



Memorandum

To: Bill Peters and Cory Ann Wind | Oregon DEQ
From: Philip Sheehy and Jeff Rosenfeld
Date: January 2017, Final
Re: Task 1: 2017 Forecast

Background

The objective of Task 1 of ICF's contract with Oregon DEQ is to design and develop a forecasting tool to serve as the analytical basis for DEQ's decision making as it relates to the potential deferral due to the clean fuel supply.

The 2017 forecast focuses on a) the estimated credits needed to meet the clean fuel standard and b) the estimated total aggregated credits available. ICF continues to develop the forecasting tool for use in subsequent forecasts. This version of the 2017 forecast relies on the same structure of the Fuel Forecast Tool and is based on a) demand side inputs, b) fuel supply, c) and carbon intensity estimates.

Fuel Forecast, 2017

Estimated Credits Needed

The State Energy Data System (SES) of the US Energy Information Administration (EIA) indicates modest growth for motor gasoline consumption over the last several years (see figure below). The Oregon Department of Transportation (ODOT) reports that the fuels tax revenue is on track for a 5.6 percent growth in 2016.¹ ODOT also forecasts an increase in motor vehicle fuels and passenger vehicle registrations of 1.2 percent from 2016 to 2017.² This growth is largely driven by increases in total employment statewide, with a focus on non-farm employment. Using these data, ICF estimates 1,586 million gallons of gasoline consumption (as E10) in 2017.

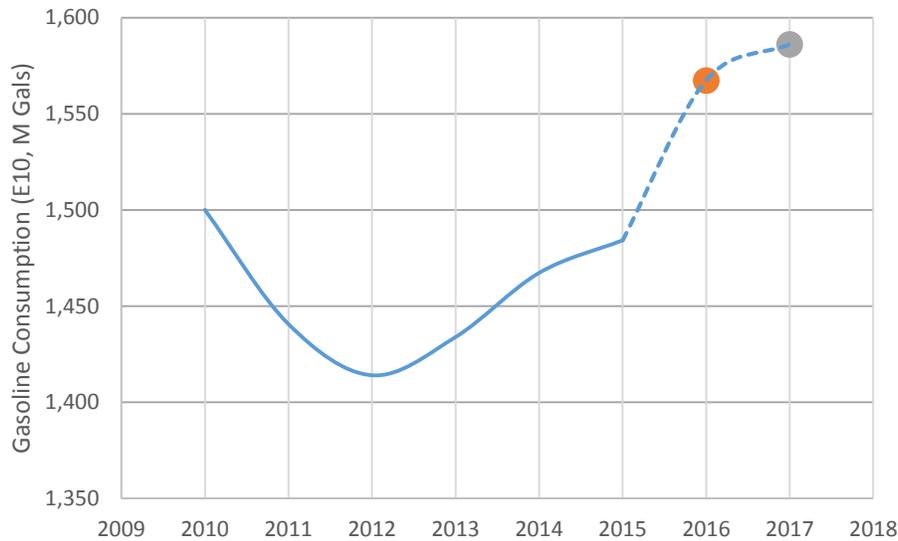
¹ The Future of Transportation Funding: The Forecasted Decline of Motor Fuel Tax and Potential Alternatives, ODOT, September 2016. Available online at:

https://www.oregon.gov/ODOT/HWY/RUFPP/Sept%202016%20Meeting%20Materials/ItemF_RUCEconomicReport.pdf

² ODOT, June 2016 Revenue Forecast. Available online at: <http://library.state.or.us/repository/2016/201607220802105/Jun2016.pdf>



Figure 1. Gasoline Fuel Consumption in Oregon, 2010—2017



The US EIA SEDS data indicate modest growth for on-road diesel consumption over the last several years; however, data for 2015 are not yet available as of publication. ICF reviewed motor vehicle fuels estimated via ODOT’s fuel taxable distribution records, which does not distinguish between gasoline and diesel consumption. If we remove the known volumes of gasoline (based on SEDS data); however, we estimate about an 8 percent increase between 2014 and 2015 (see figure below). As noted above, ODOT reports that the fuels tax revenue is on track for a 5.6 percent growth in 2016.³ ODOT also forecasts an increase in motor vehicle fuel consumption of 1.2 percent from 2016 to 2017.⁴ This growth is largely driven by increases in total employment statewide, with a focus on non-farm employment. Using these data, ICF estimates 775 million gallons of diesel consumption (which includes biodiesel blend requirements) in 2017.

