



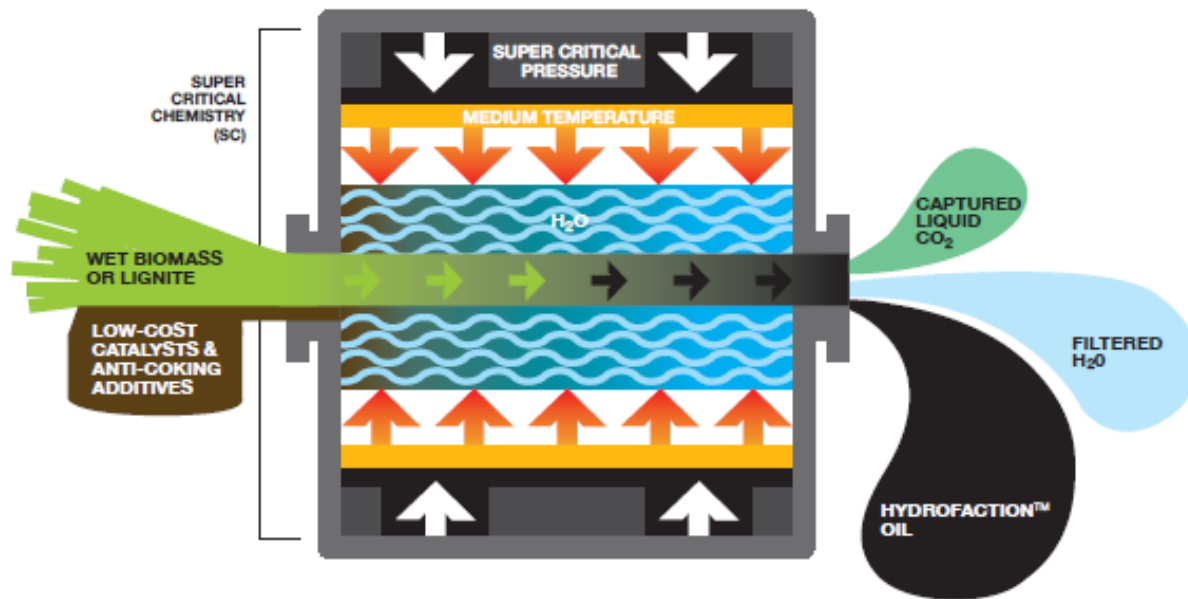
# Hydrofaction™ Oil: A Solution for Decarbonizing Long-haul Transport

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

July 2017

- Steeper'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

**Hydrofaction™** uses *super critical* chemistry ( $\pm 450^{\circ}$  C and  $\pm 350$  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.

