

International Energy Agency; Bioenergy Task 39

The Biorefinery Concept/Biofuels; It's just a matter Of time

Jack Saddler

Forest Products Bioenergy/Biotechnology

Co-Task Leader IEA Bioenergy Task 39

UBC, Canada

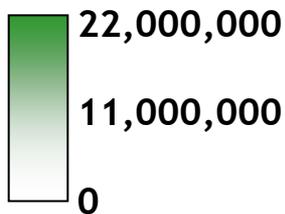
Jack.Saddler@ubc.ca



1st Brazilian BioEnergy Science and Technology Conference

Campos do Jordão

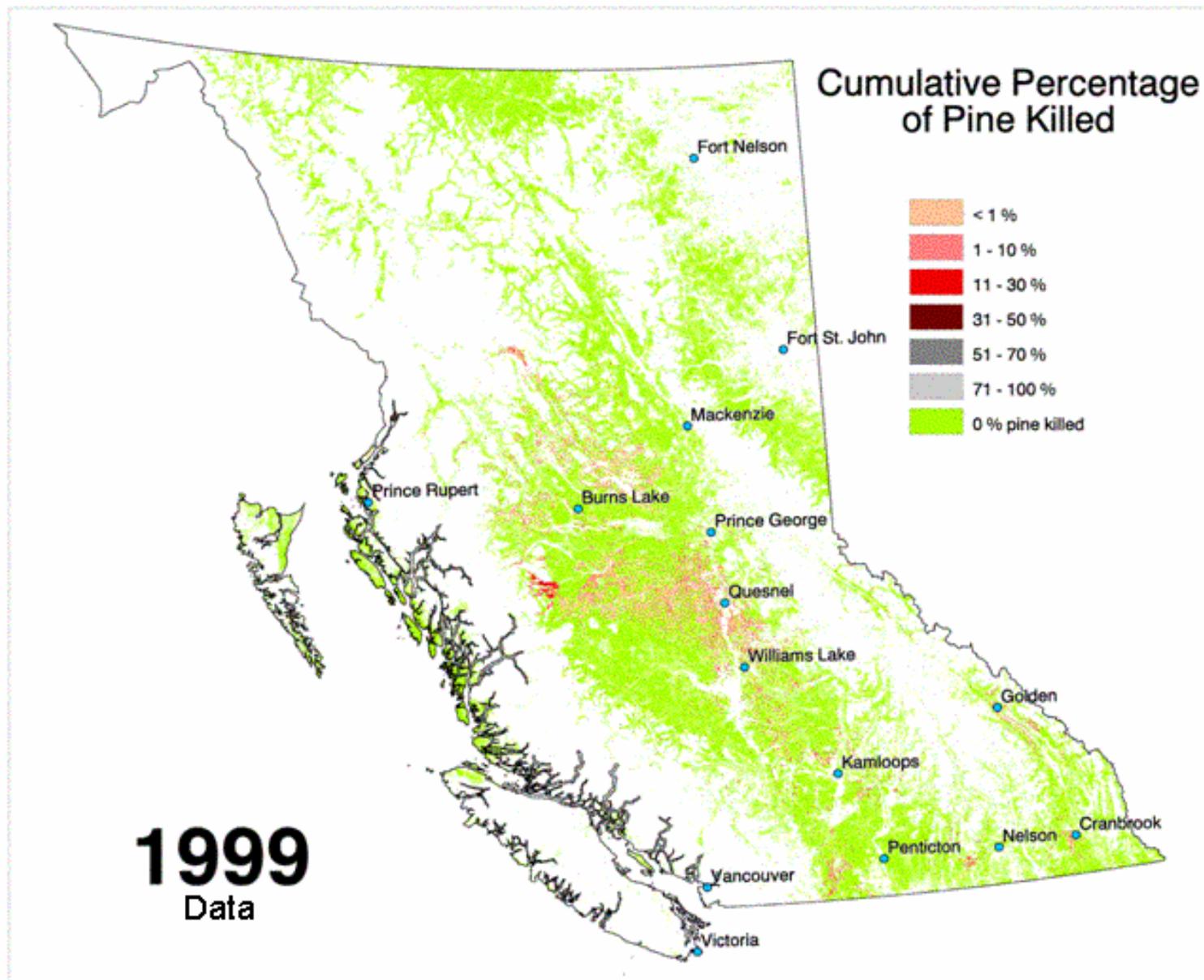
August - 14 to 18, 2011

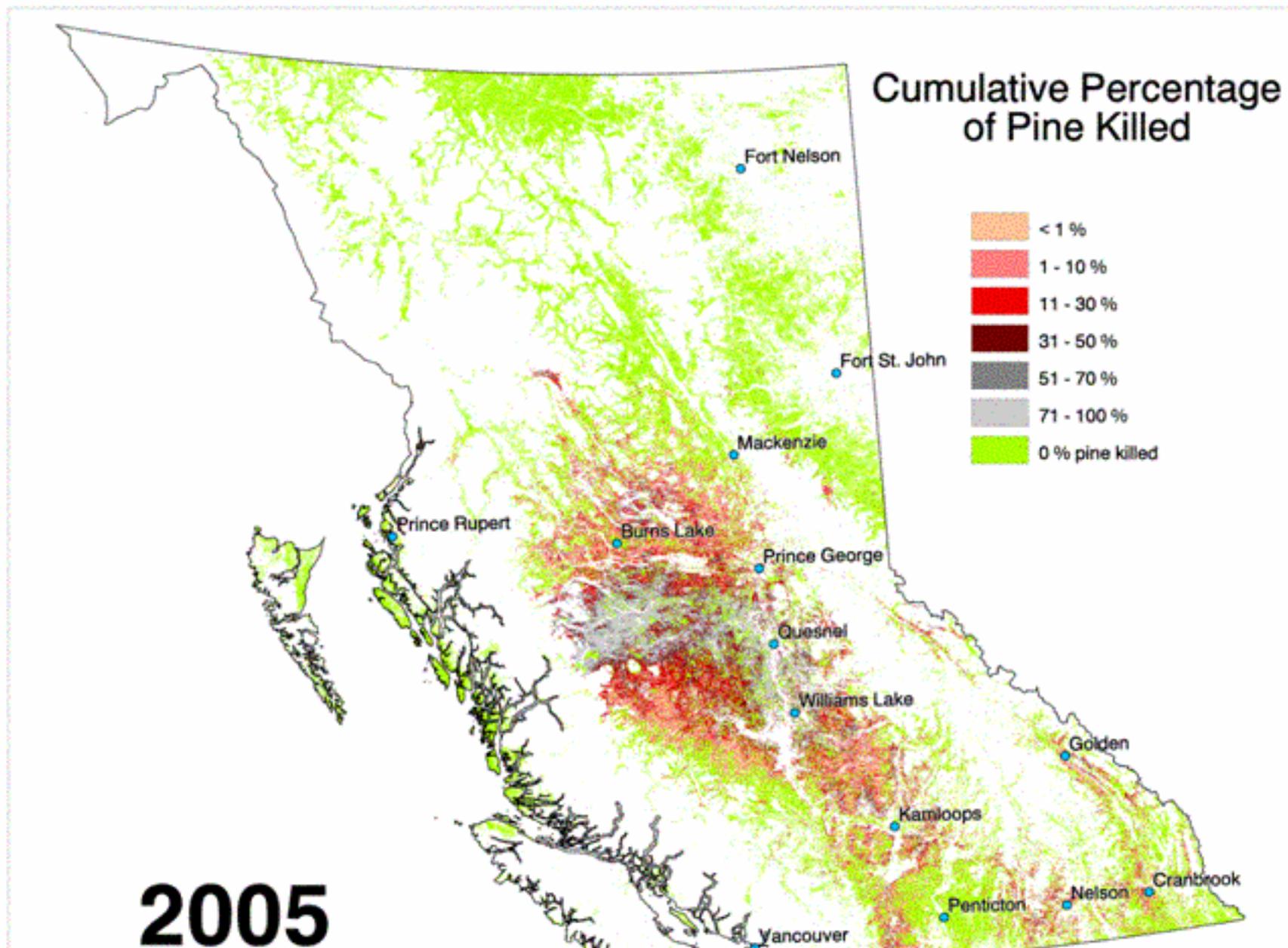


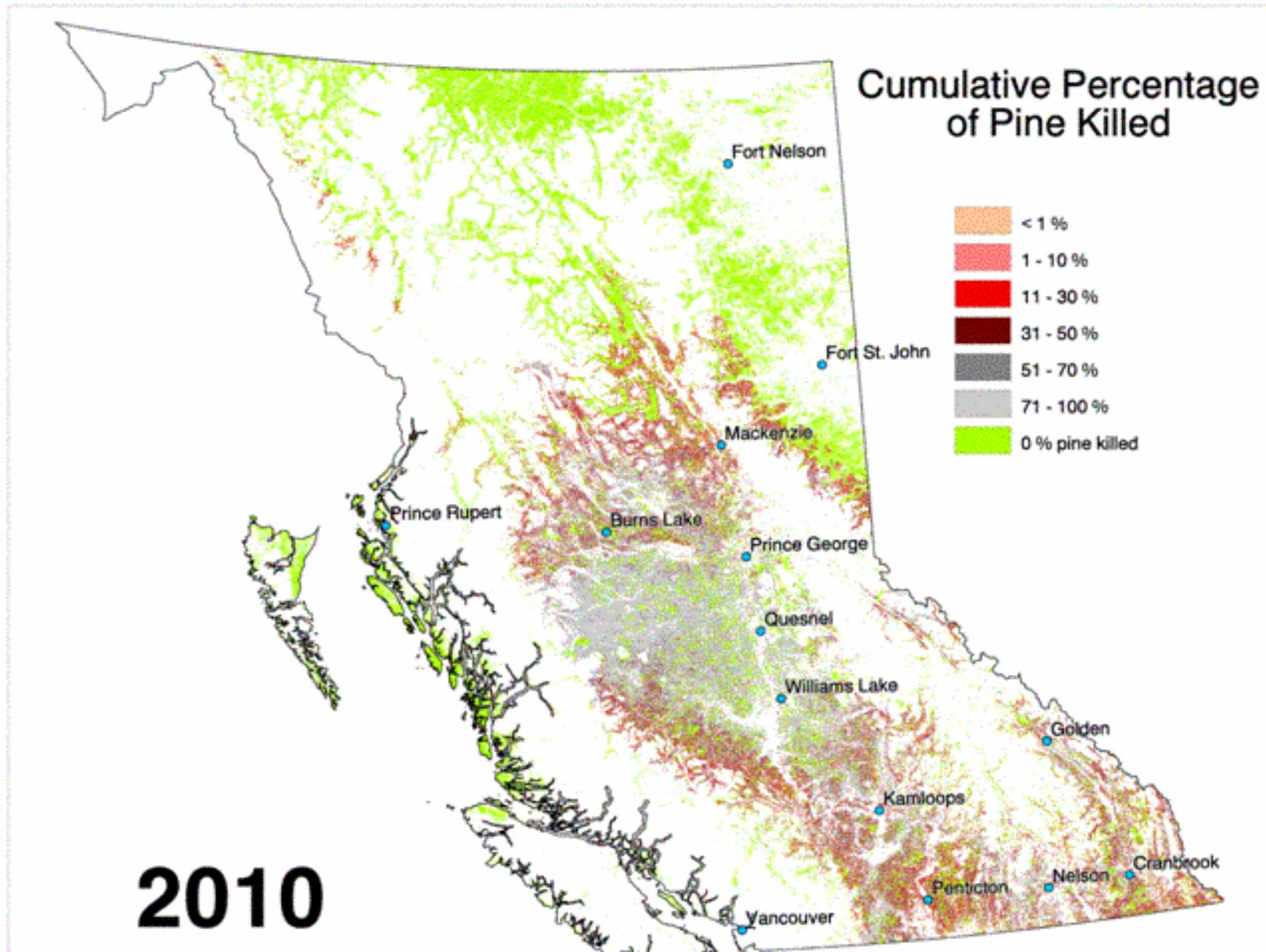
Wood Residue Generation
(Metric tonnes/year)

