Forest residues biorefinery: a diversification potential for traditional forest industries.

Biomass North Forum
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The BELT project

Objective

- To valorize the **forest residues** from **harvesting** of forest area 04 in Mauricie (Quebec, Canada) through the implementation of a **large scale biorefinery.**

☑ **First of the type in Canada… in the world?**

- **No commercial trees** cut for energy feedstock;
- **Product portfolio:** "drop-in" quality (C_xH_y) (bio)renewable diesel and/or jet fuel (kerosene, diesel,and naphta);
- La Tuque: site selected – facilities existing - strategic location - 30 528 km² (Belgium !) - 15,000 inhabitants – historical Atikamekw territory.

☑ **Second most productive forest in Quebec.**

☑ **Forest harvest residues unused !**

BELT forest residues-based refinery

Pre-feasibility studies (2010)

- **Capacity:**
  - Feedstock: forest residues 600,000 *oven dry metric* ton/year*.
  - Production: 200+ ML/year “drop-in” renewable fuel.
  - Displaces ~ 5-7 % of Quebec transport diesel consumption.
  - 470 MW wood ⇨ 290 MW diesel
  - CO_2 reduction **0.575 MT/y**
  - Vehicles off the road: **143,750/y**
- Capital investment: ≈ **1 Billion $**
- Jobs created: **490**

*FPInnovations Report, 2009. Estimation of biomass generated by harvest activities from allowable cuts 2013-2018. 2014 update. Quebec Chief Forester Office, Oct 28, 2014 ➔

1.8 MT (green)/year, including leaves & needles, no stump/root system

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Project vision

Most “related projects” take up to 15 years from original concept

April 2010:	first presentation of idea/concept to La Tuque city council
Dec. 2014:	creation of Bioeconomy-(bio)Energy (BEE) UQTR chair
Feb. 2015:	creation of BioÉnergie La Tuque (BELT)
May 2016:	FPInnovations signed in as BELT key technology partner
Sept. 2016:	A-team kick-off meeting of studies
Sept. 2016:	Quebec government initial financial support (1.5 M$) for feasibility studies (4.6 M$) – later joined by federal (1.5 M$)
Jan. 2017:	Neste Corporation announced as key project partner
March 2017:	Atikamekw Nation supports BELT project
August 2017:	Atikamekw Nation representative joins BELT Board
Jan. 2018:	BELT headquarters moved to Wemotaci (Atikamekw territory) ➔ business place in La Tuque
June 2018:	process line & technologies selection

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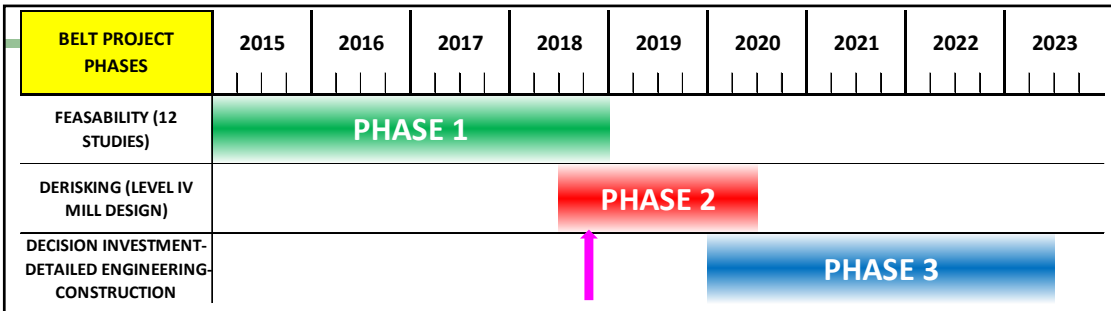

- **Phase 1:** 12 feasibility studies 95% completed.
- **Phase 2:** risk mitigation.
  - Perform demo unit trials to obtain accurate validated data on 1 to 3 selected most promising technology lines.
- **Deliverables:**
  - Critical analysis of pilot/demo trials.
  - Debottleneck critical technology parts.
  - In-depth techno-economic of 3 selected (Phase 1) process lines.
  - Basic data for engineering studies (Level III-IV for investment decision).

Key areas to secure for success

The Fantastic "Four"

1. **Long-term biomass supply at a "competitive" cost**
   - "Competitive" cost is also a function of availability, project magnitude, and products portfolio.

