# California Low Carbon Fuel Standard (LCFS)
# Analysis of Quarterly Summary: 4th Quarter 2018
# May 14, 2019

**In this quarterly edition…**

- ⇒ Surprising slight net positive balance in the credit bank for 4Q2018.
- ⇒ Renewable diesel was the star performer with growth in biodiesel also contributing.
- ⇒ Deficits decline in Oregon Clean Fuels Program.

The Stillwater LCFS Quarterly Newsletter presents our analysis of the credit and deficit data from the LCFS Reporting Tool and Credit Bank & Transfer System (LRT-CBTS). The LRT-CBTS is the repository of the LCFS transaction and credit/deficit data input by Regulated Parties (RP). The California Air Resources Board (CARB) uses this data to publish its LRT Quarterly Summary. Analysis of the data provides insight into the trends of credit and deficit generation, the trends in low carbon intensity (CI) fuel use, and potential future trends.

The fourth quarter of 2018 logged a surprising 66,815 MT (0.07 million MT) net credit, following a third quarter net deficit of nearly 340,000 MT and four straight quarters of a net deficit trend. Note that Low Complexity/Low Energy Use Refinery credits for 2018 are not yet included, so the actual net credits will be higher when these credits are posted. If the 2017 Low Complexity/Low Energy Use Refinery credits are repeated for 2018, that represents about 144,000 MT of additional credits for the year. CARB also includes the following in their report: “Please note that these figures are subject to change as regulated parties may correct their quarterly data.”

In this issue, we look at the LCFS credit and deficit trends, fuel volume trends, the contribution of alternative and renewable fuels, and the CI trends for ethanol and bio/renewable diesel through the fourth quarter of 2018. In our LCFS Quarterly Highlight we provide an analysis of the surprising net credit balance at the close of the quarter – hint: biodiesel (BD) and renewable diesel (RD) were the star performers. Finally, in a second Quarterly Highlight, we offer insights into the latest trends in Oregon’s Clean Fuels Program (CFP).

**LCFS Credit and Deficit Trends – Fourth Quarter Ends with Surprising Slight Net Credit**

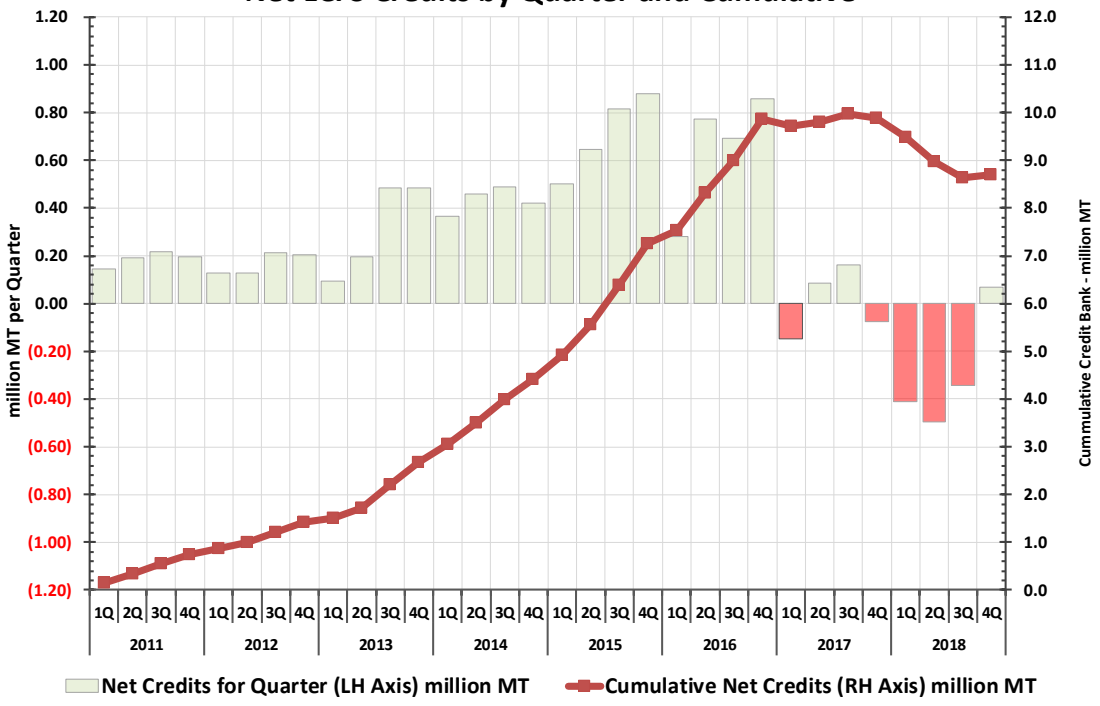
For the fourth quarter, 3.27 million MT of credits were generated compared to 3.20 million MT of deficits, resulting in a 66,815 MT (0.07 million MT) net credit position. This brings the year-end LCFS credit bank balance to 8.70 million MT. The fourth quarter broke the trend of the first three quarters of 2018 which averaged a net deficit postion of 0.42 million MT.

As illustrated in Figure 1, the cumulative credit trend that was upward through 2016, leveled off through 2017 and had become a definitively downward trend in 2018 until the fourth quarter. The credit bank peaked at 9.961 million MT at the end of the third quarter of 2017 and had been trending downward as the LCFS standard has become more stringent.

The cumulative net credits at the close of the fourth quarter represent about 2.7 quarters of the deficits generated by CARBOB and ULSD at their 4Q2018 rate of deficit generation.



**Figure 1**
**Net LCFS Credits by Quarter and Cumulative**



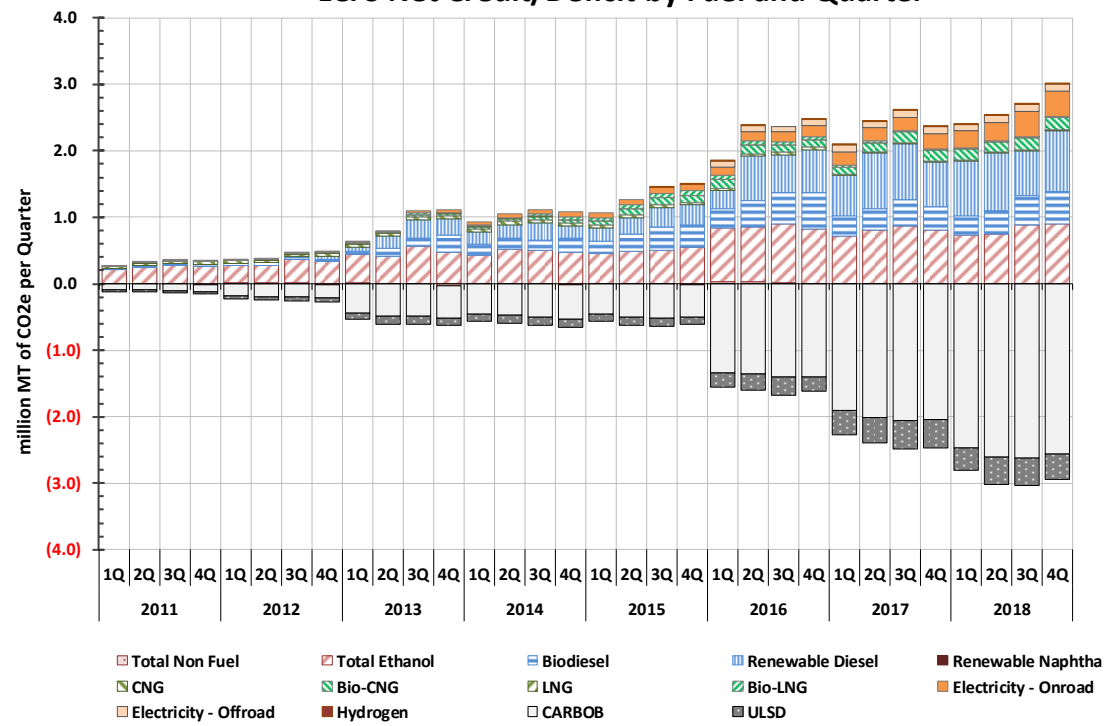
**LCFS Credit/Deficit Trends – Credit Generation Hits Record 3.0 Million MT**

Figure 2 shows the quarterly credits and deficits by fuel category as reported by CARB. Only the gasoline deficits have increased for 2018, since the diesel standard was frozen at 2017 levels until 2019 by a modified writ requiring mitigation of the increased NOx from biodiesel. (Note: The writ has now been discharged, so for 2019 the diesel standard will resume its reduction at 6.25% from the 3.5% where it was frozen.)

The total credits net of any deficits posted for credit-generating fuels reached 3.0 million MT for the quarter. (Note: There were about 0.17 million MT of deficits recorded for Renewable Diesel (RD) and Biodiesel (BD), probably representing revisions to previous transactions.) Compared to the third quarter, there was a significant increase – 0.23 million MT – in the credits from RD, a development which we discuss further in our quarterly highlight article below.



