

NOVEMBER 2018



THE BIODIESEL INDUSTRY: IMPACTS ON THE ECONOMY, ENVIRONMENT AND ENERGY SECURITY

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Executive Summary

This study considers the impact of the biodiesel industry on the U.S. economy, environment and energy security. It also examines the impact on the industry's financial health if an important incentive – the biodiesel blenders tax credit (“BTC”) – were discontinued.

The following points provide a profile of the biodiesel industry in the U.S.:

- Biodiesel production totaled 1.6 billion gallons in 2017, a significant increase over just nine million gallons produced in 2001.¹
- Current production occurs at over 120 plants in 38 states with capacity exceeding 2.5 billion gallons.²
- Biodiesel is essentially interchangeable with conventional diesel but with lower greenhouse gas (“GHG”) emissions.

By analyzing 2017 production and financial data, FTI Consulting found that the biodiesel industry generated the following impacts for the U.S. economy and environment:

- Economic output (economy-wide sales) valued at \$21.6 billion across the economy, which translates to U.S. GDP of \$6.5 billion;
- Employment for approximately 61,900 workers, 2,300 of which were employed directly in the biodiesel industry;
- Paid wages and benefits totaling \$3.8 billion;
- Federal tax and state and local tax contributions of \$1.2 billion and \$600 million, respectively; and,
- A reduction in GHG emissions by 14.8 million tons, which is equivalent to taking 3.2 million cars off U.S. roads and equal to approximately \$750 million in social benefits.

In addition to these benefits, biodiesel can help the U.S. decrease its reliance on foreign oil, particularly imports from members of the Organization of the Petroleum Exporting Countries (“OPEC”) as well as OPEC-friendly countries, which comprised over 37 percent of U.S. oil imports in 2017.³

The BTC is a critical element in maintaining the viability of the biodiesel industry – and the realization of the benefits listed above – because it helps mitigate industry exposure to fluctuations in market prices for petroleum diesel. This study finds that biodiesel producers would have suffered an average loss of \$0.25 per gallon produced in 2017 without the retroactive BTC. As such, certainty regarding the future of the BTC is vital for the biodiesel industry and, without legislative action retroactively implementing the BTC for 2018 and extending the BTC for 2019, compromises the significant economic, environmental and energy security-related benefits the industry provides.

¹ <https://afdc.energy.gov/data/10325>

² <http://www.biodieselmagazine.com/plants/listplants/USA/>

³ https://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mtbl_m.htm

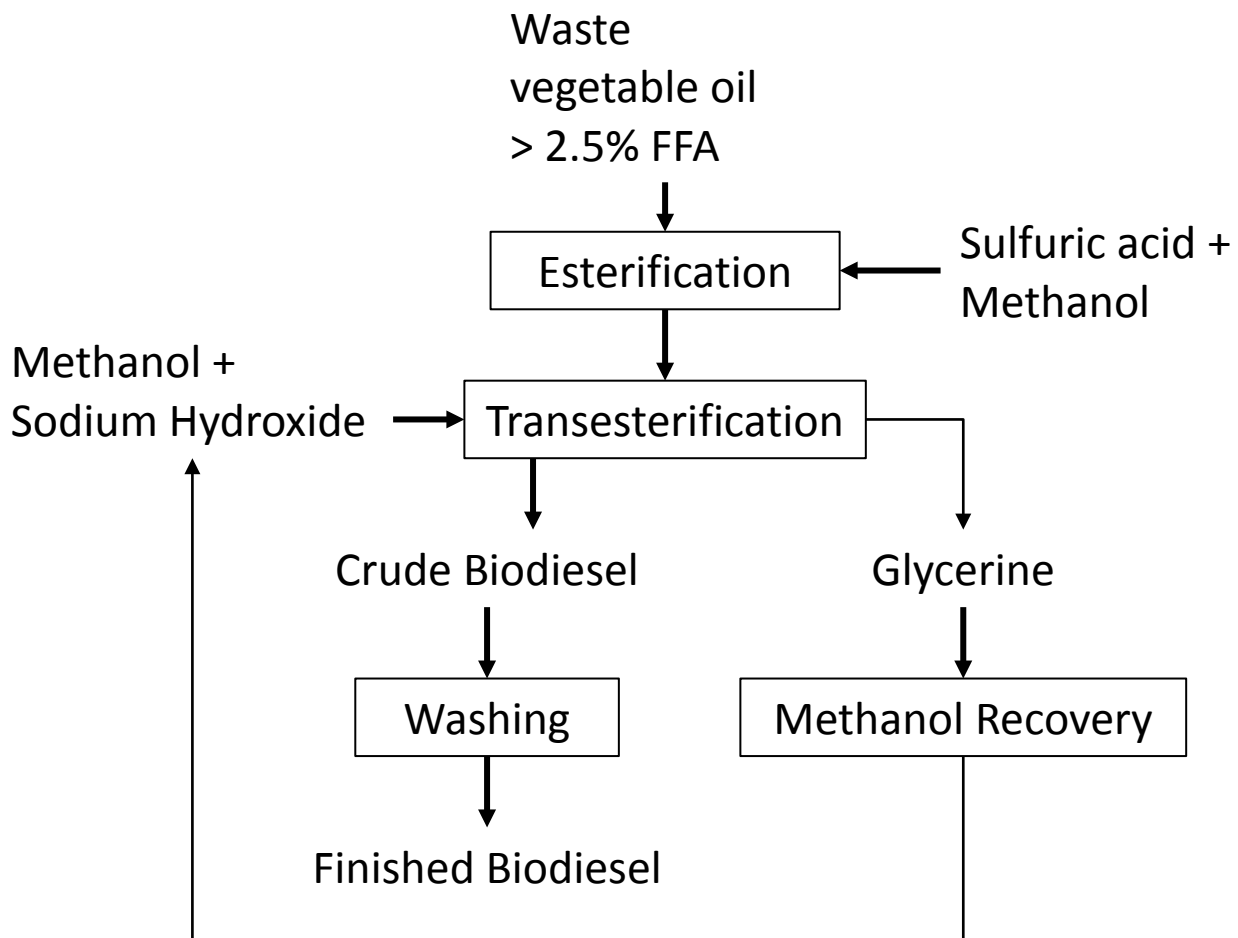
Introduction

The biodiesel industry has grown into a substantial industry in the U.S., making important economic, environmental and energy security contributions to the nation. This report provides an overview of the principal industry drivers, develops an industry profile, estimates the industry’s contributions to the economy and environment and examines the industry’s exposure if an important incentive – the BTC – were discontinued.

What is Biodiesel

Biodiesel is a green alternative to conventional diesel fuel. It is produced from a variety of natural oils such as soybean oil or soy oil, animal fats, such as chicken fat, and waste cooking oils and greases. Since the fuel is made from natural organic material, biodiesel is both renewable and biodegradable. Using a chemical process called transesterification, feedstocks such as soybean oil, canola oil, animal fats or yellow grease can be converted to biodiesel. Transesterification is a process by which oils such as soybean oil are made to react with an alcohol in the presence of a catalyst to yield an alkyl ester (the technical name for biodiesel) and glycerine. Methanol is the commonly used alcohol for this purpose. Figure 1 below shows a schematic of the biodiesel production process.

Figure 1: Biodiesel Production Flow Chart⁴



⁴ The feedstock used in this example is waste vegetable oil with 2.5 percent free fatty acid (“FFA”) content. See https://www.researchgate.net/figure/Biodiesel-production-flow-chart-Based-on-the-experiments-described-above-and-on-the_fig4_221914441.