The Thing

2. **Relevant technologies** (first and second conversion)
   - As a function of products portfolio,
   - As a function of feedstock, and
   - As a function of location….
   - With no preconceived ideas on the best technology line

Mr. Fantastic

Key areas to secure for success

The Fantastic "Four"

❸ **Sound economics** (may sound obvious but….)

- Financial structuring *as early as feasible* with banks, potential investors, and governments,
- In-depth, extensive market analysis for products including standards, logistics, and delivery channels,
- All credits potential: carbon (tax) or carbon exchange (market), RINs…

Human Torch

❹ **Full socio-political support**

- Social acceptability, First Nation support **& implication**,
- Environmental impact, carbon footprint, and LAST BUT NOT LEAST
- Fuel mandates (RFS, LCFS)

Invisible Woman

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BELT Values

- BELT adheres to a **no compromise** implementation of project on
  - a) economic/financial risk – required to secure investors,
  - b) environmental impact & social acceptance.
    - Above **implies** developing the project with a **NO SET MIND** for technology process line that will be the **SOLUTION** considering sustainable development basic principles on economics, environment, and society.

- Gaining/securing Atikamekw First Nation people support is a critical advantage.

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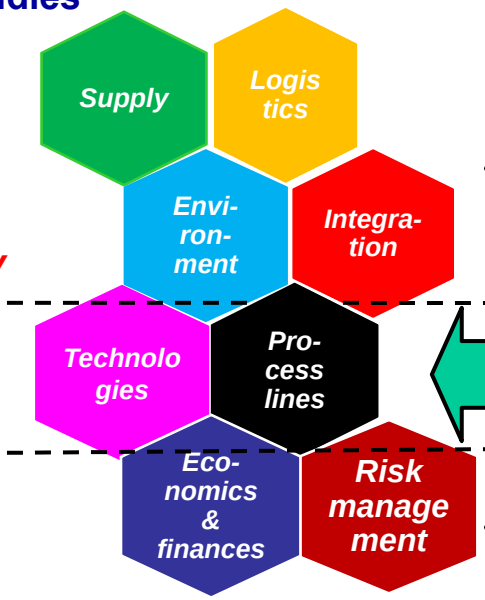
Feasibility Studies

Close integrated cooperation, performed concomitantly

for

SUCCESS



BIOMASS SUPPLY 8 STUDIES

TECHNOLOGIES ANALYSIS & OPTIMISATION 2 STUDIES

ECONOMICS 2 STUDIES

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Supply evaluation E1 to E4

Available biomass

- **E1 to E4** studies confirmed that local biomass consisting of forest harvest residues is sufficient to support the BELT project.
  - A thorough strategic analysis was performed on “Supply Units (UA)” surrounding La Tuque in a 150 km (as the crow flies) radius.
  - Emphasis was nevertheless placed on the 4 UA of Mauricie area 04.
- Various harvest procedures and scenarios allowed a precise estimation of global biomass potential solely from forest residues (last 10 year statistics).

- **RESULT: 774 500 DRY METRIC TONS /YEAR ARE AVAILABLE**
  - Guaranteed 25 years, not market dependent (Quebec legislation)
  - Reminder: *600 000 tons were considered for the initial project*.

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Supply evaluation E1 to E4
Integration to harvest operations

- Forest residues available in Mauricie may vary from 450 000 to 600 000 *oven dry metric* tons (*odm*T) per year according to the strategy/method and topping diameter used.
  - "*Unloved*" wood, *i.e.* poor commercial quality wood not considered Prof. Évelyne Thiffault study, U. Laval (IEA BioEnergy)
- Average **mill delivered** cost is **3$/GJ** (about 60$/*odm*T), not market dependent (*forests are crown, public land*)
  - Cost of transport include all transports required to get biomass to selected mill site, including wood densification strategies such as pyrolytic oil, torrefied wood, and wood pellets.
  - Unrestricted load trucks have been considered (75 tons) for calculations.

