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

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A global leader in converting sustainable biomass to drop-in advanced biofuels

Hydrofaction®

A **proven** hydrothermal liquefaction (HTL) process

Cost-effectively converts low-value biomass to biocrude upgradable to advanced biofuels and chemicals at existing refineries

Significantly **reduces carbon intensity** of transport fuels (diesel, jet, marine) when compared to fossil fuels

Validated by industry, governments and granting authorities

Ideally suited for conversion of biomass waste with high water content

A Cost Effective Advanced Biofuel Pathway

Hydrofaction® will become a cost-effective alternative to fossil fuels

Driven by tightening regulatory requirements, Hydrofaction®:

- Addresses key issues with sustainable feedstocks (fuel versus: food; land use change; biodiversity)
- Reduces carbon intensity of heavy/long-haul transport:
  - A transition path from internal combustion engines
  - Makes use of existing petroleum infrastructure
- Expands opportunities for Forestry and Agriculture

Milestones

2011
Dr. Steen Iversen, and Perry Toms, established Steeper Energy

2016
5000 operating hours reached at CBS; Hydrofaction® Oil production proven to be repeatable and reliable

2017-2019
CBS undergoes first upgrades and optimizations

2018-2019
Upgrading of Hydrofaction® Oil to on-spec diesel and marine fuel achieved; co-processing routes externally validated

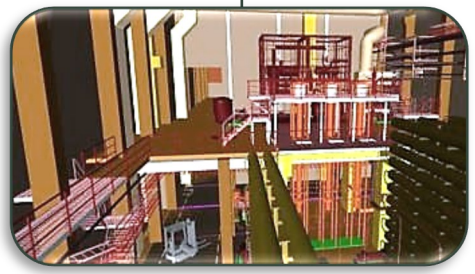
2020
Advanced Biofuels Centre established in Calgary, Canada for demonstrating pathways to finished fuels with select commercial end users

2020 - 2021
CBS undergoes reactor upgrade. Proprietary pump is commissioned

Growing IP portfolio of 25 patent families, with over 150 patents granted internationally

2013
Steeper Energy Continuous Bench Scale (CBS) pilot plant installed at the Aalborg University, DK

2016-2017
Silva Green Fuel (Statkraft and Södra JV) licenses Hydrofaction® to build 30 BPD industrial-scale demonstration plant in Tofte, Norway as a precursor to a 2000 BPD plant



2018-2020
Steeper and SGF advance the design of sub-systems, contract key suppliers and begin construction of industrial-scale Demo Plant

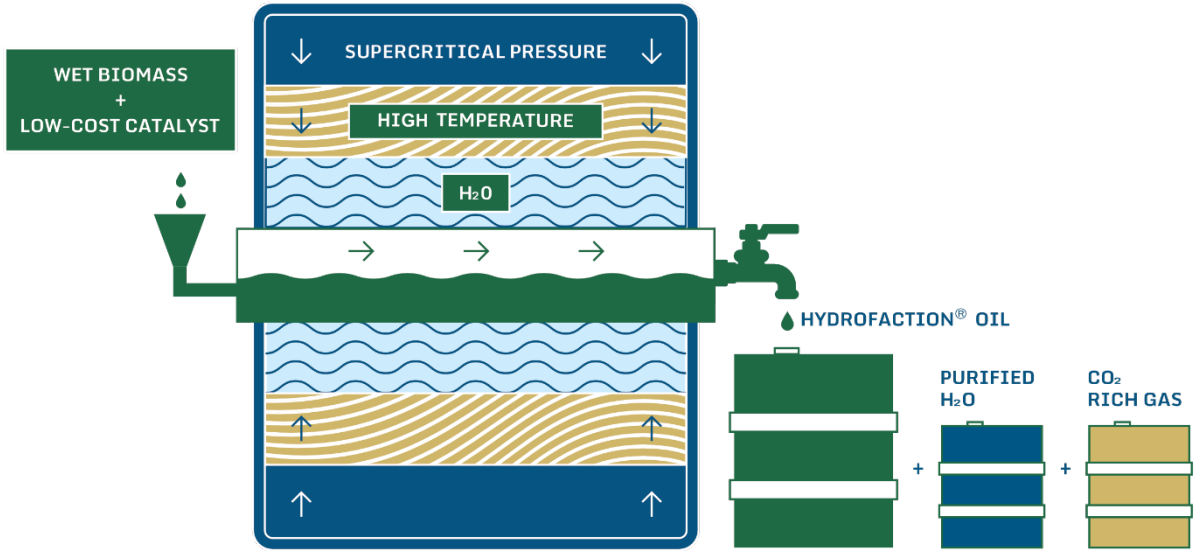
November 2021
Commissioning and start-up of Silva Green Fuel industrial-scale Demo Plant

