The Economic Impact of the Biodiesel Industry on the U.S. Economy

Study for:

National Biodiesel Board
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Research and analysis to inform your business decisions

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Introduction

For this study, our goal is to evaluate the economic impacts of the biodiesel sector on the U.S. economy. We address the impact under a range of scenarios, including assessing the economic impact if domestic production increased to four billion gallons[1]. For the purposes of this study, the term "biodiesel" refers to both traditional Fatty-Acid Methyl Esters (FAMEs) as well as Hydrotreated Vegetable Oils (HVOs), commonly referred to as renewable diesel.

This study assesses the impact of the biodiesel industry in three ways:

1. **Economic impact**: this measure quantifies the value added to the U.S. economy by the entire biodiesel value chain.

2. **Employment impact**: this measure estimates the number of full-time equivalent (FTE) jobs contributed by production, processing, and distribution of biodiesel and its feedstocks.

3. **Wage impact**: this measure evaluates the total wages for individuals employed along the biodiesel value chain.

These effects are estimated at their annual level, i.e., the value added or jobs created in a given year. These effects are not a one-time event: at a given level of U.S. biodiesel production and consumption, these effects would be applicable every year.

However, we also attempt to quantify:

4. **Temporary impacts**: this evaluates the impact on the economy, employment and wages from the construction of new biodiesel facilities. This is a one-time effect.

Note: The model uses 2018/19 market conditions to generate the estimates.

Summary of total impact

Based on 2018 production and use in the United States:

- The sector generated **$17.0 billion in total U.S. economic impact, 65,600 U.S. jobs, and $2.5 billion in wages paid**.
- If all 2.5 billion gallons had been produced in the U.S., the total economic impact would have increased to $19.5 billion (an increase of $2.5 billion compared with the 13% import share, supporting 75,500 jobs (an increase of 9,900), and $2.9 billion in wages paid (an increase of $0.4 billion).

[1] This scenario assumes that installed capacity increases to five billion gallons, while utilization increases to 80%.

Our next scenario estimates the impact of U.S. biodiesel supply of **3.0 billion gallons** (with the share of domestic production/imports at 87% vs. 13%):

- This scenario generates $20.4 billion in total U.S. economic impact, 79,400 U.S. jobs, and $3.0 billion in U.S. wages paid.
- If all 3.0 billion gallons were produced domestically, the effects would increase to $23.4 billion in total economic impact (an increase of $3.0 billion compared with the 13% import share), supporting 91,400 jobs (an increase of 12,000), and $3.5 billion in wages paid (an increase of $0.5 billion).

We include two further scenarios, with **3.5 and 4.0 billion gallons of supply**, respectively. These scenarios estimate the impact if U.S. production/imports are maintained at an 87%/13% split and, alternatively, if production is 100% within the U.S.:

- As well as the higher value added and jobs created, in order to accommodate this additional production, **new biodiesel facilities would need to be built**.
- This would create as many as 90,800 temporary jobs, $3.6 billion in temporary wages paid, and $3.4 billion in temporary economic activity.

Key Findings

The economic benefits contributed by the biodiesel sector to the U.S. economy are significant, *even under the weight of continuing low commodity prices*.

For 2018, assuming approximately U.S. production of 2.18 billion gallons and imports of 0.33 billion gallons, in line with actual figures from 2018:

- The biodiesel sector will provide **$17.0 billion in economic activity** to the U.S. economy.
- The biodiesel sector will sustain **65,600 jobs** and will support **$2.5 billion in wages paid**.

Most of the value-added activity associated with imported biodiesel takes place overseas and, therefore, on a per-gallon basis, the economic impacts of domestic biodiesel production greatly exceed those of imported biodiesel. Even if consumption levels remain flat relative to the baseline of 2.5 billion gallons, the potential benefit from shifting to 100% domestic production *could add as much as*:

- $2.5 billion in economic activity
- 9,900 further jobs supported
- $0.4 billion in support to wages paid

The benefits of shifting away from imported biodiesel to 100% domestic production become even greater as the size of the U.S. biodiesel market increases (see Diagram 2 below).

