2024 Clean Fuels Forecast

Background

Oregon Revised Statutes (2017) Chapter 750, Section 163 authorizes the Office of Economic Analysis (OEA), with substantial assistance from the Department of Environmental Quality, to assess the availability of fossil and alternative fuels to Oregon. In particular, the forecast is to determine whether fuel supply will be sufficient to generate the necessary number of carbon reduction credits from alternative fuels (ethanol, electricity, and diesel substitutes - including biodiesel, renewable diesel, natural gas, and propane) to meet the scheduled applicable low carbon fuel standards for the compliance period. The forecast report is required to include an assessment of banked deficits and credits at the beginning of the compliance period.

In preparing the forecast, the Office of Economic Analysis has formed a Clean Fuels Forecast Advisory Committee comprised of relevant experts and stakeholders to assist in reviewing forecast assumptions, as well as methodological considerations and potential data sources. A membership list can be found in Appendix A.

Data Sources

The forecast uses available public and program data to develop the estimates of low-carbon fuels available to Oregon and projected volumes of fossil and alternative fuels in Oregon. The sources of these data include:

- Oregon Fuels Reporting System (OFRS)
- Fuel Pathway Codes (carbon intensity values) approved in Oregon and California
- Oregon Department of Transportation's (ODOT) Revenue Forecast
- Oregon Department of Transportation's Electric Vehicle Forecast
- Annual Energy Outlook and other resources from the US Energy Information Administration
- Trade associations (Renewable Fuels Association and the National Biodiesel Board) on their members' production capacity

Clean Fuels Program 2024 Reported Volumes Forecast

To determine the number of deficits that will be generated in 2024, and thus the amount of credits needed for compliance, a forecast for the volumes reported to the Clean Fuels Program of all relevant fuels is made. The following are the volume projections for each fuel type.

Motor Gasoline

1508.6 million gallons of gasoline, including ethanol, were reported to the program in 2022, the most recent year of data available. ODOT's forecast for gasoline consumption projects a negative 0.8 percent annualized growth from 2022 to the 2024 compliance year, resulting in a projected volume of 1,497.2 million gallons[1]. After subtracting the projected amount of ethanol (see below), the final forecast for conventional gasoline is 1,345.2 million gallons.

[1] The projected growth in Clean Fuels reported gasoline differs due to the inclusion of actuals for 2023 quarter one.

Diesel

According to CFP reported data, 883.6 million gallons of diesel, including bio- and renewable diesel, were reported to the program in 2022, the most recent year of data collected. Growth projections exhibited in the Oregon Department of Transportation's April 2023 forecast anticipate negative 0.2 percent growth annualized from 2022 to 2024[2]. This results in a projected 844.7 million gallons of total diesel. After subtracting biodiesel and renewable diesel (see below), the final forecast for conventional diesel in 2024 is 677.4 million gallons.

Ethanol

The amount of ethanol reported for 2022 equaled 149.7 million gallons. The amount of ethanol projected for 2024 is based on a blend rate assumption driven by historical observations and trends. The latest observation for an ethanol blend rate, for calendar year 2022, was 9.92 percent. Given the passage of House Bill 3051, which allows for blends above 10 percent, the assumption for 2024 is 10.15 percent. This results in a 2024 forecast for reported ethanol of 152.0 million gallons, which is 0.8 percent above the 2022 volume on an annualized basis.

Biodiesel

The reported volume of biodiesel in 2022 amounted to 81.6 million gallons. The amount of biodiesel projected for 2024 is based on a blend rate assumption driven by historical observations and patterns. The biodiesel blend rate is expected to rise from 9.2 percent in 2022 to 9.8 percent for the 2024 compliance period, resulting in a volume projection of 82.8 million gallons. This represents growth of 0.7 percent from the 2022 actual on an annualized basis.

