

# **U.S. Ethanol Industry Efficiency Improvements 2004 through 2007**

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Christianson & Associates, PLLP (C&A) is a certified public accounting firm located in Willmar, MN. C&A provides a comprehensive Biofuels Financial Benchmarking subscription service primarily serving the ethanol industry. This financial benchmarking service measures over eighty financial and operational factors on a quarterly basis allowing plants to identify opportunities for improving processes and efficiencies. Plants that subscribe to the Benchmarking are provided with a variety of reports allowing them to compare their data to the industry average and to the top 25% quartile (referred to as Leaders) in each category measured.

This report is designed to illustrate the energy and yield efficiency gains for dry mill ethanol production facilities. The data is compiled from the Biofuels Financial Benchmarking results for the four year period beginning in 2004 and ending in 2007. This Benchmarking data set includes 100% natural gas fired dry mill ethanol plants for the years 2004 through 2006 and 97% natural gas fired plants for the year 2007. Energy and yield efficiencies that are being measured and compared include the following:

- BTUs consumed per gallon of ethanol production
- Kilowatts (Kwh) consumed per gallon of ethanol production
- Ethanol yield in denatured gallons per bushel of corn consumed
- Ethanol yield in undenatured gallons per bushel of corn consumed

The number of dry mill ethanol plants participating annually in the benchmarking subscription service has increased each year as follows:

2004	14 plants
2005	25 plants
2006	28 plants
2007	33 plants

## **Energy usage in BTUs per gallon of ethanol production:**

The average of all the plants in the data set for BTUs consumed per gallon was 31,588 BTUs per gallon in 2004 and 27,298 BTUs per gallon in 2007. This average includes all plants that produce dry, modified, and wet distillers grains. The leaders (top 25% quartile) BTUs usage was 25,368 BTUs in 2004 decreasing to 20,545 BTUs in 2007 which represents a 19.01% reduction in BTUs consumed per gallon during the four year period.

A large portion of the energy consumed in an ethanol plant is in the production of distillers grains, with dried production consuming much more than the wet production. We have broken down this report to separate plants that dry most of their production and those that do not. Dry Distillers Grains with Solubles (DDGS) is defined for this report as distillers grains that contain 10% or less moisture. Plants are producing distillers grains with varying levels of dry, modified and wet production. The percentage of dry versus wet production will depend on the local market demand. We will reference dry plants by those that produce more than 75% dry production and all others as wet plants.

A noticeable trend reflects the BTUs consumed per gallon being reduced as improved production practices and technology are occurring in the industry. The efficiency gains are larger with the leaders which represent the newer more efficient plants. A trend which is also observed is that developing plants are emphasizing energy efficiencies of the production of ethanol.

Mean BTU Usage per Denatured Gallon Produced				
	2004	2005	2006	2007
All Plants Mean ± SD*	31,588 ± 5,366	30,080 ± 6,194	27,993 ± 5,428	27,298 ± 4,862
Leaders Mean ± SD*	25,368 ± 1,898	25,102 ± 1,555	20,293 ± 2,561	20,545 ± 2,637
*SD – Standard Deviation				