For example, with **4.0 billion gallons of U.S. supply**, shifting supply from 87% domestic production to 100% domestic could support an additional:

- $4.0 billion in economic activity
- 16,100 jobs
- $0.6 billion in wages paid

Table 1: Summary of total impact of biodiesel on the U.S. economy

	Base Scenario	87%/13% Production/Imports			100% Production			
Biodiesel								
U.S. Production (billion gallons)	2.18	2.61	3.05	3.48	2.50	3.00	3.50	4.00
U.S. Imports (billion gallons)	0.33	0.39	0.46	0.52	0.00	0.00	0.00	0.00
Total U.S. Supply (billion gallons)	2.50	3.00	3.50	4.00	2.50	3.00	3.50	4.00
Impacts								
Economic (billion $)	17.0	20.4	23.8	27.2	19.5	23.4	27.3	31.2
Jobs (FTE)	65,600	79,400	93,200	107,100	75,500	91,400	107,300	123,200
Wages (billion $)	2.5	3.0	3.5	4.0	2.9	3.5	4.0	4.6
Increases								
Economic (billion $)					*2.5*	*3.0*	*3.5*	*4.0*
Jobs (FTE)					*9,900*	*12,000*	*14,100*	*16,100*
Wages (billion $)					*0.4*	*0.5*	*0.5*	*0.6*

Notes: (1) This table presents total impact, taking account of direct, indirect & induced effects, using detailed multipliers provided by the U.S. Department of Commerce's Bureau of Economic Analysis.
(2) The Base Scenario reflects the actual market in 2018, based on estimates of FAME biodiesel production from the US. Department of Energy's Energy Information Administration (EIA) and imports from the U.S. International Trade Commission (USITC). The renewable diesel production and import volumes are based on estimates from the U.S. Department of Agriculture (USDA).
(3) FTE = full-time equivalent.

Diagrams 1-6 on the following pages illustrate the results for 87%/13% domestic production/imports vs. 100% domestic production. **The shading in Diagrams 2, 4, and 6 represents the growth potential for the U.S. economy of switching to 100% domestic production.**

Diagram 1: Total economic impact from biodiesel, assuming market is 87% domestic and 13% imported

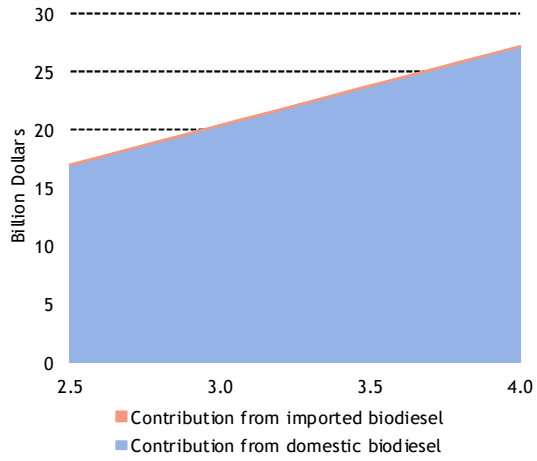


Diagram 2: Potential gains in economic impact, assuming domestic production fills 100% of market need

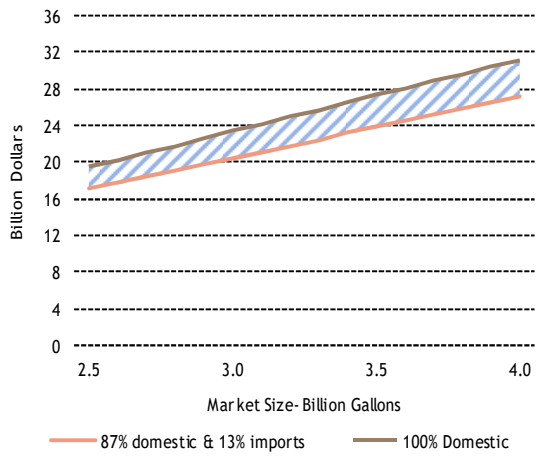


Diagram 3: Total employment impact from biodiesel, assuming market is 87% domestic and 13% imported

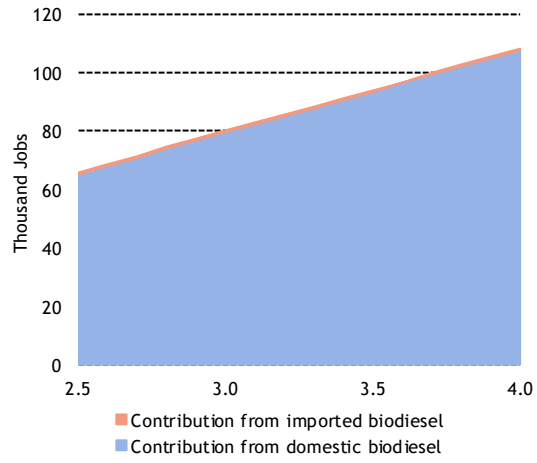


Diagram 4: Potential gains in jobs supported assuming domestic production fills 100% of market need