Renewable Diesel

The amount of renewable diesel reported in 2022 was 46.6 million gallons. Similar to biodiesel, the forecast for renewable diesel is driven by the assumption of the fraction of total diesel reported comprised of renewable diesel. The blend rate observed for 2022 in the Clean Fuels data was 5.3 percent. The blend rate is assumed to increase to 10.0 percent in 2024, leading to a forecast for reported renewable diesel of 84.5 million gallons, a 34.6 percent increase from the 2022 value on an annualized basis.

Electricity

Consumption of electricity for on-road vehicles is based on a projection of the number of plug-in hybrid and battery electric vehicles in use for the compliance period. The forecast equals an average of 30,032 Plug-in Hybrids and 73,611 Battery Electric vehicles. Estimates are employed for the average KWh charged per vehicle, both at a residence and at non-residential charging stations. While the former has been relatively constant over time (roughly 8.5 KWh per day), the latter has been increasing as more charging stations have come into existence and trip distances per charge have increased. When converted to gasoline gallon equivalents, the forecast is 11.2 million gallons including residential charging. This equates to a 27.5 percent increase from 2022 on an annualized basis.

For electricity reported for off-road use, simple growth rates are applied to the 2022 reported volume of 6.3 million gallons. At 27.2 percent annualized between 2022 and the 2024 compliance year, this results in a forecast of 10.3 million gasoline gallon equivalents.

[2] The projected growth in Clean Fuels reported dielsel differs due to the inclusion of actuals for 2023 quarter one.

Natural Gas and Liquified Petroleum Gas

The amount of natural gas, including renewable natural gas (biogas), reported in 2022 in gasoline gallon equivalents equaled 4.0 million gallons. Annualized growth from the 2022 base year to 2024 is assumed to be 12.2 percent. This results in a forecast of 5.0 million gallons. The blend rate for renewable natural gas is expected to increase from 94.0 percent in 2022 to 97.5 percent in 2024.

Liquefied Petroleum Gas exhibits the smallest quantity of alternative fuel reported in 2022 at 3.2 million gallons. Annualized growth from the 2022 base year to 2024 is assumed to be 32.4 percent, resulting in a forecast of 5.7 million gallons.

The following table presents the 2024 reported volumes forecast in detail. Note that the percent change figures for 2024 represent annual growth from the last available actuals in 2022.

Table 1: Summary of fossil and alternative fuel volumes

(Mil. gallons, percent)	2021	2022	2023F	2024F	annual %ch vs. 2022
Conventional Gasoline	1,351.4	1,358.9	1,341.3	1,345.2	-0.5%
Ethanol	157.0	149.7	153.3	152.0	0.8%
Ethanol Blend Rate	*10.4%*	*9.9%*	*10.3%*	*10.2%*	
Blendstock	1,508.4	1,508.6	1,494.6	1,497.2	-0.4%
Fossil Diesel	736.2	755.3	691.1	677.4	-5.3%
Biodiesel	75.9	81.6	79.8	82.8	0.7%
Biodiesel Blend Rate	*9.2%*	*9.2%*	*9.4%*	*9.8%*	
Renewable Diesel	9.8	46.6	76.0	84.5	34.6%
Renew diesel Blend Rate	*1.2%*	*5.3%*	*9.0%*	*10.0%*	
Total Diesel	821.8	883.6	846.9	844.7	-2.2%
Electricity (on-road)	4.7	6.9	8.1	11.2	27.5%
Electricity (off-road)	5.0	6.3	5.8	10.3	27.2%
Fossil Natural Gas	0.3	0.2	0.2	0.1	-27.7%
Biogas	3.5	3.7	4.2	4.9	14.3%
Biogas Blend Rate	*91.4%*	*94.0%*	*96.0%*	*97.5%*	
Total Natural Gas	3.8	4.0	4.3	5.0	12.2%
Fossil LPG	2.2	2.6	3.1	3.7	19.9%
Bio LPG	0.3	0.7	1.2	2.0	72.3%
LPG Blend Rate	*11.8%*	*20.7%*	*28.5%*	*35.0%*	
Liquified Petroleum Gas	2.4	3.2	4.3	5.7	32.4%

Notes:
Electricity and Natural Gas denoted in gasoline gallon equivalents.
On-road electricity includes a calculation for residential charging.