The growth from either 2015 to 2017 (gasoline) or 2014 to 2017 (diesel), while based on ODOT’s tax growth projections, produce aggressive consumption increases. The use of more aggressive conventional fuel forecasts result in a more conservative 2017 Forecast. Larger volumes of forecasted fuel consumption result in a larger number of deficits generated and conversely more credits required for compliance.

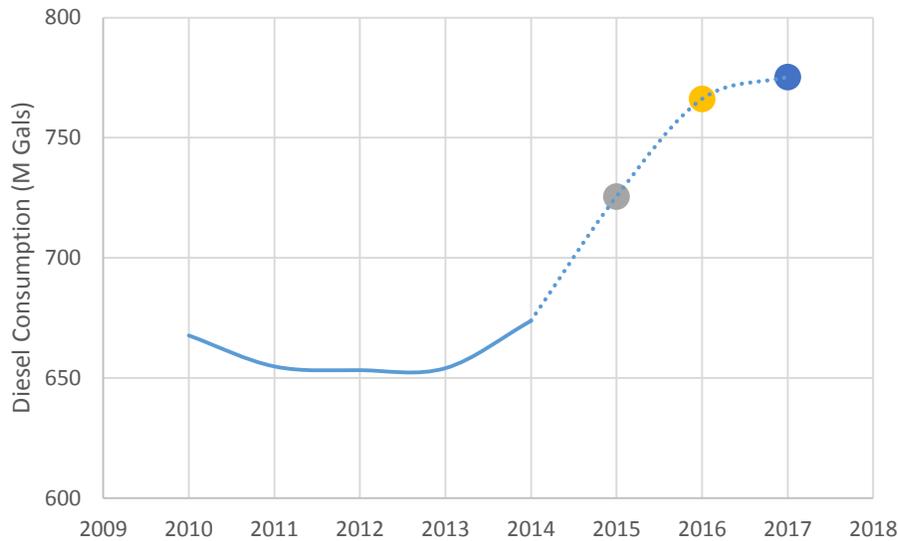
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Figure 2. Diesel Fuel Consumption in Oregon, 2010—2017



Based on ICF estimates of gasoline (as blendstock) and diesel consumption, a net of 677,000 deficits would be generated in 2017 (see table below).

Table 1. Estimated Gasoline and Diesel Consumption in Oregon, 2017

| Fuel | Demand (M Gals) | Deficits |
|---------------------|-----------------|----------------|
| Gasoline Blendstock | 1,428 | 437,500 |
| Diesel | 737 | 239,400 |
| Total | | 676,900 |

For future years, the estimation of conventional fuel consumption and deficit generation will become more streamlined. DEQ will have complete historic datasets for gasoline and diesel volumes that are covered by the Clean Fuels Program that will assist in making future forecasts.

Credit Generation Potential

The table below summarizes the initial forecasts for deficit generation, banked credits, and credit generation based on ICF’s analysis of gasoline substitutes and diesel substitutes. The banked credits for 2016 are estimated based on data provided by Oregon DEQ.

ICF notes that the forecasted volume of gasoline and/or diesel consumed would change depending on the low and high ends of *some* of the estimates, thereby decreasing the deficits generated.

- For instance, the forecasted estimate of about 740 million gallons of diesel fuel consumed assumes biodiesel consumption (at a 5% blend rate), but it does not assume any renewable diesel consumption. Each gallon of renewable diesel consumed would generate credits, as well as decrease the number of deficits generated by displacing diesel. Given that the low carbon fuels outlined in the table below are at low levels of penetration to date, we have not accounted for this type of interaction for the 2017 fuel



forecast. These interactions, however, will be accounted for in the final version of the Fuel Forecast Tool.