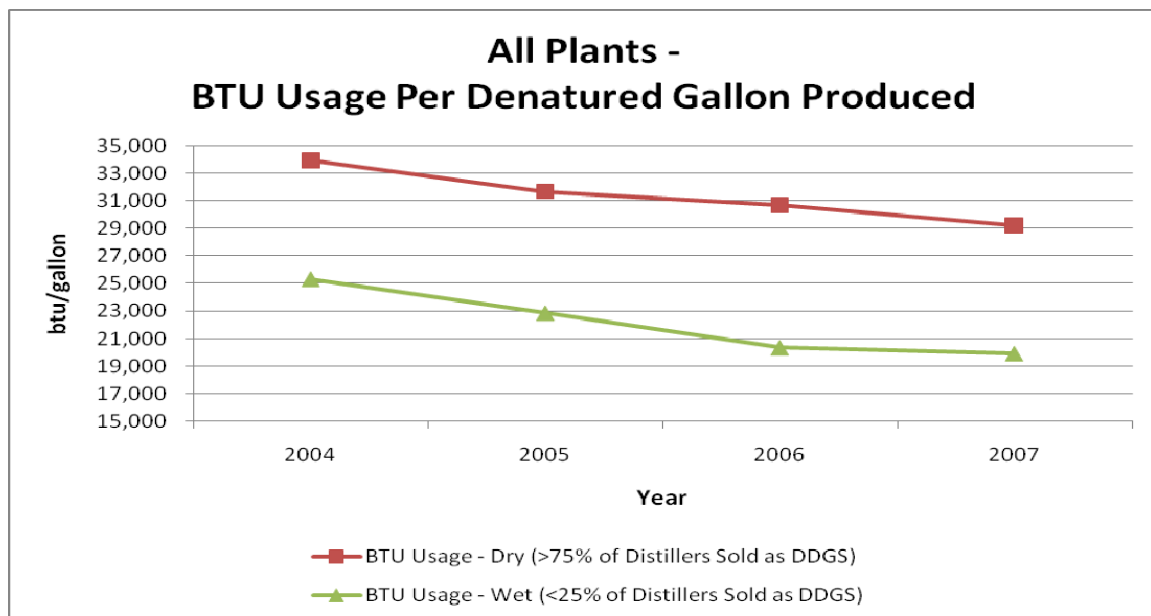
#### Energy usage - DDGS production

In 2004, these plants on average consumed 33,927 BTUs with usage decreasing to 29,231 BTUs per gallon of production in 2007. This represents a 13.84% reduction in BTU usage over this four year time period. The leaders BTUs consumed 28,583 BTUs in 2004 with usage decreasing to 26,693 BTUs in 2007.

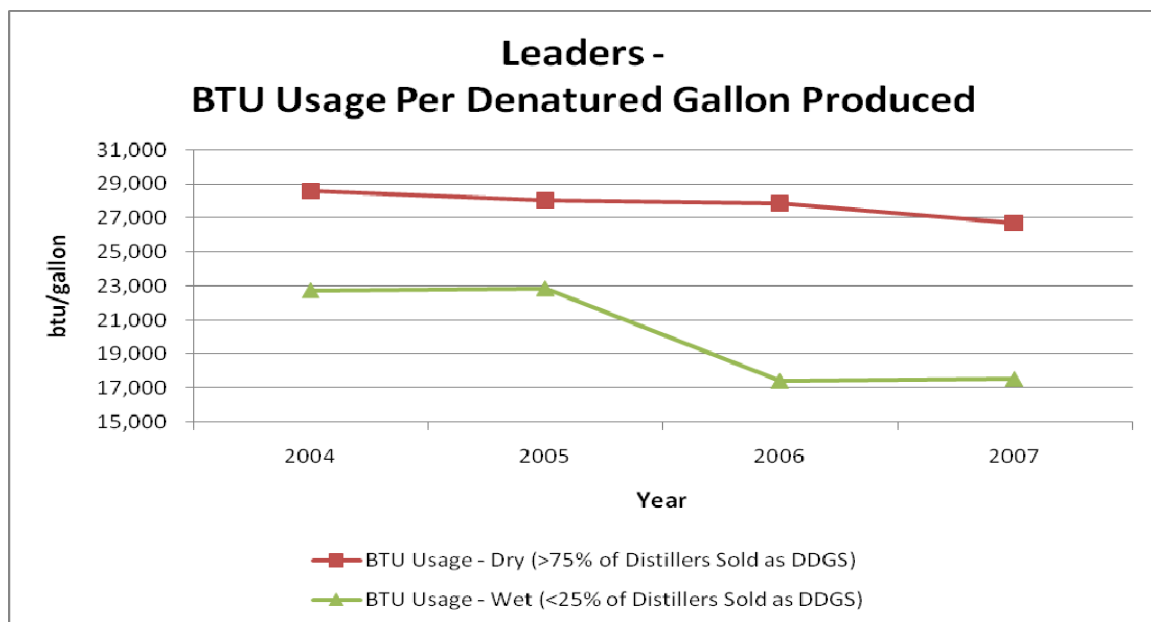
#### Energy usage – Wet production

In 2004, plants that produced wet distillers consumed 25,334 BTUs on average with a decrease to 19,901 BTUs per gallon of production in 2007. This represents a 21.45% reduction in BTU usage on average for this four year time period. The leaders consumed 22,735 BTUs in 2004 with a decrease to 17,526 BTUs in 2007 which represents a 22.91% reduction in BTU usage for this period.

Mean Energy Usage (BTUs per Denatured Gallon Produced) For All Plants				
	2004	2005	2006	2007
BTU Usage - Dry (>75% of Distillers Sold as DDGS)	33,927	31,679	30,695	29,231
BTU Usage - Wet (<25% of Distillers Sold as DDGS)	25,334	22,849	20,328	19,901



Mean Energy Usage (BTUs per Denatured Gallon Produced) For Leaders				
	2004	2005	2006	2007
BTU Usage - Dry (>75% of Distillers Sold as DDGS)	28,583	28,044	27,853	26,693
BTU Usage - Wet (<25% of Distillers Sold as DDGS)	22,735	22,849	17,398	17,526



### Electrical Usage

Total electrical usage is measured in kilowatts (Kwh) per gallon of production. In 2004, the average of all of the plants in the industry data set was .781 Kwh per gallon of production with a decrease to .680 Kwh per gallon in 2007. The leaders in electrical usage efficiency consumed .550 Kwh in 2004 with a decrease to .517 Kwh consumed per gallon of production by 2007.

Mean Electricity Usage (Kwhs per Denatured Gallon Produced)				
	2004	2005	2006	2007
All Plants Mean $\pm$ SD*	0.7809 $\pm$ 0.2444	0.7363 $\pm$ 0.2575	0.6983 $\pm$ 0.2365	0.6799 $\pm$ 0.1952
Leaders Mean $\pm$ SD*	0.5502 $\pm$ 0.0349	0.5516 $\pm$ 0.0116	0.5016 $\pm$ 0.0339	0.5166 $\pm$ 0.0642
*SD - Standard Deviation				

### Electrical usage – DDGS production

In 2004, this group of plants consumed .868 Kwh per gallon of production with electrical usage decreasing to .741 Kwh per gallon of production in 2007.

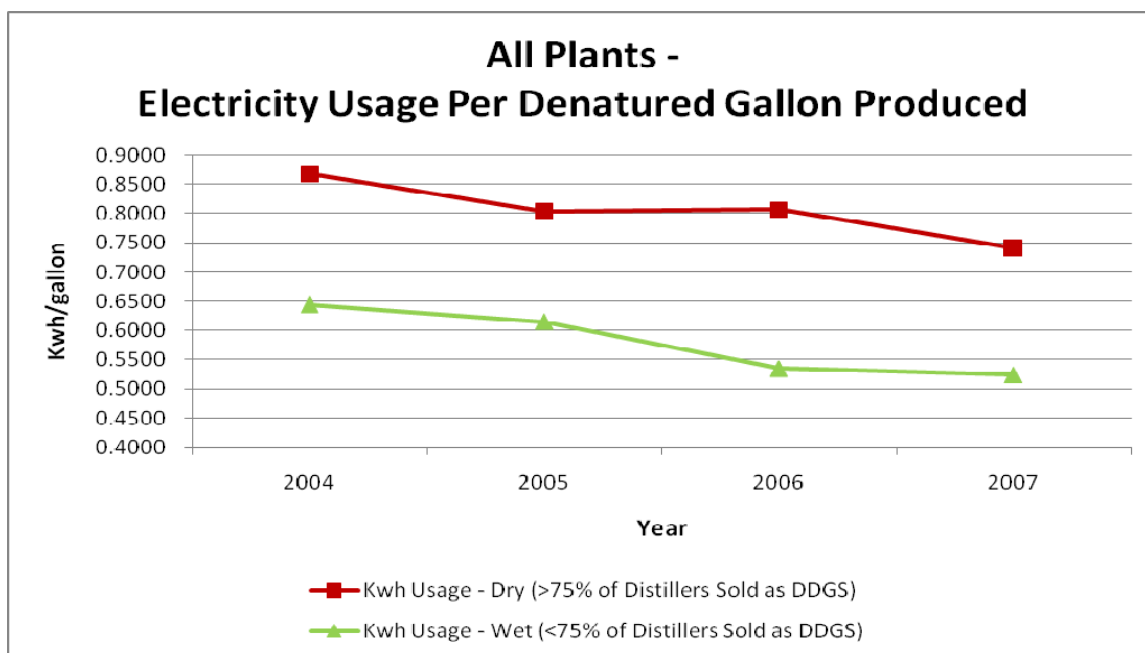
The leaders in electrical usage efficiency consumed .597 Kwh per gallon in 2004 with a reduction to .573 Kwh per gallon of production in 2007.

### Electrical usage – Wet production

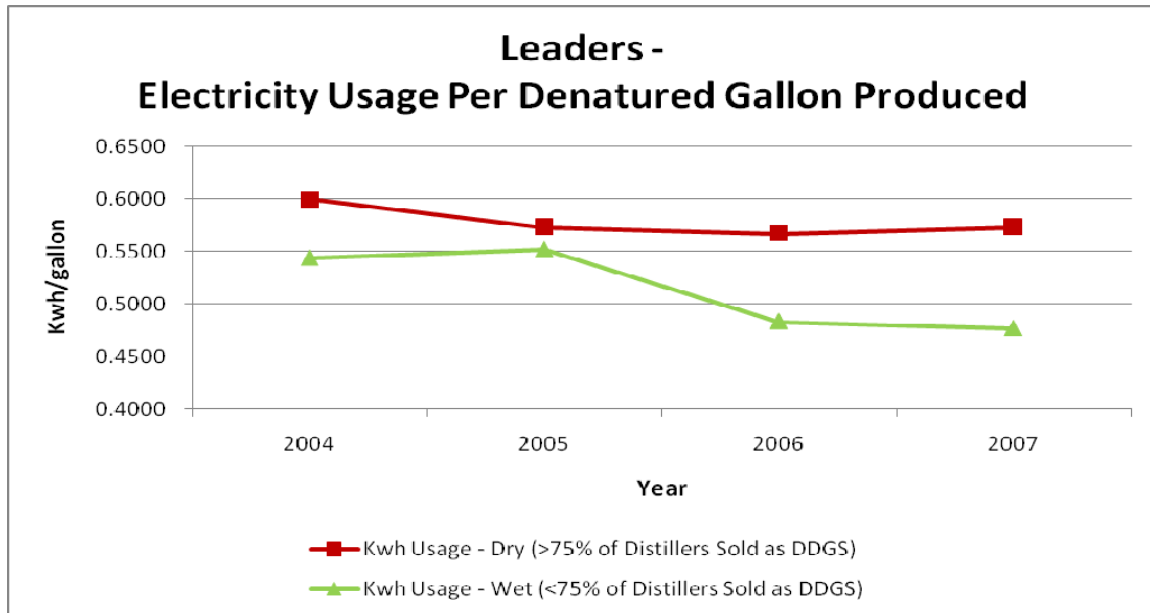
The average plant used .643 Kwh of electrical usage per gallon of ethanol production in 2004 with a decrease to .524 Kwh per gallon of production by 2007.

The leaders in electrical usage efficiency consumed .544 Kwh per gallon in 2004 decreasing to .477 Kwh per gallon in 2007 which represents a 12.32% decrease in Kwhs consumed per gallon of ethanol produced.

Mean Electricity Usage (Kwbs per Denatured Gallon Produced) For All Plants				
	2004	2005	2006	2007
Kwh Usage - Dry (>75% of Distillers Sold as DDGS)	0.8676	0.8037	0.8063	0.7412
Kwh Usage - Wet (<75% of Distillers Sold as DDGS)	0.6433	0.6145	0.5341	0.5237



Mean Electricity Usage (Kwbs per Denatured Gallon Produced) For Leaders				
	2004	2005	2006	2007
Kwh Usage - Dry (>75% of Distillers Sold as DDGS)	0.5996	0.5731	0.5670	0.5734
Kwh Usage - Wet (<75% of Distillers Sold as DDGS)	0.5440	0.5518	0.4833	0.4769



### Ethanol yield efficiencies

Ethanol yield efficiency is measured by the gallons of ethanol that can be produced from a bushel of corn. In 2004, the industry had an average yield of 2.80 gallons of denatured with the leaders at 2.87 gallons per bushel. This denatured yield held consistent over the four year time period due to varying denaturant rate usage.

However, there was an increase in undenatured yield from 2.66 gallons of ethanol per bushel in 2004 to 2.70 in 2007. The leaders also increased from 2.73 in 2004 to 2.77 in 2007. This increase in undenatured yield can be attributed to improved plant technologies as well as more experienced management teams at the plants.

Mean Ethanol Yield for All Plants				
	2004	2005	2006	2007
Denatured	2.7957	2.7724	2.8002	2.8022
Undenatured	2.6588	2.6767	2.6802	2.6970

Mean Ethanol Yield for Leaders				
	2004	2005	2006	2007
Denatured	2.8661	2.8468	2.8642	2.8715
Undenatured	2.7260	2.7432	2.7432	2.7713

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