PASSMORE GROUP Inc.

Ottawa Washinghton Toronto

THE BIOREFINERY OPPORTUNITY: REAL OR IMAGINED?

Presentation to:

Carleton University's Sustainable Energy Master's Program, the Carleton Research Unit in Innovation, Science and Environment (CRUISE), the Carleton Sustainable Energy Research Centre (CSERC)

What is a “biorefinery?”

Biorefineries: **Co-production** of fuels, chemicals,

power and materials from **biomass**

The **sustainable** processing of biomass into a

spectrum of marketable products and energy

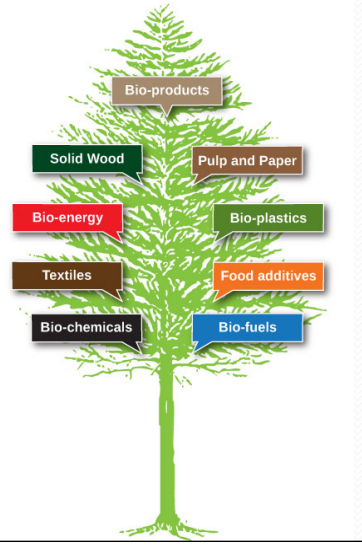
– The International Energy Agency (IEA) Task 42

Note: Competition for biomass material

What is a “biorefinery?”

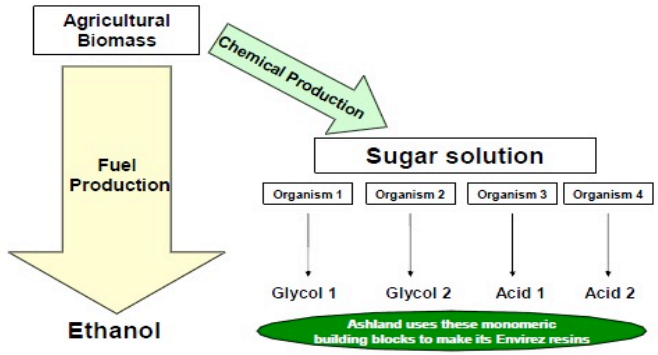
– Courtesy of the Forest Products Association of Canada

- Traditional forest products
  - Lumber and engineered wood products
  - Pulp, paper, and packaging
- Bioenergy
  - Biofuels, pellets, CHP
- Biochemicals
  - Intermediate chemicals, solvents, lubricants, plasticizers, etc
- Biomaterials
  - Composites, building systems



What is a “biorefinery?”

Vision for Chemical Production at an Ethanol Biorefinery



- Ashland does not intend to build or operate a biorefinery, but we represent a strong downstream channel-to-market partner for bio-based chemicals.

What can “biorefineries” make?

Think of it this way:

Most of the consumer products we use today could be made from carbohydrates (biomass) instead of from hydro carbons (fossil fuels):

- plastics
- cosmetics/fragrances
- paints
- adhesives
- insulation
- rubber
- textiles
- diapers
- solvents
- lubricants
- renewable fuels
- drop-in “renewable gasoline”

What is the market size for “biorefineries”?

GROSS MARKET OPPORTUNITIES

Products	Annual Growth Rate (%) 2009-2015 (approximate)	Global Market Potential 2015 (US$ billion)
Green chemicals	5.3	62.3
Alcohols	5.3	62.0
Bio-plastic and plastic resins	23.7	3.6
Platform chemicals	12.6	4.0
Wood fibre composites	10.0	35.0
Glass fibre market	6.3*	8.4
Carbon fibre	9.5	18.6
Canadian forest products industry	neg. to O-2	50.0

References:
Markets and Markets. 2009. Global Renewable Chemicals Market. The Freedonia Group. 2009. World Bioplastics. Industry Study 2548. Lucintel. 2009. Global Glass fibre Market 2010-2015: Supply, Demand and Opportunity Analysis. Acme Market Intelligence. 2010. World Carbon fibre Composite Market.
* CAGR for 2010-2015

Source: Natural Resources Canada (NRCAN) and Industry Canada (IC)

