Cardno ENTRIX
Shaping the Future

Cardno ENTRIX

10 Corporate Circle
Suite 300
New Castle, DE 19720
USA

Phone **302 395 1919**
Toll-free 800 368 7511
Fax 302 395 1920
www.cardno.com

www.cardnoentrix.com

CONTRIBUTION OF THE ETHANOL INDUSTRY TO THE ECONOMY OF THE UNITED STATES

Prepared for the Renewable Fuels Association by
John M. Urbanchuk
Technical Director
February 2011

2010 was a year of continued growth for the ethanol industry. Ethanol demand was boosted by a combination of stimulated gasoline demand as the economy recovered from the most severe recession in the post-war period and implementation of the Renewable Fuels Standard (RFS) 2. However, the year was not without its challenges to the industry. Rising feedstock prices put pressure on ethanol profitability. Early season expectations for a record corn crop and reasonable feedstock prices were dashed by poor weather and lower than expected average yields. While the U.S. harvested the third largest corn crop on record, corn prices were supported by a sustained increase in commodity prices led by oil and precious metals that was fueled by fears of inflation and a financial crisis in the European Union.

Despite the challenges to profitability, the ethanol industry continued to grow and easily met the 12 billion gallon conventional biofuels portion of the (RFS).[1] Nationally, total ethanol production increased nearly 21 percent to an estimated 13 billion gallons.[2] According to the Renewable Fuels Association, at year's end, the ethanol industry comprised approximately 200 plants in 26 states with nameplate capacity of 13.8 billion gallons. An estimated 743 million gallons of new capacity were brought online during 2010 and at year's end 840 million gallons of new capacity were under construction. This study estimates the contribution of the ethanol industry to the American economy in 2010 in terms of the employment, income, and Gross Domestic Product (GDP)

[1] The overall RFS target for 2010 was 12.95 billion gallons, 0.95 billion gallons of which was advanced biofuel.
[2] The 13 billion gallon estimate is based on annualized year-to-date ethanol production reported by the Energy Information Administration.

directly and indirectly supported by the industry. It is important to note that study results do not represent the net change in the American economy due to ethanol production, as the increased economic activity that would occur in other sectors (such as crude oil refining) in the absence of the ethanol activity is not analyzed.

Expenditures by the Ethanol Industry in 2010

Ethanol producers are part of a manufacturing sector that adds substantial value to agricultural commodities produced in the United States and makes a significant contribution to the American economy.

Expenditures by the ethanol industry for raw materials, other goods, and services represent the purchase of output of other industries. The spending for these purchases circulates through the local and national economy generating additional value-added output, household income, and employment in all sectors of the economy.[3] Ethanol industry expenditures can be broken into three major categories: construction of new production facilities, ongoing production operations and research and development.

1. New construction

   The U.S. ethanol industry added 743 million gallons of net new production capacity during 2010 and an additional 840 million gallons of new capacity was under construction at year's end. The construction of new ethanol plants and capital spending on expansion of existing plants increases demand for a wide range of goods and services. At an estimated cost of $2.00 per gallon the new capacity added during 2010 represents an estimated expenditure of $1.4 billion of capital expenditure by the ethanol industry. Nearly 60 percent of this ($862 million) spending was for steel pipe, tanks, and other machinery and equipment.

[3] Expenditures for feedstock and energy were estimated using 2010 calendar year-to-date average prices. Revenues were estimated using 2010 calendar year-to-date average prices for ethanol, FOB Iowa plant; Distiller's grains, corn gluten feed and meal, and corn oil. Prices were sourced from USDA/ERS and AMS, and EIA.

2. Ongoing production operations

The industry spent an estimated $23.9 billion on raw materials, other inputs, and goods and services to produce 13 billion gallons of ethanol during 2010. Production costs were based on a model of dry mill ethanol production maintained by the author. These estimates are consistent with generic dry mill ethanol costs such as those published by Iowa State University.[4] Table 1 details the expenditures by the ethanol industry in 2010.

Table 1
Estimated Ethanol Production Expenditures 2010

	Mil $	$/gal
Feedstocks (corn)	$18,116	$1.394
Enzymes, yeast and chemicals	$978	$0.075
Denaturant	$809	$0.062
Natural Gas	$2,165	$0.167
Electricity	$488	$0.038
Water	$159	$0.012
Direct labor	$494	$0.038
Maintenance & Repairs	$325	$0.025
Transportation	$98	$0.008
GS&A	$260	$0.020
Total Operating Costs	$23,891	$1.838

The largest share of spending was for the corn and other feedstocks used as the raw material to make ethanol. The ethanol industry used 4.6 billion bushels of corn on a gross basis in 2010, valued at more than $18 billion. Ethanol for fuel is the second largest component of demand for U.S. corn after feed use, accounting for 31 percent of total corn utilization during the 2009/10 marketing season. The corn used for ethanol production in 2010 was the equivalent of 30.1 million of the 86.5 million acres of corn planted on a gross basis.

[4] See the Ethanol profitability spreadsheet maintained by Don Hofstrand "AgDecision Maker D1-10 Ethanol Profitability" available at http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xls

Consequently, the ethanol industry is a major source of support for agricultural output and farm income. In the absence of an ethanol industry, demand for corn would fall, prices would decline and farmers would plant and produce less corn. Land would be shifted from corn to soybeans, wheat and cotton. Production of these crops would increase and their prices would likely fall as well, and farm crop revenue and income would be reduced. This analysis estimates both the total production effect and the crop price (farm income) effects of ethanol production on agriculture based on simulation of a structural model of U.S. agriculture maintained by the author.

The remainder of the spending by the ethanol industry for ongoing operations is for a wide range of inputs such as enzymes, yeast and chemicals; electricity, natural gas, and water; labor; transportation; and services such as maintenance, insurance, and general overhead.

3. Research and Development (R&D)

The ethanol industry is a significant engine for research and development both in the public and private sectors. Much of the R&D activity in the biofuels industry is aimed at discovering and developing second generation feedstocks and the technology needed to meet the RFS2 targets for cellulose and advanced feedstock biofuels. The primary public sector agencies underwriting R&D in biofuels are the Departments of Energy (USDOE) and Agriculture (USDA). In addition to the federal government, many states are funding R&D in feedstocks as well as infrastructure. These public funds are being leveraged by private sector firms undertaking research in a wide range of biofuels activities. Finally, nearly $800 million of stimulus from the American Recovery and Reinvestment Act has been allocated for R&D in biofuels.

An assessment of finance in the biofuels industry by the Milken Institute estimated that $1.3 billion was spent on biofuels R&D in 2009.[5] Considering the additional stimulus funds made available for 2010 as well private sector activity determined by a review of public releases, we estimate that R&D expenditures for biofuels amounted to $1.5 billion in 2010.

[5] *Scaling Enterprise Finance: The Future of Biofuels*. Financial Innovation Lab™ Report. The Milken Institute. April 2010

The spending associated with current ethanol production, construction of new plant capacity, and R&D circulates and re-circulates throughout the entire economy several-fold, stimulating aggregate demand, and supporting jobs and household income. Finally, and importantly, expanded economic activity generates tax revenue for government at all levels.

Methodology

We estimate the impact of the ethanol industry on the American economy by applying expenditures by the relevant supplying industry to the appropriate final demand multipliers for value added output, earnings, and employment. To understand how the economy is affected by an industry such as ethanol production it is necessary to understand how different sectors or industries in the economy are linked to each other. For example, in the renewable fuels production sector, the ethanol industry buys corn from the agriculture sector, which in turn then buys crop production products and fertilizers from the agricultural chemicals, which in turn purchases from a range of other industries. These are referred to as backward linkages. Use by other sectors of natural gas as an input, such as in manufacturing operations, is called a forward linkage. The natural gas production and transmission industries are linked through both forward and backward linkages to other economic sectors in each state's economy.

The household sector is linked to all sectors as it provides the labor and management needed by each. In turn, changes that affect the incomes of the household sector typically have more significant impacts compared to a change in the sales of other sectors. This is because households typically spend most of their income in both retail and service industries.

This study utilizes an economic model known as IMPLAN (Impact Analysis for Planning) to develop this understanding of the economy, including the sectors that support the ethanol industry, the links between them, and the level of economic activity. Previous economic impact studies conducted by this author for RFA utilized RIMS II economic impact multipliers published by the Bureau of Economic Analysis. However BEA no longer publishes or supports national level economic impact multipliers. IMPLAN is a commonly used economic input-output (I-O) model. I-O models are constructed based on the concept that all industries within an economy are linked together; the output of one industry becomes the input of another industry until all final goods and services are produced. I-O models can be used both to analyze the structure of

the economy and to estimate the total economic impact of projects or policies. For this analysis, a model for the U.S. economy was constructed using 2009 IMPLAN software and data (the most recent available) and used to estimate economic impacts of the ethanol industry.

IMPLAN models provide three economic measures that describe the economy: value added, income, and employment.

- Value added is the total value of the goods and services produced by businesses in the county and are generally referred to as GDP. It is equivalent to the sum of labor income, taxes paid by the industry, and other property income or profit.

- Labor income is the sum of employee compensation (including all payroll and benefits) and proprietor income (income for self-employed work). In the case of this analysis, demand for corn and other feedstocks to produce ethanol supports farm income through higher crop receipts than would be the case without ethanol production. The impact of this higher farm income is evaluated on a gross basis in this analysis. That is, the model does not factor in the distributional effects on consumers from higher grain prices (i.e. reduced spending on non-food goods and services).

- Employment represents the annual average number of employees, whether full or part-time, of the businesses producing output. Income and employment represent the net economic benefits that accrue to the region as a result of increased economic output.

There are three types of effects measured with a multiplier: the direct, the indirect, and the induced effects. The direct effect is the known or predicted change in the local economy that is to be studied. The indirect effect is the business-to-business transactions required to produce the direct effect (i.e. increased output from businesses providing intermediate inputs). Finally, the induced effect is derived from spending on goods and services by people working to satisfy the direct and indirect effects (i.e. increased household spending resulting from higher personal income).

Results

The contribution of the ethanol industry to the U.S. economy is summarized in Table 2. The full impact of the spending for annual operations, construction of new capacity and R&D is estimated to have supported $53.6 billion of the nation's GDP in 2010. A significant component of this is from agriculture, reflecting the importance of ethanol demand to total corn utilization, the aggregate value of crop production, and crop receipts and farm income.

Table 2
Economic Impact of the Ethanol Industry: 2010

	GDP (Mil 2010 $)	Employment (Jobs)	Income (Mil 2010 $)
Production			
Direct		8,320	$494
Indirect		30,577	$2,116
Induced		28,602	$1,341
Subtotal	$6,839	67,499	$3,951
Construction			
Direct		7,131	$299
Indirect		9,161	$603
Induced		9,926	$466
Subtotal	$2,022	26,218	$1,367
Agriculture			
Direct		45,433	$448
Indirect		23,614	$18,480
Induced		207,710	$9,757
Subtotal	$42,124	276,757	$28,685
R&D			
Direct		9,517	$970
Indirect		6,212	$351
Induced		14,473	$678
Subtotal	$2,622	30,202	$1,999
Total Impact			
Direct		70,402	$2,212
Indirect		69,564	$21,550
Induced		260,711	$12,242
Total	$53,606	400,677	$36,004

Employment

Jobs are created from the economic activity supported by ethanol production. While ethanol production is not a labor-intensive industry, accounting for about 8,600 full time equivalent direct jobs nation-wide[6], the economic activity resulting from the full activities of the ethanol industry supports a much larger number of jobs in the economy. When the direct, indirect and induced jobs supported by ethanol production, new construction and agriculture are considered, the ethanol industry supported more than 400,000 jobs in all sectors of the economy in 2010. The distribution by economic sector of jobs supported by the ethanol industry is summarized in Table 3.

Table 3
Employment Impacts by Industry
(Full Time and Part Time Jobs)

Industry	Direct	Indirect	Induced	Total
Agriculture	45,431	11,877	6,069	63,377
Mining	0	1,277	691	1,968
Construction	0	4,172	2,548	6,720
Manufacturing	15,451	6,493	14,139	36,083
Transportation/Public Utilities	0	7,429	14,543	21,972
Wholesale and Retail Trade	0	13,745	51,998	65,743
Services	9,517	23,881	167,203	200,601
Government	0	691	3,522	4,213
Total	70,399	69,565	260,712	400,677

Since ethanol production is more capital than labor intensive, the number of direct jobs supported by the ethanol industry is relatively small and is concentrated primarily in manufacturing and agriculture. Most of the agriculture jobs supported by the ethanol industry are farm workers and laborers associated with grain production. However, a wide range of jobs in support activities related to crop production ranging from farm managers and bookkeepers to farm equipment operators are supported by ethanol production. As the impact of the direct spending by the ethanol industry expands

[6] The Census Bureau does not report employment in ethanol production. The number of direct jobs associated with ethanol production is based on an estimated industry average of 43 jobs per plant.

throughout the economy, the employment impact expands significantly and is spread over a large number of sectors.

Income

Economic activity and associated jobs produces income for American households. The economic activities of the ethanol industry put $36 billion into the pockets of Americans in 2010. The distribution of income gains by industry are summarized in Table 4.

As is the case with employment, the direct impact on income by the ethanol industry is limited to manufacturing and construction. However the most significant impact of the ethanol industry is to increase income to farmers who benefit from the demand for feedstocks, which leads to both increased production acreage and increased prices.

Table 4
Income Impacts by Industry
(Million 2010 $)

Industry	Direct	Indirect	Induced	Total
Agriculture	$448.3	$17,676.5	$121.6	$18,246.5
Mining	$0.0	$250.1	$135.5	$385.6
Construction	$299.5	$558.7	$1,062.5	$1,920.7
Manufacturing	$494.0	$866.7	$1,116.8	$2,477.5
Transportation/Public Utilities	$0.0	$532.1	$1,985.1	$2,517.3
Wholesale and Retail Trade	$970.8	$1,319.7	$7,440.7	$9,731.2
Services	$0.0	$346.5	$380.0	$726.5
Government	$0.0	$0.0	$0.0	$0.0
Total	$2,212.7	$21,550.4	$12,242.3	$36,005.3

Tax revenue

The combination of GDP and household income supported by the ethanol industry accounted for nearly $8.6 billion of the revenue received by the Federal treasury in 2010. The estimated cost of the two primary Federal tax incentives (VEETC and Small Ethanol Producer Credit) was just over $6 billion in 2010. State and local governments also

benefit from the economic activity supported by the ethanol industry earning $4.8 billion in 2010.

Crude oil displacement

Ethanol reduces our dependence on imported oil and reduces the U.S. trade deficit. The production and use of ethanol displaces crude oil needed to manufacture gasoline. According to the Energy Information Administration, imports account for more than 65 percent of our crude oil supplies and oil imports are the largest component of the expanding U.S. trade deficit. The production of 13 billion gallons of ethanol means that the U.S. needed to import 445 million fewer barrels of oil in 2010 to refine gasoline. This is roughly the equivalent of 13 percent of total U.S. crude oil imports. The value of the crude oil displaced by ethanol amounted to $34 billion in 2010.[7] This is money that stays in the American economy.

Differences from Previous Studies

As noted earlier, this study used IMPLAN, whereas previous studies have utilized RIMS II. Both are Input-Output models and are based on the I-O model of the U.S. economy and both employ similar methodologies. The IMPLAN model incorporates 2009 data while the RIMS II multipliers used in previous analyses were based on 2006 data. The results presented in this study are comparable to those of previous studies. This analysis incorporates higher ethanol production and expenditures based on current prices which are generally higher than in 2009. This year's analysis also incorporates the income effect to farmers resulting from ethanol production. Additionally new construction activity and expenditures for R&D are lower this year than last. The reduction is R&D is due to retrenchment by venture capital firms in response to the financial crisis and slow disbursement of Stimulus funds.

[7] Ethanol directly competes with and displaces gasoline as a motor fuel. According to EIA one 42 gallon barrel of crude oil produces 19.2 gallons of gasoline. Ethanol has a lower energy content (76,300 btu/gal) than gasoline (116,000 btu/gal) so it takes 1.52 gallons of ethanol to provide the same energy as a gallon of gasoline. Therefore, 13 billion gallons of ethanol are the equivalent of 8.6 billion gallons of gasoline. Since one barrel of crude produces 19.2 gallons of gasoline, it takes 445 million barrels of crude to produce 8.6 billion gallons of gasoline, the amount displaced by ethanol. This oil was valued at the January to November 2010 average composite acquisition cost of crude oil by refiners of $76.27/bbl.

Conclusion

The ethanol industry continues to make a significant contribution to the economy in terms of job creation, generation of tax revenue, and displacement of imported crude oil. The importance of the ethanol industry to agriculture is particular notable. Continued growth and expansion of the ethanol industry into new technologies and feedstocks will enhance the industry's position as the original creator of green jobs and will enable America to break its dependence on fossil fuels.