# Puget Sound Regional Transportation Fuels Analysis

## Executive Summary

**September 2019**

Submitted to:

Puget Sound Clean Air Agency

Submitted by:

ICF

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## Key takeaways

- The Puget Sound region has a significant carrying capacity for low carbon fuels and the deployment of other low carbon fuel strategies.
- The Puget Sound region can achieve a 10%-16% carbon intensity reduction by 2030 with only modest changes to the transportation fuel supply.
- The maximum achievable carbon intensity reduction in the Puget Sound region is 26% by 2030.
- Compliance with a proposed Puget Sound CFS will require a range of investments in low carbon fuel production, retail distribution infrastructure, and advanced vehicle technologies.
- The economic impacts of compliance with a Puget Sound CFS are small, and would have a negligible impact on forecasted growth in the region.
- Air quality improvements resulting from the compliance scenarios will yield positive health impacts.

The transportation sector accounts for nearly 40 percent of greenhouse gas (GHG) emissions in the Puget Sound region.[1] In an effort to reduce these GHG emissions, and to improve air quality through the reduction of criteria air pollutants, the Puget Sound Clean Air Agency (the Agency or PSCAA) has sought to implement candidate actions in key focus areas including increasing zero-emission vehicle (ZEV) adoption, promoting alternative fuel use, and encouraging travel mode shifts. Public agencies are increasingly looking to low carbon fuel standards to achieve GHG reductions from the transportation sector—there are now low carbon fuel standards in California, Oregon, and British Columbia. Low carbon fuel standards are attractive to policy makers because they send a clear policy signal to investors that long-term solutions are needed for lower-carbon and cost-competitive transportation fuels.

ICF conducted a detailed analysis of the Puget Sound region's transportation fuels market and found that it has a significant carrying capacity for low carbon fuels, and the deployment of a low carbon fuel strategy such as a Clean Fuel Standard (CFS). ICF estimates that the maximum achievable carbon intensity reduction, under a CFS, in the Puget Sound region, is 26% by 2030. Compliance with a proposed CFS will require a range of investments in low carbon fuel production, retail distribution infrastructure, and advanced vehicle technologies. The modeled economic impacts of compliance with a Puget Sound CFS are small, and have a negligible impact on forecasted growth in the region (less than one tenth of one percent impact on employment growth or gross regional product [GRP]). ICF's analysis of the air quality implications of the compliance scenarios indicates positive health impacts associated with the implementation of the Puget Sound CFS.

