IEA Bioenergy
Technology Collaboration Programme

Task 39
IEA Bioenergy

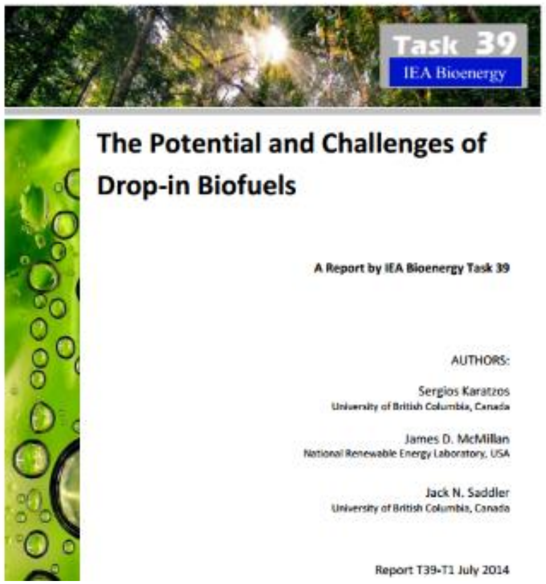
# Recent developments in the production of low carbon-intensive drop-in fuels through stand-alone production and coprocessing

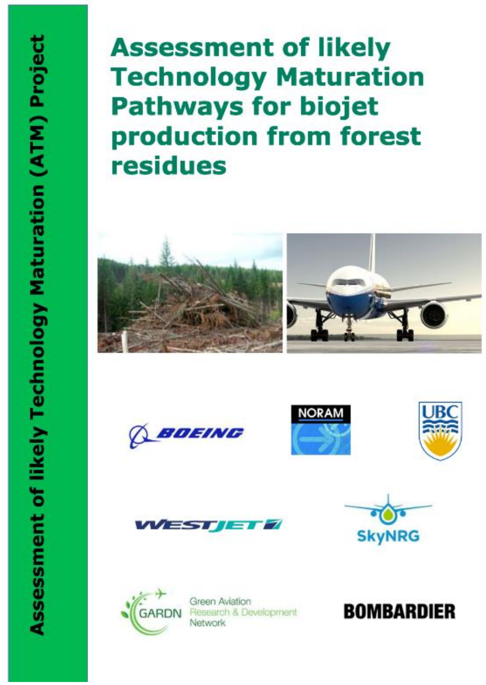
Susan van Dyk, Jianping Su, Jack Saddler

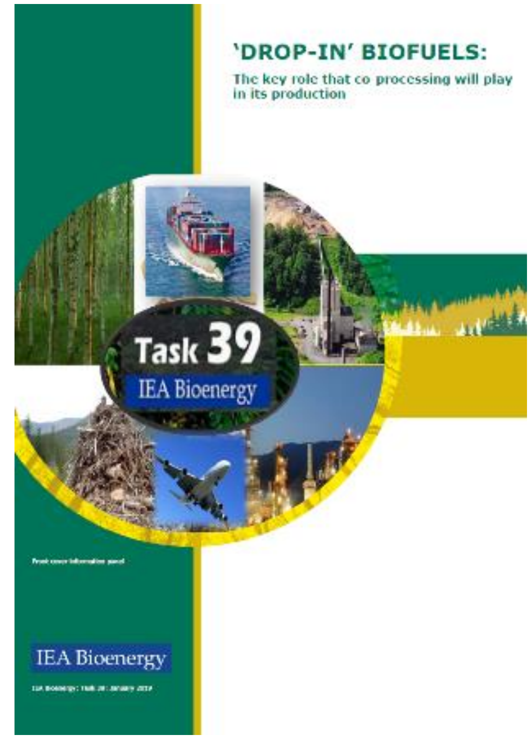
2021 April update

# Co-processing related reports: Drop-in biofuels, ATM, Co-processing

## www.Task39.org



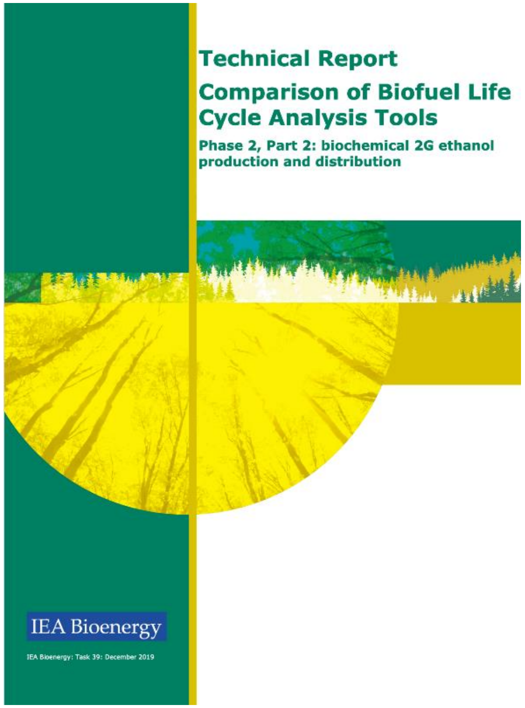




**Definition of "drop-in" biofuels**

- Drop-in biofuels: are "liquid bio-hydrocarbons that are: functionally equivalent to petroleum fuels and **fully compatible with** existing petroleum infrastructure"