Overview of the U.S. Biodiesel Industry

Increasing use of biodiesel and other renewable transportation fuels contribute towards four major policy objectives:

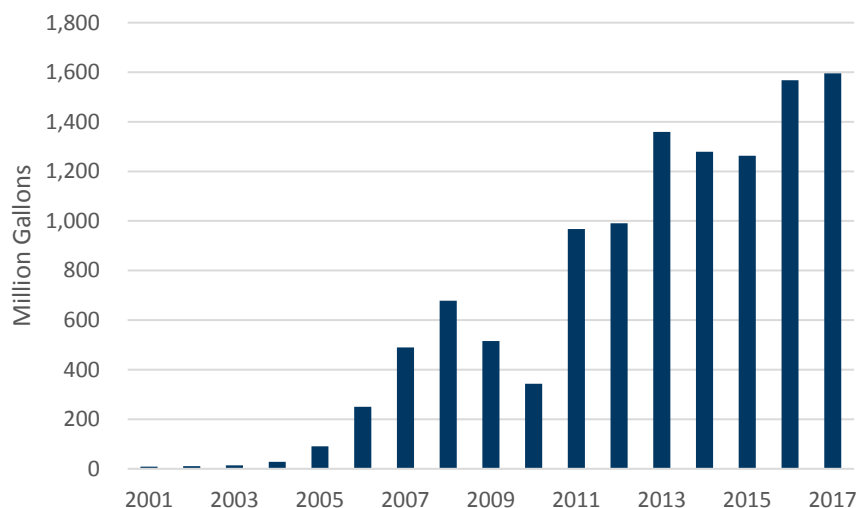
- (1) Improving air quality by introducing additional oxygenates to the country's fuel supply, especially for transportation fuels;
- (2) Lowering GHG emissions;
- (3) Improving rural economic viability by increasing demand for agricultural products; and,
- (4) Reducing U.S. dependence on foreign oil.

These policy objectives have led to the enactment of several pieces of federal legislation to promote renewable fuels. Together, these actions have facilitated the development of a domestic biodiesel industry in the U.S, as well as contributed to the U.S. economy and environment.

An early action to promote biodiesel was included in the American Jobs Creation Act of 2005, which provided the BTC to a blender/refiner that blends qualified renewable fuels (i.e., biodiesel) with conventional fuels (i.e., conventional diesel). Subsequently, through the Energy Policy Act of 2005 ("EPAct of 2005") and Energy Independence and Security Act of 2007 ("EISA"), Congress mandated the use of certain renewable fuels in the nation's transportation fuel supply. The EPAct of 2005 and EISA increased demand for renewable fuels, including biodiesel, by requiring "obligated parties" (i.e., refiners and importers) to meet annual volume targets, referred to as renewable volume obligations, ("RVOs") by blending a specified volume of renewable fuel into the fuel supply each year. Notably, the Environmental Protection Agency ("EPA") establishes the RVOs for four categories of renewable fuel, one of which is biodiesel, each year. The EPA tracks compliance with the RVOs through the retirement of renewable identification numbers ("RINs"), where each gallon of renewable fuel receives a unique RIN. Obligated parties can satisfy their RVO by either purchasing and blending renewable fuel or purchasing RINs in the market to satisfy any RVO deficit they may have.

In practice, the BTC and the RVO for biodiesel have increased the use of biodiesel in the nation's fuel supply. Figure 2 below shows the trajectory of biodiesel production in the U.S. from 2001 to 2017. Notably, the industry was virtually non-existent in the early 2000s and has grown to support a 2017 domestic production level of 1.6 billion gallons, which supports tens of thousands of jobs in the economy.⁵

Figure 2: U.S. Biodiesel Production (2001-2017)⁶



⁵ The total supply of biodiesel in the U.S. economy is larger than domestic production because it includes renewable fuel produced by non-esterification processes and imports.

⁶ <https://www.eia.gov/biofuels/biodiesel/production/>

In 2017, over 120 production facilities in 38 states produced approximately 1.6 billion gallons of biodiesel. Sold across the U.S., biodiesel is available, as a blend, at retail gasoline stations across the country.

Biodiesel Tax Credit

The BTC, established as part of the American Jobs Creation Act of 2005, was set at a level of \$1 per gallon of biodiesel blended. Several aspects of the BTC are important for the biodiesel industry:

- The original legislation only provided the BTC through 2009; thus, the ability of blenders to use the BTC after 2009 has been subject to congressional action to extend and/or retroactively renew it every year. Congress allowed the biodiesel tax credit to expire at the end of 2009, 2011, 2013 and 2016, which meant that the credit was not initially in place for 2010, 2012, 2014, 2015 and 2017. However, in each of these years, Congress retroactively reinstated the BTC through various pieces of legislation in December or the early months of the following year. This situation has created uncertainty for the industry, as the availability of the BTC affects the ability of blenders to incent producers in the price paid for biodiesel as well as to hold down prices for end-use consumers. For example, in March 2018, Congress retroactively extended the BTC for 2017 as part of the Consolidated Appropriation Act of 2018 but did not extend it for 2018.⁷ Whether or not blenders can realize the BTC in 2018 and future years, thus, depends on Congressional action to retroactively apply it to 2018 and/or implement legislation for future years.
- The blender, rather than the producer, of biodiesel claims the BTC, and there is no requirement for the blender to provide all or part of the BTC to the producer. Since the implementation of the BTC, however, producer-blender contracts for the sale of biodiesel have provided for producers to receive a portion of the credit. Thus, in practice, the BTC is a mechanism by which blenders can share the credit with producers to incentivize production (i.e., by effectively raising the price received by the producer).⁸

This study quantifies the economic impact of the industry measured in terms of key variables such as GDP, employment, labor income, as well as taxes paid at the federal and state levels. It also examines the environmental, fuel diversity and energy security benefits provided by the industry. Finally, the study looks at the role that the BTC has played and its importance to maintaining a viable industry.

Socioeconomic Contributions of the Biodiesel Industry

The biodiesel industry makes three important socioeconomic contributions to the U.S. and states. First, the biodiesel industry provides economic stimulus through its investments, operations, purchases and employment. As a consumer of feedstock oils, such as soybean oil and canola oil, and chemicals, such as methanol, the biodiesel industry represents a sizable source of demand and for the agricultural and petrochemical sectors. In 2017, the industry consumed more than \$3.4 billion of agricultural feedstock (e.g., soybean oil, canola oil) and \$0.5 billion of animal fats, waste grease and waste oil. This consumption led to the production of approximately 1.6 billion gallons of biodiesel at over 120 facilities across the country, which provided over 2,300 direct jobs and generated revenues of over \$5.1 billion in 2017. Moreover, the industry and its supply chain's employment support jobs in other sectors through employee spending on items such as food, clothing, real estate, restaurants, hotels and other consumer goods and services.

Second, the industry makes a direct positive environmental contribution by displacing a portion of conventional diesel oil with biodiesel, which is less carbon intensive and reduces GHG emissions. Third, the industry makes a direct contribution to energy security by helping to reduce the use of foreign oil in the production of transportation fuels for U.S. consumption.

⁷ <http://biodieselmagazine.com/articles/2516276/retroactive-biodiesel-tax-credit-signed-into-law-for-2017-only>

⁸ <https://farmdocdaily.illinois.edu/2017/04/blender-and-producer-sharing-retroactively.html>

Estimating Contributions to the Economy

The economic impacts of the biodiesel industry fall into three categories: (1) direct, (2) indirect and (3) induced. The following describes the economic mechanism by which each of these three impacts works its way through the economy:

- (1) **Direct impacts** refer to the economic activity resulting from the biodiesel industry's capital and operational outlays on items such as materials, labor, management and consulting and technical services. Direct impacts are the first order impacts of the industry. The increase in demand for methanol by the biodiesel industry would be a direct impact.
- (2) **Indirect impacts** refer to the economic activity resulting from the "direct" industries spending a portion of their revenues on goods and services provided to them by their own supply chain. For example, an indirect impact would be the addition of workers and increase in material purchases by methanol producers at their facilities to meet the increased demand for methanol by the biodiesel industry. These supply chain industry impacts represent the second order impacts.
- (3) **Induced impacts** refer to the economic activity resulting from the spending of income earned by employees within the "directly" and "indirectly" affected industries. The beneficiaries of induced impacts are primarily consumer-related businesses such as retail stores, restaurants and personal service industries. These "induced" impacts represent the third order impacts.

