Hydrofaction™ Oil: A Solution for Decarbonizing Long-haul Transport

From biomass to advanced biofuels, combining Canada’s Forestry and Oil&Gas strengths

July 2017
Steeper Overview

• Steeper’s proprietary Hydrofaction™: proven thermochemical process cost effectively converting biomass wastes to low-oxygenated bio-crude oil and advanced bio-fuels
  ✓ Strong IP position – over 80 patents pending across 18 patent families

• Low-carbon fuel market is deep and attracts a premium price ($145/BBL)
  ✓ Hydrofaction™ Oil easily upgradable to diesel, jet, base oil and chemicals
  ✓ Market focus: Heavy and long-haul and aviation sectors
  ✓ Waste biomass feedstocks are vast (up to 30% of global transport fuel demand)

• Steeper licences Hydrofaction™ as well as develops projects

• Offices in Copenhagen Denmark and Calgary Canada

• First strategic (Scandinavian) partner
  ✓ Licensee; Co-Funding of Demonstration Plant; 1st Commercial Plant
The Chemistry of Hydrofaction™

**Hydrofaction™** uses *super critical* chemistry (±450°C and ±350 bar) to transform low-energy density feedstocks into valuable high-energy liquid fuels.

**Hydrofaction™** removes Oxygen (O) from the organic molecular structure, increasing the H-C ratio and the energy density of the *hydrocarbon equivalent* Bio-crude.

- **Renewable** – Bio-crude produces 80%+ fewer CO₂ emissions when compared to fossil (*well-to-wheel*).
- **No need to dry feedstock** – Hydrofaction™ processes wet feedstock, resulting in reduced energy consumption.
- **Petro-equivalency** – Upgraded Hydrofaction™ Oil compatible with fossil-oil infrastructure.
- **High thermal efficiency** – thermal efficiency (80 - 90%) superior to other bio-energy systems.
Current Evolution of Hydrofaction™

Existing Pilot Plant
• 1400+ oil production hours
• Proven heat and mass balance
  ✓ Oil yields of 45% (dry weight basis)
  ✓ Energy conversion ratio of 80%
  ✓ Carbon conversion ratios above 60%
• High quality bio-crude
  ✓ Energy content ~38 MJ/kg (fossil: 42 MJ/kg)
  ✓ Oxygen content less than 10%
• Upgrading of Bio-crude to Advanced Bio-fuel

Intellectual Property
• 18 Patent Families covering feedstock milling through to Bio-crude upgrading
• Following PCT International Patent Process
• Core patent granted in Canada, China and New Zealand
• Shutdown patent granted in Canada
• 80+ additional patents pending in strategic countries/regions:
  ✓ core processes; applications, control; apparatus; and, upgrading to finished fuels
Next Step: Industrial Scale Demo and De-Risking Plant

- Physical size of one ‘module’ – multiple modules make up future commercial facilities
- Off-the-shelf sub-components at commercial-scale or supplier capable of providing at commercial-scale
- Two 3rd-party engineering studies completed for commercial 2000 BPD facility
- ISDDP is a scale-down of future commercial design
The social value proposition

• Environment
  ✓ 80-110% GHG savings (depending on feedstock and liquid CO₂ end-use)
  ✓ Low sulfur fuels (SOx emissions)

• Community
  ✓ 30 direct and 700 indirect jobs per commercial facility

• Industry
  ✓ Adding value to primary industries such as forest and agriculture utilizing low-value or residuals
  ✓ At scale solutions for industrial, regulated or urban ‘wet’ bio-wastes
  ✓ Use of existing petroleum-fuel infrastructure or refineries
  ✓ Reducing the GHG footprint of fossil exports and domestic fuels
Engaging investment capital is tough! Investors expect:

- Regulatory Certainty including RFS, carbon tax, carbon trading
- Technology proven and de-risked
- Feedstock security
- Offtake or Market acceptance and value
- High leveraging on capital (grants, loans)

Biomass conversion is an energy/utility play (no comparison to I.T.)

