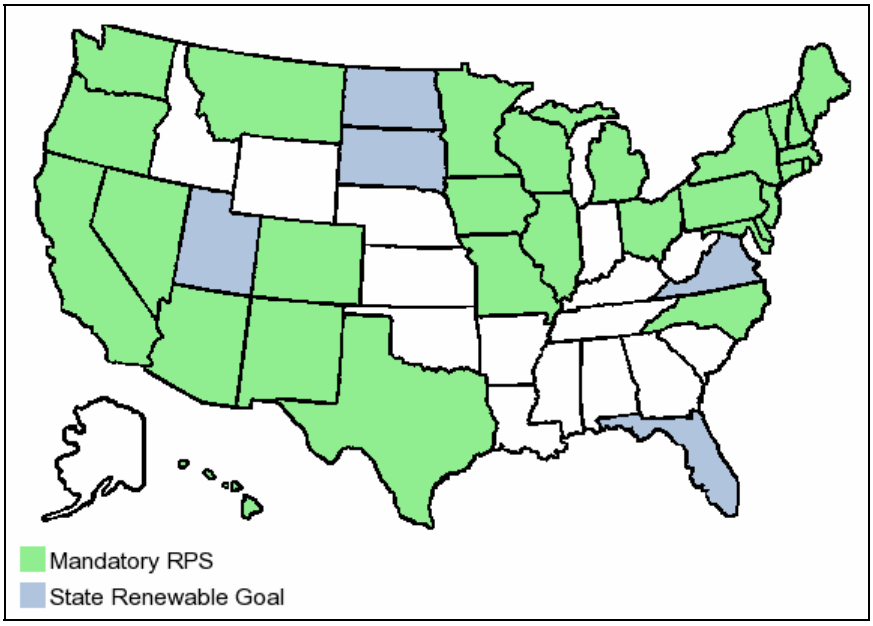

Figure 1: States with Renewable Portfolio Standards
(Source: Pew Center on Global Climate Change, January 2009)

No two Renewable Portfolio Standards are the same, but all function under the same concept. Each State RPS defines a specified amount of renewable energy to be met in future years, typically expressed as a percentage of total electricity generation. The RPS defines qualifying resources, which also varies by State, but often includes solar, wind, biomass, small hydro, and landfill gas.

Commonly, affected utilities and electricity suppliers can meet the standard by either directly using energy from renewable resources, or by purchasing RECs from qualifying resources.

For example, on August 28, 2007, Illinois set a RPS where utilities in the State must generate 2 percent of its total power from renewable sources in 2008. The RPS will increase the renewable requirement each year, with the renewable production percentage reaching 25 percent by 2025 (17.5 percent in 2020). In Illinois, the goal is 75 percent of the renewable energy from wind

power generation. The remaining 25 percent will have to be generated through other renewable resources, which can include existing hydropower sources.

Qualifications

Renewable energy is commonly thought of as energy which relies on resources that do not diminish over time. This can include sources such as the sun, wind, moving water, plant and waste material (biomass), and the earth's heat (geothermal). For the purposes of regulation, definitions vary according to the regulating entity. Hydropower is often included in the list of qualifying renewable resources, but many State RPSs contain limitations on capacity or commencement date.

The compliance market and State mandates dictate what is considered "renewable" for the purpose of creating renewable energy certificates, and States have varying definitions which range from vague (simply stating "hydroelectric") to particular (e.g., Washington's RPS states that hydroelectric generation projects are eligible if "incremental electricity produced as a result of efficiency improvements completed after March 31, 1999, are made to: (a) hydroelectric projects owned by a utility subject to this standard and located in the Pacific Northwest; or to (b) hydroelectric generation in irrigation pipes and canals located in the Pacific Northwest, where the additional generation in either case does not result in new water diversions or impoundments"). For the States with additional constraints on hydropower, the capacity cap is typically in the range of 5 to 30 MW.

Tracking

Once a definition for eligible renewable resources is officially created for a State or an entity, the concern that environmental benefits will be "double-counted" arises. To help ensure that RECs are not used to satisfy environmental standards more than once, tracking systems are being created across the U.S. and Canada. Tracking systems serve three important functions:

- To certify that a resource is renewable as defined by State regulations;
- To track a REC from creation to retirement; and
- To provide more transparency during the tracking process.

Once a generator is registered with a tracking system, each month the megawatt-hours recorded by the meter are placed into the tracking system. This data is stored in accounts as certificates, with each certificate (the non-power attributes of 1 megawatt-hour) having a unique serial number associated with it. This, in turn, allows each individual certificate to be tracked from creation through retirement (when a REC is sold to its final buyer or used to comply with a State RPS). As shown in Figure 2, the following tracking systems exist in the United States:

- WREGIS: Western Renewable Energy Generation Information System (established in 2007);
- MRETS: Midwest Renewable Energy Tracking System (established in 2007);
- ERCOT: Electric Reliability Council of Texas (established in 1999);
- PJM GATS: PJM Generation Attribute Tracking System (established in 2005); and
- NEPOOL GIS: New England Power Pool Generation Information System (established in 2002).

