

CONTRIBUTION OF THE RENEWABLE FUELS INDUSTRY TO THE ECONOMY OF IOWA

Prepared for the Iowa Renewable Fuels Association

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The U.S. ethanol industry experienced another record-breaking year in 2015, despite a challenging economic and regulatory environment. Industry output for all of 2015 increased 3.4 percent and set a new record of more than 14.8 billion gallons. The year started off with strong year-over-year gains in ethanol production as producers responded to lower feedstock prices. The third-largest ever 2015 corn crop pushed feedstock prices lower until the third quarter of the year. At just under 1.27 billion gallons in 2015, U.S. biodiesel production was down slightly from 2014. The collapse in global oil prices helped drive both ethanol and biodiesel prices lower and strained profitability.

The renewable fuels industry faced both economic and regulatory challenges in 2015. In addition to uncertainty over RFS volume requirements, which impacted both ethanol and biodiesel, the status of the biodiesel blender's tax credit remained unresolved until nearly the end of the year. The economic challenges included the sharpest decline in world oil and refined product prices since the bursting of the 2008 "Commodity Price Bubble." West Texas Intermediate crude oil prices that peaked at \$105.79 per barrel in June 2014 fell steadily through 2015, averaging \$37 per barrel in December 2015, 65 percent below peak levels. During this same period ethanol prices (FOB Iowa Plant) were down 32.4 percent and Iowa biodiesel prices fell 18 percent. As pointed out, feedstock (corn) prices also declined during 2015, but so did co-product prices DDGS (10 percent moisture, Iowa) down 7.6 percent and corn distiller's oil prices down 19.5 percent during 2015.¹ Biodiesel feedstock prices, notably soybean oil, animal fats and waste greases and oil declined throughout the year and were about 21 percent below 2013 levels.

¹ No. 2 Yellow Corn, Central Illinois; ethanol FOB Iowa Plant. Source USDA

As a result of these factors, ethanol and biodiesel profitability suffered. According to Iowa State University, net returns over variable costs for a typical Iowa dry mill ethanol plant averaged \$0.21 per gallon during 2015, down sharply from the \$0.71 per gallon return experienced in 2014. Biodiesel returns over variable costs averaged \$0.16 per gallon, down 22 percent from 2014 average returns.²

On the demand side, consumers responded to sharply lower retail gasoline prices by increasing consumption of finished motor gasoline. Reflecting this, domestic ethanol use increased 4 percent during 2015 to record levels. While still small relative to domestic use, ethanol exports posted a 3.4 percent increase for the first 10 months of 2015. Slow improvements in infrastructure continued to restrain overall growth in the availability and consumption of higher blends of ethanol.

The regulatory environment also provided challenges for the industry. In November the EPA released the final volume requirements for 2014, 2015 and 2016 under the Renewable Fuel Standard (RFS) program. EPA's final rule requires volumes for most biofuels that are well above the Agency's proposal released earlier in the year. However, the required volumes remained well below the statutory requirements set forth by the 2007 law establishing the RFS. Overall, the EPA final rule calls for total biofuels — conventional biofuel (e.g., corn ethanol), advanced biofuels, cellulosic ethanol, and biomass biodiesel -- to be blended at 18.11 billion gallons, well under the 22.25 billion gallon statutory level set by the 2007 law. In particular, the 2016 RFS level of 14.5 billion gallons for conventional biofuel (e.g., corn ethanol) is 500 million gallons under the 15-billion gallon statutory level. Similarly, the RFS targets for Cellulosic and Other Advanced biofuels, while higher than EPA's initial 2015 proposal, are substantially below statutory levels.

Iowa's ethanol industry posted a 3.8 percent increase in output during 2015, with the state's 43 operating ethanol plants producing at an annual rate of just over 4 billion gallons. Iowa continued to lead the nation in ethanol production accounting for 27 percent of U.S. output. Iowa also is the nation's leading biodiesel

² Iowa State University AgDecision Maker Ethanol Profitability and Biodiesel Profitability available at <http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xlsx> and http://www.agmrc.org/renewable_energy/biodiesel/biodiesel-profitability accessed February 24, 2016

producer. According to the Iowa Renewable Fuels Association (IRFA), Iowa's 9 operating biodiesel plants produced 242 million gallons of biodiesel in 2015, accounting for 19 percent of U.S. output.³

Both the ethanol and biodiesel industry continued to benefit from a diversification of feedstocks and co-products. In particular nearly all Iowa dry mill ethanol plants are recovering distillers corn oil, and yields have increased reflecting improvements in technology. This co-product is proving to be an additional revenue stream for ethanol producers and an increasingly important feedstock for the biodiesel industry.

