



Opportunities for the Utilization of Forest Residues Combined with PtX in Quebec and in Canada

Pr Jean-Michel Lavoie (Ph.D)

Director – Biomass Technology Laboratory &

Professor – Département de génie chimique et génie biotechnologique

Faculté de Génie

Université de Sherbrooke

Agenda

1 Carbon Availability in Canada

2 Green Energy Availability

3 Policies

4 Technology

5 Conclusion & perspectives



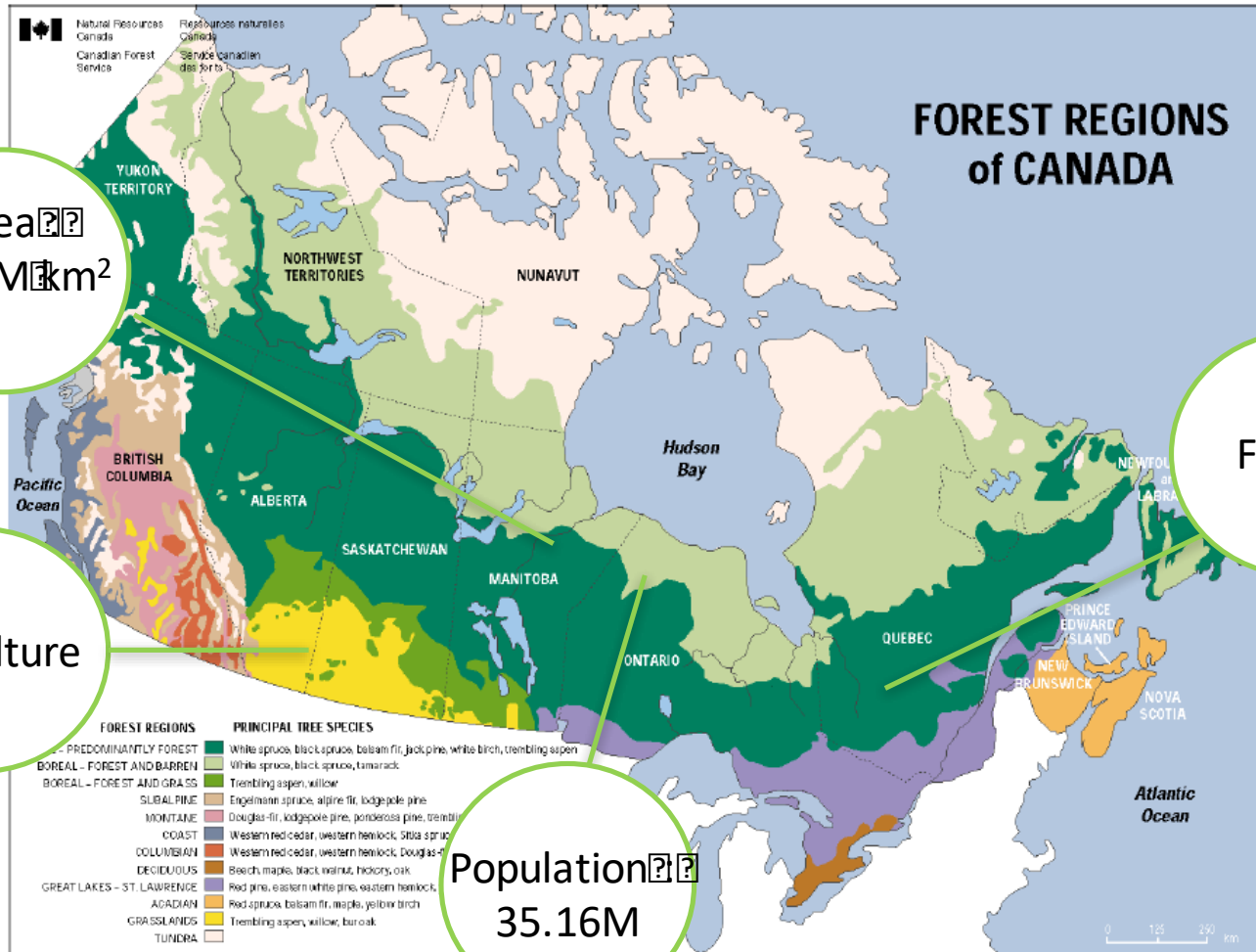
An Overview of the Country

Area??
9.99M km²

Agriculture

Forest

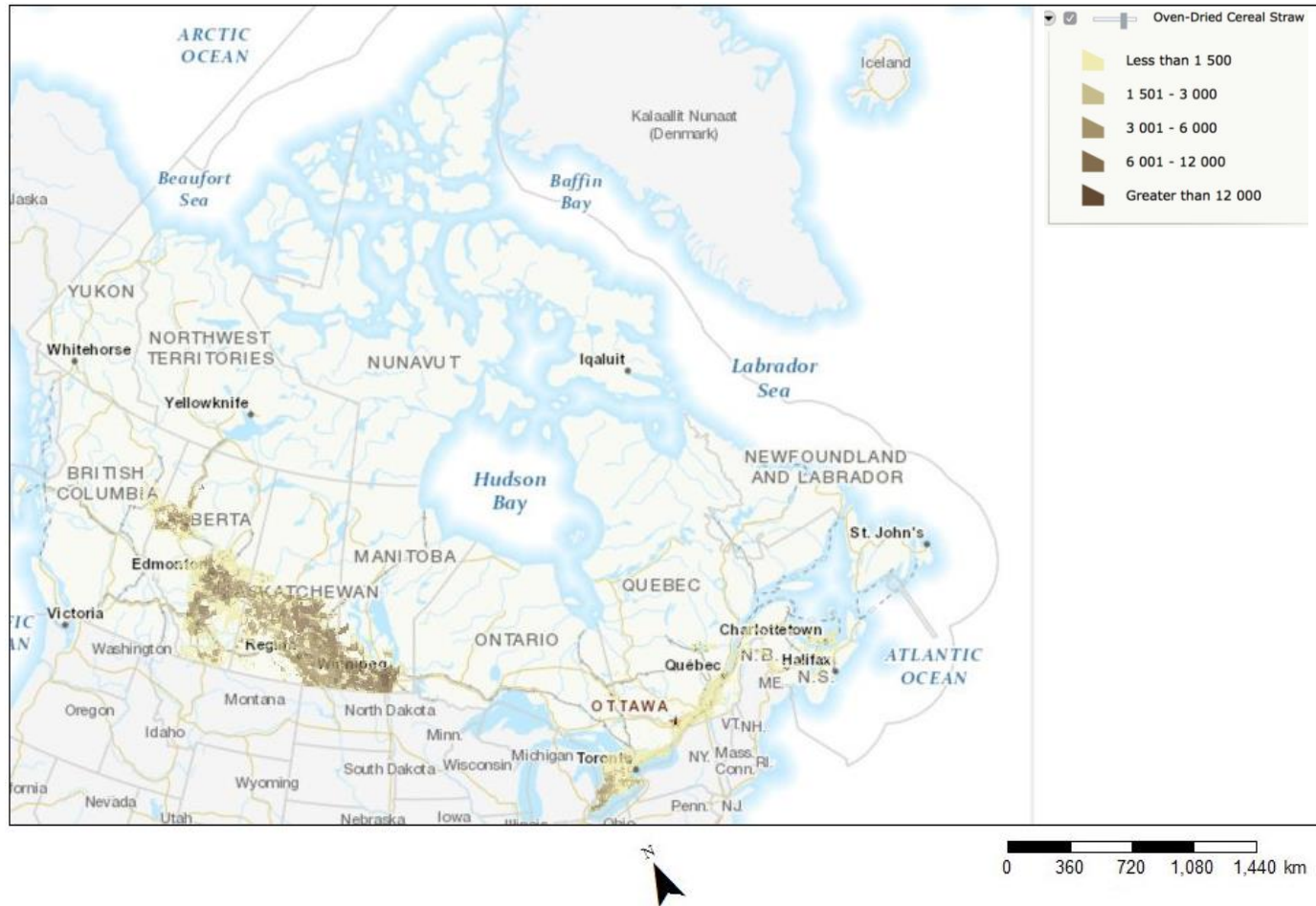
Population??
35.16M



BIOMASS
TECHNOLOGY
LABORATORY



Finding Carbon in Canada



Finding Carbon in Canada



Price for biomass



First generation biomass

Corn

- Usual crop used for starch (for production of EtOH)
- \$365/tonne (Jul.2018)

Vegetable Oil

- \$991 per tonne for Canola (May. 2018)
- \$954 per tonne for Soy (Aug. 2018)

Price for biomass

Plantation crops

Willow, poplar, panic, switchgrass, etc...

- Cost actually more than \$100 (CAN) /tonne*
- Thus more than \$5.26 /GJ (dry basis)

Biomass in competition

- Not at this point, maybe for utilisation as solid fuel for residential and institutional uses
- Chicken-or-egg situation

Availability

- *Not very available (depends on demand)
- *Opportunity for marginal lands

Price for biomass

Prime forest biomass (homogeneous biomass)

- Whitewood chips
- Cost approximately \$25-40 (CAN) /tonne
- About \$1.4 to 2.2 / GJ (dry basis)

Biomass possibly in competition

- Panel board industry
- Wood pellet industry



Availability

- Very available (becoming a concern)

Price for biomass

Residual Forest and Agricultural (such as softwood bark)

- Available depending on location
- Cost approximately \$2-10 /tonne
- About \$0.11-0.55 /GJ (dry basis)

Biomass in competition?

- Not really at this point, maybe for combustion
- Readily available in isolated area

Availability

- Very available but shipping may be costly
- Forest estimated to more than 7 Mtonne/y (only in Quebec)
- Agriculture estimated to 48 Mtonne/y