- Decades to prove technology at scale
- Years to certify new products
- Early capital must be:
  - High risk (E.g. early wind power in Europe)
  - Patient (USDA and US DOE loan guarantees)
Canada’s Policy in the BioEconomy “Ecosystem”

- Policy is “not a crutch”; required to create certainty in the Bio-Economy ecosystem
- Policy should engage and motivate all stakeholders to play, not pick winners
- Stability will attract investors and strategics for the “long race”
Summary:

How to attract capital and ensure market longevity:

- Consistent regulatory policy:
  - Supporting market security for all actors
  - Providing confidence and leverage during high-risk early adoption stages

- Cost effective low-carbon fuels:
  - Technologist play their part;
  - Hydrofaction™ is arguably the most efficient thermochemical platform;
  - Proven chemistry with strong IP position

- Market (3rd party) acceptance;
  - Hydrofaction™ chosen by a number of *strategics* as the preferred technology after investigation, comparison and validation across other chemical pathways

- ... and Steeper?
  - Raising USD $15+ M to fund commercialization program...
Experienced Team behind Steeper Energy

**Perry E. Toms** – Founder, President & CEO
25+ years leadership experience. Former SVP Ignite Energy Resources (direct competitor); ABG Biodiesel; Novera Energy (one time largest renewable energy IPP in UK); Senior management roles within Canadian Coal, Oil & Gas sectors

**Dr. Göran Olofsson** – Senior Chemical Engineer
Rambøll Sverige AB, SCF Technologies, Luleå Technical University

**Robert (Bob) Moll** – Director of Engineering & Operations
New Energy Corporation, Honeywell, various engineering roles

**Dr. Steen B. Iversen** – Founder, CTO
20+ years technical leadership, chemistry and engineering experience with conventional energy, waste-to-energy and super critical fluids/chemistry. First-of-Kind and First Commercial-of-Kind with FLSmidth and SCF Technologies

**Dr. Sergios Karatzos** – Senior Manager
UBC, IEA, EU Commission

**Dr. Julie Katerine Rodríguez** – Bio-Oil Upgrading Specialist
University of Campinas, University of Calgary
Hydrofaction™ Market – Availability of Biomass Residuals

1.9 B odt/y of “non-food” non “merchantable” biomass residue
- 14 M barrels per day (bpd) or 32% of the world’s total transport fuel demand
- Greater than 2500 million t CO₂ emission savings per year

First Commercial Plant

- 2000 Barrels-per-day
  - Circa $200M Investment
  - Forestry Residues
  - 240,000 odt feedstock per annum
- Strategic Partner to fund and build
  - Reliant on successful demo
  - Initial engineering study complete
  - Transportation fuels for the Scandinavian market
Projected Economics of 2000 bpd Facility

- Assumptions
  - Non-leveraged, pre-tax
  - Engineering design for 1st-of-kind commercial plant
  - $145/BBL Oil Price (Biodiesel)
  - Forestry feedstock @ $60/ton

- IRR of 25.0%
  - Simple payback of 2½ years
  - Return on Investment 39.0%
  - EBITDA of $80 Million
  - NPV (10%) of $360 Million
Robust Demand for Renewable Fuels

- Advanced Biofuels key to reducing carbon footprint of heavy transport sector
  - Electrification not an option for planes, trucks & marine
- IEA predicts biofuels growth of over 600% from 2020 to 2050
  - Representing over 27% of total transport sector fuels
- US, EU & China GHG commitments require 1.1 Million BPD

