2021 Illustrative Compliance Scenarios

Final Report

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Table of Contents

Abbreviations and Acronyms

AEO	Annual Energy Outlook
BD	biodiesel
CFP	Clean Fuels Program
CI	carbon Intensity
CNG	compressed natural gas
DEQ	Department of Environmental Quality
EO	Executive Order
EV	electric vehicle
FFV	flex fuel vehicles
GHG	greenhouse gas
LCFS	Low Carbon Fuel Standard
LD	light-duty
MD/HD	medium and heavy-duty
MGY	million gallons per year
MOU	memorandum of understanding
NG	natural gas
PHEV	plug-in hybrid electric vehicle
RD	renewable diesel
RNG	renewable natural gas
ULSD	ultra-low sulfur diesel
VMT	vehicle miles traveled
ZEV	zero emission vehicle

Introduction

The clean fuel standard in Oregon, implemented by the Clean Fuels Program (CFP), requires a 10 percent reduction in the baseline carbon intensity (CI) of gasoline and diesel over a ten-year period (to 2025). In addition to CI reduction, the CFP helps Oregon reduce its consumption of conventional petroleum fuels. Low carbon fuels include but are not limited to ethanol, biodiesel, hydrogen, electricity, natural gas, propane, and renewable natural gas (RNG). In March 2020, Gov. Kate Brown directed the Department of Environmental Quality through Executive Order (EO) 20-04 to expand the CFP to achieve a 20% reduction in the average CI of Oregon's transportation fuels from 2015 levels by 2030 and a 25% reduction by 2035 though the rulemaking to expand the program has not yet been completed.

This report and analysis are designed to assist DEQ in its efforts to expand the Clean Fuels Program and comply with EO 20-04 through the development of Illustrative Compliance Scenarios. The primary objectives of Illustrative Compliance Scenarios are to allow for understanding of what the main drivers and levers for compliance are, and how much of and what types of fuels are required under different conditions. Illustrative compliance scenarios are NOT meant to predict the future but inform what the important fuels or time periods are when considering compliance with the program.

ICF developed three main scenarios:

- Scenario A – In this scenario, compliance is met primarily through credits generated from electricity associated with the adoption of additional light-duty (LD) and medium- and heavy-duty (MD/HD) zero emission vehicle (ZEV) regulations including Advanced Clean Cars for the LD and Advanced Clean Trucks for MD/HD. Biofuels are then used to achieve the 20% by 2030 and 25% by 2035 CI reduction targets.
- Scenario B – In this scenario, compliance is met through a combination of existing LD ZEV regulations and biofuels to achieve the 20% by 2030 and 25% by 2035 CI reduction targets.
- Scenario C – In this scenario, potential CI reduction targets in excess of the 20% by 2030 and 25% by 2035 CI reduction targets are demonstrated by: adding the light-duty and medium- and heavy-duty ZEV regulations from Scenario A; maintaining biofuel blending levels from Scenario B; and adding additional consumption of other fuels requiring alternative technologies (i.e., natural gas and hydrogen).

For Scenarios A and B, two variations in the scenarios for high CI and low CI biomass-based diesel were run to quantify the amount of renewable fuels necessary for compliance depending on the availability of the lowest CI diesel substitutes. The low CI variation for Scenario A and the high CI variation for Scenario B are presented here to consider the range of potential biofuel demand necessary for compliance with an expanded CFP.

VISION Modeling

The Illustrative Compliance Scenarios are based on modeling the future Oregon vehicle fleet using a modified version of the Argonne VISION model based on the 2020 EIA Annual Energy

Outlook data. ICF created an Oregon version of the VISION model by estimating statewide annual vehicle sales based on annual Oregon DOT vehicles registrations.

- Light-duty vehicle sales projections (2020–2029) were based on estimates from the Oregon Privilege Tax.
- Medium- and heavy-duty sales projections starting in 2022 were based on actual Oregon sales rates (2010–2019) as a proportion of US sales.
- After 2029, the US sales projections for light- (autos and trucks separately), medium-, and heavy-duty vehicles were scaled to Oregon sales values based on estimates from the Oregon Privilege Tax.

Table 1 below shows Oregon's portion of US sales that is used for vehicle sales projections.

Table 1. Oregon Portion of US Sales by Vehicle Class

Vehicle Class	Oregon Portion of US Sales for Projections
Light-Duty Vehicles	1.10%
Medium-Duty Trucks (Class 3-6)	2.57%
Heavy-Duty Trucks (Class 7-8)	1.25%

The VISION model utilizes national data to determine vehicle life expectancy, and annual vehicle miles traveled (VMT) that ultimately combine with the Oregon fleet projections to determine fuel consumption. This data may not be consistent with Oregon's actual vehicle fleet and as such, the resulting projections for fuel were inconsistent with the data provided for 2016–2019 from the Clean Fuels Program. The VISION model was then calibrated to CFP vehicle use by scaling the VMT separately for LD (gasoline) and MD/HD (diesel). Also, for the model outputs to coordinate with the daily electricity use values utilized to quantify electric utility vehicle credits for residential charging, electric vehicles were excluded in the calibration, and certain factors, including the on-road degradation factor for fuel economy, were removed.

Clean Fuels Standard to 2035

The Clean Fuels Program currently has gasoline and diesel standards adopted in rule through 2025 and then being maintained after that. To quantify credit generation to 2035, an increasing program stringency from 2025 to 2035 was assumed and are shown in Table 2 below. The carbon intensities assume a standard linear increase from 10% in 2025 to 20% in 2030 to 25% in 2035.

Table 2. Gasoline and Diesel Standards

Fuel	Percent Reduction	Gasoline Standard (gCO_2e/MJ)	Diesel Standard (gCO_2e/MJ)
2021	3.5 percent	94.63	95.29
2022	5.0 percent	93.15	93.81
2023	6.5 percent	91.68	92.32
2024	8.0 percent	90.21	90.84
2025	10.0 percent	88.25	88.87
2026	*12.0* percent	*86.29*	*86.90*
2027	*14.0* percent	*84.33*	*84.92*
2028	*16.0* percent	*82.37*	*82.95*
2029	*18.0* percent	*80.41*	*80.97*
2030	*20.0* percent	*78.44*	*79.00*
2031	*21.0* percent	*77.46*	*78.01*
2032	*22.0* percent	*76.48*	*77.02*
2033	*23.0* percent	*75.50*	*76.03*
2034	*24.0* percent	*74.52*	*75.05*
2035	*25.0* percent	*73.54*	*74.06*

Vehicle Populations

Light-Duty ZEV Populations

The Oregon Legislature passed SB1044 which includes the following provisions:

- By 2020, 50,000 registered motor vehicles will be ZEV;
- By 2025, at least 250,000 registered motor vehicles will be ZEV;
- By 2030, at least 25 percent of registered motor vehicles, and at least 50 percent of new motor vehicles sold annually, will be ZEV; and
- By 2035, at least 90 percent of new motor vehicles sold annually will be ZEV.

