Detailed Report: 2008 National Dry Mill Corn Ethanol Survey

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UIC UNIVERSITY OF ILLINOIS AT CHICAGO COLLEGE OF ENGINEERING

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Executive Summary

The Energy Resources Center at the University of Illinois at Chicago has conducted a survey of corn ethanol technologies, ethanol and co-product yields, energy use, water use, and logistics. The survey focuses on dry mill technologies; recent industry data on wet mill plants is available from a survey conducted by the Renewable Fuels Association in 2007.

The survey was administered by the Survey Research Laboratory located at the University of Illinois at Urbana-Champaign. The survey responses represent 66% of the installed dry mill ethanol capacity during the year 2008.

The last comprehensive survey of energy consumption at corn ethanol plants dates back to 2001. The 2001 survey was conducted by BBI International and it was commissioned by the Office of Energy Policy and New Uses, US Department of Agriculture. The 2001 survey finds that, on average, dry mill plants use 36,000 Btu per gallon and 1.09 kWh per gallon of ethanol and produce 2.64 gallons of ethanol per bushel. We find that ethanol produced in 2008 requires 28% less thermal energy per gallon and 32.1% less electricity per gallon but produces 5.3% more ethanol per bushel.

On average, a dry-mill corn ethanol plant in 2008

- utilizes 25,859 Btu/gallon (LHV, anhydrous ethanol) of thermal energy and 0.74 kWh of electricity per anhydrous gallon of ethanol,
- produces 2.78 gallons of anhydrous ethanol per bushel,
- co-produces at once 5.3 lbs of DDGS and 2.15 lbs of WDG as well as 0.006 gallons of corn oil,
- uses 2.72 gallons of water per anhydrous gallon of ethanol produced and discharges 0.46 gallons of water per anhydrous gallon of ethanol,
- sources corn for ethanol production within a 47.1 mile radius from the plant,
- is considering further co-product diversification and installation of efficient water use technologies.

1) Introduction

The recently enacted California Low Carbon Fuel Standard (LCFS) and the Federal Renewable Fuel Standard (RFS) require that the greenhouse gas emissions from corn ethanol have to be assessed on a full life cycle basis, which includes emissions from energy consumed at the ethanol plants. Effective greenhouse gas regulations require sound data on the industry's current performance, which can be established by means of surveys, engineering models, or case studies.

By the end of 2008, a total of 86% of corn ethanol was commercially produced using the dry mill process. Dry mills have traditionally produced two co-products: distillers dried grain with solubles (DDGS), and wet distillers grains with solubles (WDGS). WDGS is high in moisture and therefore requires less drying energy but it is sold more locally since it has a shorter shelf life and higher transportation costs. Both products enter the animal feed market. Literature suggests that over the last three years several plants have started to produce a third co-product and separate corn oil for sale for use in biodiesel production.[1,2]

The last comprehensive survey of energy consumption at corn ethanol plants dates back to 2001. The 2001 survey was conducted by BBI International and it was commissioned by the Office of Energy Policy and New Uses, US Department of Agriculture. The survey results are published in Shapouri (2002) in conjunction with an analysis of the life cycle greenhouse gas emissions of corn ethanol production.[3] The 2001 survey included 17 dry and wet mill plants. Since the 2001 survey there has been a rapid expansion of the dry mill corn ethanol market (see graph of plant population in Figure 2). As of December 2008, there were 11.1 billion gallons of installed ethanol dry mill capacity and 9.27 billion gallons of operating dry mill capacity in the US.[4] The present study provides updated industry data in order to inform the emerging regulations.

The Energy Resources Center (ERC) at the University of Illinois at Chicago has conducted a comprehensive dry mill ethanol industry survey. The survey was administered by the Survey Research Laboratory (SRL) located at the University of Illinois at Urbana-Champaign. SRL created a web-based survey instrument, issued secure survey links to each respondent, and collected the data. The survey was conducted with broad industry support, including the renewable fuels associations from various states (Illinois, Iowa, Nebraska), the Minnesota Department of Agriculture, corn growers associations (from Nebraska, Illinois, Iowa), as well as both RFA and Growth Energy. We would like to thank these organizations for their support.

[1] Nilles D (2008) Corn Oil, Diversity on Industry's Mind. Ethanol Producer Magazine
[2] Rendleman M, Shapouri H (2007) New Technologies in Ethanol Production. United States Department of Agriculture, Agricultural Economic Report 842
[3] Shapouri H, Duffield J, Wang M (2002) The Energy Balance of Corn Ethanol: An Update. United States Department of Agriculture, Agricultural Economic Report 813
[4] Data provided by the Renewable Fuels Association

2) Survey Sample Frame

The survey sample frame was compiled from public sources including the Renewable Fuels Association's database of biorefineries (http://www.ethanolrfa.org/industry/locations/) with additional input from representatives from Monsanto and the Illinois Corn Growers Association. The survey sample frame consisted of the entire population of 150 dry mill ethanol plants operating during the 2008 calendar year (plus plants starting up in the winter of 2008/2009).

The selection of the interviewees followed Campbell's "technique of the informant," meaning that particular effort was placed on selecting a contact person at each plant who was well informed about the subject matter.[5] As a result, common titles of the interviewees were: Plant Manager, General Manager, Chief Executive Officer, and Chief Technology Officer. Each interviewee received an advance letter, followed by an e-vite and a reminder e-vite with the link to the actual web-based survey. The letters and e-vites are reproduced in Appendix A.