<table>
<thead>
<tr>
<th>Region</th>
<th>Heavy Transport (M BPD)</th>
<th>Total Transport (M BPD)</th>
<th>Heavy Transport as % of Transport</th>
<th>Transport Mandate (M BPD)</th>
<th>Heavy Transport Mandate (M BPD)</th>
<th>Steeper Facilities Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trucks</td>
<td>Marine</td>
<td>Air</td>
<td>Total</td>
<td></td>
<td></td>
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<tr>
<td>US</td>
<td>2.8</td>
<td>0.5</td>
<td>1.1</td>
<td>4.3</td>
<td>17.1</td>
<td>25%</td>
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<tr>
<td>EU</td>
<td>2.4</td>
<td>0.8</td>
<td>1.5</td>
<td>4.6</td>
<td>6.5</td>
<td>72%</td>
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<tr>
<td>China</td>
<td>2.1</td>
<td>0.3</td>
<td>0.4</td>
<td>2.8</td>
<td>3.8</td>
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Hydrofaction™ Market Focus

• Forest Sector Highly Motivated
  ✓ Declining margins in traditional markets
  ✓ Actively pursuing biofuels market

• Agreement in place with First Licensee
  ✓ Financing of first commercial facility
  ✓ 50/50 Partner in Demo Plant

• Project Funnel of 6 commercial plants
  ✓ 3 in Europe, 3 in North America
  ✓ License and co-ownership opportunities

• Future Markets:
  ✓ Sugar Bagasse; Palm Residuals, Waste Management, Ag Residues; Food Processing residuals; and, Energy Cropping or Algae
Agri-Waste Business Opportunity

• Manure from Factory Farms
  ✓ Regions with high concentrations
  ✓ Challenged by manure logistics and social license
• Facilities of similar size to Demo Plant (approximately 50 BPD)
  ✓ Cost negative feedstock
  ✓ Reduced labor through remote operations
  ✓ Additional product – fertilizer
• Steeper revenues through licensing

<table>
<thead>
<tr>
<th>Region</th>
<th>Manure (ODT)</th>
<th>Hydrofaction™ BPD</th>
<th>Plants</th>
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<tbody>
<tr>
<td>California - Tulare</td>
<td>1,025,972</td>
<td>6,496</td>
<td>130</td>
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<tr>
<td>California - Merced</td>
<td>528,923</td>
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<tr>
<td>Texas - Deaf Smith</td>
<td>468,162</td>
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<td>Iowa - Sioux</td>
<td>429,646</td>
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<td>California - Imperial</td>
<td>400,428</td>
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<tr>
<td>North Carolina - Duplin</td>
<td>362,493</td>
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<td>California - Stanislaus</td>
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<td>California - Fresno</td>
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<td>California - Kings</td>
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<tr>
<td>North Carolina - Sampson</td>
<td>341,492</td>
<td>2,162</td>
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Competitive Landscape for Hydrofaction™

- Oil Seed supplies bulk of diesel biofuels
  - Fully commercial for Biodiesel and HDRD
  - Oil Seed is expensive & land use issues

- Pyrolysis and Gasification
  - Near commercial
  - Expensive – drying of feedstocks + other issues

- Hydrothermal Liquefaction
  - Least commercial
  - Highest potential – DOE chosen pathway
  - Hydrofaction™ the most efficient
    - Operates in super-critical conditions
  - HTL Competitors operate at sub-critical

Diesel/Biodiesel and Palm Oil Prices

<table>
<thead>
<tr>
<th>Year</th>
<th>FAME Biodiesel</th>
<th>Diesel</th>
<th>Palm Oil</th>
<th>Hydrofaction Oil Production Cost</th>
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<tbody>
<tr>
<td>2013</td>
<td>$250.00</td>
<td>$100.00</td>
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<tr>
<td>2014</td>
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<td>2015</td>
<td>$200.00</td>
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<td>2016</td>
<td>$180.00</td>
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Steeper Energy Business Model and Projections

- **Revenue from:**
  - Hydrofaction™ Royalty – $10/BBL
  - Self use of Technology
  - Services

- **Option to develop own projects, co-develop or trade Royalty for ‘carry’ in to other’s projects**

- **Feedstock in Europe and North America represent 2500 potential facilities** (2000 BPD)

- **Substantial Value Accretion as Hydrofaction™ is deployed**

- **Multiple Inflection Points Create Opportunities for Future Monetization of Value**