



# Hydrofaction<sup>®</sup>, transforming organic waste into advanced biofuels and other valuable resources

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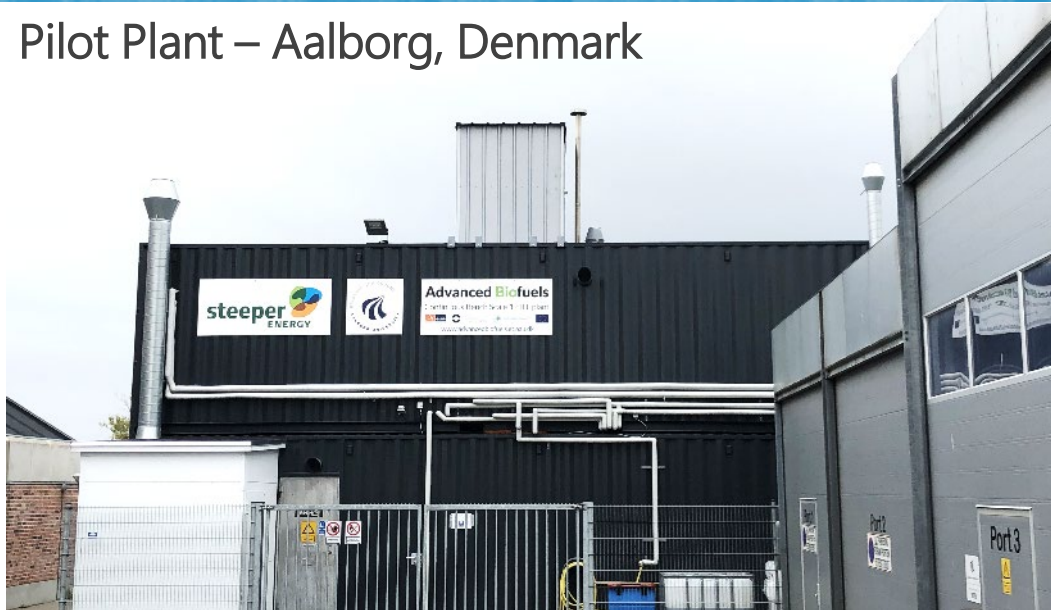
*DOE- BETO Workshop on Advancing Synergistic Waste Utilization as Biofuels Feedstocks:  
Preprocessing, Co-products, and Sustainability Workshop  
14-15 April 2021*

U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy  
BIOENERGY TECHNOLOGIES OFFICE

# Steeper Energy's Proprietary Technology-Hydrofaction®



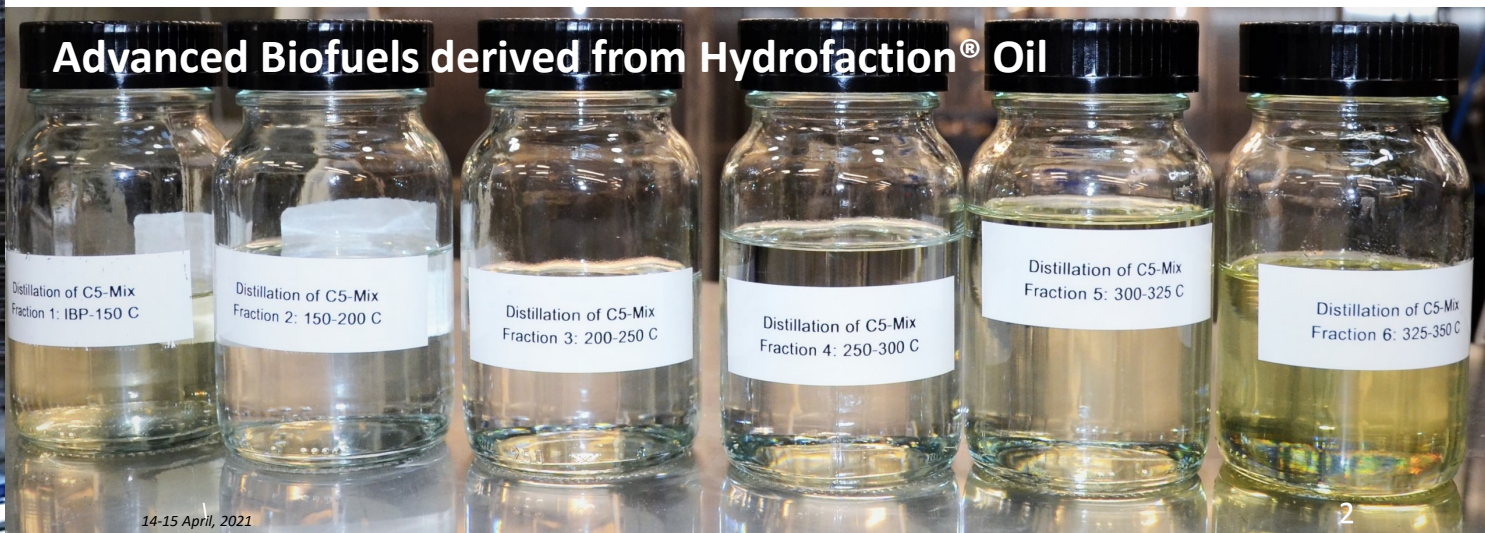
Pilot Plant – Aalborg, Denmark



Global Technology Leader  
for conversion of bio-organic residues to  
advanced fuels



