# EQC Biomass Questions and Responses

Below are responses to the questions raised by EQC members during the January EQC meeting. Staff and the DEQ provided responses. The DEQ responded to the questions directed at their research and January presentation. The DEQ provided a binder of information, with a series of 14 detailed reports related to the questions and agricultural biomass energy, to staff. Because of the size of the detailed report, a summary is provided below. Staff is happy to prepare copies of the detailed report included in the DEQ binder at the request of an EQC member.

**1. Has there been any analysis of the capacity of transmission lines near Montana sawmills that may pursue biomass?**

**Staff response:**

This is being looked at to some degree. In late 2009, NorthWestern Energy received a $125,000 grant from the Department of Commerce to complete a biomass feasibility study. The study enables the company to assess the feasibility of constructing up to eight biomass electricity plants throughout its service territory in Montana, concentrating on an area from the Flathead Valley, through Missoula, Butte, and Big Timber. That assessment includes a full review of transmission line capacity in the area, according to NorthWestern Energy. The study should be complete in May.

Staff inquired about finding an overall analysis of the capacity of 69 kV and greater transmission lines in Montana. Much of that information is proprietary. As biomass projects are proposed, developers would work with NorthWestern Energy and the Federal Energy Regulatory Commission (FERC) to secure capacity on a line. Overall a transmission path might be considered congested if no rights to use it are for sale. Congestion also can mean a path is fully scheduled and there is no firm space available or that the path is fully loaded in the physical sense and cannot carry any more electrons. Using the first definition, the paths through which generators in Montana send their power west are almost fully congested and few firm rights are available.

**2. Analysis discussing costs/prices in a carbon constrained environment? More detailed, what the impact to biomass prices would be if a federal carbon cap is adopted?**

**Staff response:**

Most analysis on the impacts of carbon constraints to-date has been limited to a review of the potential impacts of federal efforts to deal with climate change and the potential impacts to Montana's energy supply and the cost and use of coal-fired generation. Ultimately, it is anticipated that carbon cap and trade would increase fossil-fuel based energy prices, making renewable energy more competitive. Analysis that has been done is focused on H.R. 2454 the American Clean Energy and Security Act, approved by the House, and S. 1733 the Clean Energy Jobs and American Power Act. An extremely over-simplified explanation of the legislation is that it would limit or "cap" the amount of greenhouse gases. Credits or allowances would then be distributed to industries that emit those gases. Industries would have to respond by reducing emissions or buying credits from other holders.

The Energy Information Administration (EIA) provided an analysis of HR 2454. Key issues impacting the prices of specific types of energy generation are 1. inclusion of federal renewable portfolio standards in the legislation; 2. the future cost of carbon dioxide and allowances; 3. advancement of carbon capture technologies; and 4. the future price of natural gas.

HR 2454 would change the projected mix of new electricity generation capacity and increase the total amount of new electric capacity needed by 2030 to offset the retirement of many existing coal-fired power plants. Renewable capacity would help with the offset, representing between 33 percent and 63 percent of all new capacity added between 2008 and 2030, according to the EIA review. Renewable generation is dramatically higher under the provisions of HR 2454. The majority of the increase is from wind generation, followed by biomass generation. The increase in biomass comes from a combination of increased cofiring of biomass in existing coal plants and the addition of new dedicated biomass plants, according to the EIA analysis. In most cases, cofiring dominates, particularly in the early years of the projections. However, as new, dedicated biomass plants are added, they play a larger role in the later years. Cofiring is generally an economic way to reduce $CO_2$ emissions without investing in new capacity.

In early 2004, the National Renewable Energy Laboratory also examined greenhouse gas emissions and economics, with a focus on conventional fossil fuel systems retrofitted with carbon dioxide sequestration equipment. Their research found that the cost of electricity from coal increases by 191 percent from 2.5 cents/kWh to 7.3 cents/kWh and the cost of natural gas increases from 4.5 cents/kWh to 7.5 cents/kWh with carbon sequestration equipment added. Biomass power using an advanced gasification combine-cycle technology (BIGCC) would be at 5.5 cents/KWh -- cheaper than its fossil fuel competitors. The study finds that direct-fired biomass, also retrofitted with carbon sequestration, remains higher at 8.5 cents/kWh.

The national study goes on to note that $48/ton of $CO_2$-equivalent emissions credit makes a biomass direct system competitive with a coal system. That number drops to $19/ton of $Co_2$-equivalent if direct-fired biomass is compared to coal with carbon sequestration equipment.

