CAAFI Environment Team Breakout Session

October 26, 2016

Team Co-Leads: Jim Hileman (FAA), Nancy Young (A4A)

Agenda

* ICAO Market Based Measure Greenhouse Gas (GHG) Life Cycle Assessment (LCA) Methodology
* California Air Resources Board (CARB) Update
* Sustainability Discussion Follow Up (if needed)
* Next Steps – Discussion of Integrated Challenges

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Alternative jet fuel under ICAO's GMBM

ICAO recently announced agreement on a global market-based measure (GMBM) to mitigate GHG emissions from international aviation

Work has been ongoing to define how AJF should be counted towards achieving airlines' GHG carbon offsetting obligations

LCA method used to quantify GHG emissions from AJF:

- Scope
- System boundary
- Emissions species of interest & functional units
- Co-product allocation
- Intended use & fossil fuel baseline

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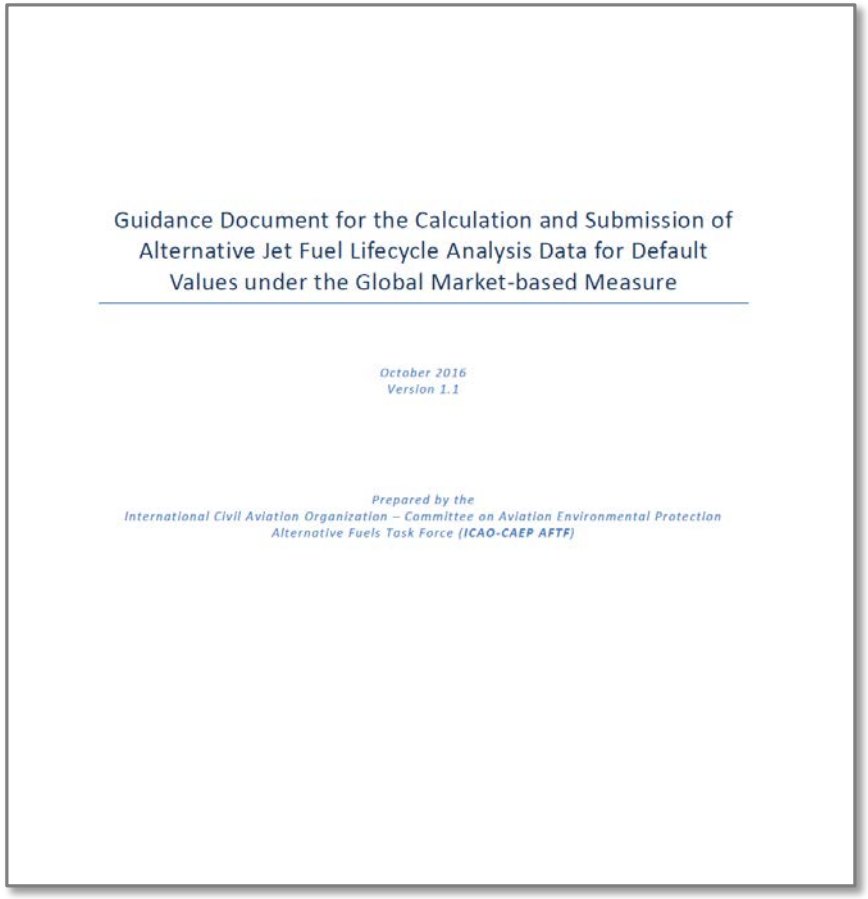
Guidance Document for Calculation of LCA Data for Default Values under GMBM

Scope

- Guidance document is only applicable to biomass and waste-derived "drop-in" jet fuels
- Non-petroleum fossil fuel-derived AJF (e.g. GTL, CTL) are explicitly excluded from guidance document
- Land use change (LUC) emissions are captured using a separate methodology, not covered in guidance document



Guidance Document for the Calculation and Submission of Alternative Jet Fuel Lifecycle Analysis Data for Default Values under the Global Market-based Measure

October 2016
Version 1.1

Prepared by the
International Civil Aviation Organization – Committee on Aviation Environmental Protection
*Alternative Fuels Task Force (**ICAO-CAEP AFTF**)*