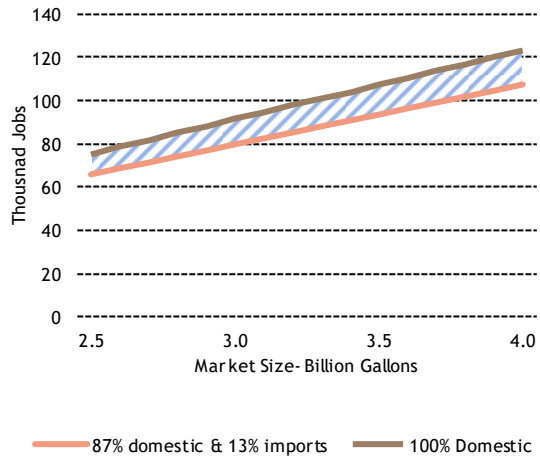


Diagram 5: Total wage impact from biodiesel, assuming market is 87% domestic and 13% imported

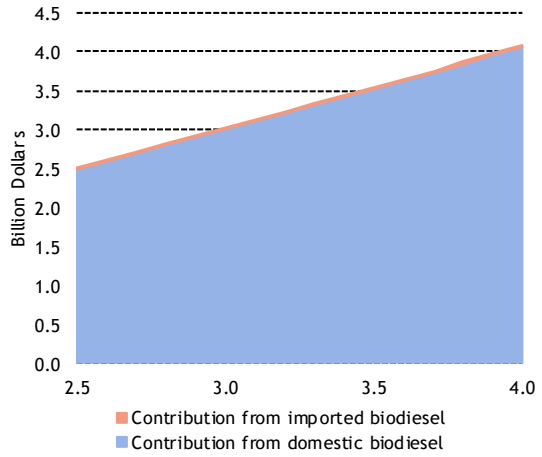
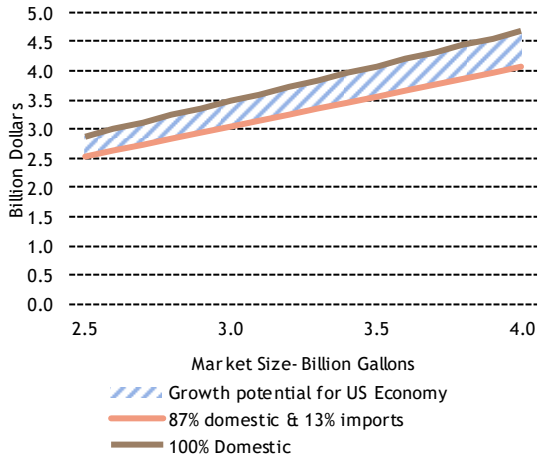


Diagram 6: Potential gains in wages supported assuming domestic production fills 100% of market need



The value chain

We calculate the economic impact of biodiesel on the U.S. economy by looking at its production and distribution. We consider 16 distinct sectors of the value chain, spanning the production, collection and processing of raw materials — oilseeds, animal fats, and waste oils to biodiesel production, distribution, importation and exportation. These steps in the value chain are listed in Table 2, along with a brief description of each.

Biodiesel has a substantial effect across a variety of sectors, but its impact is felt especially in oilseed production, biodiesel processing and manufacturing, animal processing, and transportation.

We have excluded the contribution from meal when evaluating impacts from production of seed, and we have focused only on the *oil* share of value created in oilseed (and inedible oil for corn), given that this is what is used in feedstock.

