

The Future of Biofuels

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Biofuels in Canada Today

Grain-based ethanol and biodiesel:

Concerns:

- *Competition for food crops:*
 - *high food prices;*
 - *potential for regional and global food shortages;*
- *Limited production potential, esp. in Canada;*
- *Environmental costs (biodiversity, water use, herbicides/pesticides);*
- *Insufficient benefits for climate change or rural economy.*

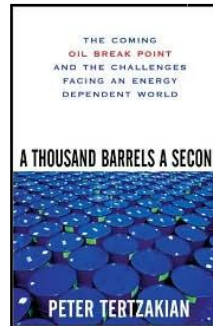
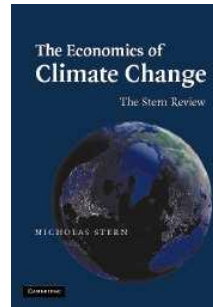


So why biofuels / bioenergy?

Why Bioenergy / Biofuels?

Official Gov't of
Canada 'Drivers'
in March 2008

What Canada's
Biofuel Policy
'Drivers' Should be.



Rural Economy

- New markets for agricultural and forest products

Climate Change

- Reducing GHG emissions

Energy Security

USA's #1
'driver'



- Rapidly rising FF prices;
- Global supply-demand issues;
- Political disruptions in supply

The 'Drivers' determine Policies and Programs.

We need to get it right!

Canadian Energy Flow

(NRCan 2006)