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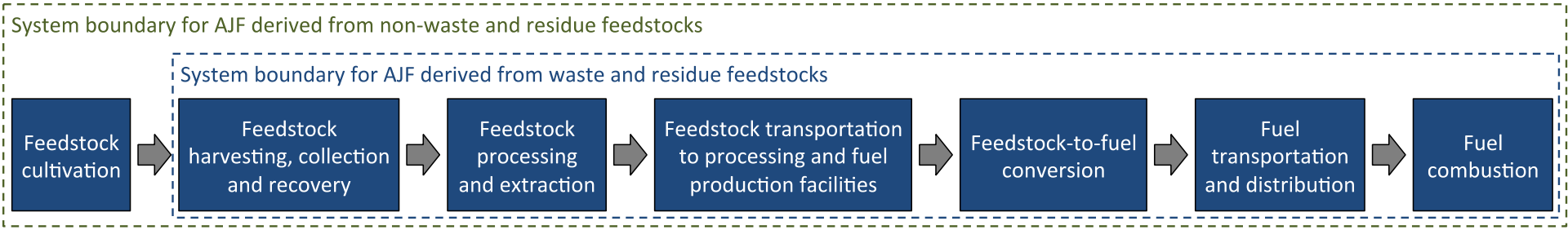
LCA methodology under GMBM

System boundary

- feedstock cultivation, harvesting, collection and recovery
- feedstock processing and extraction
- feedstock transportation to processing and fuel production facilities
- feedstock-to-fuel conversion processes
- fuel transportation and distribution
- fuel combustion in an aircraft engine



- On-going operational emissions are included, but one-time construction and equipment manufacturing emissions are not

LCA methodology under GMBM

Emissions species & functional units

- CO_2, CH_4 and N_2O are incl. in well-to-pump steps
- Only CO_2 emissions from combustion are included
- Results in gCO_2e/MJ_{jet} using IPCC AR5 100-year GWP

Co-product allocation

- Energy allocation at all steps of the analysis
- No emissions allocated to wastes in the supply chain
  - defined as materials with market value insufficient for the product to be sold or delivered to a prospective user

Fossil fuel baseline

* Compared to conventional jet baseline of 89.0 gCO_2e/MJ

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LCA Data Request for GMBM via "Guidance Document"

AJF pathways will be assigned default LCA values under GMBM

LCA studies or values can be submitted to be considered for inclusion under GMBM to aid this process. These must:

* use the methodology described
* use FT, HEFA, SIP/DSHC, or iBuOH-to-jet conversion tech., and ASTM certified
* be transparent and replicable

Requirements for LCA studies or values submitted are outlined in a "Guidance Document", to be circulated via email

Data can be submitted to Core LCA TG Co-Leads:

* Prof. Robert Malina - robert.malina@uhasselt.be
* Ms. María de la Rica Jiménez - mmrica@senasa.es

Note that submission of data is for information purposes only, and does not constitute the discussion or decision-making process of AFTF.

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CARB/LCFS Update

2008-2015: Numerous stakeholder requests in to include alternative jet fuel as a credit-generating fuel

2016: Beginning of informal dialogue between CARB and aviation/producer stakeholders

* Respond to data requests to support anticipated rulemaking needs (Fuel projections/ environmental analysis)

October 24th CARB MRV Rulemaking Workshop:

* CARB announces expansion of rulemaking scope to include consideration of credit for alternative jet fuel
* Alternative jet fuel specific workshop anticipated early 2017
* Rulemaking proposal Q4 2017/ Board Hearing 2018/Effective Date January 1, 2019