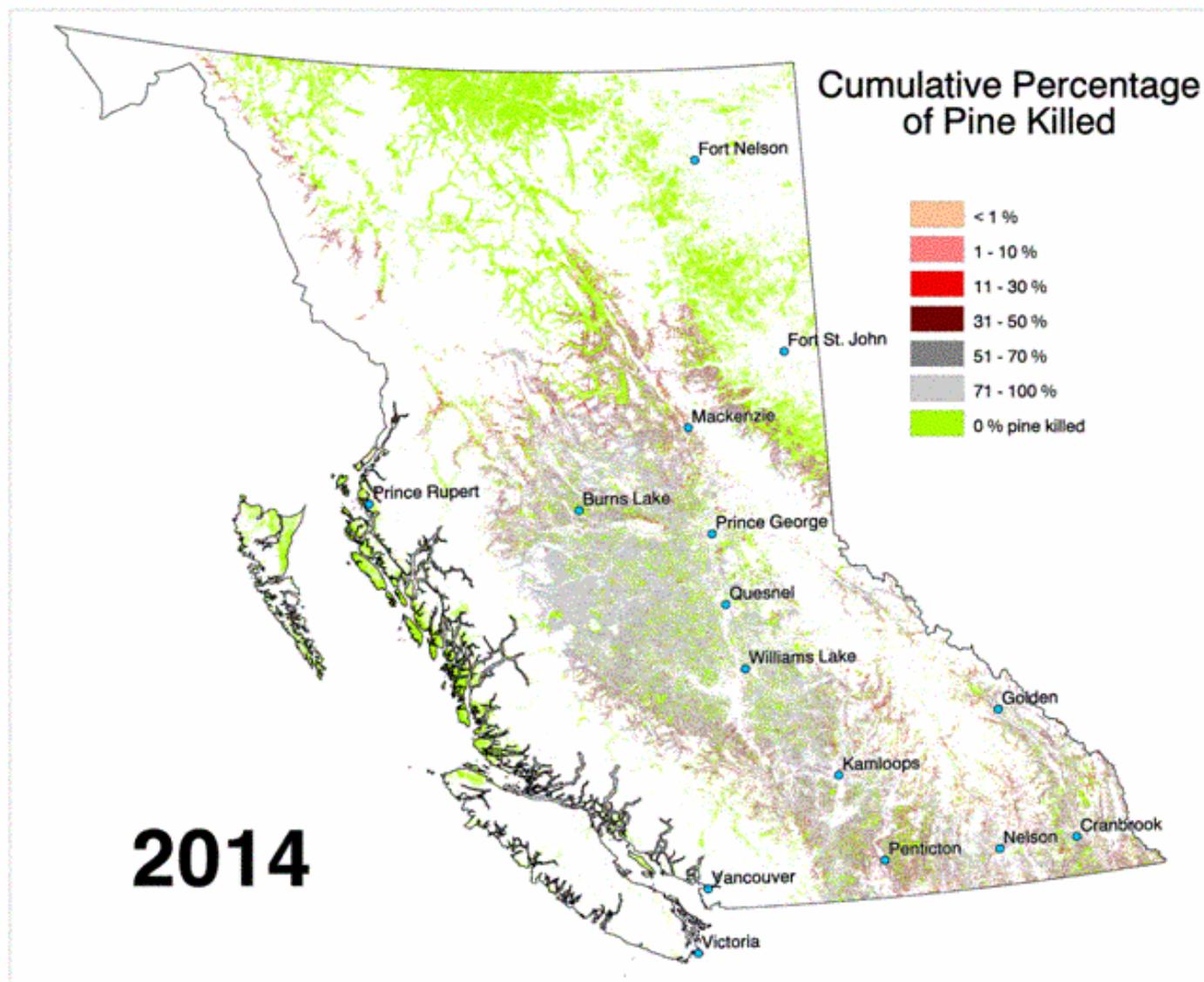
Ethanol Potential
(Million Litres/year)











Sao Paulo State 25 million ha; Extent of Beetle killed Lodgepole Pine is 15 million ha



University of British Columbia

UBC CAMPUS

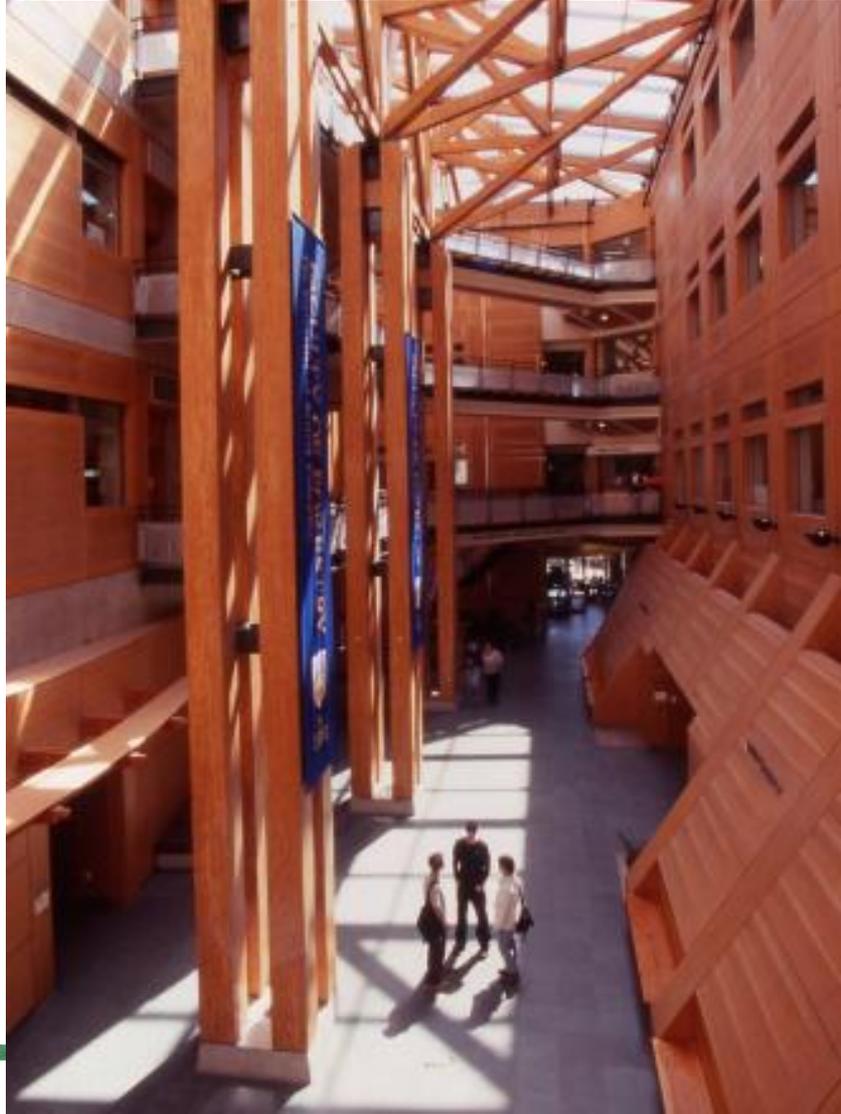
- One of the world's greatest public universities, rated among the top 35
- 50,000 students
- 6,400 (12%) international students from over 140 countries
- Revenue (2008): \$1,5 billion
- Research funding: \$470 million
- Academic staff: 9,480

