Independent Assessment of the European Commission's Fuel Quality Directive's "Conventional" Default Value

Final Report
Executive Summary

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Prepared by
ICF International
222 Somerset Street West, Suite 300
Ottawa, ON K2P 2G3
613.523.0784

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Abbreviations and Acronyms

C2H6	ethane
CARB	California Air Resources Board
CH4	methane
CO2	carbon dioxide
CO2E	carbon dioxide equivalent
CONCAWE	Conservation of Clean Air and Water in Europe
EC	European Commission
EIA	United States Energy Information Administration
EU	European Union
EUCAR	European Council for Automotive Research and Development
FCC	Fluid Catalytic Cracker
FQD	Fuel Quality Directive
GHG	Greenhouse Gas
GOR	Gas-Oil Ratio
HFO	Heavy Fuel Oil
ICCT	International Council on Clean Transportation
IEA	International Energy Agency
IOC	International Oil Company
ISO	International Organization for Standardization
JEC	JRC, EUCAR and CONCAWE
JRC	European Commission Joint Research Centre
LBST	Ludwig-Bölkow-Systemtechnik GmbH
LCA	Lifecycle Analysis
LCFS	Low Carbon Fuel Standard
MCON	Marketable Crude Oil Name
NETL	National Energy Technology Laboratory
NOAA	National Oceanic and Atmospheric Administration
NOx	Oxides of Nitrogen
OGP	Oil and Gas Producers
OPGEE	Oil Production Greenhouse Gas Emissions Estimator
SPDC	Shell Petroleum Development Company
TTW	Tank-To-Wheel
ULCC	Ultra Large Crude Carrier
VFF	Venting, Flaring and Fugitives
VLCC	Very Large Crude Carrier
WOR	Water-Oil Ratio
WTT	Well-To-Tank
WTW	Well-To-Wheels

Executive Summary

The European Union's (EU) Fuel Quality Directive (FQD) aims to reduce the greenhouse gas (GHG) intensity of fuel supplied in the EU for use in road vehicles and non-road mobile machinery. To achieve this, the FQD introduces an obligation on fuel suppliers to reduce the GHG intensity of the fuels they supply by six (6) percent by 2020, compared to a 2010 baseline intensity. The draft implementing measure for Article 7a (5)(a) of the FQD (EC 2011) would require gasoline and diesel suppliers to use default GHG intensity values that distinguish between three main categories of "feedstock": conventional crude oil, oil shale, and natural bitumen. The proposed conventional crude default values for gasoline and diesel were based on an analysis by the JEC (a consortium of the European Commission Joint Research Centre (JRC), the European Council for Automotive Research and Development (EUCAR), and the Conservation of Clean Air and Water in Europe (CONCAWE)) and the values proposed for natural bitumen were based on analysis for the European Commission (EC) by Adam Brandt.

