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
Updated January 31, 2013

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

The ethanol industry faced several major challenges in 2012. First, a weak economy and high oil prices resulted in a decline in motor gasoline demand and, by extension, lower ethanol demand; the ethanol industry ran up against the E10 blend wall; and the industry was faced with soaring feedstock prices. Early-season expectations for a record corn crop and reasonable feedstock prices were dashed by the most severe drought in decades that resulted in a 16 percent decline in yields. Despite the largest number of corn acres planted in more than 50 years, corn production for the 2012-13 marketing year fell nearly 13 percent resulting in record corn prices. Reflecting these challenges, total ethanol production nationally fell nearly 5 percent to an estimated 13.3 billion gallons.[1]

According to the Renewable Fuels Association, at year's end the ethanol industry comprised approximately 211 plants in 28 states with nameplate capacity of 14.7 billion gallons and operating at an annualized rate of 13.1 billion gallons. At year's end about 158 million gallons of new capacity were under construction. However, reflecting declining profitability, the number of operating plants and operating rates fell, particularly during the second half of the year. This study estimates the contribution of the ethanol

[1] The 13.3 billion gallon estimate is based on annualized year-to-date ethanol production reported by the Energy Information Administration.

industry to the American economy in 2012 in terms of the employment, income, and Gross Domestic Product (GDP) directly and indirectly supported by the industry.

Expenditures by the Ethanol Industry in 2012

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.[2] Ethanol industry expenditures can be broken into three major categories: construction of new production facilities, ongoing production operations and research and development.

1. Construction

   Relatively little new construction was initiated during 2012. 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 2012.

2. Ongoing production operations

   The industry spent nearly $40 billion on raw materials, other inputs, and goods and services to produce 13.3 billion gallons of ethanol during 2012. 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.[3] Table 1 details the expenditures by the ethanol industry in 2012.

[2] Expenditures for feedstock and energy were estimated using 2012 calendar year average prices. Revenues were estimated using 2012 calendar year average prices for ethanol, Omaha Rack; Distiller's grains, corn gluten feed and meal, and corn oil. Prices were sourced from USDA/ERS and AMS, and EIA.

[3] 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.xlsx

Table 1
Estimated Ethanol Production Expenditures 2012

	Mil $	$/gal
Feedstocks (corn)	$33,110	$2.49
Enzymes, yeast and chemicals	$931	$0.07
Denaturant	$1,189	$0.09
Natural Gas	$1,452	$0.11
Electricity	$649	$0.05
Water	$216	$0.02
Direct labor	$783	$0.06
Maintenance & Repairs	$346	$0.03
Transportation	$100	$0.01
GS&A	$412	$0.03
Total Operating Costs	$39,189	$2.95

The largest share of spending was for the corn and other feedstocks used as the raw material to make ethanol. The ethanol industry used 4.8 billion bushels of corn on a gross basis in 2012, 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 might 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.

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 renewable fuels 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 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 $1.7 billion in 2012.[4]

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 protection products and fertilizers from the agricultural chemicals sector, 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.

[4] For a discussion of R&D spending on biofuels see "Agricultural Preparedness and the Agriculture Research Enterprise". President's Council of Advisors on Science and Technology. Washington DC December 2012.

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 2011 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 country 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.

- 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 $43.4 billion to the nation's GDP in 2012. 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: 2012

	GDP (Mil 2012$)	Employment (Jobs)	Income (Mil 2012$)
Ethanol Production	**$8,177**	**84,575**	**$4,831**
Direct	$783	11,971	$783
Indirect	$4,419	37,231	$2,384
Induced	$2,975	35,373	$1,663
Agriculture	**$32,399**	**267,605**	**$23,380**
Direct	$1,596	66,057	$1,240
Indirect	$16,347	42,172	$14,061
Induced	$14,455	159,376	$8,080
R&D	**$2,815**	**31,081**	**$2,035**
Direct	$967	9,264	$966
Indirect	$594	6,897	$368
Induced	$1,254	14,920	$701
Total	**$43,391**	**383,260**	**$30,246**
Direct	$3,347	87,292	$2,990
Indirect	$21,360	86,300	$16,813
Induced	$18,684	209,669	$10,444

Employment

Jobs are created from the economic activity supported by ethanol production. While ethanol production is not a labor-intensive industry, accounting for about 12,000 full time equivalent direct jobs nation-wide[5], 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, construction activity, agriculture, and R&D activities are considered, the ethanol industry supported more than 380,000 jobs in all sectors of the economy in 2012. 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	66,057	15,642	4,204	85,903
Mining	0	2,332	959	3,290
Construction	0	4,862	1,781	6,642
Manufacturing	11,971	3,578	9,215	24,764
Transportation/Public Utilities	0	8,305	6,533	14,838
Wholesale/Retail Trade	0	15,670	40,015	55,686
Services	9,264	34,931	144,185	188,380
Government	0	978	2,777	3,755
Total	87,292	86,299	209,669	383,260

