The Offsetting Impact of Expanded Biomass Based Diesel Production on Diesel Prices

Prepared by:
John Kruse, PhD
Principal, WAEES

World Agricultural Economic and Environmental Services

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Over the course of 2021 and 2022, various companies announced plans to expand renewable diesel production capacity by over 7.4 billion gallons. The capacity expansion includes 2.7 billion gallons from conversion of existing oil refineries and 4.7 billion gallons from new construction. Expanded renewable diesel supply will help compensate for the idled petroleum refining capacity and moderate diesel fuel prices. Biomass-based diesel production reduces #2 diesel prices because it increases the supply of diesel fuel.

The Impact of Biomass-Based Diesel Production on Diesel Prices

Growth in the biomass-based diesel industry has occurred due to the Environmental Protection Agency's (EPA's) expansion of volume obligations in both the advanced and biomass-based diesel categories as outlined in the Renewable Fuel Standard. Biofuels, and particularly advanced biofuels such as biomass-based diesel, significantly reduce carbon emissions relative to petroleum fuels. These higher carbon emissions of petroleum-based fuels create a negative externality cost to society that is not reflected in petroleum prices resulting in overconsumption of petroleum fuels and significantly higher carbon emissions.

Since biofuels, and particularly advanced biofuels, produce lower carbon emissions, they are generally more expensive to produce than petroleum fuels and subsequently require policy backing to support their use by consumers. For biomass-based diesel the combination of biodiesel blenders' credit and the RIN price compensates biomass-based diesel producers for the extra cost of production.

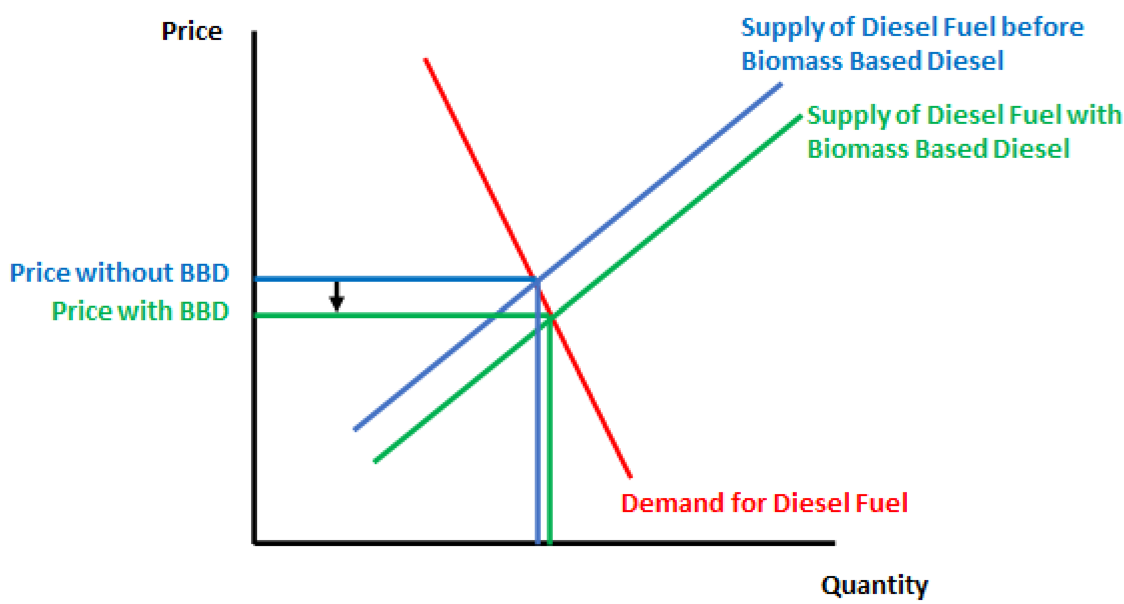
Despite being policy driven, biomass-based diesel is clearly additive to the supply of #2 diesel fuel available both in the US and globally. This additional supply reduces the price of #2 diesel fuel. How much the additional supply reduces the price of #2 diesel fuel depends upon the price elasticity (responsiveness) of demand. The steeper the demand line, the more inelastic the demand is, meaning that even small changes in supply will have a large impact on price. As the diagram below illustrates, the policy driven increase in the supply of diesel fuel including biodiesel results in a drop in the price of #2 diesel.

