

Atlantic Biorefinery Conference 2015

Community-scale resource recovery and biorefining approach

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**Resource recovery & biorefining
must first have local impacts**

**Each community must initiate
biorefining activities to create new
industrial synergies and relaunch
local economics**

Common products from biomasses

ENERGY

- ✓ Power
- ✓ Heat
- ✓ Biogas (e.g. CH₄)

MATERIAL

- ✓ Food
- ✓ Animal feed
- ✓ Fertilizers
- ✓ Wood products and non lignous products
- ✓ Pulp and paper

Biobased products from biorefining

BIOENERGY

- ✓ Power
- ✓ Heat
- ✓ Biogas (e.g. methane)
- ✓ **Biofuels** (*ethanol, butanol, diesel...*)
- ✓ **Hydrogen**

- ✓ Marketable
- ✓ **Usable on site**
- ✓ **Usable locally**

BIOPRODUCTS

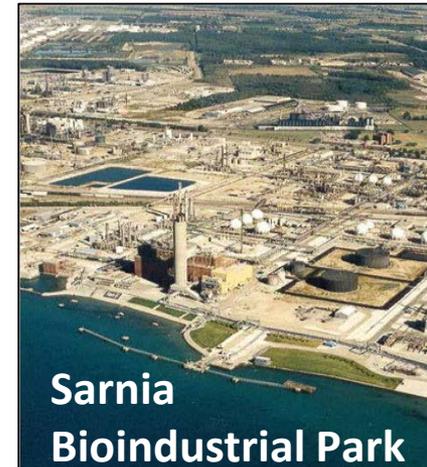
- ✓ Food
- ✓ Animal feed
- ✓ Fertilizers
- ✓ Wood products and non lignous products
- ✓ Pulp and paper
- ✓ **Biomaterials, composites with natural fibers**
- ✓ **Chemicals** (*sugars, organic acids, fatty acids...*)
- ✓ **Microbial products** (*enzymes, antimicrobial agents, proteins, oils...*)

Biorefining approaches

1. Stand alone biorefinery
2. Integrated biorefinery to a existing factory or plant
3. Repurposing abandoned plants
4. Upgrading existing facilities to improve fiber quality and then diversify its end-use
- 5. Eco-industrial cluster**
- 6. Community-scale biorefining**

Eco-industrial cluster

Industrial plants and local businesses in close proximity that maximize the share and exchange of products, energy and waste for beneficial uses, and creating value from surrounding biomasses



Community-scale biorefining

Eco-industrial cluster, small-scale biorefinery, focused on:

- **Local realities:** e.g. local factory shutting down; rural exodus of young and elderly people; mono-industrial culture; lack of business initiative; reliance on fossil resources...
- **Regional assets:** e.g. local expertise or businesses that can harvest biomass and residues; industrial activities with existing or potential synergies; organizations dedicated to regional economics; presence of university, technical colleges...

Community-scale biorefining

Eco-industrial cluster , small-scale biorefinery, focused on:

- ***On-site or local uses of coproducts:*** To reduce fossil based products consumption and dependency in region; each coproduct should attract new businesses in town or create a division/spin-off of a local business
- ***Raising local biomass processing depots :*** To prepare biomass (drying, grinding...) or produce biobased ingredients and secure the biomass chain supply (at appropriate abundance and quality)

Community-scale biorefining

Eco-industrial cluster, small-scale biorefinery, focused on:

- ***SOCIO-ECONOMIC SUSTAINABILITY :***

- Improving the social situation of workers, their families and the communities in general
- Creating and retaining jobs
- Catalyzing partnerships, business growth and economic activity
- Revitalizing infrastructure and local expertise in the region
- Curbs the exodus of youth and elders in the region
- Stimulating entrepreneurship, especially among young people in the region

Examples of community-scale biorefining projects in Quebec

Case study 1: Agricultural biorefining using crop residues

Case study 2: Forest residues densification for further biorefining

Case study 3: Value added production from pulp and paper mill residues (e.g. sludges)