ICF developed electric vehicle penetration rates to meet the above metrics for ZEVs in Oregon. These penetration rates are included in Scenarios A and C and not in Scenario B. Scenario B reaches a maximum ZEV sales rate of 22% in 2025 and maintains that level through 2035. Table 3 below presents the LD EV sales and EV population modeled from 2021 to 2035.

Table 3. LD (including BEV and PHEV) EV Sales and Population (Thousands of vehicles)

Year	Scenario A/C EV Population	Scenario B EV Population	Scenario A/C EV Sales	Scenario B EV Sales
2021	80	55	15	15
2022	111	80	20	20
2023	147	111	25	25
2024	190	147	30	30
2025	240	190	36	36
2026	302	240	42	42
2027	376	289	53	42
2028	458	335	63	42
2029	549	379	73	41
2030	648	418	82	40
2031	761	454	91	40
2032	888	487	105	40
2033	1,026	518	120	40
2034	1,176	545	134	40
2035	1,339	569	149	40

Medium- and Heavy-Duty ZEV Populations

On July 14, 2020, Governor Brown signed a joint Memorandum of Understanding (MOU) that commits the 14 signatory entities to work to advance and accelerate the deployment of electric medium and heavy-duty vehicles. The MOU includes sales targets of 100% MHD vehicles are zero emissions by 2050 with at least 30% MHD sales zero-emission by 2030. The MOU is modeled from California's Advanced Clean Trucks regulation. Currently, the California Advanced Clean Trucks regulatory language includes the sales requirement schedule shown in Table 4 below. DEQ is currently in rulemaking to adopt the Advanced Clean Trucks in Oregon and will present their staff proposal to the Environmental Quality Commission later this year.

Since the VISION model does not break down its vehicle categories in the way that the Advanced Clean Trucks regulation is structure, ICF created blended sales rates to mirror the categories. These penetration rates are included in Scenarios A and C and not in Scenario B. Scenario B uses AEO2020 developed MD/HD sales rates. Tables 5 and 6 below present the modeled MD/HD EV sales (Table 5) and population (Table 6) from 2021 to 2035.

Table 4. MD/HD Sales Rates by Category for California's Advanced Clean Trucks

Year	Class 2b–3 Group	Class 4–8	Class 7–8 Tractors Group
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035	55%	75%	40%

Table 5. MD/HD EV Population including EV and PHEV

Year	Scenario A/C EV Class 3-6	Scenario B Class 3-6	Scenario A/C Class 7-8	Scenario B Class 7-8
2021	19	19	2	2
2022	33	33	3	9
2023	47	47	4	17
2024	62	62	4	26
2025	914	93	3,043	35
2026	1,992	126	6,586	43
2027	3,327	159	10,670	52
2028	5,399	194	16,849	60
2029	8,492	231	26,018	69
2030	12,631	269	38,031	80
2031	17,843	308	52,765	90
2032	23,698	349	68,640	100
2033	30,217	391	85,821	111
2034	37,393	434	104,002	122
2035	45,240	479	123,035	132

Table 6. MD/HD EV Sales including EV and PHEV

Year	Scenario A/C EV Class 3-6	Scenario B EV Class 3-6	Scenario A/C EV Class 7-8	Scenario B EV Class 7-8
2021	13	13	2	2
2022	13	13	1	6
2023	14	14	1	7
2024	15	15	1	7
2025	851	31	213	7
2026	1,075	33	280	7
2027	1,329	34	372	7
2028	2,062	35	558	7
2029	3,075	37	771	7
2030	4,113	39	983	8
2031	5,180	40	1,194	8
2032	5,817	42	1,352	8
2033	6,483	44	1,512	9
2034	7,152	46	1,541	9
2035	7,847	48	1,575	9

For Scenario C, the baseline AEO 2020 MD/HD vehicle sales doubled for natural gas. In the baseline AEO 2020 VISION model, there were no hydrogen vehicle sales. For Scenario C, the MD/HD sales rates for hydrogen Class 7/8 trucks (VISION vehicle category) were 5% in 2033 and 2034 and 10% in 2035.

Additional Electric Vehicle Credit Generation

In all scenarios, credits from other sources of electricity used as a transportation fuel are included such as transit buses, forklifts, and fixed guideway. The credits included were using the same methodology 2017 Illustrative compliance scenarios but extended through 2035.

Table 7 below includes the number of credits generated from these additional electric vehicles each year.

Table 7. Annual and Total Credit Generation Potential from Fixed Additional Electricity

Year	Transit Buses – Scenarios A\C	Transit Buses – Scenario B	Forklifts	Fixed Guideway	Total - Scenario A\C	Total - Scenario B
2021	19,255	500	73	12,459	96,677	128,964
2022	19,397	514	77	16,026	99,137	135,152
2023	19,543	528	79	19,726	101,631	141,508
2024	19,689	543	80	23,451	104,204	147,967
2025	19,678	550	81	27,015	106,040	153,364
2026	20,301	558	82	30,553	111,192	162,687
2027	20,938	566	83	34,065	116,565	172,217
2028	20,938	566	83	36,386	121,687	179,660
2029	20,938	566	83	38,689	126,906	187,181
2030	20,938	566	83	40,974	132,221	194,782
2031	20,938	566	83	43,852	137,633	203,072
2032	20,938	566	83	46,780	143,142	211,509
2033	20,938	566	83	49,759	148,748	220,094
2034	20,938	566	83	52,789	154,450	228,826
2035	20,938	566	83	55,426	160,250	237,263

Fuel Availability

Carbon Intensity (CI)

Table 8 on the following page shows the CIs utilized for the 2021 Illustrative Compliance Scenarios. The CIs for alternatives to gasoline and diesel are weighted averages based on data supplied by the CFP for registered pathways and fuel volume reporting in 2020.