Table 2. Estimated Fuel Demand/Supply and Credit/Deficit Generation in 2017 for Oregon CFP

| Fuel | Demand / Est Supply | Deficits | Credits |
|-----------------------------|---------------------|----------------|--------------------------|
| Gasoline Blendstock | 1,428 MGals | 437,500 | |
| Diesel | 737 MGals | 239,400 | |
| <i>Banked Credits, 2016</i> | | | 160,000 |
| Gasoline Substitutes | | | |
| Ethanol | 160—190 MGals | | 200,000—600,000 |
| Electricity | 38—40 GWh | | 41,000—43,700 |
| Diesel Substitutes | | | |
| Biodiesel | 40—45 MGals | | 190,000—280,000 |
| Renewable Diesel | 40—50 MGals | | 265,000—395,000 |
| Natural Gas | 1.7—3.0 MDGE | | 4,500—15,000 |
| Propane | 0.8—1.3 MGals | | 1,200—2,000 |
| TOTAL | | 676,900 | 862,000—1,496,000 |

Gasoline Substitutes

ICF forecasted the consumption and corresponding credit generating potential of ethanol and electricity used in light-duty plug-in electric vehicles as so-called gasoline substitutes.

- Ethanol: Based on certified fuel pathways and potential pathways that could come online for 2017, ICF estimates that there are at least 440,000 credits available in the market for ethanol. If we assume that the amount of ethanol blended into gasoline is limited to 10 percent (and there are no sales of higher blends of ethanol e.g., as E85), then an average carbon intensity of 60.5 g/MJ is required to generate 440,000 credits. ICF’s review of existing pathways, production capacity at registered facilities, production capacity at facilities that have the potential to deliver ethanol to the Oregon market (including imports e.g., from Brazil), we forecast an upper limit of about 600,000 credits. Consider the existing pathways from ethanol production facilities below:
 - Pacific Ethanol Columbia (ETHCOR003), 53.81 g/MJ, 108 MGPY
 - Guardian Janesville (ETHCOR004), 62.40 g/MJ, 110 MGPY
 - Guardian Hankinson (ETHCOR005), 60.11 g/MJ, 132 MGPY
 - Pacific Ethanol Magic Valley (ETHCOR006), 54.00 g/MJ, 60 MGPY

With an estimated ethanol demand of roughly 150—160 million gallons in 2017, there is more than sufficient ethanol to meet the median estimate of 440,000 credits. The lower estimate in the table above (200,000 credits) assumes that corn ethanol with a carbon intensity of 73-75 g/MJ is blended into gasoline. The upper limit assumes an average carbon intensity of delivered ethanol at 50-52 g/MJ.



- Electricity: Registration data from sales dashboard from the Auto Alliance⁵ indicate that nearly 11,000 plug-in electric vehicles were registered in Oregon through October 2016. If sales in 2017 hold flat at 2016 levels, then that would take the registered PEV population of about 14,800 vehicles. Low gasoline prices, among other factors, have had an impact on PEV sales; most indications to date suggest that PEV sales have held steady rather than declined significantly. If the market for PEVs falters significantly in Oregon, and return to sales levels similar to 2015 for instance, then we estimate that the PEV population would be around 13,700 vehicles. Using these numbers, we estimate the number of credits from electric vehicles in the range of 41,000—43,700 credits.⁶

Table 3. Cumulative electric vehicle registrations in Oregon, 2011—2016

| Vehicle Type | 2011 | 2012 | 2013 | 2014 | 2015 | 2016* | 2017 estimated |
|--------------|------|------|-------|-------|-------|-------|----------------|
| BEV | 480 | 831 | 2,086 | 3,379 | 4,956 | 6,929 | 8,506—8,902 |
| PHEV | 84 | 712 | 1,466 | 2,262 | 3,016 | 4,467 | 5,221—5,918 |

*Data from Auto Alliance are provided through October 2016; ICF extrapolated linearly to estimate 2016 total sales

ICF notes that there are no hydrogen fuel cell vehicles currently registered in Oregon and we do not anticipate any sales for 2016 or 2017.

Diesel Substitutes

ICF forecast the consumption and corresponding credit generating potential of biodiesel, renewable diesel, natural gas, and propane as so-called diesel substitutes.

