Design and Economics of an Advanced Biomass Processing Depot - Case Study in Southern Quebec

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RÉSEAU BIOFUELNET CANADA

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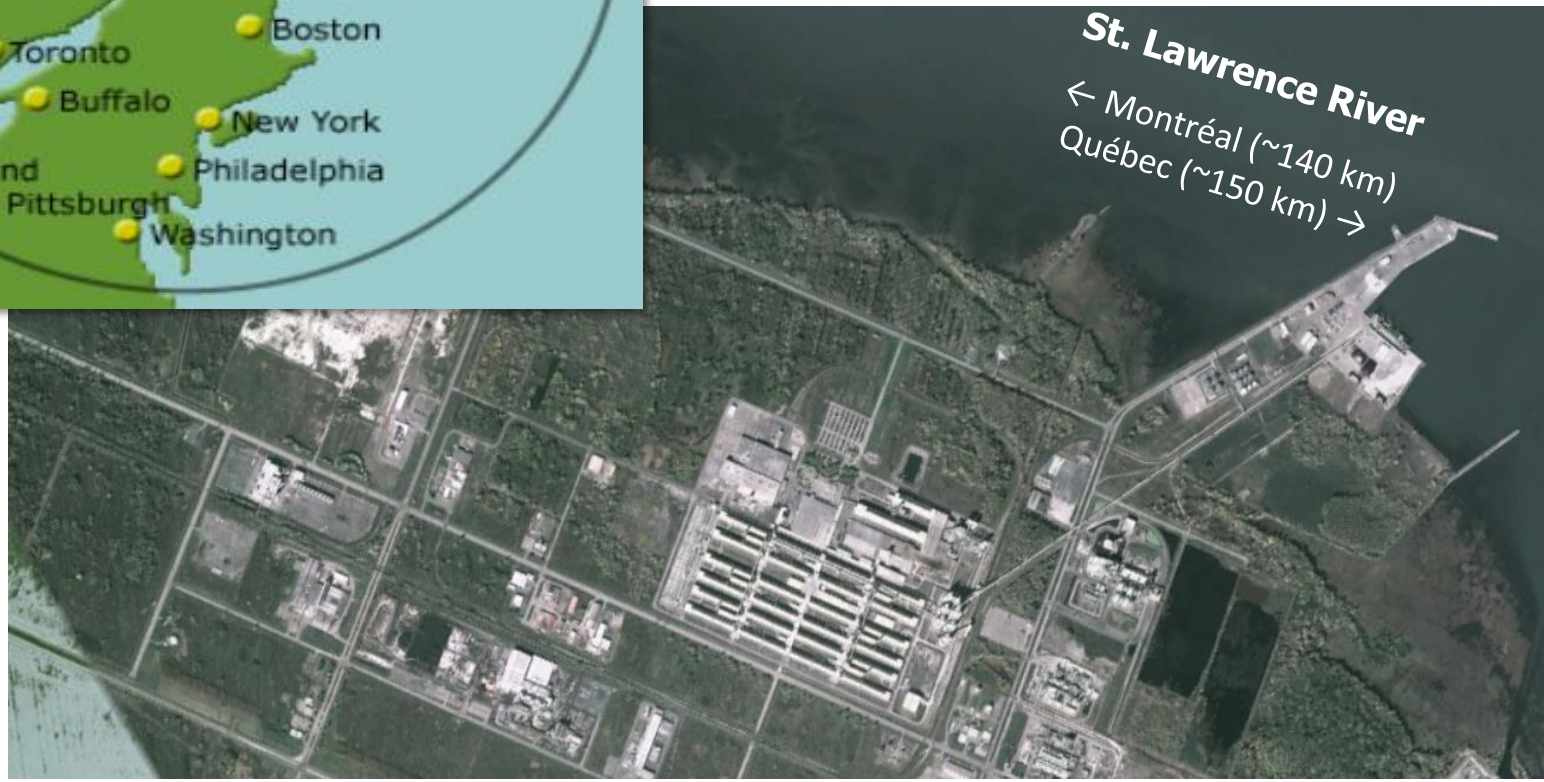
World Sustainable Energy Days 2019

27 February – 1 March 2019
Wels, Austria

Bécancour Waterfront Industrial Park
(Québec, Canada)



