

Memo

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From: Michael F. Lawrence, Lawrence@jfaucett.com

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Re: Basic Data Assumptions in Response to Requests Made at October 14 Meeting

During our presentation to DEQ last Thursday, October 14, 2010, we received inquiries for data regarding the assumptions used for projections of fuel prices, vehicle VMT, carbon coefficients and the fuel-price elasticity of VMT. We are providing our response to those questions in this memo.

Fuel Prices

Three different sets of fuel prices were used. One standard set of assumptions was used for most scenarios. A “high oil price” projection was used for Scenario F, and a “low oil price” projection was used for Scenario G. (Scenarios F and G were completed to measure the impact of different fuel prices on a biofuels-focused LCFS pathway.)

All fuel prices in the tables below are expressed in 2008 dollars per “gasoline gallon equivalents,” which means that the price is the cost of whatever amount of that fuel contains the same energy content as a gallon of gasoline. Different fuels have different energy contents per unit, and some are not easily measured in gallons (such as natural gas and electricity). This energy-content comparison allows an apples-to-apples measurement of price per unit of energy.

Standard Price Projection (dollars per gas gallon equivalent, 2008\$)

	Gasoline	Diesel	Methanol	CNG	Electricity	Ethanol	Hydrogen	F-T Dsl	Biodsl
2012	2.92	2.75	2.60	1.45	2.48	2.96	11.01	3.88	4.58
2013	3.14	2.87	2.53	1.41	2.48	3.18	10.85	4.04	4.77
2014	3.26	2.96	2.51	1.40	2.43	3.31	10.69	4.17	4.93
2015	3.36	2.99	2.55	1.42	2.41	3.26	10.53	4.24	5.00
2016	3.39	2.99	2.58	1.44	2.42	3.46	10.36	4.29	5.07
2017	3.46	3.12	2.60	1.44	2.43	3.53	10.20	4.47	5.27
2018	3.49	3.18	2.61	1.45	2.41	3.62	10.04	4.55	5.38
2019	3.52	3.21	2.63	1.46	2.39	3.77	9.88	4.59	5.43
2020	3.57	3.21	2.66	1.48	2.39	3.91	9.72	4.65	5.49
2021	3.59	3.25	2.65	1.47	2.39	3.71	9.55	4.70	5.55
2022	3.63	3.28	2.66	1.48	2.38	3.69	9.39	4.76	5.62

High Oil Price Projection (dollars per gas gallon equivalent, 2008\$)

	Gasoline	Diesel	Methanol	CNG	Electricity	Ethanol	Hydrogen	F-T Dsl	Biodsl
2012	3.40	3.12	2.60	1.45	2.48	2.81	11.01	4.14	4.89
2013	3.74	3.42	2.53	1.41	2.48	3.00	10.85	4.53	5.35
2014	4.18	3.76	2.51	1.40	2.43	3.03	10.69	4.99	5.89
2015	4.52	4.04	2.55	1.42	2.41	2.91	10.53	5.36	6.33
2016	4.70	4.29	2.58	1.44	2.42	3.07	10.36	5.69	6.71
2017	4.89	4.54	2.60	1.44	2.43	3.09	10.20	6.02	7.10
2018	5.05	4.70	2.61	1.45	2.41	3.14	10.04	6.23	7.36
2019	5.19	4.86	2.63	1.46	2.39	3.26	9.88	6.44	7.60
2020	5.28	4.97	2.66	1.48	2.39	3.39	9.72	6.58	7.77
2021	5.35	5.02	2.65	1.47	2.39	3.17	9.55	6.66	7.86
2022	5.41	5.04	2.66	1.48	2.38	3.15	9.39	6.69	7.90

Low Oil Price Projection (dollars per gas gallon equivalent, 2008\$)