FTI Consulting applied the IMPLAN model to estimate direct, indirect and induced impacts at a state level. IMPLAN model is a general input-output modeling system that tracks the movement of money through an economy, looking at linkages between industries along the supply chain, to measure the cumulative effect of an industry's impact. Additional information on IMPLAN is included in Appendix A. The IMPLAN datasets represent all industries within the regional economy – rather than extrapolating from national averages – and are derived primarily from data collected by federal agencies.⁹

Economic Contribution Metrics

For this study, we analyzed the following six key metrics to determine the contribution of the biodiesel industry:

- **Economic Output** or sales is the value of production, equal to value added plus intermediate expenditures, which consist of the monies spent purchasing goods and services to create an industry's production.
- **GDP** measures the industry's value of production over the cost of its purchasing the goods and services required to make its products. GDP includes wages and benefits paid to employees and profits earned by self-employed individuals (i.e., labor income), monies collected by industry that are not paid into operations (e.g., profits, capital consumption allowance, payments for rent, royalties and interest income), and all payments to government (e.g., excise taxes, sales taxes and customs duties) with the exception of payroll and income taxes.
- **Employment** measures the direct, indirect and induced jobs for full-time, part-time and seasonal employees and self-employed workers created by the industry.
- **Labor Income** is measured by wages and salaries, as well as profits earned by self-employed individuals, attributable to the industry's activity.
- **Federal Taxes** is measured by the payments to the federal government from employer-collected and paid social security taxes on wages, excise taxes, sales taxes, customs duties, property taxes, severance taxes, personal income taxes, corporate profits taxes and other taxes.
- **State and Local Taxes** is measured by the payments to state and local governments from employer-collected and paid taxes on wages, excise taxes, sales taxes, customs duties, property taxes, personal income taxes, corporate profits taxes and other taxes.

⁹ The 2016 IMPLAN Dataset includes data from the US Bureau of Labor Statistics ("BLS") Covered Employment and Wages program; US Bureau of Economic Analysis ("BEA") Regional Economic Information System program; US BEA Benchmark I/O Accounts of the US; BEA Output estimates; BLS Consumer Expenditure Survey; US Census Bureau County Business Patterns Program; US Census Bureau Decennial Census and Population Surveys; US Census Bureau Censuses and Surveys; and US Department of Agriculture Census.

Input Assumptions

IMPLAN represents more than 500 industry sectors in the U.S. economy. To represent the biodiesel industry within IMPLAN, the first step was to construct an economic profile of the industry based on a “bottom-up” understanding of the industry and its operations. In this work, FTI Consulting relied upon the most recent complete calendar year data available (i.e., 2017) as a basis for constructing a bottom-up profile. The industry profile shows:

- Feedstock is a major input cost for the biodiesel industry. Common feedstocks include oil from crops such as soybean, canola (rapeseed), and palm, animal oil/fats, tallow, yellow grease and waste cooking oil.
- Table 1 below shows representative plant process performance (e.g., the efficiency of feedstock conversion to biodiesel) based on industry/trade information.

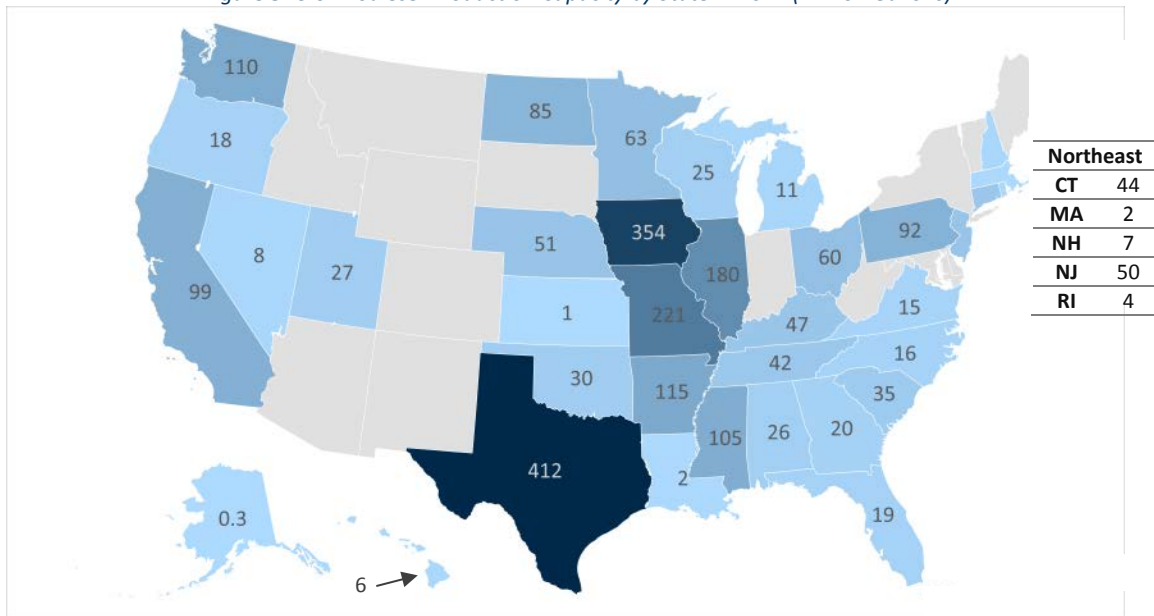
Table 1: Representative Plant Process Performance¹⁰

INPUT	PROCESS EFFICIENCY PER GALLON OF BIODIESEL
Feedstock Use	7.55 lbs.
Methanol Use	0.71 lbs.
Natural Gas Intensity	7 cu. ft.
Electricity Intensity	0.6 kWh.
Water Use	2.0 gal.

- The biodiesel industry consists of 124 facilities with a total capacity of 2.5 billion gallons spread across multiple states, as shown in Figure 3 below.
- 2017 production in the U.S. was approximately 1.6 billion gallons, representing a capacity utilization rate of 64 percent.

¹⁰ <https://www.extension.iastate.edu/agdm/energy/xls/d1-15biodieselprofitability.xlsx>

Figure 3: U.S. Biodiesel Production Capacity by State in 2017 (Million Gallons)¹¹



FTI Consulting constructed a 2017 industry profile based on the number of plants in the U.S., engineering estimates of representative biodiesel process costs and performance (as shown in Table 2, below), and biodiesel production.

¹¹ <http://www.biodieselmagazine.com/plants/listplants/USA/>

Table 2: 2017 Biodiesel Industry Profile

INDUSTRY PROFILE	AMOUNT (2017 \$ MILLIONS)
Labor (Employees)	2,311
Revenues (2017 \$ Millions)	
Biodiesel	\$5,061.6
Glycerine	\$43.2
Total	\$5,104.8
Purchases (2017 \$ Millions)	
Soybean Oil	\$3,429.4
Animal Fats	\$461.2
Methanol and Other Chemicals	\$301.7
Natural Gas	\$58.4
Electricity	\$48.0
Water	\$11.2
Transportation	\$160.0
Marketing & Procurement	\$64.0
Margin (2017 \$ Millions)	
EBITDA¹²	\$335.9

As shown in Table 2 above, FTI Consulting estimates that the biodiesel industry generated \$5.1 billion in revenue, supported 2,311 direct employees at the plants, and generated an EBITDA of \$336 million in 2017.

Based on the industry profile, FTI Consulting distributed these inputs by industry based on the preexisting industry mixture at the state level within the IMPLAN model to estimate the economic impact and jobs created from the biodiesel industry's 2017 activities. IMPLAN characterizes more than 500 economic sectors. As such, we allocated each of the purchases listed in Table 2 above within representative sectors. For example, the procurement of soy oil feedstock by the industry was represented as an addition to demand in the soybean and other oilseed processing industry of IMPLAN (NAICS 311224). Similarly, the procurement of methanol for industry operations was represented as an addition to demand in the petrochemical industry of IMPLAN (NAICS 32519).

IMPLAN-Estimated Economic Impacts

After incorporating the biodiesel industry profile, as shown above in Table 2, into IMPLAN, FTI Consulting used the model to estimate the economic impacts of biodiesel industry activity in 2017. Table 3 below shows the results of our analysis, emphasizing the biodiesel's impact on major macroeconomic metrics.

¹² Earnings before interest, tax, depreciation and amortization ("EBITDA") represents a company's operating performance.