Deficit and Credit Generation and Banked Credits

In order to estimate the number of deficits and credits associated with the reporting of each fuel type, the energy densities and carbon intensity differentials must be known. Most of the pertinent parameters are published here in administrative rule by the Department of Environmental Quality (see Tables 1, 2, 4, 6 and 7 in the PDF document referenced halfway down the page). The following table presents these parameters for each fuel. The highlighted carbon intensities for ethanol, biodiesel, renewable diesel, electricity and renewable natural gas are not set in rule and were discussed in detail by the advisory committee. Finally, energy economy ratios are presented for electric and natural gas engines.

Table 2: Parameter values for the 2024 forecast

			Carbon Intensity Assumption		
	Energy Density	Carbon Intensity Target	2022*	2023	2024
Gasoline	122.48	90.21	100.14	100.14	100.14
Ethanol	81.51	90.21	52.00	51.00	50.00
Diesel	134.48	90.84	100.74	100.74	100.74
Biodiesel	126.13	90.84	40.00	41.00	40.50
Renewable Diesel	129.65	90.84	36.00	40.50	41.45
Electricity	3.60	90.21	15.00	10.00	0.00
KWh/vehicle (res)	*3103*				
EERelect	*3.40*				
EER_NG	*0.90*				
Natural Gas	134.48	90.84	79.98	79.98	79.98
Biogas	134.48	90.84	12.00	5.00	2.50
Liq. Petroleum Gas	89.63	90.21	48.00	53.00	48.00
* represents the assumption for the 2023 Clean Fuels forecast.					

Banked Credits

The number of credits and deficits is taken from the OFRS. The number of gross credits registered through the end of calendar year 2022 equaled 8.35 million, while the number of deficits amounted to 7.70 million. The net credits banked equaled 649,244. OEA currently projects that a negative 163,102 net credits will be subtracted from the bank during the 2023 compliance year. The total projected banked credits at the beginning of the 2023 compliance period is now expected to total 486,142.

Table 3: Summary of actual and projected net banked credits

Year	Deficits	Credits	Net Banked Credits	Cumulative Total
2016	-594,832	809,411	214,579	214,579
2017	-644,372	855,272	210,900	425,479
2018	-864,883	943,646	78,763	504,242
2019	-1,002,020	1,220,755	218,735	722,977
2020	-1,153,936	1,260,580	106,644	829,621
2021	-1,507,686	1,443,556	-64,130	765,491
2022	-1,928,734	1,812,487	-116,247	649,244
2023Est.	-2,188,329	2,025,227	-163,102	486,142
Total	-9,884,792	10,370,934	486,142	

Credit and Deficit Summary

The table below summarizes the forecast for deficit generation and credit generation for both the 2024 compliance year, as well as the intervening 2023 that is still a forecast in the model. The 2024 forecast calls for 241,101 net credits to be subtracted from the credit bank leaving the credit bank at 245,041. The equations for calculating the deficits and credits can be found in Appendix B.

Table 4: Summary of Deficits and Credits

Credit / Deficit Summary			
		2023F	2024F
Deficits	Gasoline	-1,401,261	-1,636,062
	Diesel	-787,068	-901,879
Deficit Total		**-2,188,329**	**-2,537,941**
Credits	Ethanol	520,874	498,056
	Biodiesel	507,548	525,580
	Renewable Diesel	493,303	540,870
	Electricity, on-road	301,595	421,551
	Electricity, off-road	133,113	237,471
	Natural Gas	55,378	51,810
	Liquified Petroleum Gas	13,415	21,503
Credit Total		**2,025,227**	**2,296,840**
Net Credits/Deficits		**-163,102**	**-241,101**
Beginning Banked Credits		**649,244**	**486,142**
Total Net Credits/Deficits		**486,142**	**245,041**

Forecasted Fuel Supply Deferral Analysis

As shown above, the forecast does not imply such an action.

