Biomasse et carboneutralité

Biomass and Carbon Neutrality

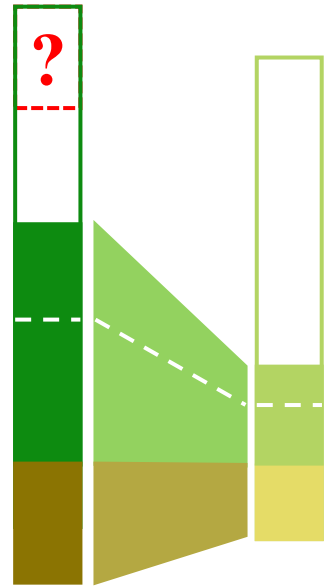
INSTITUT DE L'ÉNERGIE TROTTIER

The Transition Accelerator — L'Accélérateur de transition

Scaling up bioenergy systems

Heather MacLean, University of Toronto
Edmund Mupondwa, AAFC Saskatoon R&D Centre, and University of Saskatchewan
Stefan Pauer, Clean Energy Canada
Nazim Sebaa, Industrial Gas Users Association

Normand Mousseau, IET, moderator

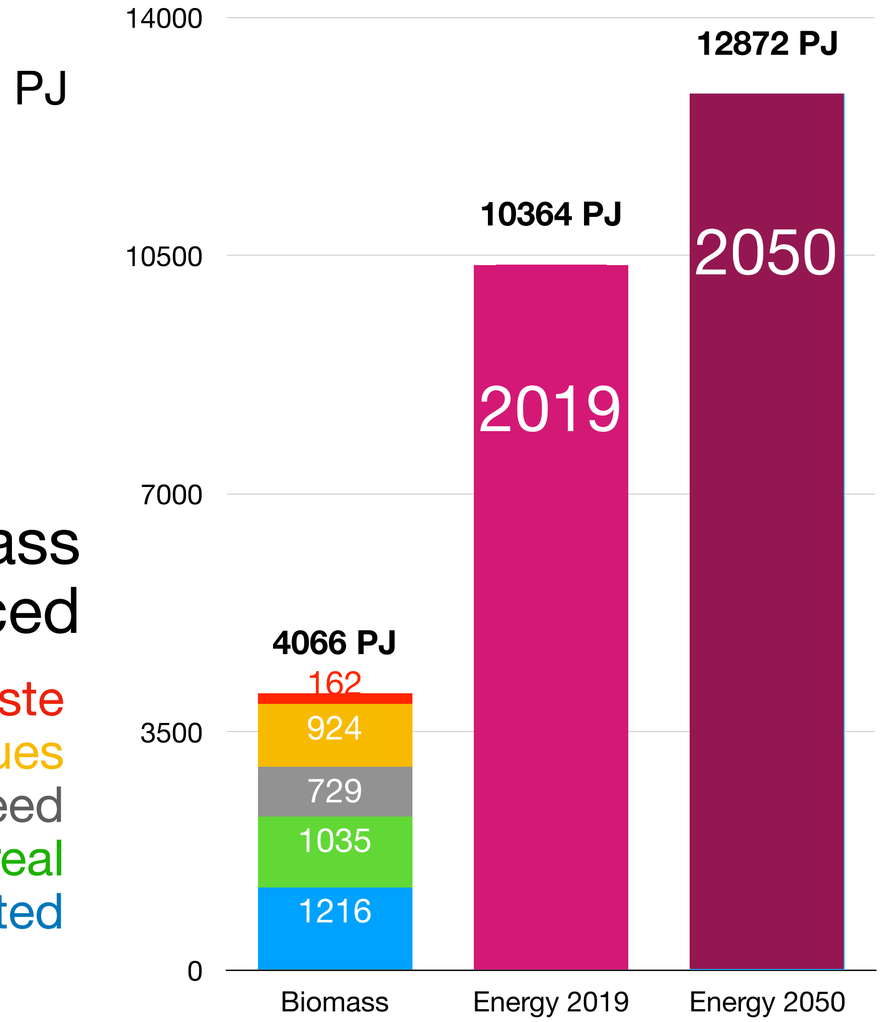


The relative role of biomass in the energy transition of Canada

Due to other usages and conversion losses, at best, 25-50 % of the total energy contained in biomass can be used for final energy usage

Biomass can contribute, therefore, to 7 to 15 % of the total energy demand in Canada.