Case study 4: Microalgae production in co-location with industrial plants



**Case study 1: Agricultural biorefining using corn
crop residues – Agrosphere project (2007-...)**

*UQTR, Ferme Olivier Lépine, Ferme Sébastien Lépine, La
Coop Profid'Or, DuPont Industrial Biosciences, Innofibre,
CNETE & collaborators*

Lanaudière (QC, Canada)

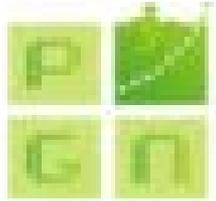
- Active agri-businesses
- Farmers facing financial difficulties
- Young people must be encouraged to take over the family land
- Tons of lignocellulosic residues available annually located in small areas
- Local infrastructure and expertise to revitalize



Agrosphere project

- Integrating an agri-biorefinery to an existing farm
- First, target of 12-16M L bioethanol from corn crop residues
- Now focusing on producing sugar hydrolysates & coproducts





AGROSPHÈRE
CRÉATEUR D'ÉNERGIE RENOUVELABLE
CREATING RENEWABLE ENERGY

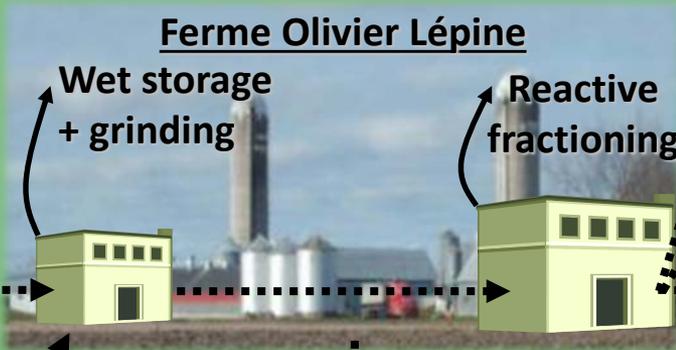


Agrosphere, at the center of a regional & international coalition, multi-sectorial ... Able to undertake the entire chain value and biggest challenges in cellulosic biofuels and sugars !

Integrating a cellulosic ethanol pilot plant to an existing farm
Agrosphere project



Sustainable & clean harvesting of corn crop residues in 30km radius



Organic residues from the farm or local businesses

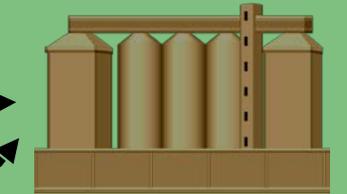
Local micro-plant for enzyme production on site
DuPont Industrial Biosciences Kruger Inc.
(co-location with a local pulp & paper plant at Crabtree, QC)

Biocontrol agents production in bioreactors

On site or local uses of coproducts

- Valuable lignin
 - Heat for plant & farm
 - Biopesticide ?
 - Local markets
- Nutritive hemicelluloses
 - Pig feeding
 - Bioplastics ?

Highly digestible cellulose



Separated enzyme hydrolysis & fermentation



Distillation

DDG

Pig feeding

BIOETHANOL

Agrosphere : a model of advanced local biomass processing depot with new assets



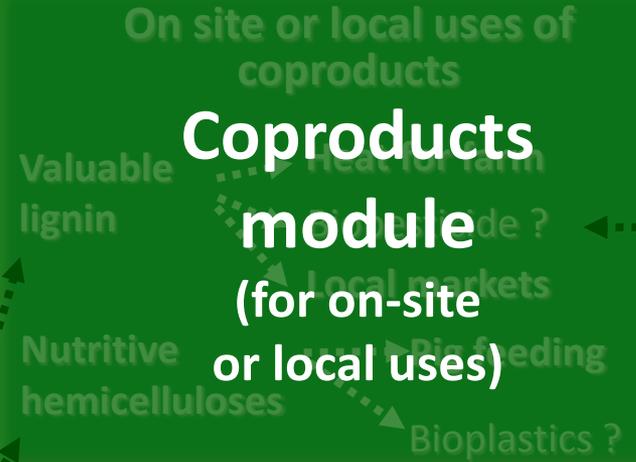
Advanced regional biomass processing depot