- **Biodiesel:** With a 5% blending requirement in place, regulated parties can seek lower carbon biodiesel via feedstock switching or increase blending levels. There are more than 50 stations in Oregon that can dispense up to a 20% blend. The 5% blend rate, coupled with ICF’s 2017 diesel consumption forecast, implies that at least 39 million gallons of biodiesel could be consumed in 2017. ICF estimates that between 190,000—280,000 credits can be generated via biodiesel consumption in 2017. The low end of the range assumes a carbon intensity of 58 g/MJ, equivalent to the Oregon default pathway for biodiesel produced from canola oil (BIODOR004). The high end of the range assumes a carbon intensity of 40 g/MJ, which would be achieved through some combination of used cooking oil biodiesel (default pathway of 18 g/MJ), corn oil biodiesel (default pathway of 37 g/MJ), and canola oil biodiesel.
- **Renewable diesel:** There are no blending constraints for renewable diesel that impact engine warranties or retail infrastructure. The domestic and international capacity of renewable diesel that can be imported to the west coast (via barge or railcar) by 2017 is on the order of 400—500 million gallons. If Oregon gets a “fair share” of renewable diesel going to carbon constrained markets (which include California and British Columbia at this point in the transportation sector), then we estimate that 40—50 million gallons of renewable diesel could be consumed in Oregon, which would generate 265,000—395,000 credits with assumed carbon intensities of 35—45 g/MJ.

⁵ Auto Alliance Sales Dashboard, available online at <http://www.zevfacts.com/sales-dashboard.html>.

⁶ We assume that BEVs consume about 3,500 kWh annually and PHEVs consume about 1,500 kWh annually.



- **Natural gas:** The US EIA reports that about 1.25 and 1.39 million DGE of natural gas was used as a vehicle fuel in 2014 and 2015, respectively, in Oregon. Those numbers represent 7% and 12% growth, respectively from previous years. At an average and modest growth rate of 9%, we forecast natural gas consumption in the range of 1.7 million DGE. This growth can definitely be accommodated, if not surpassed significantly in the state. For instance, the Alternative Fuels Data Center (AFDC) indicates that there are 21 compressed natural gas (CNG) stations and 3 liquefied natural gas (LNG) stations as of 2016 statewide. There are 14 planned CNG stations and 1 planned LNG station in Oregon. A more aggressive deployment of natural gas, in line with the expansion of fueling station availability for instance, has natural gas consumption in the range of 3.0 million DGE. Depending on the source of natural gas, which may be fossil or renewable, ICF estimates that between 4,500—15,000 credits could be available from natural gas in 2017. The lower and higher ends of the estimate assume the natural gas is exclusively fossil (at 68 g/MJ) and renewable (at 35 g/MJ), respectively.
- **Propane:** There are limited data available regarding propane consumption in Oregon. The US EIA reports that the state fleet consumption was around 19,000 gasoline gallon equivalents as of 2014. However, that number has been decreasing over time. Neither of the major transit providers in Oregon use propane. However, propane has gained substantial traction in the school bus market, with nearly 700 propane school buses deployed statewide.⁷ ICF estimates that there could be 0.8—1.3 million gallons of propane consumed annually by 2017, which would generate with an estimated 1,200—2,000 credits with a carbon intensity of 83 g/MJ.

Review of Methodology

ICF's methodology for the tool is based on the following components: a fuel demand component, a fuel supply component (with multiple facets driving the supply estimate), and a carbon intensity component.

- **Demand side inputs**
 - **Vehicle stock:** ICF worked with DEQ to obtain vehicle registration data, including new vehicle registrations—distinguished by vehicle type to the extent feasible. The vehicle stock is used to assess continually the potential for advanced vehicle technologies that use lower carbon fuels. ICF continues to improve our inventory of commercial vehicle registrations, with a focus on fleets, to identify the potential adoption of alternative fuels in those fleets.
 - **Fuel consumption:** ICF tracked Oregon fuel consumption and trends via fuel tax data collected, as well as other sources, such as the Energy Information Administration.
- **Fuel Supply**
 - **Fuels and associated feedstocks:** The fuels and applications eligible for the Clean Fuels Program are outlined in the regulation—ethanol, biodiesel,

⁷ Propane School Buses: Benefits and Opportunities for States, Propane Education and Research Council, 2016. Available online at <http://annualmeeting.naseo.org/Data/Sites/10/media/presentations/Williss-Propane-School-Buses.pdf>



renewable diesel, hydrogen, electricity, natural gas, propane, and biogas. For each fuel type, ICF included the feedstocks for consideration in the tool. These feedstocks include those used in accepted pathways and potential pathways based on ICF review of emerging conversion technologies.