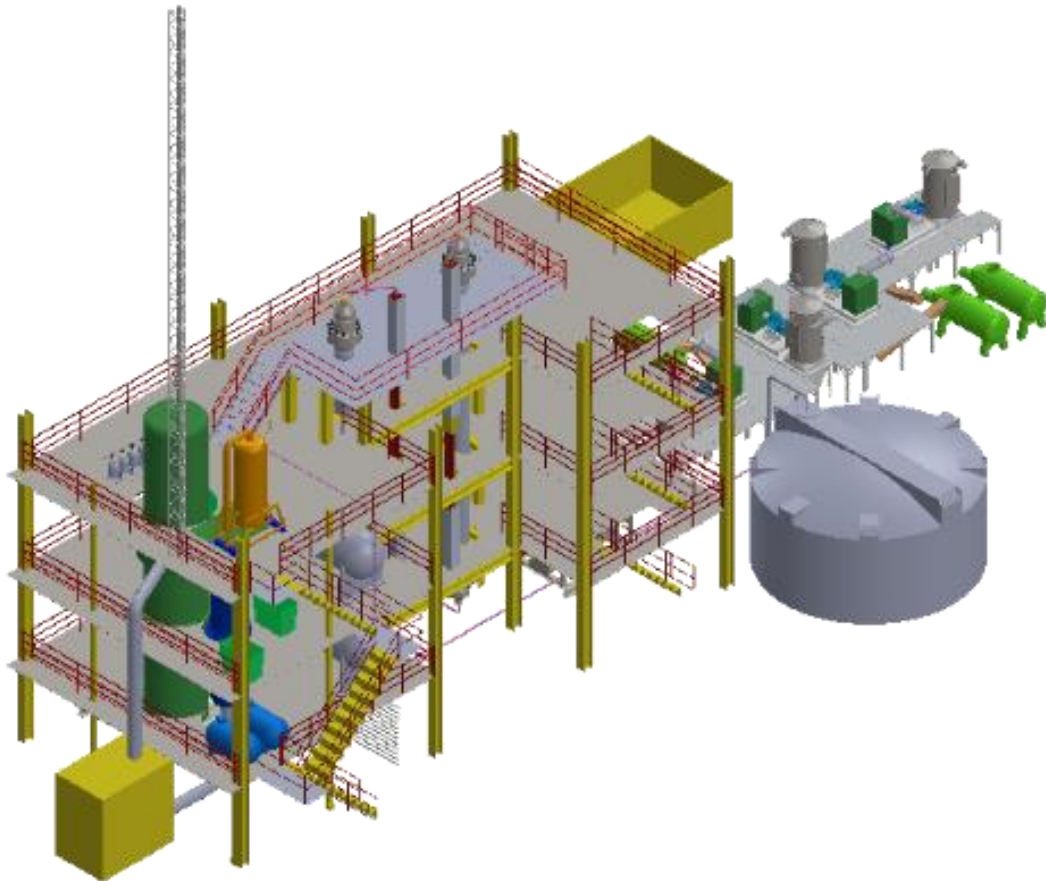
- **Renewable** – Bio-crude produces 80%+ fewer CO<sub>2</sub> emissions when compared to fossil (*well-to-wheel*).
- **No need to dry feedstock** – Hydrofaction™ processes wet feedstock, resulting in reduced energy consumption.
- **Petro-equivalency** – Upgraded Hydrofaction™ Oil compatible with fossil-oil infrastructure.
- **High thermal efficiency** – thermal efficiency (80 - 90%) superior to other bio-energy systems.

## 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



- 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 3<sup>rd</sup>-party engineering studies completed for commercial 2000 BPD facility
- ISDDP is a *scale-down* of future commercial design