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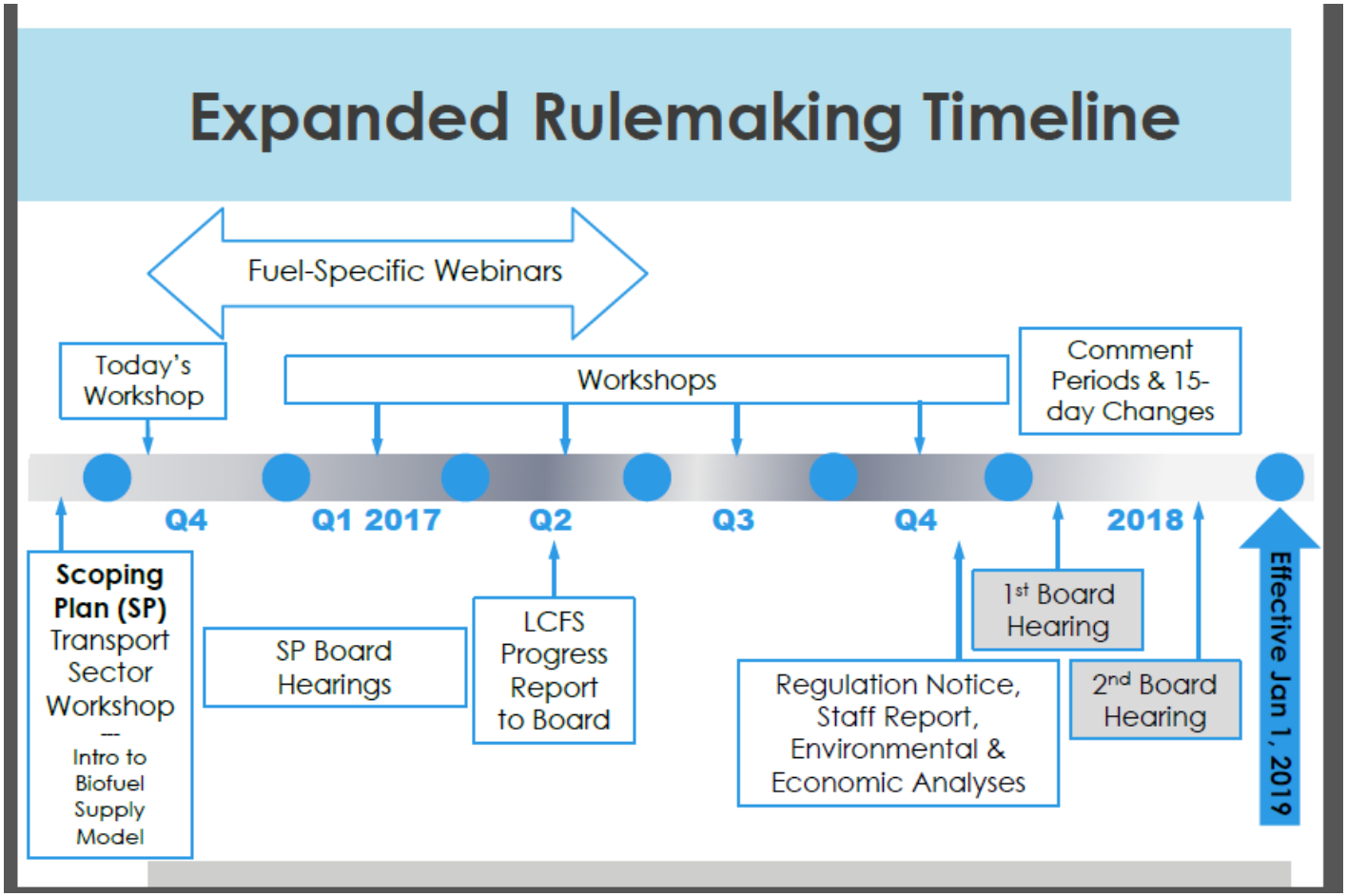
LCFS Rulemaking Timeline



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Sustainability Discussion Follow-Up

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Next Steps / Integrated Challenges

* Environment team has considered:
  * Life cycle assessment
  * Environmental sustainability
  * Combustion emissions from AJF use
* Should we consider expanding environment team to be an “Integrated Challenges Team” ?
* This expanded team could also consider:
  * Techno-economic assessment
  * Fuel production assessment
  * Supply chain analysis
* New items build on existing efforts on LCA and expand sustainability to cover economic and social aspects

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