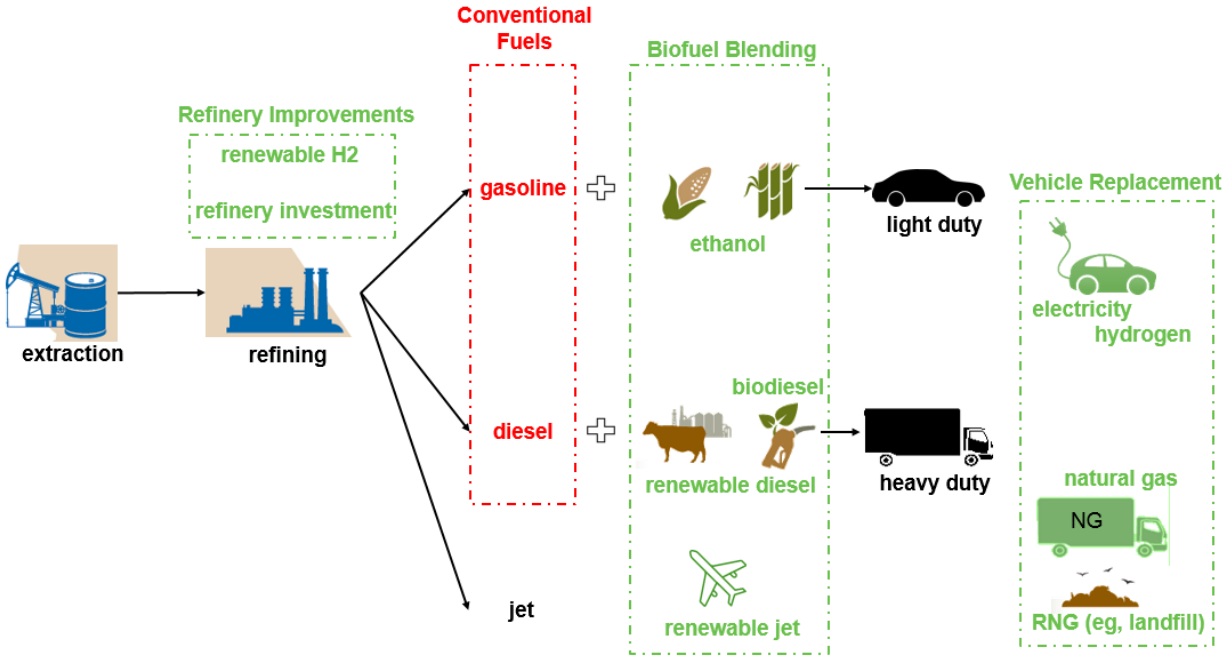
[1] Puget Sound Clean Air Agency, Greenhouse Gas Emission Inventory, June 2018. Accessed online August 2018 via http://www.pscleanair.org/DocumentCenter/View/3328/PSCAA-GHG-Emissions-Inventory.

The Puget Sound region, consisting of King, Kitsap, Pierce, and Snohomish Counties, consumes about 1 billion gallons of gasoline and 220 million gallons of diesel annually. There are significant biofuel production facilities within, or in close proximity to, the Puget Sound region, including biodiesel production, renewable diesel production, and renewable natural gas (RNG) production. The region has demonstrated significant interest in electric vehicles (EVs), with a higher than national average adoption rate. There are no specific regulatory or policy drivers in the Puget Sound region that support the deployment of low carbon fuels. Low carbon fuel producers in and around the Puget Sound region export fuel to markets in California and Oregon where it is more valuable as a result of low carbon fuel policies.

ICF conducted scenario modeling to demonstrate the levels of carbon intensity reduction that could be achieved via a Clean Fuel Standard (CFS) in the Puget Sound region under different market conditions and considerations. ICF conducted scenario modeling using a fleet turnover-based model for the light-, medium-, and heavy-duty vehicle fleets in the Puget Sound region. The model includes assumptions regarding fuel economies, vehicle miles traveled, and other key parameters associated with transportation fuel consumption. The modeled compliance scenarios include a mix of vehicle and fuel strategies, and the model tracks the credits and/or deficits generated on a year-over-year basis for each model run.

ICF developed Washington-specific carbon intensity estimates for various transportation fuels included in the modeling. ICF aggregated supply, distribution, and production data to determine the baseline carbon intensity of transportation fuels within the agency's jurisdiction. ICF conducted this analysis by developing a Washington-specific version of the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model (GREET model) and reviewing currently certified carbon intensities from California's Low Carbon Fuel Standard (LCFS).

ICF conducted the scenario modeling by assuming that the proposed program operates on the same system of deficits and credits that define California's LCFS Program and Oregon's Clean Fuels Program. Petroleum-based transportation fuels (i.e., gasoline and diesel) with a carbon intensity higher than the standard generate deficits; these deficits must be offset on an annual basis by credits generated by lower-carbon fuels. Credits can be banked without holding limits and do not carry vintages. The figure below highlights the ways that deficits and credits are assumed to be generated in the program—note that fuels in red generate deficits and fuels listed in green generate credits in a low carbon fuel policy.