Proven Technology

Hydrofaction®

- Proven and optimized hydrothermal liquefaction (HTL) for higher yields
- Supercritical chemistry (~400°C and ~330 bar)
- High conversion efficiency: 80% biomass thermal energy retained in biocrude oil product
- No Pre-drying Feedstocks. Perfect for lignocellulosics and many others
- Hydrofaction® Oil has:
  - Low oxygen content
  - High thermal stability
  - High energy density (close to crude oil)
- Ultra Low-Carbon to Carbon Negative Fuels

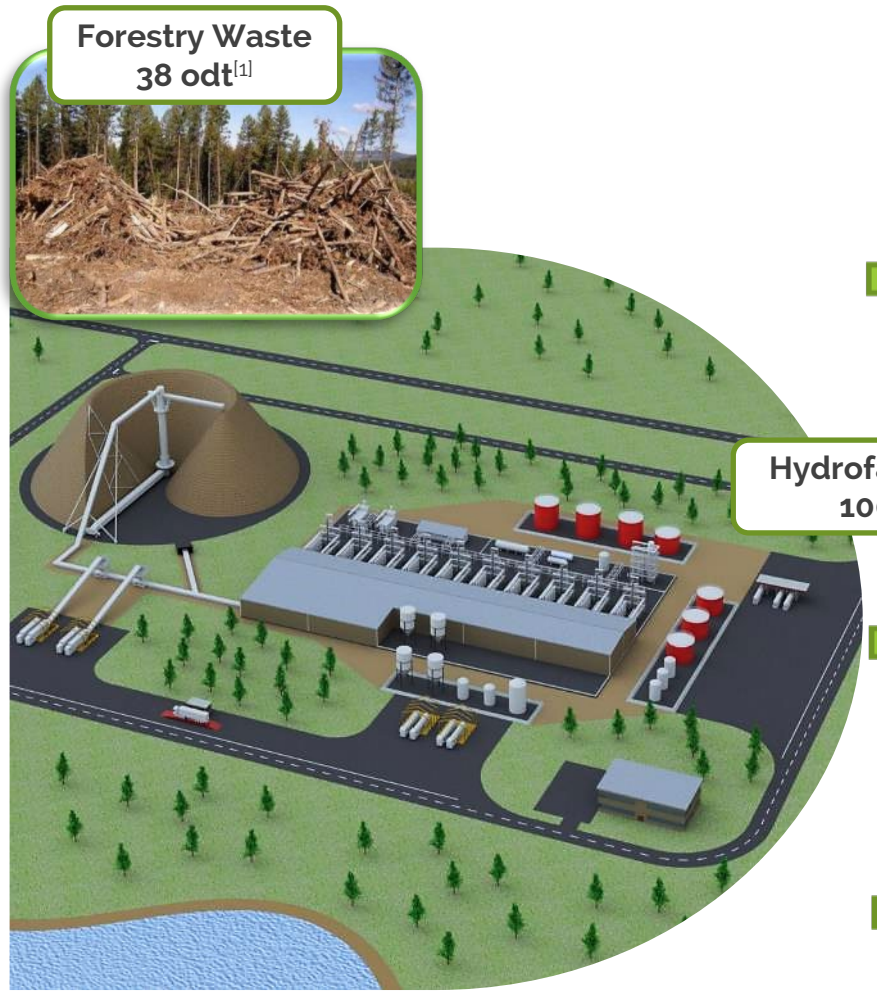
HTL is recognized by US DOE and the European Commission as an exceptionally cost and resource efficient technology for biofuel production with the greatest potential GHG mitigation for heavy transport



Biocrude to Finished Fuels

In addition to biocrude production, Steeper is advancing upgrading and co-processing pathways to ensure Hydrofaction® Oil's integration into existing energy infrastructure