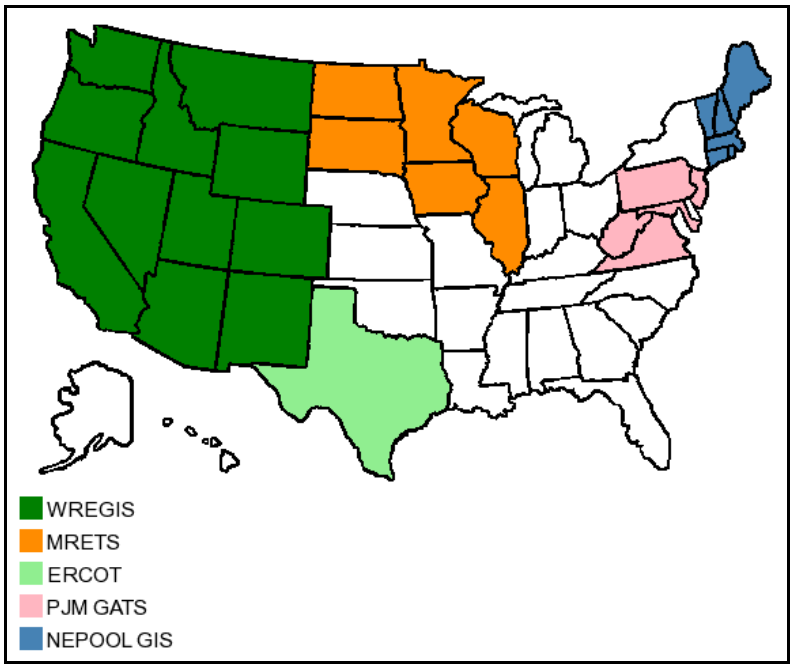

Figure 2: Geographic Territory of Tracking Systems
(Source: Pew Center on Global Climate Change, April 2008)

The Automated Power Exchange (APX) provides the infrastructure for the five existing tracking systems (NEPOOL-GIS, PJM-GATS, Texas RECs, M-RETS, and WREGIS). Although different in name, all five have the same basic functions and operate similarly. Key distinctions are geography covered, and qualifications for creating RECs (which are defined by the Renewable Portfolio Standards for the States covered in each Tracking System's geography). On May 1, 2008, APX announced that it will be launching the North American Renewables Registry, which will cover all States not currently under one of the five APX tracking systems. This will enable all facilities in the United States to have a common, web-based platform to create, track, manage, and retire RECs, which is expected to increase transparency and participation.

Certification

Independent certifiers help verify the quality of RECs (as well as carbon offsets). One in particular, Green-e, is especially well known in the REC and carbon markets. Green-e describes itself as "the nation's leading independent consumer protection program for the sale of renewable energy and carbon offsets in the retail market." In order to become Green-e certified, the product must meet the Green-e Energy National Standard, which specifies eligible sources, vintages, etc. Green-e certification increases the value of RECs on the voluntary market.

For hydropower, the requirements for Green-e certification are described in the following way:

Hydropower from new generation capacity on a non-impoundment or new generation capacity on an existing impoundment that meets one or more of the following conditions:

a) *The hydropower facility is certified by the Low Impact Hydropower Institute;*
b) *The facility is a run-of-the-river hydropower facility with a total rated nameplate capacity equal to or less than 5 MW. Multiple turbines will not be counted separately and cannot add up to more than a 5 MW nameplate capacity; or*

c) *The hydropower facility consists of a turbine in a pipeline or a turbine in an irrigation canal.*

The Board will consider on a case-by-case basis new incremental capacity on an existing dam, where the "new" output is equal to or less than 5 megawatts.

Green-e will not certify renewables from new impoundments of water.

Green-e defines “new” as “any eligible renewable facility beginning operation or repowered after January 1, 1997,” with repowered meaning that 80% of the fair market value of the project derives from new generation equipment. This provides an opportunity for projects with major rehabilitations and upgrades to qualify for Green-e certification.

As mentioned above, Green-e relies on the standards of the Low Impact Hydropower Institute (LIHI), which has a certification program made specifically for hydropower. LIHI was formed as an independent environmental non-profit organization in 1999, and launched a voluntary certification program for low-impact hydropower projects in 2000. To be certified by LIHI, projects must meet criteria in eight areas: river flows, water quality, fish passage and protection, watershed protection, threatened and endangered species protection, cultural resource protection, recreation, and components recommended for removal. The standards for these criteria are based on recommendations from State and federal resource agencies. Pumped-storage projects and any project that includes a dam built after 1998 are not eligible for LIHI certification, but there is no limit on project size. Part of the certification process involves public comment and review by an independent technical consultant.

Nearly 2,100 MW of hydropower capacity are certified by the Low Impact Hydropower Institute as of 2008. To be certified by the LIHI, the applicant must pay an application fee, which varies based on average annual energy generation, ranging from $2,500 (for facilities producing 43,800 megawatt-hours or less annually) to $57,500 (for facilities producing more than 1,795,800 megawatt-hours annually). In addition, facilities must renew their certification every five years, and must annually confirm continued compliance with all LIHI criteria (including any added criteria).

The governing board includes representatives from organizations such as American Rivers (the organization responsible for starting LIHI), Trout Unlimited, the Natural Resources Defense Council, Environmental Defense, the Appalachian Mountain Club, and the Northwest Power Planning Council. A hydropower facility does not have to be certified as low impact to produce RECs; certification is entirely voluntary.

Participation in the REC Market

In the past several years, an increasing number of Renewable Energy Certificates have been registered among the Tracking Systems. In fact, the geographic scope of Tracking themselves has increased dramatically, as discussed earlier (see Tracking) and illustrated by the creation of the North American Renewables Registry.

Because Renewable Portfolio Standards and Tracking Systems have experienced most of their growth only in the past few years, data on activity are limited. Data that are available, however, clearly shows a steep rise in the number of RECs each year. **Figure 3** below shows the number of certificates created in the ERCOT, M-RETS, and NEEPOOL GIS systems between 2001 and 2008. It should be noted that M-RETS data begin in 2007 and NEPOOL GIS data begin in 2002.

