Memorandum

To: Bill Peters and Cory Ann Wind | Oregon DEQ

From: Philip Sheehy and Jeff Rosenfeld

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Re: Task 2: 2017 Illustrative Compliance Scenarios Draft Methodology

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Background

The objective of Task 2 of ICF's contract with Oregon DEQ is to update the 2014 illustrative compliance scenarios, develop new 2017 illustrative compliance scenarios to represent compliance for 2016-2025, and create a Scenario Adjustment Tool (SAT) so DEQ can perform minor periodic update to the scenarios. This memorandum presents the methodology for the 2017 illustrative compliance scenarios.

Introduction

In 2014, ICF developed four compliance scenarios based on two fuel scenarios (alternative vehicle technologies vs biofuel blending) and two different diesel baselines (B2 vs B5). Table 1 below shows the compliance scenario matrix.

Table 1. 2014 Compliance Scenarios

Compliance Scenarios	Scenario 1 – Advanced Vehicle Technology	Scenario 2 – Higher Biofuel Blending
B2 Diesel Baseline (2010)	1 – B2	2 – B2
B5 Diesel Baseline (2015)	1 – B5	2 – B5

This memorandum outlines the methodology of the 2017 Illustrative Compliance Scenarios that build on the 2014 scenarios. Since DEQ moved forward with a B5 baseline, for the rest of the report we will remove the B2 and B5 nomenclature and call the scenarios – Scenario 1 and Scenario 2. The underlying premise of each scenario remains the same where Scenario 1 relies on advanced vehicle technologies (e.g. plug-in electric vehicles, PEVs, natural gas vehicles, NGVs, and heavy-duty hybrid electric vehicles, HEVs) and Scenario 2 relies on a higher blending of biofuels.

Methodology

VISION Modeling

ICF updated the Oregon VISION model with the AEO2016 Base Case VISION model projections for values including annual vehicle sales and new vehicle fuel economy. This updated model was used for the 2017 Illustrative Compliance scenarios. Consistent with the previous analysis, US sales projections for light- (autos and trucks separately), medium-, and heavy-duty vehicles were scaled based on the latest 10 years (2006-2015) of Oregon's proportion of US sales. The table below shows Oregon's portion of US sales based on the updated AEO2016 projections.

Table 2. Oregon Portion of US Sales by Vehicle Class

Vehicle Class	10yr Average of Oregon Portion of AEO2016 US Sales
Light-Duty Autos	1.08%
Light-Duty Trucks	0.93%
Medium-Duty Trucks (Class 3-6)	2.35%
Heavy-Duty Trucks (Class 7-8)	1.36%

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 vehicle fleet and resulting projections for diesel fuel are consistently low due to high volume of pass through truck traffic. Calibration of the model is required to match historical Oregon fuel consumption with VISION results. The vision model was calibrated by scaling the VMT so the VISION approximate historical fuel consumption as closely as possible. The figures below show the results from calibrating the light-duty gasoline consumption and heavy-duty diesel consumption with a vehicle miles traveled (VMT) scaling factors of 1.01 and 1.66, respectively. The figures also includes the adjusted fuel consumption projections from the updated 2014 illustrative compliance scenarios for comparison.