Table 8. Oregon Clean Fuel Program Carbon Intensities

Fuel	CI (gCO_2e/MJ)	
	2020	2035
Gasoline Blendstock	100.14	100.14
Diesel	100.74	100.74
Corn Ethanol	56.04	decreasing linearly to 50 in 2024 and constant to 2035
Soybean Biodiesel (BD)	54	54
Canola BD	52	52
Used Cooking Oil BD	18	18
Corn Oil BD	35	35
Tallow BD	35	35
Corn Oil Renewable Diesel (RD)	19.25	19.25
Tallow/Waste Grease RD	25	25
Soybean RD	55	55
Compressed Natural Gas (CNG)	79.93	79.93
Electricity	107.92	decreasing linearly to 0 in 2035
RNG (CNG)	40.00	decreasing to -150 in 2023 and constant to 2035
Hydrogen	120	decreasing linearly to 0 in 2025 and -50 in 2035

Assumptions for Fuels that Substitute for Gasoline

For ethanol, the average CI of ethanol supplied to Oregon since the beginning of CFP has decreased from 63 g/MJ to 56 g/MJ since the beginning of the regulation. The scenarios assumed a continued CI reduction to 50 g/MJ in 2024 without a limitation of availability. For renewable natural gas (RNG), there is sufficient supply from landfills, wastewater treatment plants, and other sources like waste feedstock digesters in the U.S. to fulfill any demand. Currently, the main source of RNG in California and Oregon is landfill gas-based RNG, but the mix is slowly changing over to dairy and swine-based RNG.

Table 9 below presents the assumptions for fuels that substitute for gasoline.

Table 9. Fuels That Substitute for Gasoline

Fuel	Assumption through 2035
Ethanol	No limitations on supply with the decreasing CI to 50 g/MJ
CNG/RNG	100% of the fuel volume RNG

Assumptions for Fuels that Substitute for Diesel

Table 10 presents the assumptions for fuels that substitute for diesel. Based on analysis done by ICF for other state and national government agencies, renewable diesel (RD) capacity is expected to exceed 4 billion gallons per year by 2025.

Table 10. Fuels That Substitute for Diesel

Fuel	Assumption through 2035
Biodiesel (BD)	BD is capped at 10% by volume with 25 MGY available of UCO BD, 10 MGY of corn oil BD and 25 MGY of tallow BD, with the balance canola BD.
Renewable Diesel (RD)	For the Low CI variation – available volumes are 40 MGY of coil oil RD, 200 MGY tallow RD and the balance soy RD For the High CI variation – available volumes are 40 MGY of tallow RD and balance soy RD
CNG/RNG	100% of the fuel volume RNG

Overview of Illustrative Compliance Scenarios

Based on the assumptions described above for the fuels that are available and vehicle populations that are anticipated, ICF developed 3 Illustrative Compliance Scenarios. Scenarios A and B achieve the proposed 20% CI reductions by 2035 and 25% CI reductions by 2035 by balancing the cumulative deficits and credits from the various fuels. Scenario C is not limited to the 25% CI reductions by 2035.

Table 11 summarizes the assumptions for each scenario.

Table 11. Overview of 2021 Illustrative Compliance Scenarios

Maximums for Scenario Assumptions	Scenario A	Scenario B	Scenario C
Ethanol: • Max ethanol blend is E15 (gasoline with 15% ethanol by volume) • Max 85% of Flex Fuel Vehicles (FFV) miles on E85	• Ethanol blend increase began in 2026 to 12% and eventually reached 15% in 2030 and stayed there till 2035 • Percent FFV miles on E85 increased from 1% in 2021 to 25% in 2030 and stayed at 25% through 2035	• Ethanol blend increase began in 2026 to 12% and eventually reached 15% in 2030 and stayed there till 2035 • Percent FFV miles on E85 increased from 1% in 2021 to 25% in 2030 and stayed at 25% through 2035	• Ethanol blend increase began in 2026 to 12% and eventually reached 15% in 2030 and stayed there till 2035 • Percent FFV miles on E85 increased from 1% in 2021 to 25% in 2030 and stayed at 25% through 2035
Biodiesel (BD):	• BD blend rate stayed at 10%	• BD blend rate stayed at 10%	• BD blend rate stayed at 10%
Renewable Diesel (RD):	• RD blend rate increased from 5%in 2021 to 20% in 2029, and only the minimum required volumes were after 2030, which eventually decreased to 0% by 2034	• RD blend rate increased from 5%in 2021 to 67% in 2035	• RD blend rate increased from 5%in 2021 to 25% in 2030 and maintained that level through 2035
Natural Gas (NG):	• 100% natural gas use as RNG	• 100% natural gas use as RNG	• Doubling of NG sales rate from Scenarios A and B and 100% of natural gas use from RNG
Zero Emission Vehicles (ZEV):	• Compliance with SB1044 and MD/HD electric vehicle policies, which result in over 900,000 LD EVs and over 67,000 MD/HD EVs or PHEVs in 2035	• Compliance with existing EV regulations, which result in over 400,000 LD EVs and less than 2,000 MD/HD EVs or PHEVs in 2035	• Compliance with SB1044 and MD/HD electric vehicle policies, which result in over 900,000 LD EVs and over 67,000 MD/HD EVs or PHEVs in 2035