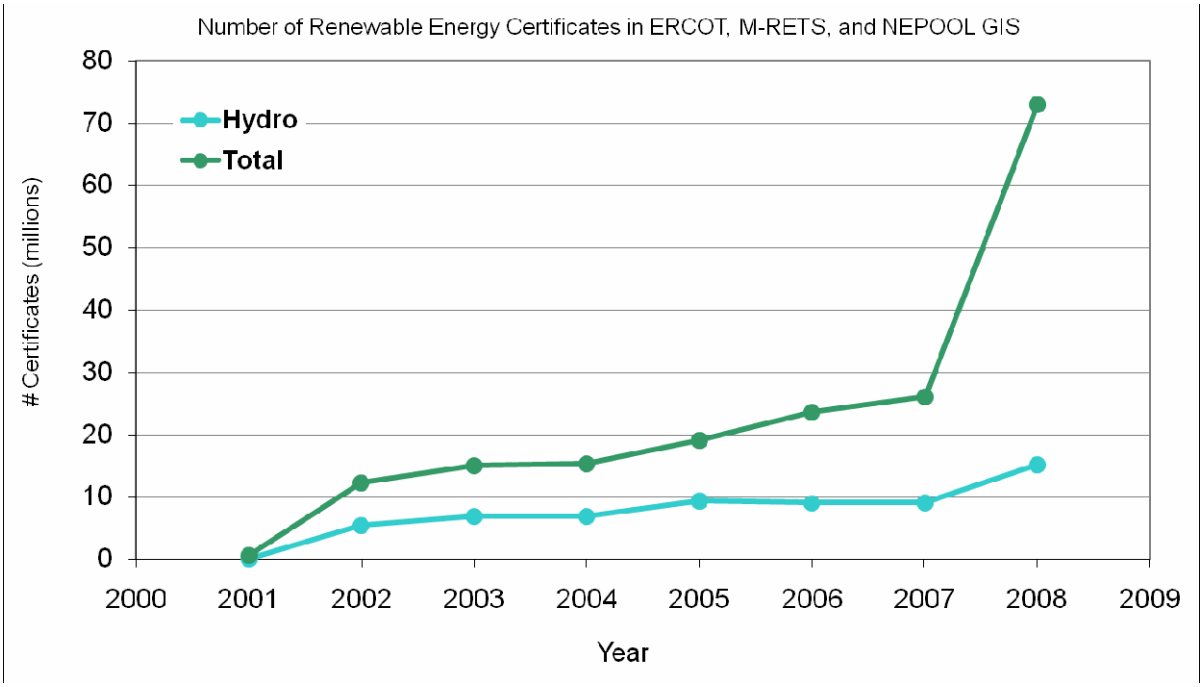

Figure 3: Millions of Certificates per year in ERCOT, M-RETS, and NEPOOL GIS (through 2008)

REC Value

At this point, the selling prices of RECs are highly inconsistent. The value of a REC varies significantly based on several factors, including: source, vintage, geography, supply/demand, volume of purchase, voluntary vs. compliance markets, and contractual considerations (e.g. penalties for non-compliance, length of contract term).

Prices have been less than a dollar to over a hundred dollars per REC, and records of prices are not always readily accessible because of the newness of the market. **Figure 4** below shows the price per REC in meeting a sample of State RPSs between 2003 and 2008, which illustrates the high variability in REC prices (over $250 per solar REC in New Jersey down to a few dollars per REC in Maryland and Washington DC).

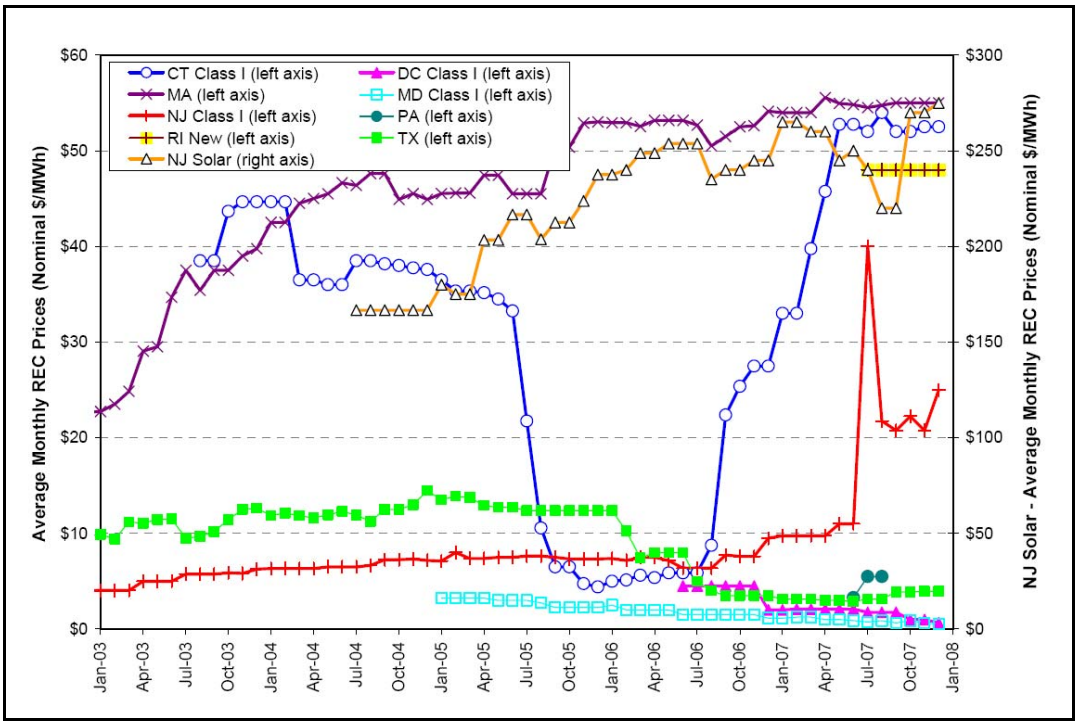

Figure 4: Selling Price per REC for RPS compliance
(Source: "Renewables Portfolio Standards in the United States: A Status Report with Data through 2007." Wiser and Barbose, 2008)

RECs and Hydropower
As discussed above (see Participation), the creation of Renewable Energy Certificates is dramatically increasing. The number of hydropower RECs registered in the five Tracking Systems exceeded 27.5 million in 2008. This represents the non-power attributes of over 27.5 million MWhs from hydropower generation, which can be bought and sold, and can provide hydropower facilities with significant additional revenues.