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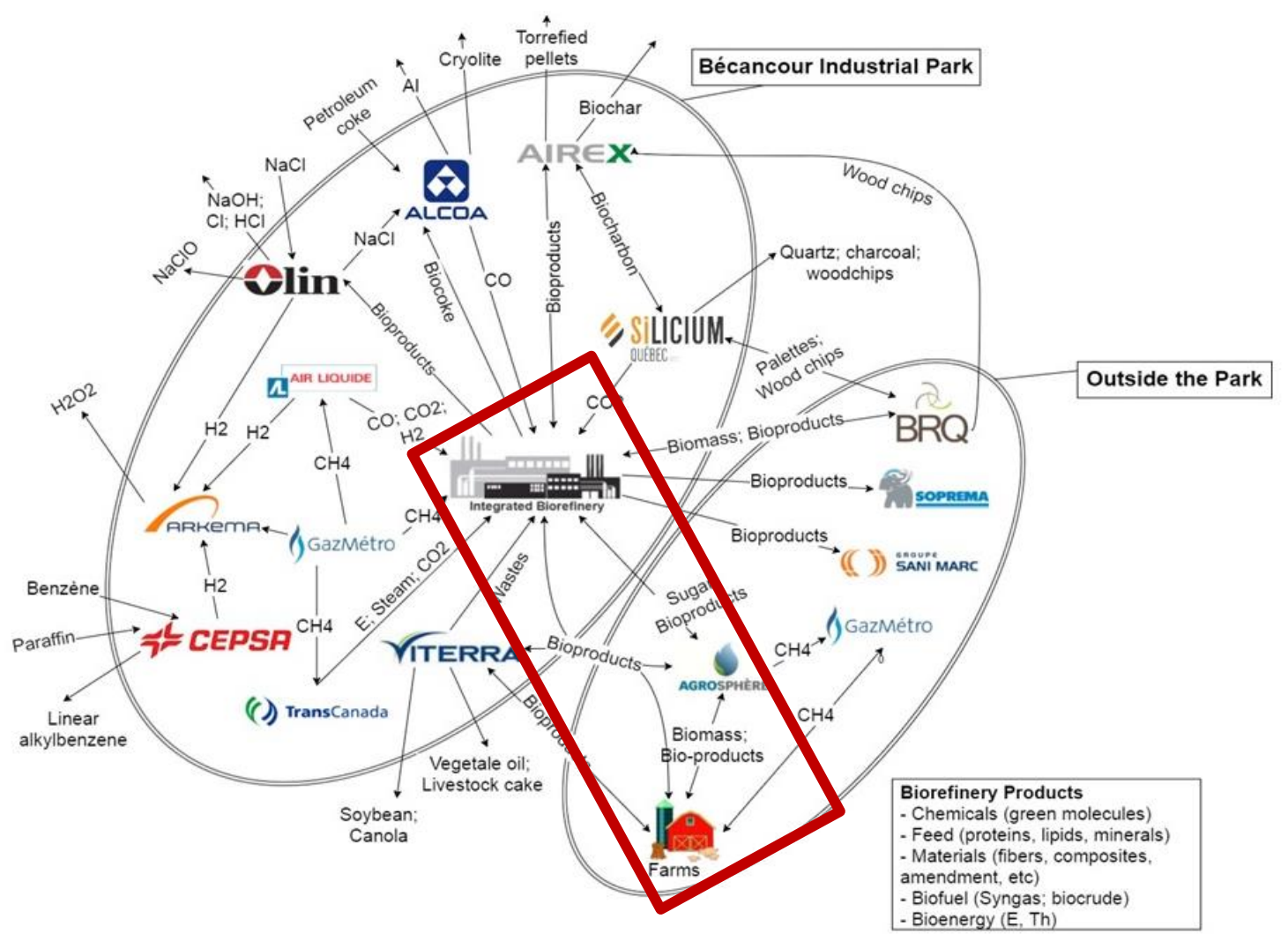