	Gasoline	Diesel	Methanol	CNG	Electricity	Ethanol	Hydrogen	F-T Dsl	Biodsl
2012	2.39	2.16	2.60	1.45	2.48	3.12	11.01	3.61	4.27
2013	2.32	2.12	2.53	1.41	2.48	3.43	10.85	3.56	4.20
2014	2.32	2.10	2.51	1.40	2.43	3.59	10.69	3.53	4.16
2015	2.29	2.08	2.55	1.42	2.41	3.58	10.53	3.58	4.23
2016	2.29	2.05	2.58	1.44	2.42	3.80	10.36	3.63	4.28
2017	2.31	2.06	2.60	1.44	2.43	3.88	10.20	3.65	4.31
2018	2.29	2.05	2.61	1.45	2.41	3.98	10.04	3.67	4.33
2019	2.31	1.95	2.63	1.46	2.39	4.14	9.88	3.68	4.35
2020	2.31	1.94	2.66	1.48	2.39	4.29	9.72	3.73	4.40
2021	2.32	1.93	2.65	1.47	2.39	4.10	9.55	3.72	4.39
2022	2.36	1.94	2.66	1.48	2.38	4.08	9.39	3.74	4.41

VMT Assumptions

VMT projections were customized to Oregon by TIAX in their work modeling various scenarios in VISION. At the baseline, based on estimates of actual light duty VMT from 2007, 2008 and 2009, light-duty VMT per vehicle (i.e. annual vehicle mileage) was estimated to be 23.1% higher than the VISION model's projected value. Future predicted values were also projected using this 23.1% magnifier applied to the baseline for projected VMT per vehicle. Heavy-duty VMT were also adjusted using the same methodology and an adjustment factor of -2.6% was developed for VISION's heavy-duty VMT projections.

VMT projections vary by vehicle type within the light-duty fleet, so there is no single "VMT per vehicle" value to report. Each of 22 different vehicle types (eleven for autos and the same eleven for light trucks) has a different VMT per vehicle projection. Very different projections are used for each of six different categories in the heavy-duty fleet, on which the biodiesel pathways focused. The full VISION model's assumptions for VMT are available as part of the model at the website of Argonne National Laboratories (http://www.transportation.anl.gov/modeling_simulation/VISION/).

The table below represents weighted averages of the auto, light truck and overall light-duty vehicle fleets:

VMT per Vehicle (Light Duty):

	Autos	Lt. Trucks	All LDVs
2012	14,638	15,313	14,970
2013	14,673	15,101	14,885
2014	14,692	14,882	14,786
2015	14,704	14,692	14,698
2016	14,742	14,549	14,646
2017	14,821	14,409	14,617
2018	14,870	14,341	14,610
2019	15,025	14,378	14,709
2020	15,161	14,447	14,815
2021	15,337	14,522	14,947
2022	15,421	14,720	15,089

VMT Sensitivity to Fuel Prices

The analysis of Oregon's low-carbon fuel standard pathways retained an elasticity formula already built into Vision. This elasticity formula assumes an elasticity factor of **-0.1**, meaning that a 1% change in the fuel price encountered results in a -0.1% change in VMT driven. The formula is actually applied to a price per mile of fueling the vehicle, allowing the calculation to take into account projected changes in vehicle miles per gallon. This allows for a scenario in which fuel price increases and fuel efficiency gains provide offsetting influences on the per-mile cost of fuel to the driver (one raising the cost and the other lowering the cost).

Carbon Coefficients of Fuels (Carbon Intensity)

Carbon Intensities were developed specifically for the Oregon LCFS analysis. Different values are projected for different types of biofuels, as well as for conventional fuels and alternate fuels such as CNG and electricity. Indirect land use change was modeled as a penalty to the carbon intensity of certain biofuels in some of the compliance scenarios, but not others. This value also varied based on the extent to which different feedstocks are expected to drive land use change and are taken from CARB. The tables below express carbon intensity for the full range of fuels considered. In these tables, CNG refers to compressed natural gas, MW refers to Midwest, NW refers to Northwest, C refers to carbon, SB refers to soybean, and BD refers to biodiesel.