# Driven by policy, so ties into the LCA (modelling) and LCFS (policy) type of work being pursued within Task 39




lnbr brazilian biorenewables national laboratory

CNPEM Brazilian Center for Research in Energy and Materials

Table 1: Main characteristics of the four assessed models

| | GHGenius | GREET | New EC | VSB |
|---|---|---|---|---|
| **Model version** | 5.0c (2018) | 2018 | 2017 | 2019 |
| **Developed for regulatory use** | No[1] | No | Yes | No |
| **IPCC GWP method** | 1995, 2001, 2007, 2013 | 2013 | 2007 | 2007 |
| **Default global warming gases** | $CO_2$, $CH_4$, $N_2O$, CO, VOC, $NO_x$, fluorinated compounds | $CO_2$, $CH_4$, $N_2O$ | $CO_2$, $CH_4$, $N_2O$ | $CO_2$, $CH_4$, $N_2O$ |
| **Lifecycle data** | Internal | Internal | Internal | Ecoinvent |
| **Functional unit** | km, MJ | km, mile Btu, MJ | MJ | km, MJ |
| **Default allocation** | Substitution | Substitution | Energy | Economic |
| **Land use change** | - | CCLUB | C stocks | - |
| **Possible boundaries** | Well-to-wheel | Well-to-wheel | Well-to-pump | Well-to-wheel |

[1] GHGenius has not been developed as a regulatory tool, although it is currently being used as one

Renewable and Sustainable Energy Reviews 110 (2019) 1–12

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

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Comparison of biofuel life-cycle GHG emissions assessment tools: The case studies of ethanol produced from sugarcane, corn, and wheat

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# Summary of some "Stand alone" facilities in the world: (technically "mature")

## Ongoing growth expected, with focus on cost, availability and CI of feedstock

| Company | Location | Feedstock | Capacity |
|---|---|---|---|
| **Neste** | Rotterdam | Vegetable oil, UCO and animal fat | 1.3 bn L/y |
| **Neste** | Singapore | Vegetable oil, UCO and animal fat | 1.3 bn L/y, expansion |
| **Neste** | Porvoo, Finland | Vegetable oil, UCO and animal fat | 385 m L/y |
| **Neste** | Porvoo 2, Finland | Vegetable oil, UCO and animal fat | 385 m L/y |
| **ENI** | Venice and Gela, Italy | Vegetable oils, UCO and animal fat | 1 bn L/y |
| **Diamond Green Diesel** | Norco, Louisiana | Vegetable oils, animal fats and UCO | 1 bn L /y |
| **UPM** | Lappeenranta, Finland | Crude tall oil | 120 m L/y |
| **World Energy (AltAir)** | Paramount, California | Non-edible oils and waste | 150 m L/y, expansion |
| **Renewable Energy Group** | Geismar, Louisiana | High and low free fatty acid feedstocks | 284 m L/y, expansion |
| **Total** | LA MÈDE | UCO and vegetable oils | 641 mL/y |

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# Recently announced:

## Demand

**Demand growing like crazy** – And that's not just thanks to low carbon fuel requirements, for example in California, but it's simply because renewable diesel is so darn attractive. It meets the same ASTM D975 specification as petroleum diesel. It reduces emissions. It uses existing infrastructure. What's there not to love?

One report has global renewable diesel capacity expected to reach 14.63 million tons in 2024, growing at a CAGR of 21.33%, during 2020-2024 while demand projected to reach 12.88 million tons, increasing at a CAGR of 15.93%. Another report shows the forecast to 2025 with renewable diesel taking a bigger chunk of the biofuels pie than in past years. S&P Global Platts forecasts that global renewable diesel supply will exceed 3 billion gallons by 2023 and 5 billion gallons by 2025.