By comparison, the latest annual data (2006) from the Energy Information Administration of the U.S. Department of Energy reports over 289 million MWhs per year of conventional hydroelectric generation.

Example – Starved Rock Hydroelectric Project
To provide an example of the certification and bidding process, this section summarizes RPS activity in Illinois, and one hydropower facility's success in creating and successfully bidding RECs in response to the State RPS.

The Illinois Power Agency Act (IPA Act) was passed in the House and Senate, and became an effective Public Act on August 28, 2007. Section 1-75(c) of the IPA Act establishes a Renewable Portfolio Standard (RPS), which requires a minimum percentage of Illinois utilities' electrical power supply to be procured from cost-effective renewable energy resources.

As defined by the IPA Act (bold added for emphasis):

"Renewable energy resources" includes energy and its associated Renewable Energy Certificate or Renewable Energy Certificates from wind, solar thermal energy, photovoltaic cells and panels, biodiesel, crops and untreated and unadulterated organic waste biomass, trees and tree trimmings, **hydropower that does not involve new construction or significant expansion of hydropower dams**, and other alternative sources of environmentally preferable energy. For purposes of this Act, landfill gas produced in the State is considered a renewable energy resource. "Renewable energy resources" does not include the incineration, burning, or heating of tires, garbage, general household, institutional, and commercial waste, industrial lunchroom or office waste, landscape waste other than trees and tree trimmings, railroad crossties, utility poles, and construction or demolition debris, other than untreated and unadulterated waste wood.

The IPA Act allows the utilities to satisfy the RPS by either purchasing energy from qualifying renewable resources, or by obtaining qualifying RECs. Both Ameren Illinois Utilities (Ameren) and Commonwealth Edison Company (ComEd) decided to fulfill these requirements through purchasing RECs. Request for Proposals (RFPs) to obtain RECs for the May 2008-June 2009 period were issued during March of 2008.

In Illinois, the City of Peru operates a small hydropower facility (Starved Rock Hydroelectric, 4 units, 2 MW each) on the Illinois Waterway, which connects Lake Michigan to the Mississippi River. The Starved Rock Hydroelectric facility qualifies as a renewable energy resource under the IPA Act, and has the advantage of being an in-State resource for the Illinois RPS (which the bid selection process favors over other States, all else equal). The City of Peru successfully bid 35,000 RECs during the 2008 procurement process (covering the period June 1, 2008 through May 31, 2009), which has provided them with significant funds that the City plans to put towards expanding their renewable energy portfolio.

For reference, the weighted average selling price in each REC category for both the ComEd and Ameren REC procurement are provided below.

Table 1: Weighted Average of Winning bid by Contract Type

REC Class	ComEd Average $/REC	Ameren Average $/REC
Illinois Wind	35.72	29.32
Illinois Non-wind	21.85	17.50
Adjacent State Wind	18.35	21.20
Adjacent State Non-wind	5.74	5.50
Other State Wind	7.34	5.65
Other State Non-wind	4.25	N/A

Future of Hydropower and the U.S. REC Market

With a new administration dedicated to addressing the challenges of climate change, a federal Renewable Portfolio Standard is likely to develop at some point. If a federal RPS is adopted, its

interaction with the existing State RPSs is uncertain, and will have a significant impact on the current REC market. Since qualifications for hydropower vary by each State RPS, education and outreach will be important for establishing the guidelines for inclusion in any potential federal standards.

Hydropower has faced challenges in the voluntary market due to strict standards imposed by independent certifiers. However, LIHI is a positive start to vocalizing hydropower as a renewable resource. Additional research, education, and outreach may help hydropower compete with the demand for other renewables in the voluntary market.

U.S. Carbon Markets

The most basic definition for a carbon market is a forum through which GHG emission entities are traded by governments, organizations, companies and individuals. Though this definition is fairly simplistic, the market system as a whole is much more complex. In order to break it down further, one must first understand the 'market currency', or entities which are traded. Note that each market and exchange typically has their own terminology for their respective entities, but overall they consist of either emissions credits or emissions allowances and can be earned in one of two ways: project based transactions (credits) or allowance transactions (allowances).

Project based transactions revolve around a building block called the carbon offset. Basically, a carbon offset is created when one ton of carbon dioxide equivalent (CO_2e) is released into the atmosphere, compensating for a ton of CO_2e which has been absorbed or avoided from release elsewhere. In order to generate them, a government, company, or organization must finance a mitigation project, examples of which can be through renewable energy, carbon sequestration, destruction of industrial gases, etc. When a project is completed and validated under a range of varying criteria, carbon offsets are created. On the open market, these offsets can be bought, sold and traded accordingly.