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

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

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

Income

Economic activity and associated jobs produce income for American households. The economic activities of the ethanol industry put more than $30 billion into the pockets of Americans in 2012. 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 2012 $)

Industry	Direct	Indirect	Induced	Total
Agriculture	$1,240	$12,361	$128	$13,729
Mining	$0	$297	$111	$408
Construction	$0	$261	$101	$362
Manufacturing	$783	$447	$739	$1,969
Transportation/Public Utilities	$0	$841	$455	$1,296
Wholesale/Retail Trade	$0	$697	$1,630	$2,327
Services	$966	$1,826	$7,046	$9,838
Government	$0	$84	$234	$317
Total	$2,990	$16,813	$10,444	$30,246

Tax revenue

The combination of GDP and household income supported by the ethanol industry accounted for nearly $4.6 billion of the revenue received by the Federal Treasury in 2012. State and local governments also benefit from the economic activity supported by the ethanol industry earning $3.9 billion in 2012.

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 2011 imports accounted for 45 percent of our crude oil and refined petroleum supplies and oil imports, compared to 60 percent in 2005.[6] Moreover, oil and refined petroleum products are the largest component of the expanding U.S. trade deficit. The production of 13.3 billion gallons of ethanol means that the U.S. needed to import 465 million fewer barrels of oil in 2012 to refine gasoline. This is roughly the equivalent of 12 percent of total U.S. crude oil imports.[7] The value of the crude oil displaced by ethanol amounted to $47.2 billion in 2012.[8] This is money that stays in the American economy.

Challenges for 2013

The renewable fuels industry faces significant challenges in 2013. Perhaps the most significant will be continuing to deal with the effects of the 2012 drought on corn supply and prices until the harvest of 2013 crop begins. Further, as 2013 began, much of the Corn Belt remained under drought conditions. However, normal moisture in the spring and a return to more normal yields accompanied with large spring plantings would result in a large harvest and would put downward pressure on commodity prices – and feedstock costs. However, feedstock supplies will remain tight until the 2013 corn crop is "in the bins."

[6] EIA. *Energy in Brief*. "How dependent are we on foreign oil?" http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm. July 13, 2012

[7] According to EIA the U.S. imported 4,161 million barrels of crude oil and petroleum products in 2011. Imports for 2012 (January through October) are running nearly 7 percent below year-earlier levels. http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_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 2012. 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, 13.3 billion gallons of ethanol are the equivalent of 8.7 billion gallons of gasoline. Since one barrel of crude produces 18.8 gallons of gasoline, it takes 465 million barrels of crude to produce 8.7 billion gallons of gasoline, the amount displaced by ethanol. This oil was valued at the 2012 average composite acquisition cost of crude oil by refiners of $101.53/bbl.

The health of the economy and future of petroleum prices also provide challenges for the industry. Continued slow growth in consumer spending and high oil prices would further constrain gasoline and diesel fuel consumption. Since ethanol is blended with gasoline, declines in gasoline consumption translate into weak demand for renewable fuels. This is a particular issue for the ethanol industry since the E10 blend wall has been met and the primary way to increase consumption is through the sale of higher blends. The EPA approved the use of E15 blends for most automobiles on the road; however, E15 sales have been slow to date. Much broader consumption of E15 is necessary not only to meet the requirements of the RFS, but also to meaningfully increase ethanol demand and prices. The oil industry will continue to support and encourage attacks on the RFS and put up hurdles to increased penetration of higher ethanol blends.

Finally, public policy and regulatory issues also present challenges. On January 2, 2013, President Obama signed into law H.R. 8, the American Taxpayer Relief Act (ATRA), known more commonly as the Fiscal Cliff deal. The focus of the legislation was aimed at averting a complete expiration of the 2001 and 2003 Bush tax cuts. This law included the extension and modification of energy tax provisions impacting numerous industries. The ATRA includes a Cellulosic Biofuel Producer Credit that extends the current $1.01 per gallon tax credit for the production of cellulosic biofuels through 2013. Such a short-term extension is unlikely to give investors the market certainty they need to make substantial investments in next-generation biofuels.

Conclusion

Despite a challenging year in 2012, 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 and rural economies 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 make further strides toward independence from imported fossil fuels.