(co-locate with a farm with unique harvesting and manutention techniques, and flexible fractioning process)

Local enzymes and industrial microorganisms production module

(for value added production from wastes and to reduce enzyme or microbial treatment costs)

Coproducts module (for on-site or local uses)

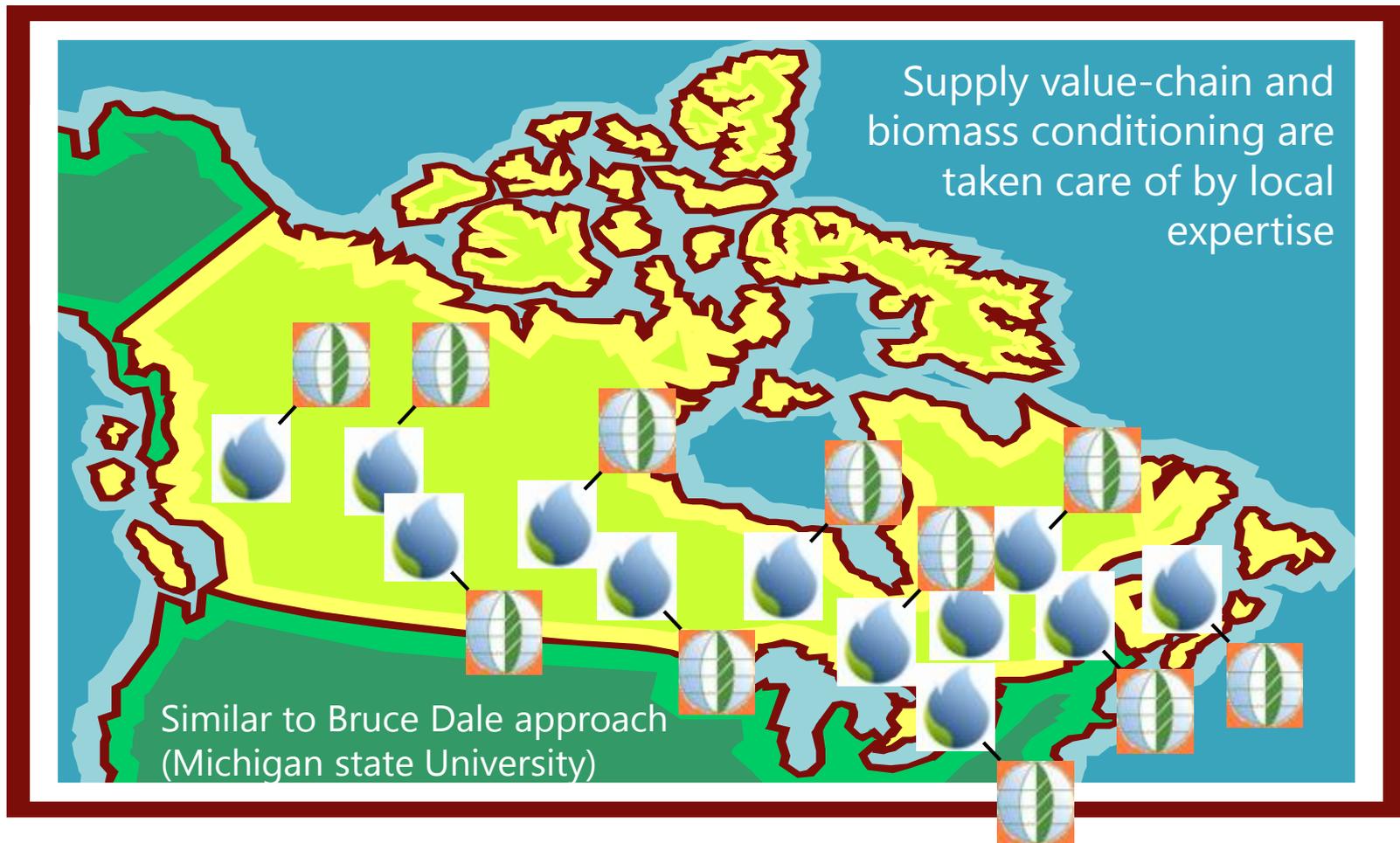


Prehydrolysates or Cellulosic sugars



- 2nd generation biofuel plants
- Chemical industries
- Bacterial bioplastics production
- Algae production – algae farm