Potential Supply of Alternative Fuels

Oregon Revised Statutes (2017) Chapter 750, Section 272 directs the Office of Economic Analysis to estimate the "potential volumes of gasoline, gasoline substitutes and gasoline alternatives and diesel, diesel fuel substitutes and diesel alternatives available to Oregon." In order to make such estimates, a number of assumptions must be made. Potential is read to mean "could be made available to Oregon under a wide range of market conditions". Currently, suppliers must be registered by the Department of Environmental Quality to deliver fuel into Oregon. In addition, they must report volumes of fuel sold in Oregon to the OFRS. Thus, the capacity of facilities that were certified for the most recent compliance period (2022) is assumed to be theoretically "available" to Oregon.

In addition, the Office of Economic Analysis is directed to consider "Constraints that may be preventing access to available and cost-effective low carbon fuels by Oregon, such as geographic and logistical factors, and alleviating factors to those constraints". Only biofuels that might pose a supply constraint that could limit the number of credits available to deficit holders are called out explicitly. Should supply issues arise for the more mature fuel markets such as conventional gasoline and diesel, as well as electricity, such issues would be added to the report. This is not anticipated for the foreseeable future. See "Risks and Considerations" for more details regarding biofuel supply.

Table 5 presents Environmental Protection Agency data for renewable fuel production through the first six months of 2023. The current year's production is estimated based on the year-over-year growth observed through June, assuming that this rate will hold for the year as a whole. With the exception of ethanol, which is not expected to experience supply constraints, all other fuel types are expected to exhibit substantial growth in 2023.

Table 5: Renewable Fuel Production

EPA Renewable Fuel Standard Program - Reported Production

(millions of gallons)		2018	2019	2020	2021	2022	2023 Est.
Ethanol	Domestic	14,985.8	14,746.4	12,870.7	14,137.7	14,431.4	14,487.9
	Importer	92.0	213.4	197.2	72.9	94.6	11.9
Total Ethanol		**15,077.8**	**14,959.7**	**13,067.9**	**14,210.6**	**14,526.1**	**14,499.9**
Y/Y change		***0.7%***	***-0.8%***	***-12.6%***	***8.7%***	***2.2%***	***-0.2%***
Biodiesel	Domestic	1,855.5	1,713.8	1,824.9	1,704.6	1,619.9	1,726.1
	Importer	175.1	184.7	209.5	208.5	240.3	444.9
Total Biodiesel		**2,030.6**	**1,898.5**	**2,034.4**	**1,913.1**	**1,860.3**	**2,171.0**
Y/Y change		***-1.0%***	***-6.5%***	***7.2%***	***-6.0%***	***-2.8%***	***16.7%***
Renewable Diesel	Domestic	305.5	492.1	533.5	845.4	1,454.5	2,373.5
	Foreign	309.8	420.4	435.5	471.0	446.4	488.5
Total Renewable Diesel		**615.3**	**912.5**	**969.0**	**1,316.4**	**1,900.9**	**2,862.0**
Y/Y change		***2.1%***	***48.3%***	***6.2%***	***35.9%***	***44.4%***	***50.6%***
Renewable CNG	Domestic	214.4	317.0	388.1	452.4	547.1	715.3
	Importer	8.3	11.1	24.3	33.0	30.6	5.9
Renewable LNG	Domestic	55.2	51.8	80.9	81.0	84.1	50.8
	Importer	27.5	24.4	10.6	3.1	6.4	29.7
Total Natural Gas		**305.4**	**404.4**	**503.9**	**569.5**	**668.2**	**801.7**
Y/Y change		***25.9%***	***32.4%***	***24.6%***	***13.0%***	***17.3%***	***20.0%***
Propane	Domestic	**0.7**	**4.2**	**4.3**	**4.6**	**4.4**	**5.6**
Y/Y change			***537.7%***	***2.3%***	***6.6%***	***-5.1%***	***28.4%***

Note: 2023 estimates based on year-over-year growth through first six months, except where varying arrival rate dictates otherwise.

