Air Resources Board

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TO: Gerald W. Bowes, Ph.D., Manager
Cal/EPA Scientific Peer Review Program

FROM: Michael S. Waugh, Chief for MSW
Transportation Fuels Branch

DATE: November 19, 2014

SUBJECT: NOTICE OF INTENT – REQUEST FOR EXTERNAL PEER REVIEW OF STAFF'S METHODOLOGY IN CALCULATING CARBON INTENSITY VALUES AND USE OF THREE LOW CARBON FUEL STANDARD LIFE CYCLE GREENHOUSE GAS EMISSIONS MODELS

By way of this memorandum, California Air Resources Board (ARB/Board) staff submits a notice of intent to submit a request for external peer review of staff's analysis of three Low Carbon Fuels Standard (LCFS) life cycle greenhouse gas (GHG) emissions models.

The information provided in this notice will allow the University of California to contact reviewer candidates. The final request for review will be sent by December 9, 2014.

BACKGROUND

The Board approved the LCFS regulation in 2009 as part of its effort to implement the Global Warming Solutions Act or Assembly Bill (AB) 32. AB 32 requires reductions in GHG emissions from all sectors of the economy in California to 1990 levels by 2020. The LCFS regulation is an early action measure under AB 32 that targets a ten percent reduction in GHG emissions from the use of transportation fuels in California by 2020.

For the LCFS, GHG emissions associated with a transportation fuel are represented by the fuel's carbon intensity (CI). The CI is calculated by conducting a full life cycle analysis starting from the recovery and transport of feedstock, transformation to fuel, transport to a retail filling station, and final use in a vehicle. Gasoline and diesel comprise the baseline fuels under the LCFS. Fuels that substitute for gasoline and diesel include compressed natural gas, liquefied natural gas, electricity, biofuels, and hydrogen. The regulation requires that the average CI from all transportation fuels, including gasoline and diesel fuel substitutes, meet the ten percent reduction target by 2020.

Staff used the following three models to calculate CI values of transportation fuels:

- California Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET) model
- Oil Production Greenhouse Gas Emissions Estimator (OPGEE) model
- Global Trade Analysis Project (GTAP-BIO) model combined with the Agro-Ecological Zone Emissions Factor (AEZ-EF) model

The estimated CI values using these three models determine the reductions or increases in GHG emissions of each fuel under the LCFS relative to the baseline fuels (gasoline and diesel). Therefore, staff directed significant effort to develop these models in order to estimate the CIs of all transportation fuels likely to be used in California. The CIs for all fuels, with their corresponding projected volumes, were used to estimate potential reductions in GHG emissions under the LCFS. Such an analysis forms an integral part of the work to assess the likelihood of fuels (with their associated GHG emissions) meeting the mandated CI reduction targets under the LCFS.

CA-GREET

Traditional life cycle analyses use a well-to-wheels (WTW) or seed-to-wheel approach to calculate the CI of a transportation fuel. Staff used the peer-reviewed Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model as a basis to estimate CIs for all fuels under the LCFS. The GREET approach uses the energy use and corresponding GHG emissions from each step starting from recovery of the feedstock to final use in a vehicle to calculate a CI for a given transportation fuel. This model was chosen since it is widely used by other agencies, numerous academics and researchers, and is considered to be the gold standard for life cycle analysis of transportation fuels. The GREET model was modified to account for California-specific factors and labeled “CA-GREET.” This model is used to calculate the CIs from direct emissions for all of transportation fuels used in the LCFS.

OPGEE

A portion of the CI of gasoline and diesel baseline fuels are the emissions associated with producing and transporting crude oil to a refinery. ARB contracted with Stanford University to develop the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) model. The OPGEE model is used to estimate the CI of all crudes supplied to California refineries. These “well-to-refinery-entrance-gate” emissions estimated by OPGEE can vary significantly depending on the method of production and field-specific

production parameters. The CIs calculated using the OPGEE model are combined with the appropriate CIs from the CA-GREET model to calculate a total life cycle CI for gasoline and diesel.

GTAP-BIO and AEZ-EF

Traditionally, approaches as detailed above have been utilized in calculating the CI of a fuel and are termed "direct emissions." However, biofuels derived from crop-based feedstock have contributions in addition to direct emissions. The current mandates for production of biofuels in the United States, the European Union, and other jurisdictions have led to the diversion of crop-based feedstocks to produce biofuels. This has either led to the conversion of previously undisturbed land to agricultural land to meet the additional demand to grow the biofuel crop or to the reduction in the rate of reversion of cropland to native grassland or forest. This effect is termed "indirect land use change" (iLUC) and the emissions attributable to iLUC are termed "iLUC emissions." iLUC emissions are combined with the corresponding direct emissions to calculate a total CI for a given crop-based biofuel.