Results

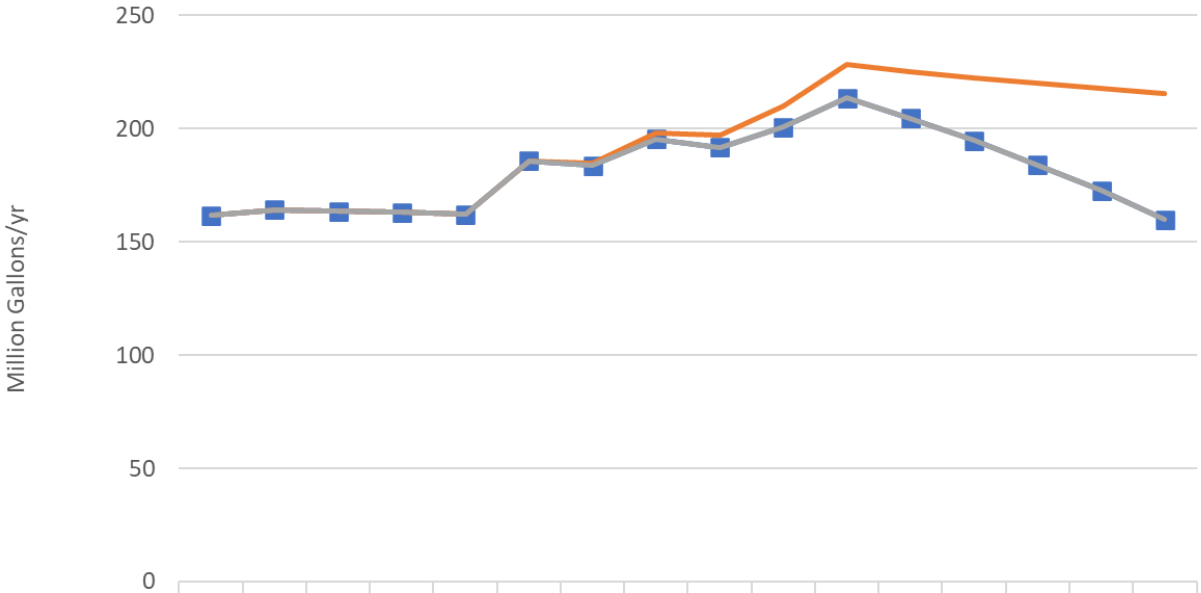
The following sections review different aspects found within each of the illustrative compliance scenarios, including required fuel volumes and credit and deficit generation.

Fuel Volumes

The following section reviews the fuels volumes ethanol, BD, RD, NG, and electricity.

Ethanol

Figure 1 below shows the ethanol fuel volumes by scenario. While all three of the scenarios have the same assumptions for transitioning to E15 and increasing the use of E85 by flex fuel vehicles, the increased electrification of LD vehicles in Scenarios A and C result in a smaller gasoline vehicle fleet mix and, therefore, lower overall consumption of ethanol gallons.

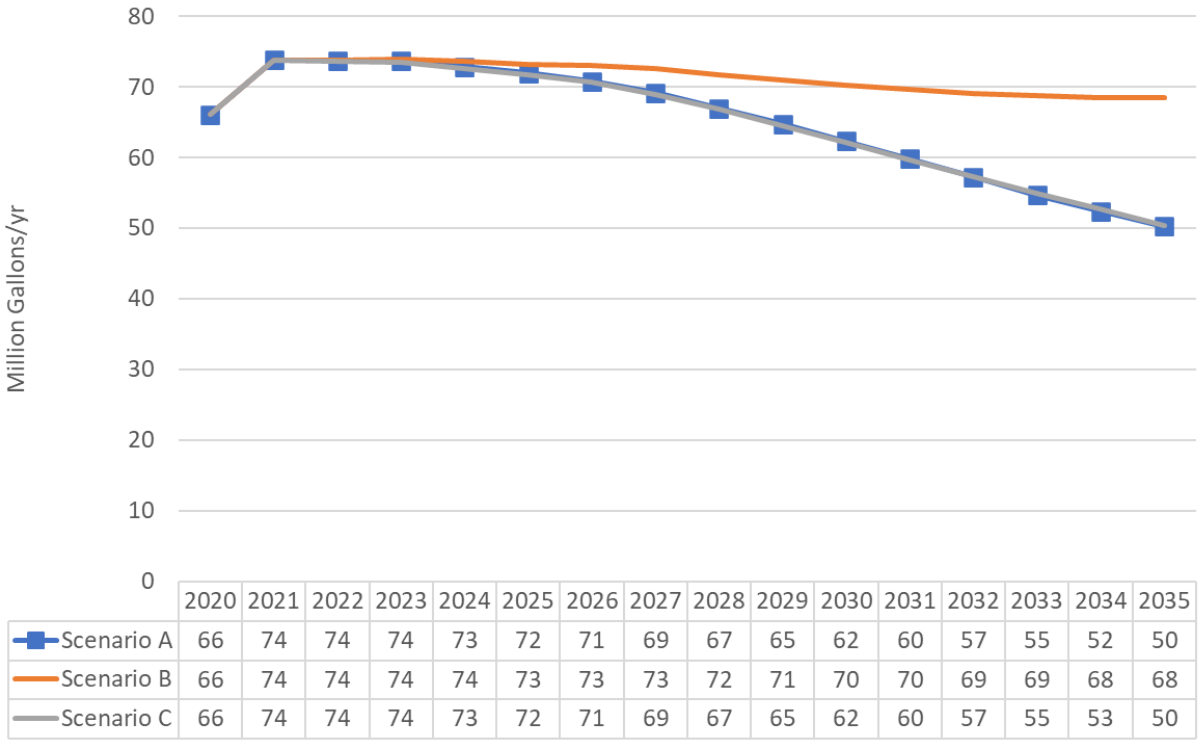


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scenario A	162	164	164	163	162	186	184	195	192	201	214	205	195	184	173	160
Scenario B	162	164	164	163	162	186	185	198	197	210	228	225	222	220	218	216
Scenario C	162	164	164	163	162	186	184	195	192	201	214	205	195	184	173	160

Figure 1. Ethanol Fuel Volumes by Scenario

Biodiesel

Figure 2 below shows the BD fuel volumes by scenario. While all three of the scenarios have the same assumptions for maintaining a 10% biodiesel blend percentage, the increased electrification of MD/HD vehicles in Scenarios A and C result in a smaller diesel vehicle fleet mix and, therefore, lower overall consumption of BD gallons.