These carbon intensities also reflect a modification to demonstrate efficiency factors, or Energy Economy Ratio (EER). Electricity in the state of Oregon, for example, is more carbon intensive than gasoline per unit of energy, but electric vehicles are three to four times more efficient per unit of energy. The high carbon intensity is adjusted by the projected efficiency of vehicles using electricity. This adjustment also explains why compressed natural gas has two different values, depending on the fuel it displaces. Diesel is slightly more efficient than gasoline, and so CNG does not achieve the same efficiency-weighted carbon intensity when displacing diesel that it achieves when displacing gasoline.

The carbon intensity also reflects the requirements of the EPA renewable fuel standard (RFS). The RFS mandates that all new corn ethanol has to be 20% below gasoline, so the decrease is showing the linear integration of 20% lower CI ethanol between now and 2022.

Adjusted g/Mj	Gasoline	Ultra Low Sulfur Diesel	Diesel for medium & heavy duty	Average Ethanol	Average Biodiesel	CNG displacing gasoline	CNG displacing diesel	Electricity
2012	92.3	91.5	91.5	91.49355	69	71	79	40
2013	92.3	91.5	91.5	90.4906	62	71	79	41
2014	92.3	91.5	91.5	89.19638	59	71	79	42
2015	92.3	91.5	91.5	87.15795	57	71	79	43
2016	92.3	91.5	91.5	85.13719	54	71	79	44
2017	92.3	91.5	91.5	83.06835	52	71	79	45
2018	92.3	91.5	91.5	80.91059	51	71	79	47
2019	92.3	91.5	91.5	78.95399	50	71	79	48
2020	92.3	91.5	91.5	76.82546	48	71	79	49
2021	92.3	91.5	91.5	73.94574	47	71	79	49
2022	92.3	91.5	91.5	71.71509	46	71	79	49

Adjusted g/Mj	NW Ethanol MW corn	MW Ethanol MW corn	Low C MW Corn	Imported Cellulosic Ethanol	NW Ethanol Forest Residue	NW Ethanol Farmed Trees
2012	86.0	94.2	76.0	20.7	20.0	20.5
2013	86.0	93.9	76.0	20.7	20.0	20.5
2014	86.0	93.6	76.0	20.7	20.0	20.5
2015	86.0	93.3	76.0	20.7	20.0	20.5
2016	86.0	92.9	76.0	20.7	20.0	20.5
2017	86.0	92.6	76.0	20.7	20.0	20.5
2018	86.0	92.3	76.0	20.7	20.0	20.5
2019	86.0	92.0	76.0	20.7	20.0	20.5
2020	86.0	91.7	76.0	20.7	20.0	20.5
2021	86.0	91.4	76.0	20.7	20.0	20.5
2022	86.0	91.1	76.0	20.7	20.0	20.5

Adjusted g/Mj	NW Wheat Straw	Brazil Sugarcane	MW SB BD	NW Canola BD	Waste Grease	Imported Cell BD
2012	20.9	72.4	82.0	26.0	13.6	36.6
2013	20.9	72.4	82.0	26.0	13.6	36.6
2014	20.9	72.4	82.0	26.0	13.6	36.6
2015	20.9	72.4	82.0	26.0	13.6	36.6
2016	20.9	72.4	82.0	26.0	13.6	36.6
2017	20.9	72.4	82.0	26.0	13.6	36.6
2018	20.9	72.4	82.0	26.0	13.6	36.6
2019	20.9	72.4	82.0	26.0	13.6	36.6
2020	20.9	72.4	82.0	26.0	13.6	36.6
2021	20.9	72.4	82.0	26.0	13.6	36.6
2022	20.9	72.4	82.0	26.0	13.6	36.6

Please keep in mind that a full description of the analytical methodology will be part of the final report for this project. If DEQ seeks a better understanding of particular inputs, please let us know.