Table 3: Industry Economic Contributions to U.S. Economy in 2017

U.S. Level	DIRECT	INDIRECT	INDUCED	TOTAL
Economic Output (2017 \$ millions)	5,100	12,400	4,100	21,600
GDP (2017 \$ millions)	300	3,900	2,300	6,500
Employment	2,300	34,400	25,200	61,900
Labor Income (2017 \$ millions)	100	2,400	1,300	3,800
Federal Taxes (2017 \$ millions)				1,200
State and Local Taxes (2017 \$ millions)				600

As shown above, the biodiesel industry had a significant impact on the U.S. economy in 2017, generating \$21.6 billion in economic output, which translates to \$6.5 billion in GDP. In addition, the industry supported approximately 61,900 jobs, paying over \$3.8 billion in wages and benefits. Notably, 2,300 of these workers were employed directly by the biodiesel industry. The biodiesel industry's activities also generated \$1.2 billion and \$600 million in federal taxes and state and local taxes.

Environmental Benefits

A major goal of government policy supporting renewable fuels is reducing GHG emissions. Obligated parties can only use renewable fuels approved by the EPA as lowering GHG emissions to satisfy an RVO. Specifically, the EPA considers the feedstock used, production process and intended use of each fuel to assess its lifecycle GHG emissions and determine whether that fuel pathway can satisfy an RVO.¹³

The use of biodiesel produces lower GHG emissions than conventional diesel because a gallon of biodiesel has a lower lifecycle GHG impact than a gallon of conventional diesel. Thus, replacing amounts of conventional diesel with biodiesel lowers GHG emissions. Table 4 and Figure 4 below estimate the effect that replacing conventional diesel with biodiesel has on GHG emissions, considering the full lifecycle GHG impact of each fuel. Based on 1.6 billion gallons of biodiesel (which equals 2017 U.S. biodiesel production), the biodiesel industry reduced GHG emissions by approximately 14.8 million tons.

¹³ <https://www.epa.gov/renewable-fuel-standard-program/what-fuel-pathway>

Table 4: Biodiesel's Contribution to GHG Reduction¹⁴

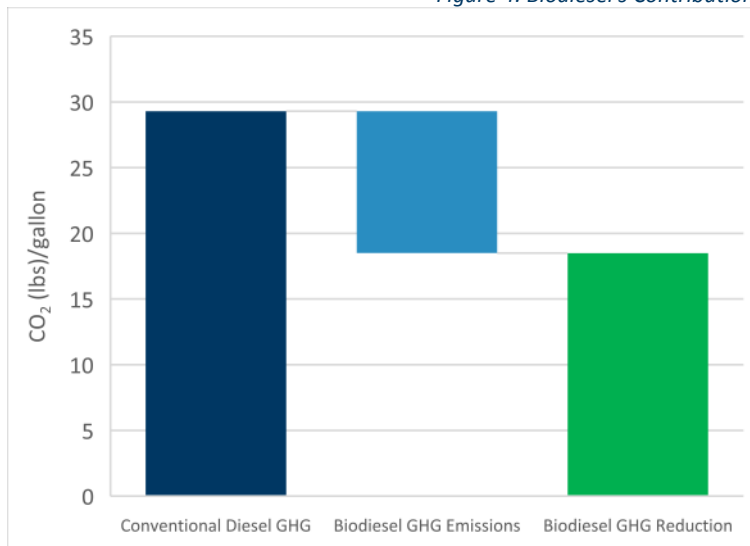
CONVENTIONAL DIESEL GHG IMPACT	BIODIESEL GHG IMPACT*	GHG REDUCTION FROM DISPLACEMENT	ANNUAL DIESEL DISPLACED	GHG REDUCTION, TONS/YEAR
29.3 lbs./gallon	10.8 lbs./gallon	18.5 lbs./gallon	1.6 billion gallons	14.8 million tons/year

*Based on a feedstock mix of oils and fats

Source: EPA

While measures for the monetary benefits of GHG reduction vary, the EPA and other federal agencies use estimates of the social cost of carbon emissions. The EPA has relied on approximately \$50 per ton of carbon dioxide avoided as the social cost of carbon.¹⁵ Based on this estimate, the biodiesel industry provided \$750 million in GHG reduction benefits to the U.S. economy in 2017, also shown below in Figure 4.

Figure 4: Biodiesel's Contribution to GHG Reduction



Impact on U.S. GHG Emissions:

- GHG Reduction: 14.8 million tons/year
- Impact equivalent to: 3.2 million passenger vehicles off the road

Energy Security Benefits and Value as a “Drop-in” Fuel

The most common types of biodiesel blends in the U.S. are diesel products consisting of up to five percent (“B5”) and between six and 20 percent (“B20”) biodiesel. B20 is a direct substitute for petroleum diesel because it can be used in current diesel engines without requiring any modifications to the vehicle or engine. Engines operating on B20 have similar fuel consumption, horsepower and torque compared to engines running on petroleum diesel and, despite a one to two percent decrease in energy per gallon compared to petroleum diesel, most B20 drivers do not notice a difference in engine performance.¹⁶ Thus, biodiesel is considered a “drop-in fuel” since it is almost completely interchangeable with petroleum diesel.

Biodiesel’s interchangeability with petroleum-based diesel is an important factor in U.S. efforts to reduce its reliance on foreign oil. In 2017, the U.S. consumed approximately 7.3 billion barrels of crude oil and petroleum products, 51 percent of which, or approximately 3.7 billion barrels, were imports.¹⁷ As such, the U.S. remains a net importer of oil. Table 5 below

¹⁴ <https://www.gpo.gov/fdsys/pkg/FR-2010-03-26/pdf/2010-3851.pdf>

¹⁵ EPA: https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html;

¹⁶ https://afdc.energy.gov/fuels/biodiesel_blends.html

¹⁷ https://www.eia.gov/dnav/pet/pet_cons_psup_dc_nus_mbb1_a.htm

breaks down U.S. oil imports in 2017 by country, showing the top 10 sources of U.S. oil imports and which of these countries are members of OPEC.

Table 5: U.S. Imports of Crude Oil and Petroleum Products by Country in 2017¹⁸

Region/Country	Million Barrels (2017)	% of Total U.S. Imports	Rank
OPEC			
Saudi Arabia	349	9.4%	2
Venezuela	246	6.6%	4
Iraq	220	6.0%	5
Nigeria	122	3.3%	8
Ecuador	76	2.0%	10
OPEC Top 10 Total	1,013	27.4%	
All OPEC Total	1,229	33.2%	
Non-OPEC			
Canada	1,480	40.0%	1
Mexico	249	6.7%	3
Russia	142	3.8%	6
Colombia	132	3.6%	7
Brazil	82	2.2%	9
Non-OPEC Top 10 Total	2,085	56.3%	
All Non-OPEC Total	2,474	66.8%	
Total U.S. Imports	3,703		

As shown above in Table 5, the U.S. receives one-third of oil imports from OPEC countries and two-thirds of imports from non-OPEC countries, the majority of which are from Canada. In addition, the U.S. imports almost four percent of oil from Russia, which, while not a member of OPEC, is considered one of the group's strongest allies.¹⁹ Notably, the U.S. has reduced its dependence on OPEC in the 21st century, as OPEC imports have declined from 45 percent of all oil imports in 2000 to 33 percent in 2017. OPEC imports remain sizeable, however, as does U.S. consumption of oil from Russia. Thus, increasing U.S. consumption of biodiesel, which, as described above, is a nearly interchangeable substitute for petroleum diesel, can further help the U.S. reduce its reliance on foreign oil, benefiting both the U.S. economy and national security.

¹⁸ https://www.eia.gov/dnav/pet/pet_move_impqus_a2_nus_ep00_im0_mbb1_a.htm

¹⁹ <https://www.reuters.com/article/us-oil-opec/opec-russia-rebuff-trumps-call-for-immediate-boost-to-oil-output-idUSKCN1M30DK>

Biodiesel Plant Economics

The economics of biodiesel at the plant level are driven not only by the market price for diesel and the underlying cost structure of producing plants, but also by demand created by the RVOs and revenue generated by the BTC. Economics at the plant level are best understood by examining each element of an income statement for a representative plant. Thus, to examine the economics of a plant, we analyze the income statements of plants using two different types of feedstocks below: (1) soybean oil, shown in Table 6, and (2) animal fats, shown in Table 7. Because 2017 is the most recent full calendar year for which information is available, FTI Consulting has benchmarked the representative plants using 2017 as a basis.

Revenues

The market value of biodiesel per gallon can be viewed in terms of three components:

- (1) The value of conventional diesel, which biodiesel can displace as a drop-in substitute.
- (2) The RIN value, driven by the RVO, that a blender would be willing to pay.
- (3) The portion of the BTC value that a blender shares with the producer through a negotiated contract.²⁰

In addition to biodiesel, plants produce a small amount of marketable glycerine as a by-product.