Forestry

University of British Columbia



Welcome to Our Classroom

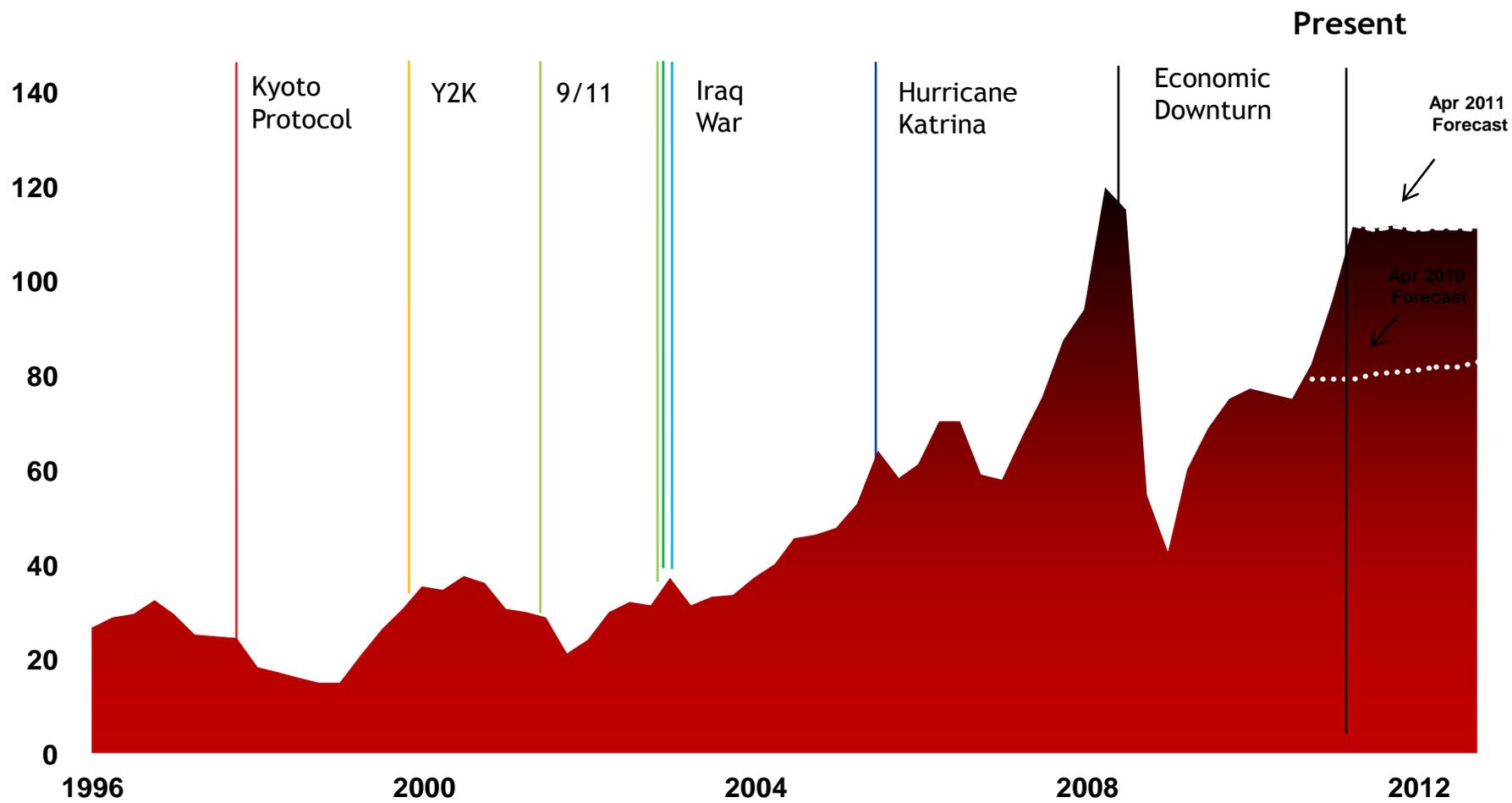


“I love working with wood!”



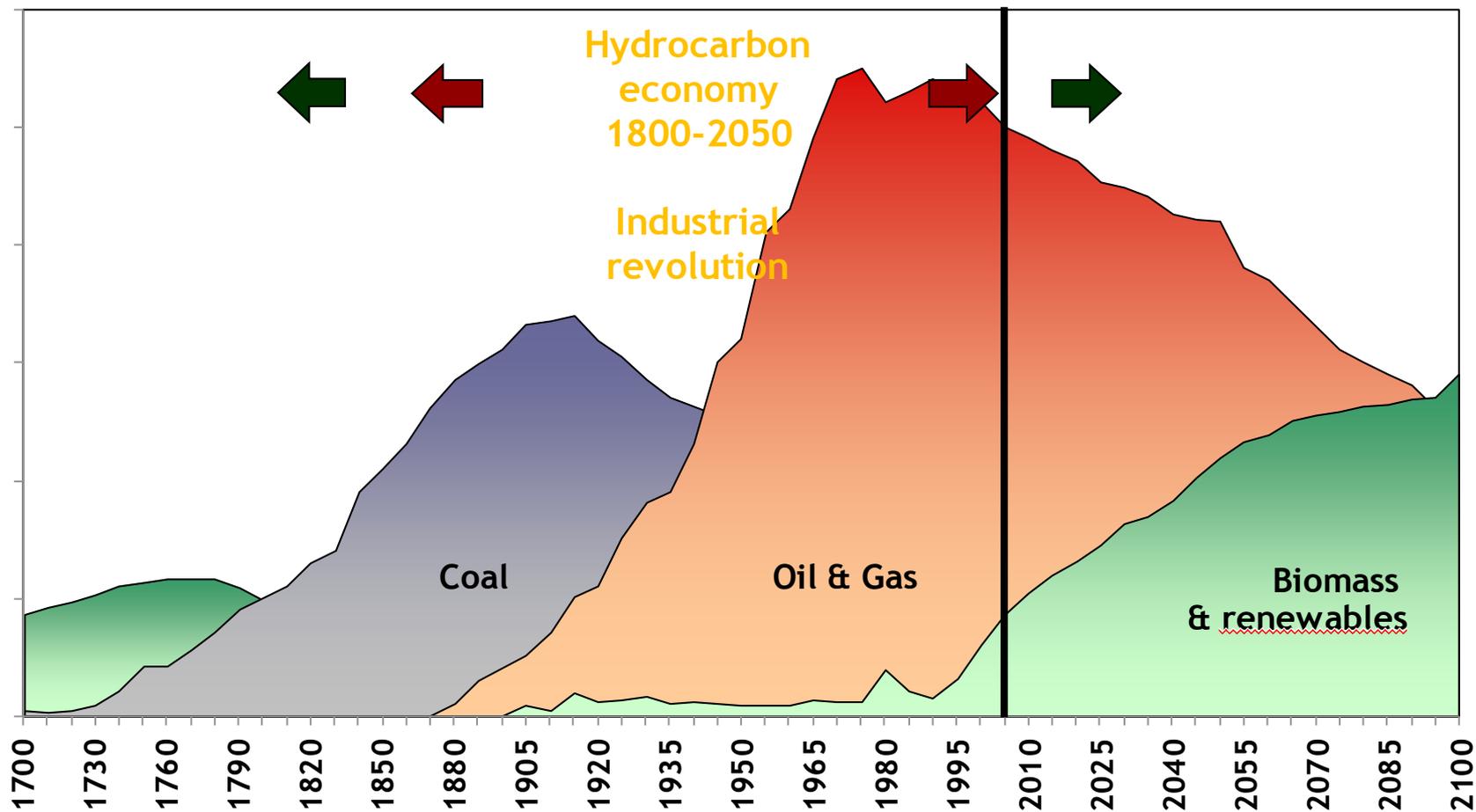
Oil Prices and World Events

Quarterly Imported Crude Oil Price



Looking back and forward...

log (primary energy use) by category



First Nations/Aboriginal time lines

- Oral history
- 7 generational time line (Great grandparents-to-Great grandchildren)
- Putting the “basics” in life to this time frame

- Food
- Shelter, clothing, “home”
- Health
- Transport
- Energy



Biorefinery: 7 Generations

- Great-grandparents hoped for housing, furniture, basic energy and sometimes “luxuries” (car, TV, fridge, washing machine, etc)
- You expect the same/better as well as packaging, design/function, facial tissues/sanitary products, “disposable” clothes/furniture, all at low cost
- Great-grandchildren won’t need the writing or newspaper, but expect more of the above for less of their income.
- Increased energy and “luxuries” (meat instead of rice!)

Timelines

- Takes 50+ years to grow a tree in most parts of the world
- A university trained individual should be relevant for at least 50 years
- Much of logging at “industrial scale” in last 50 years
- “Short” rotation forestry has been going for about 40 years
 - Increased interest spurred by the 1970s oil crisis
- How well do we know what the tree will be used for when we plant it (Seed-to-solutions)?

The 1960/70's

- Club of Rome
- Concerns regarding unlimited resource consumption in an increasingly interdependent world
- "The Limits to Growth"
- Reconcile sustainable progress within environmental constraints
- Over-population
- Limited potential of agriculture and energy

- "Green Revolution"
- Unlimited energy; Nuclear and "limitless" oil (Pruteen)

Creative Protein Solutions

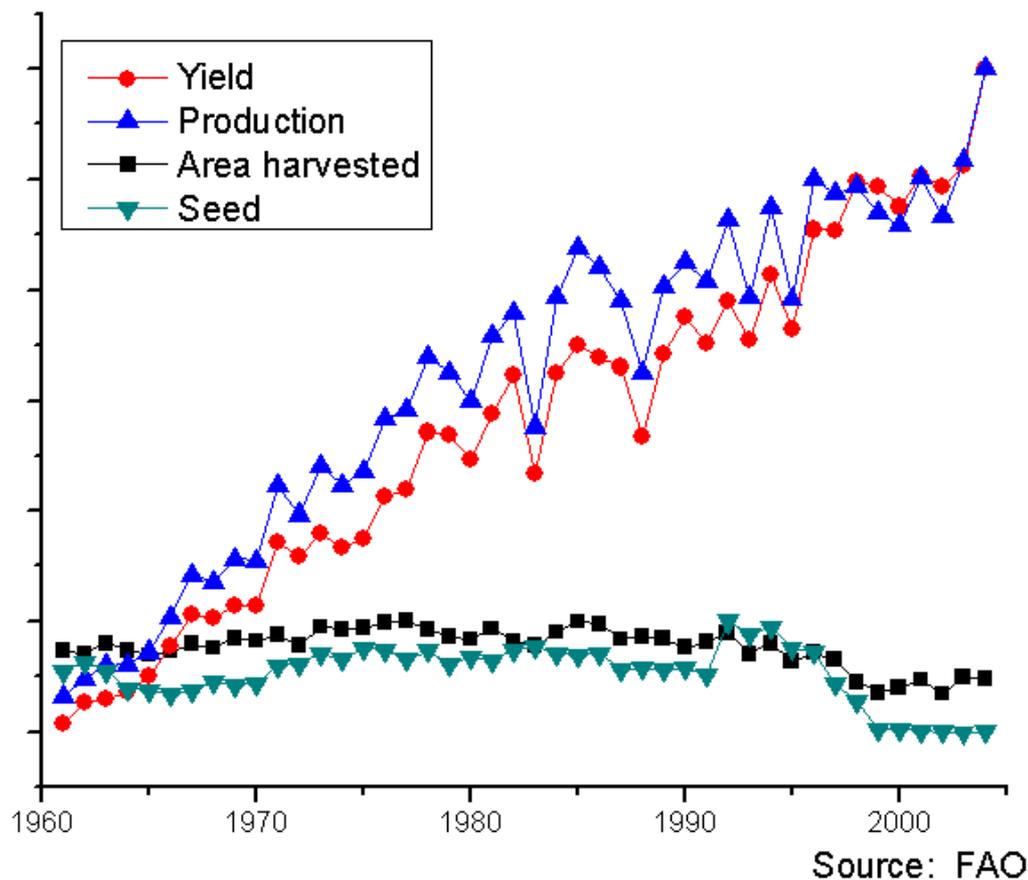
- Single cell protein
 - Variety of carbon sources can be fermented to single-cell proteins
 - SCP be obtained from algae, yeasts, fungi or bacteria