Allowance based transactions operate slightly different under what is known as a cap-and-trade system. In a cap-and-trade system, allowances of CO_2e's are either auctioned off or given to participants (typically governments and companies), which equate to the amount each is permitted to emit based on their size and emissions history. If a participant emits less than their respective 'cap', they are free to sell or trade their remaining allowances on the market. The end goal of this scheme is to gradually decrease the cap over time, using emissions data from a determined year in time as a baseline.

Current U.S. Mandatory Programs

Although the Kyoto pact was not adopted by the United States, a number of State Governments have taken the initiative and developed regional programs which act in a similar fashion to that of the European Union's Emissions Trading System and others: the Regional Greenhouse Gas Initiative, the Midwestern Regional Greenhouse Gas Accord, the Western Climate Initiative, and the Florida State Cap-and-Trade Program. **Figure 4** shows a map of these systems.

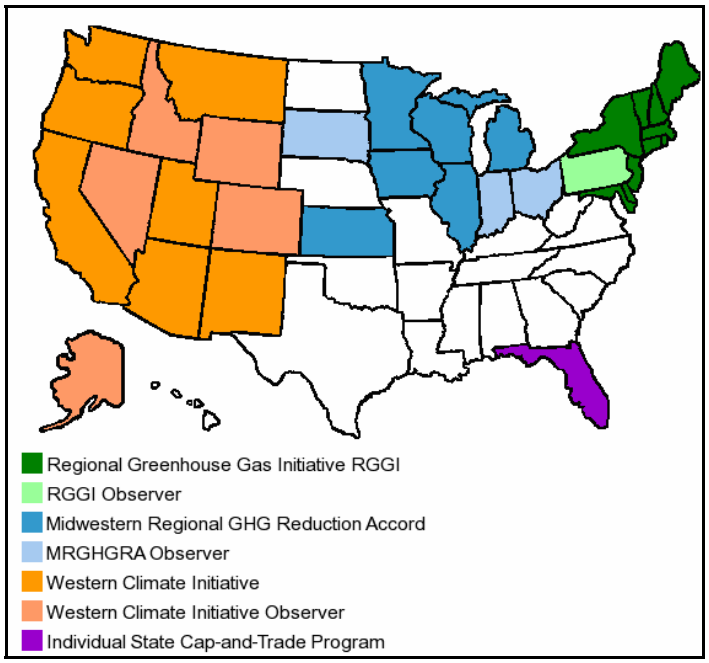

Figure 4: Regional Mandatory Programs in the United States
(Source: Pew Center on Global Climate Change, April 2008)

Regional Greenhouse Gas Initiative

In order to combat greenhouse gas emissions on a more local level while attempting to establish an effective model for a future federal mandatory system, the Regional Greenhouse Gas Initiative (RGGI, shown in green in **Figure 4** above) came to fruition in 2003 through the ideals of former New York State governor George Pataki. Though only a number of States signed on to the plan originally, today the RGGI boasts ten members: Maine, New Hampshire, Vermont, Connecticut, New York, New Jersey, Delaware, Massachusetts, Maryland, and Rhode Island, with the State of Pennsylvania, District of Columbia and the Atlantic Canadian Provinces involved as observers. The program officially launched in January of 2009, and will operate as a traditional cap-and-trade scheme with three – three year compliance periods. The first two periods will be used merely for stabilization of the power sector. It is the start of the final three year period that the reduction schedule will actually commence, with an emissions reduction goal of 2.5% per year for the years 2015 through 2018. This will result in the ultimate objective of a 10% diminution in emissions.

In the current initial phase, the targeted entities within each State are power plants and producers which generate over half their electricity through the use of fossil fuels, having a capacity exceeding 25 MW. If sustained success is observed, other entities will be considered in the future. For all participants, a sliding scale driven by the market price is used to determine the proportion of emissions each will be eligible to cover through emission reduction projects. And as with other cap-and-trade systems, reduction credits, each representing one ton carbon dioxide equivalent, will be the instruments which represent the monetary value. **Table 2** shows the RGGI sliding scale as well as project location restrictions. Eligible reduction projects can come from five sources: landfill methane capture and destruction, reduction in emissions of sulfur hexafluoride (SF_6), sequestration of carbon due to afforestation, reduction or avoidance of CO_2 emissions in the building sector, and avoided methane emissions from agricultural manure management operations. Currently, renewable energy projects are not eligible for reduction credits, however as the program matures they are to be considered.

Table 2: Emission Reduction Project restrictions

Average Price per Reduction Credit of one Ton CO_2e (X)	Percentage of Total Emissions allowed to be covered by Emission Reduction Projects	Eligible Locations for Emission Reduction Projects
X < $7	3.3%	United States
$7 < X < $10	5.0%	United States
X > $10	10.0%	United States, CDM, EU ETS

Western Climate Initiative

Although the Western Climate Initiative (WCI, shown in orange in **Figure 4**) was signed in February of 2007, there had been a number of programs already set up in the Western United States. Several States had individual programs already established, as well as two other smaller scale regional initiatives: the West Coast Global Warming Initiative launched in 2003 by California, Oregon and Washington; and the Southwest Climate Change Initiative created by Arizona and New Mexico in 2006. Using these systems as examples, the WCI built upon their efforts. Membership currently stands as: California, Arizona, New Mexico, Oregon, Washington, Montana, Utah, and the Canadian provinces of British Columbia, and Quebec, and Ontario. Observers to the initiative include Idaho, Nevada, Colorado, Alaska, and Wyoming in the United States, Saskatchewan in Canada, and Baja California, Chihuahua, Coahuila, Nuevo Leon, Sonora, and Tamaulipas in Mexico. Unlike the RGGI, participating entities include more than just major power producers. However, as with other systems, the WCI does operate as a cap-and-trade program with an ultimate goal of having an annual greenhouse gas reduction level in 2020 at 15% less than that recorded in 2005. **Table 3** shows individual State goals for participants within the WCI, with **Figure 5** providing a graphical representation of the goal for the entire region.