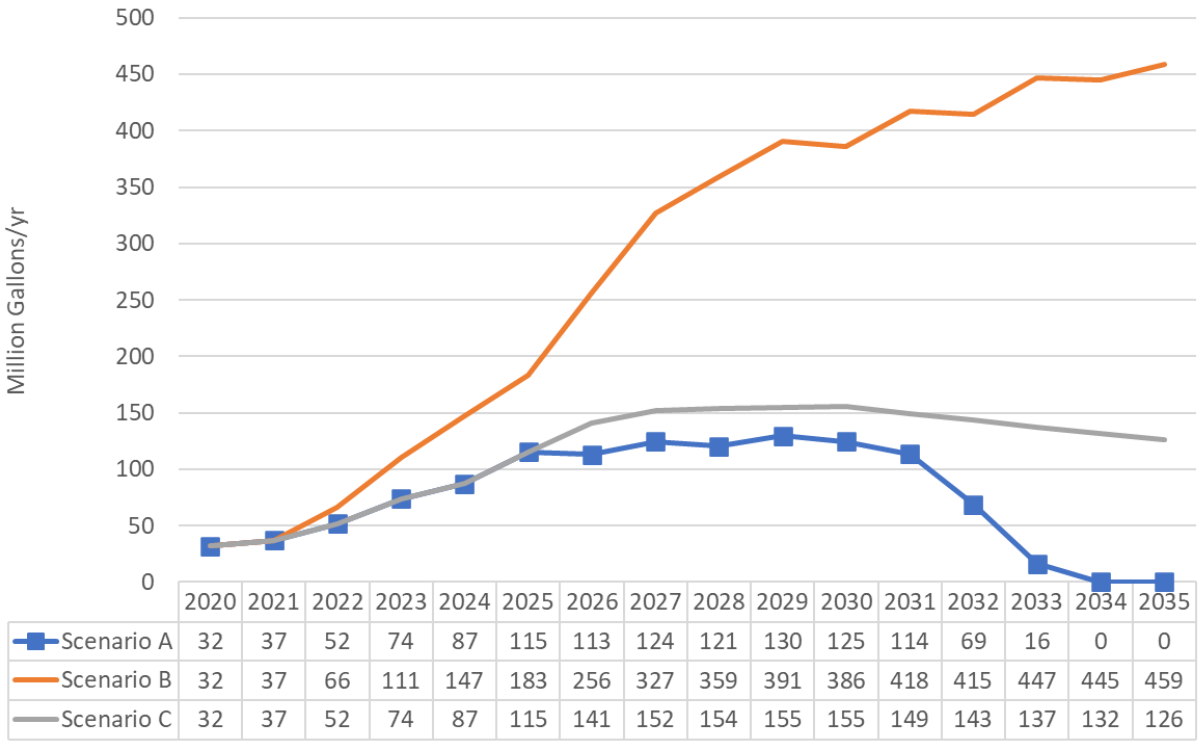


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scenario A	66	74	74	74	73	72	71	69	67	65	62	60	57	55	52	50
Scenario B	66	74	74	74	74	73	73	73	72	71	70	70	69	69	68	68
Scenario C	66	74	74	74	73	72	71	69	67	65	62	60	57	55	53	50

Figure 2. Biodiesel Fuel Volumes by Scenario

Renewable Diesel

Figure 3 below shows the RD fuel volumes by scenario. In Scenarios A and C, a lower CI RD and increased electrification result in fewer gallons required for compliance. In addition, as electricity increases rapidly post 2030, the necessary amount of RD decreases to zero for compliance purposes. Since Scenario C can exceed the 25% CI requirement, the blend percentage was maintained at 25% from 2030 to 2035, with the decreasing overall volumes in that time period due to the shrinking diesel vehicle fleet from electrification. The amount of RD required in Scenario B in 2035 is 67%. When accounting for both the BD and RD, the combined renewable content is 77%.

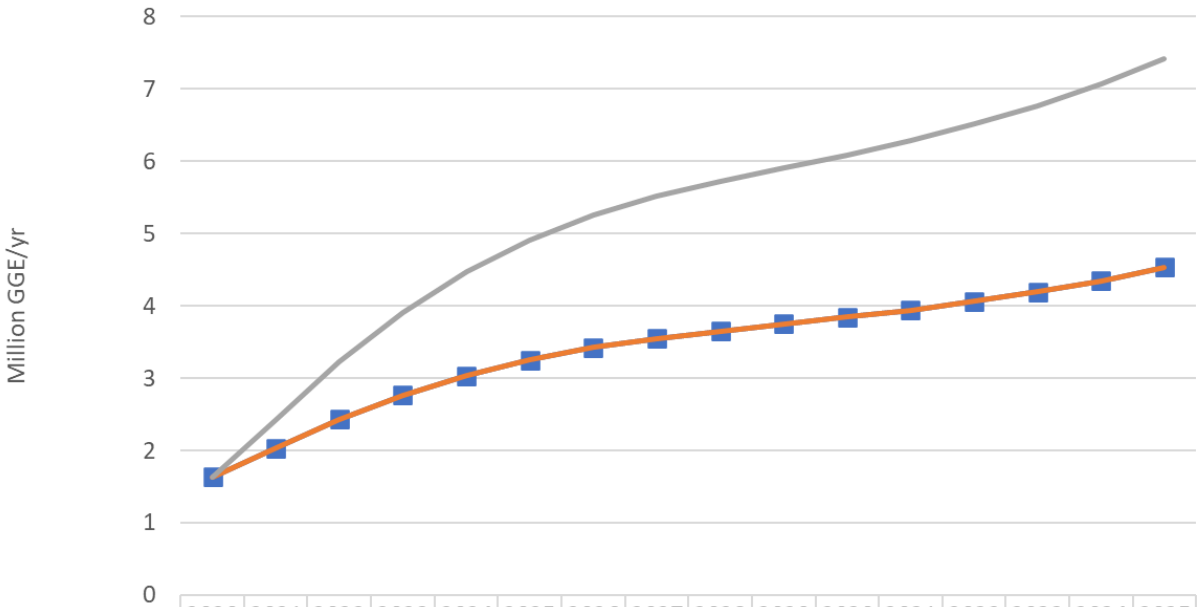


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scenario A	32	37	52	74	87	115	113	124	121	130	125	114	69	16	0	0
Scenario B	32	37	66	111	147	183	256	327	359	391	386	418	415	447	445	459
Scenario C	32	37	52	74	87	115	141	152	154	155	155	149	143	137	132	126

Figure 3. RD Fuel Volumes by Scenario

Natural Gas

Figure 4 below shows the NG fuel volumes by scenario. Scenarios A and B have the same assumptions of using the AEO penetration rates of NG vehicles, and Scenario C is two times the AEO sales rate. Thus, the modeled NG use in 2035 in the MD/HD sector is 0.5–1% of the total fuel use.