Potential Supply of Biofuels

Ethanol

As exhibited in Table 5, the potential supply of ethanol to Oregon per the methodology outlined above is 2.4 billion gallons. This compares to a projected reported volume for ethanol of 152.0 million gallons, or 6.3 percent of the potential supply, for the 2024 compliance period.

Table 5: Ethanol Supply

Ethanol Supply Available to Oregon
(Existing Suppliers in 2023)

State	Nameplate Capacity (Mil. Gallons)	Number of Facilities
South Dakota	776	11
Nebraska	645	8
Iowa	521	4
North Dakota	157	2
Minnesota	140	2
Colorado	70	2
Kansas	55	1
Oregon	40	1
Total Oregon Suppliers	2,403	31

Data from Clean Fuels Program.

Biodiesel

Table 6 presents the potential supply of biodiesel to Oregon, equaling 1,188 million gallons in capacity for certified facilities in 2023. This compares to a projected volume of biodiesel in 2024 of 82.8 million gallons, or 7.0 percent of the potential supply.

Table 6: Biodiesel Supply

Biodiesel Supply Available to Oregon
(Existing Suppliers in 2023)

Locality	Nameplate Capacity (Mil. Gallons)	Number of Facilities
Iowa	260	4
Missouri	141	3
Minnesota	130	1
Arkansas	124	2
Illinois	120	2
Oregon	112	2
Canada	101	3
Washington	84	1
Oklahoma	35	1
California	34	2
Korea	22	2
Texas	13	1
Mississippi	12	1
Michigan	1	1
Total Oregon Suppliers	1,188	26

Data from Clean Fuels Program.

Renewable Diesel

As presented below, the potential supply of renewable diesel to Oregon equals 2,041 million gallons. This compares to a projected volume of renewable diesel in 2024 of 84.5 million gallons, which translates to 4.1 percent of the potential supply.

Table 7: Renewable Diesel Supply

Renewable Diesel Supply Available to Oregon
(Existing Suppliers in 2023)

Locality	Nameplate Capacity (Mil. Gallons)	Number of Facilities
Louisiana	765	2
Texas	470	1
North Dakota	184	1
California	180	1
Wyoming	153	1
Montana	138	1
Singapore	116	1
Washington	35	1
Total Oregon Suppliers	2,041	9

Data from the Clean Fuels Program

Renewable Natural Gas

The amount of renewable natural gas potentially available to Oregon amounts to 85.3 billion gasoline gallon equivalents. This compares to a projected volume for this biofuel of 4.9 million gallon equivalents in 2024, or 5.7 percent of the potential supply.