- Food from Oil
 - 1960's BP developed "proteins-from-oil-process"
 - Yeast was fed waxy paraffins (product from oil refineries)
 - Examples include:
 - SCP - Spirulina
 - PRUTEEN SCP - made from methanol
 - Torutein SCP - made from ethanol using torula yeast

- Spent Sulphite Liquor
 - Mainly derived from hardwoods (yeast)
 - Conversion efficiencies varied (e.g. 25% - 56%)

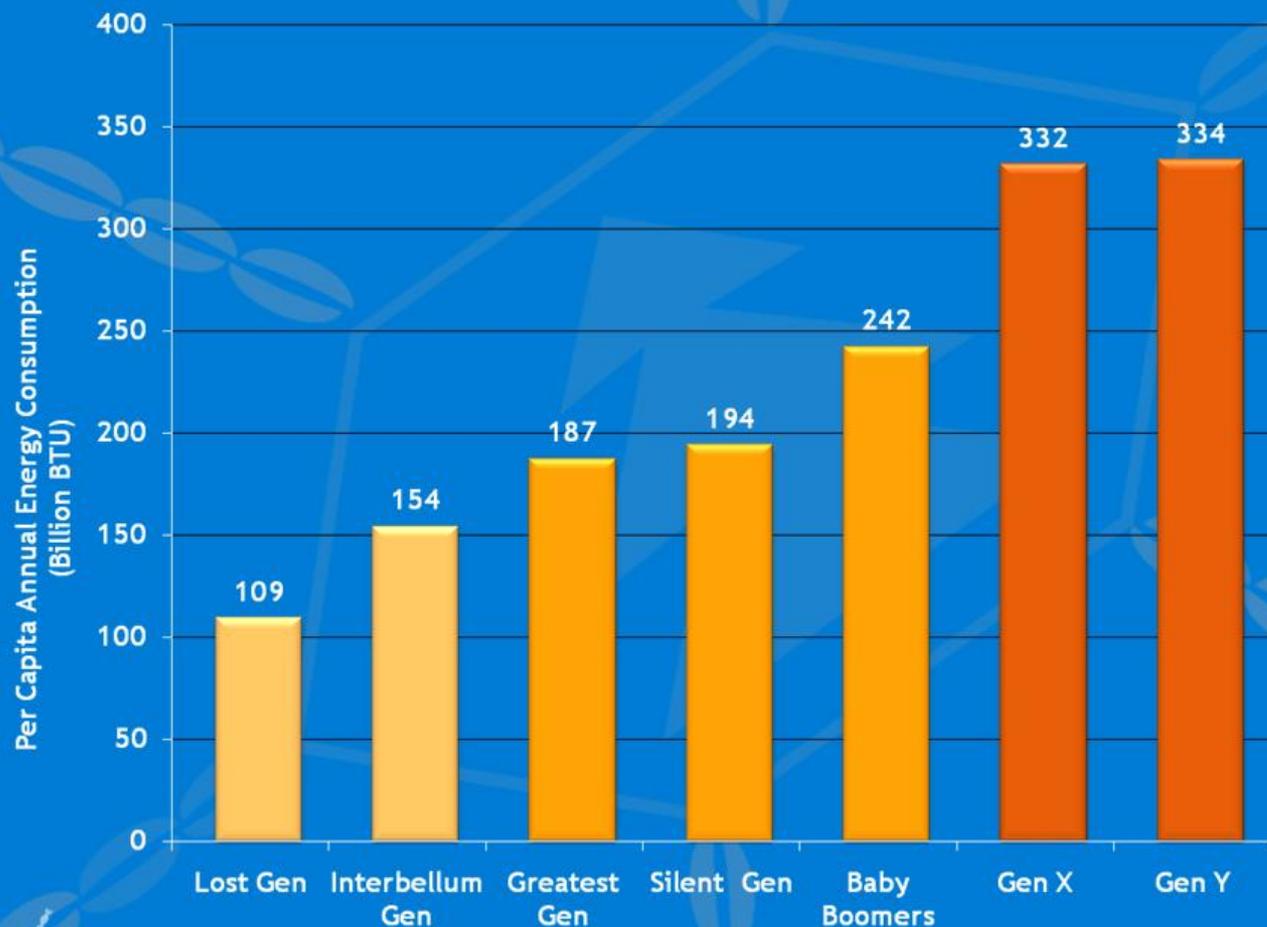
Green Revolution

Total world production of coarse grain, 1961-2004



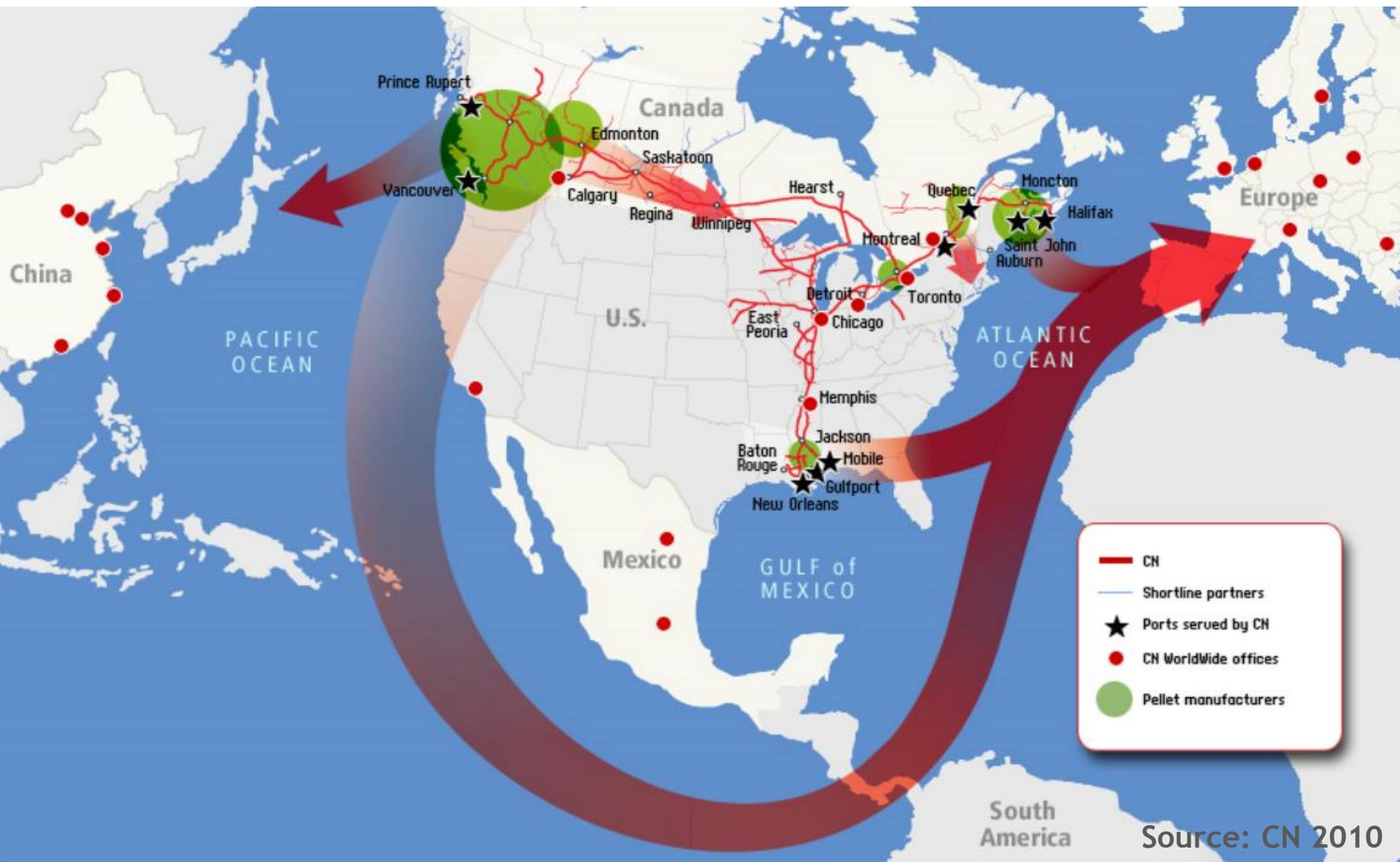
- Production/area increased dramatically
- Largest shift observed in 1960s

Generational Per Capita Energy Consumption (US)



Forest Products Biotechnology at UBC

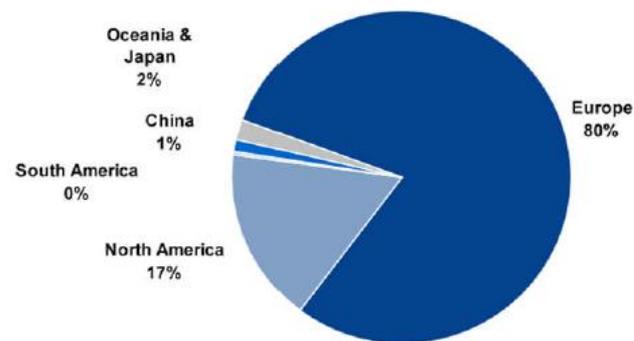
Canadian Wood Pellet Exports



Wood pellets cont'd

- ▶ British Columbia - access to Asian markets
 - 10 pellet plants ~1.2 million tonnes capacity
- ▶ The majority of North American pellets were shipped to
 - Netherlands, UK & Belgium, Sweden, Denmark
 - ~50% of the Atlantic trade destined for the Netherlands; another one-third landed in the UK
- ▶ High oil demand by Asia and Latin America & uncertainty in the Middle East/N Africa has boosted oil prices
- ▶ Higher oil prices will benefit wood pellet exporters in North America -> shipments to Europe are to increase during 2011