3) Survey Instrument

The survey instrument was developed by UIC/Steffen Mueller with primary input from RFA, ethanol plant operators, and Michael Wang/May Wu at Argonne National Laboratory. The survey instrument was issued to the respondents via a web-based template. The Survey Research Laboratory (SRL) located at the University of Illinois at Urbana-Champaign created the web-based survey template, issued secure survey links to each respondent, and collected the data. Skipping programming of the survey instrument allowed for the survey instrument to adjust follow-up questions to submitted answers. A pre-test of the survey was performed with a total of three facilities and three additional experts from the ethanol industry. The survey included a response facilitator in the form of an Amazon.com Gift Code totaling $50 for each respondent. Appendix B includes a copy of the survey script. A sample screen shot of the web-based survey instrument is shown below.

[5] Campbell, Donald T. "The informant in Quantitative Research"; American Journal of Sociology, 60, pp. 339-342, 1955.

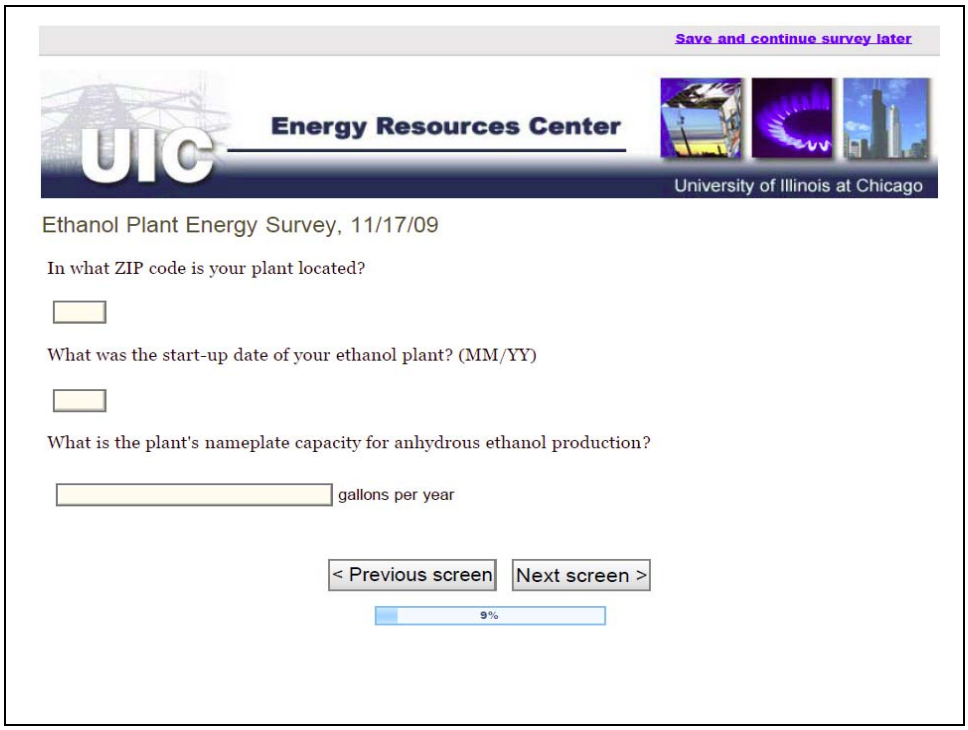

Figure 1: Survey Instrument Screen Shot

4) Survey Variables

The survey instrument was designed to explore a total of six different types of variables pertaining to: a) energy technologies (types of thermal feedstocks, energy equipment) installed at the ethanol plants; b) energy consumption, both thermal and electricity; c) processing technologies (corn oil separation, cold cook, carbon dioxide extraction, etc.) employed by plants; d) process yields (for ethanol and co-products) achieved by plants; e) logistics (corn, ethanol transport), and f) water use and adopted water efficiency measures.

5) Survey Response Characteristics

In total, 90 dry mill plants of 150 operating plants during 2008 responded to the survey. This represents 6.1 billion gallons of 9.27 billion gallons of operating capacity or a 66% response rate. The first test determined whether the plant vintage of responses matched the plant vintage of the population. As pointed out in the introduction, the energy efficiency of ethanol plants has been consistently increasing over time and plant vintage could introduce significant bias.

The histogram of plant start-ups in Figure 2 confirms that the plant vintage of the responses closely matches the plant vintage of the population indicating that plant vintage does not introduce a significant survey bias.

The second test determined whether the geographic location of the responses matched the geographic location of the population. Plant location may influence different technologies and logistics of the production process (corn is shipped different distances etc.). The

maps in Figure 3 confirm that the plant locations of the responses match the plant location of the population indicating that geography does not introduce a significant bias.

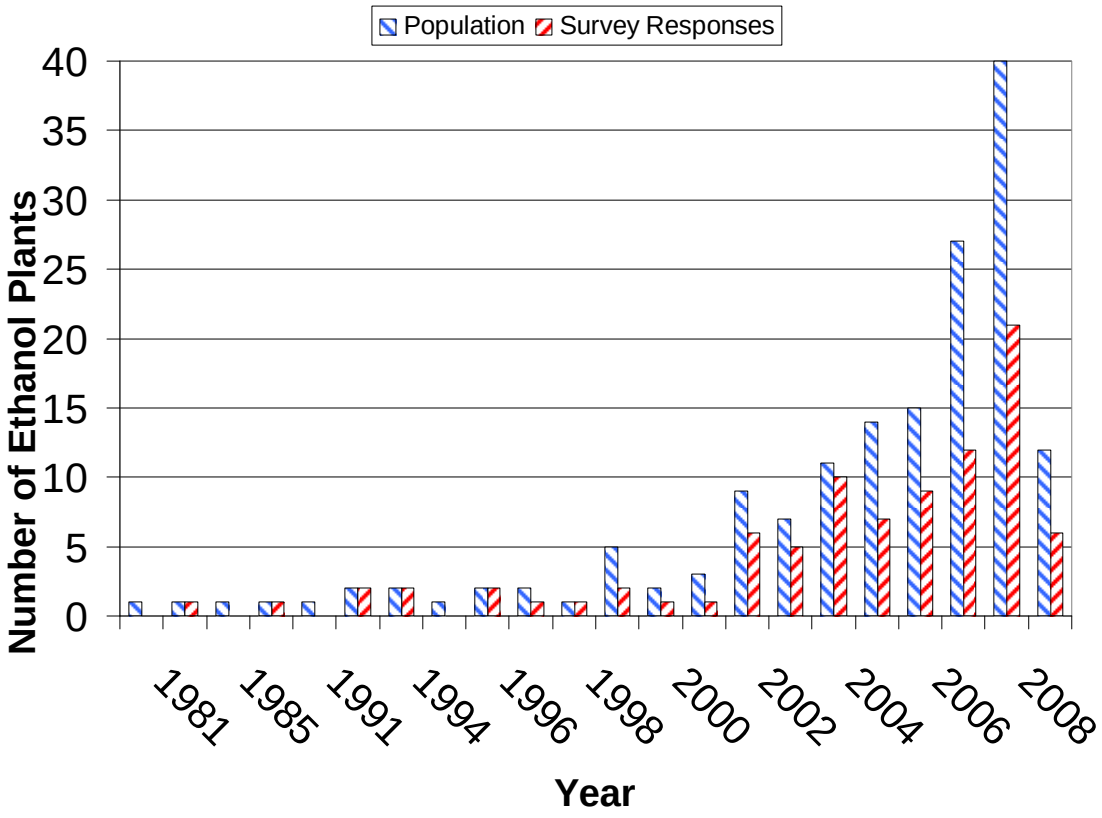

Figure 2: Plant Vintage

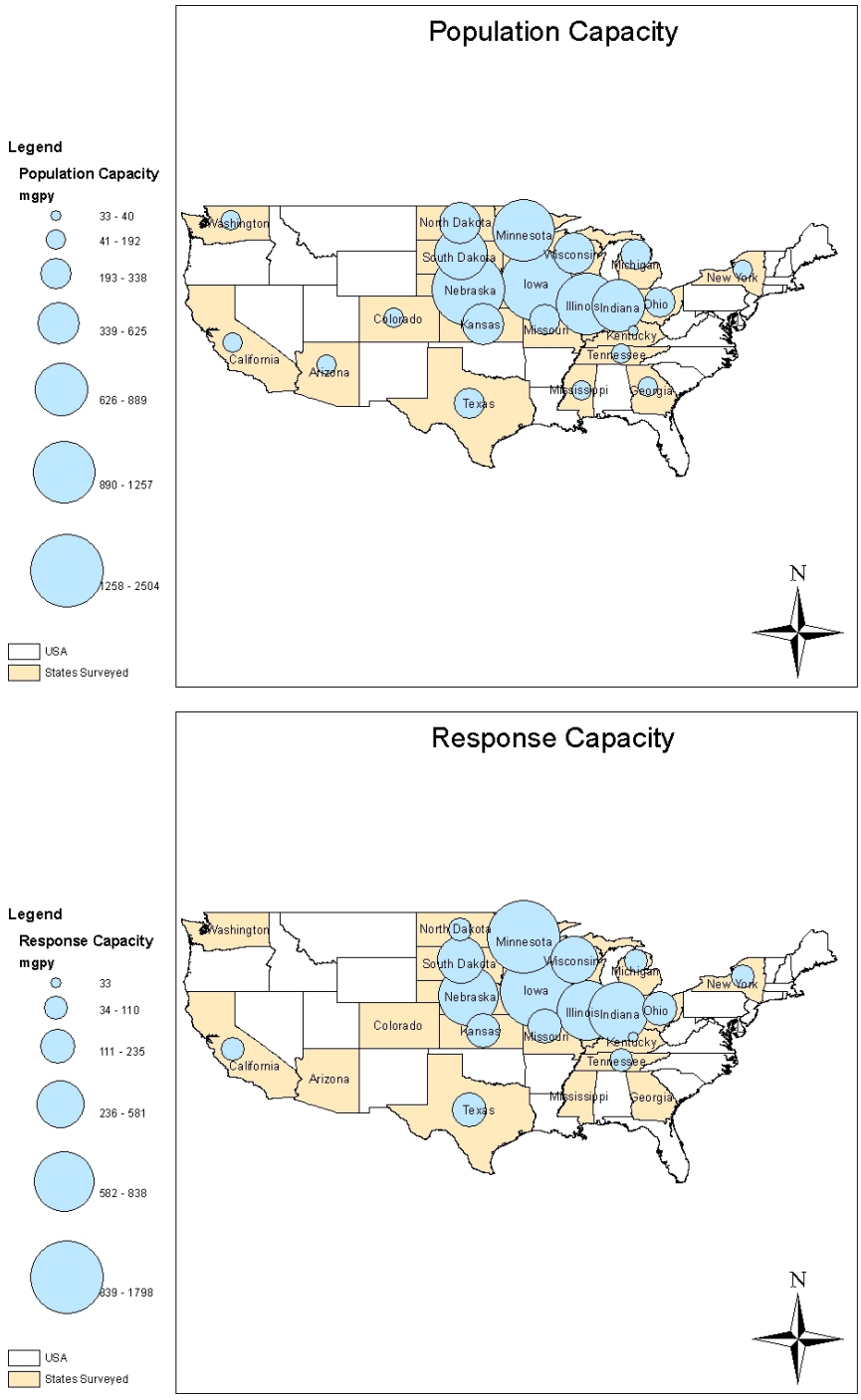

Figure 3: Plant Geography

6) Results

6.1) Energy Use

Natural gas-fired energy systems are the predominant thermal energy source for dry mill ethanol plants. The average natural gas consumption of natural gas-fired ethanol plants and their corresponding electricity use is detailed in Table 1. Numbers shown are weighted by plant capacity as well as simple average by plant count.

Three reporting plants use coal. One of the coal plants employs a fluidized bed boiler, which consumes 33,157 Btu/gal (HHV, anhydrous) of coal and 0.90 kWh/gal of electricity. The second coal plant utilizes waste steam from a nearby coal-fired power plant reducing allocated thermal energy and electricity to below 10,000 Btu/gal and 0.65 kWh/gal respectively. The third coal plant reported coal use but not detailed Btu/gal data. Two plants use biomass (gasification, syrup combustion), and one additional plant uses landfill gas. With six non-natural gas and 73 natural gas plants reporting, natural gas constitutes 92% of thermal energy supply by plant count.

In 2008, the University of Illinois at Chicago conducted a detailed case study on the energy consumption of the Illinois River Energy Center, a standard 100 mgpy natural gas fired ethanol plant. That plant uses 25,289 Btu/gal (LHV, anhydrous) and 0.71 kWh/gal. The survey results match closely to the IRE data.

Table 1: Natural Gas and Electricity Use

	All Thermal Feedstock Plants	Natural Gas Plants Only
	(Btu/gal) Anhydrous	(Btu/gal) Anhydrous
Weighted Average (HHV)	28,692	29,118
Average (HHV)	28,590	29,177
STD (HHV)	4,471	3,416
Weighted Average (LHV)	25,859	26,206
N	78	73
Weighted Average	0.74	0.73
Average	0.76	0.75
STD	0.24	0.23
N	75	70

6.2) Process and Energy Technologies

Table 2 below lists process and energy technologies employed by dry mill ethanol plants. One of the most significant new process technologies adopted by ethanol plants is backend corn oil separation, which accounts for about one third of all surveyed plants. A total of 22% of all plants utilize combined heat and power technologies.

Table 2: Process and Energy Technologies