**Figure 2**
**LCFS Net Credit/Deficit by Fuel and Quarter**



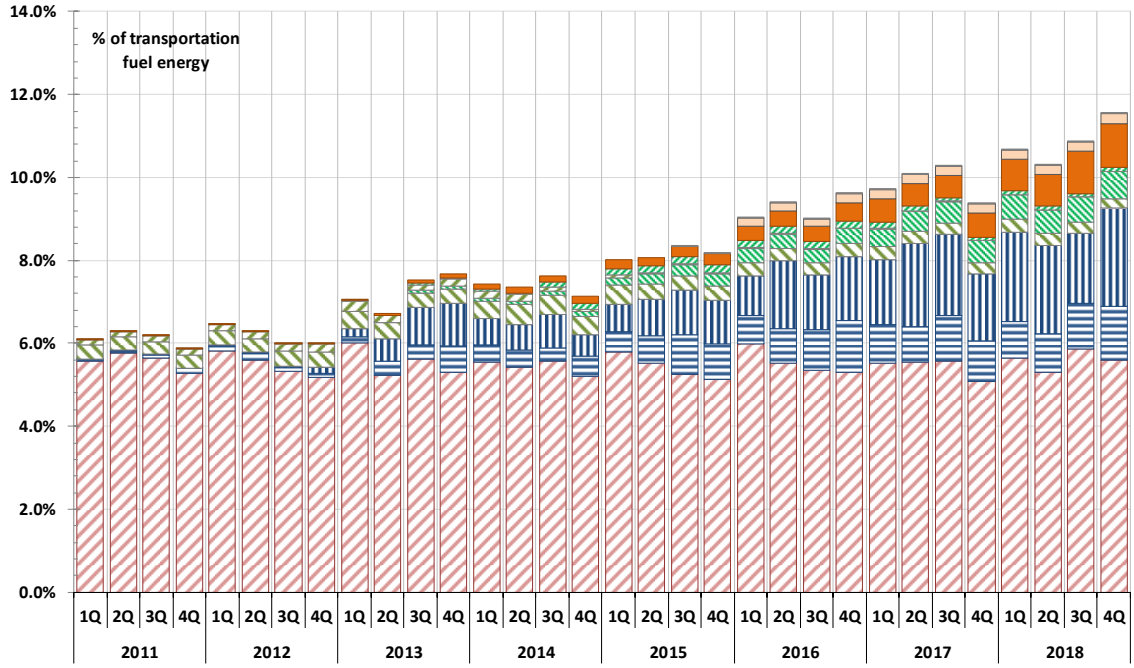
**Fuel Volume Trends – Alternative and Renewable Reach New Record High**

As shown in Figure 3, alternative and renewable fuels jumped in the fourth quarter of 2018 reaching a new high of 11.5% of transportation energy in the fourth quarter of 2018. The total alternative and renewable fuels energy have remained strong after a falloff in the fourth quarter 2017, now resuming their growing percentage of the transportation energy market. While ethanol's contribution to credit generation remains considerable, BD and RD growth are the real stand-outs this quarter. On-road electricity continues to grow as the electric vehicle (EV) fleet grows.



**Figure 3**

**Alternate and Renewable Fuel as % of Transportation Fuel Energy**

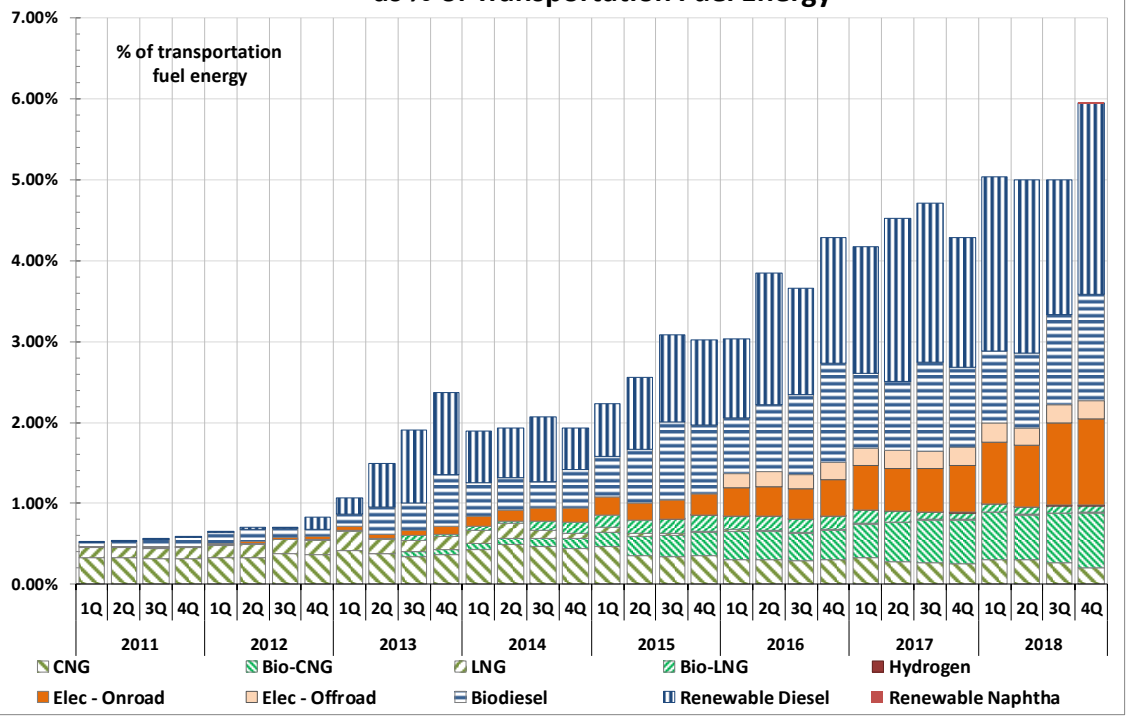


**Alternate and Renewable Fuels Excluding Ethanol – Big Jump in Fourth Quarter**

Since ethanol is essentially capped at 10% of the gasoline volume except for the volume of E85 which has been small to date, volumetric use of ethanol is dependent on gasoline use and should vary little independent of CARB gasoline. Figure 4 shows the contribution that non-ethanol alternative and renewable fuels with growth potential have made to the transportation fuel mix. The total contribution of non-ethanol renewable and alternate fuels skyrocketed to a new high of 5.95% for the fourth quarter of 2018. Electricity's growth continues to make a showing, but BD and especially RD made the largest gains for the quarter. Our quarterly highlight will examine the growth of RD this quarter in more detail.



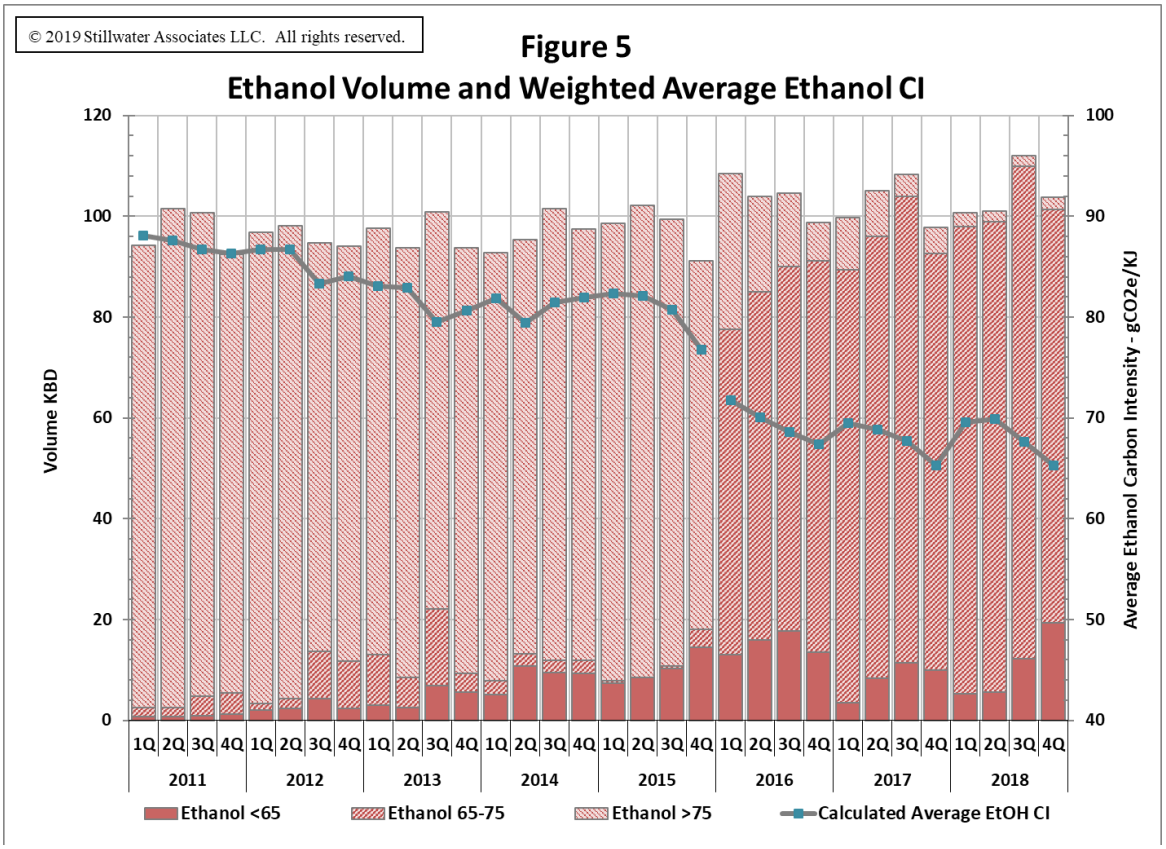
**Figure 4**
**Alternate and Renewable Fuel excluding Ethanol as % of Transportation Fuel Energy**



**Ethanol CI Trend – Small Downward Trend**

Figure 5 shows the trend for the weighted average CI for ethanol. The weighted average CI remains significantly lower than 2015 and earlier, since the 2016 indirect land use change (ILUC) value was changed in the 2015 re-adoption of the LCFS. The weighted average ethanol CI had hovered between 65 and 70 since the second quarter of 2016 with the trend indicating the lowest CI in the fourth quarters. The fourth quarter of 2018 continued this trend with the CI nearing 65. As ethanol is one of the highest-volume renewable or alternate fuels, the CI of ethanol is an important contributor to credit generation.