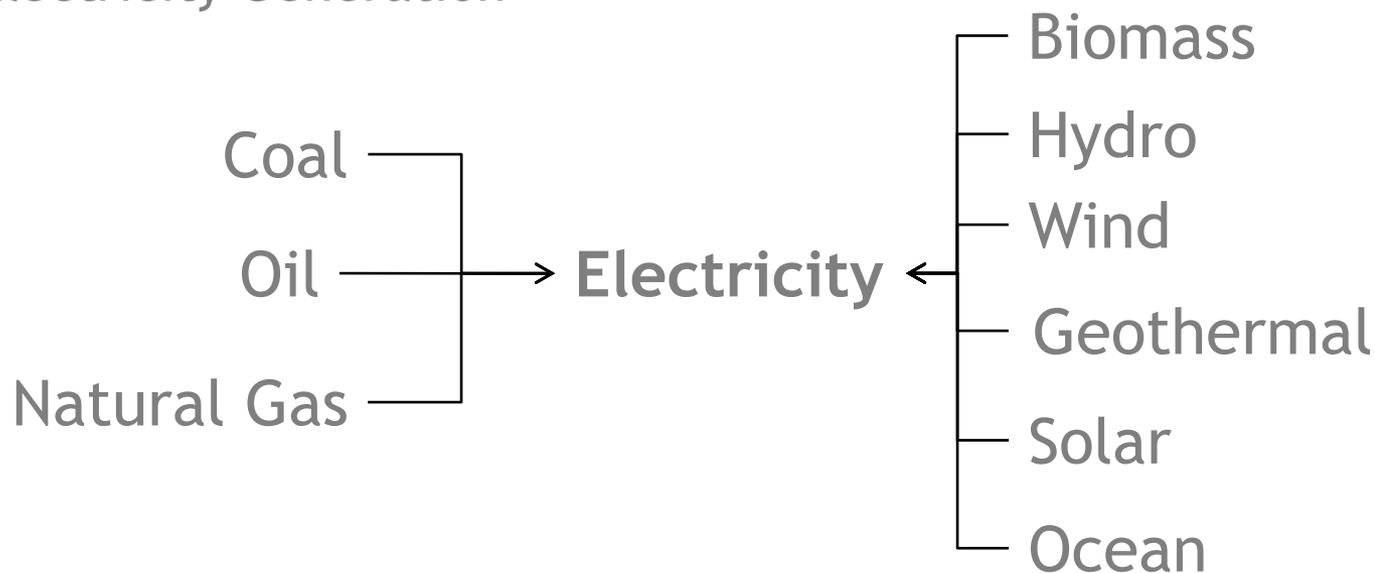
Global pellet consumption: 2008



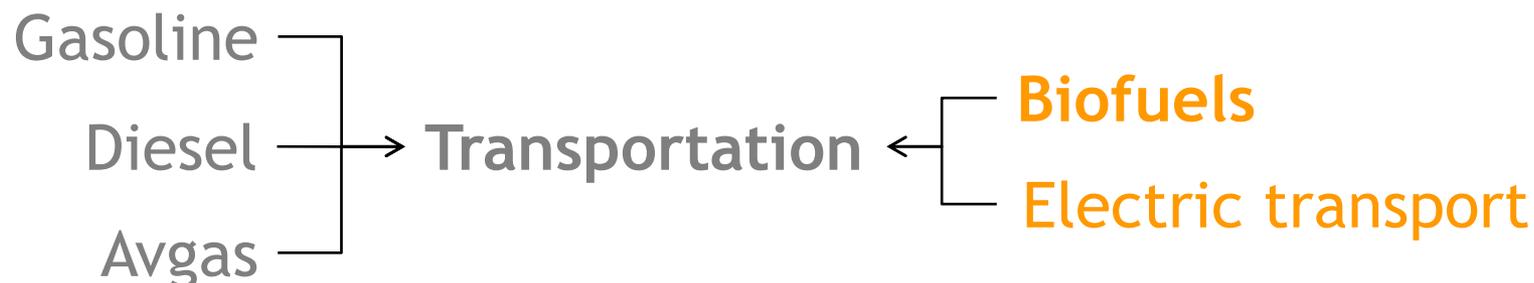
~12 M tonnes

Renewable Alternatives

1. Electricity Generation

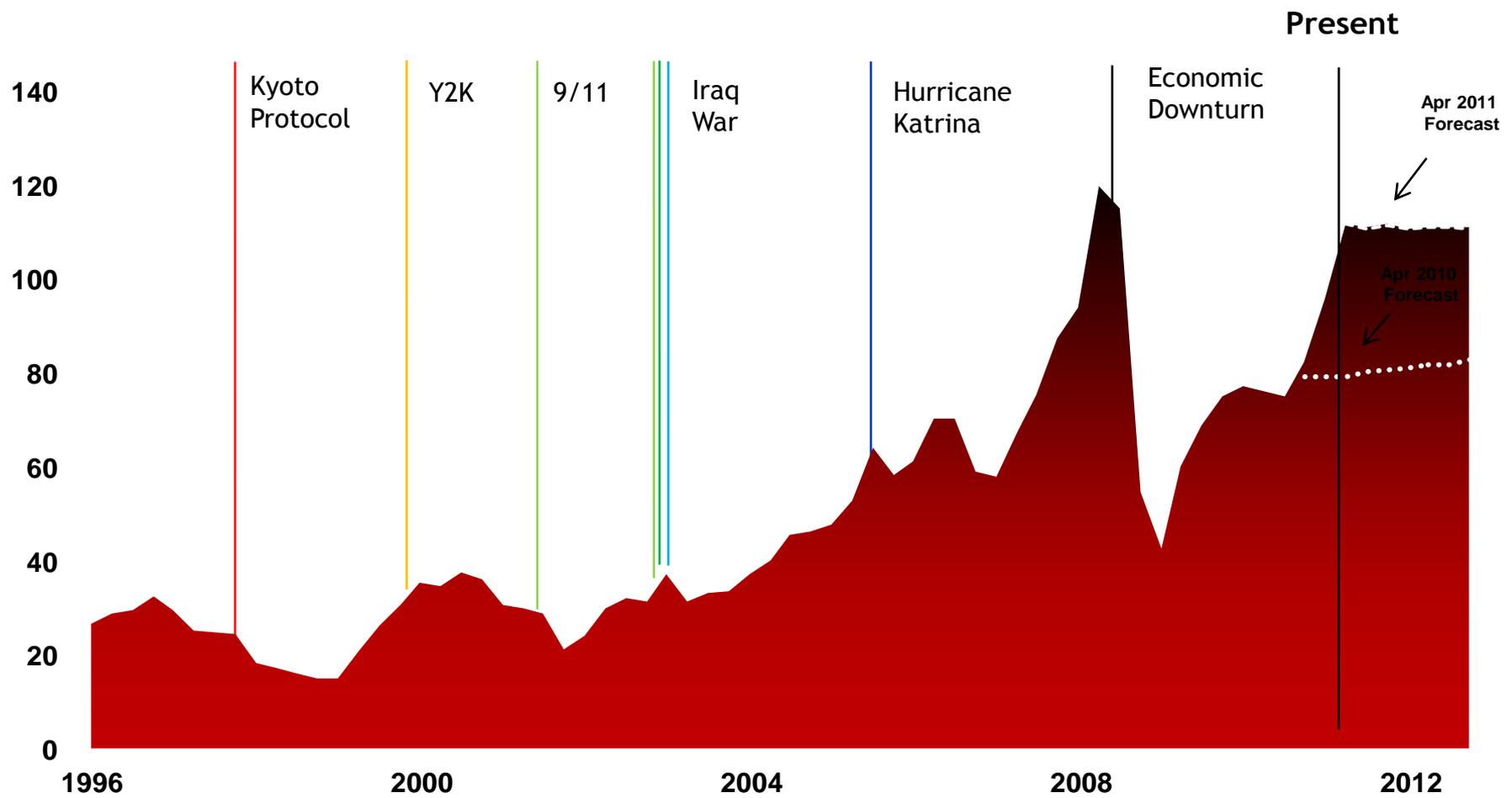


2. Transport Fuels

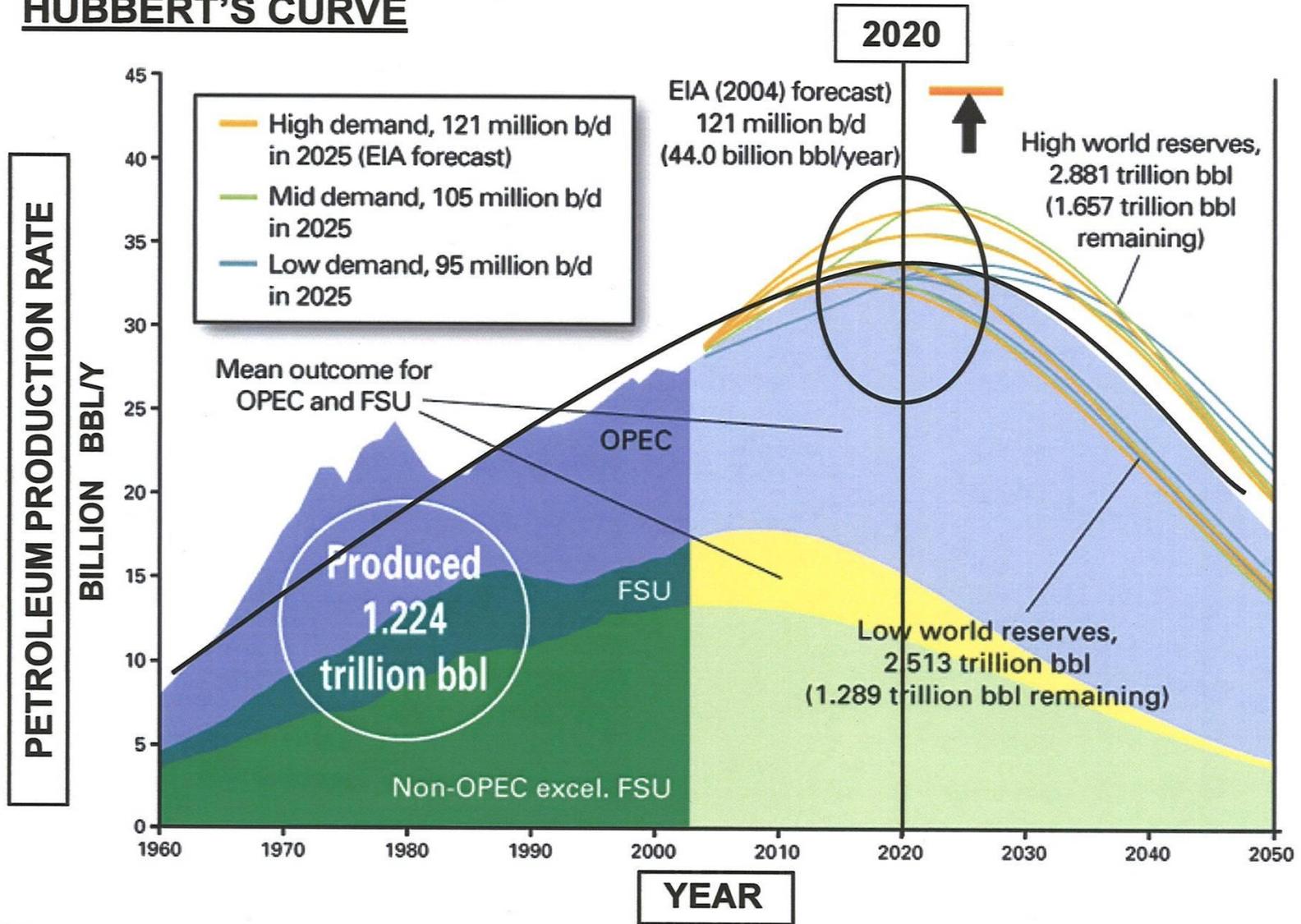


Oil Prices and World Events

Quarterly Imported Crude Oil Price

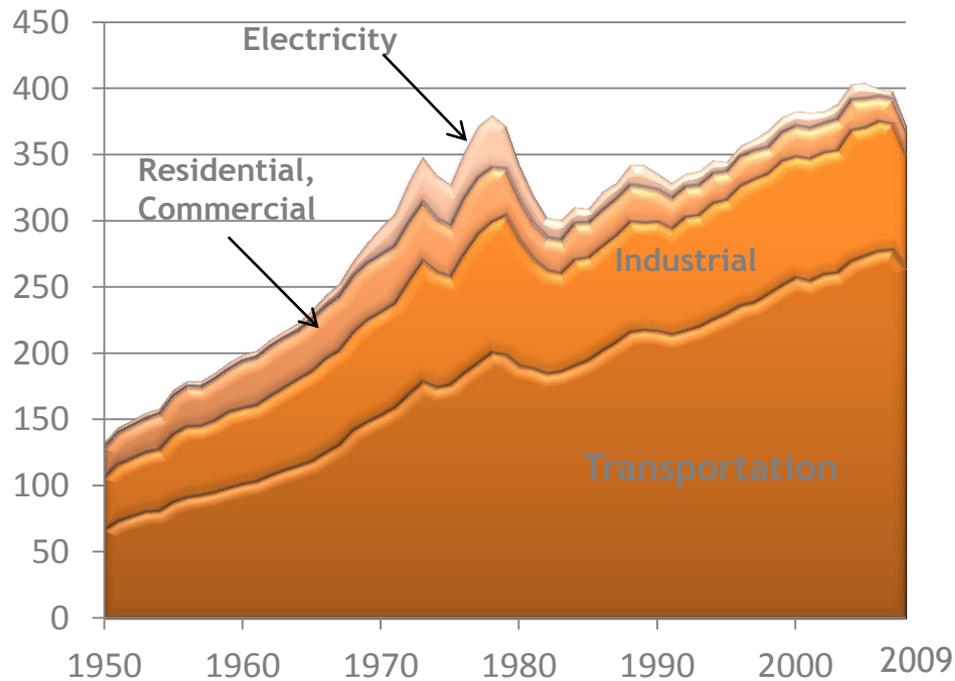