1. Canada is a major energy producer & user:
• Produce 25.4 EJ/yr, Use 12 EJ/yr

Primary Energy Use: 12 EJ/yr

3. GHG Emissions (kg CO₂/GJ)

56

100

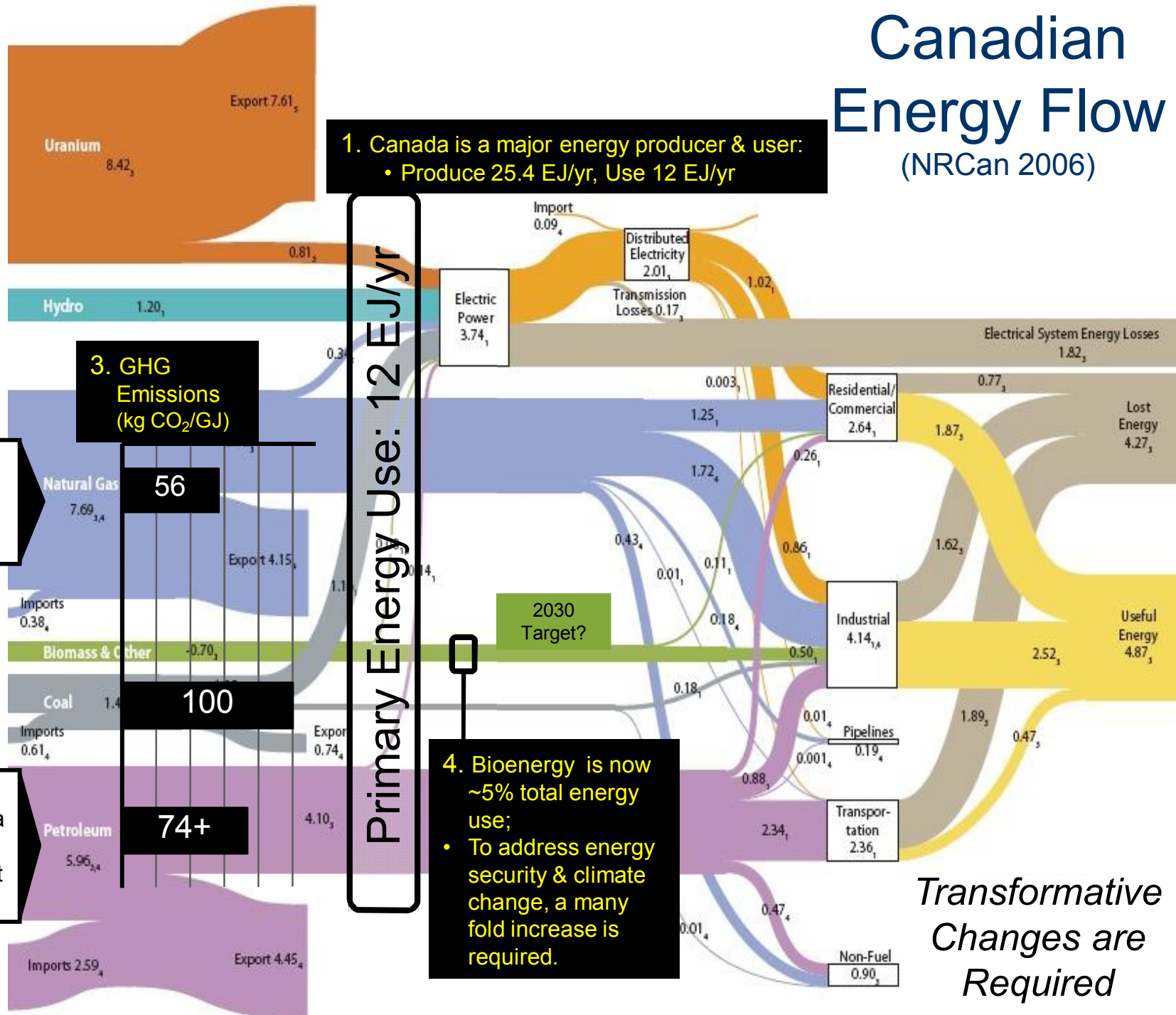
74+

• Declining Canadian Natural Gas Production

2. Energy Security Concerns

• Global Oil Supply/Demand
• Env footprint of oil sands

4. Bioenergy is now ~5% total energy use;
• To address energy security & climate change, a many fold increase is required.



Transformative Changes are Required

Bioenergy Potential - Mt(dry) biomass/yr

Canada's Total Primary Energy Demand (12 EJ/y)

12

EJ/y

8

4

0

Potential for Sustainable Biomass Production

To supply 20% of Canada's energy needs by 2030 requires the sustainable use of Agric/Forest residues **PLUS** a ~50% increase in Agric/Forest production.

Energy Content of Canada's Current Forestry & Agriculture Production (165 Mt/yr)

Corn
Hay
Wheat
Que
BC

Ag.
For.

Aggr-
essive

Conser-
vative

Biomass Crops

Silviculture/ Forest Mgmt

Pest/Disease Residue

Fire Residue

Unused AAC

Forest Harvest Residues

Mill Residues

Crop Residues

Manure

MSW

Proposed 2030

Target:

- 20% of energy use
- +2 EJ/yr (~1M boe/d)
- +130 Mt(dry)/yr

New Biomass for
Energy Prod'n

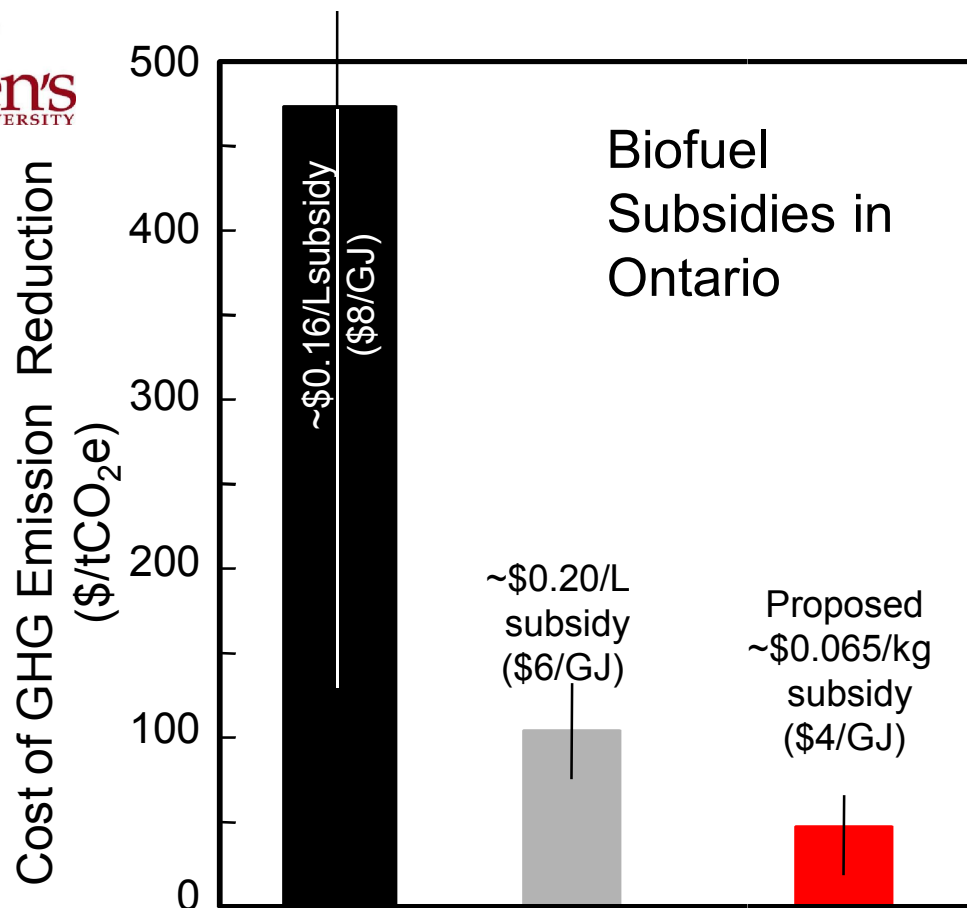
Existing
residues etc.

Existing bioenergy
(~5% Ttl energy)

What is the best way to use our biological resources:

- To address **climate change** priorities?
- To address priorities for both **climate change** and **liquid transportation fuels**?





Optimal Use of Biomass to Address Climate Change

Refs:

Robinson et al 2003; Layzell et al. 2006; Kampman et al. 2006; Zhang et al 2007; Samson et al. 2008

If climate change is the major driver, Wood/Straw Pellets would be the biofuel of choice.