## Renewable diesel kicks off 2021 with conversions, capacity increases, new feedstocks and more

April 18, 2021 | Helena Tavares Kennedy

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## Tidewater Project

**Project:** Tidewater Midstream and Infrastructure Ltd. existing Prince George refinery in British Columbia, expected to be commissioned in 2023, pretreatment facility to provide flexibility on running various renewable feedstocks.
**Partners:** Haldor Topsoe (HydroFlex and H2bridge technologies)
**Where:** British Columbia, Canada
**Capacity:** Approximately 3,000 barrels per day of renewable diesel
**Why Interesting?** When operational, the facility is expected to be Canada's first commercial-scale stand-alone renewable diesel plant.

TheDigest The world's most widely-read bioeconomy daily

https://www.biofuelsdigest.com/bdigest/2021/04/18/renewable-diesel-kicks-off-2021-with-conversions-capacity-increases-new-feedstocks-and-more/7/

# Status of commercial co-processing in North America

NB: Most Low CI fuels are <u>targeted for sale in the California market</u>, to maximize credits

- BP Cherry point (Washington State) and Kern Oil (California State) co-processing at the hydrotreater using oleochemical/lipid feedstocks
- Both have obtained fuel codes from CARB
- C14 samples were regularly taken, as required by CARB
- Alternative/cheaper, "in-house" measurements are still under development (e.g. C13)
  - However, ASTM certification can be a long/expensive process
- Determining the CI adapted from the "standalone" renewable diesel process (using GREET)
- <u>There is a need for "rationalized" LCA's (i.e. CI targets, not volumetric targets e.g. 10% ethanol)</u>

# Example; Who is doing co-processing at a commercial level internationally (outside of north America)

- Preem
  - Tall oil first processed by SunPine to produce crude tall diesel (Preem jointly owned, started in 2010)
  - Further co-processed at Gothenburg refiner

Forest and saw mill bi-products and residue liquefaction and valorization

- Preem has further interests in pyrolysis technologies
- Setra and Preem has started a JV, Pyrocell AB to build a fast pyrolysis plant Gävle. The plant would use saw dust from the Setra saw mill "Kastet"
- The pyrolysis oil would be used as a refinery feedstock

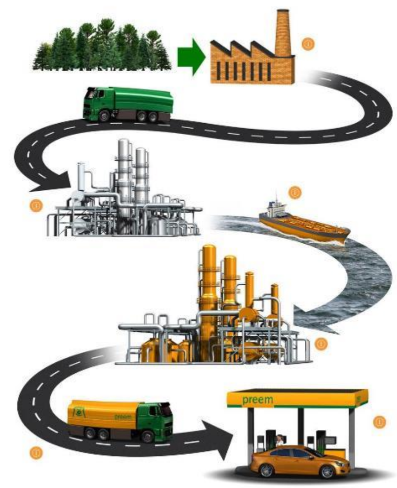
Setra

**Pyrocell selects BTG-BTL's fast pyrolysis technology**

In Sweden, Pyrocell AB has announced that it has selected the Dutch companies TechnipFMC and BTG BioLiquids (BTG-BTL) to design and build a production facility in which sawmill residues from Setra Group's Kastet sawmill will be converted into bio-oil. It will be the first plant in the world where 'green fuel' will be produced and further processed into road transportation fuels at an oil refinery – Preem's Lysekil refinery.