HUBBERT'S CURVE



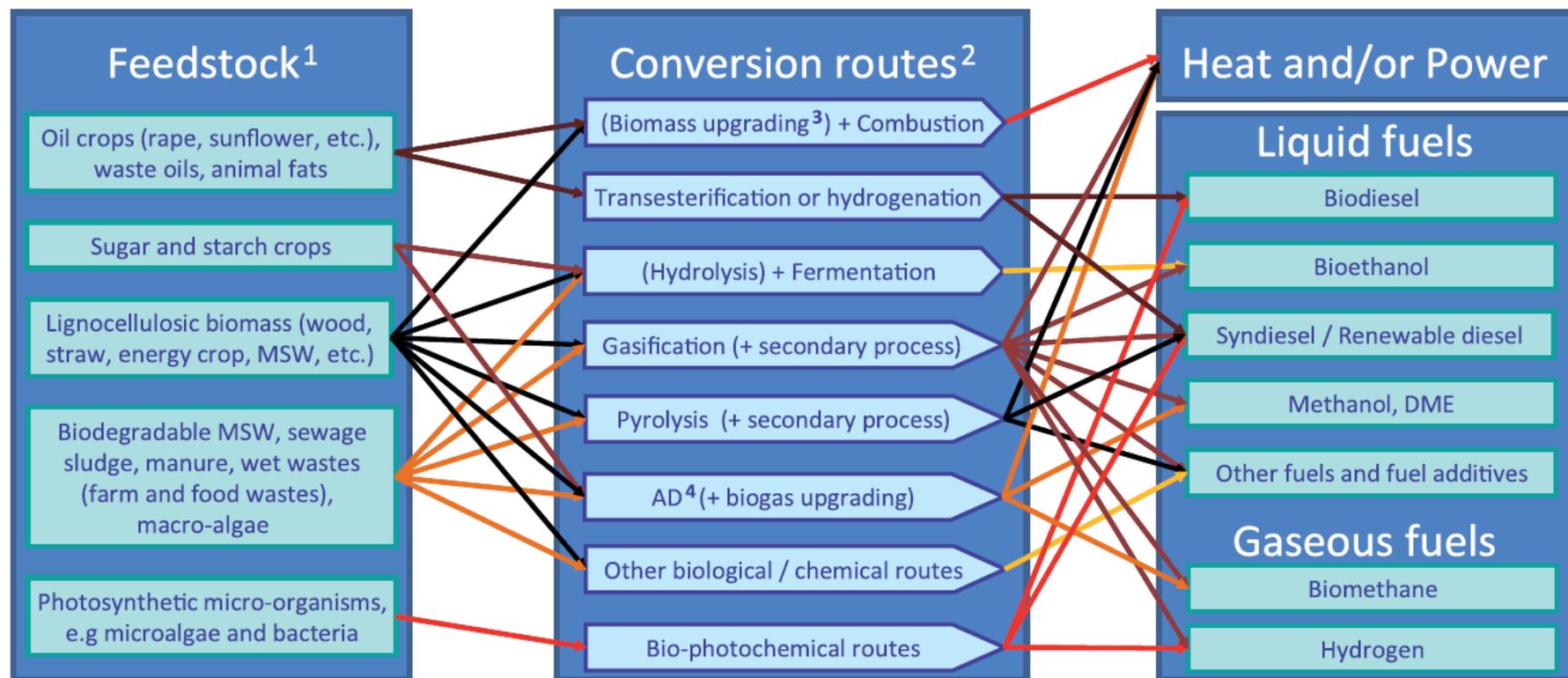
Traditional Oil Refining

Oil Demand by Sector
(Quadrillion Btu)



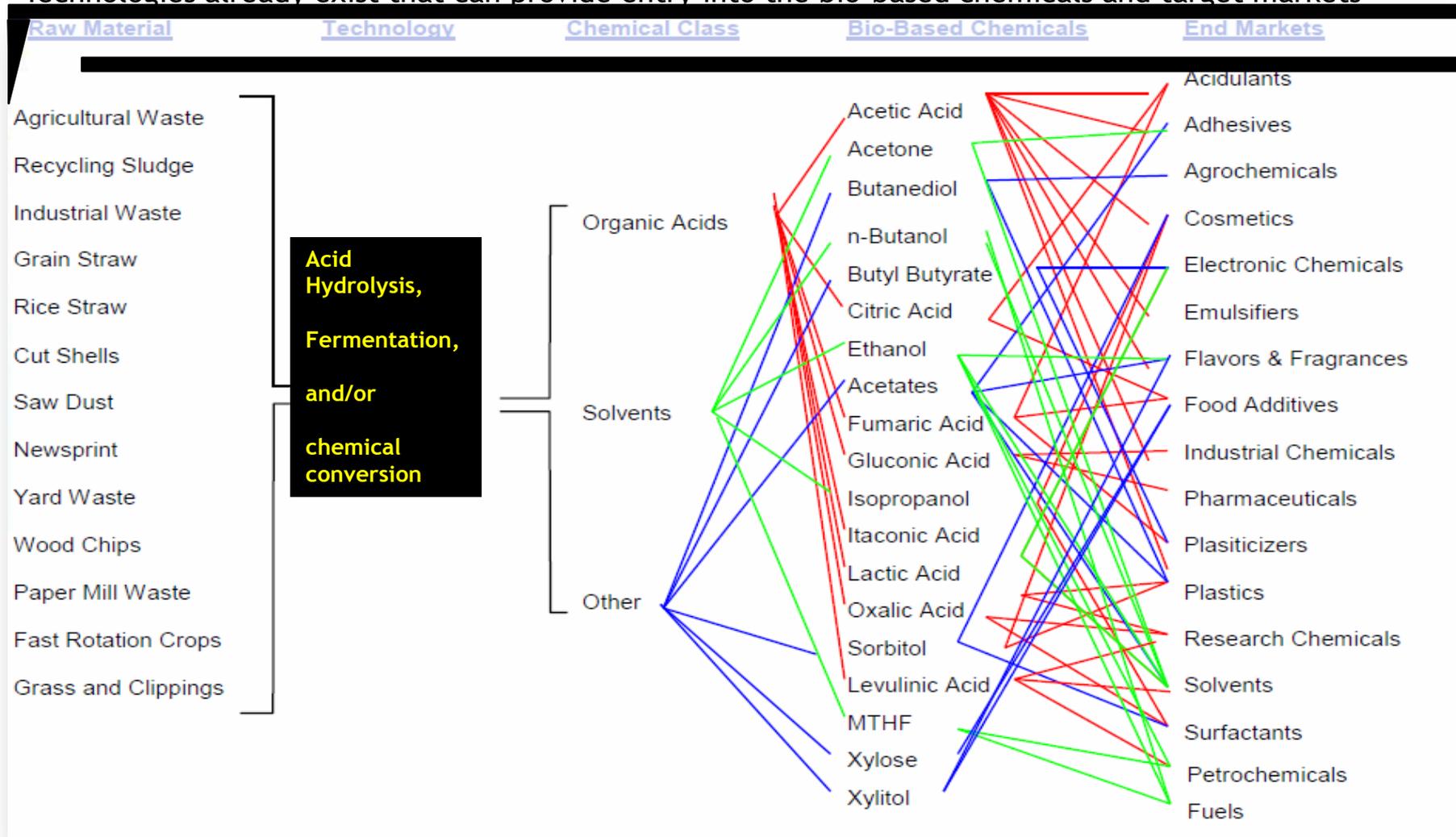
- ~71% Transportation sector (i.e. gasoline, diesel)
- ~23% Industrial processing
 - ~5% incl. plastics, chemicals (over 2,000 refinery products)
- ~5% Residential / commercial heating
- ~1% Electricity generation