Costs

Described further below, FTI Consulting relied on Iowa State University's monthly profitability of biodiesel production model ("ISU model") to develop the inputs for the representative plant income statements shown in Table 6 and Table 7.²¹

Variable Costs

Feedstock Costs

Feedstocks represent a major portion of total plants accounting for upwards of 70 percent of costs. Feedstock costs are driven by commodity markets, and, during certain periods, can account for as much as 85 percent or more of plant costs. Of the feedstocks examined at the two representative plants examined, fats are less expensive than oils (in the range of 15 to 20 percent less) but harder to aggregate in large volumes.

Methanol and Other Chemicals

Methanol is the preferred alcohol used in the transesterification process where it reacts with oils in the presence of a catalyst. For the cost of methanol and the catalyst, FTI Consulting relied upon the ISU model.

Utilities and Transportation

Production of biodiesel requires gas, electricity and water as inputs. In addition, the final product must be transported to the blender or refiner. FTI Consulting used the ISU model to determine the amount of gas, electricity and water required to produce one gallon of biodiesel produced and average costs.

Marketing and Procurement

A biodiesel plant incurs costs for input procurement (e.g., feedstock, methanol, catalysts and utilities), as well as to market the final product. FTI Consulting also used the ISU model to estimate these costs.

Annual Costs

Annual costs, based on estimates from the ISU model, include costs associated with labor at the plant, overhead labor at the plant, and maintenance items (e.g., routine replacement of parts during maintenance, routine overhauls). Long-lived capital expenditures that maintain the plant but are not annual expenses are also estimated as a separate line item. In general, annual costs depend on the production capacity at the plant, but they do not vary based on production at the plant. For

²⁰ Our research found that blenders and producers often share the value of the BTC to provide a degree of regulatory and market protection to the producer. See <https://farmdocdaily.illinois.edu/2017/04/blender-and-producer-sharing-retroactively.html>.

²¹ <https://www.extension.iastate.edu/agdm/energy/html/d1-15.html>

capitalized costs and property taxes, FTI Consulting relied on the ISU model, in addition to various other industry sources, to estimate these line items.²²

Table 6: 2017 Representative Plant Annual Economics with Soybean Oil as Feedstock

	\$	\$ / GALLON
Revenue		
Biodiesel Revenue	64,127,044	3.16
Glycerine Revenue	547,318	0.03
Total Revenue	64,674,363	3.19
Variable Costs		
Soybean Oil Cost	49,940,325	2.46
Animal Fats Cost	0	0.00
Methanol and Other Chemical Cost	3,821,927	0.19
Natural Gas Cost	740,231	0.04
Electricity Cost	608,132	0.03
Water Cost	141,897	0.01
Transportation Cost	2,027,105	0.10
Marketing & Procurement	810,842	0.04
Total Variable Costs	58,090,459	2.87
Annual Costs		
Operations - Labor	1,196,000	0.06
Operations - Maintenance - Labor	144,000	0.01
Operations - Maintenance - Ongoing & Other	608,132	0.03
Operations - Maintenance - Capital	608,132	0.03
Overhead - Labor	270,000	0.01
Property Taxes, Insurance, etc.	75,938	0.00
Total Annual Costs	2,902,201	0.14
EBITDA	3,681,704	0.18

²² See <http://www.collectivebiodiesel.org/presentations/2013presentations/cbc2013-rudypruszko-strategiesforsmallplants.pdf>; see also Gerpen, Jon Van, et al., *Building a Successful Biodiesel Business*. 2nd ed., Biodiesel Basics, 2006.

Table 7: 2017 Representative Plant Annual Economics with Fats as Feedstock

	\$	\$/ GALLON
Revenue		
Biodiesel Revenue	47,452,188	3.16
Glycerine Revenue	405,000	0.03
Total Revenue	47,857,188	3.19
Variable Costs		
Soybean Oil Cost	0	0.00
Animal Fats Cost	33,258,977	2.22
Methanol and Other Chemical Cost	2,828,117	0.19
Natural Gas Cost	547,750	0.04
Electricity Cost	450,000	0.03
Water Cost	105,000	0.01
Transportation Cost	1,500,000	0.10
Marketing & Procurement	600,000	0.04
Total Variable Costs	39,289,844	2.62
Annual Costs		
Operations - Labor	1,196,000	0.08
Operations - Maintenance - Labor	144,000	0.01
Operations - Maintenance - Ongoing & Other	450,000	0.03
Operations - Maintenance - Capital	450,000	0.03
Overhead - Labor	270,000	0.02
Property Taxes, Insurance, etc.	63,281	0.00
Total Annual Costs	2,573,281	0.17
EBITDA	5,994,062	0.40

Total Costs

The total cost, which is the sum of the variable and annual costs, can be stated on dollar per gallon (“\$/gallon”) of biodiesel produced, although the annual cost components do not vary by production level. The total cost, stated in \$/gallon, is a useful metric because it represents the amount of revenues required in \$/gallon for the plant to be profitable.

Margins

The plant margin is the difference between the revenues and total costs. It is a metric calculated before interest, taxes or depreciation and is similar to EBITDA.

Impact of the BTC

The 2017 income statement for a representative biodiesel plant is useful in understanding the impact of the BTC. As discussed earlier, the revenues available to a producer consist of three components: the market value of conventional diesel, the RIN, and the share of BTC provided to the producer. In the 2017 income statement developed, the producer's share of the BTC (\$0.46 per gallon) was estimated as the difference between the total revenues to the plant (\$3.19 per gallon) less the sum of the glycerine value (\$0.03 per gallon), the average biodiesel RIN value (\$1.01 per gallon), and the price of conventional diesel (\$1.69 per gallon). As shown in Figure 5 below, the 2017 representative plant analysis shows that without the BTC, the plant would have incurred an average loss of \$0.25 per gallon.