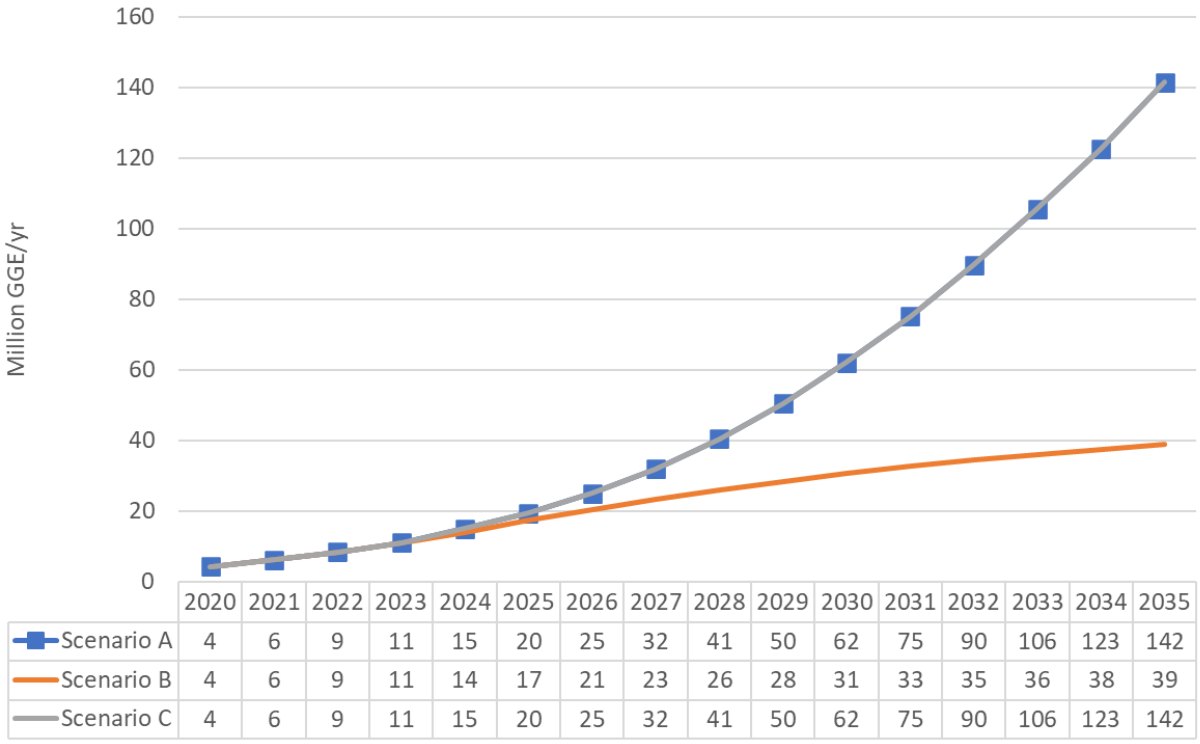


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scenario A	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	5
Scenario B	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	5
Scenario C	2	2	3	4	4	5	5	6	6	6	6	6	7	7	7	7

Figure 4. Natural Gas Fuel Volumes by Scenario

Electricity

Figure 5 below shows the electricity fuel volumes by scenario. Without any additional policies or regulations, Scenario B shows modeled electricity consumption ten times the amount in 2035 as in 2020. Scenarios A and C include additional LD and MD/HD electrification regulations. This results in a 250% increase in electricity consumption in transportation compared to Scenario B. The combination of increased electricity consumption and decreasing electricity CI results in significant credit generation from electric vehicles.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scenario A	4	6	9	11	15	20	25	32	41	50	62	75	90	106	123	142
Scenario B	4	6	9	11	14	17	21	23	26	28	31	33	35	36	38	39
Scenario C	4	6	9	11	15	20	25	32	41	50	62	75	90	106	123	142

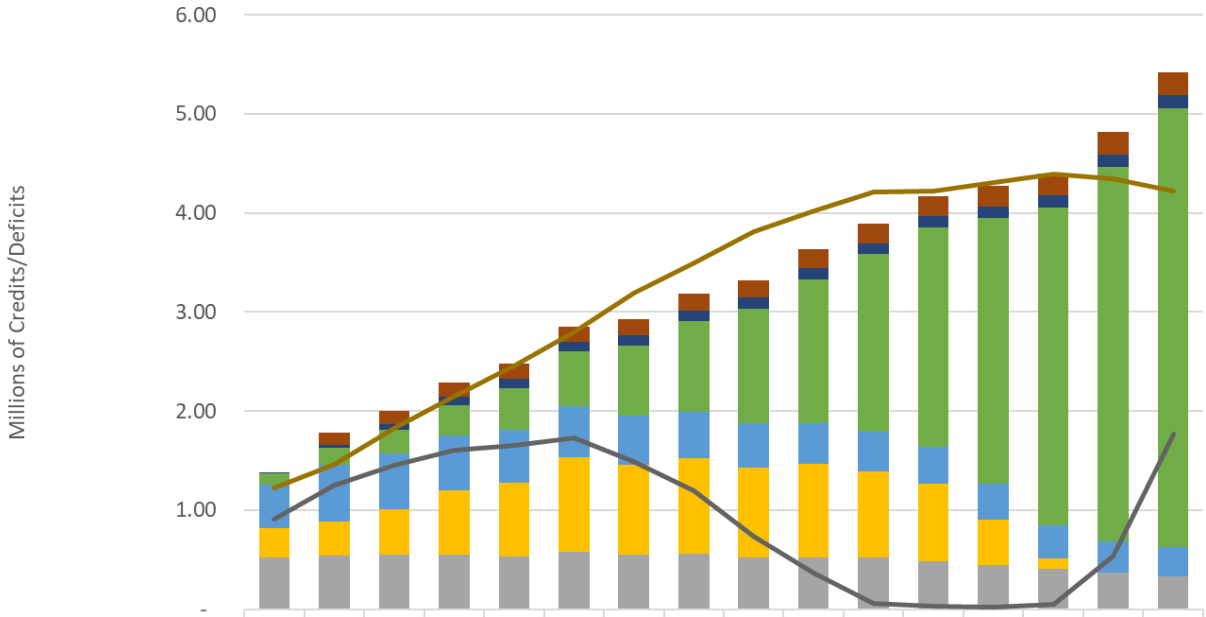
Figure 5. Electricity Fuel Volumes by Scenario

Credits and Deficits

For each scenario, a figure is presented that includes a table with annual credit generation by alternative fuel, the cumulative credit bank in that year (positive carryover of excess credits), and annual deficits. For example, for Figure 6, each colored stacked bar represents credits generated from low carbon fuels; the stacked bars are grouped by biofuels for blending at the bottom and advanced vehicle technologies at the top. The brown line represents the deficits from forecasted gasoline blendstock and ultra-low sulfur diesel (ULSD) consumption. When the bars exceed the brown line (e.g., 2020–2025 in Scenario A), annual credits exceed annual deficits, and banked credits are generated for future compliance. When the bars fall short of the blue line (e.g., 2026-2031), banked credits are used to meet annual compliance.