Solid Biofuels: *Energy Comparison*

*Thermal Energy
Content:*

Crude oil: ~\$20/GJ (at \$122/boe)
Natural gas: ~\$11/GJ
Coal: ~\$3-4/GJ



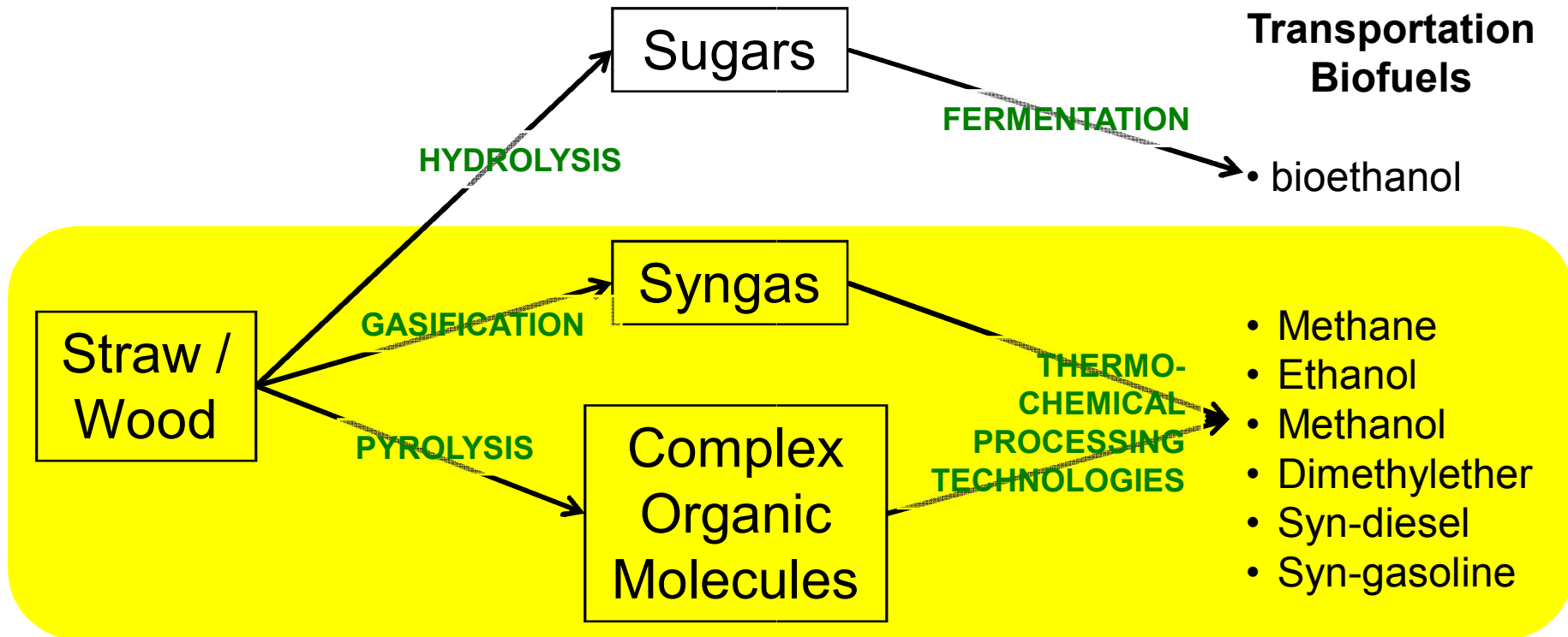
\$3 to 6 / GJ

\$7 to 9 / GJ

*Improved handling, transportation
& integration into FF sector.*

*We have - in place today – virtually all of the technologies for the
sustainable production & use of solid biofuels to replace coal*

Straw / Wood Can also be Converted into Transportation Fuels

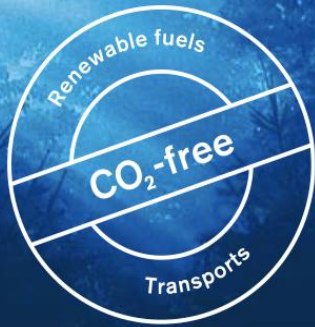


Biomass to Liquid (BTL) technologies are emerging as the ones with the most promise.