Energy demand in Canada (now and projected)



Biomass produced

Waste
Ag residues
Oilseed
Cereal
Wood harvested

Source: IET/modelling ESMIA Consultants

Panelists

Heather MacLean

University of Toronto

Edmund Mupondwa

AAFC Saskatoon R&D Centre and University of Saskatchewan

Stefan Pauer

Clean Energy Canada

Nazim Sebaa

Industrial Gas Users Association

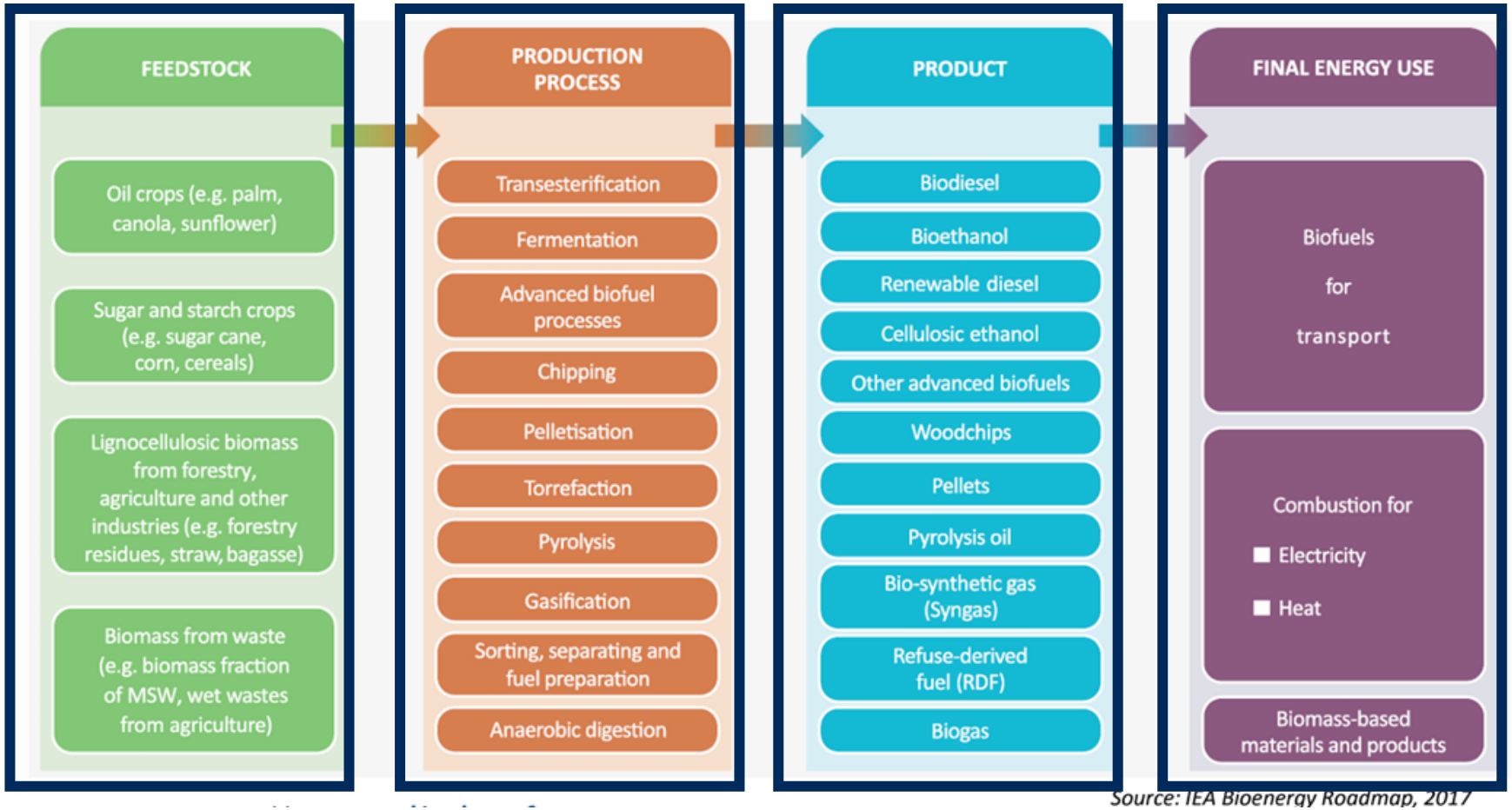
Panelist

Heather MacLean

University of Toronto

SCALING UP HAS MANY DIMENSIONS AND COMPLEXITIES

- ❑ Upstream and downstream of conversion process
- ❑ Sectoral considerations
- ❑ Temporal and spatial considerations
- ❑ Techno-economic, environmental, social, governance
- ❑ Large uncertainties