Supply evaluation E1 to E4
Integration to harvest operations

- **Five harvest scenarios** for integrating commercial wood harvesting with forest residues collection were analysed/modeled and compared to present standard commercial wood harvest scenario.
  - The scenarios were selected/developed as a function of local forest and market conditions in Mauricie including maturity of available forest residues harvesting technologies.
- **ENVIRONMENTAL IMPACT ANALYSIS** indicates that a mere 1% of soils are sensitive to biomass collection and should be preserved (*biodiversity*).
  - All in perfect agreement with existing Quebec & federal legislations.
  - Carbon footprint (E4) will meet most stringent standards.
- Methodology (E1 to E4) was validated (E5) by an external party (VTT, Finland) which also evaluated energy densification scenarios (E6).

Technology selection – Study E10

Basis : techno-economic + markets/regulations (E9)

- First level due techno-economic diligence was targeted at selecting the best technologies from an in-depth technology and economic risk considerations.

ACHIEVED

- Technologies pre-selection.
- Detailed evaluation of process lines which are technologically and economically viable.
- Technology bottlenecks identification (E10).
- Market analysis, products, standards, regulations, etc. (E9).
- **NEEDED (essential):** de-risking (Phase 2: demo scale data)
  - Detailed work plan submitted to **Clean Growth** (*federal)*, and **Technoclimat** (*provincial)*, programs for support funding plus, of course, investor.

Technology selection

First level pre-screening

- **700 technologies** analysed by technology team from available "public open source information".
- **12 technologies preselected +** an additional **6** on a **"watch list".**
  - **6 primary conversion technologies**; *i.e. converting ground wood residues in either a syngas or a liquid* (*e.g.* **pyrolytic** oil) that are then further converted in **fuels.**
  - **6 secondary conversion technologies**; *i.e.* technologies converting syngas or liquid in renewable fuels such as diesel, kerosene, and naphta.
- Selection was performed on the basis of many weighted criteria:
  - Technology Readiness Level (TRL), Market Readiness Level (MRL),
  - Existence or not of demo units, number of operating hours,
  - Company experience and reliability, etc. etc. etc.

Technology selection

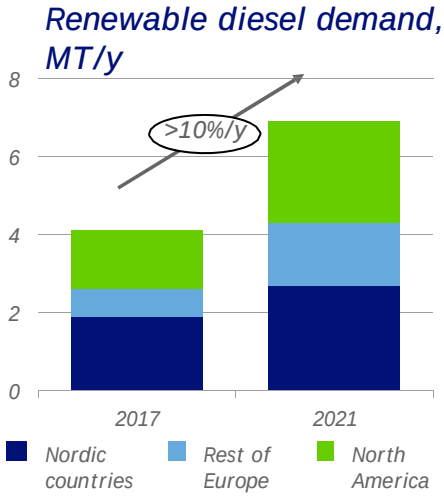
Second level ➔ process lines – setting-up mill block diagrams

- **10 process lines studied/analysed using NDA information from technology providers**
  - CAPEX (mean value) = 1,2 billion (± 300 millions $Can) – Function of technology, fuel quality, biomass feed, etc.
  - Mean carbon conversion value = 25% (± 5%)
  - Renewable fuel production = 210 millions litres (± 45 millions)
  - *Example (illustration only):*

495,000 *odm*T ➔ 191 millions litres renewable fuels "drop-in" quality
Yield 31%
Large differences as related to potential options (here H_2 addition), even from a single technology process line

Demand growth for renewable diesel

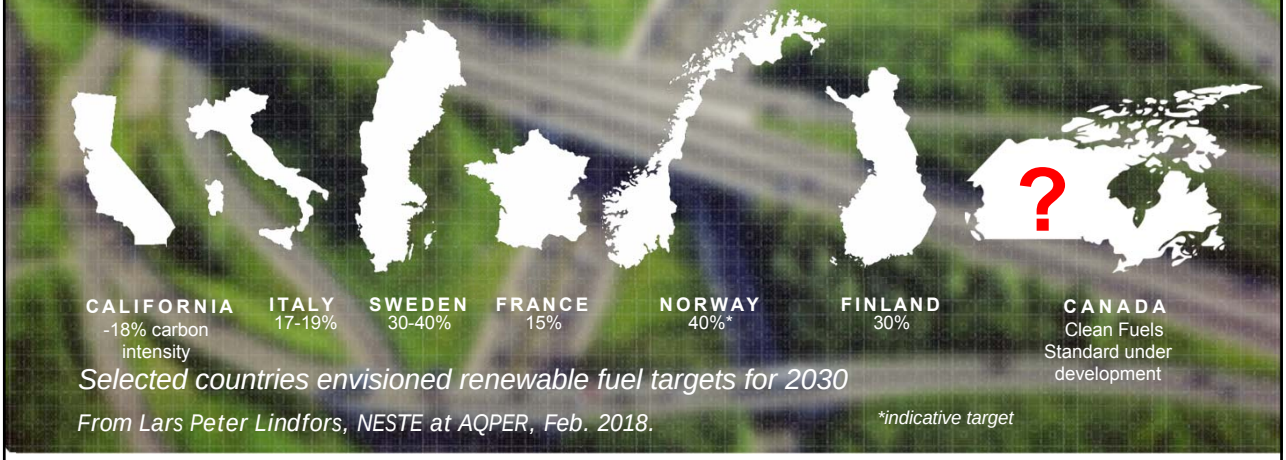
Continues to be strong both in Europe and North America