By comparison: Global crude oil and liquid fuels market in 2010 – $2.5 trillion

– US Energy Information Administration

(Canadians spend ~$45 billion/yr purchasing gasoline)

Biorefinery status report

- Lots of research and piloting; lots of young start-ups
- Some renewable fuel and renewable chemical demonstration plants operating (Europe, Canada, US)
- No commercial facilities exist but three? under construction (Canada, US, Italy)
- Initial thrust was to turn biomass into a renewable fuel
  - governments established targets (100% political market)
- This thrust contemplated building 50 – 100 million gallon multi-hundred million dollar facilities
- Raising that kind of capital post 2008 (when the technology was maturing) has proven a significant challenge
- One can do more with biomass derived sugars than distill them into renewable fuels
- Emerging technologies can turn those sugars into a host of

What "get-to-market" challenges do we face?

Large scale, fully integrated biorefineries are very expensive:

- $400 – 700 million
- capital like that only comes from large companies with deep pockets
- such `strategic` investors have competing investment opportunities
- the average credit quality of first-of-kind 'commercial' biorefineries

  is below investment grade (not even BBB)
- in many countries, the fuels component of a biorefinery is mandated

  BUT:
- strategics fear change of law that will strand their investment

What to do?

- build smaller facilities that 'bolt on' to existing plants?
- include production of chemicals along side production of

To build BIG or not – the trade-offs

Renewable fuels = high volume markets, low financial returns.
Renewable chemicals = low volume markets, better returns

If "integrated biorefineries" are too big and expensive, is the solution:

- build smaller plants making products with higher margins?

If yes:

- how big is the market for high margin products and when does that market become saturated?
- what are the trade-offs between economies of scale and available biomass feedstock material?

If we build facilities making both chemicals and fuels:

- can we thereby produce the first billion gallons of Cellulosic Ethanol (CE)

Who's playing in bio-based chemicals?

Strategics:	Approximate annual sales:
Ashland Inc.	– $8 billion
DSM	– euro 10 billion
Sud-Chemie	–euro 7 billion
Huntsman Corporation	– $10 billion
Dow Wolff Cellulosics	– $60 billion (Dow)
Procter & Gamble	– $82 billion
Coca Cola	– $?
Ford Motor Company	– $128 billion
Domtar	– $6 billion
Etc.	

Who's playing in bio-based fuels?

Strategics:	Approximate annual sales:
General Motors	~$135 billion
Honda	~$100 billion
Dupont	~$30 billion
Shell	~$400 billion
British Petroleum	~$300 billion
Total	~$?
Exxon Mobile	~$475 billion
Chevron	~$200 billion
Valero	~$82 billion

Governments too are engaging in the Bio-Economy:

Canada – NRCan; AGCAN – Growing Forward
Alberta, Ontario
USDA Bio-Preferred Program

- **biopreferred labeling**
- **5100 products identified for preferred purchasing by federal agencies**

Why are these large strategics playing?

To give the market what it wants/needs – chemicals; transport fuels

Chemical Companies:

- A desire to reduce dependence on fluctuating oil prices
- Customer needs/consumer demand for renewable alternatives to petroleum based products (10 – 15%)
- To gain competitive advantage/to be world leaders/to create highly skilled jobs
- Pursuit of sustainability
- Looking for clean, inexpensive sugars

Oil Companies:

- Government mandates
- Competitive advantage/consumer preference
- Strategic fit
- Sustainability/climate change (Europe)

There will be no "green premium" for bio-based products

1] The (proposed) product has to compete on:
- price
- quality/performance/reliability
- customer satisfaction

2] There must be an attractive return on capital (or at least a very high likelihood of competitive returns) for the investors
- the investment will be judged on the same playing field as other competing capital and resource investment possibilities

3] No regulatory free pass – must get product approval

Why do technology companies need to partner?

To get to the next stage on the path to commercialization

- need $$$ (lots of it)

Channel to markets

Seasoned, real world advice

Do we have the biomass resource?