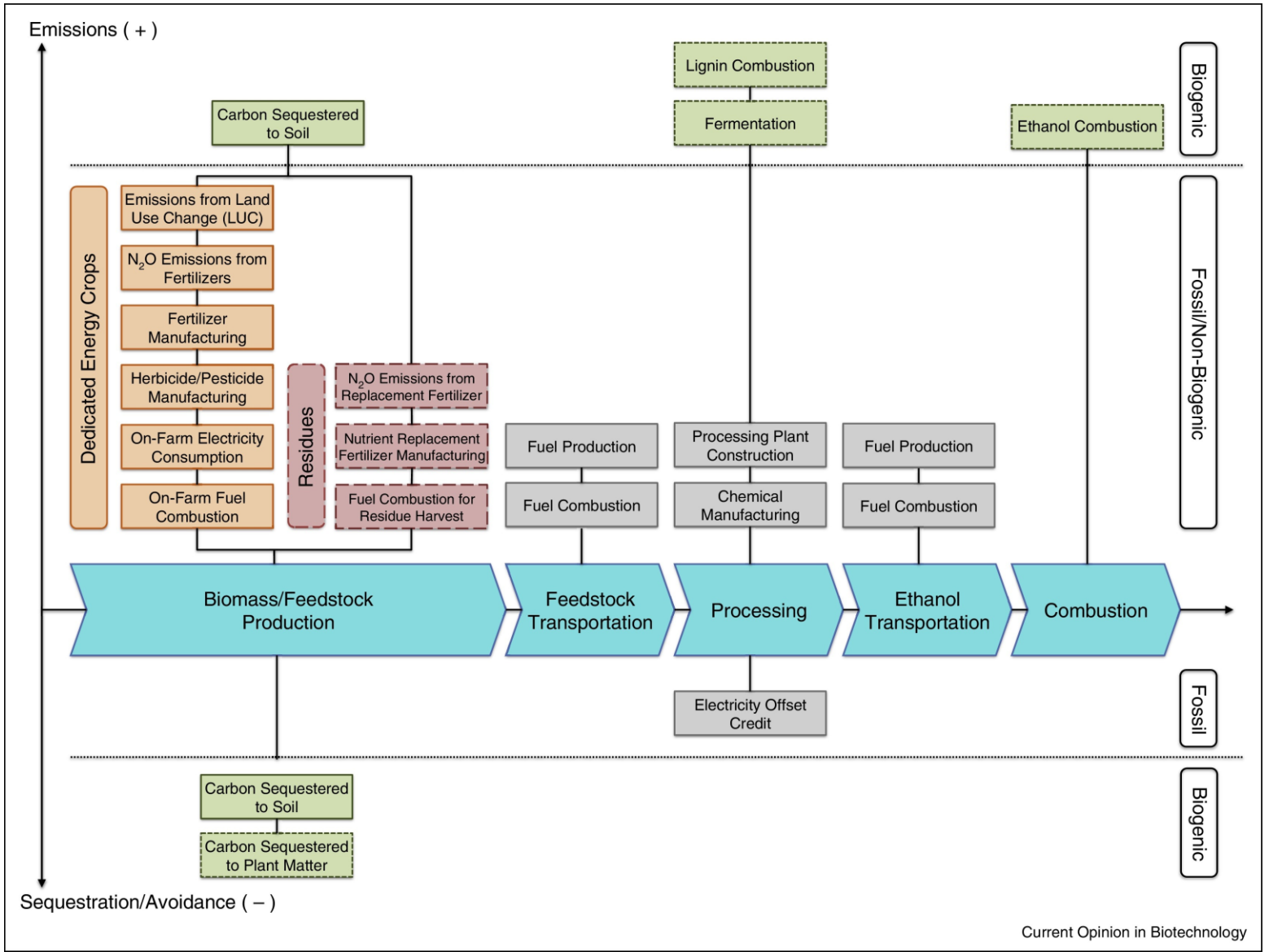


Source: IEA Bioenergy Roadmap, 2017

UNIVERSITY OF TORONTO

LIFE CYCLE IMPLICATIONS - CONTEXT MATTERS

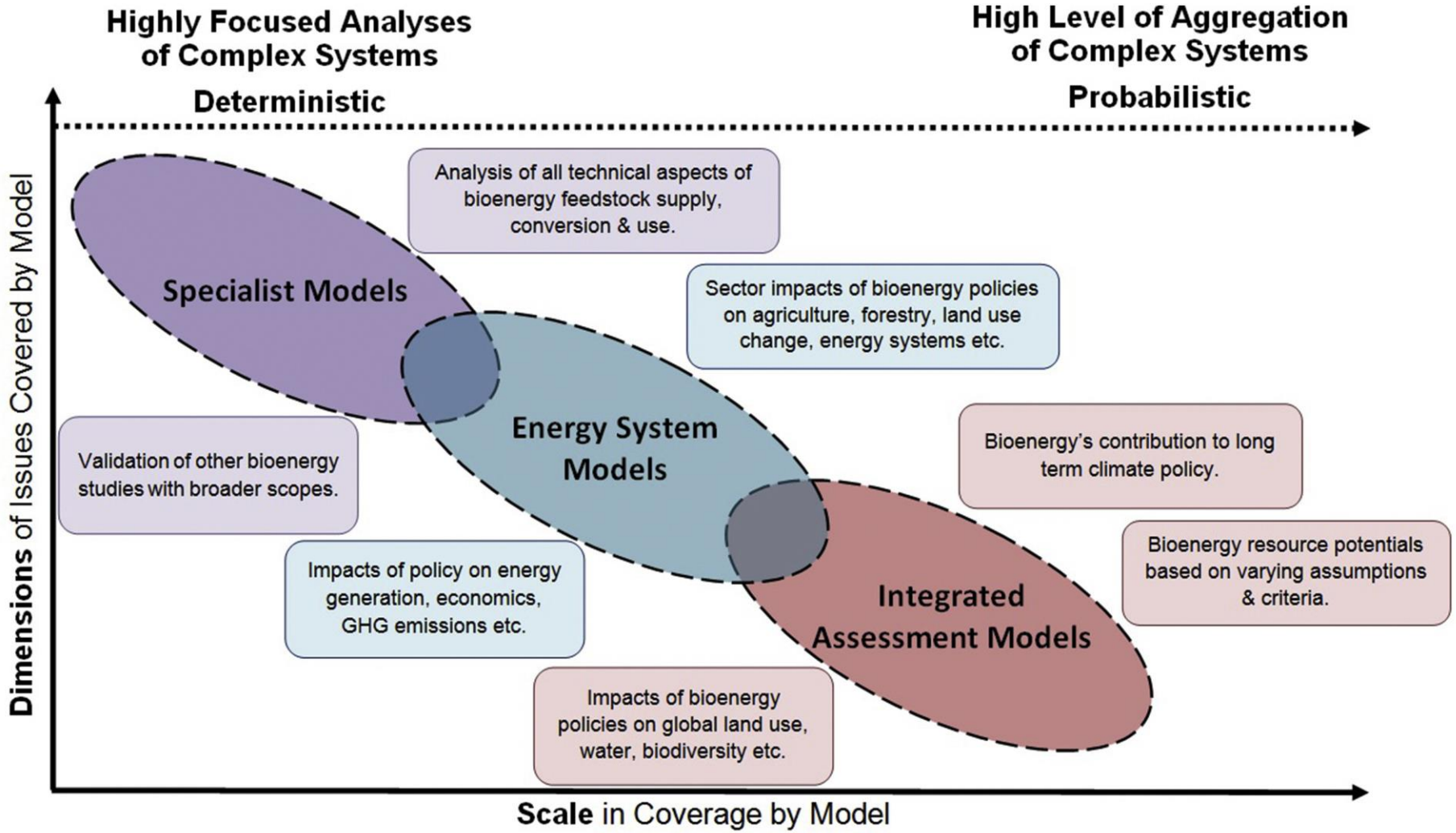
- ❑ GHG and other impacts and their drivers
- ❑ Incumbent and other alternatives
- ❑ Nonlinearities
- ❑ Consequential effects
- ❑ Economic considerations



Gerbrandt et al. 2016

DIVERSITY OF MODELING LEVELS AND RESULTS

- Modeling results report large ranges of potential contribution of bioenergy/bioenergy with carbon capture and storage by 2050
- Gaps in all levels of modeling



Welfle et al. 2020

UNIVERSITY OF TORONTO

Panelist

Edmund Mupondwa

AAFC Saskatoon R&D Centre and University of Saskatchewan

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

University of Saskatchewan

Scaling Up Agri-based Feedstocks for Clean Energy and Bioproducts in Canada

By

Dr. Edmund Mupondwa, Ph.D., MBA

Bioproducts and Bioprocesses
Saskatoon Research and Development Centre
Science and Technology Branch, AAFC, Government of Canada.
and
Department of Chemical and Biological Engineering
University of Saskatchewan