Opportunity in Energy



Energy (electricity and heat) is cheap in Canada



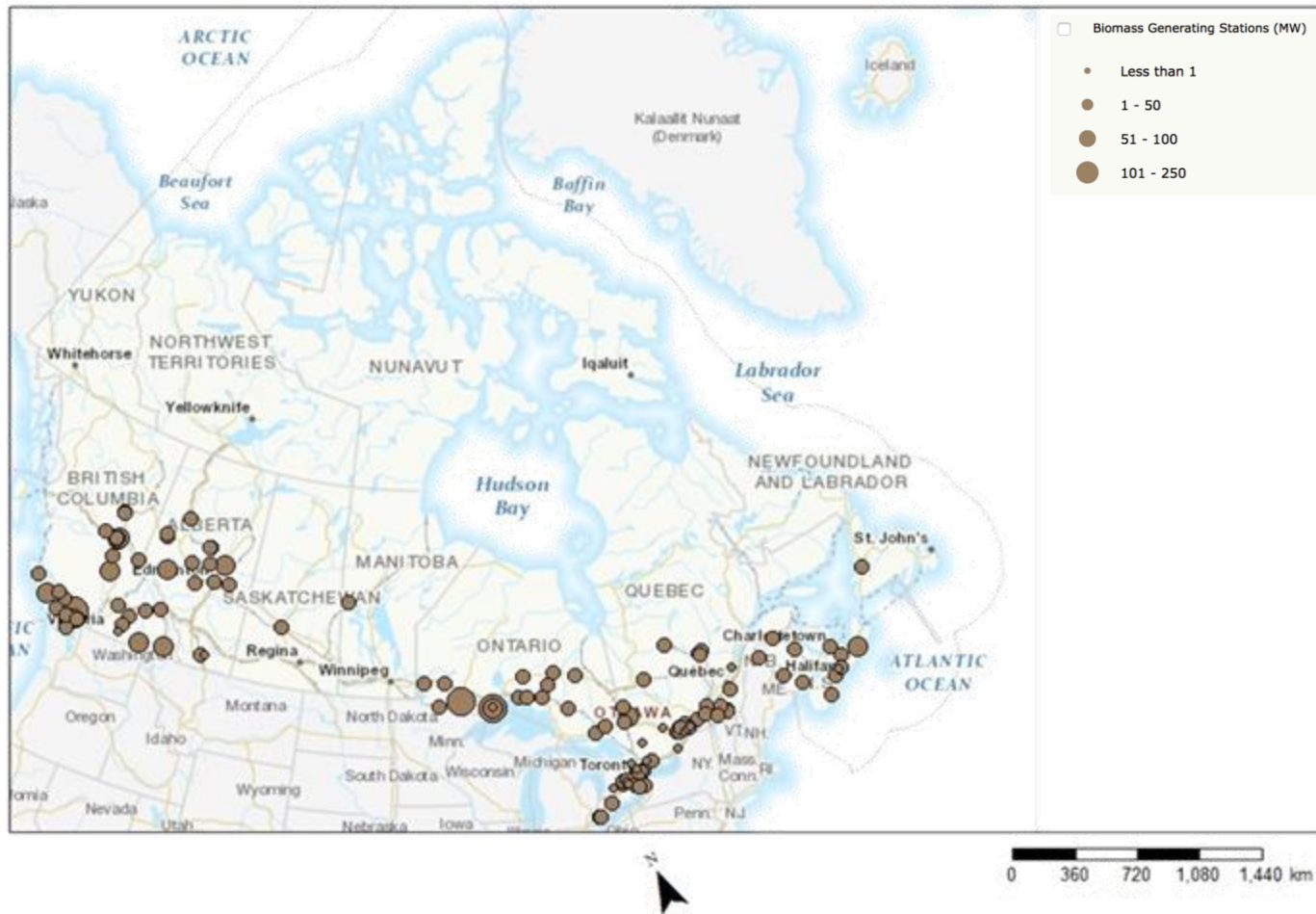
Green electricity available essentially nationwide



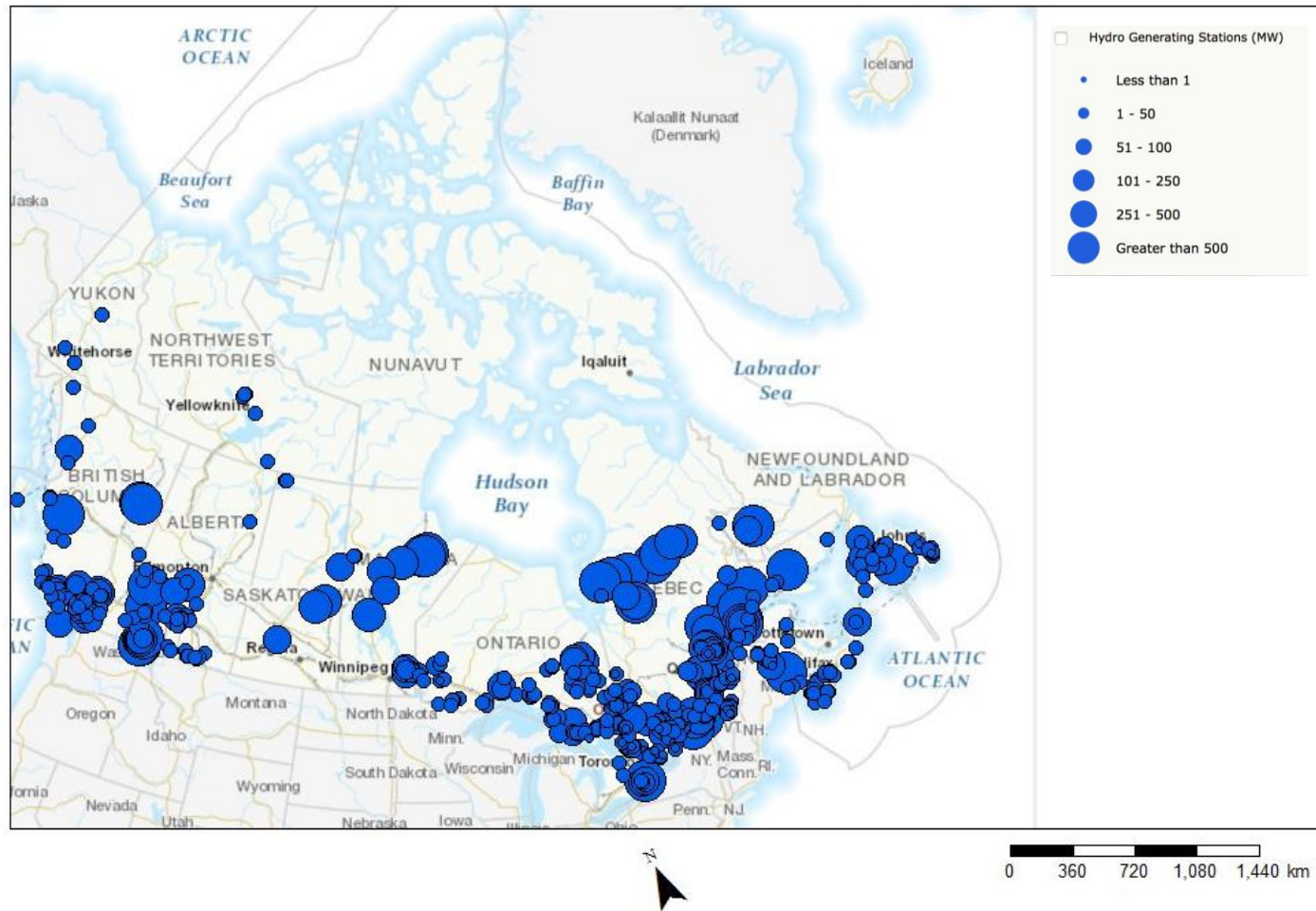
Industrial rates can get as low as \$0.05 /kWh (Quebec)