Globally – to get started on the first billion gallons – YES

Forest biomass can be pricey (unless it's from plantation)

Agriculture biomass is less pricey and easier to collect, but only about 30% of the resource is "available"

Canada (wheat, oats, barley, corn)	~40 mmt (straw & corn stover)
U.S. (corn and cereals)	~400 mmt (straw & corn stover?)
Europe (mostly cereals)	~60 mmt (mostly straw)
Total	~500 mmt at 30% = ~150 mmt

150 million tonnes of biomass will make several billion

Current status of fuel-focused biorefining

United States:
- 13+ billion gallons production mostly from corn
- Energy Independence and Security Act (2007)
    - 36 billion gallons by 2022 (16bg cellulosic target)
    - 15 billion gallon cap on grain ethanol
- ~One billion tons of fibre feedstock (USDOE/USDA)
- Blend wall reached (E10/E15/E85)

Brazil:
- ~7 billion gallons production from sugar cane
- world's largest exporter of fuel ethanol
- bagasse used to generate heat and power
- designated as "advanced biofuel" by US EPA
- qualifies under California Low Carbon Fuel Standard

(Together, the U.S. and Brazil produce 88% of the world's fuel

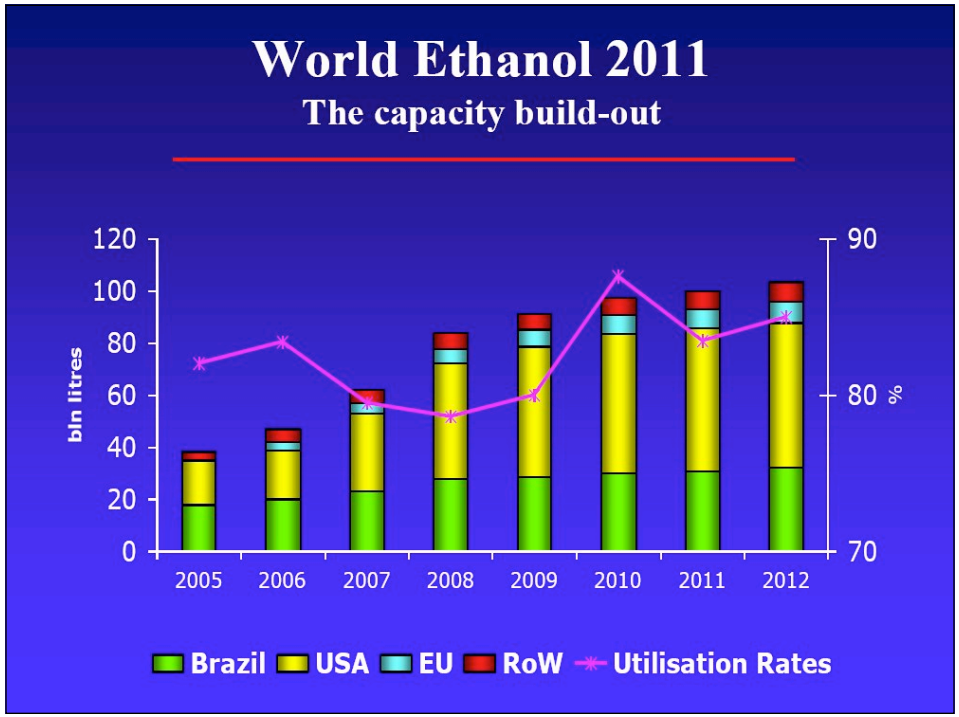
Current Status of fuel-focused biorefining

European Union:

- ~4.4 billion litres current production; 2/3 cereals (mostly wheat) 1/3 sugar beet
- EU-wide "binding target" calls for 10% GHG emissions reduction in transpor fuels by 2020 (Renewable Energy Directive, and Fuels Quality Directive)
- 2020 market size could be 13 - 15 bn litres.
- cellulosic feedstock availability could be an issue (most certainly for large biorefineries)

Canada:

- ~500 million gallons production (two billion litres)
- 5% mandate fulfilled (1.8 billion litres domestic production)
- no cellulosic set aside
- going to 10% (or an LCFS) will require an additional two billion litres
- should one billion litres of that be for advanced fuels?