An advanced model of regional biomass processing depot



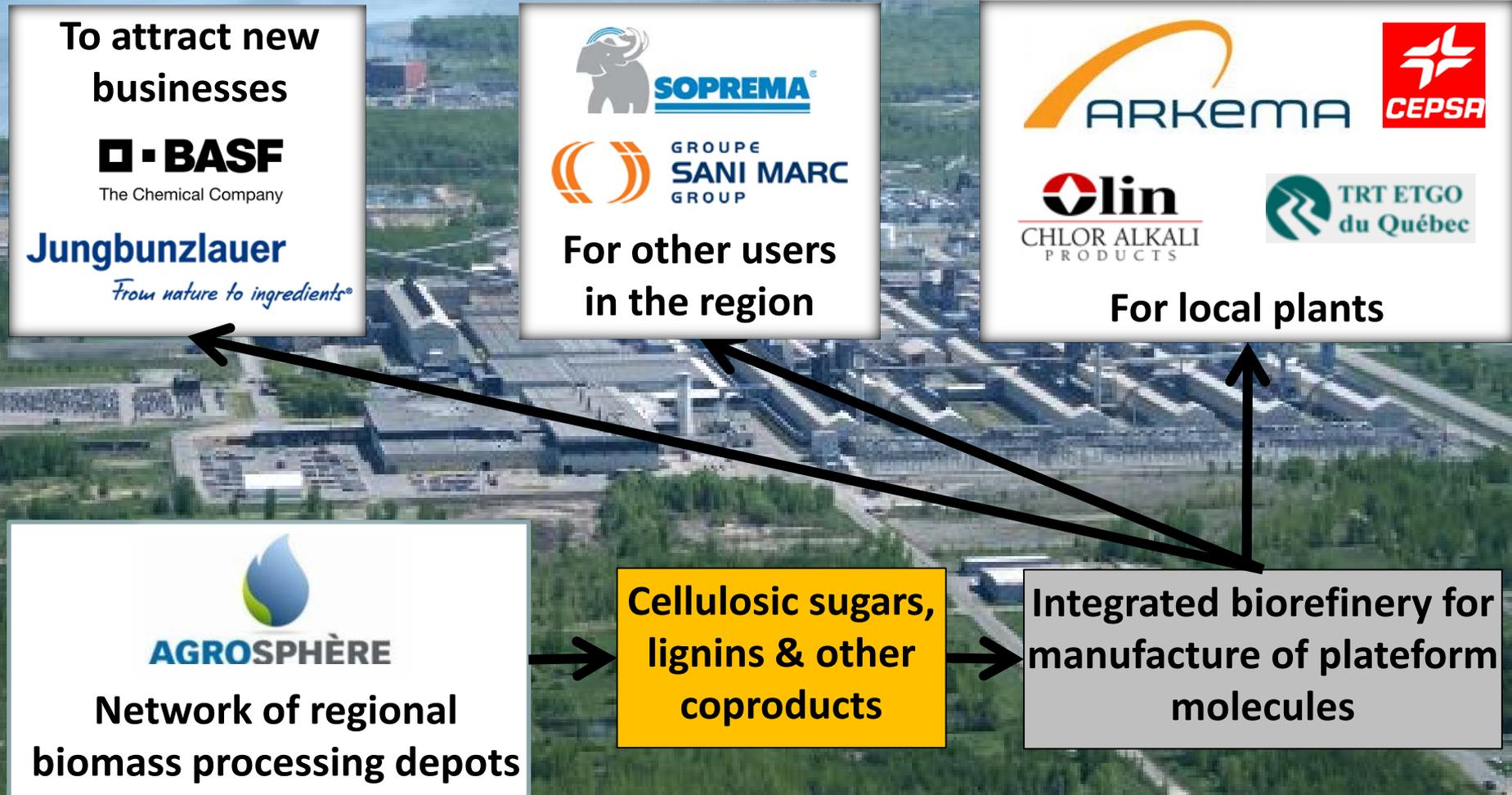
Local impacts of Agrosphere depots

- Use of local expertise for the biomass value-chain
- Driven by a new generation of young farmers who want to assure the sustainability of farm jobs
- Possibility of having a profitable biomass market
- Generating new income from residues
- Attracting new businesses
- Revitalizing local infrastructure and expertise



Establishment of a bioindustrial park at Bécancour (Quebec, Canada)

(based on the experience of the Sarnia bioindustrial park Ontario, Canada)



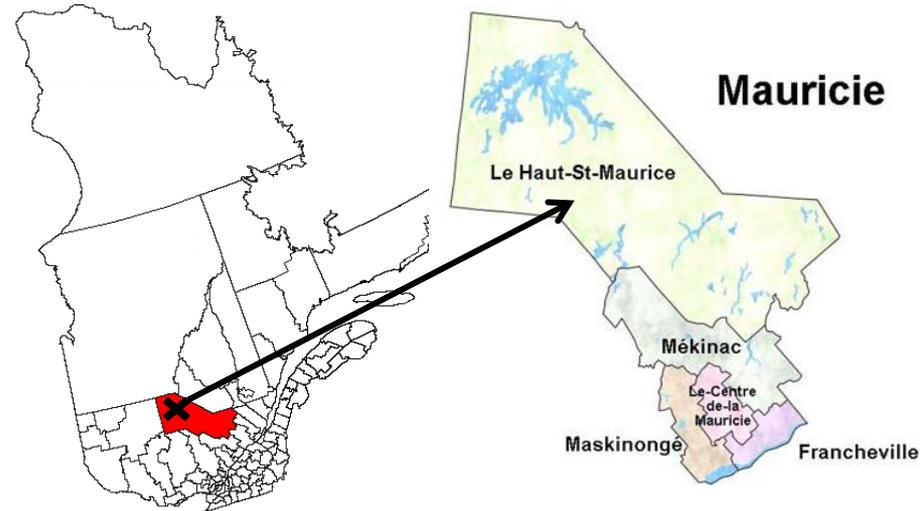


Case study 2: Forest residues densification for further biorefining – La Tuque project (2009-...)

UQTR, Ville de La Tuque, Rock Tenn, Coopérative forestière du Haut-St-Maurice, Groupe Rémabec, Innofibre, CERFO, École Forestière de La Tuque & collaborators

Realities of Haut-St-Maurice (QC, Canada)

- 2nd worst population decline in Canada
- Plants shutting down or lowering operation
- Monoindustrial
- Very few next generation of foresters
- Still relying on fossil fuels



Assets of Haut-St-Maurice (QC, Canada)

- Industrial activities generating about 650k tons/year of forest residues
- Presence of foresters with leadership
- Experimental forest on site
- Projects under progress (pellets, forest mushrooms)
- **Opportunities to overcome socio-economic problems with community-scale biorefining**





(via Remabec group)



Coopérative forestière du Haut-St-Maurice (via Énergie Miti)



Canada Economic Development for Quebec Regions



SADC Haut St-Maurice Société d'Aide au Développement des Collectivités du Haut-St-Maurice inc.

The Haut-St-Maurice supported by local institutions and businesses to implement a forest biorefinery



Institute for Chemicals and Fuels from Alternative Resources The University of Western Ontario



Facing a big challenge !