Table 2: The biodiesel value chain

Seed Production	Value of the oil produced for biodiesel feedstock in seed. (Given that meal is outside the scope of the biodiesel chain, its value is excluded)
Animal processing and waste grease delivery	Processing and rendering of animal carcasses and fats into feedstocks for biodiesel use as well as collection of waste greases
Local seed delivery	Delivery of oil share of seeds used in biodiesel to local elevation facility
Elevation	Elevation and storage of oil component of seed used in biodiesel production
Oilseed crush	Value of removing oil from seed in the crush process for use as a biodiesel feedstock
Feedstock delivery by barge	Long-range delivery of oil share of biodiesel feedstocks by barge
Feedstock delivery by rail	Long-range delivery of oil share of biodiesel feedstocks by rail
Biodiesel processing, with feedstock collection	Collection and processing of feedstocks, including waste greases, into biodiesel
Rail deliveries of domestic Biodiesel used domestically	Rail shipments of domestic biodiesel from surplus to deficit states with most traffic originating in the Midwest
Rail deliveries of glycerin	Rail shipments of domestic glycerin from surplus to deficit states with most traffic originating in the Midwest
Rail deliveries of imported Biodiesel	Rail shipments of imported biodiesel from surplus to deficit states with most traffic originating in Gulf
Rail deliveries of exported Biodiesel	Rail shipments of domestic biodiesel from surplus states to port of export with most traffic originating in the Midwest
Trucking domestic to sale	Trucking of domestically produced biodiesel (mostly blended with conventional diesel) from terminal to dealer outlet
Trucking imports to sale	Trucking of imported biodiesel (mostly blended with conventional diesel) from terminal to dealer outlet
Import port activities	Unloading ocean-going vessels laden with biodiesel imports
Export port activities	Loading ocean-going vessels with biodiesel for shipments to the export market

Using the sectors described in Table 1, the following pages present a series of tables detailing the economic, jobs, and wages impacts associated with biodiesel supply in the U.S.

The effects are presented for each step in the value chain, under the four supply scenarios of:

- 2.5 billion gallons of biodiesel (the Base Case)
- 3.0 billion gallons
- 3.5 billion gallons
- 4.0 billion gallons

The effect of each of these scenarios is calculated twice:

- for a U.S. production/import split of 87%/13%
- for the assumption that 100% of biodiesel is produced domestically.

We also include a table detailing the temporary impacts of constructing the additional biodiesel capacity that would be required to produce 4 billion gallons domestically.

Some of the key results – for the sectors that contribute most to the totals – are summarized below.

For the ***Base Case*** scenario of U.S. biodiesel supply (2.5 billion gallons, where 87% is supplied domestically[2]), the farm-level ***oilseed production sector*** benefits from biodiesel supply to the tune of:

- $5.5 billion in economic impact (more than 30% of the total economic impact of biodiesel)
- 24,700 jobs, 38% of the total
- $950 million, 38% of the total support to wages paid.

This confirms that the oilseed production sector (the farm-level of the value chain) is where a large portion of the value of biodiesel activities is experienced.

Moving along the value chain to the ***processing or crushing of oilseeds***, under the Base Case of 2.5 billion gallons, the U.S. biodiesel industry adds:

- $3.55 billion in economic activity, 21% of the total
- 5,200 jobs, 8% of the total
- $260 million or 10% of wages paid.

Note we focus solely on the oil share of value added for crushing.

Further long the biodiesel value chain, we move to the ***processing of vegetable oils, animal-based feedstocks and waste greases into biodiesel***.

Under the Base Case of 2.5 billion gallons, the U.S. biodiesel industry adds:

- $6.97 billion in economic activity, 41% of the total
- 16,000 jobs, 24% of the total
- $660 million in wages paid, 26% of the total.

[2] Based on estimates of FAME biodiesel production from EIA and imports from USITC, and estimates of renewable diesel production and imports from USDA.

Economic impact

Table 3: Economic activity supported by the U.S. biodiesel sector assuming an 87% /13% split between domestic production and imports, under 2018/19 market conditions

SUPPLY				
(Billion Gallons)	**2.5**	**3.0**	**3.5**	**4.0**
Production	2.18	2.61	3.05	3.48
Imports	0.33	0.39	0.46	0.52
IMPACT				
(Billion Dollars)	**17.0**	**20.4**	**23.8**	**27.2**
Seed Production	5.50	6.41	7.32	8.24
Animal Processing and grease collection	na	na	na	na
Local seed delivery	0.15	0.17	0.19	0.21
Elevation	0.21	0.25	0.29	0.32
Oilseed crush	3.55	4.31	5.07	5.83
Feedstock delivery by barge	0.02	0.03	0.04	0.05
Feedstock delivery by rail	0.08	0.11	0.15	0.18
Biodiesel processing	6.97	8.56	10.15	11.74
Rail deliveries of domestic Biodiesel used domestically	0.28	0.32	0.35	0.38
Rail deliveries of glycerin	0.05	0.06	0.07	0.08
Rail deliveries of imported Biodiesel	0.01	0.01	0.01	0.01
Rail deliveries of exported Biodiesel	0.02	0.02	0.02	0.02
Trucking domestic to sale	0.12	0.12	0.12	0.11
Trucking imports to sale	0.02	0.02	0.03	0.03
Import port activities	0.01	0.01	0.01	0.01
Export port activities	0.00	0.00	0.00	0.00