World Ethanol 2011
The capacity build-out
bln litres
120
100
80
60
40
20
0
90
80
70
%
2005
2006
2007
2008
2009
2010
2011
2012
Brazil
USA
EU
RoW
Utilisation Rates

What about NextGen fuel-focused biorefining?

- √ High capital costs = project finance is elusive
- √ Technology not proven at commercial scale
- √ Needs market pull
  - some form of differentiation (green premium)
- √ Needs market push

From bright idea to consumer adoption – ~who pays?

- **Fundamental Research**
  - test tubes and beakers
- **Applied Research**
  - bench testing; ~2 – 20 litre vessels
- **Pilot Facility**
  - batch processing; ~500 – 1500 litre vessels
- **Demonstration Facility**
  - batch/continuous processing; ~100,000 – 200,000 litre vessels
- **Commercial Demonstration**
  - continuous processing of commercial volumes at 1 ~full scale plant
- **Commercial Rollout**
  - multiple full scale plants; material impact on markets

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What motivates various investor types?

- **Traditional lenders / Bank financing**:
  - risk averse
  - high loan thresholds for small $amounts
  - short term loans (to match short term Gov't policy / fear of change of law)
- **Venture Capital**: (Many young renewable fuels, and renewable chemicals start-up companies)
  - seed capital / binary bet = win all or lose all
  - accept risk – need high rates of return (early stage = 10x)
  - max out at ~$10 – $20 million (insufficient for commercialization)
  - exit strategy / time horizon (3 – 8 years)

  Going public / IPO: (Enerkem, Codexis, Gevo)
  - are you 'Capital Lite;' can you offer 16% – 18% returns?
  - is the market ready? (tougher IPO market today than one year ago?)
  - could become major distraction to technology development
- **Project Finance (equity & debt)**:
  - lower weighted cost of capital (10% – 15%) (pension funds, insurance funds)
  - need to provide performance/process guarantees/technology needs to be proven, or need a Government backed loan guarantee
- **Corporates / Strategics**: (Iogen, Inbicon, CelluForce, Codexis)
  - have large capital budgets, but they are committed to core business and ROI
  - Cleantech/biorefinery ROI not competitive with core business investments
  - low technology risk tolerance
  - need change of law protection / policy stability – have fear of stranded assets
- **Sugar Daddies**: (Chemtex)
  - longer time horizons

Do we really need the strategics?

To get started, PERHAPS not

To build a $multi-billion industry, YES

To achieve 16 billion gal of NextGen fuels requires $80 – $160 billion

To be internationally competitive in bio-refining, Canada and Canadian businesses need to invest $3 – $5 billion dollars in construction capital in the next 3 – 5 years

Those funds are not going to come from Banks, Angels or VCs

They are going to come from companies with deep pockets that are motivated to invest in Biorefining commercialization because that investment is **secure**, and

Is project finance really a problem?

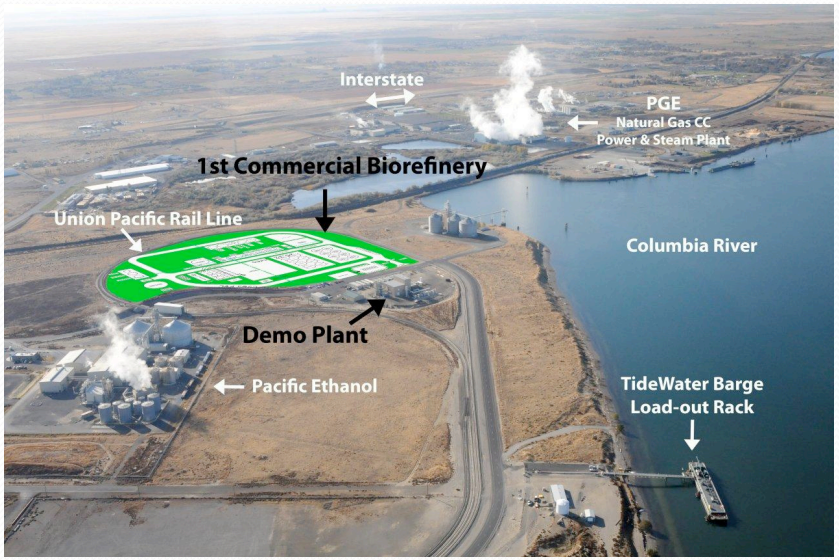
Ranking of the most problematic factors for doing business*

