

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

Prepared for the Renewable Fuels Association by
John M. Urbanchuk
Technical Director – Environmental Economics
February 2, 2012

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

2011 was a remarkable for renewable fuels. The ethanol industry experienced continued growth and posted the best margins in five years. Ethanol demand was stimulated by high crude oil and finished petroleum product prices; the requirements of the Renewable Fuels Standard (RFS2) and the unexpected strength in the export market. However, the year was not without its challenges to the industry. Sharply higher feedstock prices put pressure on ethanol profitability. Early season expectations for a near record corn crop and reasonable feedstock prices were diminished by poor weather and lower than expected average yields. While the U.S. harvested the fourth largest crop on record, corn prices increased sharply. Despite the challenges to profitability, the ethanol industry continued to grow and easily met the 12.6 billion gallon “renewable fuel” portion of the RFS.¹ Nationally, total ethanol production increased more than 4.5 percent to an estimated 13.9 billion gallons.²

According to the Renewable Fuels Association, at year’s end the ethanol industry comprised approximately 209 plants in 29 states with nameplate capacity of 14.7 billion gallons and operating at an annualized rate of 14.1 billion gallons. Relatively little new capacity was brought online during 2011 and at year’s end only 25 million gallons of new capacity were under construction. This study estimates the contribution of the

¹ The overall RFS target for 2011 was 13.95 billion gallons, 1.35 billion gallons of which was advanced biofuel.

² The 13.9 billion gallon estimate is based on annualized year-to-date ethanol production reported by the Energy Information Administration.

ethanol industry to the American economy in 2011 in terms of the employment, income, and Gross Domestic Product (GDP) directly and indirectly supported by the industry.

Expenditures by the Ethanol Industry in 2011

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

Less than 500 million gallons of new production capacity was added during 2011 and most of the expenditures for this were incurred in prior years. As a consequence we did not include capital spending associated with the construction of new ethanol plants in the estimation of industry economic contribution in 2011.

2. Ongoing production operations

The industry spent nearly \$40 billion on raw materials, other inputs, and goods and services to produce 13.9 billion gallons of ethanol during 2011. Production costs were based on a model of dry mill ethanol production maintained by the author. These

³ Expenditures for feedstock and energy were estimated using 2011 calendar year-to-date average prices. Revenues were estimated using 2011 calendar year 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.

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 2011.

Table 1
Estimated Ethanol Production Expenditures 2011

	Mil \$	\$/gal
Feedstocks (corn)	\$33,310	\$2.40
Enzymes, yeast and chemicals	\$973	\$0.07
Denaturant	\$1,147	\$0.08
Natural Gas	\$2,075	\$0.15
Electricity	\$530	\$0.04
Water	\$181	\$0.01
Direct labor	\$878	\$0.06
Maintenance & Repairs	\$361	\$0.03
Transportation	\$104	\$0.01
GS&A	\$431	\$0.03
Total Operating Costs	\$39,990	\$2.88

The largest share of spending was for the corn and other feedstocks used as the raw material to make ethanol. The ethanol industry used nearly five billion bushels of corn on a gross basis in 2011, valued at more than \$33 billion. 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, cotton, or other crops. Production of these other crops would increase and their prices would likely fall as well, and farm crop revenue and income would be reduced. Additionally, some land would be shifted out of crop production altogether into residential, commercial, and industrial areas.

Consequently, the ethanol industry is a major source of support for agricultural output and farm income. 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.

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>

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 advanced biofuels 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. Based on a review of publically available data we assume that R&D expenditures for biofuels in the U.S. amounted to an estimated \$1.5 billion in 2011 and amounted to \$1.5 billion in 2010.

The spending associated with current ethanol production 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. 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 2010 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. Our analysis for 2011 differs from previous studies in that we adjusted the farm income effects of ethanol by factoring in the distributional effects of higher corn prices on other major crops and on consumers.

- 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 impact of the ethanol industry on the U.S. economy is summarized in Table 2. The full impact of the spending for annual operations and R&D is estimated to have contributed \$42.4 billion to the nation's GDP in 2011. 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: 2011

	GDP (Mil 2011 \$)	Employment (Jobs)	Income (Mil 2011 \$)
Ethanol Manufacturing			
Direct	\$878	12,500	\$878
Indirect	\$4,892	40,600	\$2,613
Induced	\$3,278	39,800	\$1,833
Subtotal	\$9,048	92,900	\$5,323
Agriculture			
Direct	\$2,088	69,200	\$1,760
Indirect	\$15,252	44,200	\$13,492
Induced	\$13,505	166,900	\$7,545
Subtotal	\$30,844	280,300	\$22,798
R&D			
Direct	\$864	8,500	\$864
Indirect	\$531	6,300	\$329
Induced	\$1,121	13,600	\$627
Subtotal	\$2,516	28,400	\$1,819
Total			
Direct	\$3,830	90,200	\$3,502
Indirect	\$20,675	91,100	\$16,434
Induced	\$17,904	220,300	\$10,005
Subtotal	\$42,408	401,600	\$29,940

Employment

Jobs are created from the economic activity supported by ethanol production. While ethanol production is not a labor-intensive industry, accounting for about 12,500 full time equivalent direct jobs nation-wide⁵, 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 nearly 401,500 jobs in all

⁵ The Census Bureau does not report employment in ethanol production.

sectors of the economy in 2011. 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 Equivalent Jobs)

Industry	Direct	Indirect	Induced	Total
Agriculture	69,169	16,369	4,418	89,956
Mining	0	2,779	1,008	3,786
Construction	0	5,285	1,871	7,156
Manufacturing	12,510	4,180	9,682	26,372
TIPU	0	8,966	6,864	15,830
Trade	0	15,978	42,037	58,015
Services	8,451	36,476	151,476	196,403
Government	0	1,020	2,918	3,938
Total	90,130	91,052	220,273	401,455

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 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 \$30 billion into the pockets of Americans in 2011. 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 2011 \$)

Industry	Direct	Indirect	Induced	Total
Agriculture	\$1,760.3	\$12,177.0	\$121.3	\$14,058.5
Mining	\$0.0	\$287.2	\$104.4	\$391.6
Construction	\$0.0	\$266.8	\$96.7	\$363.5
Manufacturing	\$877.7	\$431.0	\$695.2	\$2,003.9
TIPU	\$0.0	\$867.5	\$432.7	\$1,300.1
Trade	\$0.0	\$658.5	\$1,578.7	\$2,237.2
Service	\$863.9	\$1,667.4	\$6,749.7	\$9,281.0
Government	\$0.0	\$78.7	\$225.9	\$304.6
Total	\$3,501.8	\$16,434.1	\$10,004.6	\$29,940.4

Tax revenue

The combination of GDP and household income supported by the ethanol industry accounted for nearly \$4.3 billion of the revenue received by the Federal treasury in 2011. State and local governments also benefit from the economic activity supported by the ethanol industry earning \$3.9 billion in 2011.

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, U.S. dependence on imported oil has dramatically declined since peaking in 2005. EIA credits increased use of domestic biofuels (ethanol and biodiesel) as one of the factors contributing to the steady decline in oil import dependence. EIA reports that in 2010 imports accounted for 49 percent of our

crude oil and refined petroleum supplies and oil imports.⁶ Moreover, oil and refined petroleum products are the largest component of the expanding U.S. trade deficit. The production of 13.9 billion gallons of ethanol means that the U.S. needed to import 485 million fewer barrels of oil in 2011 to refine gasoline. This is roughly the equivalent of 13 percent of total U.S. crude oil imports.⁷ The value of the crude oil displaced by ethanol amounted to \$49.7 billion in 2011.⁸ This is money that stays in the American economy.

Differences from Previous Studies

As noted earlier, this study is based on simulations of IMPLAN, an Input-Output economy incorporating 2010 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 substantially higher than in 2010. This year's analysis also incorporates the income effect to farmers resulting from ethanol production in a different fashion from previous analyses. Specifically, only agricultural output and income from exports and stocks created by production of ethanol were included in the analysis since these dollars reflect new output. That is, we estimated the additional dollars from higher grain prices that were not paid for by American consumers and therefore in effect a transfer from consumers to farmers. Additionally, since there was little new ethanol new construction activity in 2011 we did not estimate a contribution from construction.

⁶ EIA. "Energy in Brief". http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm. Accessed January 31, 2012

⁷ According to EIA the U.S. imported 3,807 million barrels of crude oil and petroleum products during the first 11 months of 2011. http://www.eia.gov/dnav/pet/pet_move_impqus_a2_nus_ep00_im0_mbbbl_m.htm

⁸ Ethanol directly competes with and displaces gasoline as a motor fuel. According to EIA one 42 gallon barrel of crude oil produces 18.8 gallons of gasoline in 2011. 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 9.1 billion gallons of gasoline. Since one barrel of crude produces 18.8 gallons of gasoline, it takes 485 million barrels of crude to produce 9.1 billion gallons of gasoline, the amount displaced by ethanol. This oil was valued at the 2011 average composite acquisition cost of crude oil by refiners of \$102.14/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 particularly 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.