Optimal Liquid Biofuels

- ✓ Energy Security
- ✓ Climate Change

Climate issues in focus



VOLVO

August 2007;
<http://www.volvo.com>

Feedstock

Rapeseed
Sunflower

Rapeseed oil
Sunflower oil

Process

Esterification

Fuel

Biodiesel

Wheat
Sugar beet
Straw

Hydrolysis &
fermentation

Ethanol

Waste wood
Farmed wood

Gasification

Hydrogen

Organic waste
Sewage
Manure

Anaerobic
digestion

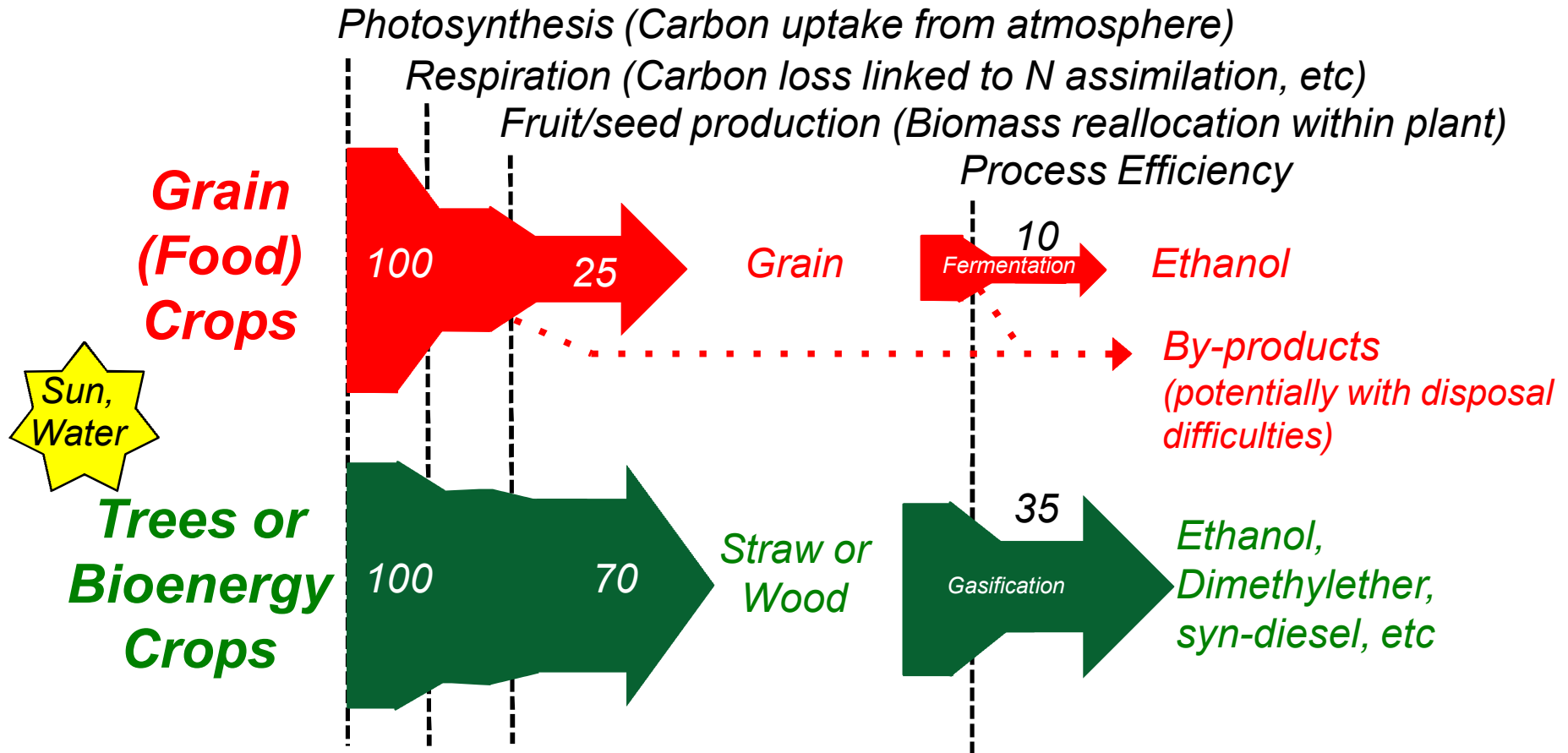
Dimethylether
Methanol
Synthetic diesel
Biogas

Fuels available from different feedstocks.

Over 7 Criteria (including climate benefits, land use efficiency, integration with fossil fuels) these BTL fuels tended to have the highest ranking.



Why Straw/Wood Feedstocks are Better than Grains for Biofuels.



Production & thermo-chemical conversion of biomass feedstocks with low nutritional value should give the greatest km/ha.



*What kind of
**Transformative Bioenergy
Systems** will Canada need
to deliver on a renewable
Biomass energy target of
130 Mt biomass / yr?*