	Corn Fractionation	Backend Corn Oil Separation	Carbon Dioxide Extraction	Cold Cook Process	Combined Heat and Power
Count	2	23	8	27	17
%	2.7	30.7	10.5	37.0	22.4
N	73	75	76	73	76

6.3) Product Yields

6.3.1) Ethanol Yield

The ethanol yield reported by plants is summarized in Table 3. The ratio of anhydrous to denatured ethanol reveals that denaturant accounted for 2.5% of denatured ethanol by volume. As usual, numbers shown are weighted by plant capacity as well as simple average by plant count.

Table 3: Ethanol Yield

	Ethanol Yield: Anhydrous	Ethanol Yield: Denatured
Weighted gallons/bushel	2.78	2.85
Avg	2.80	2.87
STD	0.12	0.13
N	77	78

6.3.2) Co-Product Yield and Moisture

a) Moisture

The moisture content reported by ethanol plants is listed in Table 4. The standard deviations indicate some variability in reported moisture. Numbers shown are weighted by plant capacity as well as simple average by plant count.

Table 4: Co-product moisture content

	Moisture DDGS	Moisture WDG
Weighted %	10.8	57.2
Avg	10.8	57.2
STD	0.9	8.3
N	40	29

b) Co-Product Yield

Traditionally, dry mill corn ethanol plants produced two co-products: DDGS and WDG. Over the last years, a third co-product, corn oil, was added and, as shown above, about one third of all plants now also produce corn oil.

The yields of the three key products that are co-produced with ethanol during dry mill operations are further analyzed. The production of these co-products is interrelated: producing one product reduces the output of the two other ones. Therefore, for the purpose of yield analysis, the data set cannot contain missing values for any product. We were able to isolate a total of 53 plants for this analysis. The cumulative products from these plants are shown in Table 5. On average each gallon of ethanol results in the co-production of 5.3 lbs of DDGS and 2.15 lbs of WDG as well as 0.006 gallons of corn oil.

However, co-products from individual plants vary widely. These variations are illustrated in Figure 4, where individual co-product data for 10 plants is shown. For example, Plant 10 produces 5.73 lbs/gal of DDGS and an additional 0.57 lbs/gal of WDG, but it does not separate corn oil, whereas Plant 7 produces 6.14 lbs/gal of DDGS, 0.42 lbs/gal of WDG, and separates 0.025 gal/gal of corn oil.