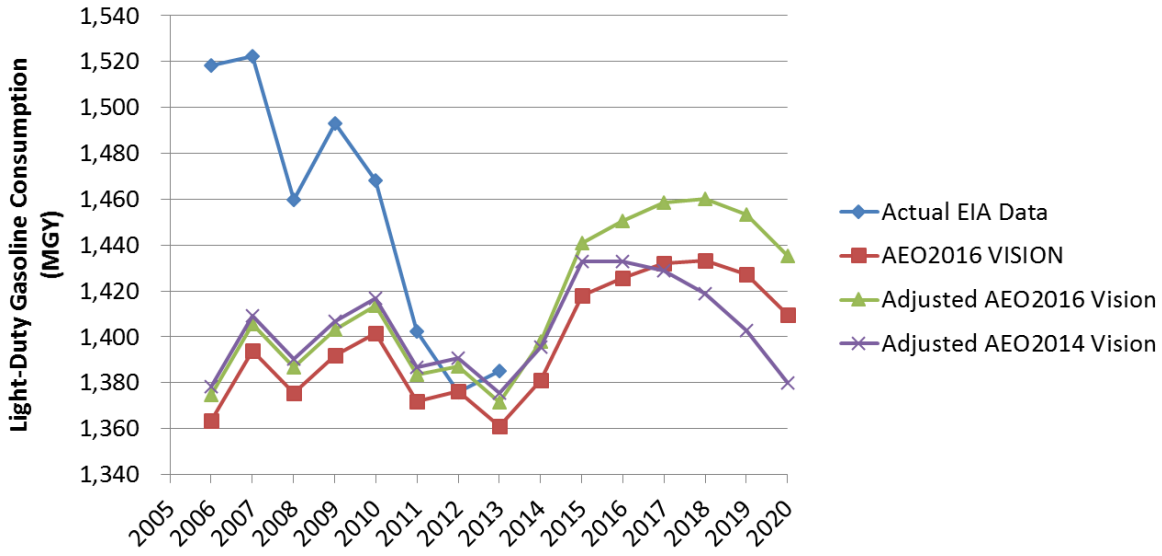

Figure 1 Actual Oregon and VISION Projected Light-Duty Gasoline Consumption

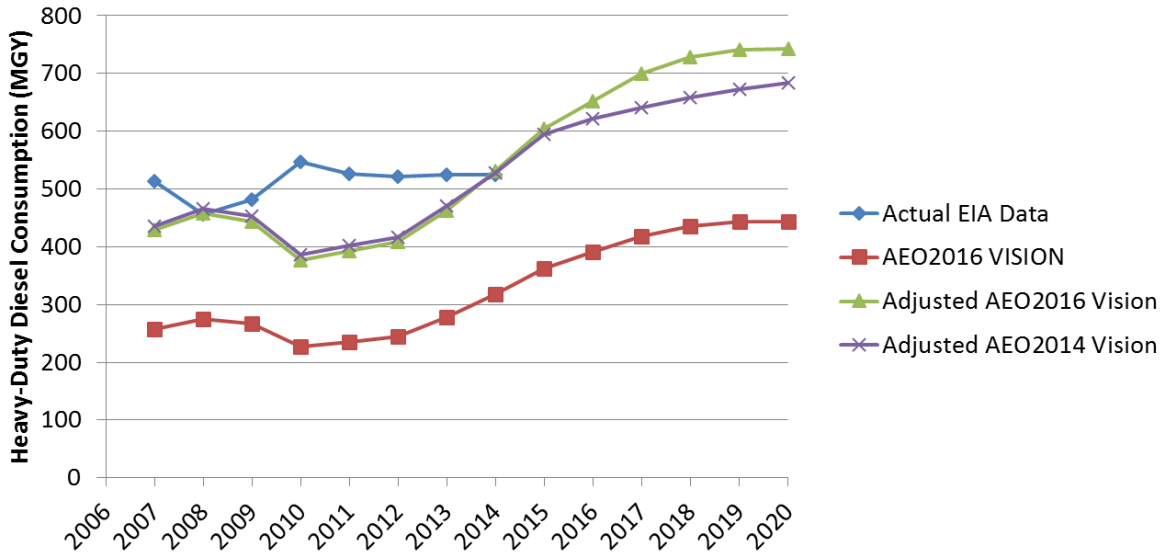

Figure 2 Actual Oregon and VISION Projected Heavy-Duty Diesel Consumption

Figures 1 and 2 above show that AEO2016 has more aggressive sales projections for light, medium and heavy duty vehicles than AEO2014 resulting in increased projected fuel consumption.

Biofuel Feedstocks

DEQ supplied data for the first three quarters (Q1-Q3) of 2016 of biodiesel volumes reported by feedstock. The data shows the feedstock breakdown is currently 77% canola, 12% soy and 11% used cooking oil.