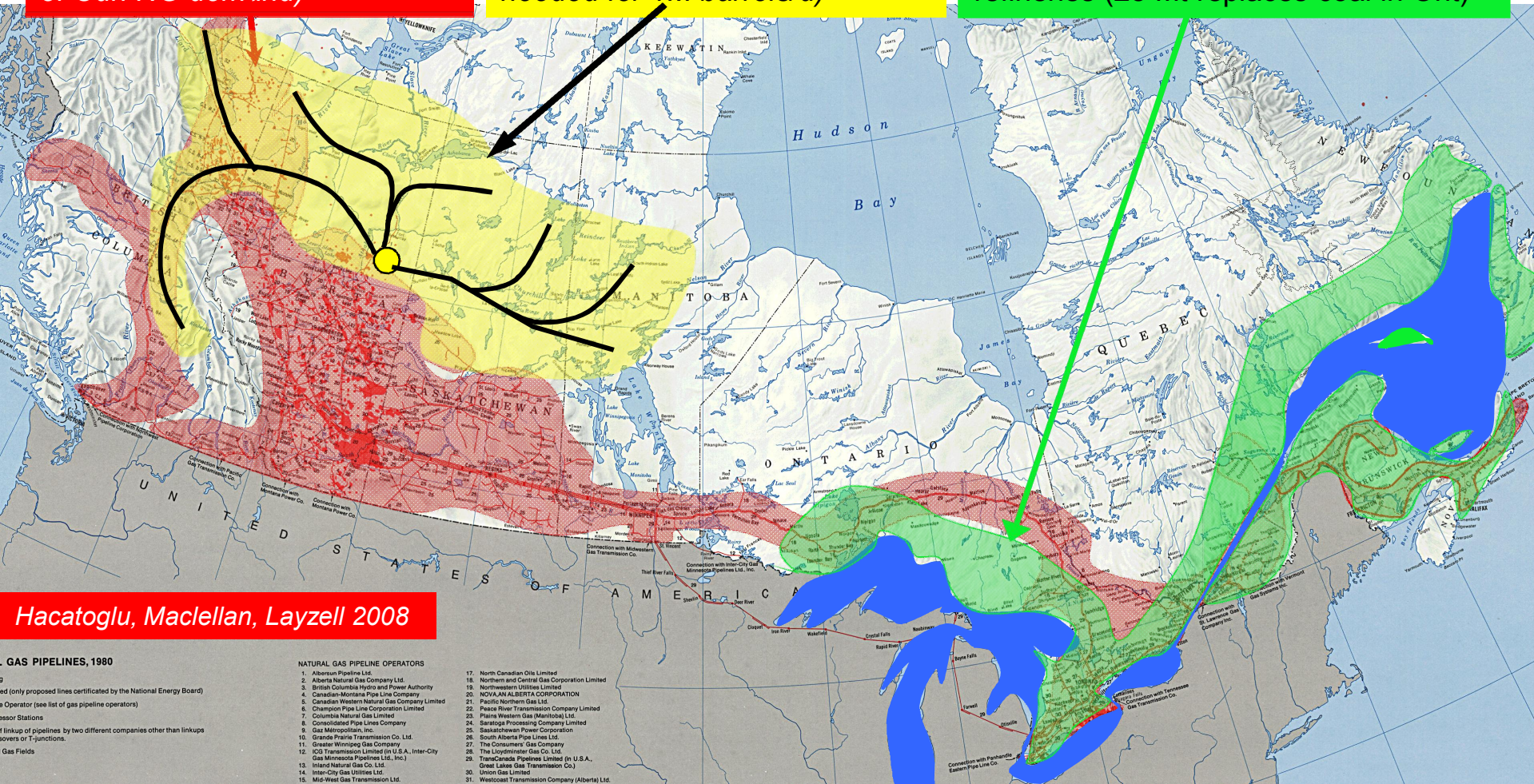


Examples of Transformative Bioenergy Systems

Example 1. Create Bioenergy Corridor around NG pipelines.
Convert biomass to bio-SNG.
(200Mt/yr could provide 60+% of Cdn NG demand)

Example 2. Pipeline solid biofuels to Oil Sands as energy for extraction and upgrading. (15 Mt replaces the 8 Bm³ NG needed for 1M barrels/d)

Example 3. Use Great Lakes / St Lawrence shipping to connecting biomass production with industrial demand for coal power, cement & oil refineries (25 Mt replaces coal in Ont)



Conclusions

1. Canada has vast biological resources that could be used to address climate change / energy priorities;
 - *Policies are needed to align with these drivers;*
 - *Major opportunity for rural economic development*
2. Solid biofuels replacing coal give best climate benefit;
 - *Incentives/standards are needed;*
3. BTL biofuels have the high 'km/ha' needed to address energy security & CC priorities;
4. We need Transformative & Sustainable Bioenergy Systems:
 - *Address transportation challenge;*
 - *Integrate forestry & agriculture with the fossil energy sector;*

University
R&D
can play a
key role