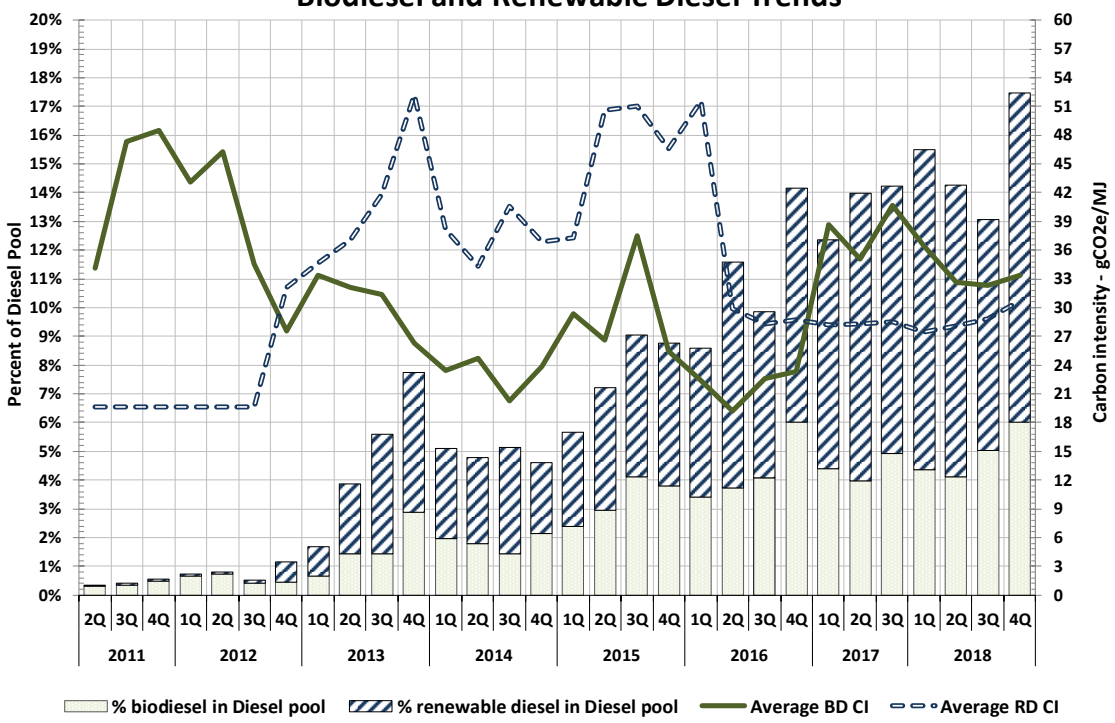


**Biodiesel, Renewable Diesel Shares and CI Trends – BD and RD Reach a Combined 17.5%**

Figure 6 shows the percentage of biodiesel and renewable diesel as a share of the liquid diesel pool (the combined ULSD, BD, and RD pool) and the weighted average CI for each. RD and BD reached a record combined 17.5 volume % of the diesel pool with RD at 11.5% and BD at 6.0% of the diesel pool in the fourth quarter of 2018.



**Figure 6**
**Biodiesel and Renewable Diesel Trends**



**LCFS Quarterly Highlight: Surprise! A Small Net Credit in the Fourth Quarter**

Credit generation jumped in the fourth quarter of 2018 far beyond the trend of the first three quarters, enough to provide a small net credit position of 66,815 MT. All of the renewable and alternate fuels showed increased credit generation, but the prime reasons for the sharp increase in credits was a strong showing by renewable diesel (RD) and small decreases in CARBOB and ULSD deficits. There were big increases in credits from RD, biodiesel (BD), ethanol, and on-road electricity.

Table 1 below compares the volumes and credits for the fourth quarter, sorted by net credits, to the average of the first three quarters, illustrating the percentage changes.

**Table 1. Comparison of Fourth vs First Three Quarters of 2018**

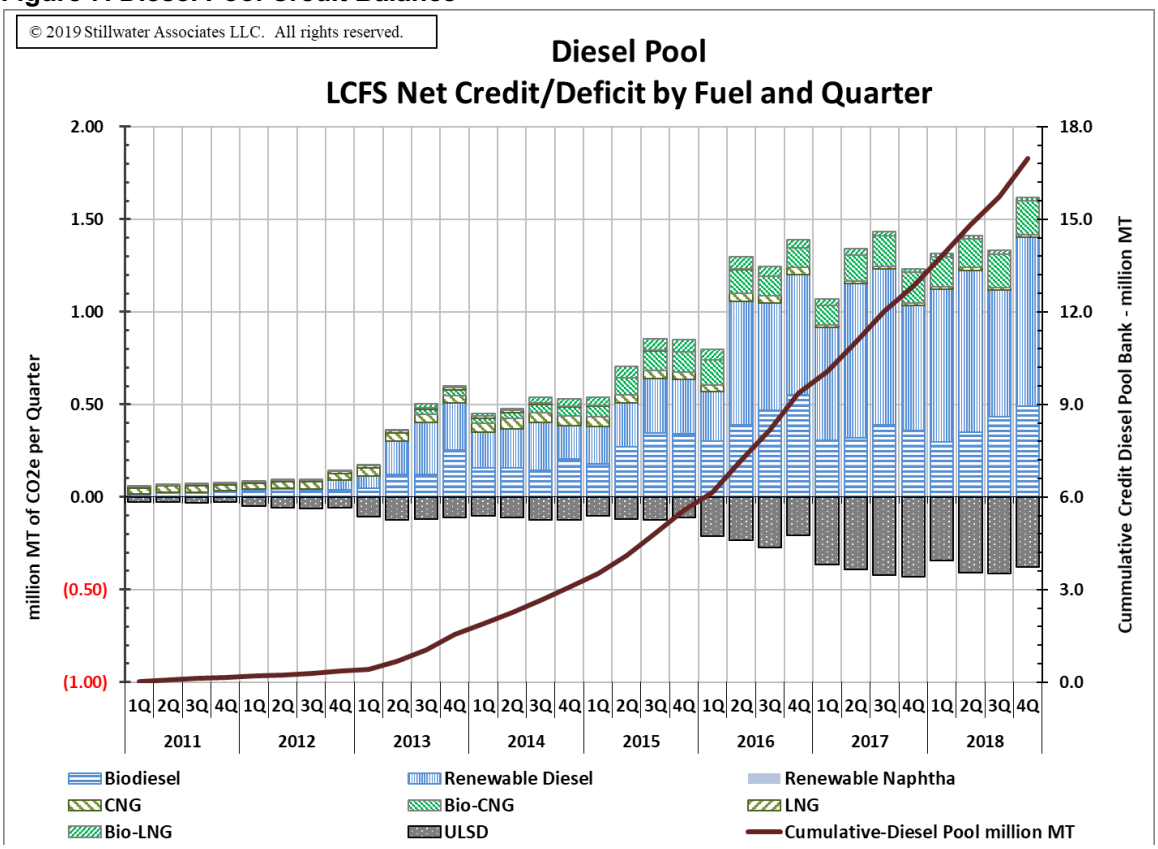
| | CREDITS (million MT per Quarter) | | | VOLUME (million GGE or DGE) | | |
|---|---|---|---|---|---|---|
| **Fuel** | **4Q18** | **4Q18 vs 1Q-3Q18** | ***Change*** | **4Q18** | **4Q18 vs 1Q-3Q18** | ***Change*** |
| Renewable Diesel | 0.913 | 0.121 | *15.2%* | 109.4 | 18.1 | *19.8%* |
| Total Ethanol | 0.904 | 0.118 | *15.0%* | 400.8 | 0.6 | *0.1%* |
| Biodiesel | 0.490 | 0.128 | *35.5%* | 57.3 | 14.8 | *35.0%* |
| Electricity – On-road | 0.377 | 0.077 | *25.7%* | 15.3 | 3.1 | *25.7%* |
| CNG/LNG | 0.215 | 0.017 | *8.3%* | 83.9 | 0.3 | *0.3%* |
| Electricity – Off-road | 0.105 | 0.004 | *3.5%* | 11.3 | 0.3 | *2.7%* |
| Hydrogen | 0.002 | 0.001 | *32.9%* | 0.2 | 0.0 | *31.1%* |
| CARBOB | (2.563) | 0.003 | *(0.1%)* | 3,442.3 | (4.0) | *(0.1%)* |
| ULSD | (0.378) | 0.010 | *(2.6%)* | 787.5 | (20.7) | *(2.6%)* |

Two components of the diesel pool – RD and BD – were big contributors to the jump in credits in the fourth quarter when compared to the first three quarters of 2018. The Stillwater LCFS team has recently received increased inquiries about RD, and with the surprising jump in the fourth quarter RD volume and credits, we thought this would be a good time to dig deeper into RD and the diesel pool. In this highlight, we'll take a look at questions like: What does the liquid diesel pool look like? Where is RD coming from? How much RD will be available in the future? And where is RD headed compared to past projections?

