Bioeconomy: Global Vs. in Ontario!
Where are the bottle-necks in Innovations?

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December 7, 2011
Global Bioeconomy: Value-chain Alteration

How are we doing in Canada & in Ontario!

Where are the bottle necks?

Biomaterials: Wonder Materials (Biobased or Biodegradable!)

Discovery ≠ Innovation (Just “biobased” ≠ Sustainable)

Can we Re-fix!

What to Focus in Bioeconomy & How!

December 7, 2011
Canada scores a “D” in innovation

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<th>Report Card</th>
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<tr>
<td>Innovation</td>
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<tr>
<td>1 Switzerland</td>
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<td>2 Ireland</td>
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<td>3 U.S.</td>
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<td>4 Japan</td>
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<td>5 Sweden</td>
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<td>16 Italy</td>
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<td>17 Norway</td>
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Conference Board of Canada

Basis: Knowledge Production + Its transformation + Market share by Industries

Economic & Social Values: From Knowledge Discovery!

December 7, 2011

Courtesy & Reference: Bio Business, Summer 2010

Courtesy: C&EN, p. 36, Dec. 13, 2010
An Example: Let’s Talk on Education 1st!
Sole “Mantra” for Innovation

Where America stands now in education ?: Once tops in education
(Now: 31st in Math; 23rd in Science & 15th in reading)

Who are tops now?
- South Korea & Finland

Secret for such phenomenal growth:
- South Korea: Long hours in school ... (Hard working!)
  (Almost 2 more yrs in classroom over typical US schedule)
- Finland: Teachers & Teaching profession: Highly respected: Most brilliant brains enter in to Teaching Profession over Medicine and Law!

Ref. F. Zakaria, CNN; GPS Special: Fixing Education

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BioEconomy: Must help To Improve Life!

BioEconomy can NOT be realized through Technology Alone!

BioEthanol
BioDiesel
BioEnergy
Bio-Gas
Bio-Electricity
1, 3 Propane Diol
Lactic Acid
Biochemicals
BioFuels

BioMaterials
Packaging
Plastics
Plants

Car Parts
Building Products
Bio-/Green composites

Bioenergy: Must help To Improve Life!

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What is a Low-Carbon Economy? Why to Care? “Bio-C” Matters !!!

“C” in the form of CO₂: Major GHG (Green House Gas)
- Climate change… Global warming
- Raise: the temperature of earth & sea-level
- Affect our agriculture and eco-system

Use of bio resources (bio “C” – new carbon) unlike fossil fuel feedstock (petro “C” – old carbon)
- Help in reducing GHG
- Improve “Carbon Credit” (Emission reduction credit)
- Entering new economy – Emerging BioEconomy
- “Green Business” …Would inject ~ $1000 billion boost / yr …Global Economy
- To secure both Economic & Environmental Future

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Learning from Petroleum Refineries!

Petroleum Consumption

- Transportation Fuels: 70.4%
- Chemicals, Plastics, Rubber: 26%
- Other Fuels & Products: 4%

Revenues

- Transportation Fuels: $385 B
- Chemicals, Plastics, Rubber: $135 B
- Other Fuels & Products: $375 B

Ref.: Todd Werpy, Presentation at World Congress on Industrial Biotechnology, Montreal, 2009

Biomaterials & Biochemicals: Quite Significant
Revenue: Emerging Bioeconomy

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Value-Chain Alteration: Single to Multiple

**Current**

- **Edible Crops** (Soy/Rape/Corn)
  - Unidirectional
  - Biofuel
  - Bio-Fuel

**Future**

- **Non - Edible Crops** (Jatropha/Algae/Switchgrass)
  - Diversified
  - Bio-refinery
  - Bio Fuels
  - Bio Chemicals
  - Bio Materials
  - Nano-materials

**Raw Materials**

**Technology**

**Products**

**Rising Sustainability**

**Single Product Strategy**

**Multiple Product Strategy**
“Wastes” or Undervalued Coproducts of One Manufacturer As Raw Material For Another Industrial Products (Value-Addition)

Lignin
(Cellulosic Ethanol Industry)

Crude Glycerol
(Biodiesel Industry)

DDGS or Distillers’ Dry Grains
(Corn Ethanol Industry)

Soy Sediment
(Soy Oil Industry)

Soy Meal
(Soy Oil Industry)

Canola Meal
(After Grinding to Oil)

Lignin
(Paper Industry)

Lignin
(Paper Industry)
Plastics & Sustainability: Urgency!