The Electric Power Research Institute (EPRI), which is funded by the electric power industry, also has provided detailed analysis of the potential for alternative energy resources and their economic feasibility. EPRI has developed financial forecasts on the price of fossil fuel and alternative energy technologies for the years 2010 and 2025, comparing the future costs of pulverized coal-based generation, integrated gasification combined cycle (IGCC) generation, wind power, nuclear power, and biomass combustion.

EPRI hypothesizes that by 2015, pulverized coal and natural gas will remain the two favored fuels of power utilities and new power producers. EPRI believes carbon capture and sequestration technologies will be advanced, keeping carbon-based combustion competitive even in a carbon-constrained environment. However, EPRI also acknowledges that renewable energy generation will significantly increase. Concerning future use of biomass as an energy source, EPRI believes there will be a limit to the amount of organic material that can be used for electricity generation. In 2015, if carbon costs are at $20/metric ton, pulverized coal (with no carbon capture) costs are estimated at about $82/MWh; nuclear power is estimated at about the same price; and biomass is estimated at about $90/MWh. The biomass price, however, does not assume a production or investment tax credit. By 2025, those projections change dramatically.

EPRI shows biomass prices at closer to $80/MWh; nuclear at $75/MWh; and pulverized coal (with carbon capture) at $95/MWh.

EPRI highlights four significant uncertainties for the future of energy production in a carbon constrained world: $CO_2$ emission limits, the price of natural gas, the reliability of spent nuclear fuel storage, and the refinement of $CO_2$ capture and storage technology.

**3. Has the feasibility of cofiring been explored in Montana? (Beyond Thompson Falls) Is cofiring something any of Montana's utilities have discussed?**

**Staff response:**

In Montana, Thompson River Co-Gen opened in December 2004 and burned coal and waste wood to produce electricity. The plant only operated about nine months before being charged with exceeding the nitrogen oxide and sulfur dioxide emission limits allowed by its initial air quality permit. Prior to closing, Thompson River Co-Gen had an agreement to send its power to Thompson River Lumber Co. and to NorthWestern Energy. A new air quality permit for the facility was issued by DEQ but was challenged. In January 2010, the case was sent back to the District Court and the Board of Environmental Review.

The Hardin Generating Station, owned by Rocky Mountain Power, a subsidiary of Centennial Power, which in turn is a subsidiary of Bicent Power Company, has also investigated the potential of cofiring biomass with coal. Managers investigated using woody debris and slash as fuel to cofire 5 percent to 10 percent. Analysis showed that there is enough timber and mill activity in the area to provide enough fuel for cofiring. The company also looked at switchgrass in the area, but found that the irrigation needs and short growing season reduced its feasibility. The use of surplus straw from irrigated cereal grains or surplus on Conservation Reserve Program (CRP) lands also was reviewed. Woody biomass, however, has been shown to be the most likely source of fuel for cofiring, and it would require about $1 million in boiler modifications, according to Bicent. Total project costs would be $15 million to $17 million.

**4. Do you have any information showing the increase in "dead" trees or dead standing woody biomass in Montana's National Forests or on timberland in Montana overall?**

**Staff response:**

The number of acres of pine forest in Montana infested with the mountain pine beetle nearly doubled in 2009. Pine beetles had infested 1.2 million acres of forest in 2008 and 2.7 million acres in 2009, based on aerial surveys. Gregg DeNitto with the U.S. Forest Service's Region 1 in Missoula said elevated levels of pine beetle are likely for five to seven more years.

DeNitto says unless the pine beetles are killed off by some significant weather event, like an extremely cold winter, the outbreak will continue until most of the susceptible trees in the area have been killed. Most of the outbreak has occurred in forests near Butte, Anaconda, and Helena.

**5. How many tons of woody biomass (dry tons) are needed to produce one megawatt of energy?**

**Staff response:**

1 bone dry ton (bdt) ~ 1 MW. Or one bdt burned in a commercial boiler produces about 10,000 lbs. of steam; 10,000 lbs. of steam will produce about one megawatt hour (MWh) of electricity.

**6. When will the feasibility studies be complete and returned to the Department of Commerce for review?**

**Staff response:**

The three entities that received contracts have six months to bring their feasibility studies back to the state. The contracts were signed in mid-December, making the deadline mid-June. NorthWestern Energy ($125,000 grant) and Porter Bench Energy, LLC ($300,000 grant) have indicated they will have proposals back to the Department of Commerce in early April. The Department of Commerce has said it would be happy to be a part of the EQC's May agenda.