Midterm forum of the project "*Biomass and carbon neutrality: putting in place an evaluation framework*", organized by the Institut de l'énergie Trottier, Institut de l'énergie Trottier, Polytechnique Montréal.
National Arts Centre, Ottawa

February 13, 2024

Canada

Sustainable Production and Integration of Agri-based Biomass

- Only a certain quantity can be removed and used for bioenergy and biproducts.
- Impact on soil productivity, soil carbon, soil erosion
- Tillage system
- Early modelling
- AAFC BIMAT (Biomass Inventory Mapping and Analysis Tool)
- 1G, 2G, 3G.
- Dedicated bioenergy crops (Switchgrass, Miscanthus, SRC (Willow, Poplar)

Fig. 3. Average available crop residues removed from land in Canada

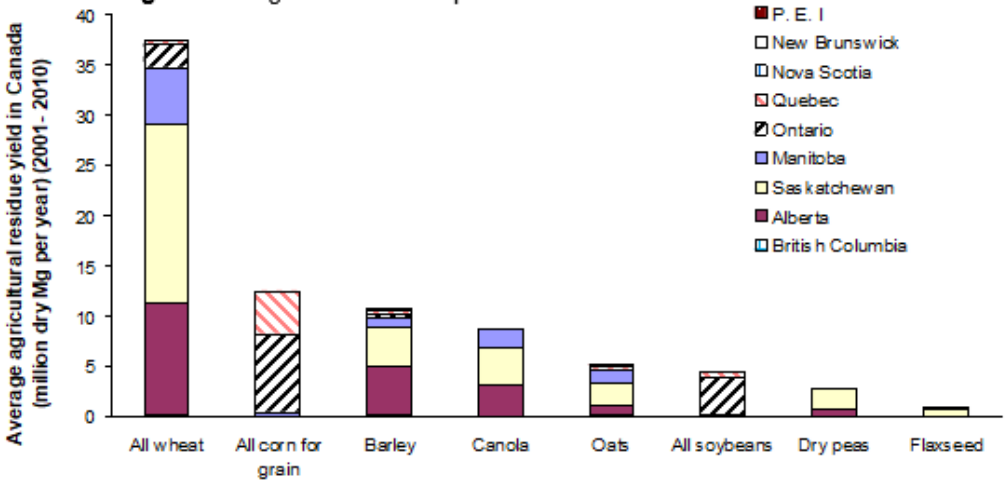


Fig. 9. Average crop residue yield by soil zone in Saskatchewan

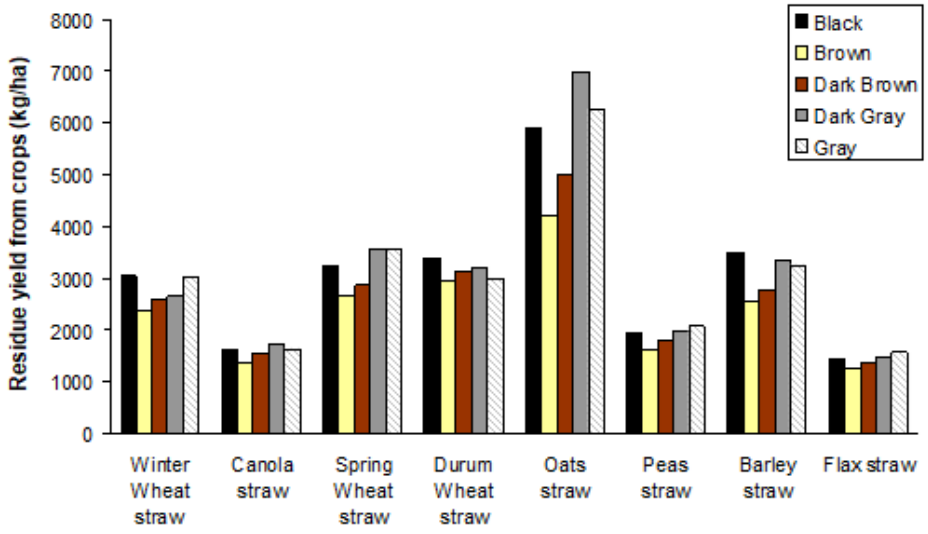
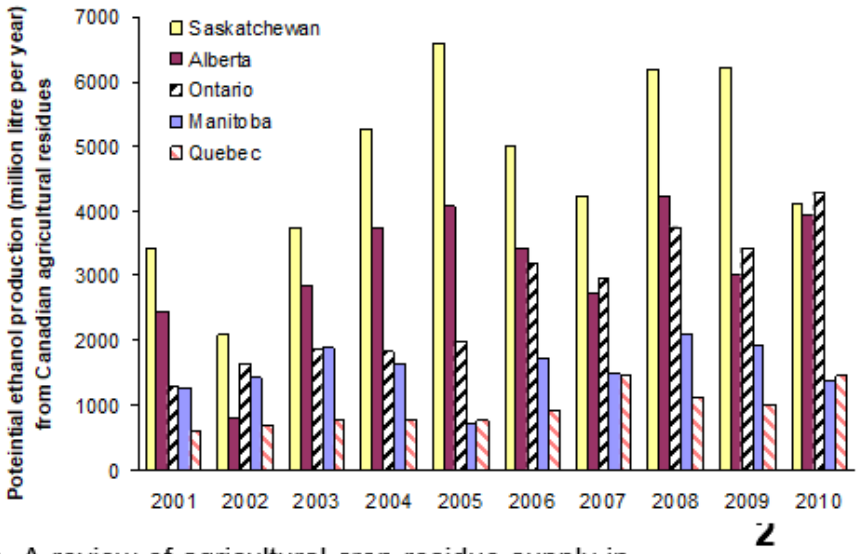