Table 5: Cumulative Co-Products

	DDGS (tons)	WDG (tons)	Corn Oil (gallons)	Ethanol Produced (gallons)
	8,530,970	3,463,315	19,005,589	3,221,417,924
N	*53*	53	53	53

Table 6: Co-Product Yields per Gallon

	DDGS (lbs/gal)	WDG (lbs/gal)	Corn Oil (gal/gal)
Weighted Average	5.30	2.15	0.006
N	53	53	53

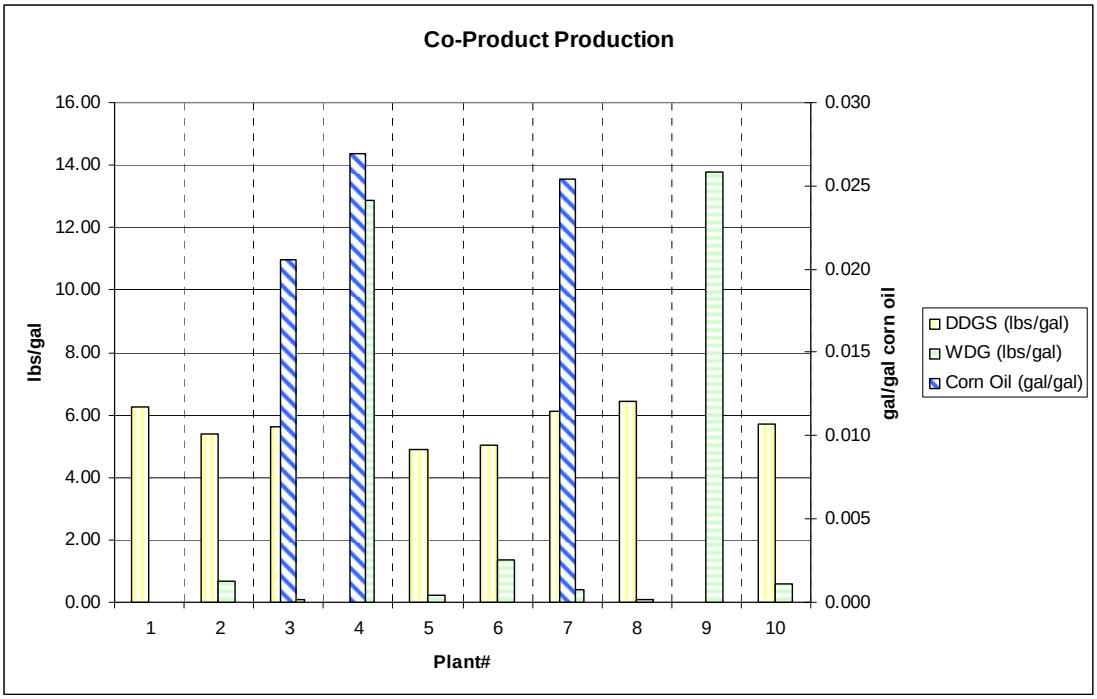

Figure 4: Co-Product Variation

Several plants are reporting co-products other than DDGS, WDG, or corn oil, a trend which seems to indicate further diversification within the industry. Table 7 summarizes additional co-products and the number of reporting plants.

Table 7: Co-Product Diversification

Co-Product	# of Plants
Syrup	3
Modified Distillers Grains	3
Carbon Dioxide	1
Bran, Germ Syrup	1
Syrup, Carbon Dioxide	1
Condensed Distiller Solubles	2
Solubles	1

6.4) Logistics

6.4.1) Corn Shipments to the Plants

The survey asked the following question: "The vast majority (90%) of corn is grown within what radius of your plant (please estimate or provide best guess)?" The responses are summarized in Table 8. The statistics were skewed by two ethanol plants located in the southwest which reported large corn transportation distances (in excess of 1000 miles). Excluding these two plants results in much lower transportation distances and standard deviations for the reporting plants. In fact, the average corn draw circle of 47.1 miles indicates that plants source their corn in very close proximity to their plants.

Table 8: Corn Supply Radius

	The vast majority of corn is grown within what radius of plant?	Excluding two plants located in the southwest
Weighted Miles	91.5	47.1
Avg	75.6	45.7
STD	189.7	42.4
N	78	76

6.4.2) Ethanol Shipments from the Plants

The ethanol distribution mode from the plants was assessed. The transportation modes of 42 valid responses weighted by ethanol volume are as follows: 25% of ethanol is distributed by truck, 3% by ship/barge, and 72% by rail/tankcar. The transportation modes vary significantly by plant as indicated in Figure 5.