For the LCFS, land cover changes were estimated using an economic model called Global Trade Analysis Project (GTAP-BIO) which was developed and modified by Purdue University. The land cover changes estimated by the GTAP-BIO model was mapped to corresponding carbon emission factors in the Agro-Ecological Zone Emissions Factor (AEZ-EF) model to produce iLUC emissions for a given biofuel. The AEZ-EF model was developed by the University of California (UC), Berkeley, UC Davis, and the University of Wisconsin, Madison. In addition, staff contracted with UC Berkeley to develop Monte Carlo Analysis to estimate uncertainty in iLUC estimates.

REQUEST | PROJECT GOALS

ARB staff requests external peer review of staff's analysis of the following three models used to calculate CIs of transportation fuels under the LCFS:

- CA-GREET model
- OPGEE model
- GTAP-BIO and AEZ-EF models

1. **Materials to be reviewed and approximate page numbers:** The reports are currently being finalized. Page numbers provided below are approximations.

    a. **Report on CA-GREET Model** by ARB – *50 pages required*

    The report consists of staff's methodology in calculating fuel pathway CI values and use of the CA-GREET model, including life cycle inventory data, emission factors, and process efficiency values used. The report also includes staff's findings and conclusions based on the results of the model.

    b. **Report on OPGEE Model** by ARB – *50 pages required*

    The report consists of staff's methodology in calculating CI values of crude oil used by California refineries and use of the OPGEE model, including staff's methodology in calculating California annual crude average CI values. The report also consists of staff's findings and conclusions based on the results of the model.

    c. **Report on GTAP-BIO and AEZ-EF Models** by ARB – *100 pages required*

    The report consists of staff's methodology in calculating indirect land use change emissions and CI values for crop-based biofuels and use of the GTAP-BIO and AEZ-EF models. The report also includes staff's findings and conclusions based on the results of the models.

2. **Specific expertise requirements**

    a. **CA-GREET**: Life cycle analysis of transportation fuels.

    A minimum of two reviewers would be adequate. Reviewers must be familiar with well-to-wheel life cycle analysis related to transportation fuels. Experience with the GREET model is optional.

    b. **OPGEE**: Life cycle analysis of crude oil production methods.

    A minimum of two reviewers would be adequate. Reviewers must be familiar with crude oil production, developing models for GHG life cycle assessments of crude production, and the application of life cycle analysis models for the assessment of crude production emissions.

c. **GTAP-BIO and AEZ-EF**: Economic modeling of agricultural impacts, including general expertise with global economic models used to estimate indirect land use effects, carbon emissions inventory, and release of carbon emissions from land conversion.

   A minimum of three reviewers would be adequate. Collectively, reviewers must have expertise in the following areas: econometric modeling, dynamics of land cover change, carbon emissions, and uncertainty analysis. For uncertainty analysis, reviewers must be familiar with Monte Carlo simulations. Reviewers must also be familiar with the GTAP model (or similar computable general equilibrium model), its database, application of economic models to estimate land conversions, protocols established by the Intergovernmental Panel on Climate Change or other global agencies for GHG accounting and carbon dynamics in various ecosystems, and changes in carbon stocks resulting from land conversion.

3. **Estimated date material will be ready for review:** Peer review material will be available to send by December 16, 2014.

4. **Completion date for reviews:** Allow at least 30 days for review. Timing of this review is critical given the legal mandate to complete the peer review before completion of the rulemaking to establish the LCFS regulation.

   The proposed LCFS regulation is currently scheduled to be presented to the Board on February 19, 2015. The final Board hearing to take action for approval is currently scheduled on July 23, 2015. Therefore, the proposed schedule is below:

   - Peer Review – December 16, 2014 to January 30, 2015
   - ARB Hearing (Board takes no approval action) – February 19, 2015
   - ARB Hearing (Board may approve resolution) – July 23, 2015

5. **Relationship of review material to regulation development:** The peer review of staff's analysis of the CA-GREET, OPGEE, and GTAP-BIO and AEZ-EF models are in support of the proposed LCFS regulation.

6. Names of Participants Involved

Air Resources Board

Michael Waugh
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If you have any questions regarding this notice, please contact Jim Aguila, Manager, Substance Evaluation Section at (916) 322-8283 or by email at jaguila@arb.ca.gov, or Aubrey Gonzalez, Air Resources Engineer, Substance Evaluation Section at (916) 324-3334 or by email at agonzale@arb.ca.gov.

Thank you for your time and consideration.

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