# The social value proposition

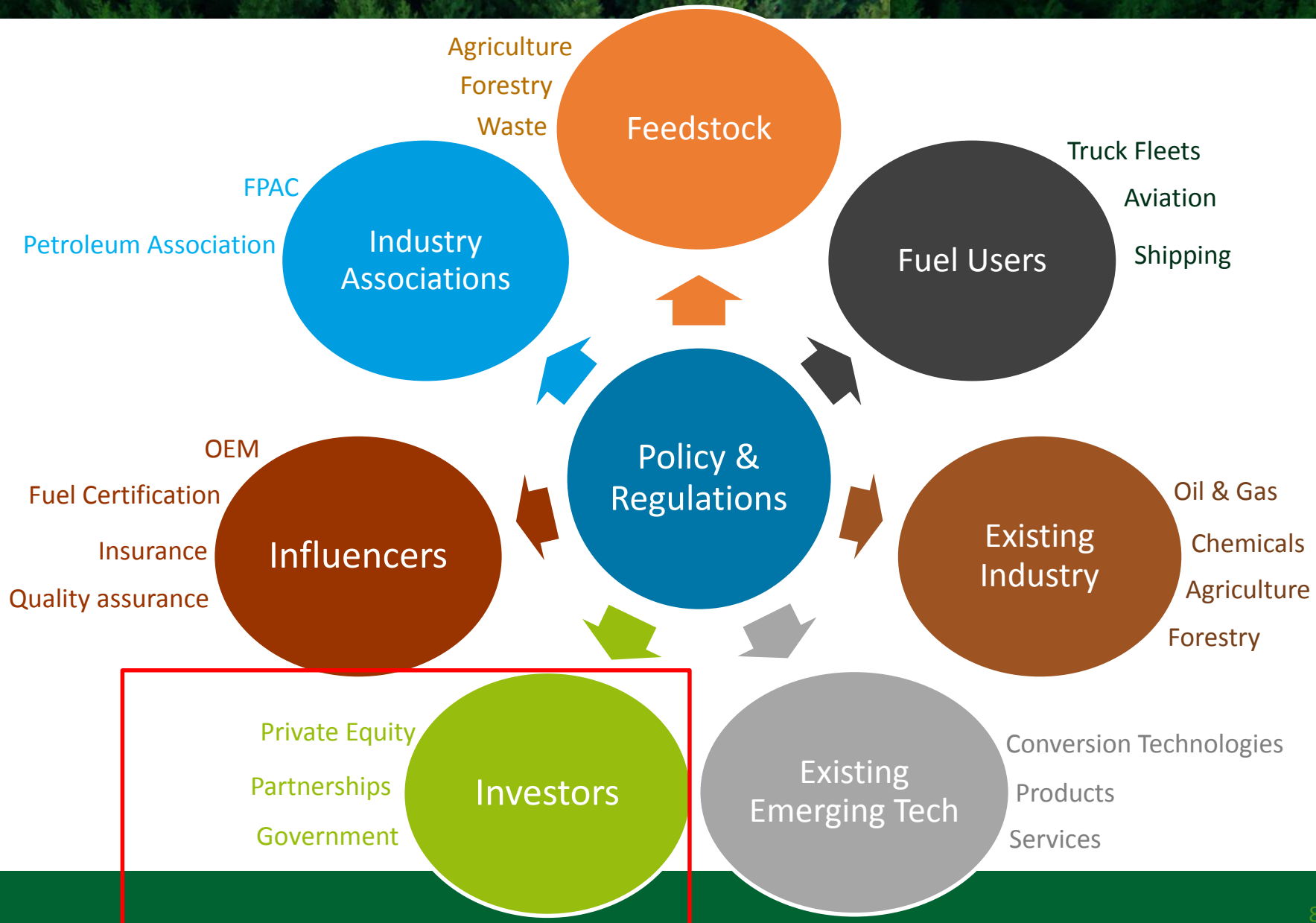
- Environment
  - ✓ 80-110% GHG savings (depending on feedstock and liquid CO<sub>2</sub> end-use)
  - ✓ Low sulfur fuels (SO<sub>x</sub> emissions)
- Community
  - ✓ 30 direct and 700 indirect jobs per commercial facility
- Industry
  - ✓ Adding value to primary industries such as forest and agriculture 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”





## 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:
  - ✓ Technologists play their part;
  - ✓ Hydrofaction™ is arguably the most efficient thermochemical platform;
  - ✓ Proven chemistry with strong IP position
- Market (3<sup>rd</sup> 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...