Demo Plant – Tofte, Norway





**Petroleum-equivalent** advanced biofuel



Targeting heavy transport sector – that is **incompatible with electrification or low energy density fuels**



**Compatible** with petroleum infrastructure or refineries (co-processing patents)



Base input for **renewable** lubricants and fine chemicals



**Upgradable** to diesel, marine, gasoline, and jet fuels

100 BBL Hydrofaction<sup>®</sup> Oil



### Upgrading Scenarios

Up to 35 BBL Jet Fuel\*

Gasoline ~23 BBL  
Diesel ~25 BBL  
Marine Fuel ~10 BBL

Up to 70 BBL Diesel

Gasoline ~14 BBL  
Marine Fuel ~32 BBL

Up to 95 BBL Marine or Stationary Generation Fuel

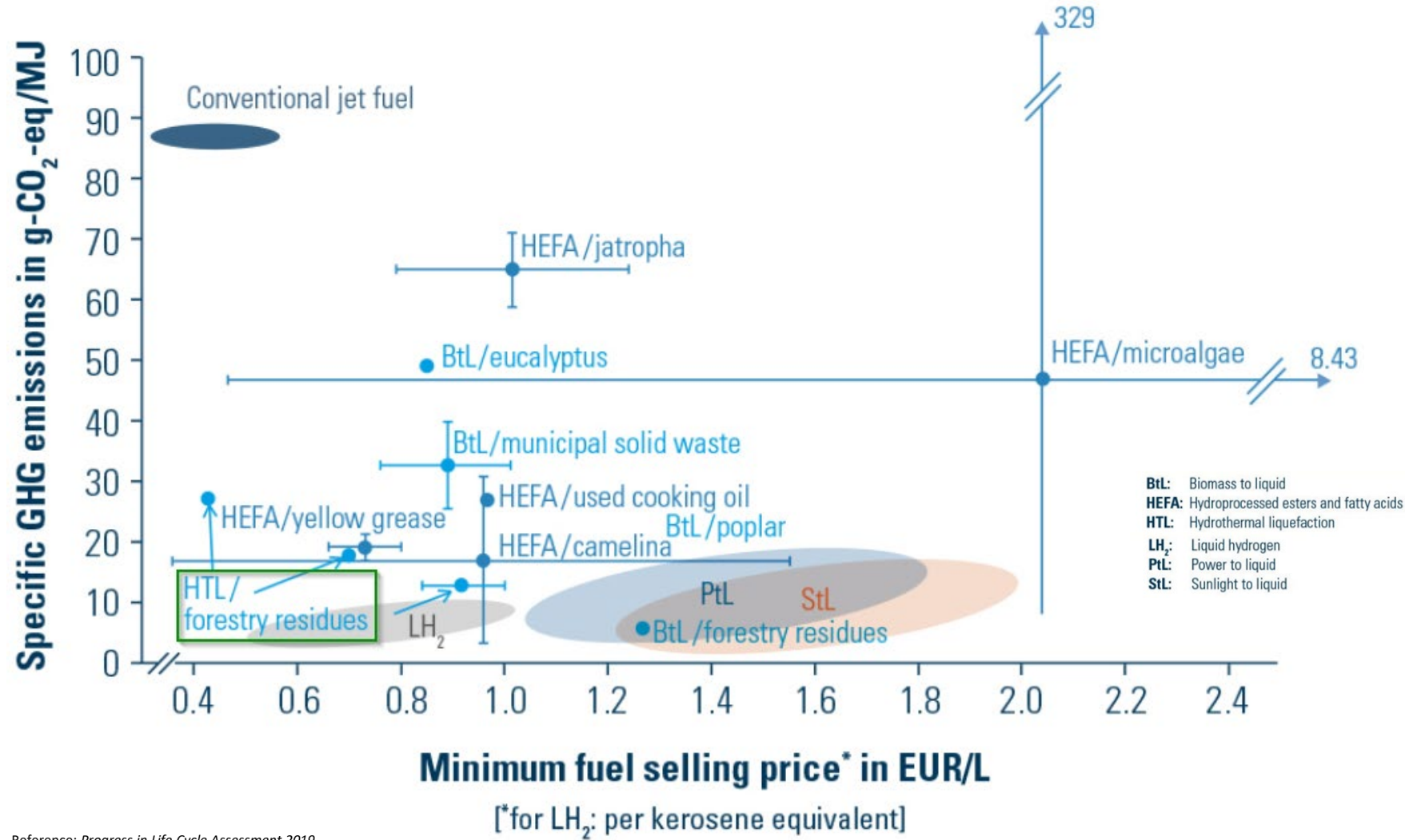
Gasoline ~4 BBL

Demonstrated Upgradability to Finished Fuels

EN590 blends achieved

ISO 8271 blends achieved

*Hydrofaction® is working toward an incentive-free future*



Reference: *Progress in Life Cycle Assessment 2019*.