Hydrofaction® Oil to Fuels



Hydrofaction® Oil Pathways To Market

Stand-Alone Upgrading

Simple Refinery

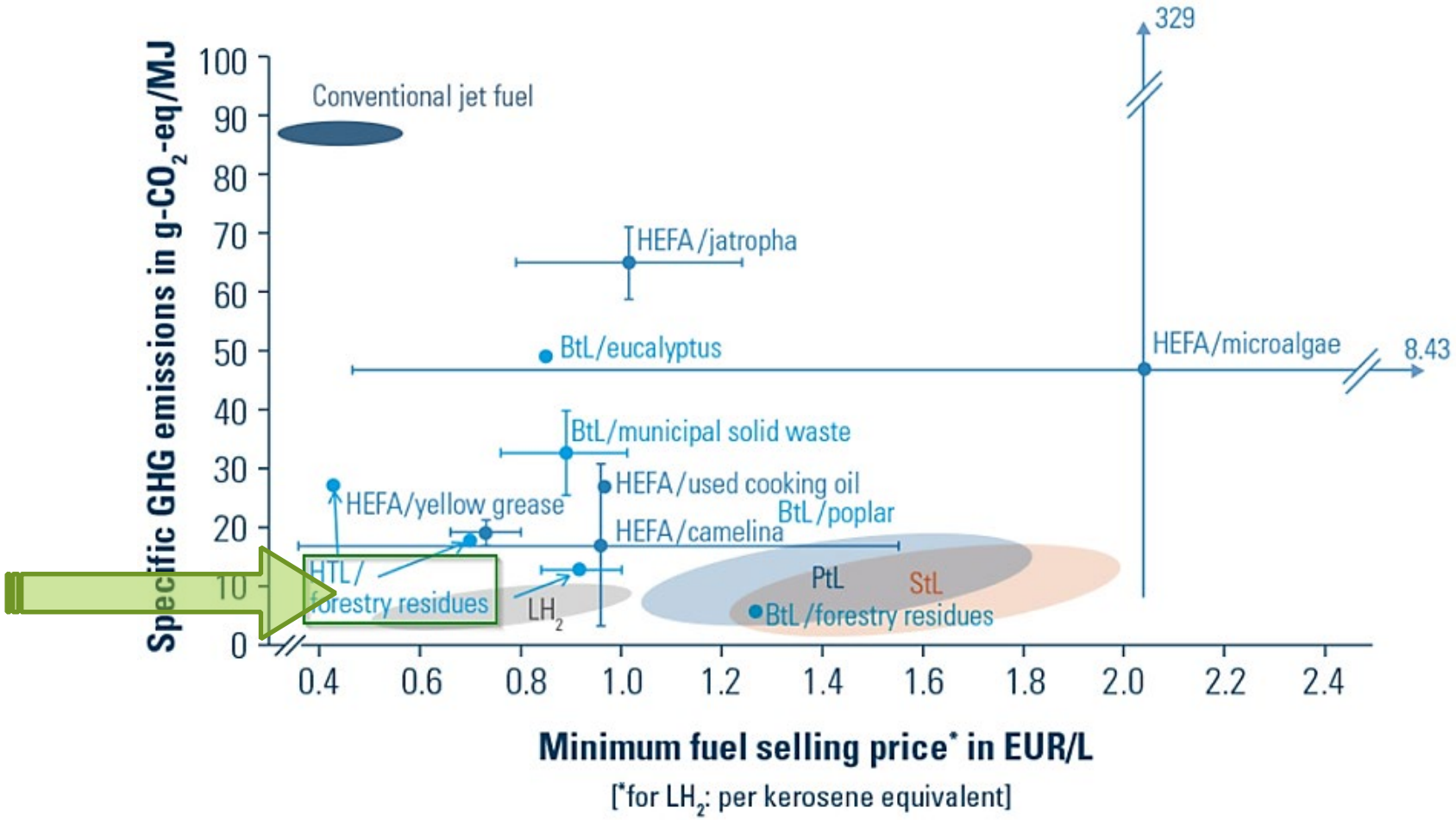
Modern Refinery

Heating Oil	60/40 ISO 8217	
Marine Fuel		
Diesel Blend	60/40 EN590	
Marine Fuel	~18 BBL[2]	
Diesel	~37 BBL[2]	
Jet Fuel	~32 BBL[2]	
Gasoline	~22 BBL[2]	
Value Added Products		

[1] Dry forestry waste to show yield. The process does not require drying
[2] Estimated
Note: Reduction in density through upgrading to finished products increases overall volume

Carbon Efficient and Cost Competitive

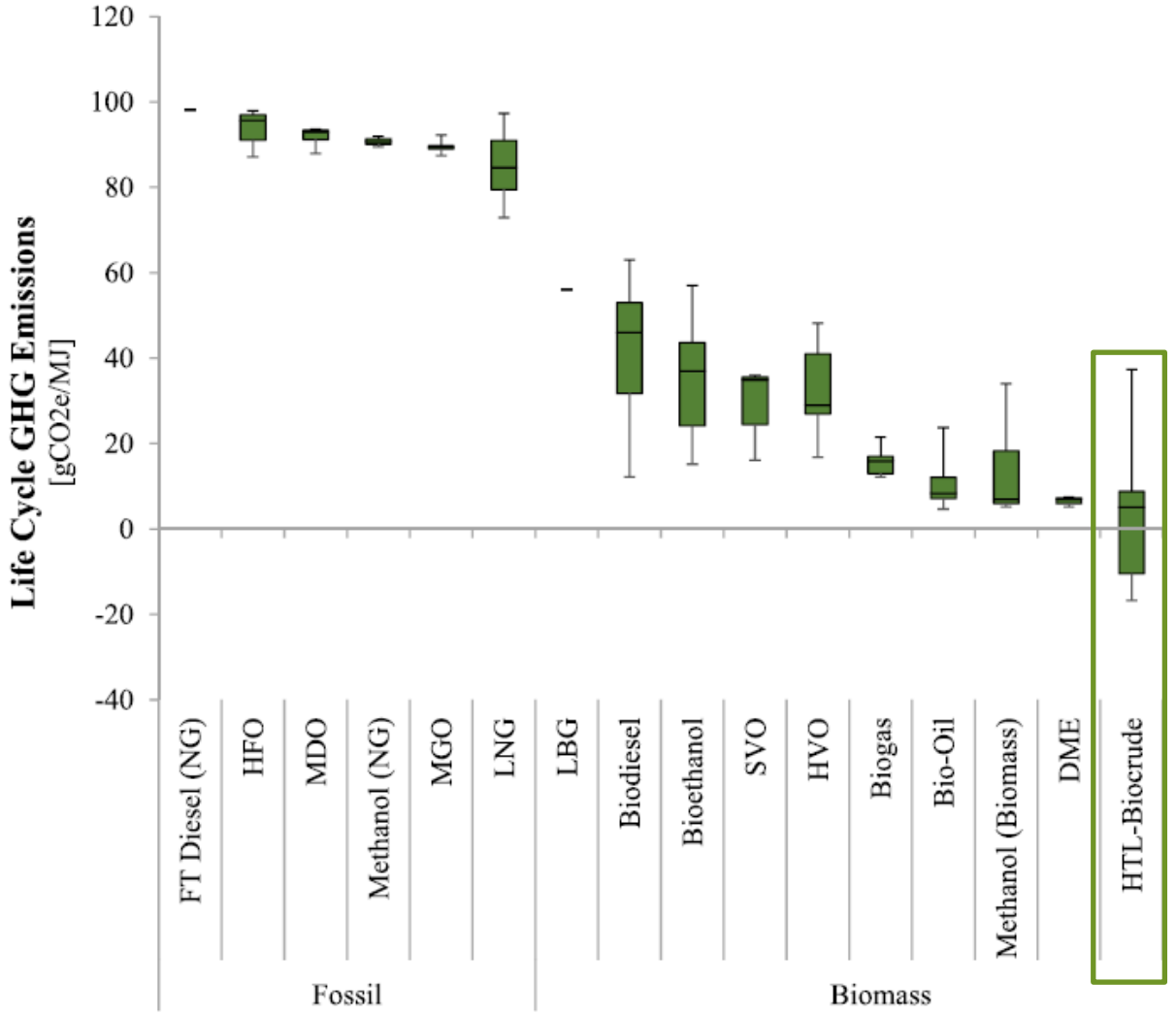
Hydrofaction® is a carbon-efficient and cost-competitive advanced biofuels solution for producing globally relevant volumes of heavy and long-haul transport fuels



Source: https://www.bauhaus-luftfahrt.net/en/topthema/hy-shair/

Carbon Competitiveness

Hydrofaction® is an effective decarbonisation solution for Marine Transport.