Table 4: Economic activity supported by the U.S. biodiesel sector assuming domestic production captures 100% market share, under 2018/19 market conditions

SUPPLY				
(Billion Gallons)	**2.5**	**3.0**	**3.5**	**4.0**
Production	2.50	3.00	3.50	4.00
Imports	0.00	0.00	0.00	0.00
IMPACT				
(Billion Dollars)	**19.5**	**23.4**	**27.3**	**31.2**
Seed Production	6.18	7.23	8.28	9.33
Animal Processing and grease collection	na	na	na	na
Local seed delivery	0.16	0.18	0.21	0.23
Elevation	0.24	0.28	0.33	0.37
Oilseed crush	4.06	4.94	5.81	6.69
Feedstock delivery by barge	0.03	0.04	0.05	0.06
Feedstock delivery by rail	0.1	0.14	0.18	0.22
Biodiesel processing	8.16	9.98	11.81	13.64
Rail deliveries of domestic Biodiesel used domestically	0.31	0.34	0.38	0.41
Rail deliveries of glycerin	0.05	0.07	0.08	0.09
Rail deliveries of imported Biodiesel	0.00	0.00	0.00	0.00
Rail deliveries of exported Biodiesel	0.02	0.02	0.02	0.02
Trucking domestic to sale	0.12	0.12	0.11	0.11
Trucking imports to sale	0.00	0.00	0.00	0.00
Import port activities	0.00	0.00	0.00	0.00
Export port activities	0.00	0.00	0.00	0.00

Employment impact

Table 5: Jobs supported by the U.S. biodiesel sector assuming an 87% /13% split between domestic production and imports, under 2018/19 market conditions

SUPPLY				
(Billion Gallons)	**2.5**	**3.0**	**3.5**	**4.0**
Production	2.18	2.61	3.05	3.48
Imports	0.33	0.39	0.46	0.52
IMPACTS				
(Total Jobs)	**65,600**	**79,400**	**93,200**	**107,100**
Seed Production	24,700	29,800	35,000	40,100
Animal Processing and grease collection	11,800	15,900	20,100	24,200
Local seed delivery	1,000	1,300	1,600	1,900
Elevation	2,400	3,100	3,900	4,600
Oilseed crush	5,200	6,400	7,500	8,700
Feedstock delivery by barge	900	1,300	1,600	1,900
Feedstock delivery by rail	300	400	500	600
Biodiesel processing	16,000	17,600	19,300	20,900
Rail deliveries of domestic Biodiesel used domestically	1,300	1,400	1,400	1,500
Rail deliveries of glycerin	300	300	400	500
Rail deliveries of imported Biodiesel	0	0	0	0
Rail deliveries of exported Biodiesel	200	200	200	200
Trucking domestic to sale	1,100	1,200	1,400	1,500
Trucking imports to sale	300	200	200	200
Import port activities	100	100	100	200
Export port activities	0	0	0	0

Table 6: Jobs supported by the U.S. biodiesel sector assuming domestic production captures 100% market share, under 2018/19 market conditions

SUPPLY				
(Billion Gallons)	**2.5**	**3.0**	**3.5**	**4.0**
Production	2.50	3.00	3.50	4.00
Imports	0.00	0.00	0.00	0.00
IMPACTS				
(Total Jobs)	**75,500**	**91,400**	**107,300**	**123,200**
Seed Production	28,500	34,400	40,300	46,200
Animal Processing and grease collection	14,900	19,700	24,400	29,200
Local seed delivery	1,200	1,500	1,900	2,200
Elevation	2,900	3,800	4,700	5,500
Oilseed crush	6,100	7,400	8,700	10,000
Feedstock delivery by barge	1,200	1,600	1,900	2,300
Feedstock delivery by rail	400	500	600	700
Biodiesel processing	17,200	19,100	21,000	22,900
Rail deliveries of domestic Biodiesel used domestically	1,400	1,400	1,500	1,500
Rail deliveries of glycerin	300	400	500	600
Rail deliveries of imported Biodiesel	0	0	0	0
Rail deliveries of exported Biodiesel	200	200	200	200
Trucking domestic to sale	1,200	1,400	1,500	1,700
Trucking imports to sale	0	0	0	0
Import port activities	0	0	0	0
Export port activities	0	0	0	0