Figure 5: 2017 Estimated Profitability of Representative Soy Oil Plant

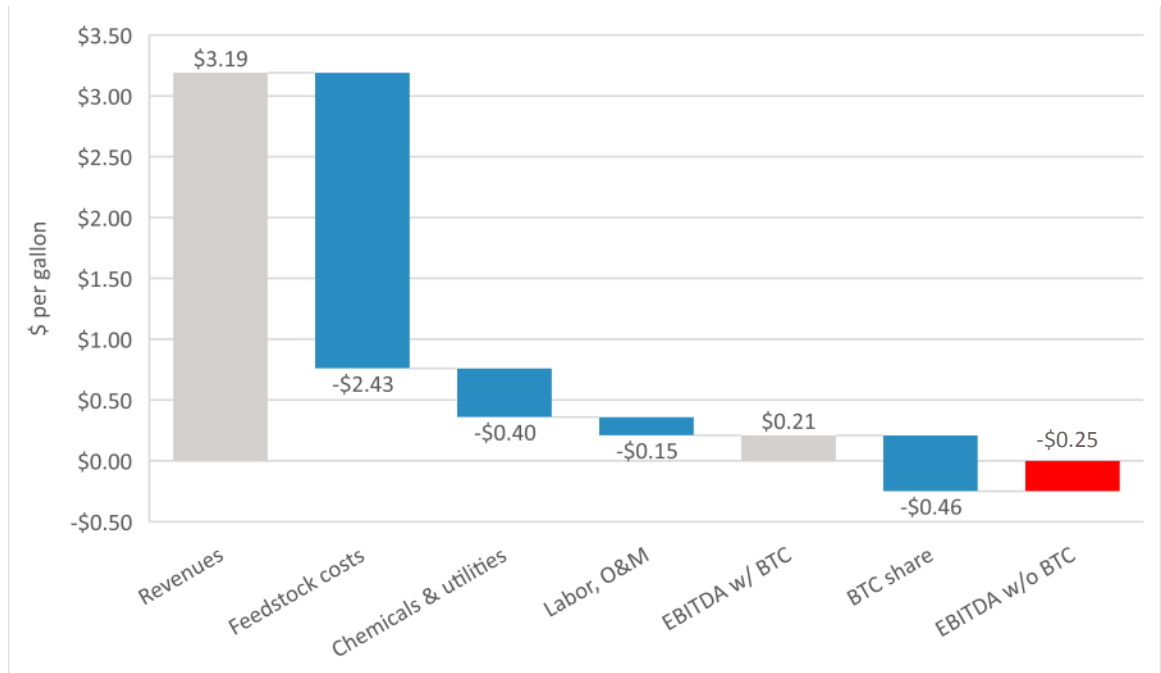
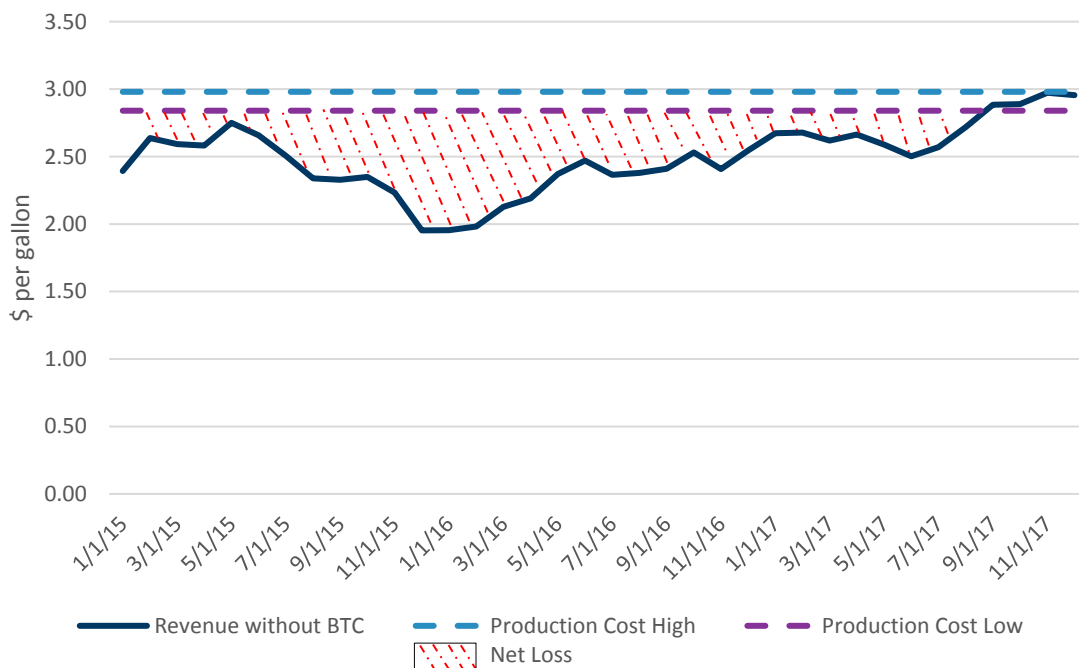


Figure 6 shows the monthly revenues without the BTC, going back to 2015, as well as a range of production costs. The “Low” end of the range corresponds to costs observed in 2015, a relative low, while the “High” end of the range represents current costs observed in 2017. In analyzing the BTC, several points are worth emphasizing:

- The BTC is generally shared between producer and blender and the producer does not automatically receive the BTC.
- The economics of biodiesel plants can vary across plants and from year-to-year for multiple reasons, including:
 - Sudden declines in diesel prices, thereby lowering the price paid to a producer;
 - Sudden increases in feedstock costs or methanol costs (due to commodity market conditions); and,
 - Structural factors that may make some plants have higher costs – e.g., lower conversion efficiency, unanticipated maintenance costs due to equipment failures, higher labor costs in some regions.

Figure 6: Revenues Without BTC vs. Costs



As Figure 6 shows, in the absence of the BTC, the industry does not recover its production costs for many months. The revenues from month to month vary as diesel prices and RIN prices vary. Costs can also fluctuate, especially for feedstock. In the face of uncertainties, the BTC acts as a mechanism to partially mitigate the economic risk from exposure to market prices for diesel, feedstock market fluctuations, and the dynamics of the RIN mechanism that threaten the viability of individual plants and hence the industry. Because the tax credit flows to the blender and is shared with the producer, blenders can adjust the level that is shared with producers, potentially using the remaining amount to lower the amount of biodiesel costs passed onto to ultimate customers in the retail price of diesel. Therefore, the BTC remains an important incentive to preserve industry viability. Without the BTC, the many benefits the industry brings would be put at risk.

Conclusions

Biodiesel is a green alternative to conventional diesel presents numerous benefits to the U.S. economy and environment, including lower GHG emissions, improved rural economic viability through more demand for agricultural products, and reduced U.S. dependence on foreign oil. Support for these objectives in the public policy realm has resulted in two legislative mechanisms designed to support biodiesel production:

- (1) The provision of a BTC to blenders, which reduces costs for blenders and producers alike; and,
- (2) The requirement for refiners and importers to meet a volume-based target (RVO) for blending renewable fuels (including biodiesel) into the conventional fuel and diesel supply.

As a result of these initiatives, the U.S. biodiesel industry has grown substantially over the past decade, reaching a production level of 1.6 billion gallons of biodiesel in 2017. Based on production and financial data, FTI Consulting found that 2017 biodiesel production generated \$21.6 billion in economic output, added \$6.5 billion to GDP, supported approximately 61,900 jobs across the economy, and paid over \$3.8 billion in labor income.

Notably, the BTC, which blenders share with producers through their purchase contracts, helps both entities mitigate exposure to fluctuations in market prices for diesel and feedstock that threaten the viability of the industry. Without the BTC, FTI Consulting found that a representative plant in the industry would have suffered a loss of \$0.25 per gallon produced in 2017. Despite the socioeconomic benefits the biodiesel industry yields, producers face uncertainty over whether Congress will retroactively extend the BTC beyond 2017 and/or provide certainty for future years. Failure to extend the BTC in future years will likely threaten industry viability in the long term and jeopardize the significant, quantifiable benefits provided by the industry.

Appendix A: Description of IMPLAN Model

IMPLAN, produced by MIG, Inc.,²³ is a software program containing an IO model of the U.S. or regional economies. Our version of the software here includes the U.S., as well as Alabama, Arkansas, Georgia, Oregon and Wisconsin. IMPLAN sees wide application throughout economic impact analysis and policy research.²⁴

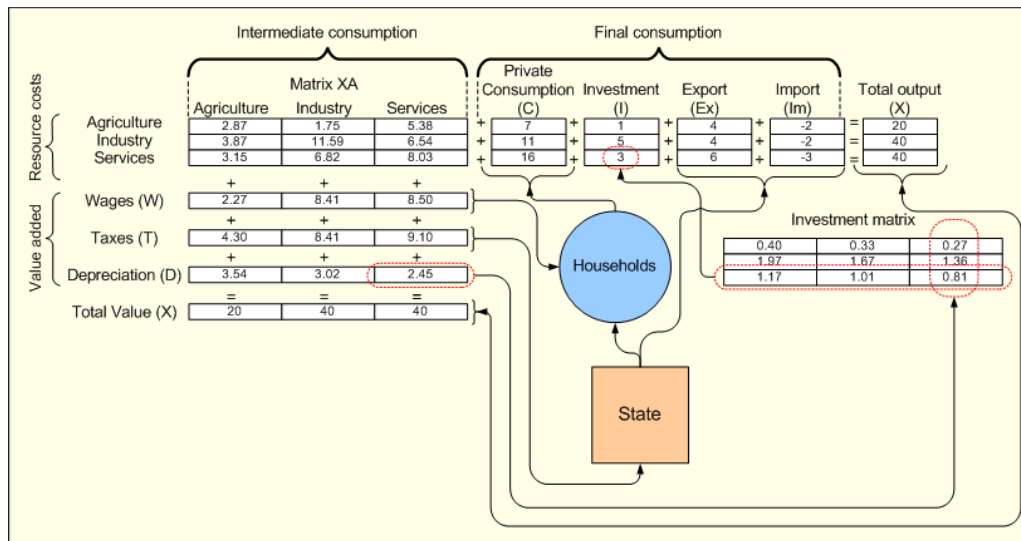
IMPLAN works by constructing a series of multipliers throughout the economy where an initial, “direct” activity stimulates a supply chain and related industry. A classic example involves automotive manufacturing in the Midwest or Southeast, where an automobile assembly plant has a complex supply chain of parts suppliers feeding into it from throughout the region, the U.S., and even the rest of the world in a long and complex production process.

