

Conversion of Forestry Waste to Finished Transportation Fuels through Hydrofaction® Technology

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### Proven Technology



# Hydrofaction<sup>®</sup>

- Proven and optimized hydrothermal liquefaction (HTL) for higher yields
- Supercritical chemistry (~400°C and ~330 bar)
- High energy efficiency (no pre-drying) with 80% of net external and biomass chemical energy retained in biocrude oil product
- Hydrofaction<sup>®</sup> Oil has:
  - Low oxygen content
  - High thermal stability
  - High energy density (close to crude oil)
- Ultra Low-Carbon to Carbon Negative Fuels through Carbon Capture, Utilization and Storage (CCUS) technologies

Hydrofaction<sup>®</sup> is a highly optimized version of HTL, with an industry leading feedstock to biocrude conversion rate



### A Cost Effective Advanced Biofuel Pathway



## Hydrofaction<sup>®</sup> is a cost-effective, low CI, fossil fuel alternative process

- Hydrofaction<sup>®</sup> achieves an industry-leading 45% biomassto-oil conversion on a mass basis, and 85% on an energy basis
- Hydrofaction<sup>®</sup> biocrude similarities to fossil crude means less refining is required
- Makes use of existing petroleum infrastructure
- Ideally suited for multiple types of wet waste feedstocks, as no drying is required
- Addresses key issues with sustainable feedstocks (fuel versus food; land use change; biodiversity)
- Pathway to carbon negative liquid long haul transport fuels





### **Carbon Competitiveness**





Source: Foretich, Anthony, et al. "Challenges and opportunities for alternative fuels in the maritime sector ." Maritime Transport Research, vol 2, Aug. 2021,

#### **Biocrude from an Alberta Hydrofaction® Plant:**

- With a green grid, Steeper's biocrude is roughly carbon neutral
- With a green grid and CCS, Steeper's biocrude CI is roughly negative 30 gCO2e/MJ
- Accounting for
  - feedstock preparation, transport
  - utilities, catalysts, hydrogen
  - drop-in biofuel combustion
  - avoided waste wood emissions

HTL is recognized by US DOE and the European Commission as an exceptionally cost and resource efficient technology for biofuel production with the greatest potential GHG mitigation for heavy transport

### Milestones





### Hydrofaction<sup>®</sup> Biocrude to Fuels





[1] Dry forestry waste to show yield. The process does not require drying

[2] 60 vol% blend of partially upgraded Hydrofaction® biocrude and 40 vol% RMG 180 marine fuel oil meets ISO 8217 specification

[3] 60 vol% blend of Hydrofaction® renewable diesel fraction with 40 vol% fossil diesel meets EN590 ultra-low sulfur diesel specification

[4] Maximum upgrading scenarios for producing marine biofuels, renewable diesel, and jet fuel in various proportions

[5] Gasoline as a secondary fuel product in some of the scenarios with production ranging from 12 BBL to 22 BBL.

### Advanced Biofuels Centre



#### Defining the value of Hydrofaction<sup>®</sup> Oil

- Advancing biocrude stability, blending, and compatibility
- Utilizing in-situ renewable H<sub>2</sub>
- Demonstrating refinery integration
- Developing techno-economic pathways to renewable fuels
- Delivering flexibility in commercial design for Hydrofaction<sup>®</sup> licensees

This highly specialized laboratory is enhancing Steeper's upgrading and refinery co-processing capabilities







#### Phase I: Demo Plant

A € 50M demo plant with capacity of 30 BPD converting forestry residues to renewable biocrude



#### **Strategic Partner**

Silva Green Fuel, Steeper's first commercial licensee, chose to invest in Hydrofaction® after extensive diligence on ~40 competing technologies



#### **Phase II: Commercial Plant**

Capacity of 2,000 BPD or 125,000 Fuel Tonnes per Annum to be built adjacent to the Demo Plant



#### **Engineering Verification**

We are currently in the process of having Steeper's capital costs and engineering verified by a third-party engineering firm



#### Operations

Construction of Phase I completed in 2021 and startup in progress with operation through 2023. Phase II to follow

### Standard Modular Plant Design





Hydrofaction<sup>®</sup> plants are designed using a philosophy of repeatable standard capacity modules which are replicated to the appropriate plant scale

This design methodology delivers consistency, replicability, and redundancy, which leads to high availability

Modular design reduces on-site construction costs and moves sub-components to a controlled manufacturing environment, which yields quality, cost-effectiveness, and reduced risk

Modular design allows plants to be right sized to meet any given plant location's feedstock reality

### Hydrofaction®



Steeper Energy has arguably the most advanced HTL-based renewable fuels technology and is positioned for rapid commercialization and tremendous growth

Steeper's Next Step: Driving Commercialization



- Pathway to carbon negative long haul transport fuels
- Pilot plant >8000 hours
- Industrial demo plant presently being commissioned
- Over 400 demo plant operational hours with slurry
- 3<sup>rd</sup> party engineering validation of commercial plant design in process
- Robust prospective of projects in the pipeline
- Off-take MOU's signed and being further developed
- Over 150 patents in 25 patent families
- Contact us if you would like to know more



# Thank you

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