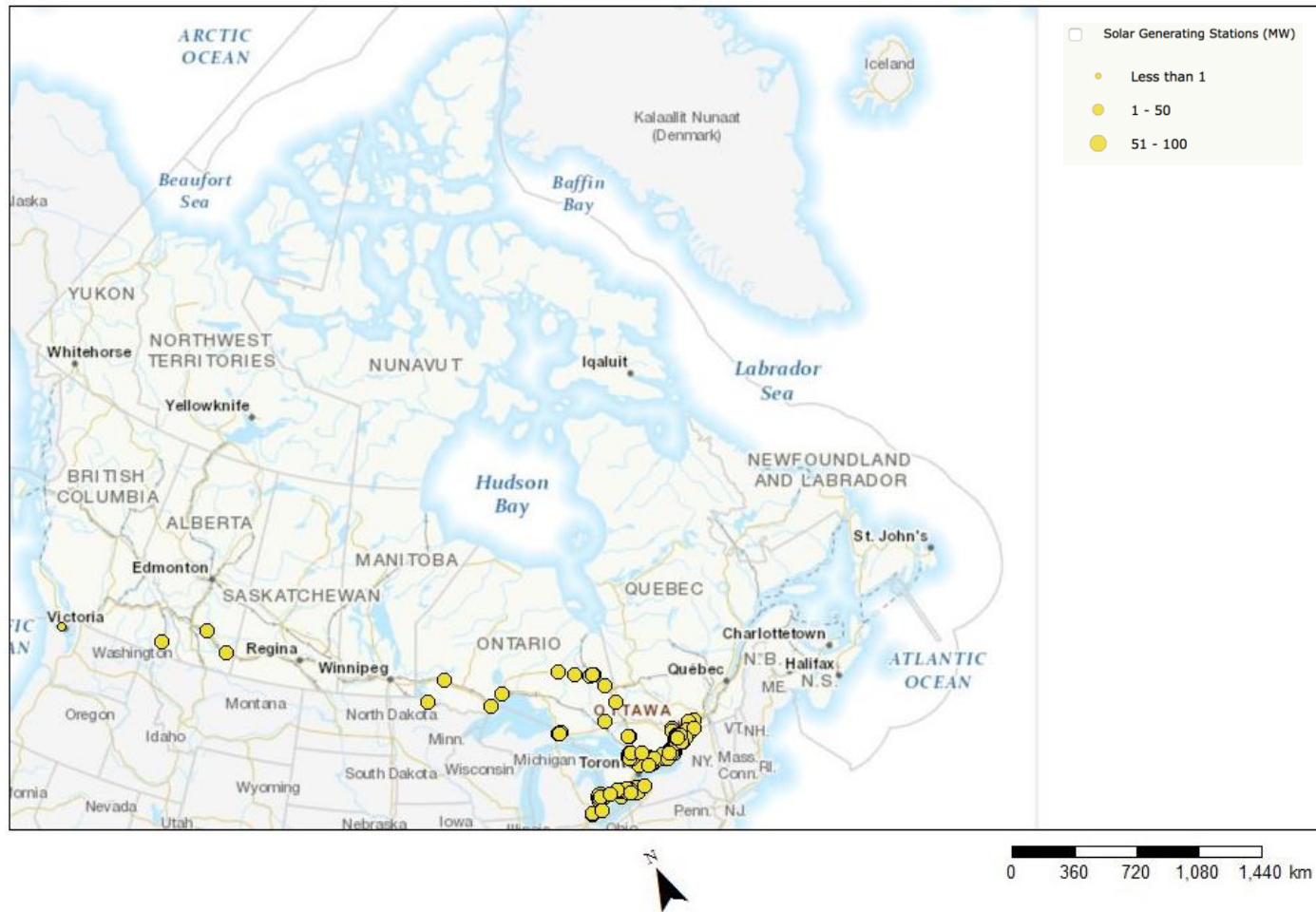
Energy from Biomass



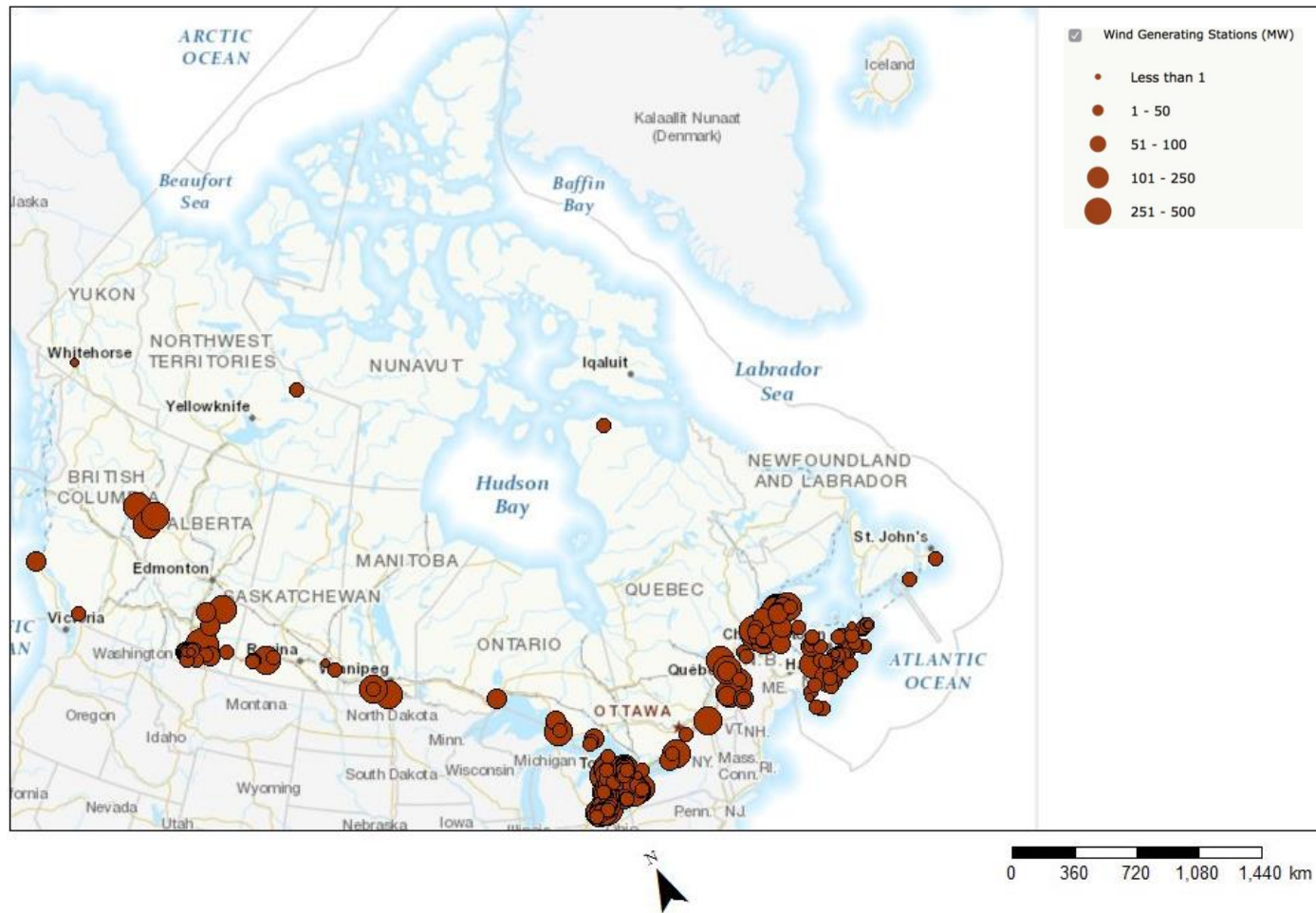
Energy from Hydro



Energy from Solar



Energy from Wind



Policies - Canada

CO₂ has a value in Canada

- Starting at 20\$/tonne in 2018 up to 50\$/tonne
- Value per tonne or cap-and-trade

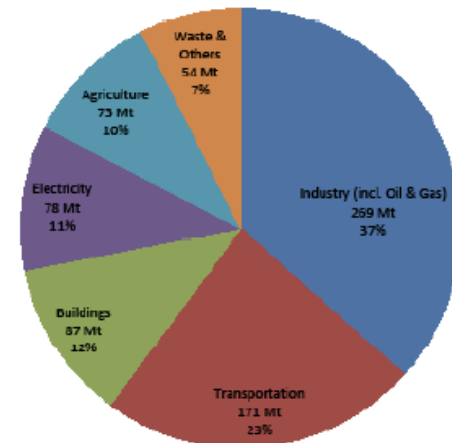
National objective

- Reduce emissions by 30% below 2005 by 2030

Two most important producers

- Industry
- Transport

Emissions by sector in 2014
(megatonnes of CO₂ eq.)



Policies - Quebec



Cap-and-trade system with California



Provincial objective

- Reduce emissions by 37% below 1990 by 2030



Two most important producers

- Transport – 43.5%
- Industry – 28%



Policies – Biofuels

National requirement to add 5% EtOH & 2% biodiesel

Clean Fuel Standard is being prepared at federal level

At provincial level

- Follow the federal mandate
- Tax credits (2018-2023)
 - First generation ethanol – 0.03\$/L
 - Second generation ethanol – 0.16\$/L
 - Biodiesel – 0.14\$/L
 - Pyrolytic oil – 0.08\$/L (capped to 7M\$/5 years)

SO... what's next?



First take home message : « Even if everything is there, pushing forward the new bioeconomy still represents a massive challenge »

Technology

Biomass in Quebec

- Forest
- Agricultural

Residual forest biomass becoming a concern

- 6M tonne wood residues/y
- 1M tonne bark residues/y

While wood residues had a market

- Pulp and Paper
- Wood panels

Bark still represent a challenge



Technology

Targetting forest biomass would hence allow

- Coping for an increasingly alarming concern
- Partly replace a vanishing industry

At the same time

- Produce a new source of ethanol
- Decrease dependency towards fossil fuels
- Use the residues for added value applications
- Getting renewable fuel credits

Without forgetting

- Attacking at least one of the biggest GHG emitters
- Getting CO₂ credits as well?