Forest residues spread over $>10\,000\text{ km}^2$



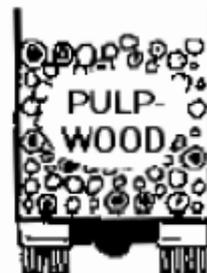
15 - 20 %



35 - 40 %



~ 40 %



60 - 70 %

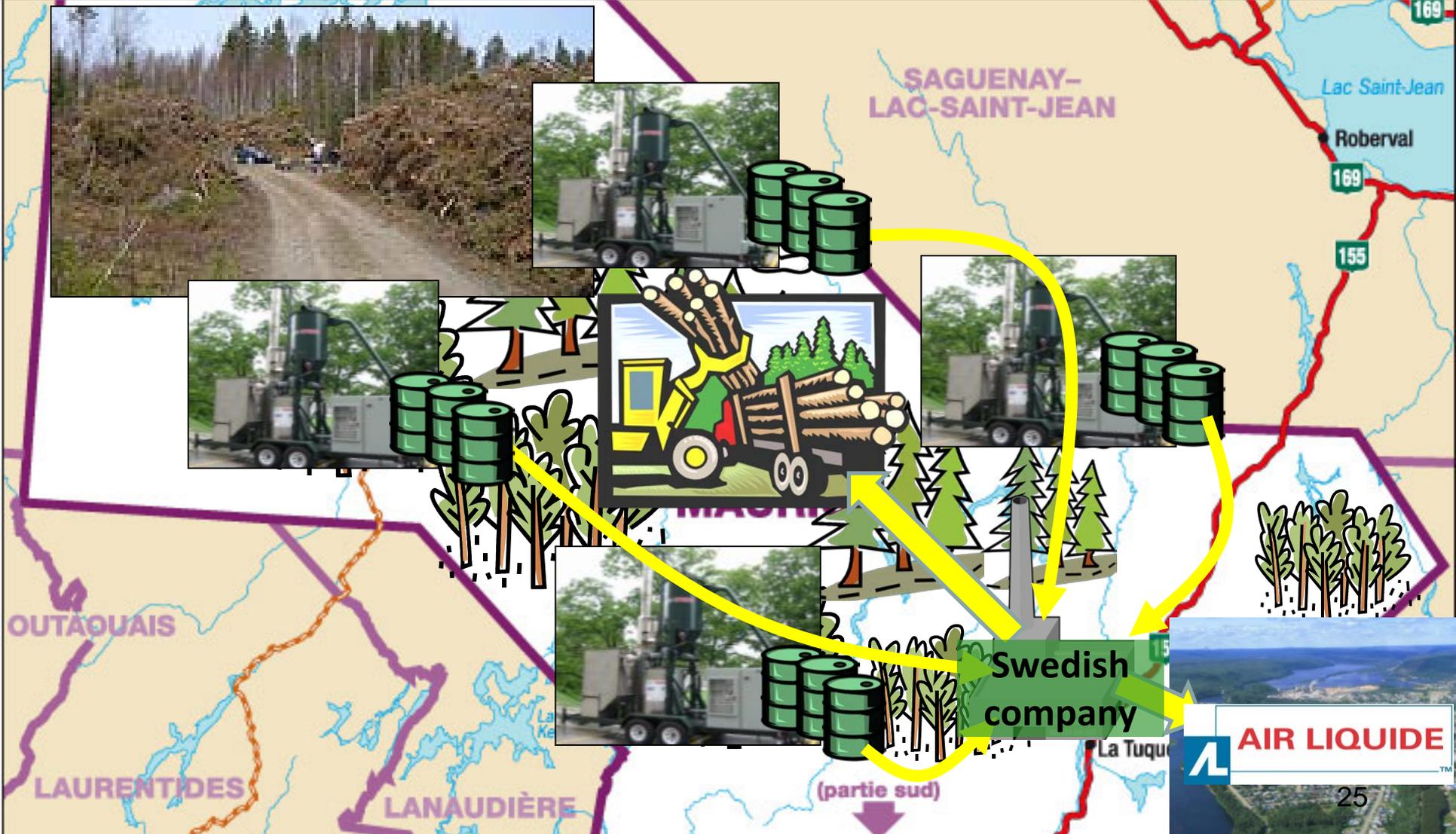


...Must resort to biomass densification !