Scenario A

Figure 6 below shows the credit and deficit results for Scenario A. From 2020 to 2025, credits generated exceed deficits, and the credit bank increases (grey line). This is mainly due to the increased blending of RD combined with the lower compliance levels. From 2026 to 2031, deficits exceed credits and the bank is depleted almost to zero. This result is mainly due to the rapidly increasing stringency of the CFP from 10% in 2025 to 20% in 2030 (a 2% increase per year). As the rate of stringency decreases to a 1% CI increase per year from 2030 to 2035 with an ultimate CI requirement of 25% in 2035, credits and deficits balance out between 2031 and 2033. After 2033, credits from electrification drive over compliance with credits generated exceed deficits.

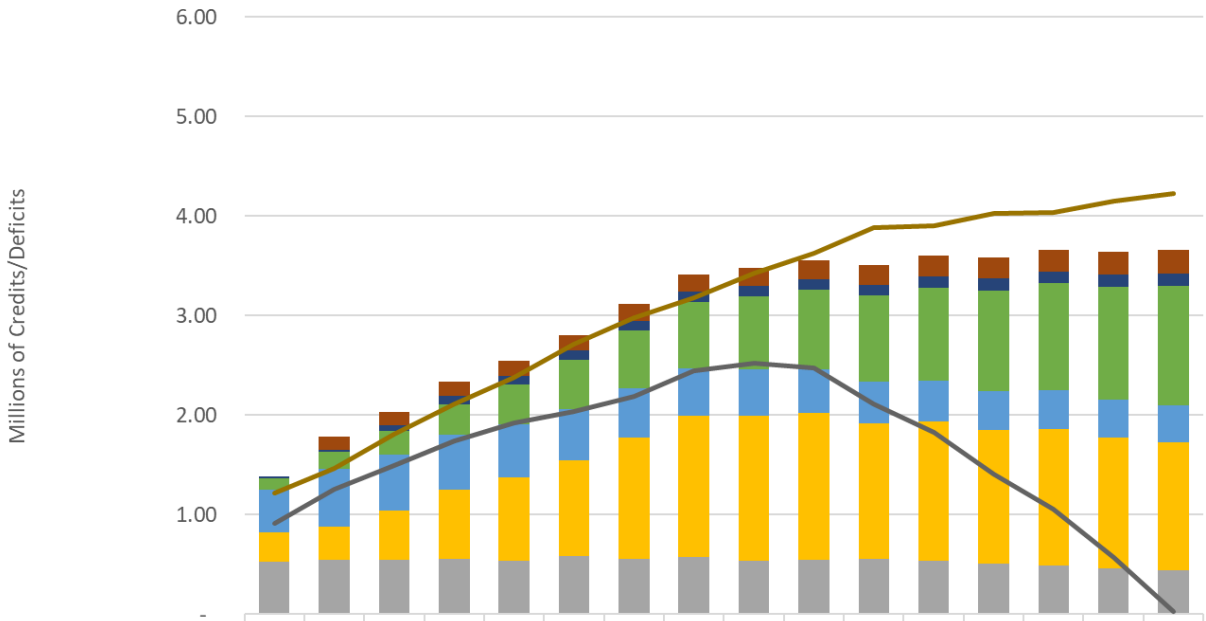


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
OffRoad Electrification	-	0.13	0.14	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.21	0.22	0.23	0.24
CNG/RNG	0.01	0.02	0.06	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.13
Electricity	0.12	0.17	0.23	0.31	0.42	0.55	0.71	0.91	1.16	1.45	1.79	2.21	2.68	3.21	3.78	4.43
BD	0.44	0.58	0.57	0.55	0.54	0.51	0.49	0.47	0.44	0.42	0.39	0.38	0.36	0.34	0.32	0.30
RD	0.29	0.34	0.46	0.64	0.75	0.95	0.91	0.97	0.91	0.94	0.87	0.78	0.46	0.11	-	-
Ethanol	0.52	0.54	0.55	0.55	0.53	0.58	0.55	0.56	0.52	0.52	0.52	0.48	0.44	0.40	0.37	0.33
Credit Bank	0.91	1.25	1.45	1.61	1.66	1.73	1.49	1.20	0.73	0.36	0.06	0.03	0.02	0.05	0.54	1.76
Annual Deficits	1.22	1.46	1.82	2.15	2.45	2.80	3.19	3.50	3.81	4.02	4.21	4.22	4.31	4.39	4.35	4.22

Figure 6. Balance of Credits and Deficits in Scenario A

Scenario B

Figure 7 below shows the credit and deficit results for Scenario B. From 2020 to 2028, credits generated exceed deficits and the credit bank increases (grey line). This result is mainly due to the increased blending of RD combined with higher blend levels to generate credits from higher CI RD and the lower percentage of remaining petroleum ULSD in the blended mix. From 2029 to 2035 deficits exceed credits and the bank is depleted almost to zero, which is mainly due to the increasing stringency of the CFP. The relatively small amount of electrification compared to Scenario B results in higher levels of RD required for compliance, where biofuels in 2035 still account for over 57% of credits generated, while in Scenario A, electrification makes up 85% credits generated in 2035.