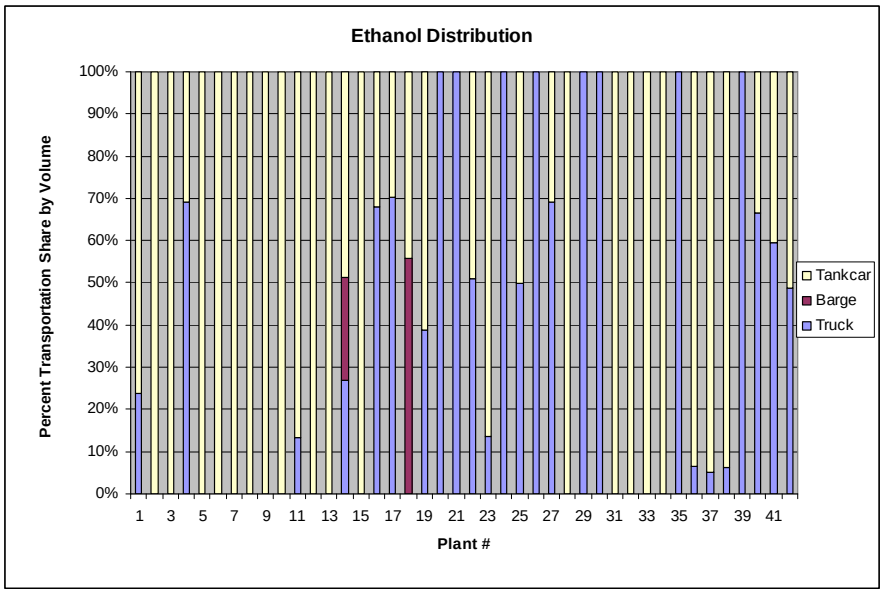

Figure 5: Transportation Mode by Plant

6.5) Water Use

The water use and discharge reported by ethanol plants is summarized in Table 9. The survey also asked the following open ended question: "Has your plant made any recent improvements to reduce fresh water usage?" Table 10 shows the verbatim responses, which appear to indicate a trend towards overall water use/discharge optimization by ethanol plants.

Table 9: Ethanol Plant Water Use

	Fresh Water	Water Discharge
Weighted gal/gal (anhydrous)	2.72	0.46
Avg	2.69	0.43
STD	0.88	0.63
N	48	55

Table 10: Improvements to Fresh Water Usage

Responses to Open Ended Question
Installed 2 [reverse osmosis] RO systems to recycle water from our waste stream. Installed a fin fan system on our cooling tower.
Coming up with a plan to
Complete recycle of water and went zero liquid discharge during 2008
Cooling tower makeup water pretreatment. Evaporator modifications
Improved water treatment capacity to reduce cooling tower water usage by increasing cycles
Increased cycles of concentration of water in the system.
Installed/modified heat exchangers to capture more heat to be used in the process and reduced the heat loading to the cooling tower
Optimization of RO operations Continued optimization of fermentation
Proprietary, cut 25% of required water to CO2 scrubber while remaining below required emissions limits
Recover more heat from stack, reducing boiler make up and less fresh water to the sky.
Single prop from 3 prop system NH3 Addition to Ferm vs. Urea Use some RO water makeup to the CT Discontinue use of Methanator No longer use hydroheater
Use a recycle stream as inlet to the front end water needs
Use storm water for make up water in the process
Water is recycled back to the slurry instead of disposing it. About 10%
Water reuse/ cleaning program.
We added a fourth reverse osmosis machine to help clean more gallons of water.
We cycled up our cooling tower.
We have installed additional piping and valves for the recycling of used steam and condensate.
Zero discharge Plant with RO concentrating to reduce water to be discharged
One plant uses zero discharge

Appendix A: Advance Letter and E-Vites

Advance Letter

Dear [%%First Name%%],
Dear Ethanol Plant Operator:

Recent regulations, including the California Low Carbon Fuel Standard and the Renewable Fuels Standard II, use models to compare the energy and environmental footprint of ethanol against gasoline. In order to assure correct representation of the ethanol industry during these modeling procedures, the University of Illinois at Chicago Energy Resources Center (UIC-ERC), with broad industry support, is conducting a survey of ethanol plant energy consumption.

The energy use numbers from the ethanol plants will be aggregated with the intent to update the GREET Model that is managed by Argonne National Laboratory. The energy use numbers from the ethanol industry have not been updated in the GREET Model since 2004. The GREET Model is a full life cycle fuel analysis model used to determine the greenhouse gas emissions of different transportation fuels. This model is used by both the California Air Resources Board and the USEPA to determine the direct greenhouse gas emissions of ethanol compared to gasoline for the Low Carbon Fuel Standard and the RFS II respectively.

Argonne has committed to the Illinois Corn Growers Association, the Illinois Renewable Fuels Association and the University of Illinois-Chicago that they will update the GREET Model with the new numbers if a statistically representative number of ethanol plants complete this survey completely and accurately. This updated data is critical if we want USEPA and CARB to correctly represent reductions in the Global Warming Impact of corn ethanol compared to gasoline.

None of the collected data will be used for commercial/competitive purposes. All collected data will be aggregated to provide a snapshot of the average industry; the ethanol plant's individual information will never be released. Participation in this assessment is strictly voluntary. However, a large sample of responses is crucial to the success of this project.

In the next few weeks, we will email ethanol plant operators a link to a web-based assessment form, which will primarily assess basic capacity, co-product, and energy (gas, coal, electric use) information. The requested information should be readily available and take no longer than 30 minutes to complete. In appreciation for your time, you will receive a $50 Amazon.com® Gift Card* for completing the questionnaire. Your Gift Card will arrive via email within two weeks from the University of Illinois at Chicago.

All submitted information will be collected and aggregated by the University of Illinois at Chicago Survey Research Laboratory (www.srl.uic.edu). Steffen Mueller, Principal Economist at UIC-ERC will be available to provide guidance and answer any questions throughout the survey process. He can be reached at 312-355-3982 or muellers@uic.edu.