Proportion of solids in forest fuels. All loads have the same solid content. (Modified after Nilsson 1983).

Vision 2023 La Tuque

Preparing the field to build a forest biorefinery, to produce bioenergy for local uses, obtain coproducts for specific markets and to welcome new companies relying on biorefining activities



Vision La Tuque 2023 : Update

- Purchase of a pilot mobile pyrolysis unit with DEC (2,5T/day)
- La Tuque Mission in Scandinavia (Oct 2014)
- Rising an industrial research chair on regional bioenergy & bioeconomy (Dec 2015)
- Vision La Tuque proposed to be a flagship project for Quebec (March 2015)
- Establishment of *Bioénergie La Tuque* (BELT) (May 2015)





**Case study 3: Value added production from pulp
& paper sludges to obtain bioproducts usable on
site or locally (2008-2015)**

*UQTR, University of Manitoba, Kruger, Cascades, Innofibre &
collaborators*

Biobased ingredients or products usable on site to replace chemicals or fossils fuels

E.g.: Kruger plants



Wastewaters

Treatment

Additives for packaging or composites

White waters toward value added production

Bacterial cellulose

G. xylinus

Pulp & paper sludge



Monoculture of industrial microorganisms



Commercial bioreactors or modified pulp&paper vessels

Projects lead by UQTR

H₂, 3rd gen ethanol, organic acids (acetate, lactate, formate) from *C. thermocellum*

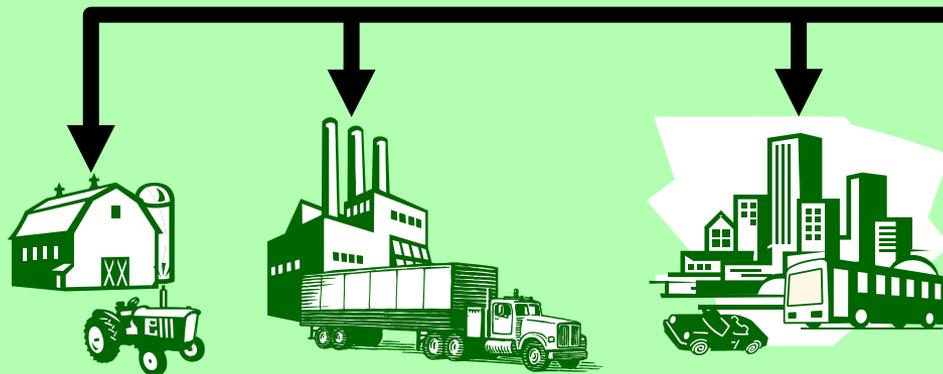
Cellulolytic enzymes cocktails with cellulases & xylanases from *T. reesei* et *Bacillus* sp.

Inoculants for wet storage of cellulosic biomasses, PGPr for agri crops

Bacterial bioplastics (PHAs)

Deinking sludge

(autres boues ou résidus organiques locaux)



Other local users (near the plant or in the region)

Twin-screw extruder

Community scale resource recovery and biorefining to relaunch local economics

- **Residual biomasses or waste streams are rallying, endogenous tools for local development**
 - ✓ Diversifying products and coproducts from biomass can give a boost to rural economics and bring new or additional income
 - ✓ Be successful locally before going globally
- **Cooperate, co-locate and co-produce (3C rule)**
 - ✓ Cover the entire chain of value with local key players
 - ✓ Find end users in your region that could benefit from biobased products or materials even unusual local businesses

How can we have more biorefining activities in NB ?