ICF modeled four scenarios, as summarized here and with some additional detail in the table that follows:

- Scenario A is focused on biofuel blending, with decreases in carbon intensity of those biofuels. The carbon intensity reduction target is 10% below 2016 levels by 2030.
- Scenario B is focused on electrification, and has a more rapid increase of EV deployment for both the light- and medium/heavy-duty vehicle sectors than what is included in the reference case or in other cases. The carbon intensity reduction target is set at 10% below 2016 levels by 2030.
- Scenario C is a blend of Scenario A and Scenario B, with a mix of increased biofuel blending, lower carbon intensity biofuels, and electrification. It is also introduces increased penetration of natural gas vehicles using renewable natural gas (RNG), small volumes of renewable jet fuel, and reduced carbon intensity at refineries through efficiency measures and renewable hydrogen. The carbon intensity reduction target is set at 16% below 2016 levels by 2030.
- Scenario D is meant to capture the upper limit of carbon intensity reduction that ICF viewed as feasible for the Puget Sound region by 2030. This includes more aggressive biofuel blending, lower carbon intensity biofuels, and more aggressive EV deployment in all vehicle segments. It also includes the increased penetration of natural gas vehicles using RNG, more substantial volumes of renewable jet fuel than included in Scenario C, and more aggressive carbon intensity reductions at refineries through efficiency measures and renewable hydrogen. ICF modeled this scenario in two ways with respect to the carbon intensity reduction target: we employed a 20% target by 2030, and then through iterative calculations determined that the effective maximum carbon intensity reduction through this scenario is 26% by 2030.

| Low Carbon Fuel Strategy | Scenario A: Biofuel Blending | Scenario B: Aggressive Elec | Scenario C: Mixed Technology | Scenario D: All-in Max |
|---|---|---|---|---|
| Biofuel Blending | | | | |
| Ethanol | • E15 by 2030 | • E10 | • E15 by 2030 | • E15 by 2030 |
| Biodiesel | • B10.5 by 2030 | • B5 by 2030 | • B20 by 2030 | • B20 by 2030 |
| Renewable diesel | • RD10.5 by 2030 | • RD10 by 2030 | • RD15 by 2030 | • RD20 by 2030 |
| Renewable jet | • n/a | • n/a | • 25 MG by 2030 | • 50 MG by 2030 |
| Vehicle Replacement | | | | |
| EVs / FCVs, LD | • 10% of new sales by 2025 | • 15% of new sales by 2025 | • 14% of new sales by 2025 | • 20% of new sales by 2025 |
| EVs / FCVs, Class 3-6 | • Baseline | • 7% of new sales by 2025 | • 7% of new sales by 2025 | • 7% of new sales by 2025 |
| NG / RNG | • 95% blend of RNG by 2024 | • Baseline | • 95% blend of RNG by 2024<br>• 5% NGVs into Class 7/8 fleet | • 95% blend of RNG by 2024<br>• 7% NGVs into Class 7/8 fleet |
| Refinery Improvements | | | | |
| Renewable $H_2$ | • n/a | • n/a | • 20% penetration | • 40% penetration |
| Refinery investment | • n/a | • n/a | • 5% efficiency improvement | • 10% efficiency improvement |

ICF's analysis demonstrates that the Puget Sound region can achieve a 10%-16% carbon intensity reduction by 2030 with only modest changes to the transportation fuel supply. Scenario A and Scenario B in ICF's analysis focused on modest changes to biofuel blending and more aggressive assumptions regarding electrification, focusing primarily on light-duty vehicles. Similarly, ICF's analysis of a 16% carbon intensity reduction by 2030 can be achieved with feasible changes to the transportation fuel supply—assuming that the price signal from the program is strong enough to attract lower carbon liquid biofuels, RNG, and that the credits generated from the program can help to defray the costs of purchasing more expensive vehicles like EVs, hydrogen fuel cell vehicles (FCVs), and natural gas vehicles (NGVs).