The suppliers needed to construct a final automobile—parts, materials suppliers of glass, rubber, leather, electronics, legal and accounting—are “indirect” impacts in the IMPLAN model. The direct and indirect industries pay wages and salaries to their employees, which support the living expenses of households. These include the standard accoutrements of daily life in any family budget, such as housing and groceries. IMPLAN calls the impact of consumer spending the “induced” effect, which it also includes inside of its modeling and the overall impact results.

The core of IMPLAN is in IO model, otherwise known as a Leontief model. Named for Wassily Leontief, a Nobel Laureate for this and other research,²⁵ an IO model imagines the economy as a series of transactions between buyers and sellers. Every transaction must have both sides to exist. Most transactions are between industries (the supply chain) though there are also transactions between businesses and households (through either consumption or wages).

Leontief built a matrix, with inputs and outputs from each industry and households on each axis, to show the volume of the transactions between every sector to one another and allow for the computation of changes to the existing structure. The matrix then shows how initial spending flows through into other industries.

Figure 7: Structure of an example input-output model with three industries²⁶



²³ <<http://implan.com/>>

²⁴ <<http://www.ci.richmond.ca.us/DocumentCenter/Home/View/6474>>

²⁵ <<http://www.econlib.org/library/Enc/bios/Leontief.html>>

²⁶ <<http://dankozub.com/simulation/>>

Appendix B: State IMPLAN Analysis Results

Employment – 2017

STATE	DIRECT EMPLOYMENT	INDIRECT EMPLOYMENT	INDUCED EMPLOYMENT	TOTAL EMPLOYMENT
Alabama	24	616	440	1,080
Alaska	0	2	7	9
Arizona	0	59	93	151
Arkansas	106	1,448	875	2,429
California	91	2,081	1,667	3,838
Colorado	0	39	97	136
Connecticut	40	67	96	204
Delaware	0	12	18	30
District of Columbia	0	4	11	15
Florida	18	274	392	684
Georgia	18	789	614	1,421
Hawaii	5	75	58	138
Idaho	0	43	43	86
Illinois	166	3,163	2,147	5,475
Indiana	102	1,984	1,308	3,394
Iowa	325	2,803	1,927	5,056
Kansas	1	614	437	1,052
Kentucky	43	674	491	1,209
Louisiana	2	285	227	515
Maine	1	6	14	22
Maryland	0	139	129	268
Massachusetts	2	248	219	469
Michigan	10	344	307	661
Minnesota	58	1,757	1,299	3,114
Mississippi	96	641	390	1,127
Missouri	203	1,829	1,236	3,268
Montana	0	51	44	95
Nebraska	47	1,279	914	2,240
Nevada	7	187	138	332
New Hampshire	6	9	19	34
New Jersey	46	203	241	490
New Mexico	0	22	28	50

STATE	DIRECT EMPLOYMENT	INDIRECT EMPLOYMENT	INDUCED EMPLOYMENT	TOTAL EMPLOYMENT
New York	0	200	288	487
North Carolina	15	441	386	842
North Dakota	78	419	292	789
Ohio	55	2,675	1,709	4,439
Oklahoma	28	1,063	641	1,732
Oregon	16	128	122	267
Pennsylvania	85	580	501	1,166
Rhode Island	4	426	256	685
South Carolina	32	245	201	478
South Dakota	0	269	194	463
Tennessee	39	1,107	766	1,912
Texas	379	3,271	2,435	6,085
Utah	25	69	78	172
Vermont	0	45	29	74
Virginia	14	151	184	349
Washington	101	1,035	744	1,880
West Virginia	0	69	52	121
Wisconsin	23	398	330	751
Wyoming	0	26	20	46
United States	2,311	34,364	25,155	61,830

GDP – 2017

STATE	DIRECT GROSS DOMESTIC PRODUCT	INDIRECT GROSS DOMESTIC PRODUCT	INDUCED GROSS DOMESTIC PRODUCT	TOTAL GROSS DOMESTIC PRODUCT
Alabama	\$3.5	\$67.3	\$39.5	\$110.3
Alaska	\$0.0	\$0.9	\$0.7	\$1.7
Arizona	\$0.0	\$6.9	\$8.9	\$15.7
Arkansas	\$15.4	\$152.8	\$74.5	\$242.7
California	\$13.2	\$238.7	\$162.2	\$414.1
Colorado	\$0.0	\$6.7	\$9.1	\$15.8
Connecticut	\$5.9	\$8.4	\$9.6	\$23.9
Delaware	\$0.0	\$2.1	\$1.8	\$3.9
District of Columbia	\$0.0	\$0.7	\$1.2	\$1.8
Florida	\$2.6	\$29.9	\$36.3	\$68.7
Georgia	\$2.7	\$86.5	\$56.5	\$145.7
Hawaii	\$0.7	\$7.5	\$5.4	\$13.7
Idaho	\$0.0	\$4.6	\$3.8	\$8.4
Illinois	\$24.1	\$365.9	\$198.9	\$588.9
Indiana	\$14.8	\$216.7	\$115.4	\$346.9
Iowa	\$47.3	\$312.7	\$165.2	\$525.2
Kansas	\$0.2	\$71.4	\$39.8	\$111.3
Kentucky	\$6.3	\$68.9	\$44.4	\$119.6
Louisiana	\$0.3	\$36.3	\$19.8	\$56.5
Maine	\$0.2	\$0.7	\$1.3	\$2.2
Maryland	\$0.0	\$15.8	\$12.5	\$28.3
Massachusetts	\$0.3	\$29.8	\$21.5	\$51.6
Michigan	\$1.4	\$38.8	\$28.3	\$68.5
Minnesota	\$8.4	\$199.3	\$118.0	\$325.6
Mississippi	\$14.0	\$61.0	\$32.1	\$107.0
Missouri	\$29.5	\$192.2	\$107.9	\$329.7
Montana	\$0.0	\$5.7	\$3.9	\$9.6
Nebraska	\$6.8	\$153.5	\$81.0	\$241.3
Nevada	\$1.1	\$21.1	\$12.9	\$35.1
New Hampshire	\$0.9	\$1.0	\$1.8	\$3.6
New Jersey	\$6.7	\$28.6	\$23.6	\$58.9
New Mexico	\$0.0	\$3.4	\$2.5	\$5.9
New York	\$0.0	\$26.4	\$30.0	\$56.4

STATE	DIRECT GROSS DOMESTIC PRODUCT	INDIRECT GROSS DOMESTIC PRODUCT	INDUCED GROSS DOMESTIC PRODUCT	TOTAL GROSS DOMESTIC PRODUCT
North Carolina	\$2.2	\$48.7	\$35.7	\$86.6
North Dakota	\$11.4	\$48.5	\$25.5	\$85.4
Ohio	\$8.0	\$289.3	\$153.5	\$450.8
Oklahoma	\$4.0	\$119.8	\$55.6	\$179.4
Oregon	\$2.4	\$14.9	\$11.0	\$28.3
Pennsylvania	\$12.3	\$67.8	\$46.0	\$126.1
Rhode Island	\$0.5	\$47.6	\$23.2	\$71.3
South Carolina	\$4.7	\$25.1	\$18.0	\$47.7
South Dakota	\$0.0	\$31.9	\$17.5	\$49.3
Tennessee	\$5.6	\$120.1	\$69.8	\$195.5
Texas	\$55.1	\$400.1	\$219.4	\$674.6
Utah	\$3.6	\$7.0	\$6.8	\$17.4
Vermont	\$0.0	\$4.5	\$2.6	\$7.1
Virginia	\$2.0	\$17.6	\$17.8	\$37.3
Washington	\$14.7	\$117.9	\$70.4	\$203.0
West Virginia	\$0.0	\$7.8	\$4.7	\$12.6
Wisconsin	\$3.3	\$46.0	\$30.0	\$79.4
Wyoming	\$0.0	\$4.0	\$1.8	\$5.8
United States	\$335.9	\$3,880.8	\$2,279.5	\$6,496.2