The demand line pictured in the diagram has a fairly steep slope, meaning diesel demand is fairly unresponsive to changes in diesel price (inelastic). A product is considered to be inelastic when the percentage change in quantity is smaller than the percentage change in price.

There is considerable literature for studies that have estimated the price elasticity of diesel fuel demand with respect to diesel fuel prices. These studies agree that diesel fuel price elasticity of demand is less than 1 in absolute value, and in the short to medium term (next 10 years), is likely less than 0.5 in absolute value. One of the most extensive studies was conducted in 2012 by Carol Dahl[1] which documents diesel and gasoline price elasticity of demand estimates for over 120 countries in the world. Weighting these elasticity estimates by the diesel fuel consumption in each country results in a global weighted average of -0.23 based on the country elasticities reported by Carol Dahl. In the short to medium term, not only is the diesel fuel price elasticity of demand inelastic, it is very inelastic. This implies that even small changes in the supply of diesel fuel will result in relatively larger changes in the diesel fuel price.

More recently, Edelenbosch[2] et al. measured the price elasticities of fuel demand across several different types of models. Presumably, these models were estimated or derived based on actual data, so the elasticities are still relevant. The authors document transport energy elasticities ranging from 0 to -0.4 in 2030 (short to medium run) across the various models.

Dahl's article mentions that long-run fuel elasticities as measured by dynamic models may be 60 to 100 percent higher than short-run elasticities. Even if these elasticities were 100 percent higher, Dahl's elasticity would become -0.46, suggesting a long-run impact of -21 cents (-$0.21 per gallon).



[1] [1] Dahl, Carol A. "Measuring global gasoline and diesel price and income elasticities" Energy Policy, Volume 41, February 2012.
[2] Edelenbosch, O.Y., van Vuuren, D.P., Bertram, C., Carrara, S., Emmerling, J., Daly, H., Kitous, A., McCollum, D.L., Failali, N. Saadi. "Transport fuel demand responses to fuel price and income projections: Comparison of integrated assessment models" ScienceDirect, volume 55, pp 310-321, March 2017.

Analysis Methodology

Petroleum and petroleum products are globally traded with a high degree of transparency and arbitrage that keep port prices consistent with transportation costs, tariffs, and other factors. As such, changes in supply and demand in one region of the world or country affect all other regions. Therefore, in order to determine the impact of biomass-based diesel on #2 diesel prices, we must consider the quantity of biomass-based diesel consumed relative to global consumption of diesel plus biomass-based diesel.

We derive the price impact from the formula for elasticity:

$$elasticity = \frac{\%\,\Delta\ in\ price}{\%\,\Delta\ in\ quantity}$$

In this analysis, we know the value for % increase (Δ) in quantity equals the quantity of biomass-based diesel consumed divided by the global consumption of diesel plus biomass-based diesel. From other studies, we have a measure of the elasticity.

Therefore, we can derive the percentage change (Δ) in price as:

$$\%\,\Delta\ in\ price = \frac{\%\,\Delta\ in\ quantity}{elasticity}$$

Results

The table below shows the derived impact on #2 diesel prices from the introduction of biofuels into the global market over the 2010 to 2021 period. Using the Dahl elasticities, the global impact of biomass-based diesel on #2 diesel prices in the short to medium run varies from year to year ranging from a decline of 8 percent to nearly 19 percent.

The table also shows the impact from US production only. If only the United States had produced biomass-based diesel, diesel prices would have declined between 1 and 4 percent across the estimation period.

Using Dahl's elasticities, world #2 diesel consumption, and world biomass-based diesel production, the impact on global #2 diesel prices vary from -$0.19 to -$0.48 per gallon depending on the price of #2 diesel, the quantity of biomass-based diesel produced, and the quantity of distillate fuel oil consumed.