Sky-rocketing Oil Price + Climate Change (Water-Food-Economic Downturn) + Population Growth (7 billion!)

Aggressive Move: Sustainability in All Forms

Dialogues on Plastics & Sustainability

- Waste & Resource Management
- Energy & Oil Price
- Climate Change & Carbon

Search for Alternatives: Energy to Plastics (A common consensus now!)

Ref.: S. Odwerwald, Plastics Engineering, Feb. 2011

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Biochar Production & Application: Pyrolysis (Biofuel, Bio-oil & Biochar)

Eco-fertilizer application in soil

Courtesy: Prof. R. Navia, U of La Frantera, Chile

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BioCarbon In Biomaterials: A Strong Future In Bioeconomy

Agro Residues → LIGNIN → Carbon nanostructures → Polymer nanocomposites

Pyrolysis → BIOCHAR + Plastic → Injection Molding → Automotive Parts

Renewable Bio-Carbon

Bio-Carbon Nanostructures → Bioplastics, Carbon Fibre, CARBON FIBER BIO-COMPOSITE

High voltage Power Supply → Lignin+ Polymer Solution → Collector → SEM image of Lignin Fibre
The “White Pollution”

5.3 billion mobile phones in 2010 = 77% of the world population


[http://maps.grida.no/go/graphic/cell_phone_composition](http://maps.grida.no/go/graphic/cell_phone_composition)
Bioproducts Industry in Canada!

- Not realised to that extent even-if we have resources! (Strong Industrial sector; Scientific Excellency & Biomass)

- Biomass Resources: Agricultural & Forestry (Overall Trend: Greater use of Agri-biomass)

- R&D is Vital: Innovation (Is R&D funding in this subject area adequate!)

- An Example: Biomaterials: Mostly through SMEs!

- Are SMEs are Funded/Encouraged Adequately!

- We need “Bio-preferred Initiative” here in Ontario!

Ref.: Sparling, Chenny & Cranfield, 2011

- University R&D is deeply Required Towards BioEconomy
- True collaboration is Needed: SMEs & University R&D
- Innovation: Can not be achieved through tech. alone
- Technology Development: *Around the “Supply Chain”*
- University R&D: Must be disseminated to Public (Peer-review Publications!)
- University R&D: Truly to be encouraged *for Innovation*
- How? New IP strategy! *Continuity*: In New Materials

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Bioproducts Discovery & Development Centre (~ 3 Years Old!)

- **R&D Funding**: Peer-Reviewed Competitive Grants
- **Collaborations (Progress / Development)**:
  - **Industries**: 25 (~9 SMEs)
    - National Univs.: 9
    - National labs.: 2
  - **International**:
    - USA (3); UK (1); China (2); Chile (2);
    - India (5);
    - Sweden (1)
    - Mexico (1)
- **HQP Trained/Under Training**: 55
- **Peer-Reviewed Publications**: 46
- **Conferences**: ~ 35
- **Keynotes/Invited**: ~ 25
- **HQP Awards**: 12
- **Tech. Transfer**: 1
- **Patents Applied**: 2
- **Extensive Outreach**

**Vision**

- **Develop R&D- to Enable**
- **Produce greener Bioproducts substitute Non-Renewable Materials**
- **Explore ways to add value to Agricultural residues, Biofuel Co-products & Forestry products**

**Auto Parts, Consumer products, Packaging & Buildings**

**Biomaterials: Focus**

**Ontario to become world leader in**
“Canada turns back on Kyoto commitment despite Chinese offer” The Canadian Press: December 5, 2011

“….Canada will spend a total of $1.2 billion as part of an international “fast-start” plan to help poor countries with their climate change efforts.”

Inevitable Economic shift to Green or Bioeconomy: Globally

Two Choices for BioEconomy (Technological Society):

➢ To **Wait** until **catastrophic failures**

➢ **Correct us:** **Prevention** **prior to catastrophic failures**!

Courtesy & Ref.: R. K Pachauri, IPCC

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