***The Power of the Diesel Pool***

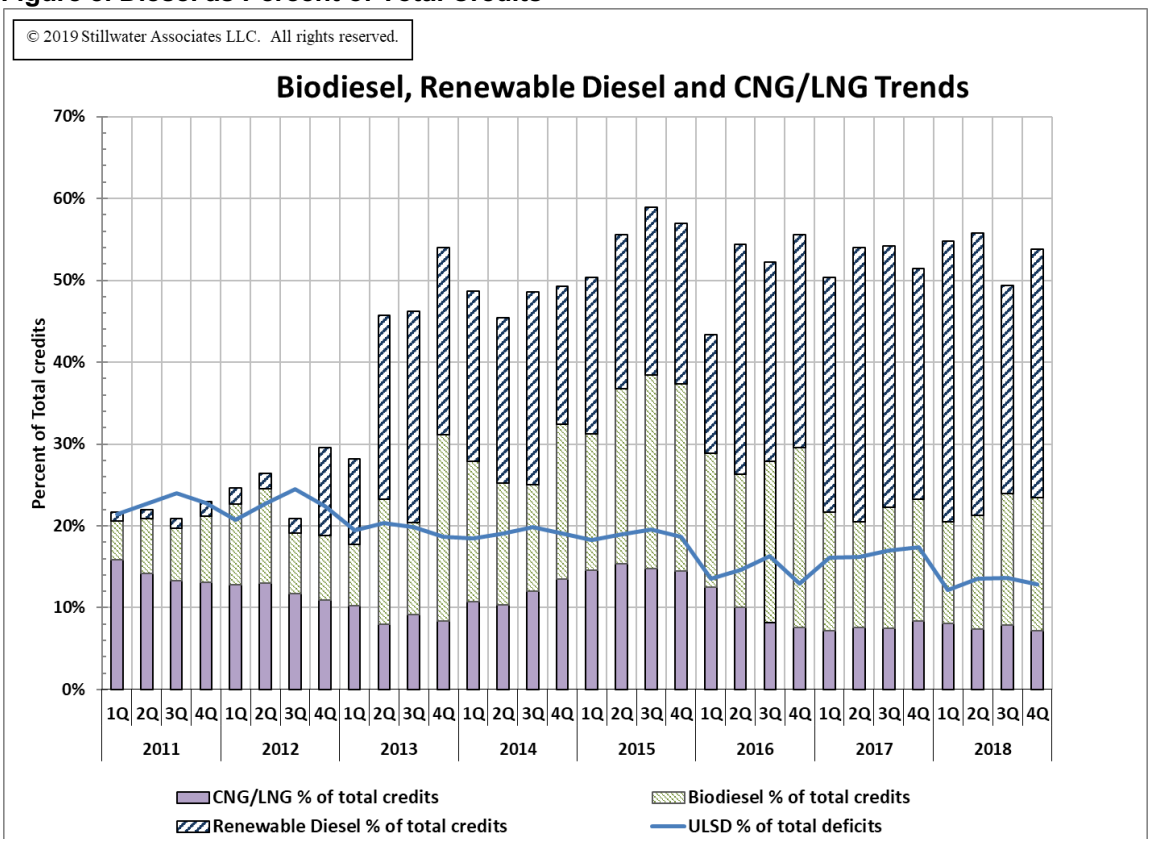
We have noted before and it continues that the diesel pool, diesel fuel, and those fuels and technologies substituting for diesel have contributed a disproportionate share of the LCFS credits. Figure 7 below illustrates the volumes of each of the fuels and the percent CI reduction compared to the 2010 baseline for the diesel pool.

**Figure 7. Diesel Pool Credit Balance**




The diesel pool contributes over half of the credits in the LCFS program and less than 15% of the deficits. RD has done the heaviest lifting to reduce the CI of the diesel pool, followed by BD. Figure 6 above illustrates that combined RD and BD reached a high of 17.5% of the liquid diesel pool in the fourth quarter of 2018. The credits from the diesel pool represent a critical part of LCFS compliance into the future. California uses a large portion of the global RD production while BD is more widely used in the U.S. and globally. As a “drop-in” fuel, widespread RD usage faces far fewer hurdles than BD which has some restrictions because of its different qualities. This “drop-in” status makes RD particularly attractive as a key tool for LCFS compliance.

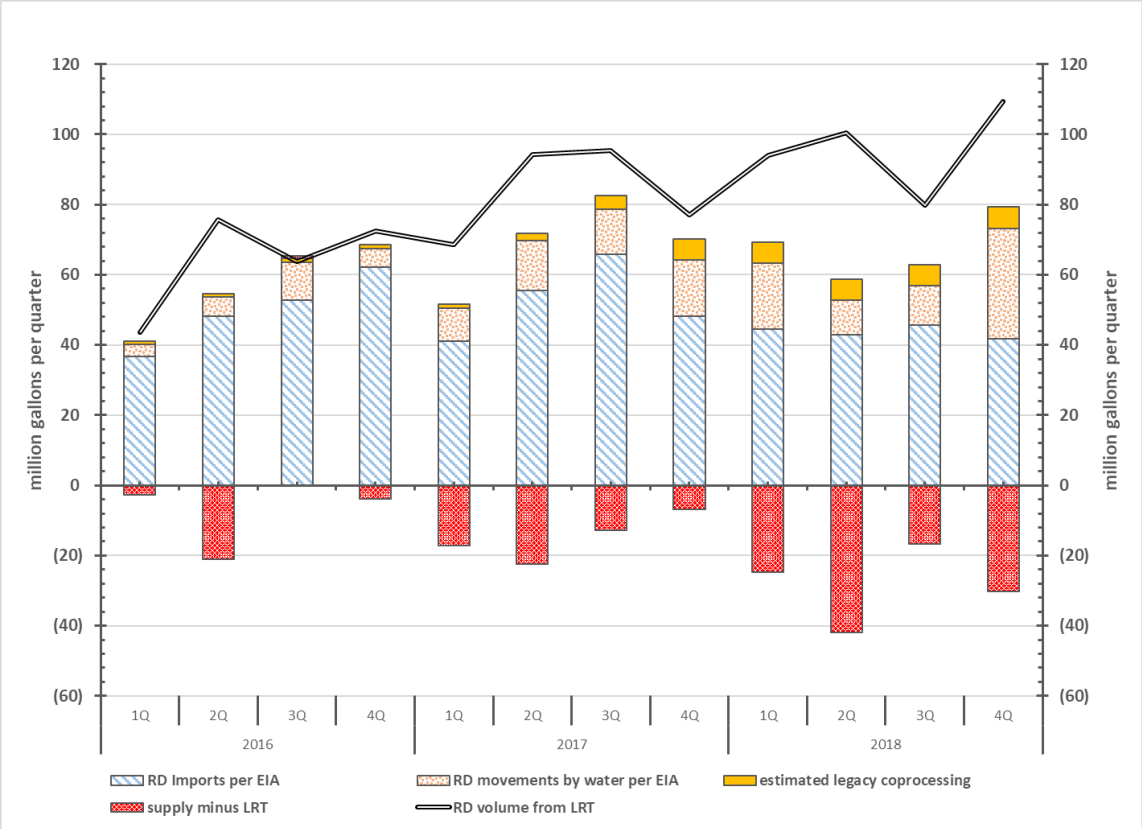
**Figure 8. Diesel as Percent of Total Credits**




***Unaccounted RD Supply?***

We have occasionally tracked the RD volumes from the LRT quarterly data reports and the supply of RD as imports or water movements as reported by the U.S. Energy Information Administration (EIA). By using these sources and our estimate of RD production in California from Kern Refining and World Oil in Paramount, we cannot bring closure to the California RD balance as the volumes in the LRT are significantly higher than what can be accounted for by the EIA data. In 2018, about 28 million gallons per quarter (or about 7,400 barrels per day (BPD)) was unaccounted for. Figure 9 illustrates this analysis of the supply from the data sources and estimated legacy production, and the volumes from the LRT by quarter from 2016.

**Figure 9. Renewable Diesel Supply Compared to LRT Volume**




There are two plausible reasons behind this. First, the missing volume may be delivered by rail. The EIA rail movement data does not capture RD, although BD is captured, so if RD is moving to California by rail it will not be accounted for in the available data. Second, refiners are coprocessing vegetable oils (and the like) with diesel from crude oil in existing hydrotreaters. Rail supply may account for a portion of the unaccounted-for volume but that must be limited as it would require more than ten railcars per day to make up the unaccounted-for volume. So, there must be a considerable amount of coprocessing in refineries beyond the two that are widely known RD producers to balance the RD in California.

***Will there be more RD?***

Renewable Diesel continues to demonstrate its value as a drop-in fuel, generating more LCFS credits than any other fuel. It has similarly proven its value in complying with renewable fuels requirements in the European Union. In response to the demonstrated utility and consequent growing demand, a number of parties are in the process of adding new stand-alone production capacity. Co-processing of vegetable oils in refinery hydrotreaters is also expected to increase in response to growing regulatory requirements, but these increases are less visible.