Analysis of the Impact of Biomass Based Diesel Production on Diesel Fuel Prices

Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	billion gallons											
Distillate fuel oil and biodiesel used by the transportion sector*												
World	259.2	268.1	274.6	279.7	287.0	294.2	299.0	305.5	312.9	315.4	291.1	306.6
United States	42.1	43.3	41.4	42.6	44.5	45.2	44.8	45.1	47.3	48.9	44.4	45.2
Biomass based diesel consumption**												
Methyl Ester Biodiesel												
World	4.8	6.2	6.4	7.2	7.9	7.5	9.0	9.2	9.8	10.8	10.7	11.1
United States	0.3	0.9	0.9	1.4	1.4	1.5	2.1	2.0	1.9	1.8	1.9	1.6
Renewable Diesel												
World	0.1	0.2	0.7	1.1	1.2	1.4	1.5	1.6	1.6	2.1	2.3	2.9
United States	0.0	0.1	0.1	0.3	0.3	0.4	0.5	0.4	0.5	0.8	0.8	1.2
Energy Equivalence with #2 Diesel Fuel***	ratio											
Methyl Ester Biodiesel	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Renewable Diesel	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biomassed Based Diesel Consumption in Diesel Energy Equivalent												
Methyl Ester Biodiesel	billion gallons											
World	4.49	5.79	5.93	6.67	7.36	6.96	8.39	8.55	9.16	10.07	9.93	10.30
United States	0.24	0.81	0.84	1.33	1.32	1.39	1.92	1.82	1.76	1.68	1.73	1.53
Renewable Diesel												
World	0.12	0.24	0.75	1.05	1.22	1.39	1.45	1.58	1.58	2.07	2.35	2.87
United States	0.01	0.08	0.08	0.32	0.28	0.38	0.46	0.45	0.48	0.75	0.81	1.24
	ratio											
Global Short to Medium Diesel Alternative Price Elasticiti	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23
Biomass Based Diesel Impact on Diesel Fuel Prices	percent											
Total global biomass based diesel production	-7.8%	-9.9%	-10.7%	-12.2%	-13.2%	-12.5%	-14.5%	-14.6%	-15.1%	-16.9%	-18.6%	-18.9%
From only US biomass based diesel production	-0.4%	-1.5%	-1.5%	-2.6%	-2.5%	-2.7%	-3.5%	-3.3%	-3.2%	-3.4%	-3.9%	-4.0%
	US dollars per gallon											
Without Biomass Based Diesel (counter factual)												
#2 Petroleum Diesel Wholesale (Refiner Sales Price)	2.40	3.37	3.48	3.45	3.25	1.91	1.61	1.98	2.51	2.36	1.58	2.53
#2 Petroleum Diesel Retail	3.18	4.17	4.34	4.34	4.25	2.95	2.54	2.94	3.56	3.46	2.84	3.77
With Biomass Based Diesel (Actual)***												
#2 Petroleum Diesel Wholesale (Refiner Sales Price)	2.22	3.04	3.11	3.03	2.82	1.67	1.38	1.69	2.13	1.96	1.29	2.05
#2 Petroleum Diesel Retail	2.99	3.84	3.97	3.92	3.83	2.71	2.30	2.65	3.18	3.06	2.55	3.29
Price Increase without biomass based diesel												
#2 Petroleum Diesel Wholesale (Refiner Sales Price)	0.19	0.33	0.37	0.42	0.43	0.24	0.23	0.29	0.38	0.40	0.29	0.48
#2 Petroleum Diesel Retail	0.19	0.33	0.37	0.42	0.43	0.24	0.23	0.29	0.38	0.40	0.29	0.48

*Source: US Department of Energy, Energy Information Administration - International Energy Outlook 2021, Transportation sector energy consumption by region and fuel, released October 2021.

** Sources: International data complied from various USDA Gain country reports compiled from 2010 to 2022, Eurostat, and US methyl ester data based on Energy Information Administration monthly reports and renewable diesel estimates from the US EPA's EMTS.

*** Source: Based on EIA Conversions and the Alternative Fuels Data Center - Fuel Properties Comparison.

**** Source: Author calculations based on Carol A. Dahl's article entitled, "Measuring global gasoline and diesel price and income elasticities", Energy Policy, Volume 41, February 2012.

***** Source: US Department of Energy, Energy Information Administration, Monthly Energy Review, February 2022.