Biofuel Conversion Technologies



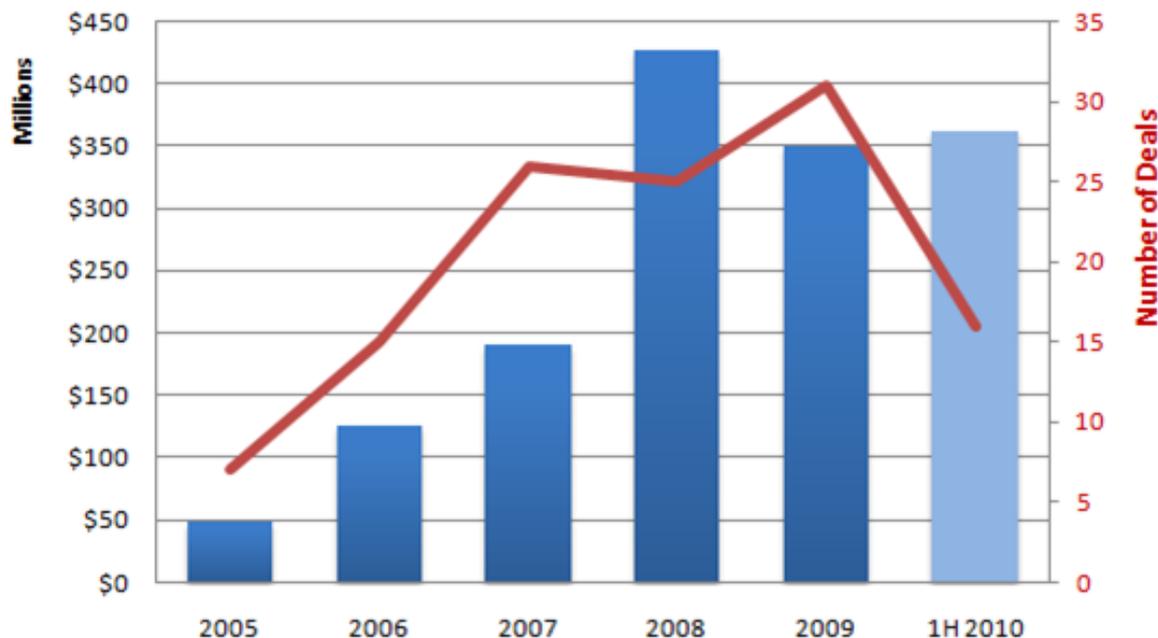
Bio-chemicals

Technologies already exist that can provide entry into the bio-based chemicals and target markets



Investment into Biofuels **WITH** Renewable Chemicals

Biofuels/Materials VC deals with a Renewable Chemicals aspect



Source: Cleantech Group

Biorefining = Biofuels + More

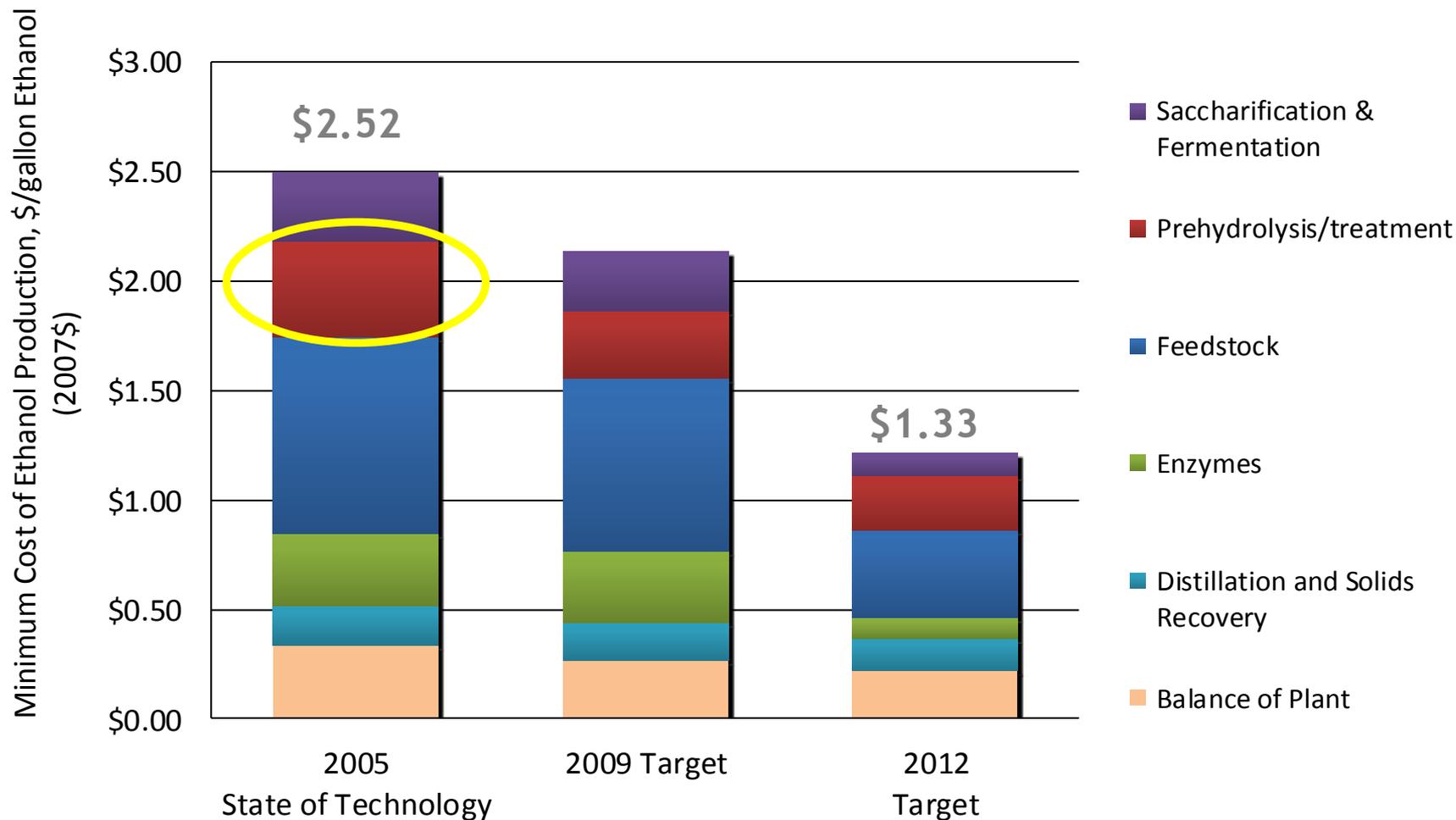
Business models attracting investment are increasingly looking to leverage 'biofuels technologies'

Companies capable of producing renewable chemicals cut across multiple traditional technology areas

Examples: Amyris, Green Biologics, Coskata

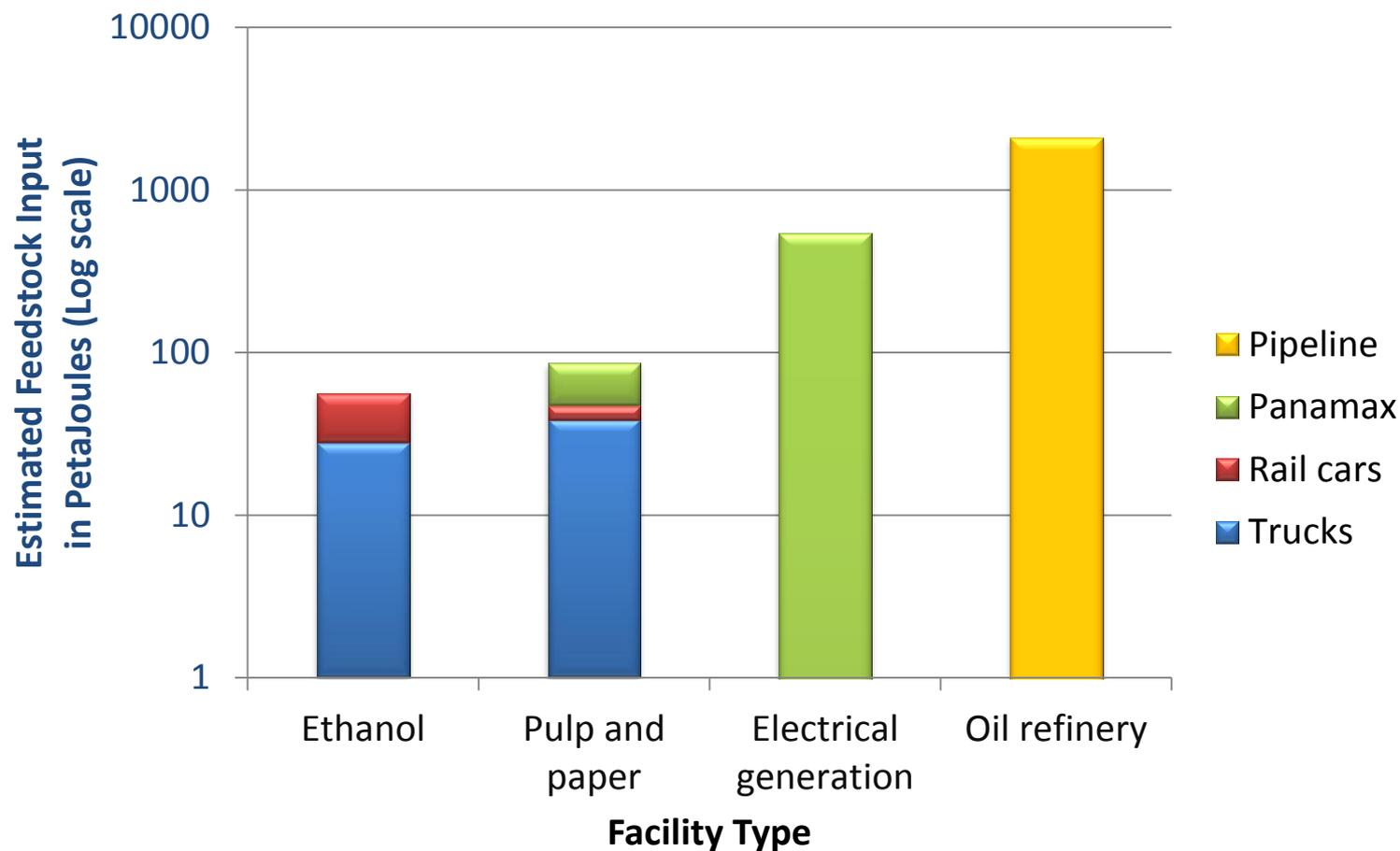
Note: Figure for 2010 is just first half of the year