The feasibility studies will include cost/benefit information to provide potential investors with sufficient information to determine the financial viability of a project, the potential public and private biomass supply in western Montana that could be used as feedstock, potential power that would be generated and transmission infrastructure, sustainability impacts, regulatory and permitting processes, National Environmental Policy Act and Montana Environmental Policy Act requirements, and a risk assessment.

**7. Mr. Haines mentioned "another presentation" on cost analysis, could he provide a written copy of that presentation?**

**DEQ response:**

Mr. Haines meant to say that the DEQ could prepare another presentation that might address processing costs for various technologies and biomass feedstocks as they are available.

The DEQ would need more detail as to what is meant by "cost analysis," since these technologies are feedstock-specific and site-specific. We know of no known study that offers a consistent basis for all the process technologies and potential products and co-products.

For example, the U.S. Department of Energy (DOE) has funded a number of pilot-scale cellulosic ethanol processes (corn stover). Some are co-locating with a starch ethanol plant to provide economies of scale. These will not be stand-alone plants, yet they meet DOE's vision to develop biorefineries.

**8. Could you provide a more detailed discussion of Slide 27 on biofuels net energy. Council members would like more detail about how the energy output was derived and what went into the calculations for "in" and "out".**

**DEQ response:**

The numbers on Slide 27 are derived from multi-agency, peer-reviewed models to generate the energy balance. Ethanol's energy balance is sometimes defined as the difference between the amount of energy stored in a gallon of ethanol and the amount of energy needed to grow, produce, and distribute that gallon of ethanol.

David Pimentel, PhD, of Cornell University has consistently argued -- in more than 20 published articles -- that the amount of fossil fuel needed to produce ethanol is greater than the energy contained in the ethanol. According to Pimentel and his colleague Tad Patzek of the University of California, Berkeley, "There is just no energy benefit to using plant biomass for liquid fuel." (Pimentel, David and Tad W. Patzek, March 2005, "Ethanol Production Using Corn, Switch Grass".) Other studies find that ethanol has a positive energy balance. Some studies calculate an energy balance as high as 2.62, meaning more than two-and-a-half times as much energy comes out of the ethanol fuel as was used to produce it. Published studies since 1990 come up with a ratio between 1.2 and 1.8. (Morris, David. 2005. "The Carbohydrate Economy, Biofuels and the Net Energy Debate." www.newrules.org/agri/netenergyresponse.pdf) Nonetheless, Pimentel and a small number of other authors continue to argue that ethanol production is an energy-loser.

As a backdrop to the debate, the U.S. Department of Agriculture (USDA) and DOE identified a need for researchers and practitioners to uniformly evaluate emissions, energy, and greenhouse gases from various technologies and fuels under consideration to replace the spark-ignition, four-stroke internal combustion engine (i.e., gasoline-powered automobiles). The modeling effort between USDA, EPA, and DOE became the "Greenhouse Gases, Regulated Emissions, and Energy used in Transportation (GREET) model. (http://www.transportation.anl.gov/modeling_simulation/GREET/)

The GREET model was developed over six years (starting in 1995) and uses total energy inputs and outputs to estimate amounts of energy and emissions from transportation fuels and advanced transportation technologies. The model is refined constantly and updated as new data becomes available. It considers:

- full-cycle energy consumption from planting, growing harvesting, processing, and distribution (total energy, all sources; fossil fuels: coal, natural gas, LPG, and petroleum);
- fuel cycle emissions ($CO_2$, $CH_3$, $N_2O$) and criteria emissions (VOC, CO, $NO_x$, PM, $SO_x$). A 4-page summary is located at: http://www.deq.mt.gov/Energy/bioenergy/pdf/EthanoloBrochure-Rev%2012%2020%2005.pdf

Below is a short summary of the references and attachments (included in the binder provided by DEQ). Some documents are only available in hard copy or for purchase.