Table 8: Renewable Natural Gas

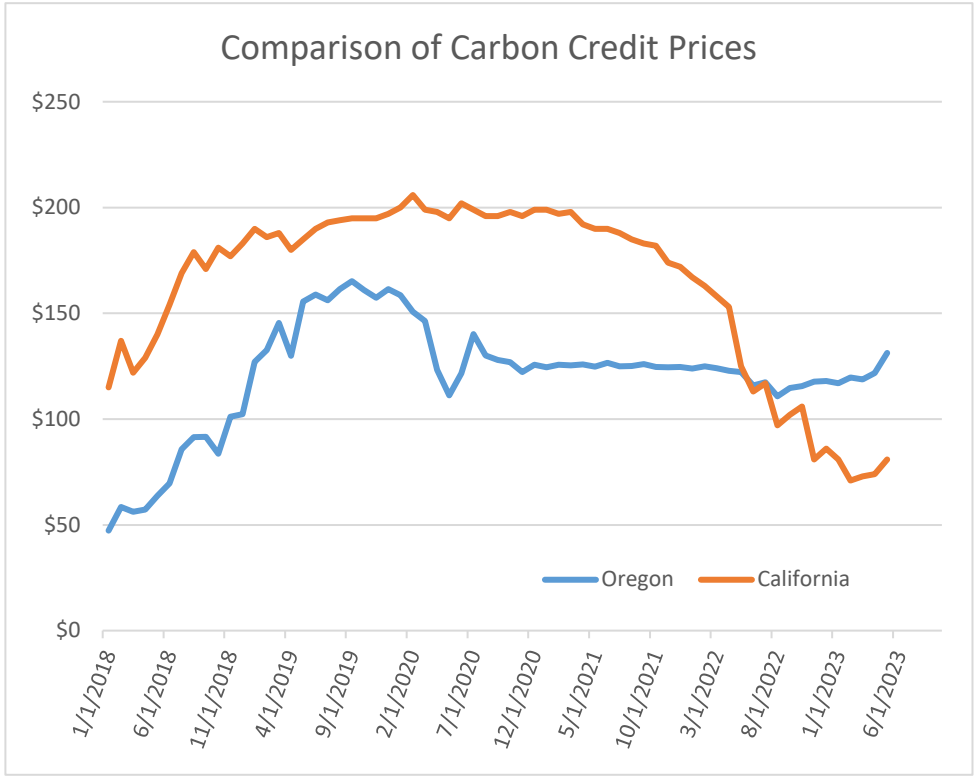
Renewable Natural Gas Supply Available to Oregon
(Existing Suppliers in 2023)

Locality	Nameplate Capacity (Mil. Gallons)	Number of Facilities
Pennsylvania	34.4	2
Louisiana	17.4	1
Canada	14.0	1
Texas	10.0	1
Kentucky	9.5	1
Wisconsin	0.0	4
Washington	0.0	1
Total Oregon Suppliers	85.3	11.0

Data from the Clean Fuels Program

Finally, that a particular volume of fuel will make its way to Oregon depends on the relative value of the fuel between Oregon and other states. Currently, the value of credits, which are currently unique to Oregon, California, Washington and British Columbia, add a premium to the market value of the fuel relative to other states and for the most part ensure that sufficient supply will be available to Oregon. Oregon Revised Statutes (2017) chapter 750 section 166 subsection (4) specifies a maximum credit price, indexed for inflation. At some point in the future, this constraint could theoretically pose a barrier to supply. The chart below presents the recent history of the price of credits in Oregon and California (Washington's program has yet to publish credit price data, while British Columbia is omitted due to frequently missing data)[3].

Chart 1: Credit Prices



[3] Information regarding credit prices is presented for informational purposes only. The reported volumes, credit/deficit and supply forecasts are not dependent on any specific credit price values.

Forecast Risks and Considerations

This section highlights factors and considerations that could cause the projected volumes and associated credits and deficits to deviate from the baseline outlook presented earlier. In particular, there are a number of potential risks to this 2024 Clean Fuels Forecast, both positive and negative, and they are:

(a) The most fundamental risk to the forecast amounts to potential deviations from the assumptions highlighted in each fuel type discussion. In particular, blend rates and carbon intensities for biofuels could be subject to significant error.
(b) This forecast represents a "current law" representation of the compliance period in question. OEA's methodology does not take potential future state or federal policy actions into account.
(c) There is a discrepancy between the diesel consumption numbers reported to the Clean Fuels Program data and the taxable gallons tabulated by ODOT. Explicitly, more gallons of diesel are reported to the former than the latter. This forecast applies projected growth of taxable diesel, at least initially, to the base year 2022 reported volumes of diesel in the CFP. To the degree that taxable gallons per ODOT are not a perfect proxy for reported gallons in the CFP, actual reporting of diesel to the Clean Fuels program, and thereby the number of deficits and credits generated could deviate from this forecast.
(d) The ethanol availability presented above is not comprehensive and does not include other potential sources, such as sugarcane ethanol imported from Brazil. Given that potential supply characterized in table 5 greatly exceeds the projected 2024 volume, this is not an immediate threat to the forecast. However, it may need to be addressed as consumption increases or as carbon intensity targets are lowered.

