BIOMASS INNOVATION

Canada’s Leading Cleantech Opportunity for GHG Reduction and Economic Prosperity

Jamie Stephen, PhD
Managing Director, TorchLight Bioresources

Susan Wood-Bohm, PhD
Executive Director, AI Bio GHG Management
Alberta Program - Partnership between Alberta Innovates Bio Solutions and the Climate Change and Emissions Management Corporation (CCEMC)

- Funded 17 projects to date
- Reducing GHGs from agriculture, forestry, municipal waste; using biogenic carbon to reduce emissions from other sectors
ABOUT CCEMC

• Industry-sourced funds
• Funds innovative clean technology projects to reduce GHGs in AB
• >$320M invested in >100 projects with value of $2.2B; impact of 11Mt by 2020*
• Conference Board of Canada estimates >15K person-years of employment and $1.95B impact to AB GDP*

*Estimates from Conference Board of Canada
ABOUT CCEMC

- > $100M to advancing renewable energy, including support for renewable fuels*
- 24 biological projects (2MT reductions by 2020)*
- Other investment areas: energy efficiency, cleaner energy production, carbon use, adaptation and ccs

*Statistics correct as of May 31, 2016
Biomass from biological material

= only source of renewable carbon

Use biomass and biological systems to improve environmental outcomes

Bioenergy, Bioproducts, Biosystems
BIO CLEANTECH ADDRESSES IMMEDIATE NEEDS

• Reduce GHG emissions from largest & fastest growing sources
  ➢ Unique GHG profile: large, northern, resources
  ➢ Low electricity GHG intensity (avg)

• Utilize in existing carbon-based infrastructure
  ➢ Biomass = renewable carbon
  ➢ Blend with coal, NG, bitumen, fuels, chemicals
BIO CLEANTECH CREATES A COMPETITIVE ADVANTAGE

- **More jobs, builds on existing skills**
  - More operating jobs than wind/solar (10x)
  - Transferable skill sets from O&G

- **Cleantech, Biotech, Ag/ForestTech, High Tech**
  - Operating jobs today, new products tomorrow
  - Link resource mgmt with high tech = bioeconomy

- **Indigenous Economic Development**
  - Traditional knowledge of ecosystems
  - Major role in feedstock supply, market (esp. remote)

- **Competitive Advantage in Biomass**
  - Canada has most biomass per capita globally
  - Forestry AND Agriculture AND Urban
CANADA’S GHG EMISSIONS (2014)

Energy - Transport; 203
- Aviation; 7
- Road; 140
- Rail; 8
- Other; 43
- Navigation; 5

Energy - Fugitive Sources; 60
- Wastewater; 1
- Landfills; 27
- Incineration; 1

Energy - Stationary Combustion; 331
- Other; 4
- Residential; 46
- Commercial & Institutional; 31
- Manufacturing; 46
- Upstream Oil and Gas; 101
- Petroleum Refining; 17
- Public Electricity and Heat; 86

Energy - Stationary Combustion; 331
- Chemicals; 6
- Non-Energy Products from Fuels; 13
- Minerals; 8
- Metals; 15
- Other; 9

Industrial Processes & Product Use; 51

Agriculture; 59
- Livestock; 33
- Ag Soils; 23
- Fertilizers; 3

Waste; 29

732 Mt CO₂ eq

86/732 = 11.7%
GHG REDUCTION TARGETS

• Transportation (Canada’s Size)
  - Biofuels in existing infrastructure
  - Electrification for heavy duty trucking, rail, aviation, and marine highly unlikely in short term

• Space Heat (Canada’s Climate)
  - 50% of population = no NG
  - Biomass in existing heating systems: residential to city-wide district energy

• Process Heat, Carbon, & Baseload Electricity (Canada’s Resource Economy)
  - Thermal energy = oil sands, cement, steel
  - Carbon for reduction reactions = steel production
  - Baseload, deployable electricity for grid stability
BIOMASS IN INFRASTRUCTURE

1. Co-firing in Coal-fired Power Plants
2. Bioheat including District Energy
3. Liquid Transportation Fuels
4. Process Heat for Cement Production
5. Renewable Natural Gas in Pipelines
6. Biochar for Steel Production
7. Biocrude in Upgraders & Oil Refineries
1. Firing in Coal-fired Power Plants

- Drax (UK) converted 2,000 MW from coal to wood pellets
- All imported fuel (largely NA)
- Designed supply chain from scratch
- No previous biomass experience
2. Bioheat, including District Energy

- >85% efficient biomass heat in existing systems
- From individual residence to city-wide district energy
- Already deployed in many Canadian projects (e.g., UBC campus, OB) but small number compared to the potential
3. Liquid Transportation Fuels

- Cellulosic biofuels are now commercial
- DuPont commissioned 115 ML Nevada, IA plant in 2015
- US ethanol consumption now exceeds total gasoline consumption in Canada
4. Process Heat for Cement Production

- LafargeHolcim cement plant in Bath, ON is company worldwide test site for biomass fuels to reduce GHG emissions
- Can accommodate most types of biomass and waste
5. Renewable NG in Pipelines

- Biogas upgrading for NG pipeline injection is commercial
- Methanation of wood-based syngas and upgrading is at demo scale; City of Gothenburg, Sweden (GoBiGas)
- RNG can reduce GHG emissions in all NG applications (e.g., oil sands *In situ*)
6. Biochar for Steel Production

- Steel production requires reduction reaction (carbon) that MUST release CO$_2$
- Brazil has used biochar instead of coal-based coke at industrial scale for decades (e.g. ArcelorMittal)
7. Biocrude in Upgraders & Refineries

- Eni converted Venice refinery to renewable diesel (360 ML/yr)
- TOTAL converting La Mède (Marseille) refinery (600 ML/yr)
- Canada has unique upgrading infrastructure for biocrude
- Bio content in all downstream products (e.g., biojet)
ECONOMICS

• Low NG and Oil Prices are Challenging
  ➢ Markets volatile
  ➢ $2/GJ for NG, $30/bbl
  ➢ Enabling policy essential
  ➢ Ethanol industry – large cost decreases over time

• Avoid CapEx
  ➢ Fuel switching
  ➢ Existing infrastructure & fleet (fuel flexible)
  ➢ Competitive with greenfield fossil

• Energy is a Low Value Co-Product
  ➢ Primary = solid wood, grains, chemicals/ materials
  ➢ Oil refinery model - biorefinery
  ➢ Poor margins on fuels, great margins on low-volume
  ➢ Energy/primary product integration is key
SOCIAL IMPACTS

• High Quality Jobs
  ➢ 10x operating jobs
  ➢ Management of resources
  ➢ Urban & rural

• Leverage Existing Expertise
  ➢ Oil and gas recovery & processing
  ➢ Manufacturing
  ➢ Forestry & agriculture
  ➢ Urban energy management
  ➢ High-tech, biotech

• Export Potential
  ➢ Biomass worldwide
  ➢ Services in resource management & utilization
  ➢ Services in engineering & operations
  ➢ Technologies
  ➢ Bioproducts
BIO CLEANTECH FOR CANADA

• **Addresses Largest and Growing Emissions**
  - Unique GHG profile that needs a different approach
  - Thermal energy and transportation dominate

• **Use Existing Infrastructure and Expertise**
  - Power plants, upgraders, pipelines, transportation fleet
  - Chemical, steel, cement producers

• **New Markets for Sustainable Feedstocks**
  - 46% of world’s certified forests are in Canada
  - More biomass per capita than any other country

• **Clear Economic Benefits**
  - Public ownership of forest resources
  - Complements production of high value primary products: solid wood products, grain, etc.
  - Improve market access for other resources/products
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Jamie Stephen, PhD
Managing Director, TorchLight Bioresources
JStephen@TLBio.com

Susan Wood-Bohm, PhD
Executive Director, AI Bio GHG Management
Susan.Wood-Bohm@albertainnovates.ca
www.cceemc.ca