- (Soy biodiesel, 1:4.56 with 2002 USDA data) September 2009. Energy Life-Cycle Assessment of Soybean Biodiesel. Dev S. Shersta, A. Pradham, A. McAloon, M. Haas, W Yee, J. A. Duffield, and H. Shapouri. September 2009. USDA Office of Energy Policy and New Uses, Agricultural Economic Report No. 845. Also presented by University of

Idaho, National Biodiesel Board, February, 2009. http://www.usda.gov/oce/reports/energy/ELCAofSoybeanBiodiesel91409.pdf, page 23 of 31. http://www.uiweb.uidaho.edu/bioenergy/NewsReleases/Biodiesel%20Energy%20Balance_v2a.pdf . Also attached (In the DEQ binder) is a rebuttal of Pimentel's paper on soy biodiesel energy balance, identifying errors in his calculations.

- (Biomass derived diesel, 1:15, 1:60) These reports are primarily interested in the amount of carbon capture and sequestration, so the energy balance was minimally or only partly addressed, not using the complete GREET model. They are cited because these reports are used by DOE in its long-term research programs. Final Report, Carbon Sequestration of Gas Turbine Emissions, Red Hawk, AZ (1:15, producing algae from emissions and biodiesel from the algae oil), http://www.nrel.gov/biomass/pdfs/sun.pdf slide 7 and NREL-AFOSR Workshop Algal Oil for Jet Fuel Production, February 19-21, 2008, http://www.nrel.gov/biomass/pdfs/zemke.pdf 43 L/$m^2$-yr, ~ 45,600 gallons per acre per year, or 1:60 for soybean oil. Biodiesel from Algae, NREL 2008, http://www.nrel.gov/biomass/pdfs/sears.pdf, slide 17.
- Issue Brief, Net Energy Balance of Ethanol Production, summer 2004, page 5. Douglas Durante, Mattmittenberger, Argonne National Laboratory, Clean Fuels Development Foundation (US Senators Ben Nelson, (D-NE) and Conrad Burns (R-MT) Fall 2004 (corn ethanol, 1.67) Referenced also in Issue Brief Net Energy Balance of Ethanol Production, Spring 2009 page 10. http://www.ne-ethanol.org/pdf/net_energy_balance2009.pdf. Also attached (in DEQ binder) is an item-by-item comparison of the USDA-Oakridge National Lab 2002 study compared to the Pimmentel and Patzek 2005 study showing that proper addition in the later (Pimmentel) study would have yielded a positive energy balance for ethanol. Argonne National Lab, USDA 2002 study versus Pimentel & Patzek, 2005 http://www.nrbp.org/pdfs/ethanol_balance.pdf. U.S. Ethanol Industry Efficiency Improvements 2004 through 2007, By John O. Christianson, CPA, Christianson & Associates, PLLP, Report Date: August 5, 2008. http://www.ethanolrfa.org/objects/documents/1916/usethanolefficiencyimprovements08.pdf.
- (Ethanol, cellulosic) KL Energy, "…20,000 Btu to produce a gallon of ethanol or roughly 1 energy unit in for 4 units out in ethanol…" http://smallwoodnews.com/Forum/phpBB2/viewtopic.php?t=1069. http://www.klprocess.com/, Upton Wyoming plant (KL Energy is in Rapid City, South Dakota) Converting Cellulose into Ethanol and Other Biofuels http://www.ne-ethanol.org/pdf/briefs/CellulosicEthanolIssueBrief11109.pdf.
- Net Energy Balance for Bioethanol Production and Use, US Department of Energy, Energy Efficiency and Renewable Energy: http://www1.eere.energy.gov/biomass/net_energy_balance.html "…On the basis of liquid fuels alone, the net balance is 6.94 (USDA Office of Energy Policy and New Uses, The Energy Balance of Corn Ethanol: An Update)." http://www.klprocess.com/pdf/USDOE_Energy_Bal.pdf.
- (Petroleum gasoline, diesel, 1:0.88) Wang et al., Argonne National Laboratory, Biofuels: Energy Balance, 1999,

http://www.iowacorn.org/ethanol/documents/energy_balance_000.pdf Presented (in the DEQ binder) is the updated (2005) reference. http://www.deq.mt.gov/Energy/bioenergy/pdf/EthanoloBrochure-Rev%2012%2020%2005.pdf. “Ethanol” a Complete Energy Lifecycle Picture, DOE Energy Efficiency and Renewable Energy Argonne National Laboratory, December 2005, page showing 1/1.23 or every one energy unit to produce petroleum gasoline produces 0.81 energy units out. page 3.