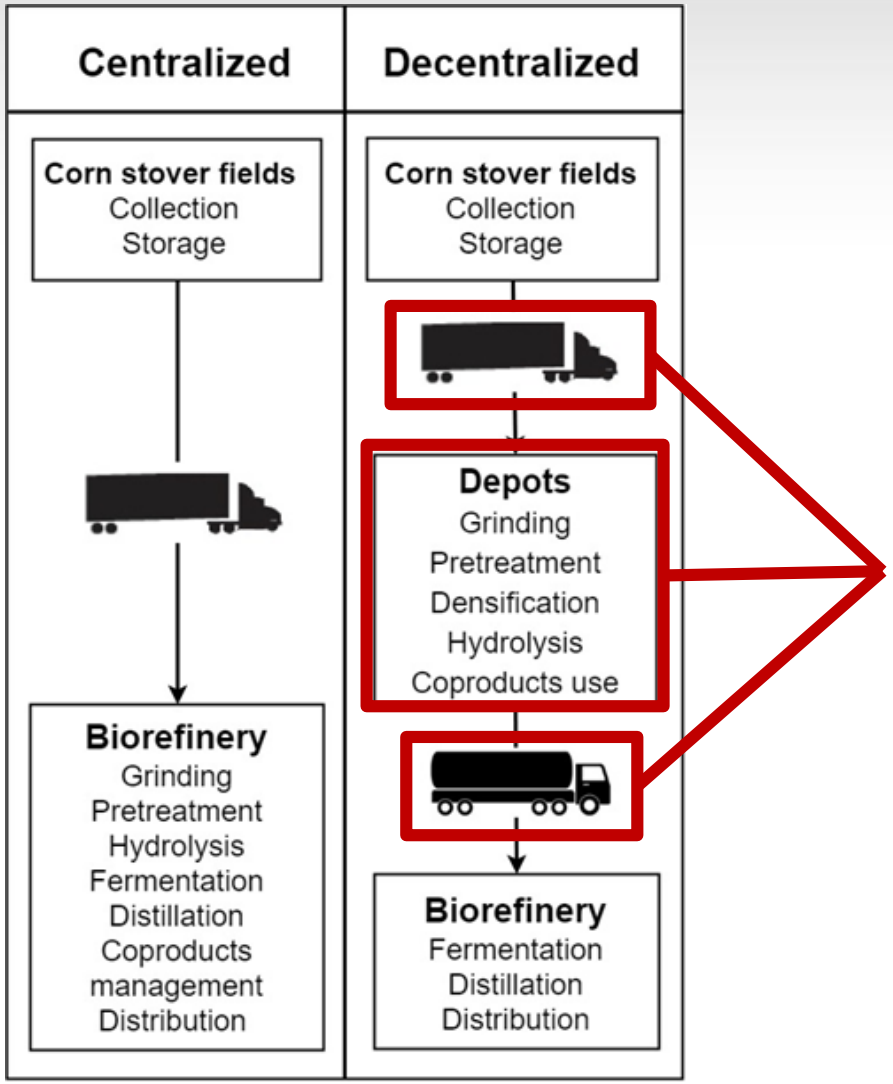
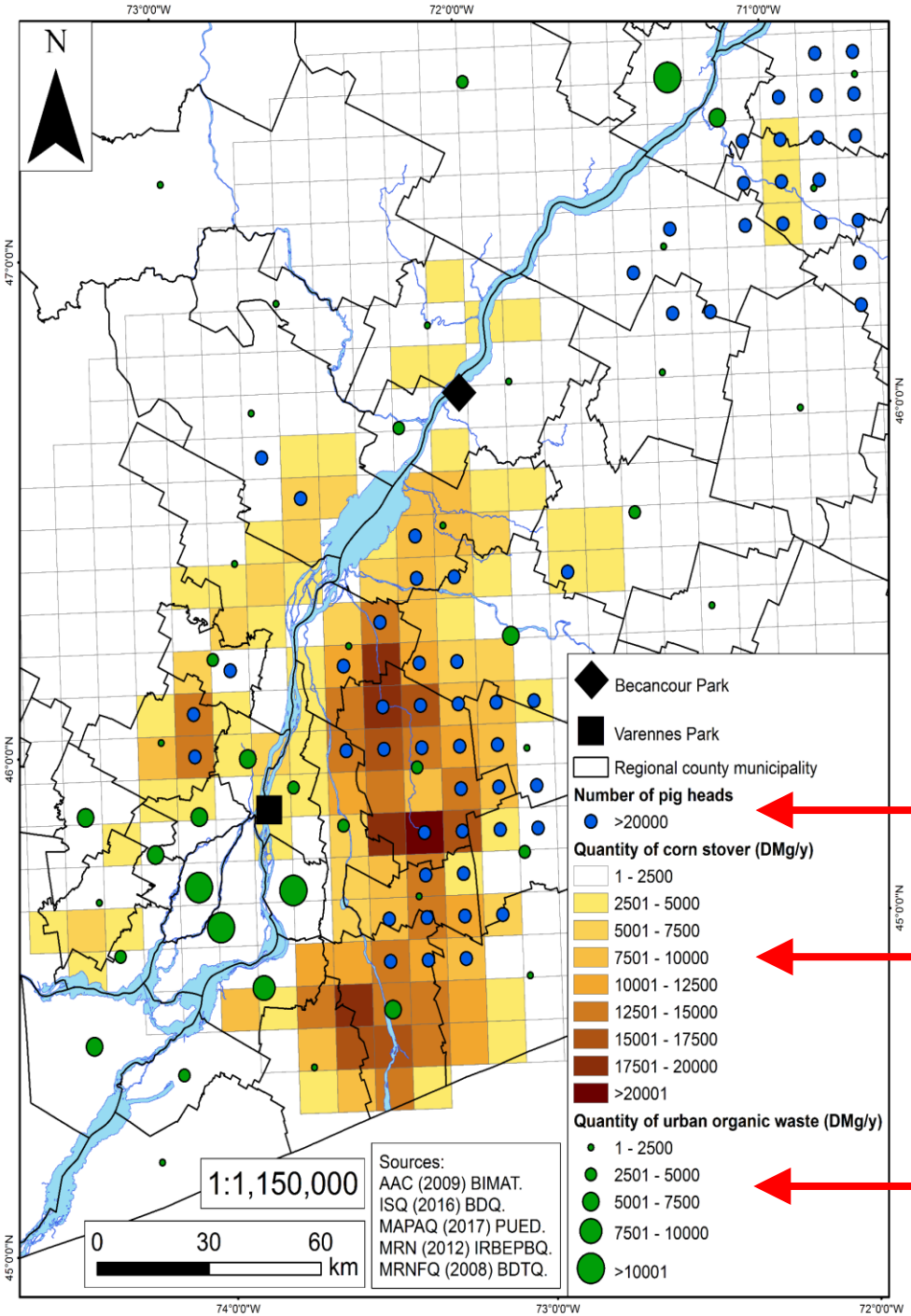