Ethanol consumption approached 10 percent of the motor fuel supply, but resistance from integrated oil companies slowed improvements in infrastructure and continued to restrain overall growth in the availability and consumption of higher blends of ethanol. Despite this the number of refueling stations offering E-85 and E-15 in Iowa expanded slightly during 2015.

Construction and expansion of biofuels refineries has provided an economic boost to Iowa for over a decade. However, construction on two stand-alone cellulosic ethanol plants was largely completed in 2015 and no major plant expansions have been announced. As such, the lack of construction activity helped reduce economic impact compared to prior years. But to understand the full extent of the missed opportunity in this facet of the biofuels industry, one must also remember that had RFS volumes been enforced at statutory levels, Iowa would have been well-positioned to benefit from the resulting industry diversification and expansion. In other words, the economic impact from construction and expansion of biofuels refineries in Iowa not only didn't take a step forward, it actually took a step back.

Failure to fully implement the RFS is felt in other sectors as well. Farmers have continued their historic trend of producing more commodities with fewer inputs on fewer acres. Between 2005 and 2013, increases in ethanol production utilized much of the increased corn production, resulting in robust farm gate prices and record farm income. As ethanol production leveled off in 2014 and 2015, a large surplus of corn has put immense downward pressure on corn prices, resulting in lower farm income. While this trend has allowed ethanol to remain competitive with petroleum alternatives even in the face of lower oil

³ http://www.iowarfa.org/biodiesel_refineries.php

prices, it reduces the positive economic impact on states like Iowa from the purchase of corn and other commodities by the biofuels industry.

In addition to biofuel refining and agriculture, there is a significant amount of public and private sector funding for research and development 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 U.S. Departments of Energy (USDOE), Agriculture (USDA), and Defense (DOD). In addition to the federal government, many states are funding R&D in feedstocks as well as infrastructure. These public funds are being leveraged significantly by private sector firms undertaking research in a wide range of biofuels activities. Based on a review of publically available data and recent published research on Federal government spending on R&D, we have reduced our estimate of R&D expenditures for biomass biofuels in the U.S. to \$850 million in 2015, about half that assumed for 2014.⁴ Iowa was a major participant in these R&D activities.

The renewable fuels industry is multifaceted. Ethanol and biodiesel producers are part of a manufacturing sector that adds substantial value to agricultural commodities produced in Iowa. The first and second-generation feedstocks used to produce renewable fuels are produced primarily by Iowa farmers, and the R&D expenditures for renewable fuels provide important support for Iowa's universities. Combined, these activities make a significant contribution to the Iowa economy. Based on its size and scope the renewable fuels industry had the following impacts on Iowa's economy in 2015.⁵

- Accounts for about \$4.6 billion, or about 3.5 percent, of Iowa GDP;

⁴ Estimates of the amount of R&D spending on biomass and biofuels vary substantially. 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. A 2013 study prepared by Mary Solecki, Anna Scodel and Bob Epstein at E2 Environmental Entrepreneurs. "Advanced Biofuel Market Report 2013" suggests that R&D spending on biofuels approaches \$1.7 billion. A (relatively) new report on federal spending on R&D in energy published by EIA ("Direct Federal Financial Interventions and Subsidies in Energy in Fiscal year 2013", March 2015) estimates Federal R&D expenditures for biomass of \$300 million in FY 2013. This study does not include estimates for corporate (private sector) R&D.

⁵ This study estimates the annualized impact of producing 4 billion gallons of ethanol and 242 million gallons of biodiesel on Iowa's economy. These figures reflect the capacity of ethanol and biodiesel plants operating at year's end.

- Generates \$2.3 billion of income for Iowa households; and
- Supports nearly 43,000 jobs through the entire Iowa economy. This is equivalent to 3 percent of total State employment.

The annualized contribution of the ethanol and biodiesel industries is summarized in Table 1.

Table 1
Total Economic Impact of the Renewable Fuels Industry for Iowa: 2015

	Purchases (Mil 2015\$)	GDP (Mil 2015\$)	Household Earnings (Mil 2015\$)	Employment (Jobs)
Ethanol*	\$7,049.8	\$4,296.5	\$2,068.0	39,592
Biodiesel	\$689.0	\$344.3	\$198.1	3,059
Total	\$7,738.8	\$4,640.8	\$2,266.1	42,651

* Includes agriculture and investment in R&D

Methodology

The spending associated with renewable fuels production, construction, and R&D circulates throughout the entire Iowa economy several fold. Consequently this spending stimulates aggregate demand, supports the creation of new jobs, generates additional household income, and provides tax revenue for State and local governments. We estimate the impact of the renewable fuels industry on the Iowa economy by applying expenditures by the relevant supplying industry to the appropriate final demand multipliers for value added output, earnings, and employment.