PEV Vehicle Populations - ZEV Mandate

The California Air Resources Board recently published an Advanced Clean Cars Midterm Review[1]. In this review ARB developed three compliance scenarios for California and for Section 177 (S177) ZEV States. A S177 ZEV State is a state that is administering the California ZEV requirements pursuant to section 177 of the federal Clean Air Act. There are currently 9 S177 states: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont. The following table compares the total PEV, BEV and PHEV sales from 2011-2016 as tracked by ZEV Fact sales dashboard[2].

Table 3. 2011-2016 ZEV Sales from ZEV Facts for S177 States

State	Total PEV Sales	BEV Sales	PHEV Sales
CT	4,903	1,832	3,070
ME	1,134	203	931
MD	7,863	2,892	4,971
MA	8,467	3,262	5,205
NJ	10,946	3,991	6,955
NY	19,274	5,497	13,777
OR	10,825	6,600	4,225
RI	841	236	605
VT	1,521	305	1,216
OR % of S177 States	16.5%	26.6%	10.3%

The results from the three scenarios developed by ARB for the S177 States are shown in the table below. The names of the scenarios are Mid Range (Scenario 1), Low Tech (Scenario 2) and High Tech (Scenario 3).

[1] https://www.arb.ca.gov/msprog/acc/acc-mtr.htm
[2] http://www.zevfacts.com/sales-dashboard.html

Table 4. ARB Forecasted Annual PEVs Sales for S177 States

Year	Mid Range Scenario		Low Tech Scenario		High Tech Scenario	
	BEV Sales	PHEV Sales	BEV Sales	PHEV Sales	BEV Sales	PHEV Sales
2018	9,863	58,654	3,075	27,860	8,703	45,498
2019	18,743	72,614	7,375	36,767	17,712	59,598
2020	29,505	92,374	13,702	65,734	29,320	72,356
2021	39,078	105,304	9,962	73,569	41,810	81,066
2022	42,699	109,491	14,391	88,042	44,891	90,212
2023	48,698	119,000	16,862	98,286	52,327	97,958
2024	54,081	127,766	19,208	108,163	60,452	105,116
2025	59,200	136,668	21,548	118,308	68,891	112,311

The Low Tech Scenario assumes a lower percentage of auto makers are making only ZEVs than the High Tech Scenario resulting the Low Tech Scenario relying heavily on PHEVs and increased used of banked credits. Since over 16% of total S177 PEV sales have occurred in Oregon but over 26% of BEV sales have been in Oregon, ICF made the assumption to apply Oregon's share of current PEV sales to the High Tech Scenario to forecast Oregon's PEV sales from the ZEV Mandate. The table below shows Oregon forecasted PEV sales.

Table 5. Oregon Forecasted Annual PEVs Sales Resulting from the ZEV Mandate

Year	Oregon PEV Forecast	
	BEV Sales	PHEV Sales
2018	1,432	7,488
2019	2,915	9,809
2020	4,825	11,908
2021	6,881	13,342
2022	7,388	14,847
2023	8,612	16,122
2024	9,949	17,300
2025	11,338	18,484

The table above shows forecast sales of 162,640 PEVs from 2018-2025. This is a decreased from 185,346 PEVs in the 2014 updated illustrative compliance scenarios. ICF assumed that there will be a 50/50 split between PHEV10 and PHEV40. An important update from AEO2016

that will have an effect on the scenarios is an update to the percent vehicle miles traveled (VMT) that PHEV40 operate in all electric mode. In AEO2014 the all-electric mile VMT was 54% but AEO2016 has an updated value of 62%. Each PHEV40 will now consume 15% more electricity and 17% less gasoline.

Carbon Intensity and Gasoline and Diesel Fuel Standard

The following tables shows the carbon intensities and gasoline and diesel fuel standards utilized for the 2017 illustrative compliance scenarios which are consistent with the carbon intensities utilized for the updated 2014 illustrative compliance scenarios.

Table 6. Oregon Clean Fuel Program Carbon Intensities

Fuel	Carbon Intensity (gCO2e/MJ)
Gasoline Blendstock	100.77
ULSD	101.65
NW Corn Ethanol	53.81
MW Corn Ethanol	69.89
Low CI Corn Ethanol	57.58
Sugarcane Ethanol	51.04
MW Soybean BD	58.25
NW Canola BD	57.84
NW Yellow Grease BD	18.12
Waste Oil RD	19.25
NW Tallow BD	37.93
Tallow RD	19.25
CNG	79.93
Electricity	120.27
RNG (CNG)	40.00
Corn Oil BD	36.89
Sorghum Ethanol	75.00

The gasoline and diesel standards for 2016-2025 are shown in the table below.