Country	Access to financing	Policy instability	Ranked # One
United States	1	8	
Spain	1	10	
Netherlands	1	8	
Ireland	1	5	
China	1	2	
Morocco	1	14	
Vietnam	1	3	
Mozambique	1	14	
Canada	2	8	Tax rates
United Kingdom	2	5	Tax rates
Italy	2	8	Inefficnt gov't bureaucracy
Denmark	2	8	Tax rates
Russian Federation	2	11	Corruption
Malaysia	2	3	Inefficnt gov't bureaucracy
Kuwait	2	8	Inefficnt gov't bureaucracy
Kenya	2	9	Corruption
Germany	3	7	Tax regulations
France	3	7	Restrictive labour regs
Czech Republic	3	4	Corruption
Mexico	3	10	Inefficnt gov't bureaucracy

Inbicon's 5mm litre/yr Denmark demo

ZeaChem's Oregon demo facility

ZeaChem's Oregon demo facility



Case Study – Iogen's demonstration plant:

Iogen CE fueled events:
E10; E85; High performance

But what about commercialization?

What has Iogen accomplished to date?

- √ Successful production of significant volumes of cellulosic ethanol at a demo plant
- √ Commercial plant sites identified
- √ Contracts for feedstock (farmers contracted for straw supply)
- √ Public consultations (conducted in June/'09)
- √ Ethanol customer (Shell)
- √ Government policy initiatives ($200 million in Canada)
- X Project Financing / Investment decision – still elusive

So are large scale biorefineries the right model?

Not if we can't unlock the necessary capital

What's been tried to date?

U.S.

- Loan Guarantees (USDOE, USDA)
- Grants (USDOE)
- Carved out markets (16 billion gallon target)
- Production Tax Credit ($1.01/gallon)

Canada

- SDTC – 40% of the capital cost up to $200 million

So are large scale biorefineries the right model?

It hasn't worked…

- Three? commercial demonstration facilities under construction globally (Canada, USA, Italy)

What's the solution?

- Take away the price and market (change of law) risk
- Remove the stranded asset risk

Price risk – can't sign long term contracts (like FIT / PPA)

Market risk
- U.S. – 2016 waiver risk
- Canada – no CE carve out
- Blendwall

The solution? – A Contract

(gov'ts can't commit future gov'ts,

but can sign contracts that future gov'ts will honour)

What should be the basis for a public-private contractual partnership?

At commercialization, private sector should be prepared to assume risks of:

- ✓ technology
- ✓ management
- ✓ project execution / construction
- ✓ fuel production / performance
- ✓ environmental sustainability
- ✓ project finance
- X "stranded asset risk"

Public Sector should **initially** (1st billion litres?) assume risks of:

- ✓ Market – future change of law protection (grandfathering)
- ✓ Price – capped at ($1.00/litre + market); paid on performance only – think FIT or wind PPA

Wrap up (almost)…

Investors :

- assume the worst case financial outcome
- have many competing investment opportunities
- prefer low risk options with guaranteed long term revenue flow (PPA)
- may assume front-end risk if the back-end market and price rewards are substantial (one billion litres at $1/litre + market price)

Bio-refineries need to assure investors of :

- long term regulatory stability that delivers price clarity and market certainty

Therefore, governments should :

- **decide** whether bio-refineries matter (deliver on multiple policy objectives)

The Bio-refinery opportunity is real

Biomass for fuels and chemicals

- The transition to the bio-economy is just beginning
- Canada's forestry and agriculture biomass resource base is enormous
- There is growing consumer demand for bio-based consumer products to replace hydro carbon based products (solvents, plastics, paints, adhesives, insulation, textiles, cosmetics, diapers…)
- Demand growth for bio-plastic is forecast to grow 25% per year
- The 2009 global market for green chemicals was $46 billion and is forecast to reach $62 billion by 2015
- Challenges are:

Happy to take ?'s

Contacts: