The potential of co-processing to expand the production of low-carbon-intensive (CI) drop-in fuels

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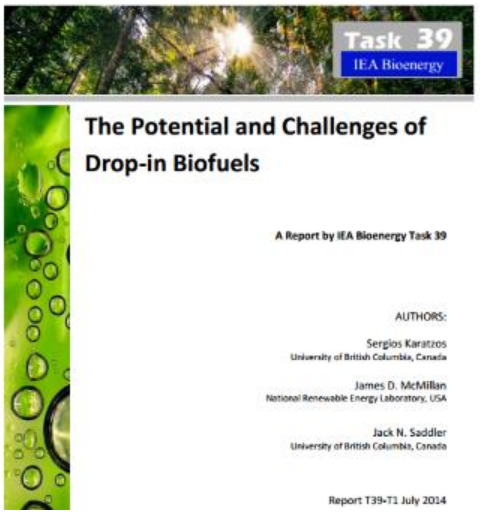
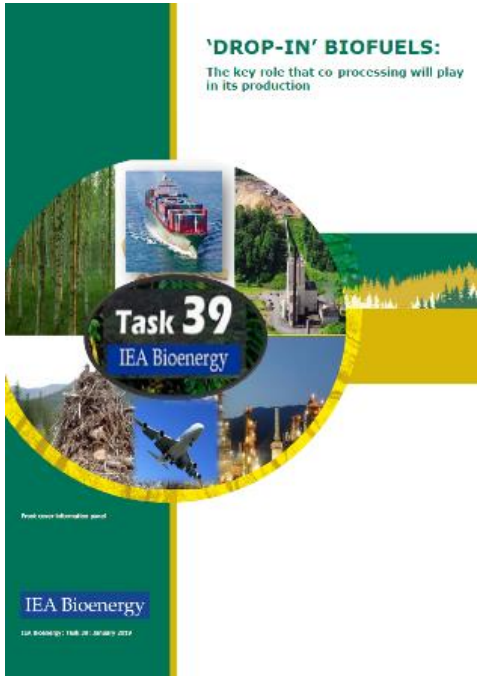
Drop-in biofuels reports (2014 & 2019)