Thank you very much for participating in this important project.

Sincerely,

Steffen Mueller, PhD
Principal Economist, University of Illinois at Chicago
Energy Resources Center

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Initial e-vite

Subject: Ethanol Plant Energy Survey

From name: Steffen Mueller, Ph.D.
From email: lisakw@srl.uic.edu

Dear [%%First Name%%],

Greetings from the Energy Resource Center at the University of Illinois at Chicago!

Recent regulations, including the California Low Carbon Fuel Standard and the Renewable Fuels Standard II, use models to compare the energy and environmental footprint of ethanol against gasoline. In order to assure correct representation of the ethanol industry during these modeling procedures, the University of Illinois at Chicago Energy Resources Center (UIC-ERC), with broad industry support, is conducting a survey of ethanol plant energy consumption.

The energy use numbers from the ethanol plants will be aggregated with the intent to update the GREET Model that is managed by Argonne National Laboratory. The energy use numbers from the ethanol industry have not been updated in the GREET Model since 2004. Argonne has committed to the Illinois Corn Growers Association, the Illinois Renewable Fuels Association, and the University of Illinois-Chicago that they will update the GREET Model with the new numbers if a statistically representative number of ethanol plants complete this survey completely and accurately. This updated data is critical if we want USEPA and CARB to correctly represent reductions in the Global Warming Impact of corn ethanol compared to gasoline in both the RFS II and LCFS.

None of the collected data will be used for commercial/competitive purposes. All collected data will be aggregated to provide a snapshot of the average industry; the ethanol plant's individual information will never be released. Participation in this assessment is strictly voluntary. However, a large sample of responses is crucial to the success of this project. In appreciation for your time, you will receive a $50 Amazon.com® Gift Card for completing the questionnaire. Your Gift Card will arrive via email within two weeks from the University of Illinois at Chicago.

Please click here to access the survey: [%%Secure Survey Link%%]. The requested information should be readily available and take no longer than 30 minutes to complete.

If you have any questions about this questionnaire, please contact Steffen Mueller at 312-355-3982, muellers@uic.edu. For questions about the web survey administration or problems with the link, please contact Lisa Kelly-Wilson at lisakw@srl.uic.edu.

Thank you very much for participating in this important project.

Sincerely,

Steffen Mueller, PhD
Principal Economist
University of Illinois at Chicago
Energy Resources Center

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Reminder e-vite

Subject: Reminder to Participate in the Ethanol Plant Energy Survey

From name: Steffen Mueller, Ph.D.
From email: lisakw@srl.uic.edu

Dear [%%First Name%%],

Greetings from the Energy Resource Center at the University of Illinois at Chicago!

We recently invited you to participate in an survey of the ethanol industry. To date, we have not received your response, so I am writing again to once again request your participation.

Recent regulations including the California Low Carbon Fuel Standard and the Renewable Fuels Standard use models to compare the energy and environmental footprint of ethanol against gasoline. In order to assure correct representation of the ethanol industry during these modeling procedures, the University of Illinois at Chicago Energy Resources Center (UIC-ERC), with broad industry support, is conducting a survey of ethanol plant energy consumption.

None of the collected data will be used for commercial or competitive purposes. All collected data will be aggregated to provide a snapshot of the average industry; the ethanol plant's individual information will never be released.

Participation in this assessment is strictly voluntary and can be cancelled at any time. However, a large sample of responses is crucial to the success of this project. Your responses will be kept confidential by the UIC Energy Resource Center.

Please click here to access the survey: [%%Secure Survey Link%%]. The requested information should be readily available and take no longer than 30 minutes to complete. In appreciation for your time, you will receive a $50 Amazon.com® Gift Card for completing the questionnaire. Your Gift Card will arrive via email within two weeks from the University of Illinois at Chicago.

If you have any questions about this questionnaire, please contact Steffen Mueller at 312-355-3982, muellers@uic.edu. For questions about the web survey administration or problems with the link, please contact Lisa Kelly-Wilson at lisakw@srl.uic.edu.

Thank you very much for participating in this important project.

Sincerely,

Steffen Mueller, PhD
Principal Economist
University of Illinois at Chicago
Energy Resources Center

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Informed Consent

Welcome to the survey!

The University of Illinois at Chicago Energy Resources Center is conducting a survey with approximately 160 ethanol plants. The purpose of the survey is to collect information on ethanol plant energy use, ethanol and co-product volumes, and shipping characteristics.

Compensation: There is no compensation for participating in this study. We value your input and hope that you can devote about 30 minutes of your time to answering the questionnaire.

Participation in this survey is completely voluntary. You are free to stop anytime or skip any items you do not like.

This survey is anonymous: The information you provide will only be reported as group data.

What are the risks & benefits? There are no known risks associated with participating in this study. Your participation will benefit your industry and assure that policy makers (including those involved with the California Low Carbon Fuel Standard and the Renewable Fuels Standard) use correct information during modeling procedures that compare the energy and environmental footprint of ethanol against gasoline. Aggregated results of the survey will be posted on the UIC-Energy Resources Center website.

Who is administering the survey? The Survey Research Laboratory (SRL) of UIC is administering this survey. SRL will not release any personal, identifying information.