This study utilizes IMPLAN (Impact Analysis for Planning) economic model 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 Iowa economy was constructed using the most recent IMPLAN software and data and used to estimate economic impacts of the ethanol and biodiesel industry. Detail regarding the IMPLAN model and how it was used is presented in Appendix A.

In addition to using the updated IMPLAN data discussed above we continued to recognize the impact of income generated by locally owned renewable fuels firms. All corporations earn income that directly

impacts GDP. However the income earned by firms owned by lowans largely stays in Iowa and has a more significant impact on the State economy than earnings that are transferred to firms domiciled outside of Iowa. A review of ownership of ethanol and biodiesel firms based on information provided by IRFA suggests that more than half of Iowa's ethanol and biodiesel plants are locally owned. The earnings of locally owned firms are treated as an addition to the household sector since the income is paid to lowans and their impact is estimated using multipliers for the household sector. The earnings by firms domiciled outside of Iowa are treated as direct additions to GDP.

Contribution of the Renewable Fuels Industry

The contribution of the renewable fuels industry to the economy of Iowa is detailed in Table 2. The ethanol industry provides a significant contribution to the Iowa economy, spending \$7.05 billion on raw materials, other inputs, goods and services to produce 4 billion gallons of ethanol. The largest share of this spending is for corn and other grains used as the raw material to make ethanol, distiller's grains and industrial corn oil. The Iowa ethanol industry currently uses more than 1.4 billion bushels of corn, or 57 percent of Iowa's corn crop.⁶ At 2015 Iowa farm gate prices this amounts to \$5.2 billion of revenue to Iowa corn farmers. Reflecting lower prices, expenditures for feedstocks (corn) by Iowa ethanol producers fell 7.6 percent from 2014 levels.

⁶ The 4 billion gallons of ethanol production required 1.43 billion bushels of corn. This amounts to 57 percent of the 2.5 billion bushels of corn harvested in Iowa in 2015. Without the demand for corn provided by the ethanol industry Iowa farmers would likely plant fewer acres to corn, purchase fewer inputs, and produce a smaller crop, thereby reducing the economic contribution provided by the corn industry.

Table 2
Contribution of the Renewable Fuels Industry to Iowa: 2015

	GDP (Mil 2015\$)	Jobs (Thou)	Income (Mil 2015\$)
Ethanol Manufacturing			
Direct	\$509.7	2,150	\$393.3
Indirect	\$1,030.0	5,703	\$416.5
Induced	\$344.7	4,660	\$168.2
Subtotal	\$1,884.4	12,512	\$978.0
Biodiesel Manufacturing			
Direct	\$20.3	270	\$21.1
Indirect	\$257.3	1,882	\$144.3
Induced	\$66.7	907	\$32.7
Subtotal	\$344.3	3,059	\$198.1
Agriculture			
Direct	\$396.4	7,248	\$168.6
Indirect	\$1,420.9	12,044	\$573.4
Induced	\$304.4	4,111	\$148.4
Subtotal	\$2,121.6	23,403	\$890.4
R&D			
Direct	\$131.3	1,721	\$117.8
Indirect	\$91.4	1,042	\$48.8
Induced	\$67.8	914	\$33.0
Subtotal	\$290.5	3,677	\$199.6
Total			
Direct	\$1,057.7	11,389	\$700.8
Indirect	\$2,799.6	20,671	\$1,183.0
Induced	\$783.4	10,591	\$382.3
2015 Grand Total	\$4,640.8	42,651	\$2,266.1
Change from 2014	-5.6%	-8.8%	-11.6%

In addition to providing a growing and reliable domestic market for Iowa farmers, the ethanol industry also provides the opportunity for farmers to enjoy some of the value added to their commodity by further processing. Locally owned ethanol plants account for nearly half of Iowa fuel ethanol plants and production capacity.

The remainder of the spending by the ethanol industry is for a wide range of inputs such as industrial chemicals, electricity, natural gas, and water, labor, transportation and services such as maintenance, insurance, and general overhead. Spending for these goods and services represents the purchase of output of other industries, mostly in Iowa. The price assumptions used in estimating the value of expenditures for both ethanol and biodiesel are shown in Appendix Table 1.