Centralized vs. decentralized supply chain



Value proposition

Materials & methods



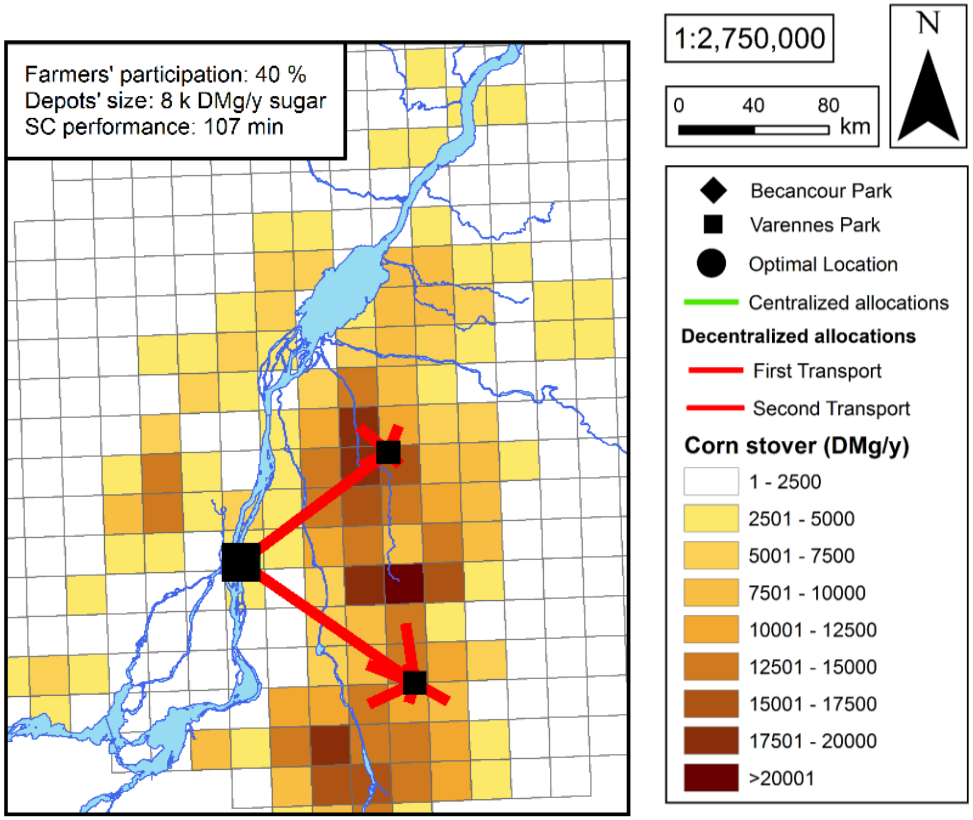
Location criteria

Animal distribution

Availability ag feedstock

Availability urban feedstock

Decentralized performance



Depending on farmer participation, decentralized performance can be 16% to 42% more efficient than centralized configurations.