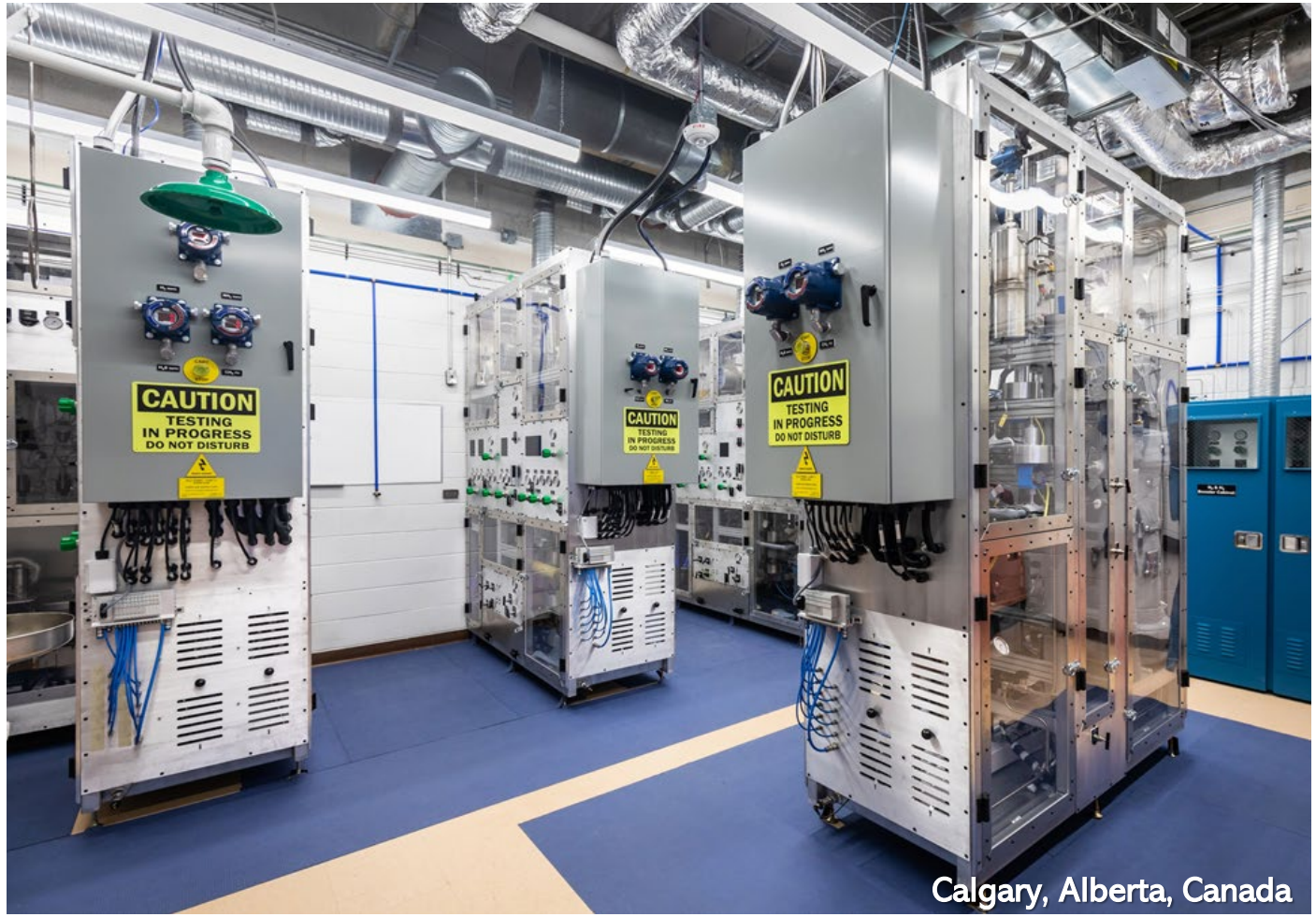
Source: Foretich, Anthony, et al. "Challenges and opportunities for alternative fuels in the maritime sector ." Maritime Transport Research, vol 2, Aug. 2021,

Advanced Biofuels Centre

Defining the value of Hydrofaction® Oil

- Advancing biocrude stability, blending, and compatibility
- Utilizing in-situ renewable H_2
- Demonstrating refinery integration
- Developing techno-economic pathways to renewable fuels
- Delivering flexibility in commercial design for Hydrofaction® licensees

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

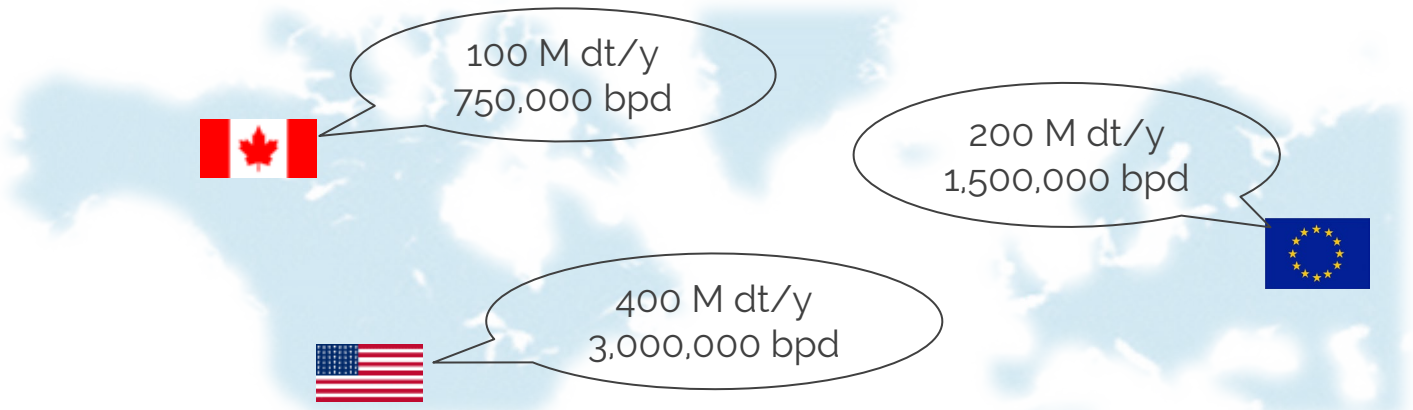


Calgary, Alberta, Canada

Substantial Potential Biomass Availability

Estimated global residual biomass availability:

1.9B dry tonnes (dt) annually of non-food, non-merchantable, forestry and agriculture biomass residues…



7,000
Hydrofaction® plants could be built

14M bpd
Hydrofaction® Oil could be produced

34%
of global diesel, jet fuel and marine fuel demand could be satisfied

>18%
of the 2030 global GHG emissions reduction target could be achieved

1. Canada Report on Bioenergy, 2010. http://www.cancarb.ca/pdfs/pubs/NRCAN%20canada-report-on-bioenergy-2010-sept-15-2010.pdf
2. US EIA "Billion-ton study", https://www1.eere.energy.gov/bioenergy/pdfs/billion_ton_update.pdf
3. EUBIA 2015 & Monforti et al. 2015, https://gallery.mailchimp.com/6518403df5fe7c761f9d31bfd/files/EUROPEAN_BIOMASS_RESIDUES_EUBIA.pdf & http://www.sciencedirect.com/science/article/pii/S1364032114010855
4. IEA Sustainable Production of Second-Generation Biofuels, https://www.oecd.org/berlin/44567743.pdf
5. IEA, 2013 http://203.117.10.102/media/news_pdfs/WEO2012 Singapore Fatih Birol.pdf
6. https://www.ipcc.ch/site/assets/uploads/2018/12/UNEP-1.pdf
7. Reductions assume a target of limiting warming to 2 degrees.

Regulatory Drivers

Clean Fuel Standard (CFS)

Goal: >20 million tonnes GHG reductions in 2030
Liquid fuel class regulations will come into force in 2022 or 2023

British Columbia-Low Carbon Fuel Standard (BC-LCFS)

Goal: Reduce the carbon intensity of fuels used in British Columbia by 20% by 2030.