Labor Income – 2017

STATE	DIRECT LABOR INCOME	INDIRECT LABOR INCOME	INDUCED LABOR INCOME	TOTAL LABOR INCOME
Alabama	\$1.4	\$41.9	\$22.1	\$65.4
Alaska	\$0.0	\$0.3	\$0.4	\$0.7
Arizona	\$0.0	\$4.2	\$4.9	\$9.1
Arkansas	\$6.1	\$94.4	\$40.8	\$141.3
California	\$5.2	\$150.0	\$90.7	\$245.9
Colorado	\$0.0	\$5.5	\$5.1	\$10.6
Connecticut	\$2.3	\$6.5	\$5.5	\$14.3
Delaware	\$0.0	\$1.2	\$1.0	\$2.1
District of Columbia	\$0.0	\$0.5	\$0.7	\$1.2
Florida	\$1.0	\$18.6	\$20.0	\$39.6
Georgia	\$1.1	\$54.1	\$31.5	\$86.6
Hawaii	\$0.3	\$4.8	\$3.0	\$8.1
Idaho	\$0.0	\$3.0	\$2.1	\$5.1
Illinois	\$9.5	\$217.9	\$111.4	\$338.8
Indiana	\$5.8	\$134.2	\$65.0	\$205.1
Iowa	\$18.7	\$201.9	\$90.9	\$311.6
Kansas	\$0.1	\$43.9	\$22.2	\$66.2
Kentucky	\$2.5	\$43.5	\$25.0	\$70.9
Louisiana	\$0.1	\$21.9	\$11.1	\$33.1
Maine	\$0.1	\$0.5	\$0.7	\$1.3
Maryland	\$0.0	\$9.6	\$7.0	\$16.5
Massachusetts	\$0.1	\$19.4	\$12.4	\$32.0
Michigan	\$0.6	\$24.2	\$15.8	\$40.6
Minnesota	\$3.3	\$127.0	\$67.3	\$197.6
Mississippi	\$5.5	\$38.0	\$17.3	\$60.8
Missouri	\$11.7	\$119.8	\$60.0	\$191.5
Montana	\$0.0	\$3.4	\$2.2	\$5.6
Nebraska	\$2.7	\$95.1	\$45.2	\$143.0
Nevada	\$0.4	\$12.7	\$7.0	\$20.1
New Hampshire	\$0.3	\$0.7	\$1.0	\$2.1
New Jersey	\$2.6	\$18.0	\$13.4	\$34.0
New Mexico	\$0.0	\$1.8	\$1.4	\$3.2
New York	\$0.0	\$16.1	\$16.7	\$32.8
North Carolina	\$0.9	\$30.2	\$19.9	\$51.0

STATE	DIRECT LABOR INCOME	INDIRECT LABOR INCOME	INDUCED LABOR INCOME	TOTAL LABOR INCOME
North Dakota	\$4.5	\$29.2	\$14.3	\$48.0
Ohio	\$3.2	\$172.7	\$85.1	\$261.0
Oklahoma	\$1.6	\$72.0	\$31.2	\$104.8
Oregon	\$0.9	\$9.1	\$6.2	\$16.2
Pennsylvania	\$4.9	\$43.9	\$26.0	\$74.7
Rhode Island	\$0.2	\$29.3	\$13.0	\$42.5
South Carolina	\$1.9	\$15.6	\$9.9	\$27.4
South Dakota	\$0.0	\$20.3	\$9.8	\$30.1
Tennessee	\$2.2	\$73.4	\$39.9	\$115.5
Texas	\$21.8	\$242.5	\$123.2	\$387.5
Utah	\$1.4	\$4.4	\$3.7	\$9.5
Vermont	\$0.0	\$2.7	\$1.5	\$4.2
Virginia	\$0.8	\$10.6	\$9.8	\$21.1
Washington	\$5.8	\$73.3	\$39.0	\$118.1
West Virginia	\$0.0	\$4.4	\$2.6	\$7.1
Wisconsin	\$1.3	\$28.1	\$16.8	\$46.2
Wyoming	\$0.0	\$2.2	\$0.9	\$3.2
United States	\$132.9	\$2,398.7	\$1,273.4	\$3,805.0

Economic Output – 2017

STATE	DIRECT ECONOMIC OUTPUT	INDIRECT ECONOMIC OUTPUT	INDUCED ECONOMIC OUTPUT	TOTAL ECONOMIC OUTPUT
Alabama	\$52.8	\$211.0	\$71.5	\$335.3
Alaska	\$0.6	\$1.1	\$1.3	\$3.0
Arizona	\$0.0	\$20.4	\$16.0	\$36.5
Arkansas	\$233.5	\$545.3	\$134.2	\$913.0
California	\$200.0	\$740.2	\$284.8	\$1,225.0
Colorado	\$0.0	\$12.7	\$16.3	\$29.0
Connecticut	\$89.4	\$21.2	\$16.0	\$126.5
Delaware	\$0.0	\$6.6	\$3.1	\$9.7
District of Columbia	\$0.0	\$1.5	\$2.0	\$3.6
Florida	\$39.0	\$87.1	\$65.2	\$191.3
Georgia	\$40.6	\$266.9	\$101.4	\$409.0
Hawaii	\$11.2	\$25.3	\$9.7	\$46.2
Idaho	\$0.0	\$15.3	\$7.0	\$22.2
Illinois	\$366.2	\$1,168.0	\$349.7	\$1,883.9
Indiana	\$224.4	\$716.7	\$206.7	\$1,147.8
Iowa	\$718.9	\$1,017.8	\$296.2	\$2,032.9
Kansas	\$2.4	\$215.4	\$71.8	\$289.6
Kentucky	\$95.7	\$211.2	\$80.7	\$387.5
Louisiana	\$4.5	\$116.3	\$35.8	\$156.5
Maine	\$3.0	\$1.6	\$2.4	\$7.1
Maryland	\$0.0	\$56.2	\$21.9	\$78.1
Massachusetts	\$4.5	\$112.2	\$37.3	\$153.9
Michigan	\$21.5	\$112.3	\$51.0	\$184.7
Minnesota	\$127.9	\$564.7	\$212.1	\$904.7
Mississippi	\$212.2	\$210.9	\$58.5	\$481.7
Missouri	\$448.8	\$612.4	\$192.7	\$1,253.9
Montana	\$0.0	\$20.9	\$7.1	\$28.0
Nebraska	\$103.6	\$446.1	\$145.5	\$695.3
Nevada	\$16.2	\$76.8	\$22.9	\$116.0
New Hampshire	\$13.2	\$2.2	\$3.1	\$18.5
New Jersey	\$101.5	\$83.5	\$40.7	\$225.8
New Mexico	\$0.0	\$5.7	\$4.6	\$10.3
New York	\$0.0	\$91.7	\$51.3	\$142.9

STATE	DIRECT ECONOMIC OUTPUT	INDIRECT ECONOMIC OUTPUT	INDUCED ECONOMIC OUTPUT	TOTAL ECONOMIC OUTPUT
North Carolina	\$32.9	\$149.4	\$64.4	\$246.7
North Dakota	\$172.6	\$136.0	\$46.0	\$354.6
Ohio	\$121.9	\$945.2	\$273.8	\$1,340.8
Oklahoma	\$60.9	\$450.3	\$100.8	\$612.0
Oregon	\$36.4	\$44.8	\$19.6	\$100.7
Pennsylvania	\$186.9	\$207.0	\$80.3	\$474.1
Rhode Island	\$8.1	\$214.9	\$40.7	\$263.7
South Carolina	\$71.5	\$77.4	\$32.5	\$181.4
South Dakota	\$0.0	\$98.6	\$31.6	\$130.2
Tennessee	\$85.3	\$371.0	\$125.2	\$581.5
Texas	\$836.8	\$1,293.9	\$389.2	\$2,520.0
Utah	\$55.2	\$18.6	\$12.3	\$86.2
Vermont	\$0.0	\$21.6	\$4.7	\$26.3
Virginia	\$30.3	\$49.6	\$31.7	\$111.6
Washington	\$223.4	\$372.4	\$124.3	\$720.1
West Virginia	\$0.0	\$23.2	\$8.5	\$31.7
Wisconsin	\$50.8	\$137.5	\$54.1	\$242.3
Wyoming	\$0.0	\$6.6	\$3.3	\$9.9
United States	\$5,104.8	\$12,415.4	\$4,063.4	\$21,583.5