Wage impact

Table 7: Wages supported by the U.S. biodiesel sector assuming an 87% / 13% split between domestic production and imports, under 2018/19 market conditions

SUPPLY				
(Billion Gallons)	**2.5**	**3.0**	**3.5**	**4.0**
Production	2.18	2.61	3.05	3.48
Imports	0.33	0.39	0.46	0.52
IMPACTS				
(Billion Dollars)	**2.5**	**3.0**	**3.5**	**4.0**
Seed Production	0.95	1.15	1.35	1.55
Animal Processing and grease collection	0.36	0.49	0.62	0.74
Local seed delivery	0.04	0.05	0.07	0.08
Elevation	0.10	0.13	0.17	0.20
Oilseed crush	0.26	0.31	0.37	0.43
Feedstock delivery by barge	0.02	0.02	0.03	0.04
Feedstock delivery by rail	0.01	0.01	0.01	0.01
Biodiesel processing	0.66	0.72	0.79	0.86
Rail deliveries of domestic Biodiesel used domestically	0.03	0.03	0.03	0.03
Rail deliveries of glycerin	0.01	0.01	0.01	0.01
Rail deliveries of imported Biodiesel	0.00	0.00	0.00	0.00
Rail deliveries of exported Biodiesel	0.00	0.00	0.00	0.00
Trucking domestic to sale	0.05	0.05	0.06	0.07
Trucking imports to sale	0.01	0.01	0.01	0.01
Import port activities	0.01	0.01	0.01	0.01
Export port activities	0.00	0.00	0.00	0.00

Table 8: Wages supported by the U.S. biodiesel sector assuming domestic production captures 100% market share, under 2018/19 market conditions

SUPPLY				
(Billion Gallons)	**2.5**	**3.0**	**3.5**	**4.0**
Production	2.50	3.00	3.50	4.00
Imports	0.00	0.00	0.00	0.00
IMPACTS				
(Billion Dollars)	**2.9**	**3.5**	**4.0**	**4.6**
Seed Production	1.10	1.33	1.56	1.79
Animal Processing and grease collection	0.46	0.60	0.75	0.90
Local seed delivery	0.05	0.07	0.08	0.10
Elevation	0.13	0.16	0.20	0.24
Oilseed crush	0.3	0.36	0.43	0.49
Feedstock delivery by barge	0.02	0.03	0.04	0.04
Feedstock delivery by rail	0.01	0.01	0.01	0.02
Biodiesel processing	0.71	0.78	0.86	0.94
Rail deliveries of domestic Biodiesel used domestically	0.03	0.03	0.03	0.03
Rail deliveries of glycerin	0.01	0.01	0.01	0.01
Rail deliveries of imported Biodiesel	0.00	0.00	0.00	0.00
Rail deliveries of exported Biodiesel	0.00	0.00	0.00	0.00
Trucking domestic to sale	0.05	0.06	0.07	0.07
Trucking imports to sale	0.00	0.00	0.00	0.00
Import port activities	0.00	0.00	0.00	0.00
Export port activities	0.00	0.00	0.00	0.00

Temporary economic impacts

According to EPA, the biodiesel capacity at registered facilities in the United States was 4.1 billion gallons in 2018. This implies a recent utilization rate of less than 60%. As demand rises, so will utilization rates. We judge 80% capacity utilization to be a realistic longer-term rate, as the EU's well-established biodiesel sector runs at about 80%. Therefore, to accommodate increased domestic production up to 4.0 billion gallons, we expect that an additional 900 million gallons of capacity will have to be installed. We have assumed greenfield construction, especially in view of the number of impending greenfield projects for renewable diesel, but we note that industry expansion can, and probably will, occur through individual plant expansions as well.

- This would create as many as 90,800 temporary jobs, $3.6 billion in temporary wages paid, and $3.4 billion in temporary economic activity.