Table 3: State goals for GHG Reduction

State	Short Term (2010-2012)	Medium Term (2020)	Long Term (2040-2050)
Arizona	not established	2000 levels by 2020	50% below 2000 by 2040
California	2000 levels by 2010	1990 levels by 2020	80% below 1990 by 2050
Montana	not established	not established	not established
New Mexico	2000 levels by 2012	10% below 2000 by 2020	75% below 2000 by 2050
Oregon	arrest emissions growth	10% below 1990 by 2020	>75% below 1990 by 2050
Utah	not established	not established	not established
Washington	not established	1990 levels by 2020	50% below 1990 by 2050

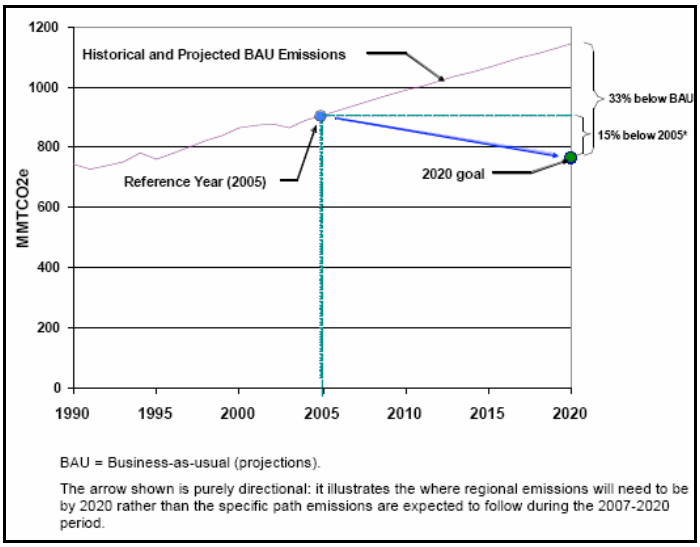

Figure 5: WCI GHG Emissions and Regional Goal

(Source: the Western Climate Initiative)

Under the WCI, regulated entities have three basic compliance options: (1) through investing in their own energy-efficient technology or making process improvements to reduce greenhouse gas emissions, (2) through allowances and allowance trading, and (3) through the use of carbon offsets. Proper quantification protocols for projects have yet to have been established for earning carbon offsets. Currently the types of renewable energy projects that can qualify to generate carbon offsets vary by State. For example, while the State of Washington does not currently view hydropower as being a 'green' energy source, its neighbor to the south California encourages the undertaking of hydro projects for reduction credit.

Midwestern Greenhouse Gas Accord

Following the development of regional mandatory programs on the east and west coasts of the United States, nine Midwestern State governors and one Canadian provincial premier reached an agreement in 2007 to create a program for their respective region, coined the Midwestern Regional Greenhouse Gas Accord (MWRGHGA, shown in blue in **Figure 4**). To date, membership includes: Wisconsin, Illinois, Michigan, Minnesota, Iowa, Kansas, and Manitoba, with South Dakota, Ohio, and Indiana as observers. As of now, there are a number of decisions that have yet to be made. To address these, the following goals have been set by the Midwestern Governors Association:

- Establish greenhouse gas reduction targets and time frames consistent with signing States' targets;
- Develop a market-based and multi-sector cap-and-trade mechanism to help achieve those reduction targets;
- Establish a system to enable tracking, management, and crediting for entities that reduce greenhouse gas emissions; and
- Develop and implement additional steps as needed to achieve the reduction targets, such as low-carbon fuel standards and regional incentives and funding mechanisms.

Once all targets and goals have been set, the program will begin on a projected date of somewhere in mid to late 2009. The status and qualification of renewable and hydro projects which would be considered for reduction credit on the MWRGHGA is still under consideration. The Climate Registry has been contracted to manage the greenhouse gas registry for the accord.

Florida State Cap-and-Trade System

Under Florida House Bill 7135 signed by Governor Charlie Crist in June of 2008, the Florida Climate Protection Act was launched to develop an electric utility cap-and-trade program (shown in purple in **Figure 4**). Goals which have been established to date include reducing electric sector GHG emissions to 2000 levels by 2017, 1990 levels by 2025, and 80% below 1990 levels by 2050. All renewable energy technologies, including hydropower, will be eligible. This program could potentially lead to the formation of a southeast regional cap-and-trade pact, should a federal plan not be put into effect beforehand.

Current U.S. Voluntary Programs

Before any mandatory programs were created in the United States, several voluntary exchanges were providing the nation a link to the carbon market. The Chicago Climate Exchange and Chicago Climate Futures Exchange have been operational since 2003 and the New York Mercantile Green Exchange began trading during the first quarter of 2008.

Chicago Climate Exchange

When the U.S. administration decided not to ratify the Kyoto Protocol, the door for a voluntary market opened in the U.S. Originally modeled to be the primary trading protocol for a mandatory market, the Chicago Climate Exchange (CCX) operates, like many other exchanges, under a cap-and-trade regime where members voluntarily join and then are bound legally to a reductions policy. The tradable units are called Carbon Financial Instrument (CFI) contracts. A CFI represents the equivalent of 100 metric tons of carbon dioxide (100 $mtCO_2e$) and can be either an allowance-based credit, issued based on the emitting members' emission baseline and the CCX reduction goals, or an offset credit earned from a qualifying reduction project. Types of projects having a set of standardized compliance rules under the CCX are as follows: agricultural methane, coal mine methane, landfill methane, agricultural soil carbon, rangeland soil carbon management, forestry, renewable energy, and ozone depleting substance destruction. For hydropower projects, the CCX is currently finalizing a 'Hydro Protocol' which will set criteria for acceptance into the exchange. MWH is a member of the CCX Hydro Power Advisory Sub-Committee. Projects evaluated on a case by case basis are energy efficiency, fuel switching projects and CDM eligible projects.