Technology

The ReSolve process

- Feedstock agnostic
- Allows direct saccharification of lignocellulosics

A simple and cheap process

- 1 reactant
- Max operating temperature around 100°C

Provides two products

- Second generation, cheap and traceable sugars
- Third generation wood pellets



Technology



Bark



Wood Chips



Sawdust



Reactant

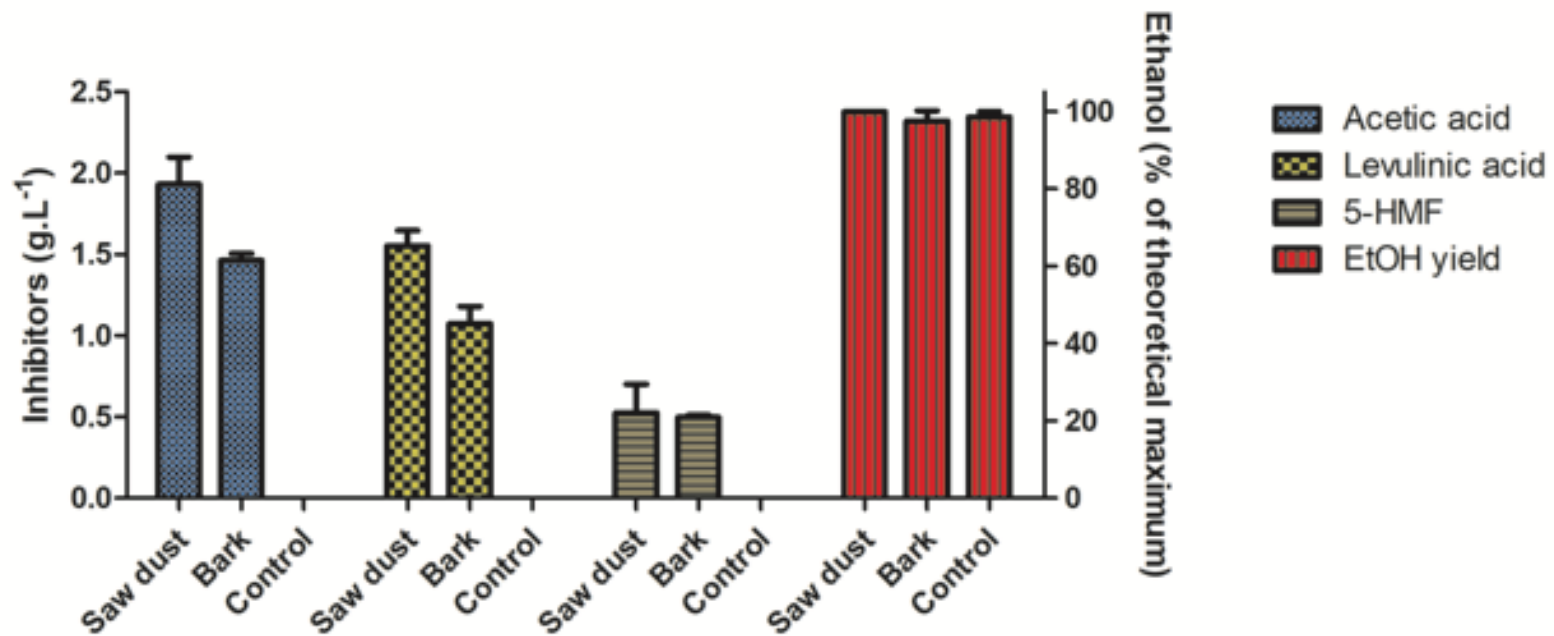
ReSolve Tech

Ethanol (2^e Gen)



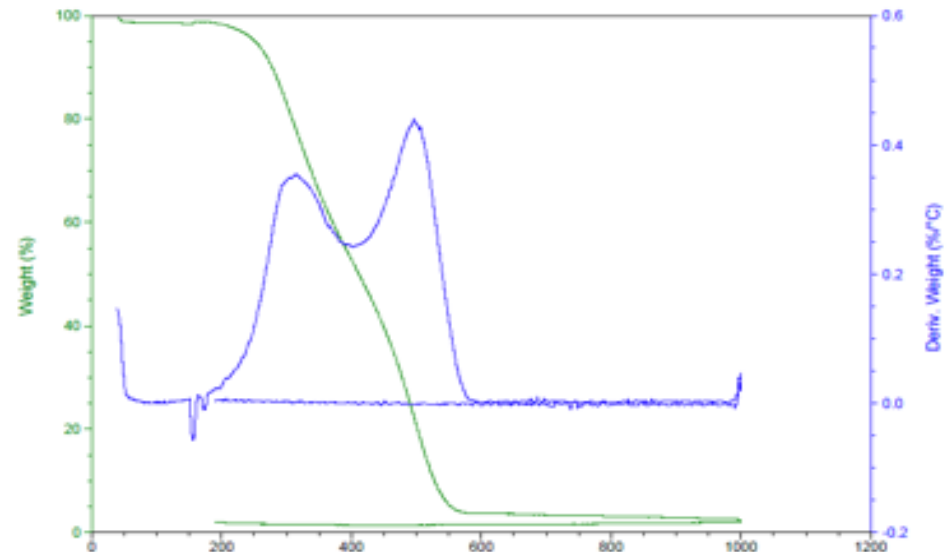
Pellets (3^e Gen)