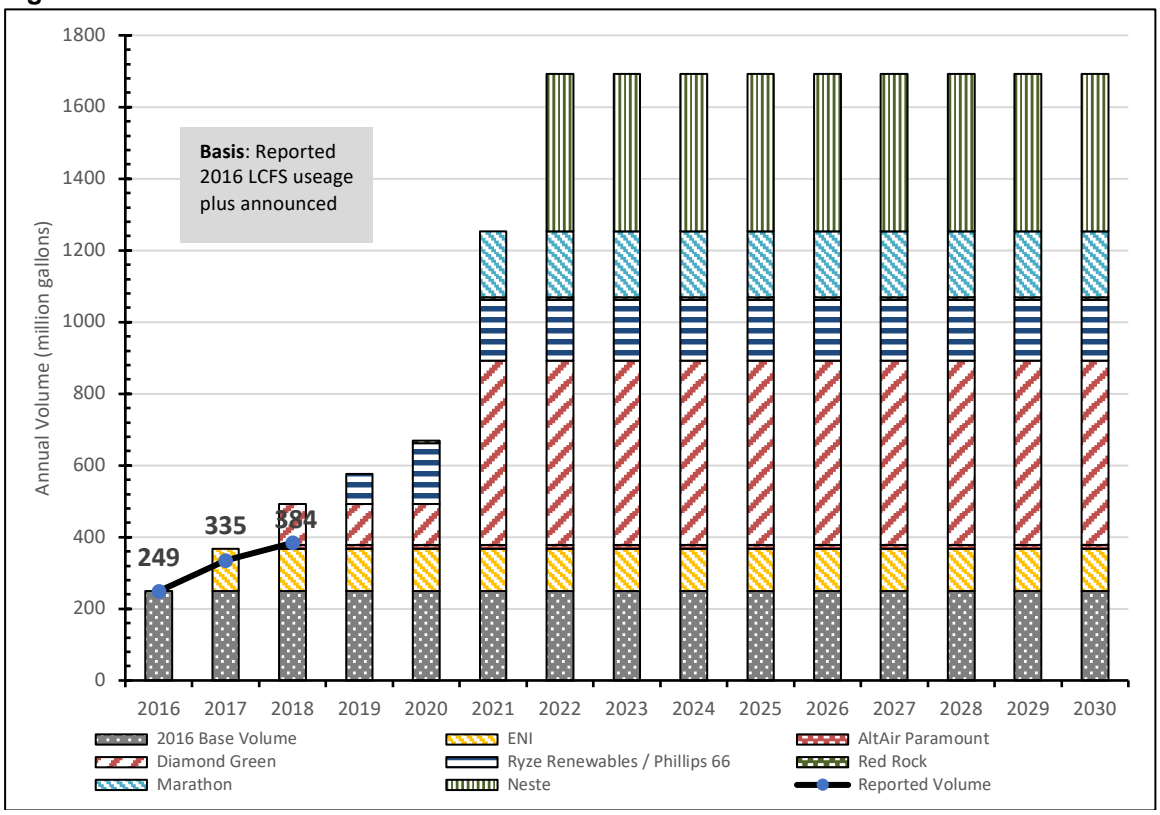
Figure 10 illustrates new and announced stand-alone RD capacity from 2017 onward. While the last announced capacity addition is in 2022, it would be unusual for parties to announce capacity additions further out than that. These capacity additions are added to a base of reported LCFS RD use in 2016.

- **2017** – ENI started up a 119 million gallons per year (mgal/year) unit at its converted refinery in Genoa, Italy. While that plant primarily supplies European markets, this indirectly frees up additional Neste-Singapore production as a supply source for California.

- **2018** – World Oil (formerly AltAir) added a mix of renewable jet and RD production at Paramount, CA, and Diamond Green started up a 115 mgal/year expansion of its Norco, LA plant. Stillwater believes that BP began co-processing of RD at Cherry Point but does not have an estimate of the production volume.
- **2019** – The joint venture of Ryze Renewables and Phillips 66 are expected to start up their new 84 mgal/year unit in Reno, NV.
- **2020** – The Ryze Renewables/Phillips 66 joint venture is expected to start up its second plant in Las Vegas, NV. This plant is expected to also produce 84 mgal/year. Red Rock Biofuels is also scheduled to start up a Fischer-Tropsch plant in Lake County, OR which will use forestry waste as its feedstock and will produce 7.2 mgal/year of RD plus renewable jet and renewable naphtha.
- **2021** – Diamond Green is expected to add a new, 400 mgal/year RD unit at its Norco, LA site. Additionally, Marathon is expected to start-up a 184 mgal/year unit at its Dickinson, ND refinery (which it required through their recent acquisition of Andeavor).
- **2022** – Neste is expected to start up an additional 440 mgal/year of RD capacity in Singapore.
- *In November 2018 Phillips 66 and Renewable Energy Group (REG) announced that they are planning for a "large-scale" RD plant to be located adjacent to the Phillips 66 Ferndale refinery. This potential project is not included in the current calculations as the planned capacity and start-up date have not been announced.*

Cumulatively, these capacity additions, on top of the base volumes, would bring potential RD production available to California to 1,700 mgal/year or 45% of the 2018 California diesel pool of 3,800 million gallons. However, much of the new production is expected to feed growing demand in Europe as well as potential demand from the Oregon Clean Fuels Program (CFP) and potential new low-carbon fuel requirements in Canada, Washington State and other U.S. and global markets. So, while the production side of RD looks good for the LCFS, developments in other markets may provide competition for some of the RD volumes. Also, to the extent that new markets evolve slower than currently anticipated or feedstock supplies are less abundant than currently expected, some of these projects may be delayed or cancelled.

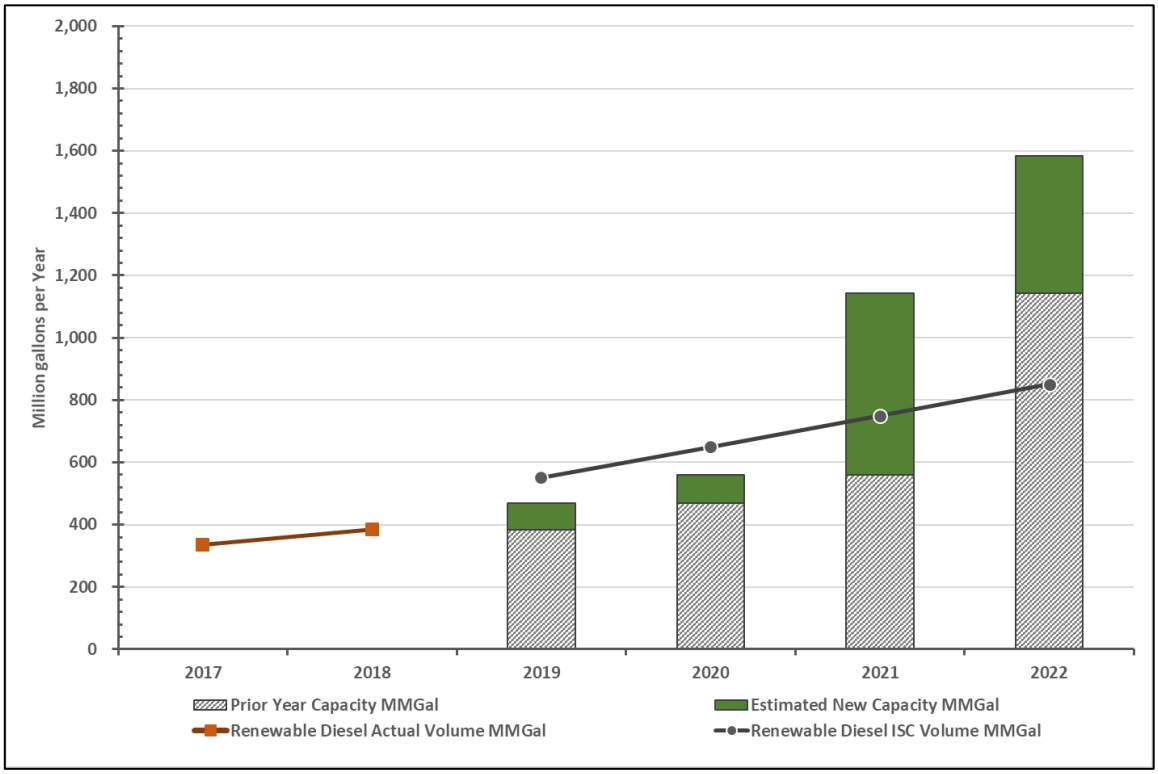
**Figure 10. Potential RD Volume for LCFS**



***How does this compare to the Illustrative Scenario?***
In our second quarter 2018 newsletter we discussed the projections in the Illustrative Scenario Calculator (ISC) to present a view to the future that is based on CARB scenarios. In our second quarter analysis, we noted that the RD volume in the ISC grew to 950 million gallons in 2023. We have recast that information in Figure 11 to compare the 2018 RD volumes as a base plus capacity additions listed above to 2022. As can be seen in the figure, it appears that in 2019 and 2020 there will not be enough RD capacity from identified projects to fulfill the ISC projections. This gap can potentially be filled from currently unidentified refinery co-processing volumes or by bidding away volume currently being supplied to other markets. However, the ISC projection level is exceeded in 2021 if all the projects come online and all the RD volume is directed to California. In fact, the RD capacity could exist by 2022 to meet the ISC projections of 2030.

Given the list of projects that may add to the RD supply, RD will remain an important and growing contributor of LCFS credits.

**Figure 11. Renewable Diesel – Projected Potential Capacity Compared to CARB's Illustrative Scenario**




**STAY TUNED! More to come . . .**
Based on 4Q2018 data, the RD trend is steeply rising. Will that trend last? How much of the listed capacity will come online and when? Will other jurisdictions draw off some RD volumes? Stay tuned as we follow this topic!

**Oregon Clean Fuels Program Quarterly Data Review**

Last quarter we included a highlight in which we reviewed the quarterly data published by the Oregon Department of Environmental Quality (DEQ) on its Clean Fuel Program. We plan to include an update of this analysis in every LCFS Quarterly Newsletter. As shown below in Figure 12, net credits generated in the CFP grew from 24,000 in 3Q2018 to 37,000 in the fourth quarter, continuing the recovery from a small negative balance in the second quarter. This stronger showing is encouraging to program balances going forward as the CI reduction requirement increased from 1% to 1.5% in January of 2019.