# Additional slides



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



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

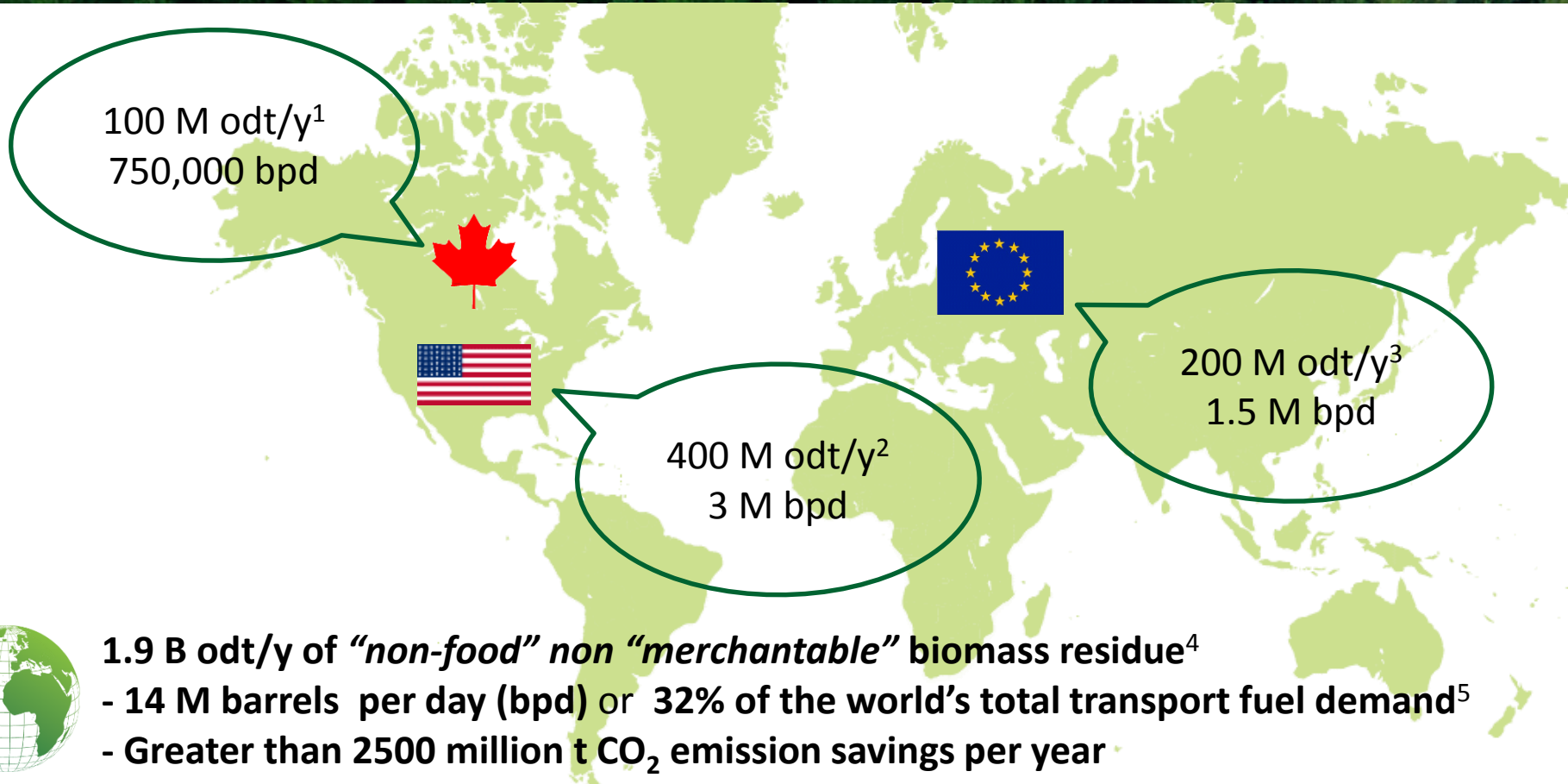


**Dr. Sergios Karatzos** – Senior Manager  
UBC, IEA, EU Commission



**Dr. Julie Katerine Rodríguez** –  
Bio-Oil Upgrading Specialist  
University of Campinas,  
University of Calgary

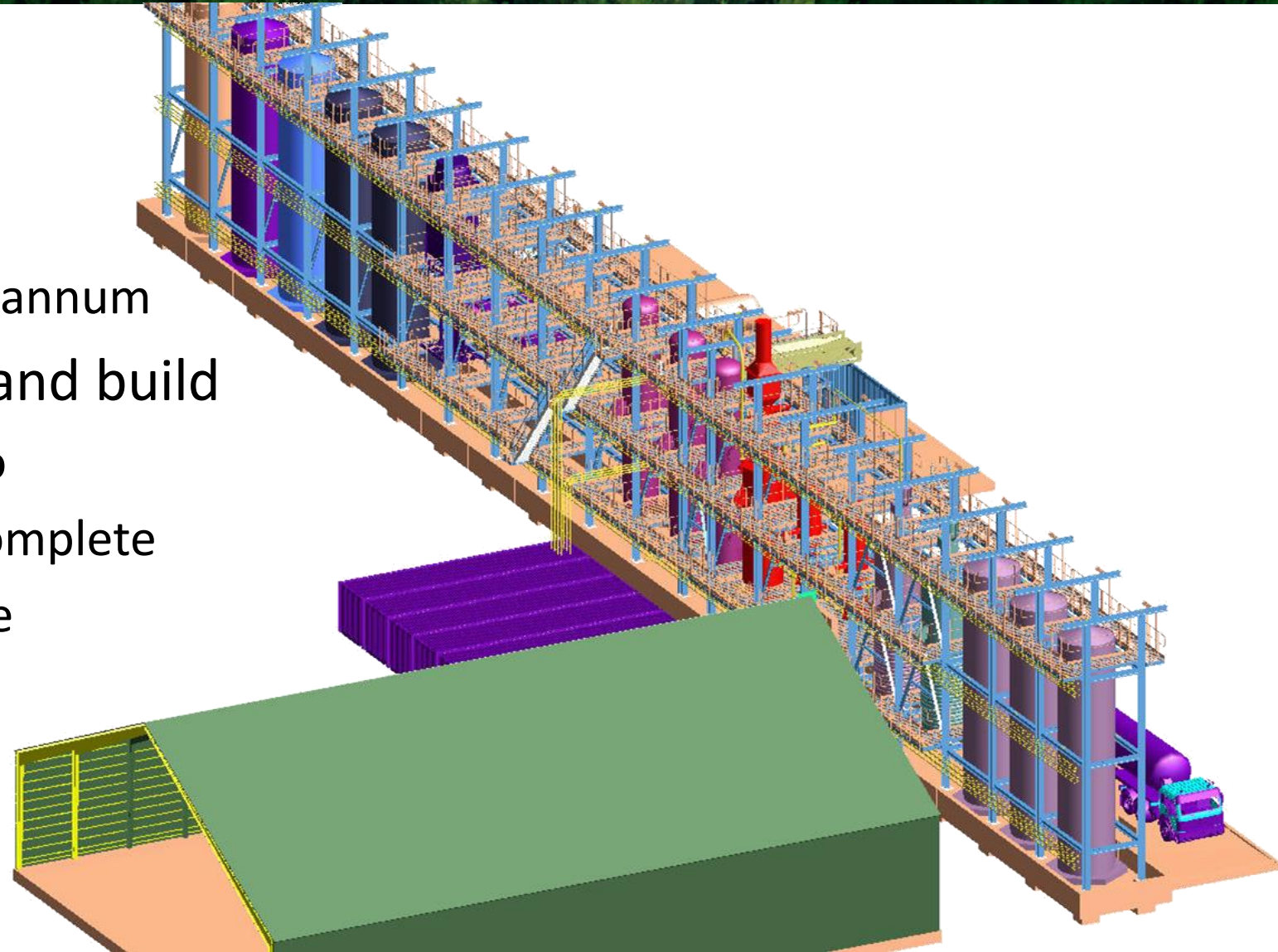
# Hydrofaction™ Market – Availability of Biomass Residuals



1. Canada Report on Bioenergy 2010, <http://www.bioenergytrade.org/downloads/canadareportonbioenergy2010sept152010.pdf>
2. US EIA “Billion-ton study”, [http://www1.eere.energy.gov/bioenergy/pdfs/billion\\_ton\\_update.pdf](http://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](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.iea.org/publications/freepublications/publication/second\\_generation\\_biofuels.pdf](https://www.iea.org/publications/freepublications/publication/second_generation_biofuels.pdf)
5. IEA, 2013 [http://203.117.10.102/media/news\\_pdfs/WEO2012\\_Singapore\\_Fatih\\_Birol.pdf](http://203.117.10.102/media/news_pdfs/WEO2012_Singapore_Fatih_Birol.pdf)