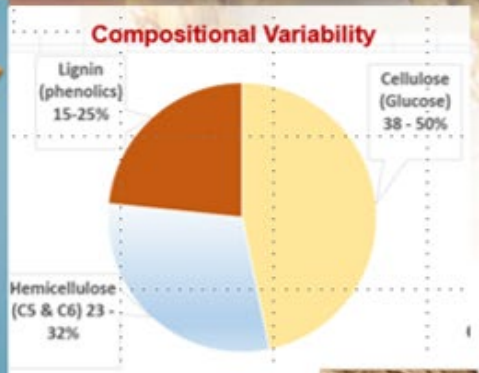
Fig. 11. Potential ethanol production from agricultural residues in Canada

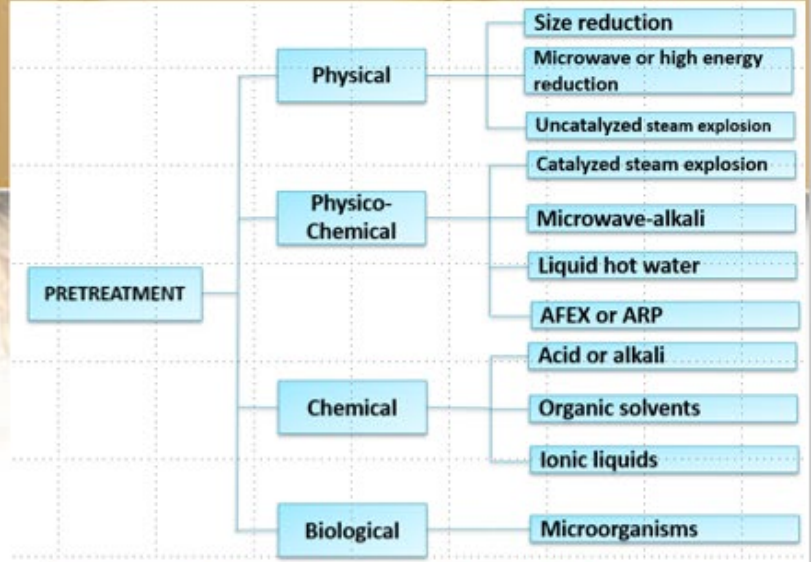


Li, X., **Mupondwa, E.,** Panigrahi, S., Tabil, L., Sokhansanj, S. 2012b. A review of agricultural crop residue supply in Canada for cellulosic ethanol production. *Renewable and Sustainable Energy Reviews*, **16**(5), 2954-2965.