- Individually, NB biomass based companies are going well in diversifying products... Together, they can do more !
- Involve woodlot owners, farm and fish co-operatives
- Involve municipality stakeholders (mayors)
- Seek for unusual biomasses (e.g. sludges, recycled woods) and synergies with other sectors

How can we have more biorefining activities in NB ?

- Bioenergy is a good start
- Prepare the field to attract a chemical industry (e.g. with cellulosic sugars or sugar beet sugars)
- Promote a flagship project
- FORM CLUSTERS – Regionalize yourselves around biomasses
- Have your own approach of « inter-community biorefining » !

**Here the best tip
for implementing
biorefining
activities :**

***Socio-economic
sustainability***

Brothers Lépine in Agrosphere Project



**Involve the next generation
of farmers and foresters,
show them the possibility
of new incomes and their
role in securizing biomass
supply at appropriate
quality and abundancy for
biorefining**



Carrier family in La Tuque Project

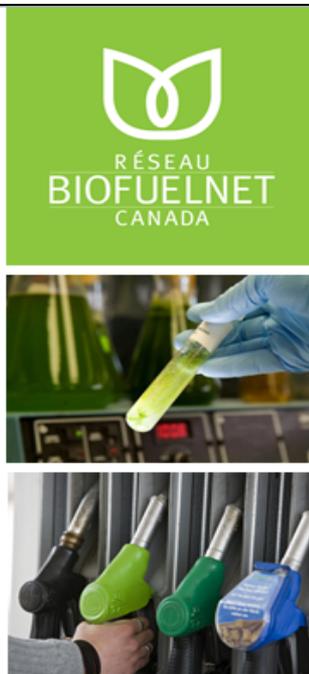
**Training in technical colleges,
universities and professional
schools is essential for
implanting successful biorefining
activities on a territory!**

**Incite local businesses to recruit
HQP or train directly their
employees**

Advanced Biofuel Course

Lecture 12: Community-scale resource
recovery and biorefining approach

Simon Barnabé & collaborators
Industrial Research Chair on Environment & Biotechnology (CRIEB)
Renewable Materials Research Center
University of Quebec at Trois-Rivières (UQTR)



UQTR



Université du Québec
à Trois-Rivières

Savoir. Surprendre.

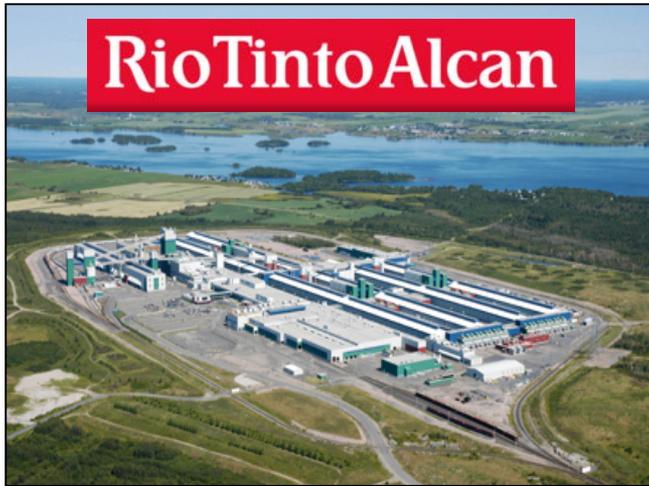
**VALORISATION
DE LA BIOMASSE
PROGRAMME COURT
DE 2^E CYCLE**

Département de Génie chimique

**COMMENT RENTABILISER
VOS RÉSIDUS EN LES
TRANSFORMANT
EN ÉNERGIE**



Don't forget microalgae biomass production in co-location using waste nutrients and waste energy... It easily creates eco-industrial clusters !



RTA project (2010-2015)



Victoriaville



Alga-Fuel pilot tank 10m³, RT-Algae process



EBI project (2015-2017)

VERTECH CITY 2 student international contest



Imagine your city without waste

The selected team will have the chance to present their ideas at VERTECH 2016 symposium at Namur, Belgium, next March !