# First Commercial Plant

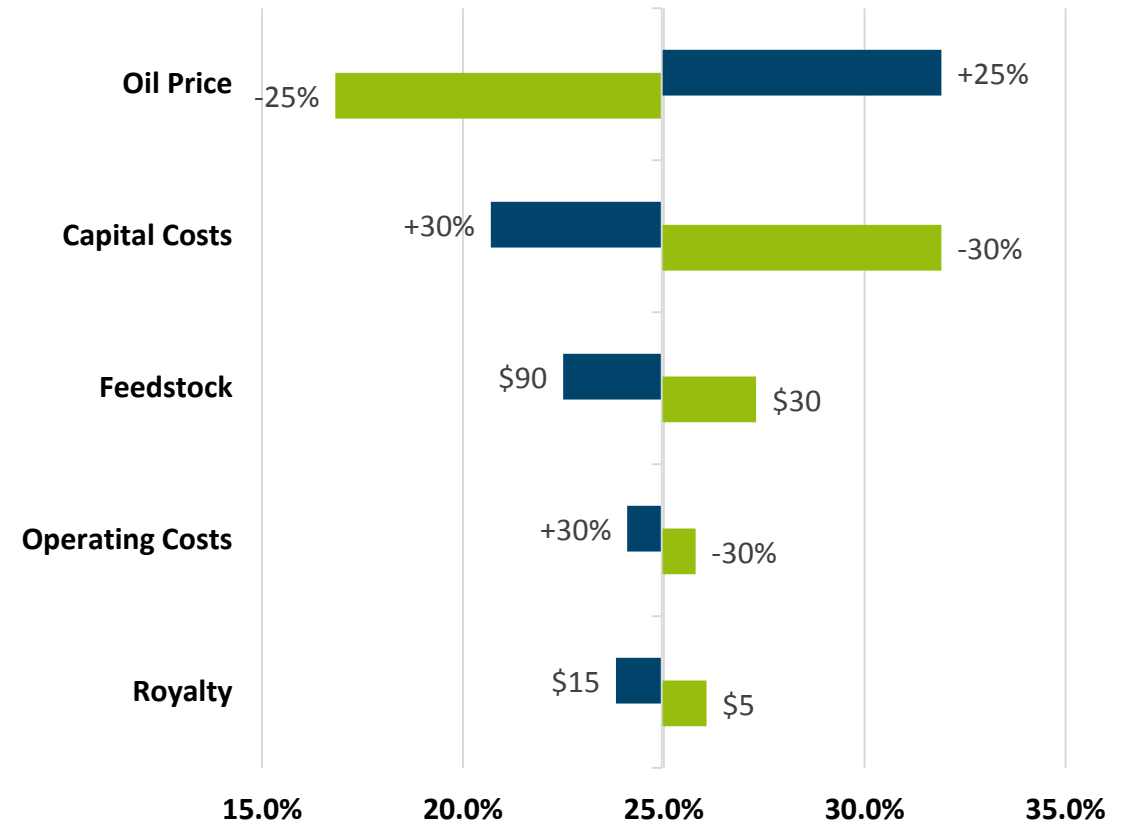
- 2000 Barrels-per-day
  - ✓ Circa \$200M Investment
  - ✓ Forestry Residues
  - ✓ 240,000 odt feedstock per annum
- Strategic Partner to fund and build
  - ✓ Reliant on successful demo
  - ✓ Initial engineering study complete
  - ✓ Transportation fuels for the Scandinavian market



# Projected Economics of 2000 bpd Facility

- Assumptions
  - ✓ Non-leveraged, pre-tax
  - ✓ Engineering design for 1<sup>st</sup>-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

IRR for 2000 BPD Project Licensee



# Robust Demand for Renewable Fuels

- Advanced Biofuels key to reducing carbon foot-print 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

Region	Heavy Transport (M BPD)				Total Transport (M BPD)	Heavy Transport as % of Transport	Transport Mandate (M BPD)	Heavy Transport Mandate (M BPD)	Steeper Facilities Required
	Trucks	Marine	Air	Total					
US	2.8	0.5	1.1	4.3	17.1	25%	1.0	0.5	248
EU	2.4	0.8	1.5	4.6	6.5	72%	0.6	0.5	232
China	2.1	0.3	0.4	2.8	3.8	74%	0.2	0.1	63
								<b>1.1</b>	<b>543</b>