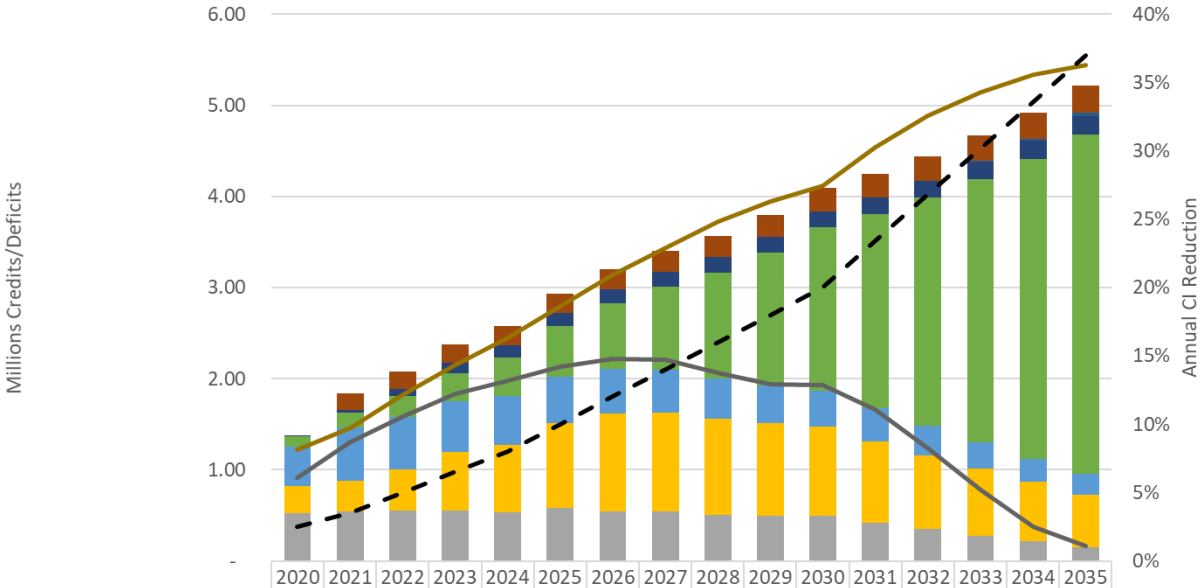


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
OffRoad Electrification	-	0.13	0.14	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.21	0.22	0.23	0.24
CNG/RNG	0.01	0.02	0.06	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.13
Electricity	0.12	0.17	0.23	0.31	0.39	0.49	0.58	0.66	0.73	0.80	0.87	0.94	1.01	1.07	1.13	1.20
BD	0.44	0.58	0.57	0.55	0.54	0.52	0.50	0.48	0.46	0.44	0.42	0.41	0.40	0.39	0.38	0.37
RD	0.29	0.34	0.49	0.69	0.84	0.96	1.21	1.42	1.46	1.47	1.36	1.40	1.34	1.38	1.31	1.29
Ethanol	0.52	0.54	0.55	0.55	0.53	0.58	0.56	0.57	0.54	0.55	0.56	0.53	0.51	0.48	0.46	0.44
Credit Bank	0.91	1.25	1.50	1.74	1.93	2.04	2.19	2.45	2.52	2.47	2.11	1.83	1.41	1.06	0.57	0.03
Annual Deficits	1.22	1.46	1.81	2.11	2.38	2.71	2.98	3.17	3.42	3.62	3.89	3.91	4.02	4.03	4.15	4.22

Figure 7. Balance of Credits and Deficits in Scenario B

Scenario C

Figure 8 below shows the credit and deficit results for Scenario C. Scenario C is unique compared to Scenarios A and B since it is not constrained to comply with a 20% CI reduction by 2030 or a 25% CI reduction by 2035. Scenario C results include a 20% CI by 2030 and a 37% CI reduction by 2035. From 2020 to 2026 credits generated exceed deficits and the credit bank increases (grey line). This is mainly due to the increased blending of RD combined with the lower compliance levels. From 2026 to 2035 deficits exceed credits and the bank is depleted almost to zero in 2035 with the rapidly increasing stringency of the CFP from 10% in 2025 to 20% in 2030, a 2% increase per year, and 20% to 37% from 2030 to 2035, a 3% increase per year. After 2030, electrification credits drive compliance while the RD blend level maintains at 25%, and credits from ethanol decrease with reduced gasoline consumption. With maintaining the RD blend level, increase in natural gas consumption, and inclusion of hydrogen, electrification only contributes 70% of credits in 2035.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
OffRoad Electrification	-	0.18	0.19	0.20	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.26	0.27	0.28	0.28	0.29
H2	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.02	0.04
CNG/RNG	0.01	0.03	0.08	0.12	0.14	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.20	0.20
Electricity	0.12	0.17	0.23	0.31	0.42	0.55	0.71	0.91	1.16	1.45	1.79	2.14	2.50	2.89	3.29	3.72
BD	0.44	0.58	0.57	0.55	0.53	0.51	0.49	0.47	0.44	0.42	0.39	0.36	0.32	0.29	0.26	0.23
RD	0.29	0.34	0.46	0.64	0.74	0.93	1.08	1.08	1.05	1.01	0.98	0.89	0.81	0.73	0.65	0.57
Ethanol	0.52	0.54	0.55	0.55	0.53	0.58	0.54	0.55	0.51	0.50	0.50	0.42	0.35	0.28	0.21	0.15
Credit Bank	0.91	1.31	1.59	1.83	1.98	2.13	2.22	2.20	2.06	1.93	1.93	1.66	1.24	0.78	0.37	0.16
Annual Deficits	1.22	1.46	1.82	2.15	2.45	2.80	3.14	3.44	3.73	3.95	4.12	4.54	4.88	5.15	5.34	5.44
CI Reduction %	3%	4%	5%	7%	8%	10%	12%	14%	16%	18%	20%	23%	27%	30%	34%	37%

Figure 8. Balance of Credits and Deficits in Scenario C

Conclusions

The following are key highlights from the 2021 Illustrative Compliance Scenarios:

- The expanded Clean Fuels Program can be achieved through a diverse fuel supply. In other words, all of the scenarios include a combination of ethanol, biodiesel, and renewable diesel from various feedstocks, electricity, renewable natural gas, and propane to achieve the carbon intensity reduction targets.
- Over-compliance prior to 2025 allows time for the increasing adoption of electric vehicles to build a healthy bank of credits that will carry the Clean Fuels Program to achieve its compliance targets through 2035.
- Current and additional light-, medium- and heavy-duty electrification policies plus expected reductions in the carbon intensity of electricity have the potential for significant credit generation and contribution to compliance of the expanded Clean Fuels Program.
- Renewable diesel is necessary for compliance as the primary drop-in fuel to generate credits and reduce deficits with the existing diesel vehicle fleet.
- The combined potential of renewable diesel plus electrification has the potential to exceed the carbon intensity reduction targets identified in Executive Order 20-04. The critical period for compliance is during the late 2020s to 2030, when the carbon intensity reduction targets are increasing 2% per year, and the zero emission vehicle sales requirements are still ramping up. After 2030, the electric vehicle policies have resulted in modeled populations that can significantly contribute credits and reduce deficit generation by replacing diesel vehicles as the zero-emission vehicle population continues to grow.