## First vertical – Forestry Residues

Producing renewable bio-oil at competitive price level



## Second vertical – Sewage Sludge and Biogenic MSW

Producing renewable bio-oil, fertilizers and more





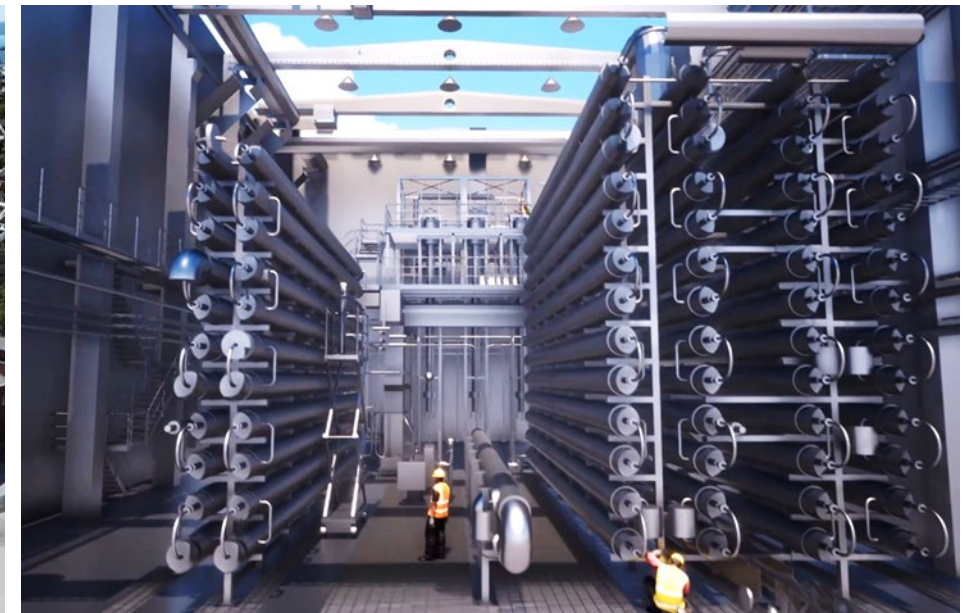
Silva Green Fuel (SGF): JV between Norway's **Statkraft** (Europe's largest generator of renewable energy), and Sweden's **Södra** (major producer of paper pulp, sawn timber and bioenergy)

- 🌍 Woody residues to renewable diesel and marine fuels
- 🌍 SGF evaluated **40** technology pathways before choosing Hydrofaction®



Commercialization in two phases

- 🌍 Phase I: **€50+ M** industrial-scale demonstration and de-risking plant at Tofte, Norway
- 🌍 Phase II: Commercial facility capable of producing **2,000 bpd** or **100,000 Fuel Tonnes per Annum** ( $\cong$  €250 M)





**Evolving and tightening regulatory standards** open opportunity for disruptive technologies:

- Urban bio-organics;
- Digestate disposal/management
- Nutrients recovery (e.g. N or P); and,
- Landfill controls



**Public concerns on contaminants entering farming systems, air or water...**

- Air emissions from incineration
- Pharmaceuticals (endocrine-disruptors)
- Micro-plastics
- Heavy Metals



**Growing population** requires new infrastructure



**Rising costs** for municipalities and residents

*Pine Creek WWTP at Calgary, Canada  
Steeper's Sewage Demo Project*





An advanced biofuel laboratory for characterization and upgrading of bio-crude oils to drop-in fuels and value-added chemicals, being commissioned in Calgary Canada.

## The Laboratory will:

- Define the value of Hydrofaction® Oil:
  - bio-crude oil; and,
  - advanced renewable fuels.
- Deliver choices for Project Licensees to maximize returns:
  - balance capital investment vs. product sale opportunities.

## Questions to be answered:

- Attributes and direct markets for Hydrofaction® Oil;
- Utilization of the in-situ renewable H<sub>2</sub> for cost-effective upgrading;
- Evaluation integration of bio-crude into existing refineries;
- Advancing understanding of chemical-linkers to improve compatibility of Hydrofaction® Oil with existing fuels; and,
- Developing economic pathways to 100% renewable: gasoline, diesel, jet-fuel, marine fuels, and fine chemicals.



# Conclusions

1. Steeper Energy is commercializing its Hydrofaction® technology locally and globally:
  - a) lignocellulosic biomass
  - b) paid for *bio-organic* waste destruction
2. Looking for strategic project partners:
  - a) significant biomass resources;
  - b) or refiners.
3. Advanced Biofuel Laboratory:
  - a) Competitive edge for adoption of Steeper's biomass-to-liquid fuel solution into existing fossil value chain
  - b) Leading the way for broad market acceptance of Hydrofaction® derived advance biofuels