**Figure 12. Net Oregon CFP Credits by Quarter and Cumulative**

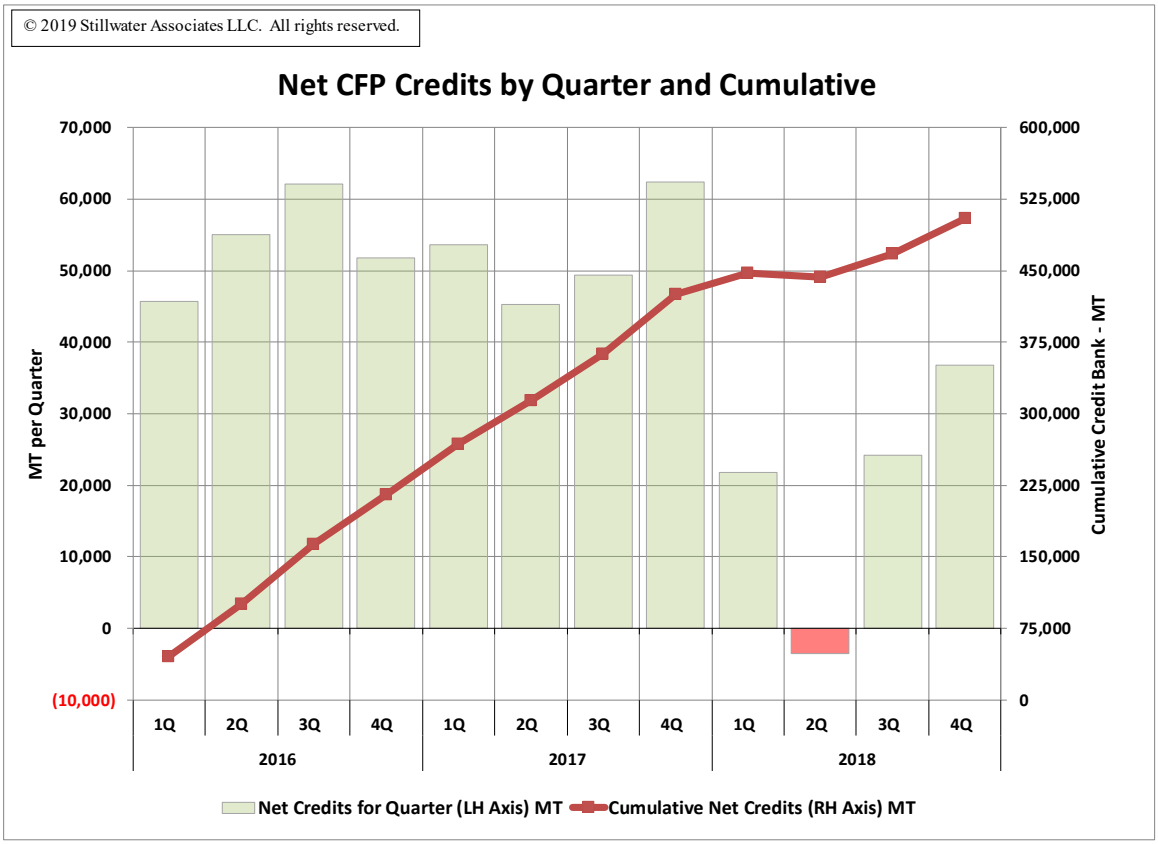
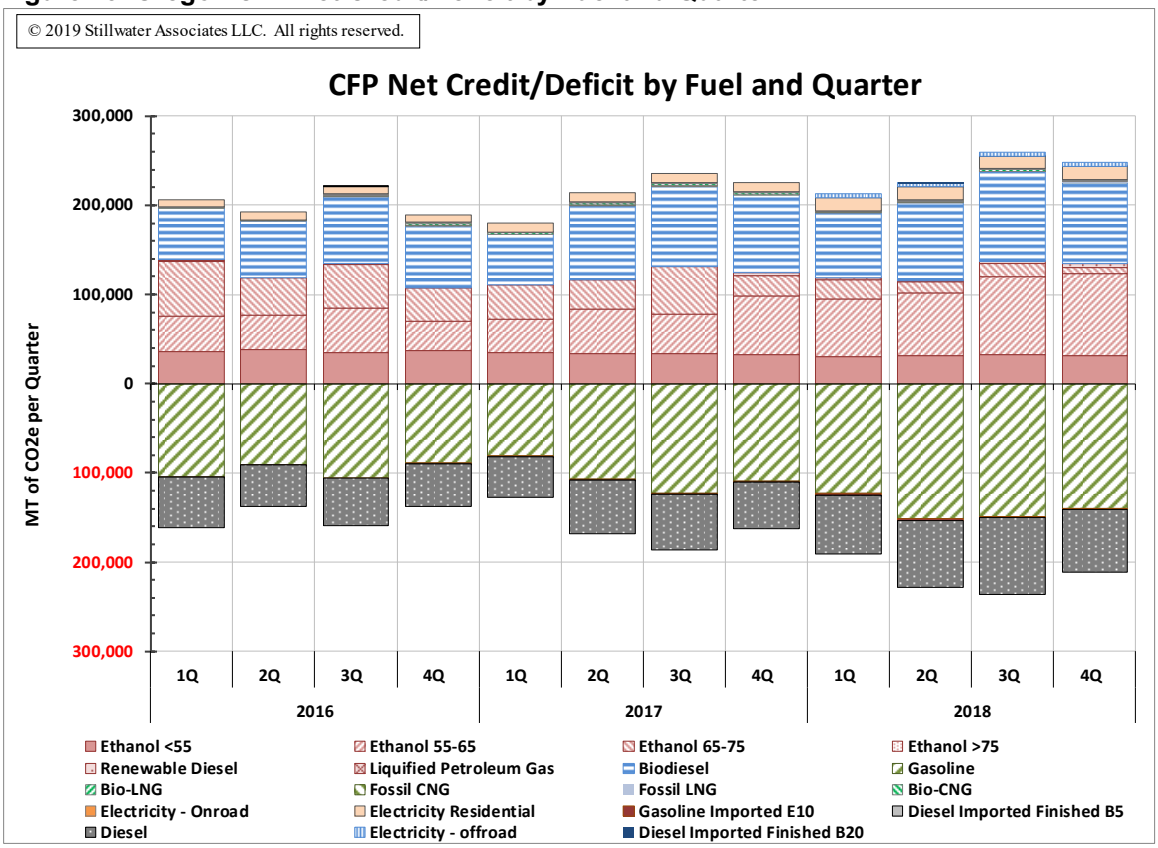


Figure 13 below provides some insight into the improvement – credits generated remained almost flat from the prior quarter while deficits decreased significantly due to seasonal decline in fuel demand. This is positive since both credits and deficits change proportionately with changes in product demand if the distribution of lower carbon fuels remains unchanged.

**Figure 13. Oregon CFP Net Credit/Deficit by Fuel and Quarter**



For a better view of the changes in the fourth quarter, let's look at Figures 14 and 15 which show credit and deficit generation trends for the gasoline and diesel pools, respectively. Figure 14 shows that credits deficits from gasoline declined a bit more than credits, leading to a slight rise in CFP cumulative credits generated in the gasoline pool

**Figure 14. Gasoline Pool CFP Net Credit/Deficit by Fuel and Quarter**

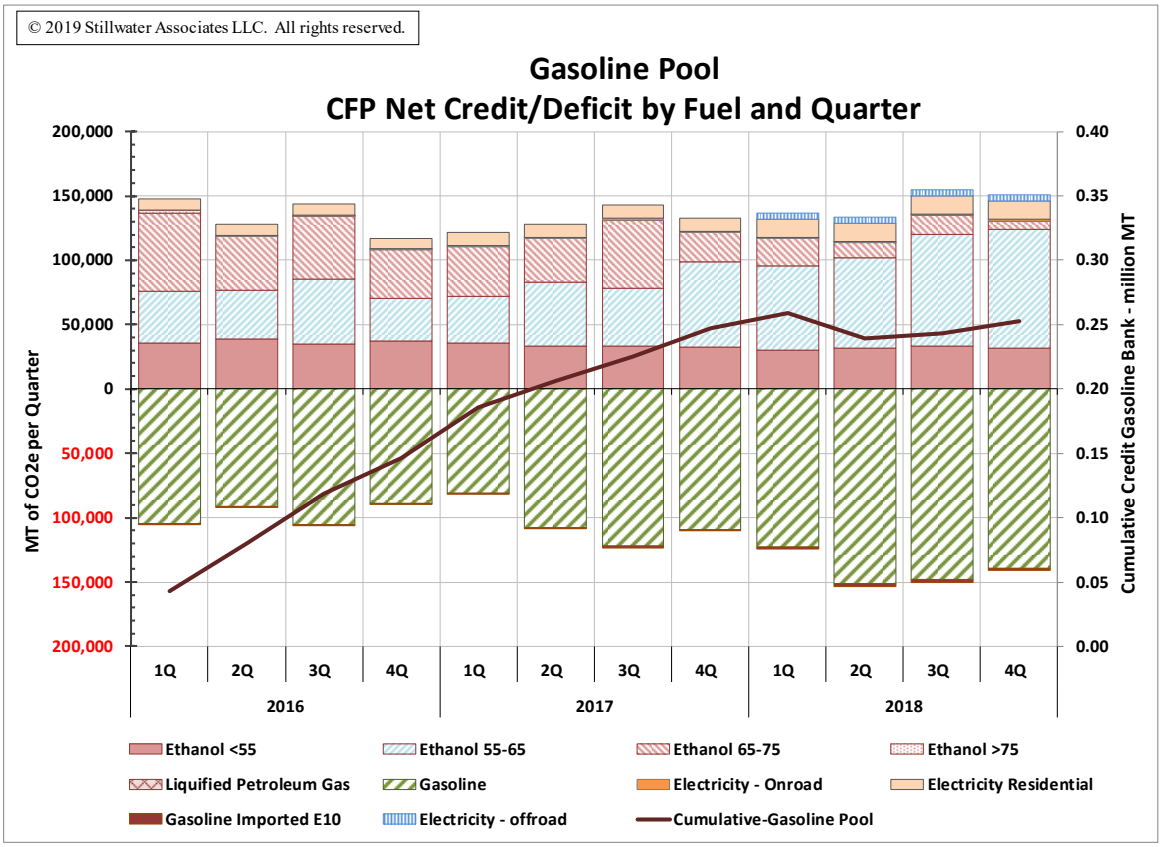


Figure 15 shows Oregon's diesel pool continuing to generate credits in excess of deficits at an almost constant rate since the CFP was initiated. Credit generation declined in the fourth quarter, but not as much as deficits. The vast majority of credits here continue to be generated from biodiesel with very little use of renewable diesel. Clearly, California remains the preferred market for renewable diesel producers.