Renewable Fuel Standard (RFS2)

Goal: Increase the volume of renewable fuel required to be blended into transportation fuel to 36 billion gallons by 2022

California Low Carbon Fuel Standard (LCFS)

Goal: Reduce the carbon intensity of transportation fuel pool in California by at least 20% by 2030

Oregon Clean Fuels Program (CFP)

Goal: Reduce the carbon intensity of transportation fuel pool in Oregon by 25% by 2035

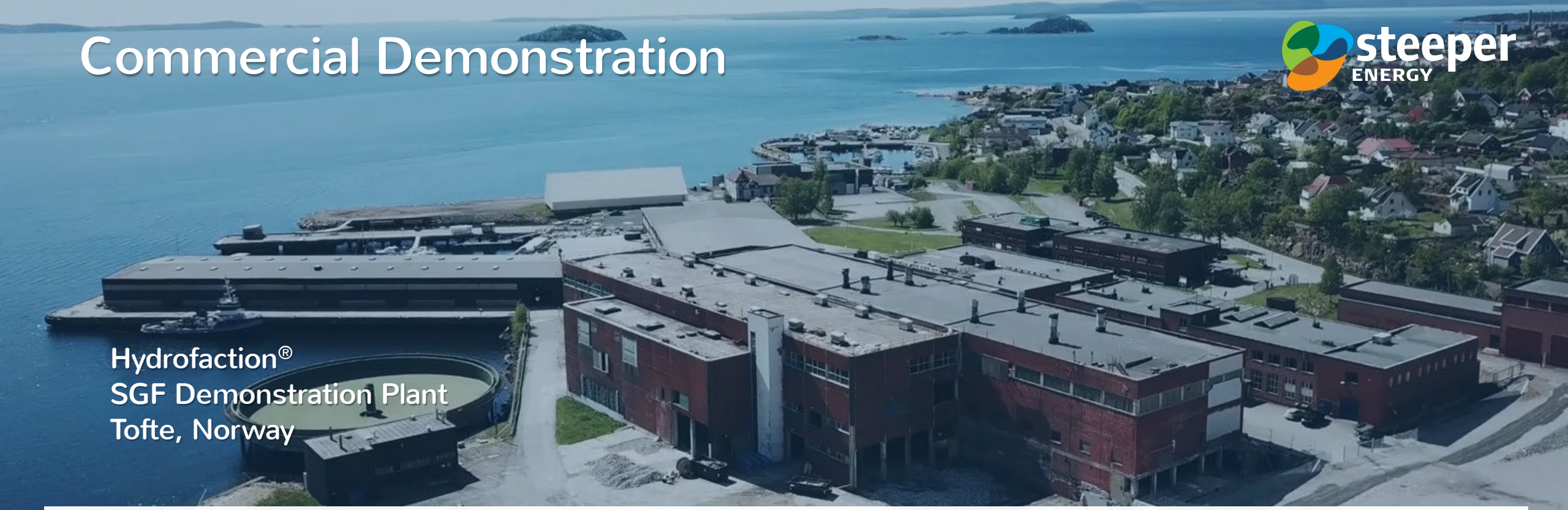
Renewable Energy – Recast to 2030 (RED II)

Overall target for Renewable Energy Sources consumption by 2030 has been raised to 32%. Member states must supply at least 14% of road and rail transport energy as renewable. Advanced biofuels qualify for twice the incentives

Hydrofaction® maximizes North American and European incentives for low-carbon intensity transport fuels

Incentives improve project economics bridging the time required for Hydrofaction® to become fully optimized leading to reduced cost of production