ICF estimates that the maximum achievable carbon intensity reduction in the Puget Sound region is 26% by 2030. ICF assumes that this can be achieved via the aggressive implementation of low carbon fuel strategies including, but not limited to, increased liquid biofuel blending (for ethanol, biodiesel, and renewable diesel), increased natural gas vehicle deployment ( using RNG), accelerated EV deployment in light-, medium- and heavy-duty applications, renewable jet fuel blending, refinery efficiency improvements, and renewable hydrogen use at refineries.

ICF used the REMI (Regional Economic Models, Inc) model to characterize the macroeconomic and distributional impacts of compliance with a Puget Sound region CFS on different sectors and regions. REMI is a dynamic regional economic impact model that allows for a second-stage analysis to be conducted using outputs from ICF's analysis of expenditures required to achieve compliance as inputs and provides projections of the distributional impacts of the compliance scenarios being analyzed. The REMI model provided the ability to forecast impacts over time,

across industry sectors, and among regions. In this study, the analysis modeled impacts through 2030 and for five regions: Snohomish County, King County, Pierce County, Kitsap County, and the Rest of Washington. Inputs to the REMI model for each scenario were derived from the outputs of ICF analysis of each compliance scenario, including expenditures for fuel production, distribution infrastructure (including transportation, storage, and retail infrastructure), vehicles, and fuel pricing.

ICF's analysis using the REMI model indicates that the impacts of compliance with a Puget Sound CFS are small, and have a negligible impact on forecasted growth in the region. ICF's analysis shows results ranging from a -0.099% to +0.017% change in regional employment levels to a -0.091% to -0.026% change in economic output (Gross Regional Product, or GRP) across the four scenarios. In other words, ICF's analysis indicates that the economic impacts across all four scenarios considered yield employment and GRP impacts less than 0.1%. It is also important to note that this change is on top of forecasted baseline economic growth in the region of 260,000 jobs and a 12% increase in GRP (2020-30). This means that, for example, a predicted change in job growth of +/- 1,000 would result in 261,000 new jobs or 259,000 new jobs in 2030. The trends revealed from the economic impact modeling indicate that fuel diversification, including through the increased use of electricity and natural gas as transportation fuels, can help increase GRP and employment in the region. The increased costs of advanced vehicle technologies, most notably EVs, and the assumed pass-through of compliance costs contribute to the slight reductions in GRP and job growth in the modeling.

ICF also analyzed the air quality and health impacts of the compliance scenarios developed. ICF's analysis focused solely on the air quality and public health impacts of changes in tailpipe (or downstream) fine particle pollution ($PM_{2.5}$) emissions resulting from each scenario. ICF's modeling considered the entire region, rather than individual "hotspots." Only PM-related health effects from direct emissions of $PM_{2.5}$ were included. ICF based the air quality impacts on a screening level modeling approach relying on the C-LINE[2] model. ICF implemented the analysis in two steps: 1) Estimate changes in $PM_{2.5}$ concentrations from implementing the CFS, reported at the Census Block Group (CBG) level (which is a suitable resolution to quantify human health benefits associated with $PM_{2.5}$ reductions); 2) Quantify human health benefits associated with the $PM_{2.5}$ reductions using EPA's Benefits Mapping and Analysis Program (BenMAP) to estimate reduction in adverse health impacts and the monetary value of human health benefits from implementation of the Puget Sound CFS in each of the four affected counties.

ICF's analysis of the air quality implications of the compliance scenarios indicates significant positive health impacts associated with the implementation of the proposed Puget Sound CFS. ICF reports one to six avoided all-cause mortality cases per year (including adults over 25 years old and infants under 1) from changes in $PM_{2.5}$ levels resulting from the implementation of the proposed Puget Sound CFS with a present value of benefits from a reduction in $PM_{2.5}$ levels in 2030 range from $13.8 million to $45.7 million. This estimate of health benefits does not include all $PM_{2.5}$ health endpoints, and also does not include health benefits of other tailpipe emissions reductions that would be achieved under a clean fuel standard.

[2] https://www.cmascenter.org/c-tools/