- 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





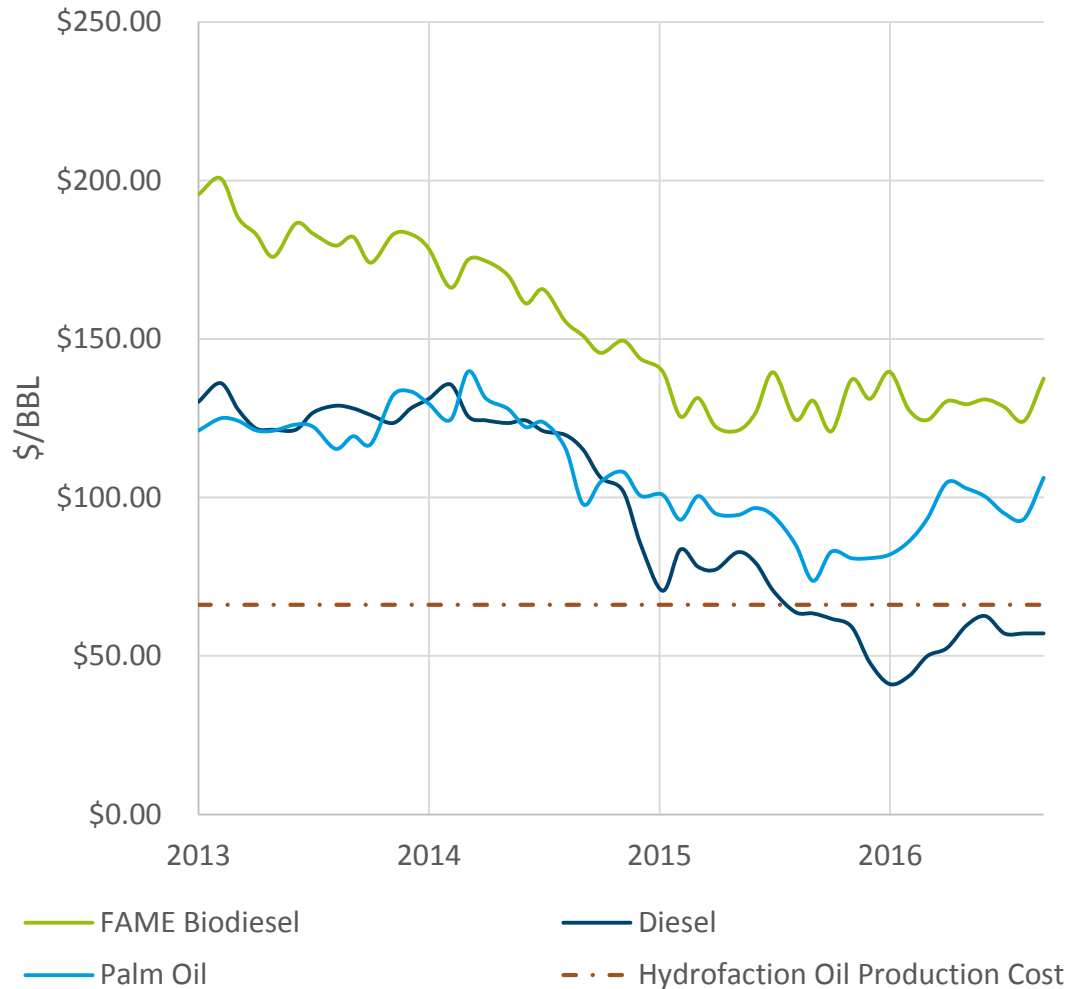
# Agri-Waste Business Opportunity



- 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

Region	Manure (ODT)	Hydrofaction™	
		BPD	Plants
California - Tulare	1,025,972	6,496	130
California - Merced	528,923	3,349	67
Texas - Deaf Smith	468,162	2,964	59
Iowa - Sioux	429,646	2,720	54
California - Imperial	400,428	2,535	51
North Carolina - Duplin	362,493	2,295	46
California - Stanislaus	359,588	2,277	46
California - Fresno	352,150	2,230	44
California - Kings	342,655	2,170	43
North Carolina - Sampson	341,492	2,162	43

Diesel/Biodiesel and Palm Oil Prices



- 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

# 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

