Co-processing of Biogenic Feedstocks in Refineries: 2nd Work Group Meeting

Transportation Fuels Branch
Industrial Strategies Division

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Sacramento, CA

California Environmental Protection Agency
Air Resources Board

Agenda

- Welcome
- Feedback from first work group meeting
- Review core objectives of the work group
- Staff Presentation
- Presentation by Michael Talmadge - National Renewable Energy Laboratory (NREL)
- Presentation by Dr. Jim Rekoske Honeywell/UOP
- Discussion
- Next steps

Feedback from first meeting

- General support for mass balance approach for quantifying biogenic fraction of fuels
- Concerns over C^{14} analysis
  - ❑ Applicability of method for less than 10 percent biogenic feedstock
  - ❑ Cost
  - ❑ Availability

Feedback from first meeting (contd.)

- How to address feedstock supply and logistic barriers to co-processing within CA?
- Include provisions for co-processed fuels out-of-state to participate in the program
  - ❑ Match out-of-state production of co-processed fuels with in-state sales of fuel (similar to biomethane)
- Include opportunities for fuel derived from co-processing recycled petroleum feedstocks and incorporation of renewable hydrogen derived from RNG

Core objectives of the Work Group

- Establish guidelines for quantification of renewable fuel volumes from co-processing
- Evaluate greenhouse gas emissions of co-processing operations and corresponding carbon intensities of final product streams
- Develop guidelines to facilitate certification of carbon intensity for biogenic feedstock-derived renewable fuel streams
- Develop monitoring and verification protocols for co-processed fuels

Draft discussion paper

- Literature review presented in draft discussion paper
- Approaches to quantification of renewable content
- Approaches to estimating GHG emissions of renewable streams from co-processing

Quantification of Renewable Volumes

Renewable content calculation

- Possible approaches to quantifying renewable content
  - ❑ C^{14} analysis
  - ❑ Potential mass balance approaches
    - ➢ Estimate renewable factions by carbon mass balance (NREL)
    - ➢ Estimate renewable factions based on product yields (NREL)
    - ➢ Total mass balance method
  - ❑ Estimate renewable fractions using energy content method

Staff is soliciting inputs from stakeholders on all approaches presented in the draft discussion paper. Other approaches for consideration are also being solicited from stakeholders

Quantification – carbon mass balance

- Carbon mass-balance approach from NREL
  - Determine mass carbon content of biogenic feedstocks
  - Determine amount of biogenic carbon lost as CO and CO_2 during processing
  - Apply remaining biogenic carbon to produced fuels proportionately
  - Convert biogenic carbon content to mass/volume of renewable finished fuels using conversion factors
  - Additional details to be provided in NREL presentation

Quantification – product yields

- Product yields approach from NREL
  - ❑ Determine overall yield of100% fossil feedstock
  - ❑ Determine overall yield of co-processing (fossil plus biogenic feedstocks)
  - ❑ Mathematically determine renewable yield as a percent of overall co-processing yield
  - ❑ Additional details to be provided in NREL presentation

Quantification – mass balance

- Total mass balance approach
  - ❑ Establish mass balance around the unit
  - ❑ Determine percent of biogenic feedstock converted to CO, CO_2 and H_2O (“loss”)
    - ➢ Either compare the baseline mass balance data with co-processing mass-balance data, or
    - ➢ Or confirm production of CO+CO_2+H_2O from 100% petroleum intermediates is negligible
  - ❑ Apply the loss factor to mass of biogenic feedstock to estimate adjusted biogenic mass allocation factor (%)

Quantification – mass balance (cont.)

- Apply the adjusted biogenic allocation factor (%) to the mass of fuel outputs including LPG, coke and unconverted feedstock
- Illustrative example in draft discussion paper

Quantification – energy content

- Energy content approach
  - Determine energy content of biogenic and petroleum feedstocks individually
  - Determine percent renewable energy relative to the total energy of the combined biogenic and fossil feedstocks
  - Apply the calculated percent renewable energy to produced fuels
  - Illustrative example in draft discussion paper
  - Requires additional research to validate the accuracy
    - Relationship between energy content and oxygen + plus water content
    - May need to apply constraints such as less than X% oxygen and Y% water content

Quantification – Next steps

Are there issues/concerns with the quantification approaches presented here?

Do stakeholders have alternate approaches to be considered?