CCX reduction goals are illustrated in **Figure 6** below. When the exchange began, it was decided that reductions would be made over two separate phases: 2003 to 2006, where members had to reduce their emissions by a minimum of 1% per year, and 2007 to 2010, where a minimum 6% reduction would have to be made. For those organizations that have chosen to join in the phase II period, a minimum of 1.5% emissions decrease per year is required.

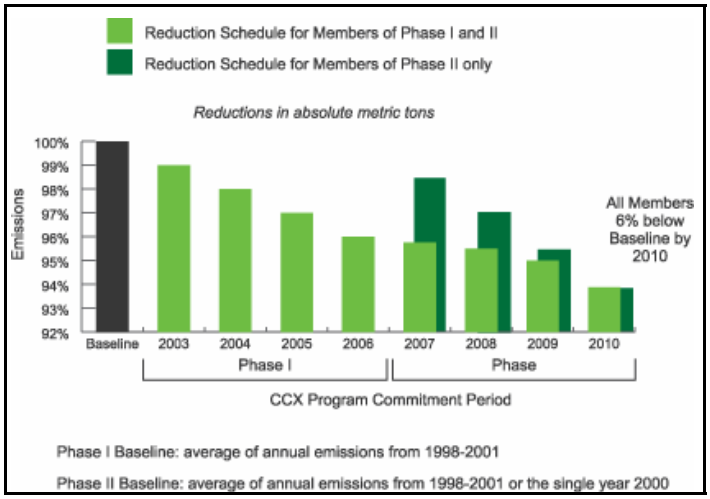

Figure 6: CCX Emissions Reduction Schedule
(Source: The Chicago Climate Exchange)

Since 2003, overall growth has been substantial as well. The first full year contracts were traded in 2004, 2.3 million were exchanged. In 2006, that number grew to 10.3 million. And in only the first eight months of 2008, roughly 54.3 million CFI's have been traded. **Figure 7** helps further illustrate that growth by showing the volume of CFI's traded in each year on the lower portion of the graph as well as the trend for market value per instrument in U.S. dollars.

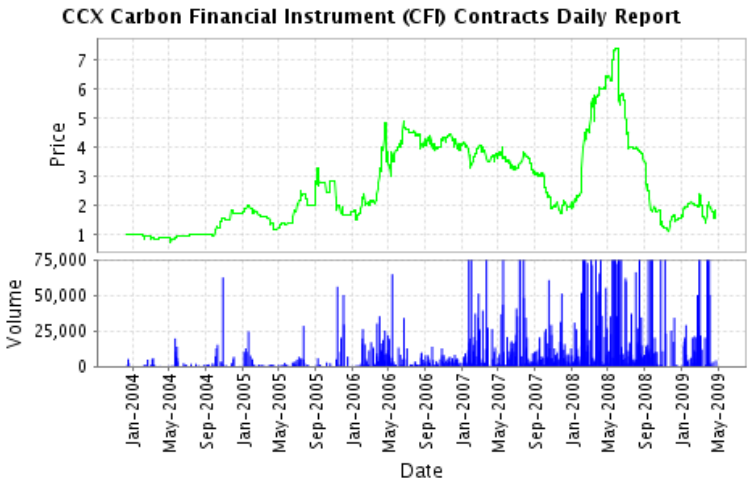

Figure 7: CFI traded volume and year-end value on the CCX
(Source: The Chicago Climate Exchange)

Chicago Climate Futures Exchange

The Chicago Climate Futures Exchange (CCFE) is built upon trading futures and options contracts for emissions allowances and is a subsidiary of the CCX. The motivation behind dealing with futures and options contracts can be either profit or compliance driven, depending on what type of entity is making the trade. The first RGGI futures were traded in mid-August 2008. **Table 4** below shows what types of products are traded on the CCFE.

Table 4: Products Traded on the CCFE

Symbol	Product
CCAR-CRT	California Climate Action Registry - Climate Reserve Tons
CER	Certified Emission Reduction Futures and Options
CFI	Carbon Financial Instrument Futures and Options
DJSI-W	Dow Jones Sustainability World Index Futures
Eco-Index	ECO-Clean Energy Index Futures
IFEX	Event Linked Futures - U.S. Wind
IFEX-FLW	Event Linked Futures - Florida Wind
IFEX-GCW	Event Linked Futures - Gulf Coast Wind
NFI-OS	Nitrogen Financial Instrument Ozone-Season Futures
NFIA	Nitrogen Financial Instrument Annual Options
RGGI	Regional Greenhouse Gas Initiative Futures
REC-CT	Connecticut Renewable Energy Certificate Futures
REC-MA	Massachusetts Renewable Energy Certificate Futures
REC-NJ	New Jersey Renewable Energy Certificate Futures
REC-V	Voluntary Renewable Energy Certificate Futures
SFI	Sulfur Financial Instrument Futures and Options

New York Mercantile Green Exchange

In the first quarter of 2008, the New York Mercantile Exchange launched The Green Exchange (NYMEX Green Exchange) as a separate designated contract market. Like the Chicago Futures Climate Exchange, the NYMEX Green Exchange deals in trading of futures and options. Products traded on the exchange can be viewed in **Table 5**.