Commercial Demonstration



Constructed in 2021

Phase I: Demo Plant

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

Engineering Verification

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

Phase II: Commercial Plant

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

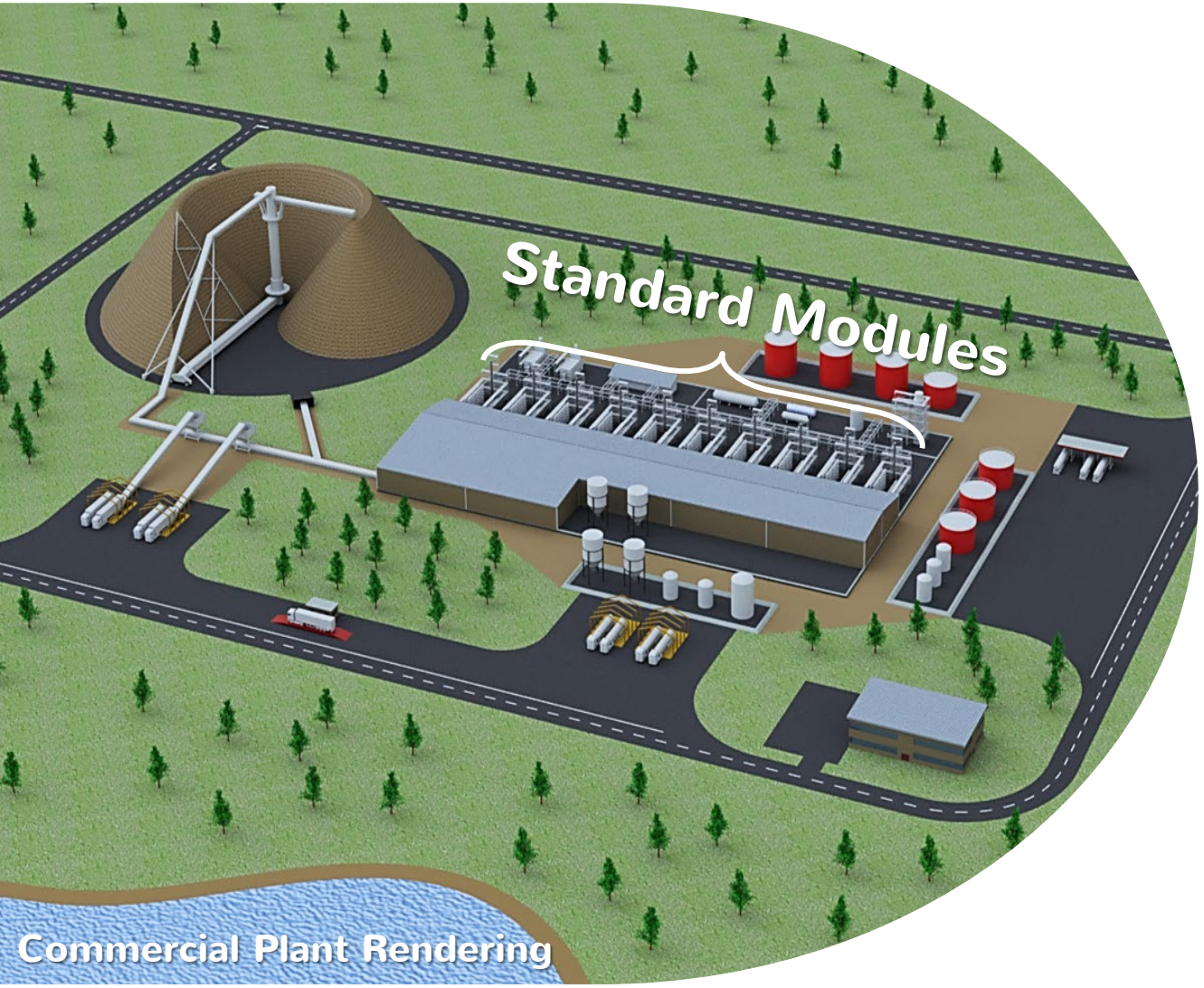
Strategic Partner

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

Operations

Construction of Phase I completed in 2021 and startup in progress with operation through 2022. Phase II to follow

Standard Modular Plant Design



Hydrofaction® plants are designed on 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

Controlled, repeatable engineering, manufacturing, and regulatory approval processes leads to rapid plant deployment

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

Global Leader in HTL Technology

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Commercial adoption

Scale-up

Fuel Offtakers Signed MOU 2022

Commercial Plants 2025

Demo Plant 2021

Testing and Refinery Partners

Advanced Biofuels Centre 2020

Pilot Plant 2013

Industry validation

Knowledge transfer

Leveraging Pilot, Demo and HTL Expertise, Steeper brings a near-market-ready solution that stimulates cross-industry collaboration, job creation and cleantech growth

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

- Pilot plant >8000 hours
- Industrial demo plant presently being commissioned.
- 3rd Party Engineering Validation on Plant Design in process.
- Robust prospective project pipeline
- Off-take MOU's signed and being further developed.
- Over 150 Patents in 25 Patent families.

Thank you

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Lignofuels 2022
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