**Figure 15. Diesel Pool CFP Net Credit/Deficit by Fuel and Quarter**

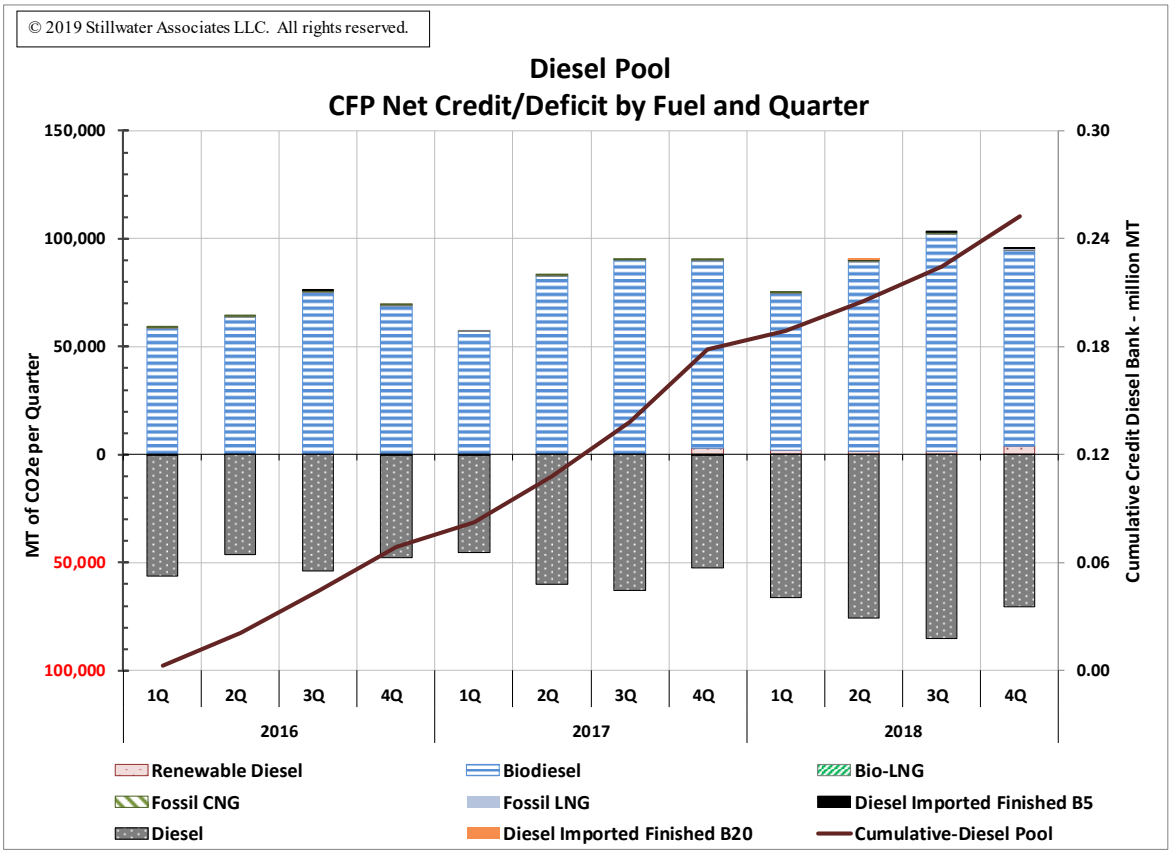


Figure 16 shows that renewable content increased for the second quarter in a row from a low observed in 2Q2018. The level has still not changed significantly over the three years of the program. Increased credit generation is clearly coming from the use of lower-carbon alternatives rather than higher volumes of renewables.

**Figure 16. Alternate and Renewable Fuel as Percentage of Transportation Fuel Energy in the Oregon CFP**

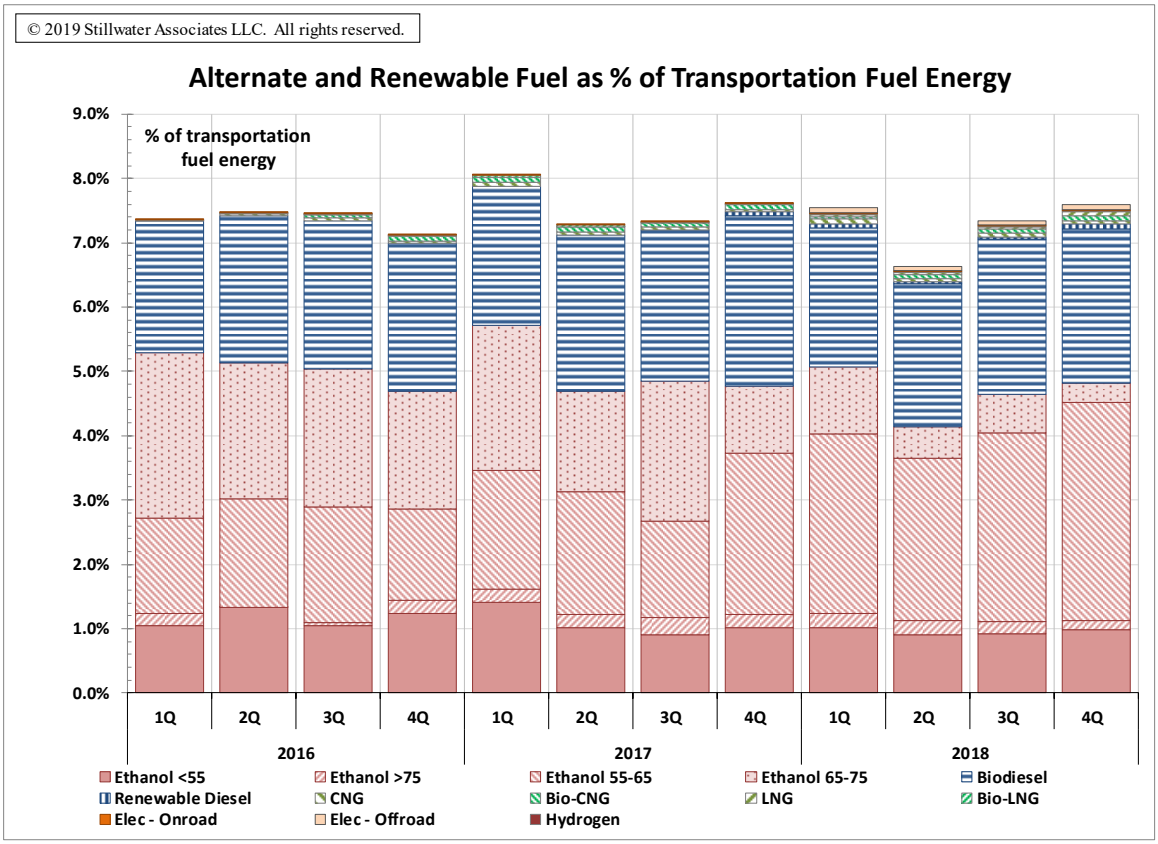
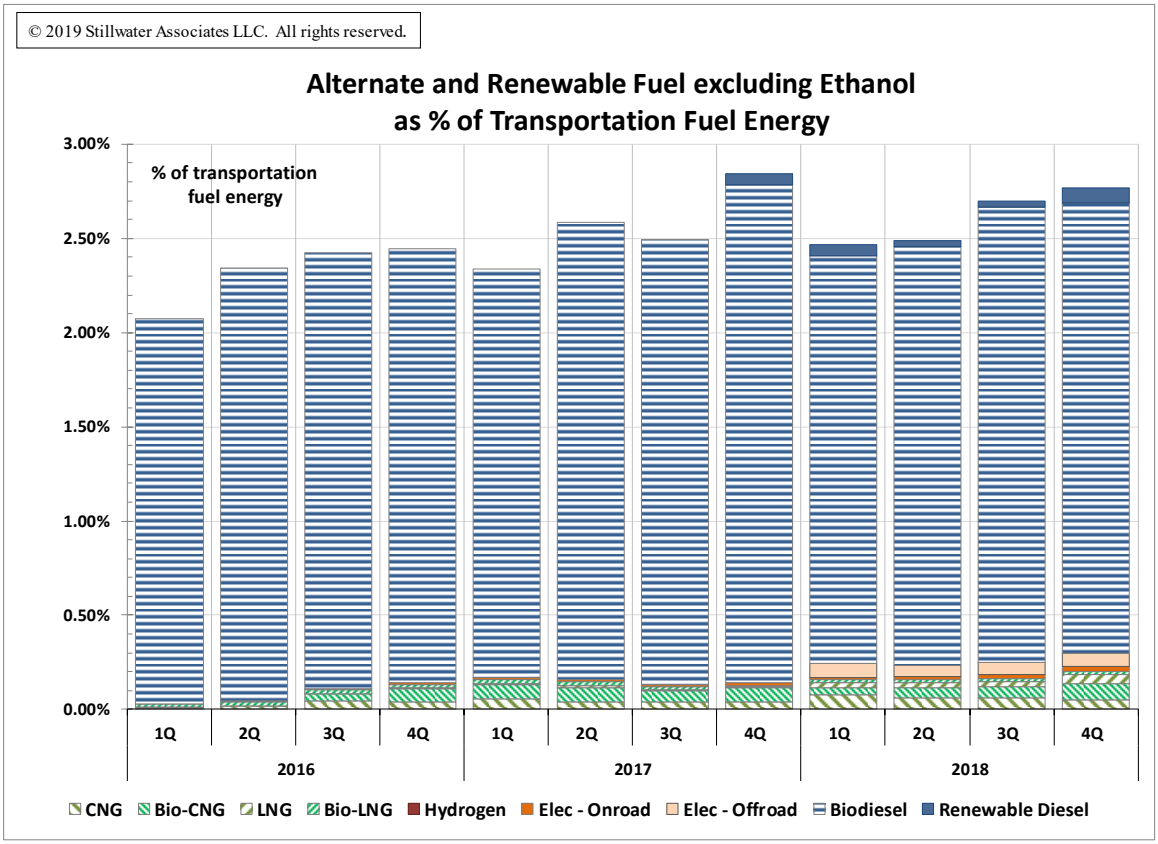