Technology



Fermentation test on different ReSolve sugars

Technology



The ReSolve 3rd generation energy pellets– LHV = **26GJ/tonne***

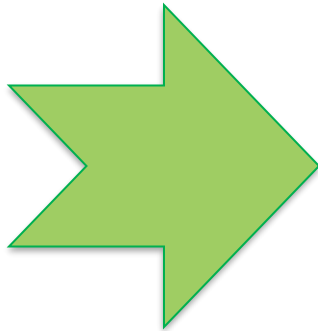
Original Biomass : LHV 15-18 GJ/tonne
Torrefied Biomass : LHV 20-23 GJ/tonne
Pet coke : LHV 27-31 GJ/tonne
Lignite: LHV 20-25 GJ/tonne
ReSolve Energy Pellets: LHV 25-27 GJ/tonne

Technology

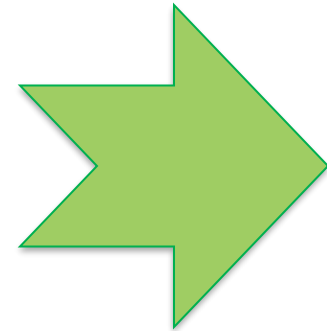
Technology readiness level (TRL) of the ReSolve Process



2014



2017



DEMO

2019

Technology

Economics

- Target: produce 2nd generation sugars & ethanol at the price of the 1st generation

Biomass

- First target is softwood bark, then excess wood chips, sawdust, etc
- Cheap process (1 reactant low temp)

Technology support

- Local and supported by a local team

Perspectives



Liquid fuel demand in Quebec

-8.3BL gasoline (2016)

-2.78BL diesel (2016)



Potential biofuels from forest residues

-2.45BL EtOH potential



Assuming a 100% GHG reduction per volume

25% reduction of GHG in transport

Would bring the 35,6Mt eq. CO₂ per year

To

26.7Mt eq. CO₂ per year

Below 1990 target at 27.4 Mt eq. CO₂ per year

Technology

Nice scenario – but we still have a problem

- Heavy transportation
- Train
- Boats
- Planes

(those guys like fuel too but have less opportunities)