- The gross value of the ethanol industry output (ethanol and co-products) amounts to \$7.5 billion. Based on the IMPLAN model, the ethanol and supporting agriculture industries accounts for nearly \$4.3 billion of Iowa GDP.
- Jobs are created from the economic activity supported by ethanol production. While ethanol production is not a labor-intensive industry, accounting for about 2,150 full time equivalent direct jobs in Iowa⁷, the economic activity resulting from the full activities of the ethanol industry supports a much larger number of jobs in the economy. The direct jobs supported by the ethanol industry are concentrated primarily in manufacturing and agriculture. When the indirect and induced effects of ethanol manufacturing and associated R&D are considered, the industry accounts for more than 12,512 full time equivalent jobs throughout the entire economy.
- Since renewable fuels production uses feedstocks produced by Iowa farmers, the ethanol and biodiesel industry has the largest impact on agriculture, supporting 7,248 direct farm and farm-related jobs. 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 and biodiesel industry expands throughout the economy, the employment impact expands significantly and is spread over a large number of sectors. The indirect and induced jobs supported by the agriculture output used by renewable fuels amount to an additional 16,100 jobs throughout the entire Iowa economy.

⁷ 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 50 jobs per plant.

- Increased economic activity and new jobs result in higher levels of income for Iowa households. The ethanol and supporting agriculture industry accounted for \$2.1 billion of income for Iowans in 2015.

Biodiesel

The Iowa biodiesel industry is not as mature as the ethanol industry but also makes sizeable contributions to the Iowa economy. According to the Iowa Renewable Fuels Association (IRFA), Iowa's 9 operating biodiesel produced 242 million gallons of biodiesel in 2015.⁸

The Iowa biodiesel industry spent nearly \$690 million on raw materials, other inputs, goods and services in 2015. The largest share of this spending is for fats and oils used as the raw material to make biodiesel. The Iowa biodiesel industry used more than 1.2 billion pounds of soybean oil in 2015 to produce biodiesel totaling two thirds of total feedstock use. In addition Iowa biodiesel producers used approximately 338 million pounds of animal fats, 188 million pounds of corn refiner's oil (supplied largely by Iowa ethanol producers) and 91 million pounds of canola and used cooking oil. The majority of the raw material for biodiesel production in Iowa is procured locally. The remainder of the spending by the biodiesel industry is for a wide range of inputs such as industrial chemicals, electricity, natural gas, water, labor, and services such as maintenance, insurance, and general overhead. As with ethanol, spending for these goods and services represents the purchase of output of other industries.

The spending associated with biodiesel production also circulates throughout the entire Iowa economy stimulating aggregate demand, supporting jobs, generating additional household income, and creating new tax revenue. The following summarizes the economic contribution of the Iowa biodiesel industry at the end of 2015.

- The gross value of the biodiesel and glycerin produced in Iowa totaled more than \$690 million. When the impact of manufacturing and R&D are combined the biodiesel industry accounts for nearly \$350 million of Iowa GDP.

⁸ http://www.iowarfa.org/biodiesel_refineries.php

- Jobs are created as a consequence of increased economic activity caused by biodiesel production. The increase in economic activity generated by biodiesel production supports more than 3,000 full time equivalent jobs in all sectors of the Iowa economy.
- Increased economic activity and jobs result in higher levels of income for Iowa households. The biodiesel industry accounts for about \$200 million of household income for Iowans.

Challenges for 2016

The most significant challenges facing the renewable fuels industry in 2016 are likely to result from competitive pressures from falling world oil and refined product prices, and an uncertain import/export environment.

The competitive environment for renewable fuels has deteriorated as refined product prices continue to fall along with world oil prices. As of this writing crude oil prices have fallen 70 percent from their mid-2014 highs. Crude oil prices are now approaching the breakeven price for most new wells in North America. According to a recent CNBC report, "It's still cost-effective down to prices of \$10 per barrel to maintain many existing wells across the United States, which is why drillers have not shut in production. But producers face a significantly higher bar when it comes to authorizing new production, because the cost of drilling and finishing a well accounts for the lion's share of lifetime costs." ⁹ Moreover, the North Dakota Department of Mineral Resources reported that the break-even cost of drilling in the Bakken formation has fallen to the mid-\$20 range. As the oil industry adjusts production in response to falling prices and supply and demand for petroleum comes into balance, the market for renewable fuels is expected to continue to expand.