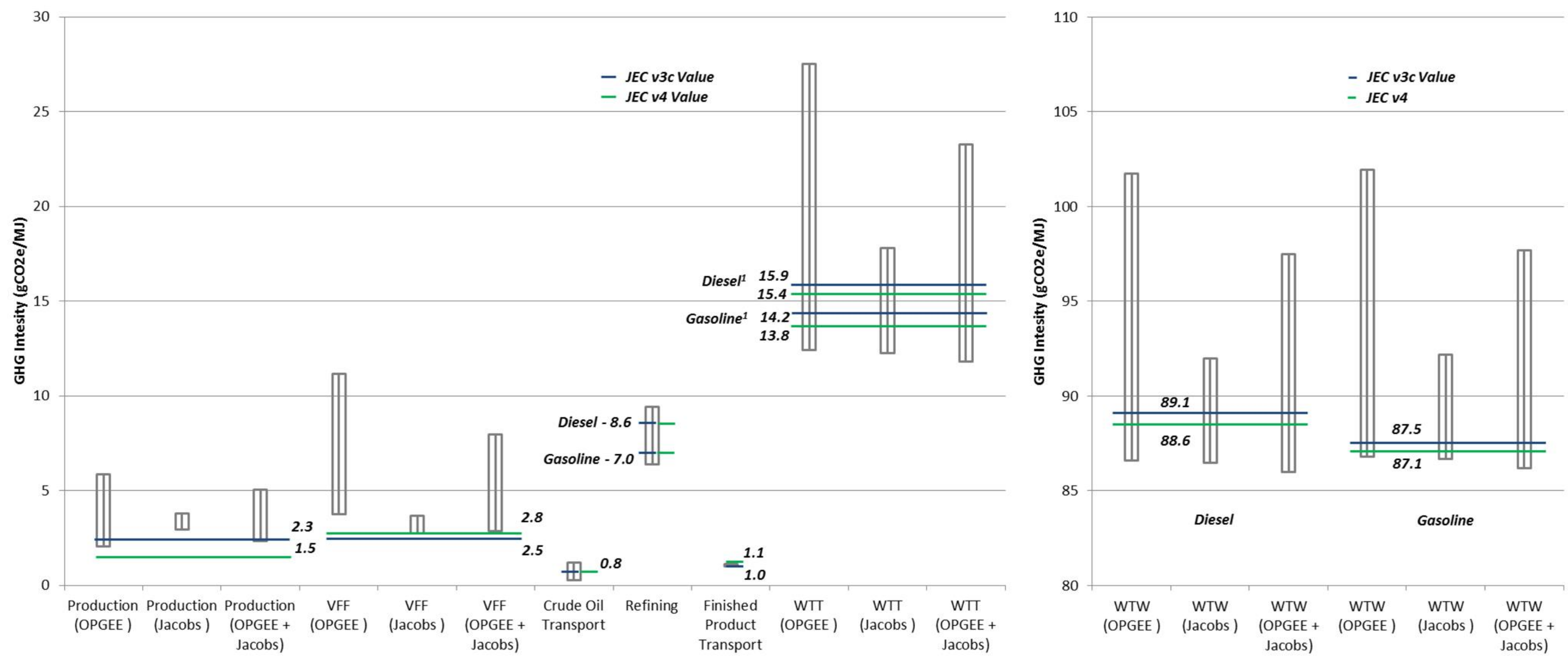
The objective of this study was two-fold: 1) analyse the methodology that has been used in the JEC reports (JEC v3c and v4) to determine the default conventional crude oil gasoline and diesel GHG intensity values; and 2) using that improved understanding, develop a more accurate default GHG intensity range for gasoline and diesel from conventional crude oils. This study had a seven (7) week timeline commencing on August 22, 2013 and a final deliverable date of October 9, 2013.

The JEC reports (JEC v3c and v4) include lifecycle analyses (LCA) that determine GHG intensities for gasoline and diesel. The LCA stages reviewed in this study were: 1) crude oil production; 2) venting, flaring, and fugitives; 3) crude oil transport; and 4) refining. The final LCA stages of finished product transport and combustion are not analysed, as there is general consensus in the scientific community on carbon intensity for these stages.[1] Data quality and availability are two of the most important factors in LCAs. Worldwide crude oil LCAs, including those performed in the JEC reports, need to make critical assumptions due to limited acceptable data outside of Canada and the USA. While these limitations prevent the determination of the exact GHG intensities for gasoline and diesel, improvements, including the most up-to-date data and models and a consistent LCA methodology, can increase an LCA's accuracy.

ICF determined three most likely ranges for gasoline and diesel GHG intensities using the Oil Production Greenhouse Gas Emissions Estimator (OPGEE_v1.0) and the Jacobs Study (Jacobs 2012) for crude oil production, venting, flaring, and fugitives, and crude oil transport. These ranges are identified as *OPGEE Only*, *Jacobs Only,* and *OPGEE + Jacobs*. The CONCAWE study (CONCAWE 2007) was used to develop a most likely range for refining. Figure 1 below shows the most likely ranges for the LCA stages analysed and their corresponding JEC values.

[1] Greenhouse Gas Regulated Energy and Emissions Tool (GREET) Model developed by Argonne National Laboratory, JEC v3c and v4.

Figure 1. Comparison of JEC Report and the Estimated Most Likely Range



Note: 1 – JEC individual stages are not additive to the WTT value due to crude energy loss during the refining stage

The following are key elements of the analysis:

Overall

- GHG intensities of conventional crude oils fall on a continuum, not just one value, and some light and heavy conventional crudes have GHG intensities that are similar or even higher than those of crudes derived from natural bitumen. The results of the study do not support the current FQD categorization of feedstock by conventional, natural bitumen and oil shale crude oils.
- Gasoline and diesel GHG intensities from conventional crude oil fall within a very large spectrum shown by the estimated most likely ranges. The estimated diesel ranges for the three sets of data are 86.6–101.7 gCO_2/MJ (OPGEE), 86.5-92.0 gCO_2e/MJ (Jacobs), and 86.0-97.4 gCO_2e/MJ (OPGEE + Jacobs). The estimated gasoline ranges for the three sets of data are 86.8–101.9 gCO_2/MJ (OPGEE), 86.7-92.2 gCO_2e/MJ (Jacobs), and 86.2-97.6 gCO_2e/MJ (OPGEE + Jacobs). The ranges are due to data uncertainty and limited data availability and a variety of recovery techniques and flaring volumes and efficiencies. Differences of 3-4 gCO_2e/MJ are equivalent to 50-75% of the 6% GHG intensity reduction standard.
- Given that the intent of the FQD is focused on average crude oil feedstocks supplied in the EU, the GHG intensity of conventional crude oil should focus on the **average** energy and emissions associated with crudes actually delivered to EU refineries. The JEC report uses a combination of average and marginal methodologies (i.e., the next barrel refined) to determine the marginal gasoline and diesel GHG intensity rather than the average intensity.
- The data sources and methodologies used in the JEC report to determine the gasoline and diesel GHG intensities from conventional crude oil are dated and do not fully represent the GHG intensity of current operations or the latest methodologies for estimating emissions.
- Data quality and availability are two of the most important factors in LCA estimations. There is limited high-quality data available for crude oils outside of Canada and the USA. For most other crudes, the LCA studies need to make many assumptions, leading to high uncertainty in comparing the crudes.
- Not distinguishing the GHG intensities of the different conventional crudes in the FQD could result in shifts to high GHG intensity crudes from countries such as Russia, Nigeria, or Venezuela, which would increase actual GHG emissions instead of reducing them.

Crude Oil Production

- Oil and Gas Producers (OGP) (OGP 2005 and 2011) is the main source of data for conventional crude oil production. The limitations of OGP data include: a) data are reported voluntarily by the industry and are not audited; b) data are aggregated at a country and regional level and not at a field- or crude-specific level; c) data are also aggregated as hydrocarbon production, including crude oil and natural gas; d) data coverage is limited (fewer than 50% of regions supplying crude to the EU report data); e) estimation methodologies employed by Member Companies used to report data are unclear; and, f) data are only representative of the companies reporting and is likely introducing sampling bias.

- The JEC report uses OGP data in regions with low data coverage and considers them representative of the entire region (e.g., over 37% of the crude refined in the EU originates from the Former Soviet Union region, which has only 4% data coverage). This increases the uncertainty of the LCA.

Venting, Flaring, and Fugitives

- Flaring and venting from oil production are the most important factors in uncertainty for LCA estimations.
- While NOAA data (National Oceanic and Atmospheric Administration) (NOAA 2011) were used to estimate flaring GHG intensities, the JEC report uses both oil and gas production as the denominator for flaring estimates. However, most, if not all, flaring happens in oil fields where infrastructure is insufficient to handle the associated gas. This underestimates the GHG intensity from flaring.
- The JEC report used OGP data for venting and fugitives, which lack the level of detail and specificity necessary to estimate the emissions.
- Ranges of uncertainty in the potential flaring efficiencies (90%-98%) for countries with significant flaring emissions (i.e., Russia, Cameroon, and Nigeria) suggest that the reported GHG intensities for these countries could be 3-7 gCO2e/MJ crude higher than the JEC reports.

Crude Oil Transport

- The JEC performed a marginal analysis for the GHG intensity from crude oil transport and determined the emissions from transporting heavy Middle East crude to Europe via the Cape of Good Hope.
- An average LCA approach that considers separate emissions from crude oil transport for each producer/reservoir and to each destination would result in a more accurate LCA. Crude oil transport GHG intensity can range from 0.3-2.1 gCO2e/MJ.

Refining

- The JEC uses a marginal analysis developed by CONCAWE for gasoline and diesel GHG intensity even though the FQD requires an average approach for calculating the GHG intensities.
- The CONCAWE refinery analysis uses a proprietary refinery model, which lacks transparency. Consequently, the results cannot be replicated or confirmed.

Recommendations to Improve the Accuracy of the GHG Intensity Values

- Due to the spectrum of crude oil GHG intensities, accurate LCA modeling needs to differentiate and evaluate GHG intensities for each crude oil individually (including natural bitumen and oil shale feedstock crude oils). The result of such modeling would be more representative of the actual gasoline and diesel GHG intensity.
- The most recent public, transparent, verifiable, and reproducible data and models (such as OPGEE) should be used to determine the individual crude oil GHG intensities. The data and models should

be able to determine crude oil specific (e.g., by Marketable Crude Oil Name (MCON) or field) GHG intensities.

- LCA modeling should determine the average gasoline and diesel GHG intensity for refining in 2010 using the EU 2010 set of crudes and total EU refining emissions and apply this value to all crude oil feedstocks. The chosen allocation or substitution methodology needs to be transparent.