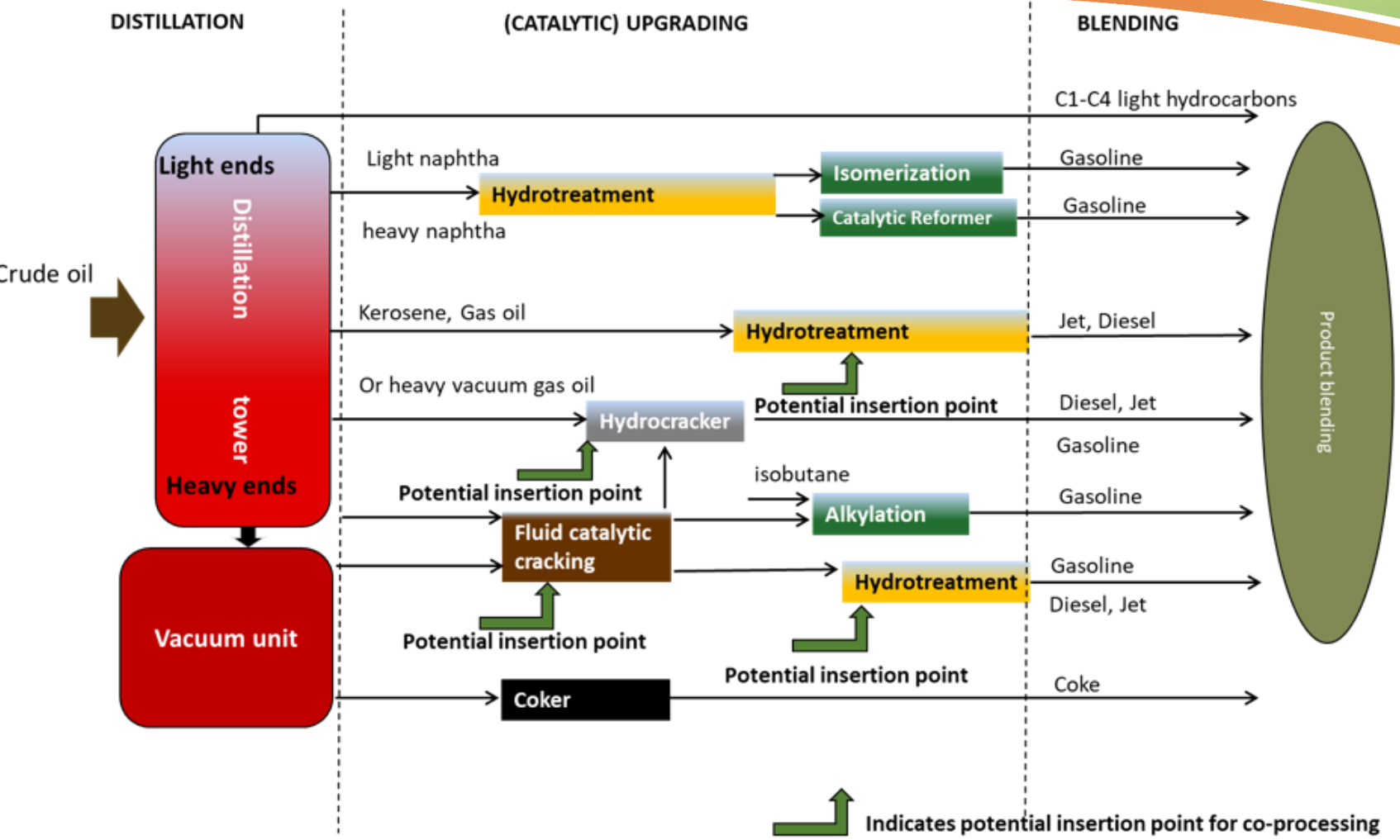


Definition of "drop-in" biofuels

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

Where is co-processing likely to occur?

"Conventional" Oleochemical/Lipid	"Advanced" biocrudes
• Hydrotreater • Fluid catalytic cracker (FCC) • Hydrocracker	• Hydrotreater • Fluid catalytic cracker (FCC) • Hydrocracker



TRL	1-3	4-6	7-8	9
	Research	Pilot	Demonstration	Commercial
	Biocrudes hydrotreater/hydrocracker co-processing		Fast pyrolysis FCC co-processing	Oleochemical hydrotreater co-processing Oleochemical FCC co-processing

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Oleochemical hydrotreater co-processing vs. Stand-alone (e.g. World Energy/Neste)

- Both are fully commercialised, but why are standalone units preferred?
  - US excludes co-processing as a way of making biomass based diesel (D4). Co-processed diesel can only qualify for half of the credits from blender tax credits (1USD/Gallon)
  - Less competitive refineries in US and EU are more likely to be *repurposed* as stand-alone units
  - As Carbon Intensity (CI) determination has improved, it seems that the CI of fuels obtained via co-processing do not differ significantly from standalone units
  - Commercial examples: Preem, BP, Kern oil, etc.

Co-processing Oleochemicals in the FCC

- Commercial operations underway at Parkland refinery, Vancouver, BC
- Refinery's previous owner (Chevron) announced further FCC co-processing trials in California
- Technically less risky than hydrotreater co-processing
- Determining the Carbon Intensity (CI) of the various fuels is on-going and will likely be more challenging
- Although an FCC insertion point will be more flexible, quantifying the baseline will prove to be more challenging

Co-processing “biocrudes” in the FCC

- FCC co-processing of biocrudes has most promise. However, the bottleneck is the supply and availability of biocrudes as long-term co-processing trials are needed to quantify their impact on refinery operations
- More work is needed on aspects such as if prior hydrotreatment will be needed to stablise the biocrude
- Substantial differences in biocrude characteristics are anticipated, e.g. pH, water content, stability, etc.
- Availability (plus knowing the sustainability, cost, etc.) of biocrudes at a commercial level is still needed

Conclusions

- Co-processing is a combination of different technologies, each of which is at a different TRL
- Operations/trials are already happening at a commercial level. Although various insertion points (FCC, hydrotreater, etc.) can be used, only oleochemical feedstocks are currently used. However, reproducible and industrial scale data is now being generated.
- This experience is being used to address other questions, particularly those that impact overall refinery operations
- “Demonstration” amounts of biocrude volumes are not yet available. The nature, composition and “pretreatment” of biocrudes will influence how they might be inserted/upgraded in a refinery

Thanks!

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