**9. Has there been any additional study or other, similar calculations for corn ethanol costs shown on Slide 27?**

**DEQ response:**

Costs were not shown in Slide 27, just energy balance numbers. There have been many corn ethanol energy balance studies. The DEQ used the federally accepted, multi-agency, peer reviewed studies noted above (Question 8), as updated in 2005 by USDA using 2002 agricultural data.

**Staff response:**

The U.S. Department of Agriculture in 2002 produced "The Energy Balance of Corn Ethanol: An Update". The report finds "production of corn-ethanol is energy efficient, in that it yields 34 percent more energy than it takes to produce it, including growing the corn, harvesting it, transporting it, and distilling it into ethanol".

Cornell University Agricultural Scientist David Pimentel has been one of the most outspoken scientists to dispute the costs of ethanol. Mr. Pimentel provides the following in his research: An acre of U.S. corn yields about 7,110 pounds of corn for processing into 328 gallons of ethanol. But planting, growing and harvesting that much corn requires about 140 gallons of fossil fuels and costs $347 per acre, according to Pimentel's analysis. This puts feedstock costs at $1.05 per gallon of ethanol. Adding up the energy costs of corn production and its conversion to ethanol, 131,000 Btu are needed to make 1 gallon of ethanol. One gallon of ethanol has an energy value of 77,000 Btu. "Put another way," Pimentel said, "about 70 percent more energy is required to produce ethanol than the energy that actually is in ethanol. Every time you make 1 gallon of ethanol, there is a net energy loss of 54,000 Btu." Ethanol from corn costs about $1.74 per gallon to produce, compared with about 95 cents to produce a gallon of gasoline.

Pimentel and Tad W. Patzek, professor of civil and environmental engineering at Berkeley, conducted an analysis of the energy input-yield ratios of producing ethanol from corn, switch grass, and wood biomass as well as for producing biodiesel from soybean and sunflower plants. In 2005, their report is published in Natural Resources Research (Vol. 14:1, 65-76).

The amount of energy used at ethanol conversion facilities differs greatly among various studies -- for example, some include energy expended on capital equipment, and some use a higher conversion rate.

**10. How far were people trucking products that were being taken to the Culbertson plant? What is the greatest distance people came from?**

**DEQ response:**

Culbertson had been the oil chemical extraction plant in the region (eastern Oregon/Washington, Idaho, northern Wyoming, western North and South Dakota, Montana, and southern Alberta and Saskatchewan) through the 2008 growing season. Haul distances for oilseeds were under contract.

The recent owners, Sustainable Systems LLC, defaulted on payments to Montana producers, and the Montana Department of Agriculture took over operations to reimburse farmers for the 2009 crop. Fort Benton was the farthest distance from Culbertson that a contracted Montana safflower grower was located (333 miles). The second farthest was 118 miles away in Wibaux. The farthest distance a North Dakota safflower grower was located from Culbertson was 226 miles (Bowman, ND). The meal was sold in bulk to local feeders around Miles City (160 miles). Source: Brent Sarchet, Commodity Services Bureau, Montana Department of Agriculture, 444-3950.

**11. Has there been any analysis of the cost of trucking and transportation for biomass in northeastern Montana? Has there been any such analysis done anywhere in Montana?**

**DEQ response:**

The most recent publically available study of cellulosic agricultural wastes in Montana is a 2000 update of a 1997 study conducted by MSU-Bozeman and funded by the National Renewable Energy Laboratory (NREL). The report identified large-bale baling costs of grain straw at approximately $9 per giant round bale, and straw prices were $30 and $35 per ton, with haul costs of approximately $0.10 per ton per mile with an average haul distance of 50 miles, or $5 per ton. NREL had set the study goal for feedstocks at $2 per million BTU or less (~$15 per dry ton of straw). This study concluded Montana straw was not a cost-effective option at that time.

**12. Do you know of any analysis or reports that discuss water consumption for ethanol production and other biomass technologies?**

**DEQ response:**

According to the "Environmental Impacts of Ethanol Production," (Summer 2009) the industry average for corn ethanol production is 3 to 3.5 gallons of water for each gallon of ethanol produced. Only 15% of the entire crop is on irrigated soil (USDA), and the corn crop returns 4,000 gallons of water per acre per day to the atmosphere. The report also states most new plant varieties offer lower rates, since these newer plants have more water-conscious designs. Conservation tillage techniques may also reduce water consumption. Source: http://www.ne-ethanol.org/pdf/environmental_impact_ethanol_2009.pdf.

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