For the first time in three years, the renewable fuels industry enters a year with set RFS levels. While not at statutory levels, the certainty is helpful in making business decisions. Perhaps the best outlook in 2016 is for biodiesel, which entered the year with both an RFS level and federal biodiesel blender's tax credit in place for the first time since 2013. While biodiesel demand is expected to increase in 2016, pressure of Argentinian biodiesel imports creates some uncertainty. A longer term challenge for

⁹ Tom DiChristopher. "US crude oil's break-even cost: How low can it go? CNBC 20 August 2015.
<http://www.cnbc.com/2015/08/20/>

the renewable fuels industry is the uncertainty surrounding the 2016 Presidential election and the impact a change in administration may have on EPA leadership and rulemaking and the continued implementation of the RFS. The recent EPA final rule on the RVO for 2015 and 2016 sent a less than positive message to the investment community, particularly for sorely needed new cellulosic and advanced biofuels capacity. Whether and how this changes remains an open question. Legislative changes to the RFS are not expected in 2016. However the outcome of the Presidential and Congressional elections may or may not change the dynamic for possible legislative or regulatory changes to the RFS.

APPENDIX A

IMPLAN Methodology

We estimate the impact of the ethanol industry on the economy of Iowa 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 renewable fuels production, it is necessary to understand how different sectors or industries in the economy are linked. For example, in the renewable fuels production sector, the ethanol industry buys corn from the agriculture sector; which in turn, buys inputs from other suppliers such as fertilizer and pesticide producers that also purchase products 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 manufacturing operations, is a forward linkage. 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 resources. In turn, changes that affect incomes of the household sector typically have significant impacts compared to a change in the sales of other sectors. This is because households typically spend most of their income on both retail and service goods and this is a critical component of the economy

This study uses an economic model known as IMPLAN (Impact Analysis for Planning) to develop a model of the national economy, including sectors that support the ethanol industry, the links between them, and the level of national 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 in an economy are linked together; and the output (i.e., sales) 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 Iowa economy was constructed using current IMPLAN software and the most recent data available.

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 is 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 feedstock 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 businesses producing output. Value added including labor income and employment represent the net economic benefits that accrue to the nation as a result of increased economic output.

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

APPENDIX TABLE 1: PRICES

	Corn Farm Price (\$/bu)	Corn Price No 2. Yel (\$/bu)	Distillers Grains 10%, Iowa (\$/ton)	Distillers Grains 65%, Iowa (\$/ton)	Ethanol FOB Iowa (\$/gal)
Jan	\$3.86	\$3.73	\$171.72	\$76.78	\$1.31
Feb	\$3.80	\$3.79	\$171.75	\$78.44	\$1.31
Mar	\$3.83	\$3.80	\$175.69	\$81.56	\$1.41
Apr	\$3.74	\$3.70	\$180.35	\$85.20	\$1.50
May	\$3.61	\$3.58	\$166.56	\$80.31	\$1.56
Jun	\$3.58	\$3.55	\$146.67	\$71.00	\$1.43
Jul	\$3.78	\$3.82	\$142.95	\$61.75	\$1.48
Aug	\$3.67	\$3.52	\$141.75	\$61.83	\$1.42
Sep	\$3.57	\$3.59	\$123.88	\$57.15	\$1.43
Oct	\$3.58	\$3.58	\$109.06	\$56.44	\$1.48
Nov	\$3.53	\$3.49	\$116.06	\$56.88	\$1.40
Dec	\$3.53	\$3.53	\$120.85	\$57.70	\$1.33
Average	\$3.67	\$3.64	\$147.27	\$68.75	\$1.42

	Crude Soy Oil Iowa (cents/lb)	Distillers Corn Oil Iowa (cents/lb)	Choice W. Grease Central US (cents/lb)	Yellow Grease Midwest (cents/lb)	B100 FOB Plant Iowa (\$/gal)
Jan	32.22	26.97	23.91	23.50	\$2.86
Feb	30.29	27.13	26.44	23.00	\$2.95
Mar	30.71	28.45	24.53	23.50	\$2.88
Apr	30.83	25.50	23.00	21.75	\$2.93
May	32.34	27.38	25.28	24.00	\$3.12
Jun	34.15	28.13	27.41	22.50	\$3.24
Jul	31.72	25.20	25.98	22.00	\$3.01
Aug	28.13	23.50	22.78		\$2.61
Sep	26.11	22.75	21.10		\$2.52
Oct	27.65	23.57	18.19	17.00	\$2.60
Nov	26.72	22.94	17.47	17.00	\$2.59
Dec	29.58	22.90	17.12	17.38	\$2.77
Average	30.04	25.37	22.77	21.16	\$2.84