A decentralized network with several small depots tends to reduce the average impedance as biomass availability increases.

This is due to the transport savings related to a denser and more connected network.

Inputs - Specificity & logistics

24 k DMg y^{-1}

Harvest area: Corn residue

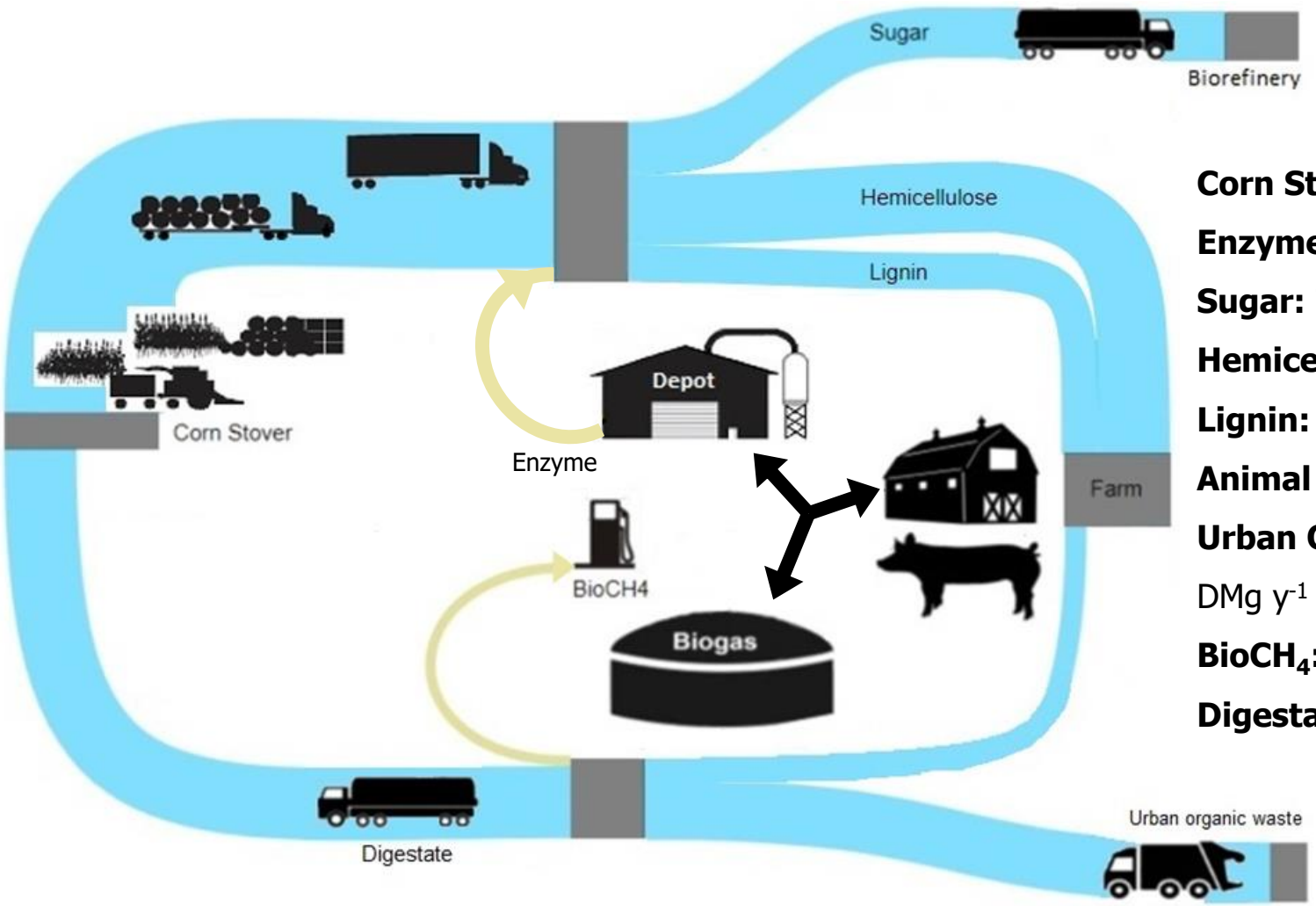
Purchase; Harvesting; Collection; Storage; Transport; Nutrients; Handling; Pre-treatment