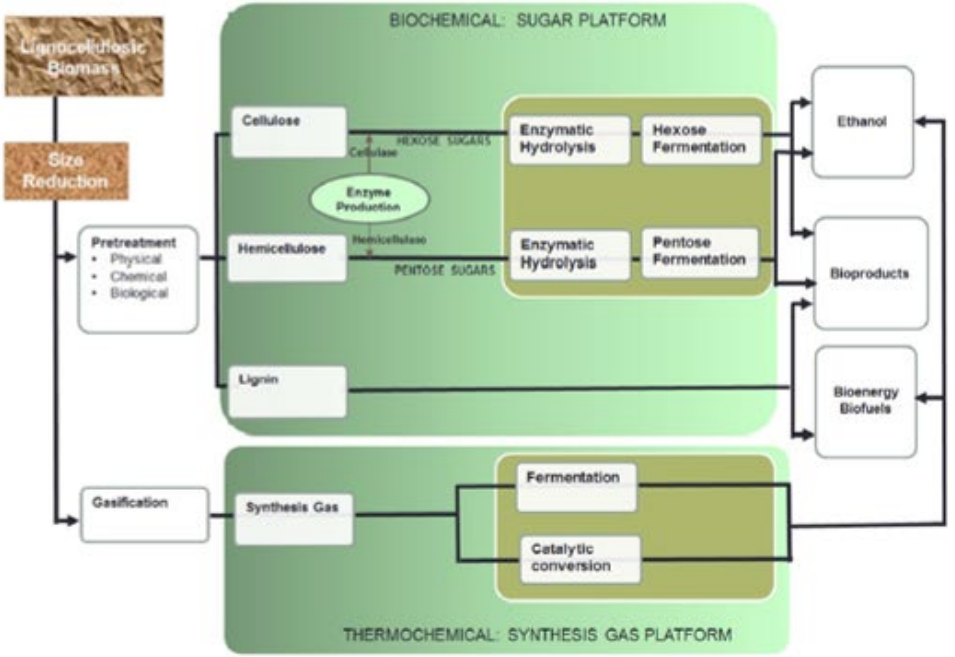
Scaling up Conversion Pathways: Biomass-to-Biorefinery and Circular Economy

Bulk Density, Complex Cell-Wall, Pretreatment, Logistics, TEA., LCA





Mupondwa, E., Li, X., Tabil, L., Sokhansanj, S., Adapa, P. 2017. Status of Canada's lignocellulosic ethanol: Part I: Pretreatment technologies. *Renewable and Sustainable Energy Reviews*, 72, 178-190.



Alizadeh P, **Mupondwa E**, Tabil LG, Li X, Cree D. 2023. Life cycle assessment of bioenergy production from wood sawdust, *Journal of Cleaner Production* (2023),

Mupondwa, E., Li, X., Tabil, L., Phani, A., Sokhansanj, S., Stumborg, M., Gruber, M., Laberge, S. 2012. Technoeconomic analysis of wheat straw densification in the Canadian Prairie Province of Manitoba. Bioresource Technology, 110, 355-363.

Alizadeh, P., Dumonceaux, T., Tabil, L.G., **Mupondwa, E.**, Soleimani, M., Cree, D. 2022. Steam Explosion Pre-Treatment of Sawdust for Biofuel Pellets. *Clean Technologies*, 4(4), 1175-1192.

Olughu, O.O., Tabil, L.G., Dumonceaux, T., **Mupondwa, E.**, Cree, D. 2021. Comparative study on quality of fuel pellets from switchgrass treated with different white-rot fungi. *Energies*, 14(22).

Agu, O.S., Tabil, L.G., **Mupondwa, E.**, Emadi, B. 2021. Torrefaction and Pelleting of Wheat and Barley Straw for Biofuel and Energy Applications. *Frontiers in Energy Research*, 9.

Dao, C.N., Tabil, L.G., **Mupondwa, E.**, Dumonceaux, T. 2023. Microbial pretreatment of camelina straw and switchgrass by Trametes versicolor and Phanerochaete chrysosporium to improve physical quality and enhance enzymatic digestibility of solid biofuel pellets. *Renewable Energy*, 217.

Onyenwoke, C., Tabil, L.G., Dumonceaux, T., Cree, D., **Mupondwa, E.**, Adapa, P., Karunakaran, C. 2022. Investigation of Steam Explosion Pretreatment of Sawdust and Oat Straw to Improve Their Quality as Biofuel Pellets. *Energies*, 15(19).

Alizadeh, P., Tabil, L.G., **Mupondwa, E.**, Li, X., Cree, D. 2023. Technoeconomic Feasibility of Bioenergy Production from Wood Sawdust. *Energies*, 16(4). 1914.