Table 9: U.S. biodiesel capacity utilization and temporary economic impacts associated with new capacity construction

Production			
Billion Gallons	**3.0**	**3.5**	**4.0**
Total Capacity	4.48	4.76	5.00
Capacity Utilization	67.0%	73.5%	80.0%
Additional Capacity Built	0.38	0.66	0.90
Total Temp Construction Job-Years Created	38,200	66,800	90,800
Total Temp Construction Wages Created (billions)	1.5	2.7	3.6
Total Revenues (billions)	1.4	2.5	3.4

The 2018 market conditions underpinning these projections

Subdued prices are a continued theme in agricultural commodity markets (Diagram 7). This weighs on the prices for vegetable oils and oilseeds, which remain near their lowest levels since 2009. When commodity prices move beyond their current lows, we can expect the economic impacts of the biodiesel industry to rise, especially in the farm sector.

The excellent soybean yields achieved by U.S. farmers are a characteristic of the U.S. soy sector. For the purposes of modeling the economic impacts of biodiesel, however, high yields for soybeans, the largest biodiesel feedstock, are something of a double-edged sword. This is because in a high-yielding year, it takes fewer farmers to produce a given unit of soybeans and the soybean oil that goes into biodiesel. If everything else remains as before, this results in lower employment impact, for example.

Diagram 7: Commodity price cycle

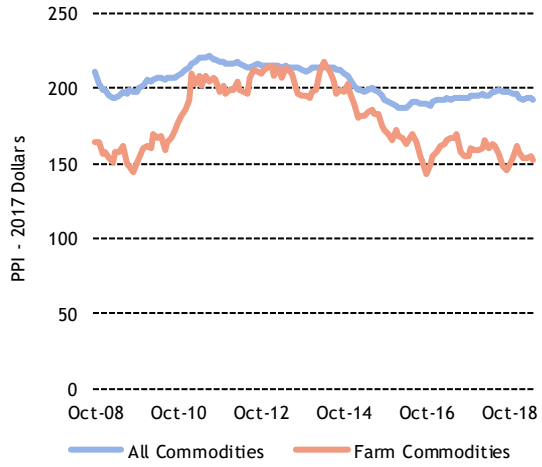
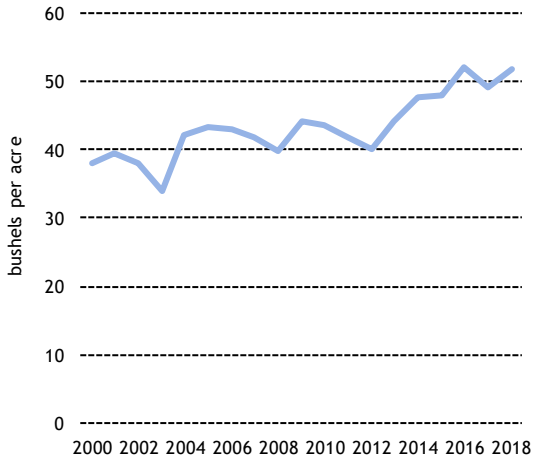


Diagram 8: U.S. soybean yields



Summary of methodology for this study

Our study evaluates the impact of biodiesel in the U.S., including both domestic production and imports, across the value chain via three different measures:

1. **Economic impact**
2. **Employment impact**
3. **Wage impact**

The economic indicators for each step of the biodiesel value chain are evaluated at three different levels, ***Direct***, ***Indirect***, and ***Induced:***

- ***Direct effects:*** These are the economic, employment, and wage impacts that can be directly attributed to the biodiesel value chain. These results have been calculated by LMC International, using models populated with data from public and private sources, our in-house industry knowledge and databases, and interviews with industry stakeholders. The direct effects of biodiesel on the U.S. economy are significant, but they fail to capture the full impact of the sector. There is a "ripple" effect that the biofuel industry has on supporting industries. We term these the "indirect" effects.
- ***Indirect effects:*** These are the economic, employment, and wage impacts created by those industries that supply the biodiesel value chain, or by individuals who work at the periphery of the sector. For some steps in the biodiesel value chain, the indirect effect can be quite large. This is especially true for capital-intensive aspects of the sector like oilseed crushing and crude oil refining. To illustrate this point, consider the typical biodiesel facility in the U.S., with an average capacity of 40-60 million gallons annually, which *directly* employs between 40 and 50 people (although there is considerable variation across the capacity and staffing rates of the country's 100+ operational facilities). *This does not include the many jobs associated with keeping that facility operational*, from white collar jobs in engineering to the work of trade professionals like electricians, plumbers, and pipefitters, which is done on a contractual basis, making the true impact of that facility much higher.