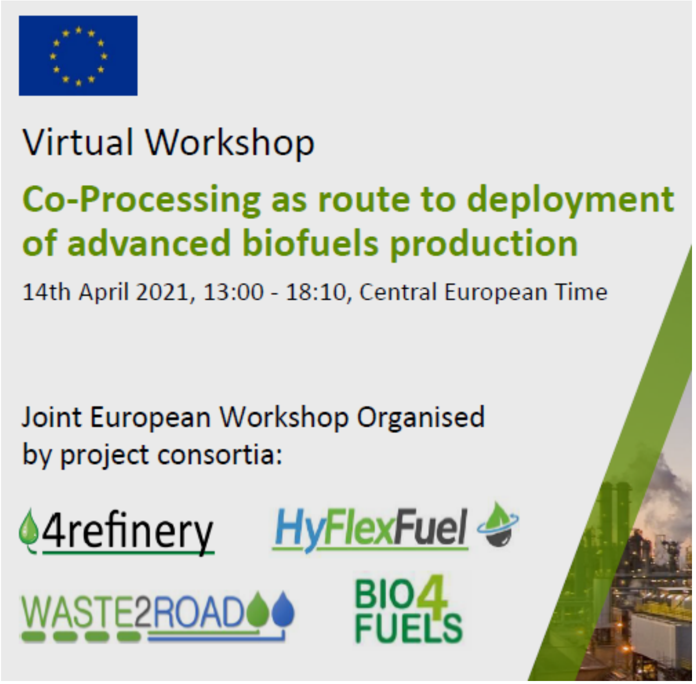
btg biomass technology group

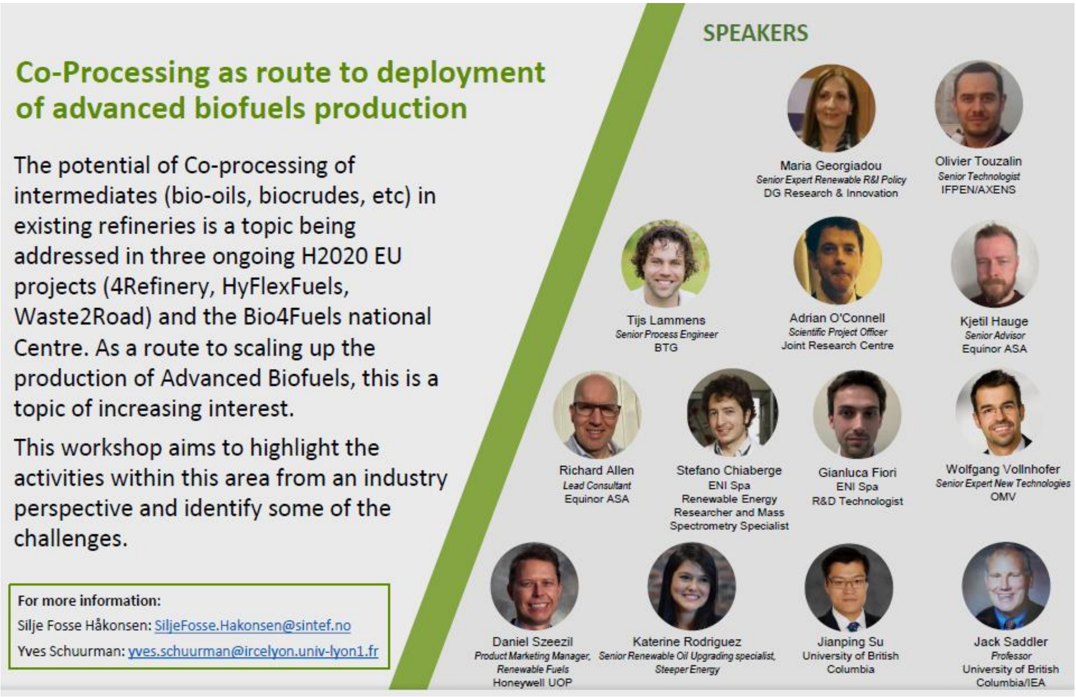
Venderbosch 2019




Preem 2019

# Thanks to Duncan for organising a very informative workshop!



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# Summary of "Parkland study"
## (Su *et al*, published in *Fuel*, 294, June, 2021, 12056)

- Commercial scale data was collected and assessed over a year
- Each flow's mass balance was re-evaluated
- Statistical analysis was performed, to compare the average yield
- Visualization/single variable analysis was used to screen parameters
- Multiple linear regression was used to "normalize" changing variables
- Selected samples were sent out for external C14 analysis

ELSEVIER
Fuel
Volume 294, 15 June 2021, 120526
FUEL

Full Length Article

Challenges in determining the renewable content of the final fuels after co-processing biogenic feedstocks in the fluid catalytic cracker (FCC) of a commercial oil refinery

# Some observations from the work with Parkland

- Tracking the “green molecules” proved challenging!
- Co-processing oleochemical feedstocks at the FCC is already commercial.
- Insertion at the FCC makes co-processing technically less risky (N.B. can more readily co-process “biocrudes” in the future).
- A low (less than 5%) percentage levels of co-processing, does not generate a strong enough signal such that the renewable content can be readily identified
- However, using long term data combined with multiple linear regression can be used to quantify the impact of adding biogenic feedstocks via the FCC
- A combination of both multiple linear regression and C14 analysis will likely needed to generate credits under BC’s low carbon fuel standard

## What will be covered in the final "drop-in" biofuels report:

Entitled: *"Recent developments in the production of low carbon-intensive drop-in fuels via stand-alone and coprocessing production"*

- Global expansion of stand-alone facilities for drop-in biofuel production (including feedstocks)
- Recent developments and progress in coprocessing of lipids (short term) and biocrudes(long term)
- Progress in the production of biocrudes (HTL, FP, CP, etc.)
- Technical challenges in coprocessing in the FCC and hydrotreater and measures needed to overcome these challenges (e.g. pretreatment, upgrading, etc.)
- Progress in tracking the green molecules during co-processing and determining carbon intensity of coprocessed fuels
- The role of hydrogen in carbon intensity and moving towards low CI and green hydrogen
- Other topics?

# Report will be completed by mid-to-later in 2021

## Thanks and questions?

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