Figure 17 shows a continuation of the small but noticeable trend of increase in non-ethanol alternative fuels. Large fluctuations in ethanol blending (varying from below 9% to above 12% of the gasoline pool) make it difficult to decipher the non-ethanol alternative fuels trend in the prior figure.

**Figure 17. Alternate and Renewable Fuel Excluding Ethanol as Percentage of Transportation Fuel**



**Energy in the Oregon CFP**

Another trend that is important to compliance in the gasoline pool is the average CI of the ethanol blended. Even though the volume of ethanol with a CI under 55 grams per megajoule (g/mj) has been constant, the overall average CI of the pool has been declining for the past year, as depicted in Figure 18. Thus, the additional ethanol blend volume and lower ethanol CI in the third quarter of 2018 both contributed to reversing the negative credit balance from the prior quarter. It is also worth noting that the long-term trend for decreasing ethanol CI from the beginning of the program continues through 2018.

**Figure 18. Average Ethanol CI under the Oregon CFP**

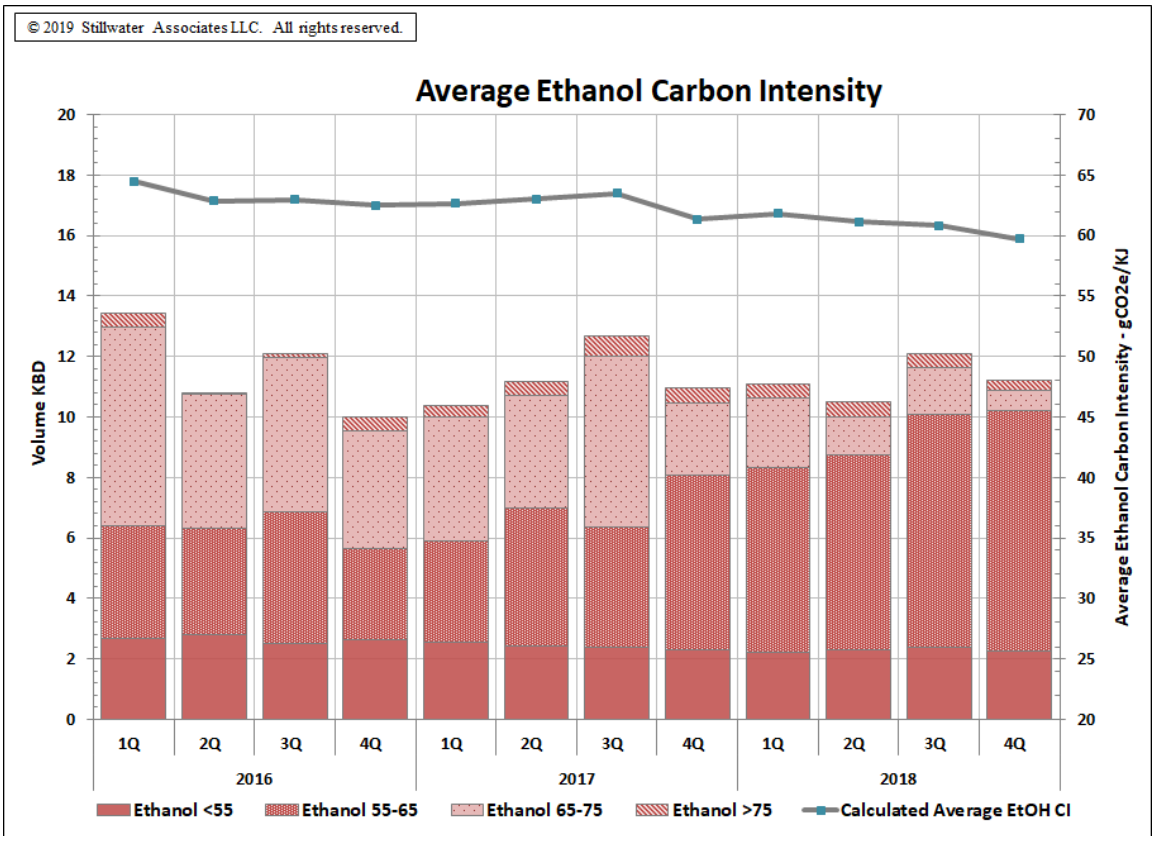
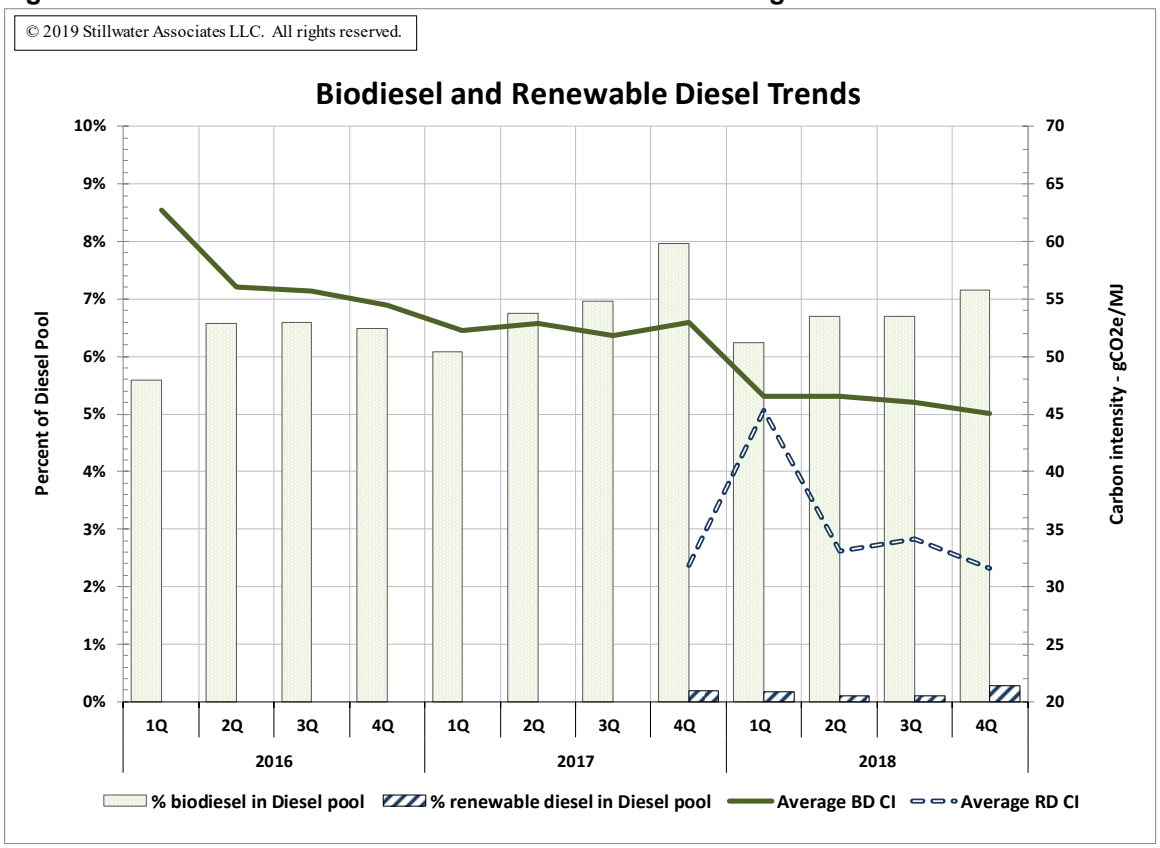


Figure 19 shows the long-term trends of increasing biodiesel content in the diesel pool and decreasing average biodiesel CI. These generally continue into the fourth quarter, along with a small increase in renewable diesel volume. As discussed above, global renewable diesel production is slated to rise in the coming years. It remains to be seen how much of the growth in supply finds its way into Oregon.

**Figure 19. Biodiesel and Renewable Diesel Trends in the Oregon CFP**



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