- **Regional fuel supply:** ICF is tracking fuel supply for each fuel type on a regional basis. ICF is using the nine regions employed in the EIA's Annual Energy Outlook—New England, Middle Atlantic, East Coast North Central, West Coast North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific. ICF also has a 10th region referred to as imports. Where possible, ICF documents the fuel production on a facility-basis; however, for modeling purposes, these point sources will be aggregated together into regions.
- **Supply chain infrastructure constraints (Out-of-state):** For each region, ICF assesses the supply chain infrastructure constraints that inhibit or facilitate the delivery of fuel to Oregon. ICF's forecast focuses on the physical constraints to fuel supply.
- **State-wide fueling infrastructure:** ICF developed an updated inventory of state-wide downstream fueling infrastructure such as blending and storage terminals, natural gas pipeline distribution, and fueling stations. This information helps determine qualitatively the impact of fueling infrastructure on the supply of low carbon fuels within Oregon. Where appropriate, ICF considers any regulations or ordinances that explicitly constrain the supply of alternative transportation fuels.
- **Carbon intensity estimates**
 - ICF assigns a carbon intensity for each facility documented. In most cases, ICF has used carbon intensity values reported to DEQ. Where necessary, ICF uses the GREET model to develop carbon intensity estimates for fuels.

Data and Metrics

The underpinning of the proposed tool is robust and defensible data. The table below outlines ICF's sources for various data points relevant to the three components listed above: demand side inputs, fuel supply, and carbon intensity estimates.



Table 4. Data and Sources for Fuel Forecast Tool

| Model Component | Data / Metric | Potential Sources |
|--|--|---|
| Demand side inputs | Past OR fuel consumption and trends | <ul style="list-style-type: none"> Fuel tax data collected by ODOT Check against EIA reported data Travel Oregon (Oregon Tourism Commission) |
| | OR and nationwide alt fuel trends | <ul style="list-style-type: none"> ODOT / OR DEQ where possible EIA data Clean Cities Coalitions (mainly for fleet-related consumption) Trade organizations |
| | Alt fuel vehicle deployment | <ul style="list-style-type: none"> State of Oregon DMV IHS Automotive (formerly RL Polk; data available for purchase) |
| | Projected total fuel consumption | <ul style="list-style-type: none"> VISION modeling ODOT revenue forecast modeling Travel Oregon (Oregon Tourism Commission) |
| Fuel supply | Planned projects in/near OR (e.g., EV charging or NG fueling infrastructure) | <ul style="list-style-type: none"> NREL’s Alternative Fuels Data Center Utility filings (e.g., NW Natural) Stakeholder outreach/interviews |
| | Existing and planned fuel production facilities | <ul style="list-style-type: none"> Market reports (e.g., UC Davis work,⁸ trade publication e.g., National Biodiesel Board) DOE and SEP solicitations for pre-commercial scale facilities |
| | Nationwide volumes for RFS-eligible fuels | <ul style="list-style-type: none"> EPA maintains a monthly update of RINS generated under the RFS2, tracked via the EPA Moderated Transaction System (EMTS); these data are disaggregated by fuel type Additional nuance can be provided via analysis of industry publications (freely available) |
| | Other data | <ul style="list-style-type: none"> Environmental commodity data; these can help ascertain investment activity USDA FAS National reports for potential exports (e.g., biofuels from Brazil) |
| Fuel supply & Carbon intensity estimates | Banked clean fuel credits | <ul style="list-style-type: none"> Clean Fuels Program data (via OR DEQ) |
| Carbon intensity estimates | Updates to the CI of fuels | <ul style="list-style-type: none"> Fuel pathways submitted to OR DEQ and ARB as part of the LCFS program are usually a leading indicator regarding the directional changes for CI of transportation fuels For new and emerging fuels that may not have a CI, GREET modeling from ANL and others can help characterize low-high ranges |



ICF has documented our findings regarding data sources and data availability in the tool and separately (not addressed in this forecast). ICF maintains these findings to provide rationale for including or excluding data in the forecasting tool, especially as it relates to data limitations or other concerns regarding data quality/reliability.

ICF continues to quantify the analytical relationships between metrics so that the fuel supply forecast can be updated in the event certain data elements are inconclusive in a given year (e.g., because the data are not available, sources have changed, there are quality control issues, etc.).

⁸ It is ICF's understanding that UC Davis has taken on work related to the production of conventional and advanced biofuels, work that was previously conducted by Environmental Entrepreneurs (E2).