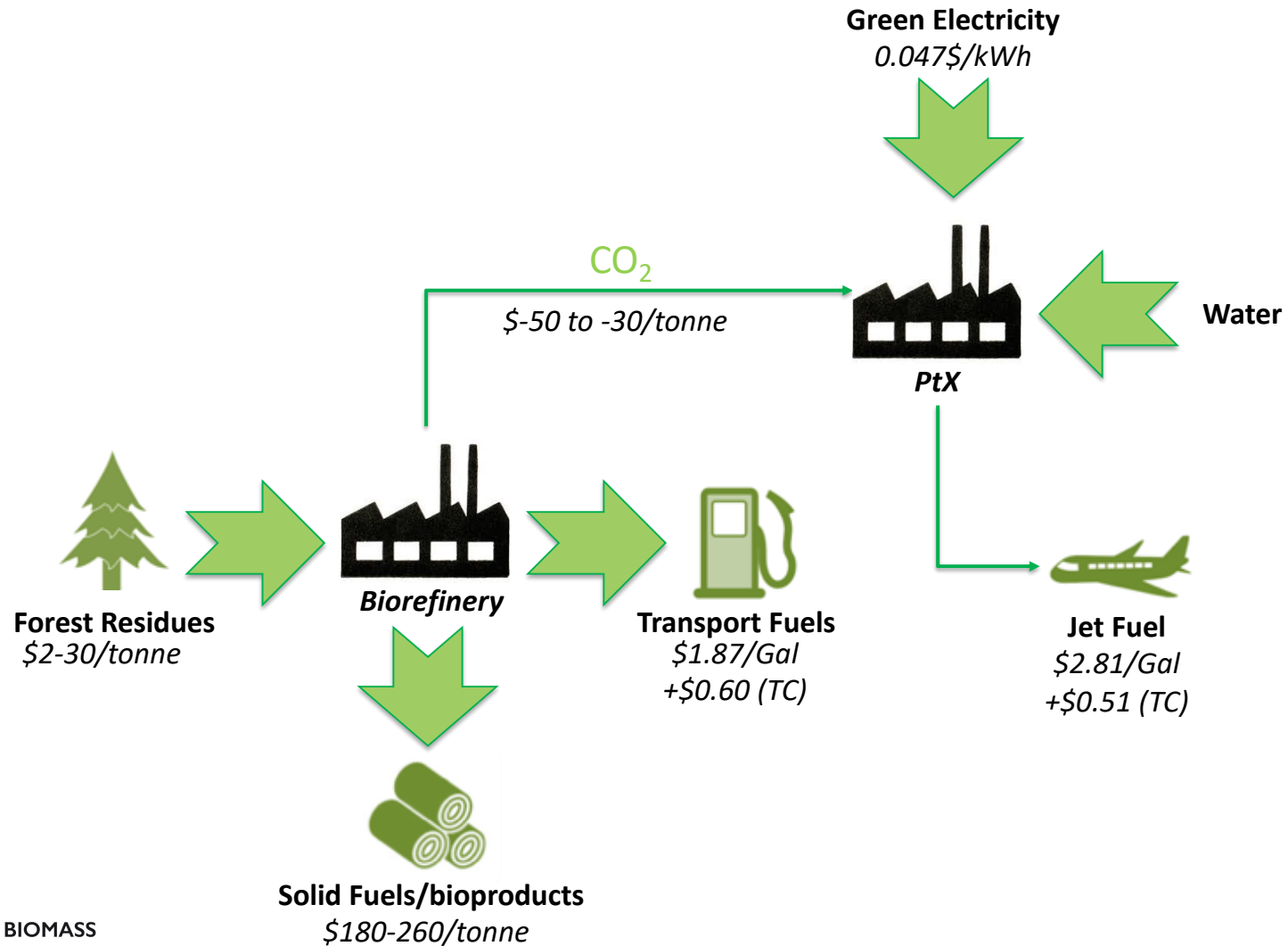
In places like Quebec

- Large volumes of carbon
- Excess amounts of energy

A very potent environment for PtX technologies

- Combine CO₂ and electricity to produce fuel

Perspectives



Conclusion

Biomass in Canada and in Quebec

- Abundant although widespread
- Very large territory

Green electricity abundant or in excess

Technology

- Available but require a clever business plan
- Technology is often region-specific
- Canada is a good example

Conclusion

○ Policies are getting in line

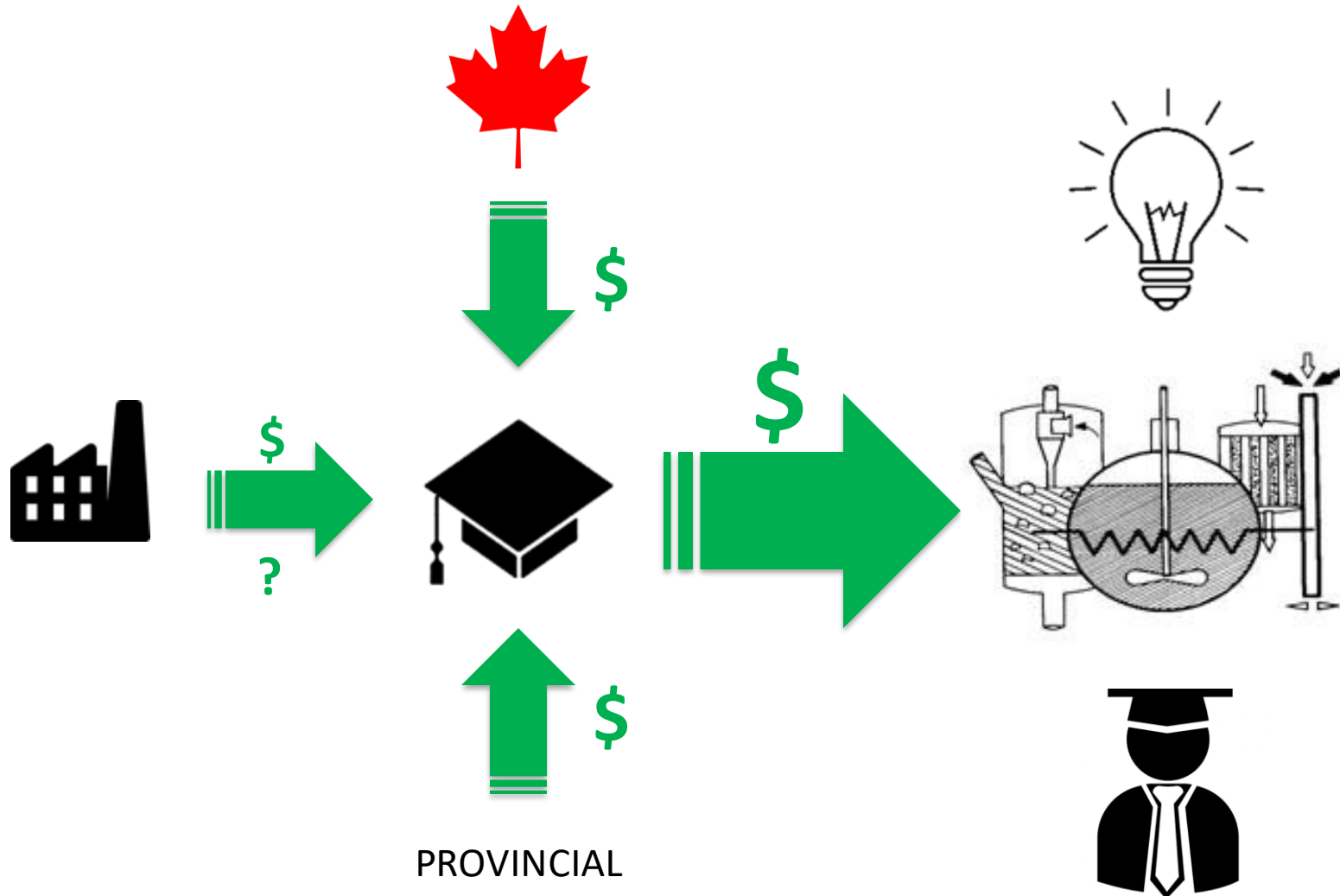
- Putting a value on CO₂ helps
- Providing a support on fuel helps as well

○ Overall the objective would be for this industry to be sustainable and competitive on its own

○ Opportunities to consider

- Converting even CO₂ to fuel
- Store green electricity while using CO₂

The Biomass Technology Lab



The BTL state-of-the-art infrastructure



Analytical lab

R&D – Piloting lab



Building dedicated to biomass



Thank you!



The 2017-2018 BTL team



Without forgetting (better not ;-) – OUR SPONSORS



BIOMASS
TECHNOLOGY
LABORATORY

INFO/COMMENTS



**BIOMASS
TECHNOLOGY
LABORATORY**

<http://www.criecb.com>

jean-michel.lavoie2@usherbrooke.ca



Think green – contact us!

Unique opportunities available for motivated students.