- ***Induced Effects:*** Direct effects also fail to capture the economic activity stemming from expenditures of households drawing a salary from a given sector. In our case, employees in the biodiesel value chain spend their income in the wider economy, generating value added and jobs. We term these the "induced" effects, the economic, employment, and wage impacts that stem from household spending of the income earned from the biodiesel sector. While these induced effects are typically smaller than indirect effects, they can still constitute a sizeable benefits, particularly when the sector being evaluated is large, as is the case for biodiesel.

Use of multipliers to evaluate indirect and induced impacts

To capture indirect and induced effects, economists use multipliers, which are developed from "input-output" tables and measure the impact on the broader economy from some kind of exogenous shock to a specific sector of the economy. Because input-output tables and economic multipliers are the convention when estimating indirect and induced effects, they are available for many economies globally. In the case of the United States, multipliers are made available by the U.S. Department of Commerce's Bureau of Economic Analysis across 406 detailed industries and, in most cases, by state.

Table 10 presents the most important multipliers used in this study, along with the industry classification NAICS code. To capture indirect and induced effects, these multipliers are applied to the direct effects that LMC has calculated.

Our results in this report are presented in terms of Total Effects, which are the sum of direct, indirect, and induced effects.

Table 10: Effective multipliers (state-weighted averages) used to calculate results for this study

		TOTAL = Direct+Indirect+Induced		
NAICS	**Codes & Activities**	**Economic**	**Employment**	**Wage**
31122A	**Crushing**	2.79	5.96	4.28
311225	**Refining**	2.67	5.00	4.06
482000	**Rail**	1.93	3.97	2.50
31161A	**Animal Processing**	na	4.30	4.09
1111C0	**Oilseed Farm**	2.08	3.26	3.19
484000	**Trucking**	2.14	2.41	2.20

Estimating impacts at various levels of production and imports

After calculating direct impacts based on 2018/19 market conditions and applying multipliers to estimate *total* impacts, the next step for this study was to estimate impacts at various levels of production and imports. For most steps within the value chain, with feedstock production being a good example, the relationship between production and economic impacts would be linear, which we have modeled accordingly.

However, for some categories, notably oilseed and biodiesel processing, there are clearly economies of scale at the factory level.

Approach to estimating renewable diesel volumes

LMC previously used RIN data from EMTS to calculate implied renewable diesel production volumes as a function of consumption and imports. However, our phone interviews raised concerns that the RIN-derived methodology sometimes produces misleading results. This is because some RINs become retired or separated and thus do not necessarily indicate consumption accurately.

Following discussions, LMC carried out further research to make an informed judgment on the reliability of the RIN-derived methodology. As part of this research, we analyzed California's consumption data in detail, since the state publishes its own HVO consumption numbers, thus allowing for cross-comparison.

California, with its significant premium for HVO, would be expected to attract the vast majority of HVO. However, when comparing the "implied HVO consumption using RINs" with California's published consumption figures, there seemed to be an unrealistically high amount of renewable diesel being consumed in other states. For this reason, along with the concerns raised in the telephone interviews, we decided to switch to USDA data, which recently began publishing renewable diesel volumes. USDA uses trade data for renewable diesel from the DOE and EIA, and production data derived from industry contacts.

Accounting for the difference in prices between renewable diesel and biodiesel

Renewable diesel is currently sold at a premium to FAME biodiesel in the U.S. However, unlike biodiesel prices, renewable diesel prices are not widely published. Therefore, in order to capture the higher margins from renewable diesel production, we calculated the implied prices for renewable diesel using the annual financial reports of the leading producers, and adopted this as a proxy for U.S. market prices of renewable diesel.

However, the full effect of higher prices does not feed into the processing margin because renewable diesel requires more feedstock per unit of diesel produced. While biodiesel (FAME) uses one unit of feedstock for almost one unit of diesel production, renewable diesel requires approximately 1.2 units of feedstock for a given unit of diesel production. These differences in efficiency, along with the differences in by-product production have been captured in the model.

Estimating the added jobs derived from renewable diesel production

Renewable diesel production is more complex than biodiesel production due to the greater number of chemical processes required. In order to manage these chemical processes, renewable diesel plants typically employ more workers than comparable biodiesel plants. Discussions with senior representatives of renewable diesel plants in the U.S. allowed us to formulate estimates for the added jobs that derive from renewable diesel production, and factor these into the model.