Table 7. Gasoline and Diesel Standards

Fuel	Gasoline Standard (gCO2e/MJ)	Diesel Standard (gCO2e/MJ)
2016	98.37	99.39
2017	98.13	99.14
2018	97.63	98.64
2019	97.14	98.15
2020	96.15	97.15
2021	95.17	96.15
2022	93.69	94.66
2023	92.21	93.16
2024	90.73	91.67
2025	88.76	89.68

Assumptions for Fuels that Substitute for Gasoline

The table below presents the assumptions for fuels that substitute for gasoline.

Table 8. Fuels That Substitute for Gasoline

Fuel	Assumption
Corn Ethanol, MW	The balance of ethanol consumed in Oregon will be MW corn
Corn Ethanol, NW	Pacific Ethanol Columbia has a production capacity of 40 MGPY, assume up to 40 MGPY stay in Oregon
Corn/Sorghum Ethanol, Low Carbon Intensity	An additional 302 MGPY of capacity exists in the Oregon NW region in addition to the Pacific Ethanol Columbia facility, another 150 MGPY of low CI corn ethanol could be consumed
Sugarcane Ethanol	Up to 50 million gallons per year of sugarcane ethanol could be consumed in Oregon
Cellulosic Ethanol	Consumption only if necessary to meet the standard
Electricity	For Scenario 1, ICF considered the potential for all PHEVs in the to be PHEV40s and not a split between PHEV10 and PHEV40
Natural Gas	The balance of natural gas consumed, after taking into account renewable natural gas, will be fossil
Renewable Natural Gas	It is assumed that up to 90% of natural gas consumption in Scenario 1 and 99% in Scenario 2 (since the volumes are much smaller) could be from biogas
Propane	It is assumed that propane consumption will reach a maximum of 1% of total natural gas consumption.

Assumptions for Fuels that Substitute for Diesel

The table below presents the assumptions for fuels that substitute for diesel. There is also one technology, hybrid-electric vehicles (HEVs), in the diesel fleet that is included below.

Table 9. Fuels That Substitute for Diesel

Fuel	Assumption
Soy Biodiesel	Will be the balance biodiesel after accounting for the other feedstocks
Waste Grease/UCO Biodiesel	Will maintain the current waste grease portion of biodiesel consumption of 11% of all biodiesel consumed for as long as possible until more lower CI feedstocks are required
Canola Oil Biodiesel	Will maintain the current canola portion of biodiesel consumption of 77% of all biodiesel consumed for as long as possible until more lower CI feedstocks are required
Corn Oi Biodiesel	Corn oil biodiesel will be used as needed for the compliance scenarios
Renewable Diesel	A conservative assumption was made to remain at a an average statewide 2% blend with a maximum of 10 million gallons per year from tallow and the balance from waste oil
Natural Gas	It is assumed that up to 90% of natural gas could come from biogas. For Scenario 1, it is assumed that medium and heavy duty CNG vehicle sales increase to the point where 5% of diesel pool fuel consumption in 2025 is a combination of natural gas, biogas and LPG; updated to 5% from 10% based on the California
Propane	It is assumed that propane consumption will reach a maximum of 1% of total natural gas consumption.
HEVs	In Scenario 1, the assumption is made that HEVs achieve 10% sales penetration in the medium- and heavy-duty markets. The business as usual (BAU) case and Scenario 2 do not included medium- and heavy-duty HEVs

Overall, the previous assumptions have been to cap the biodiesel blend at 10% and maintain a R2 blend as long as possible. Another option for the 2017 illustrative scenarios is to maintain the B5 blend and allow a R5 average statewide blend. Note that an average statewide blend does not mean that all fuel is blended to 5% renewable diesel but on average 5% of the liquid fuel volume in the diesel pool is renewable diesel.