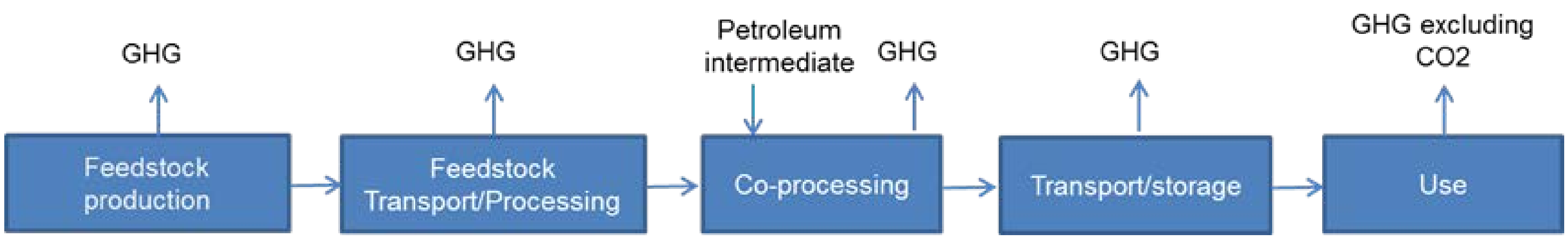
What data could be offered in support of selecting one or more methods of quantification?

Do any of the approaches listed or being suggested facilitate monitoring and verification?

Estimation of GHG Emissions

LCA methodology for co-processing

- Covers well-to-wheel GHG emissions including direct and indirect emissions if applicable



- Except for the co-processing step, GHG accounting methods are similar to typical biofuel pathways

- Work Group discussion focuses on co-processing GHG emissions only

GHG emissions quantification from co-processing

- Suggested approaches to estimating GHG emissions and carbon intensity of co-processed renewable fuels
  - ❑ Default value approach
  - ❑ Process unit level
    - ➢ Energy content-based allocation
    - ➢ Hybrid marginal allocation approach

Default value approach

- Use CA-GREET default refinery values for gasoline, diesel and jet fuel produced in-state.
  - ❑ Conservative approach
  - ❑ Apply to renewable diesel, gasoline and jet fuel
  - ❑ Confirm no additional energy or chemical GHG burden per unit of renewable streams relative to baseline
  - ❑ Prefer co-processing ratios to be less than 10%

Process unit level allocation

- Process unit level allocation based on energy content
  - GHG emissions from the co-processing unit attributed proportionally to the fuel product outputs based on energy content of an individual output relative to the total energy content of outputs
  - Starts with the unit at which biogenic feedstock is introduced, and is carried through subsequent process units involving renewable fuels
  - Illustrative example detailed in draft discussion paper

Marginal hybrid allocation

- Process unit marginal hybrid allocation approach
  - May be preferable if additional inputs are required to process biogenic feedstock, compared to 100% fossil feedstock (H_2, steam, etc.)
    - Calculates any incremental increase in GHG emissions
    - In addition, calculates the remaining GHG emissions from co-processing attributable to renewable fuels
    - Emissions from these two steps are combined and divided by fuel energy of renewable fraction = CI
  - Starts with the unit at which biogenic feedstock is introduced, and is carried through subsequent process units involving renewable fuels.
  - Illustrative example detailed in draft discussion paper

GHG emissions– Next steps

Are there issues/concerns with the GHG estimation approaches presented here?

Do stakeholders have alternate approaches to be considered?

What data could be offered in support of selecting one or more approaches for CI estimation?

Do any of the approaches listed or being suggested facilitate monitoring and verification?

Monitoring and verification

- ARB is in the process of developing a monitoring and verification program targeted to begin in 2019
- The complexity involved in co-processing creates challenges in tracking, monitoring and verification.
- Staff from the monitoring and verification team will outline steps for verification co-processed renewable fuels
- Will be made available at a future LCFS meeting.

Questions?

Expert Presentations

- Michael Talmadge - NREL

❑ Renewable product allocation methods assessed for FCC co-processing of pyrolysis oil

- Dr. James Rekoske – UOP

❑ Mass Balance Approach for Co-processing

Questions?

Next steps

- Additional work group meetings
  - ❑ May and August 2017
- For discussion at the next meeting
  - ❑ Review feedback from stakeholders
  - ❑ Potentially firm up one or more approaches on quantification and carbon intensity estimation
  - ❑ Guidelines related to monitoring and verification
  - ❑ Explore modeling to support quantification and CI estimation

Next steps

- Stakeholder inputs requested on:
  - Potential process units for co-processing
  - Are there data from trial production runs?
  - New research reports on quantification?
  - Renewable mass quantification and LCA methods
  - Technological barriers to deployment of co-processing
  - Challenges to reporting and verification of finished fuel
  - Other comments to assist with objectives of this work group

Feedback

Feedback related to Co-processing Work Group Discussions should be sent to:
LCFSworkshop@arb.ca.gov
by March 17, 2017

Presentations available at:
http://www.arb.ca.gov/fuels/lcfs/lcfs_meetings.htm