- Demand for renewable diesel almost doubles to 2021, as conventional biofuels face blending limitations and GHG-based targets spur demand for waste-based renewable diesel
- European demand continues to develop favorably, particularly in the key Nordic markets
- US demand growing as markets at federal and state level support growth to 2021 and beyond
- Biodiesel demand estimated to grow from 28 MT in 2017 to 33 MT in 2021.
  - **BELT biorefinery will produce about 0,225 MT/year**.

Source: Neste analysis based on Platts, 2017; IEA, 2016. From Lars Peter Lindfors, NESTE at AQPER, Feb. 2018.

PROGRESSIVE REGIONS
Future leaders in renewable fuels



CALIFORNIA	ITALY	SWEDEN	FRANCE	NORWAY	FINLAND	CANADA
-18% carbon intensity	17-19%	30-40%	15%	40%*	30%	Clean Fuels Standard under development

Selected countries envisioned renewable fuel targets for 2030

From Lars Peter Lindfors, NESTE at AQPER, Feb. 2018.

**indicative target*

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BELT Progress shows that
Biorefinery challenges can be solved

- ***CAPEX and OPEX: solutions have been developed***
- ***Long-term security of supply at low cost: OK – 25 years secured at 3$/GJ (7-7.5 $ in Europe) – Market independent***
- ***Complex biomass supply & logistics chains: OK – cooperative scenario developed – negotiations to conclude***
- ***Mandatory renewable fuels content: required for Canada/Quebec – target and legislation by 2020 for LCFS (federal) – RFS needs to reach leading countries levels***
- ***Techno-economics, competitiveness, and risk management: risk mitigation (Phase 2) in progress –credits initially required***

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Conclusion

Some achievements which are key to success

1. Achieving alignment of all parties, *incl.* governments/stakeholders
2. Hand-picking and bringing together an A-team of experts
3. Succeeding in reaching good cooperation among stakeholders
4. Considering social acceptability as a project asset and continuously working on it: study, media communication, public presentations, etc.
5. Obtaining Atikamekw Nation support at an early stage in the process.

➡ In conclusion, *although not that obvious at project inception from governments and investors stand-points*, the **no compromise approach** based on a university chair looking for regional bioeconomy/bioenergy development was not so foolish after all.

BELT – Nation Atikamekw - NESTE

June 4, 2018, NESTE Headquarters, Helsinki, Finland

L. to R.: Patrice Bergeron, BELT Chairman of the Board; Patrice Mangin, BELT CEO; Dany Chilton, Nation Atikamekw, BELTBoard Member; Jean Hamel, Senior VP Industry, FPInnovations; Lars Peter Lindfors, Senior VP NESTE; Constant Awashish, Grand Chief, Nation Atikamekw; Petri Lehmus, VP R&D, NESTE

Partners & financers

UQTR Université du Québec à Trois-Rivières

FPInnovations

Atikamekw Sipi

Ville de La Tuque

FORAC DE LA FORÊT AU CLIENT

Réseau BIOFUELNET Canada

NESTE

BELT La Tuque

AQPER Association québécoise de la production d'énergie renouvelable

Polytechnique Montréal — Le génie en première classe

Mitacs

Bioénergie La Tuque

IEA Bioenergy

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Ressources naturelles Canada

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THANK YOU VERY MUCH FOR YOUR ATTENTION

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