Mupondwa, E., Li, X., Tabil, L., Sokhansanj, S., Adapa, P. 2017. Status of Canada's lignocellulosic ethanol: Part II: Hydrolysis and fermentation technologies. *Renewable and Sustainable Energy Reviews*, 79, 1535-1555.

Mupondwa, E., Li, X., Tabil, L. 2017. Large-scale commercial production of cellulosic ethanol from agricultural residues: A case study of wheat straw in the Canadian Prairies. Biofuels, Bioproducts and Biorefining, 11(6), 955-970

Panelist

Stefan Pauer

Clean Energy Canada

Track the energy transition

Each Monday we publish the Clean Energy Review, a free weekly digest of must-read climate and clean energy stories from across Canada and around the world.

For follow-up questions, contact:

Dr. Stefan Pauer
stefan@cleanenergycanada.org

Bioenergy at the global level

Globally	IEA (NZE)	IPCC (NZ scenarios)
2050	100 EJ	200 (median) to >300 EJ
Growth compared to 2020	***>50%***	***>200-350%***

Bioenergy at the global level and in Canada

Globally	IEA (NZE)	IPCC (NZ scenarios)
2050	100 EJ	200 (median) to >300 EJ
Growth compared to 2020	***>50%***	***>200-350%***

Canada	CER (NZ scenarios)	CEC (NZ scenario)
2050	1,100-1,200 PJ	1,000-2,700 PJ
Growth compared to 2019	***>45-50%***	***>30-250%***

Panelist

Nazim Sebaa

Industrial Gas
Users Association

CHALLENGES FACED BY INDUSTRIAL IN MEETING THEIR TARGETS

Reinventing industrial processes is a highly complex process requiring investments in range of hundreds of millions or even billions

1- Two opposing visions

Industrial have a vision in terms of reducing their GHG emissions, while distributors and governments have a volumetric vision of energy.

2- Electrification of industrial processes to reduce GHG emissions

Electrifying the industrial process is either impossible (chemical process) or very complex to implement (major change in industrial process, availability of energy, etc.)

3- Keeping industries competitive.

In addition to major CAPEX, alternative energies are generally more expensive, increasing operating costs compared to other regions.

The energy transition must continue to ensure that the competitiveness of the economy is maintained and strengthened. **Industry must be seen as a strategic asset in our economy.** Access to reliable, competitive energy is vital.

IGUA | ACIG

INDUSTRIAL INTEREST IN BIOGAS AND RNG

1- An option for decarbonizing processes

RNG and biogas represent one of several options for reducing GHG emissions. The industry relies on a portfolio of solutions and not a single option or energy to decarbonize its emissions.

2- A viable substitute for fossil natural gas

By viable substitute, IGUA needs a natural gas substitute that meets, among other things:

- The needs of the industrial processes for which it is used for

  Biogas especially RNG can be used as a direct substitute to fossil gas, blending as we transition, utilizing existing infrastructure and industrial processes.

- Availability requirements

  Based on available data, there will not be enough RNG to substitute all industrial gas load, but when available it represents a good option

- Cost-effectiveness requirements

  Biogas represent an interesting option for decarbonization

  Do not require any additional investment to distribute these gases. Existing distributor assets enable distribution, The cost of RNG can be offset by its environmental value (**its carbon intensity**)

3- Under some condition

- Carbon intensity (CI score)
- Book and claim

IGUA | ACIG

CARBON INTENSITY AND ENVIRONMENTAL ATTRIBUTE

1- Importance of having a CI score register for available biomethane

- For heavy industry, the appeal of RNG lies in its ability to offer a viable solution for reducing GHG emissions. This appeal is conditioned by the establishment of a carbon intensity registry so that industries can establish their GHG reduction and decarbonization strategies most effectively
- RNG distributed by suppliers has a carbon-neutral profile. It takes 20 GJ of RNG to reduce one ton of emissions, while RNG having a carbon intensity of -0.25 TeqCO2/GJ, it would only take 4 GJ of RNG to reduce one ton of CO2 emissions

2- Book and claim

- Another avenue that could be considered to allow the full potential of the RNG sector would be the implementation of mechanisms allowing for the separation and exchange of the environmental attribute of RNG. This market mechanism would primarily aim to facilitate compliance with decarbonization goals

Nazim Sebaa / nsebaa@igua.ca

Scaling up bioenergy systems

Heather MacLean

University of Toronto

Edmund Mupondwa

Saskatoon Research and Development Centre, and University of Saskatchewan

Stefan Pauer

Clean Energy Canada

Nazim Sebaa

Industrial Gas Users Association