In addition, the advisory committee discussed a couple of considerations outside the scope of the baseline forecast:

(a) The supply forecast assumes that certified fossil and renewable fuel capacity is potentially available to Oregon fuel distributors and consumers. This depends on a number of factors, including transportation modalities and storage availability. While stated capacity may be more available in the urban corridor, it may not be universally available in the rural areas of the state. Specifically, storage options are limited outside of the Portland metropolitan region.
(b) The impact of climactic conditions on the various fuels is another factor that is not explicitly considered in the supply forecast. For example, "cloud point", i.e. the temperature at which a liquid begins to emulsify and/or solidify, is something that should be considered as biodiesel, renewable diesel and fossil diesel all have different cloud points and ways to address that concern.

Accessibility
Documents can be provided upon request in an alternate format for individuals with disabilities or in a language other than English for people with limited English skills. To request a document in another format or language, call Michael Kennedy in the Office of Economic Analysis at (971) 678-5595 or email him at michael.kennedy@das.oregon.gov

Appendix A

Membership of the Clean Fuels Forecast Advisory Committee:

Member Name	Affiliation	Email
ALDERSON, Greg	PGE	gregory.alderson@pgn.com
Apter Nora	Oregon Environmental Council	noraa@oeconline.org
Bach, Marissa	Shell Oil Company	Marissa.Bach@shell.com
BAKER Lindsay	Dept. of Transportation	Lindsay.BAKER@state.or.us
BOLTE John	Oregon State University	boltej@engr.orst.edu
Bond Steve	Crimson Sequential	Steve.bond@crimsonrenewable.com
BRENNAN Patrick H	OR Leg. Policy and Research	Patrick.H.Brennan@state.or.us
Brooks, Kelly	Oregon Governor's Office	Kelly.S.Brooks@oregon.gov
BUNCH, Mark J	BP	Mark.Bunch@bp.com
Chingos, Thomas	Shell Oil Company	Thomas.Chingos@shell.com
CONSTANTINO, Jon	Tradesman Advisors	Jon@tradesmanadvisors.com
DODDS Marie	Oregon/Idaho AAA	marie.dodds@aaaoregon.com
FREESE Mike	The Romaine Group	mfreese@theromaingroup.com
Garcia Oscar	Neste US, Inc	Oscar.Garcia@neste.com
GILSTRAP Don	Chevron	dgilstrap@chevron.com
HAWLEY Kate	Pacificorp	kate.hawley@pacificorp.com
HEPP Elizabeth	Valero	beth.hepp@valero.com
HOFFMAN Jessica	RPMG	jwhoffmann@rpmgllc.com
Illig, Danielle	Clean Energy Fuels	Danielly.Illig@cleanenergyfuels.com
JARVIS Jana	Oregon Trucking Association	jana@ortrucking.org
KENNEDY Michael	Office of Economic Analysis	Michael.KENNEDY@das.oregon.gov
KLEEB Douglas J	Dept. of Transportation	Douglas.J.KLEEB@state.or.us
KOEHLER Tom	Alto Columbia	tom@tomkoehler.org
LEHNER Joshua	Office of Economic Analysis	Joshua.LEHNER@das.oregon.gov
MALIK Mazen G	Legislative Revenue Office	Mazen.G.Malik@state.or.us
Malsam, Derek	Jubitz	Derek.malsam@jubitz.com
MARTIN Jeremy	Union of Concerned Scientists	jmartin@ucsusa.org
MCCONNAHA, Colin	Dept. of Environmental Quality	Colin.McConnaha@deq.oregon.gov
MCDONALD Brian	Andeavor	brian.c.mcdonald@andeavor.com
MCMULLEN Mark	Office of Economic Analysis	Mark.MCMULLEN@das.oregon.gov
Mitrovic, Stefan	Shell Oil Company	Stefan.Mitrovic@shell.com
MORGAN Tim	Oregon AAA	tim.morgan@aaaoregon.com
NEAL Shelby	Darling	Shelby.Neal@darlingii.com
Neild, Pam	City of Portland	Pam.Neild@portlandoregon.gov
Nowicki, Jesse	RPMG	jnowicki@rpmgllc.com
NOYES Graham	Noyes Law Corporation	graham@noyeslawcorp.com
PETERS Bill	Dept. of Environmental Quality	Bill.N.Peters@deq.oregon.gov