If you have any questions about this survey please contact Steffen Mueller at 312-355-3982 or by email at muellers@uic.edu. For questions about the web survey administration you can contact Dr. Sowmya Anand at (217) 333 2219, sowmya@srl.uic.edu. For concerns about the study or questions about your rights as a research participant, please call the UIC Office for the Protection of Research Subjects (OPRS) at 312-996-1711 (local) or 1-866-789-6215 (toll-free), uicirb@uic.edu.

In appreciation for your time, you will receive a $50 Amazon.com® Gift Card for completing the questionnaire. Your Gift Card will arrive via email within two weeks from the University of Illinois at Chicago.

Thank you for your participation in this study!!

Click the *print* button on the browser if you would like to print this document for your records.

If you have read and understood this document and voluntarily consent to participate, please click on *next page* below to begin the survey.

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Appendix B: Survey Instrument

1) In what zip code is your plant located?

_____ Zip Code

2) Is your ethanol plant a dry mill or a wet mill?

Dry Mill

Wet Mill

Other (SPECIFY _____)

3) When did your ethanol plant start-up? (dd/mm/yy)

4) What is the plant's nameplate capacity for anhydrous ethanol production?

(million gallons per year)

5) How much anhydrous ethanol did the plant produce in 2008? You may want to use EIA-819.

(million gallons per year)

6) Which of the following energy and process technologies does your plant have installed? (CHECK ALL THAT APPLY)

6a) Energy Technologies
Natural gas boiler
Natural gas direct-fired dryer
Super heated Steam Dryer (SSD)
Steam dryer
Electricity steam turbine
Electricity combustion turbine
Biomass Boiler
Biomass Gasifier
Anaerobic Digester generating methane for in-plant fuel use
Coal Boiler
Wind turbines
High efficiency motors (NEMA Premium Efficiency)
Other energy technologies (please specify)

6b) Process Technologies
Corn Fractionation Unit
Backend Corn Oil Extraction Unit
Carbon Dioxide Extraction Unit
Cold Cook Process

Other process technologies (please specify)

7) What is the total volume of corn your plant received for processing in 2008?

_____ bushels of corn

8) The vast majority (90%) of corn is grown within what radius of your plant (please estimate or provide best guess)?

_____ MILES

9) What is your plant's average yield per year of the following ethanol products?

_____ anhydrous gallons per bushel

_____ denatured gallons per bushel

10) To how many states does your plant distribute ethanol?

_____ state(s)

11) In the following table, please indicate the 3 primary states your plant distributes ethanol to, the amount distributed, and the mode of transport. If your plant distributes ethanol to more than 3 states, please report on the 3 top recipients. If your plant distributes to fewer than 3 plants, leave the columns blank.

RECIPIENT 1 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN GALLONS)	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 2 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN GALLONS)	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 3 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN GALLONS)	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	

12) What co-products does your plant distribute? (CHECK ALL THAT APPLY)

DDGS
WDG
Corn Oil
Other (SPECIFY)

FOR EACH CO-PRODUCT CHECKED, THE RESPONDENT WILL BE PRESENTED WITH THE FOLLOWING FOLLOW-UP QUESTIONS

IF DGGS:

Who are the primary recipients of DGGS co-product?

RECIPIENT 1 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 2 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 3 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	

IF WDG:

RECIPIENT 1 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 2 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 3 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	

IF CORN OIL:

TANKCAR	
RECIPIENT 1 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 2 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 3 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	

IF OTHER (SPECIFY)

RECIPIENT 1 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 2 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	
RECIPIENT 3 (CITY/STATE)	
QUANTITY DISTRIBUTED (IN TONS)	
% MOISTURE	
MODE OF TRANSPORT	
TRUCK	
BARGE/SHIP	
TANKCAR	

The final set of questions relates to your plant's energy use for calendar year 2008.

13) Does your plant Use Natural Gas for Process Energy?
If no, skip to 14)

If yes, is it possible to use your 2008 natural gas bills to total your plant's natural gas needs (preferred method)?
If yes, skip to 13)a
If no, skip to 13)b

13a) are your natural gas bills stated in therms or BTU?
IF therms
How many therms of natural gas were purchased for plant production in 2008? _____ therms

IF BTU
How many BTU of natural gas were purchased for plant production in 2008? _____ BTU

13b) Please report your 2008 natural purchases in BTU of Higher Heating Value

14) How many BTUs of coal were purchased for plant production in 2008? _____BTU

15) How many BTUs of Biomass were purchased for plant production in 2008?_____BTU

16) Did you purchase any other energy feedstocks in 2008 (please specify) _____BTU

17) Who is your plant's electricity provider?

18) How many kilowatt hours for plant production were purchased for plant production in 2008?

19) What is your plant's source of fresh water?

City
Onsite well
Other (SPECIFY)

20) How many gallons of fresh water per anhydrous gallon were used in 2008?

21) How many gallons of water per anhydrous gallon were discharged in 2008?

22a) Has your plant made any recent improvements to reduce fresh water usage?

Yes
No –SKIP TO Q21

22b) Please explain your recent improvements to reduce fresh water usage.

23) In the event we have questions about the data you have provided, may we contact you for clarification?

YES
NO –SKIP TO END/THANK YOU

24) Thank you. Please provide your name and phone number or e-mail address at which we can contact you.

NAME
PHONE #
E-MAIL ADDRESS

END/THANK YOU: Thank you for taking the time to complete this questionnaire. Within the next couple of weeks, you will receive an e-mail with your Amazon.com Gift Card claim code.