Table 5: Carbon Products traded on the NYMEX Green Exchange

Symbol	Product
EUA	European Union Allowance Futures and Options
CER	Certified Emission Reduction Futures and Options
RGGI	Regional Greenhouse Gas Initiative Futures and Options
NOX	Nitrogen Oxide Seasonal and Annual Allowance Futures
SO2	Sulfur Dioxide Emission Allowance Futures and Options

U.S. Hydro Projects for Carbon Offsets

As the carbon markets have continued to mature and grow in the United States, more and more renewable energy projects are being utilized to generate carbon offsets. By engaging the carbon market, these projects may receive funding in a number of ways: through carbon funds (e.g. Carbonfund.org) who obtain the majority of their finances though individuals voluntarily offsetting their own carbon footprint at a premium, through companies who wish to install new technology so as to reduce their own emissions, and from regulated emitters who look to offset their emissions through carbon credits, as examples. Unlike other countries, hydroelectric projects for carbon credit in the United States are not prevalent. This is likely due to that fact that there is not yet a standardized definition of which hydro projects qualify, and carbon offsets are not as competitively priced as Renewable Energy Credits for hydropower. For example, the CCX attributes each megawatt-hour from hydropower generation to offsetting 0.4 $mtCO_2e$. When applied to the current value price in the carbon market ($2.30 at the time of writing), this works out to less than $2 per MWh, which is much less than the value hydropower can get by participating in the REC market today. Wind projects are the most popular at this time; the Carbon Catalog, which tracks carbon offset projects globally, reports that there are currently 22 registered projects for wind power and five registered solar projects in the U.S.

Example: Rocky Reach Hydroelectric Project

The Rocky Reach Hydroelectric Project was a first for the Chicago Climate Exchange. By registering the project on the CCX, the Public Utility District No. 1 of Chelan County in Washington State effectively became the pioneering hydroelectric power producer in providing carbon offsets. In order to do this, PUD No. 1 of Chelan County had to qualify the project under a number of basic CCX specifications, adhere to State and local environmental considerations, and have the project independently verified by a third party CCX approved verifier. The offsets were essentially created however, through system upgrades at Rocky Reach in two different areas. The first was achieved by increasing and improving the operating capacity of the turbine generating units. The second upgrade came through construction of new juvenile fish passage facilities, which consisted of a fish surface collector and a fish bypass pipe. The second improvement, in turn, reduced the spill and created greater annual generation at the power plant. With this accomplishment, it was determined that the increased reduction was equivalent to 702,000 metric tons of CO_2 for the period of 2003 through 2006. MWH was the CCX approved independent verifier for the Rocky Reach Hydroelectric Project.

Future of Hydropower and the U.S. Carbon Markets

With the current Obama administration presiding in Washington, a great deal of the focus has shifted to climate change and the future installation of a United States federal cap-and-trade system. March 31, 2009 marked the proposal of the American Clean Energy and Security Act (ACESA) discussion draft to congress. This may be better known as the Waxman-Markey Bill. Under the bill, an economy wide greenhouse gas cap-and-trade system is proposed, as well as a number of other critical complementary measures. The cap-and-trade calls for the following reduction schedule:

- 2010-2019 Cap: 3% below 2005 level in 2012

- 2020-2029 Cap: 20% below 2005 level in 2020
- 2030-2050 Cap: 42% below 2005 level in 2030; 83% below 2005 level in 2050

With this in place, it is estimated by the U.S. Environmental Protection Agency that the price of one tonne CO_2e will range between $13 and $26 by 2015 and $17 to $33 by 2020. The bill currently has the backing of President Obama. Some other select highlights include:

- Domestic and international offsets allowed; Administrator to determine project list based on Offsets Integrity Advisory Board (OIAB) recommendations
- 2 billion tons of emissions system wide can be used for compliance (1 billion domestic, 1 billion international)
- President has power to make recommendations to Congress as to the quantity of offset credits which must be submitted for a ton of emissions
- Operates as a multi-year compliance with rolling 2-year period
- Unlimited banking and next year borrowing with no interest; borrowing up to 15% of compliance obligation in years 2-5 beyond calendar year at 8% interest
- Quarterly strategic reserve auctions: takes a small percentage from the cap each year; proceeds used to buy international reduced deforestation offset tons

As was mentioned earlier in this paper, a standardized definition of which hydroelectric facility types are currently eligible to generate carbon offsets has yet to have been established. However, with the continual technological improvements projected for the hydropower sector, including the potential for hydrokinetic, tidal, and ocean energy generation expansion, there is very little doubt to whether it will become a major contributor in the fight to reduce emissions. In a report by The Electric Power Research Institute entitled "Assessment of Waterpower Potential and Development Needs: 2009 Update", it is predicted that 2,790 tons CO_2/yr can be reduced for each MW of hydro capacity. Though this estimation is subject to variation due to a number of factors including the type of technology, climate where the facility is installed, and capacity, it still provides a very real look into hydropower's potential value as a revenue source within the future carbon markets. Taking the current price of a Chicago Climate Exchange CFI, for example (currently at $1.80), would demonstrate a potential revenue stream of $5,022 / yr per MW of capacity. This can only be expected to rise, as well, with a future cap-and-trade system and maturation of the markets within the United States.

Conclusion

As the United States continues to encourage the development of renewable energy as a means of increasing its energy independence and reducing greenhouse gas emissions, it is imperative that the hydropower industry continue to participate in these markets and establish itself politically as a leader in renewable energy to ensure inclusion in future State or federal regulations. The recent surge of activity in carbon and renewable energy certificate markets – along with the current political flux – illustrate the importance of early action, and highlight potential opportunities for hydropower both now and in the future.

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