12 k DMg y^{-1}

Urban and ag organic waste

Negative cost; Transport; Handling; Storage; Pre-treatment

Local circular design



Corn Stover: 24 k DMg y^{-1}

Enzyme: 1.2 k DMg y^{-1}

Sugar: 7.5 k DMg y^{-1}

Hemicellulose: 12 k DMg y^{-1}

Lignin: 5.5 k DMg y^{-1}

Animal waste: 3.3 k DMg y^{-1}

Urban Organic waste: 8.6 k DMg y^{-1}

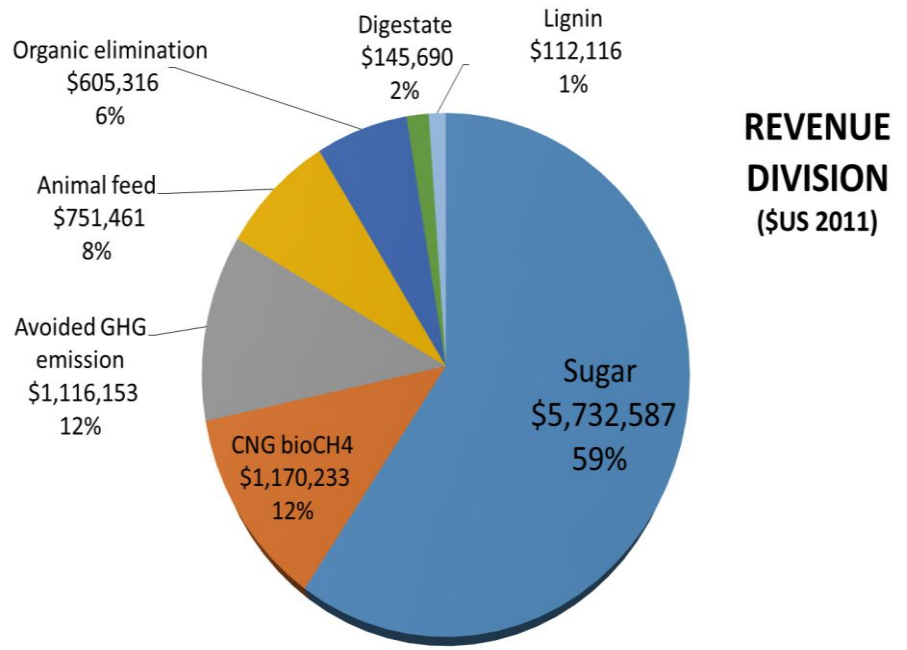
$BioCH_4$: 2.2 M Nm^3 y^{-1}

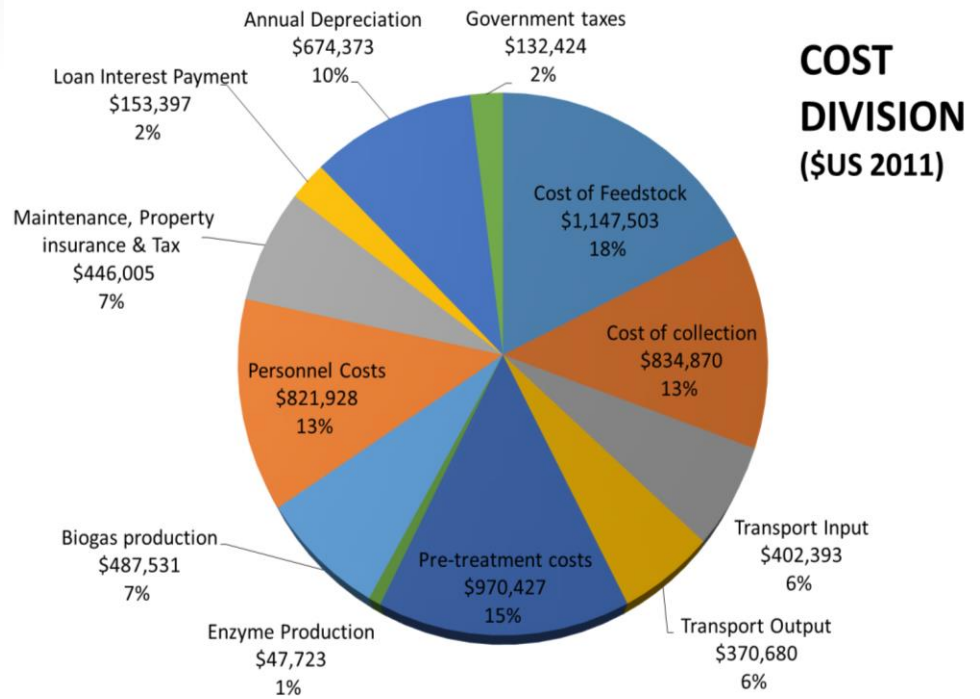
Digestate: 11 k DMg y^{-1}

Total Capital Investment

		2011 US Dollars
A000	Land	$700,000
A100	Handling, Storage and Utilities	$1,500,000
A200	Pretreatment & Hydrolysis	$2,500,000
A300	Enzyme	$300,000
A400	Biogas & Wastewater	$2,900,000
	Installation	$10,900,000
	Total Inside battery limits (ISBL)	**$7,600,000**
	Total Direct Costs (TDC)	**$19,400,000**
	Indirect Costs	**$11,700,000**
	Fixed Capital Investment (FCI)	**$31,000,000**
	Total Capital Investment (TCI)	**$32,600,000**

Costs & Revenues





CO_2e avoided, reduced or stored

1. **2nd G sugar:** -6,600 tCO_2e/yr
2. **BioCH4:** -6,300 tCO_2e/yr
3. **Lignin use**: -6,900 tCO_2e/yr
4. **Good agricultural practices:** -31,200 tCO_2e/yr
5. **Efficient transport & decentralized SC:** -350 tCO_2e/yr

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TOTAL: -51,500 tCO_2e/yr

Over 30 years: 1.5 M tCO_2e

Economic Analysis

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - I_0 = 0$$

Assumptions	Value
Inside battery limits (ISBL)	$7,600,000
Fixed Capital Investment	$31,000,000
Equity	40%
Loan Interest	6%
Interest rate	10%
Income Tax Rate	27%
Sugar Production Rate (MMlb/yr)	16.8
Net Present Worth	**$0**

Minimum Sugar Selling Price

US$ (2018) /lb	**$0.384**
US$ (2018) /Metric tonne	**$846**

US retail price of dextrose ($US 2018)

Milling & Baking News. Table 8 - 12/17/2018.
https://www.ers.usda.gov/data-products/sugar-and-sweeteners-yearbook-tables.aspx

Conclusions

1. Economy

- Value creation and profit at regional scale
- Diversification of farmers' incomes
- New local circular business model

2. Social

- Jobs creation in agri-business
- Creating a common shared vision among stakeholders

3. Environment

- Closed-loop bioresource system
- Reduction of greenhouse gas emissions
- Bio-based chemical building block