PORTER Daniel R	Dept. of Transportation	Daniel.R.PORTER@state.or.us
PROUDFOOT Josh	Good Company	joshua.proudfoot@goodcompany.com
ROMAIN Danelle	The Romaine Group	dromain@theromaingroup.com
Sandquist, Meg	Clean Energy Fuels	Meg.Sandquist@cleanenergyfuels.com
Sutton, Julie	Clean Energy Fuels	Julie.Sutton@cleanenergyfuels.com
THORNTON John	Clean Future	john@cleanfuture.us
Van't Hof, David	NEXT, Inc.	Vanthofd30@gmail.com
VENTURA Marc	Phillips 66	marc.v.ventura@p66.com
VERBURG Jim	Western States Petroleum Assoc.	jverburg@wspa.org
WADE Samuel	RNG Coalition	sam@rngcoalition.com
WIND Cory-Ann	Dept. of Environmental Quality	Cory.ann.wind@deq.oregon.gov
WINE Sean	Clean Energy Fuels	Sean.Wine@cleanenergyfuels.com

Appendix B

The following are the formulas resulting in the deficits and credits presented in Table 4 of the Clean Fuels Forecast.

Gasoline

$Deficit_G = CBOB * ED_G * (CIT_G - CIA_G)/1{,}000{,}000$

Diesel

$Deficit_D = V_D * ED_D * (CIT_D - CIA_D)/1{,}000{,}000$

Ethanol

$Credit_E = V_E * ED_E * (CIT_G - CIA_E)/1{,}000{,}000$

Biodiesel

$Credit_{BD} = V_{BD} * ED_{BD} * (CIT_D - CIA_{BD})/1{,}000{,}000$

Renewable Diesel

$Credit_{RD} = V_{RD} * ED_{RD} * (CIT_D - CIA_{RD})/1{,}000{,}000$

Electricity

$Credit_C = K_C * EER_C * ED_C * (CIT_G - (CIA_C/EER_C)/1{,}000{,}000$

Natural Gas

$Credit_{NG} = V_{FNG} * ED_D * EER_{NG} * (CIT_D - (CIA_{FNG}/ EER_{NG})/1{,}000{,}000 + V_{RNG} * ED_D * EER_{NG} * (CIT_D - (CIA_{RNG}/ EER_{NG})/1{,}000{,}000$

Propane

$Credit_P = V_P * ED_P * (CIT_G - CIA_P)/1{,}000{,}000$

Table B.1: Definition of Symbols

Where:	
G = Gasoline	D = Diesel
CBOB = Conventional Blendstock for Oxygenated Blending	E = Ethanol
	BD = Biodiesel
ED = Energy Density	RD = Renewable Diesel
V = Volume consumed	C = Electricity
CIT = Carbon Intensity Target	NG = Natural Gas
CIA = Carbon Intensity Actual	FNG = Fossil Natural Gas
K = Total Kilowatts (Total Electric Vehicles * Kilowatts Per Vehicle per Year)	RNG = Renewable Natural Gas
EER = Energy Economy Ratio	P = Propane