Bioconversion Costs



Largest Facility in Each Sector

Comparison of feedstock energy input transport mechanism



Scale of Facilities & Location

- Biorefineries to resemble pulp mills, not oil refineries
- Conventional
 - Location: Agriculture-intensive regions
- Advanced - Thermochemical
 - Larger scale
 - Coastal Regions
- Advanced - Biochemical
 - Smaller scale
 - Interior
- Hydrogen, Algal, other Biofuels
 - To Be Determined! (TBD)



IEA - International Energy Agency

- IEA - Autonomous organization linked to OECD
- Created due to oil-shocks
- IEA Objectives:
 - Assist in integration of environmental and energy policies
 - “Improve the world’s energy supply and demand structure by developing alternative energy sources and increasing efficiency of energy use”

IEA Objectives

- Maintain and improve systems coping with oil supply disruptions
- Promote rational energy policies in a global context through co-operative relations with non-Member countries, industry and international organizations
- Operate a permanent information system on the international oil market
- Improve the world's energy supply and demand structure by developing alternative energy sources and increasing efficiency of energy use
- Assist in integration of environmental and energy policies

IEA Bioenergy Tasks 2010-2012

Social & Environmental Issues:

- Task 29 - Socio-economic drivers in implementing bioenergy projects
- Task 38 - GHG Balances of Biomass and Bioenergy Systems

Conversion Technologies:

- Task 32 - Biomass combustion and co-firing
- Task 33 - Thermal gasification of biomass
- Task 34 - Pyrolysis of biomass
- Task 36 - Energy recovery from municipal solid waste
- Task 37 - Energy from biogas and landfill gas
- **Task 39 - Commercializing liquid biofuels** (Task Leaders: Jim McMillan & Jack Saddler)
- Task 42 - Biorefineries

Trade:

- Task 40 - Sustainable international bioenergy trade
- Task 41 - Joint project with the Advanced Motor Fuels IA
- Task 43 - Biomass Feedstocks and Energy Markets

IEA Bioenergy Task 39

- Commercializing of sustainable Liquid Biofuels
- Collaboration between 15 countries
 - Analysis on policy, markets and sustainable biofuel implementation
 - Catalyze cooperative research and development
 - Information dissemination & outreach with stakeholders
 - Focus on Technical and Policy issues

TECHNICAL ANALYSIS

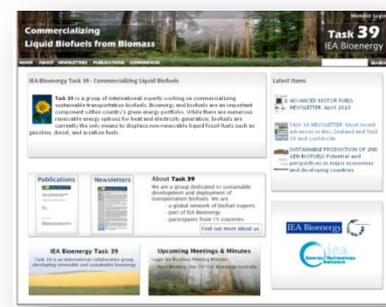
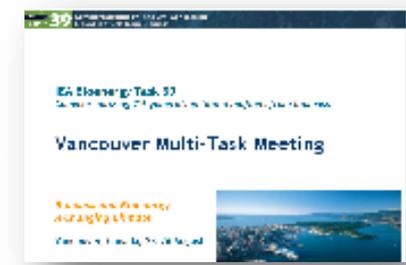
POLICY AND IMPLEMENTATION





Task 39 Outputs cont'd

- Newsletters
 - Featuring newest developments)
- Facilitating international collaboration
 - Organized Multi-Task Conferences (i.e. Vancouver 06, 09)
 - 2-3 Business Meetings / year
- Website / Facility database
 - Resource for biofuels stakeholders
 - Worldwide biorefinery database



www.Task39.org

Commercializing Liquid Biofuels from Biomass

Task 39 IEA Bioenergy

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ABOUT

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EVENTS

SEARCH

Meeting Minutes & Presentations

Please login for the most recent minutes and Country presentations



Upcoming Meetings

The next Business will be on May 2-5 2010, in Glasgow, Ireland. For details please login.



Featured Material



SUSTAINABLE PRODUCTION OF SECOND-GENERATION BIOFUELS: Potential and perspectives in major economies and developing countries



GLOBAL ASSESSMENT OF 2nd GEN BIOFUELS: Status of 2nd generation biofuels pilot facilities (interactive link)



FROM 1st- TO 2nd- GENERATION BIOFUELS TECHNOLOGIES: An overview of current industry and RD&D activities

Publications



Newsletters



About Task 39

We are a group dedicated to sustainable development and deployment of transportation biofuels. We are

- a global network of biofuel experts
- part of IEA Bioenergy
- participants from 15 countries

[Find out more about us](#)

News

[www.renewableenergyaccess.com]

Project LIBERTY director to give update of POET's cellulosic work - Project LIBERTY Director Jim Sturdevant will outline progress and upcoming work for POET's effort to commercialize cellulosic ethanol at two Iowa events in coming weeks.

IHS Acquires Emerging Energy Research - IHS Inc. announced the acquisition of Emerging Energy Research this week. The purchase price is approximately \$18 million.

Propel Fuels Raises US \$20M to Expand Fueling Station Network - Propel Fuels this week announced a US \$20 million investment in the company. This funding will allow Propel to expand its network of fuel stations into all major markets across California, supporting the state's emissions reduction goals and stimulating jobs.



Newsletters - Subscribe at www.Task39.org

Newsletter Issue #24 April 2010

**Commercializing
Liquid Biofuels from Biomass**



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From the Task

From Jack Saddler and Jim McMillan, Task Co-Leaders

This spring marks the beginning of a new triennium for our Task. We would like to welcome you to the redesigned IEA Bioenergy Task 39 Newsletter. As many of you know, the Task 39 Newsletter provides regular updates on activities of member countries, helps distribute contributions from the R&D community, and provides a platform for information exchange and collaboration. We are undertaking a re-invention of our Newsletter and website in order to facilitate more effective communication between country representatives and biofuel stakeholders. We would like to introduce Jana Hanova, who is spearheading the process and is our new Newsletter editor and Task Coordinator.

We would also like to welcome Brazil, New Zealand and South Korea as the newest members of IEA Bioenergy Task 39. We extend our welcome to the three countries and sharing their perspectives and experience in the biofuels area. The first Newsletter of 2010 will feature and in-depth report on New Zealand's efforts and advances in the biofuels space. Hopefully, these contributions will then be followed by articles on Brazil's, South Korea's and Norway's experience in forthcoming issues.

We are in the process of finishing up three feature reports will include Task 39's 1) Biofuels Sustainability Report as well as an algal biofuels report tentatively entitled, 2) "Algal Biofuels: Current Status and Potential" and 3) a report accompanying the Task 39 demonstration plant database, known as the [Global Assessment of 2nd Generation Biofuels Projects](#). We anticipate releasing penultimate drafts of these reports to Task 39 country representatives for review shortly.

- Jack Saddler and Jim McMillan

Task 39 Representatives - ExCo* (Executive Committee*) and Country Representatives

Australia Stephen Schuck* Les Edye	Denmark Jan Bunker* Michael Persson, Henning Jørgensen	Japan Tatsuo Hamamatsu* Shiro Saka	Norway Peter Nilsen* Karin Øyaas Judit Sandquist Gisle Johansen	Sweden Björn Telenius* Bärbel Hahn-Hägerdal Kenneth Werling Guido Zacchi
Austria Josef Spitzer* Manfred Wörgetter	Finland Kai Sipilä* Tuula Mäkinen Niklas von Weymarn	Netherlands Kees Kwant* John Heeft	South Africa Nomawethu Qase* Bernard Prior Emile van Zyl	United Kingdom Kieran Power* Tony Sidwell
Brazil Ricardo Dornelles* Paulo Barbosa Viviana Coelho	Germany Hans-Jürgen Froese* Axel Munack	New Zealand Michael Jack* Ian Suckling	South Korea Soon Chul Park* Jun Suk Kim Jin Suk Lee Seonghun Park	United States Paul Grabowski* Jim McMillan
Canada Ed Hogan* Jack Saddler				

IEA Bioenergy Task 39 Newsletter Newsletter #24 - April 2010



Image Source: ef.edu.org

Editor's Notes

Welcome to Issue 24 of the Task 39 Newsletter. I am pleased to join IEA Bioenergy's Task 39 as an editor and coordinator, and look forward to interacting with you in the future. My background includes a Master's of Science degree from the University of British Columbia in Resource Management and Environmental Studies. After completing my degree I then worked on commercializing alternative energy technologies at BC Hydro, British Columbia's electricity utility. I look forward to working with you, the Task 39 Representatives and sustainable biofuels stakeholders.

I would like to invite you to submit your feedback and input for Issue 25 as new information becomes available over the next 4 months. In particular, I am soliciting the most recent developments in your respective countries to provide readers with developments representative of each region. We are currently testing whether this section of the Newsletter (see page 8) will be of value. The benefits of participating include increased exposure of your country's efforts and further discussion of issues of particular relevance. Please send me your:

- Industry developments (incl. important press releases)
- New R&D updates and partnerships, reports and publications
- Opportunities for collaboration and/or faculty exchanges
- Other relevant material on biofuel advancements

I hope you enjoy edition #24 of the Task 39 Newsletter, and I look forward to receiving your feedback and Newsletter submissions. *- Jana Hanova*

About Task 39

The goal of IEA Bioenergy Task 39 is to provide participants with comprehensive information to assist with the development and deployment of transportation biofuels. The Task coordinates both technical and infrastructure issues related to biofuels; we help facilitate collaboration between country representatives, biofuels stakeholders, and industry. Task 39 has the following objectives:

1. Provide information and analyses on policy, markets and implementation issues that help the encourage adoption of sustainable 1st gen and 2nd biofuels
2. Catalyze cooperative research and development projects that will help participants develop improved, cost-effective processes for the production of 'second-generation' liquid biofuels
3. Provide information dissemination, outreach to stakeholders, and coordination with other related groups

We welcome your feedback on the layout and scope of the Newsletter – Please [Contact Us!](#)



Task 39 Management

Operating Agent (Agency) Task Leader (Agency) Associate Task Leader (Agency)	Ed Hogan (Natural Resources Canada) Jack Saddler (Univ. of British Columbia, Canada) Jim McMillan (National Renewable Energy Lab, USA)
Subtask Leads: (Biochemical conversion, N. America) (Biochemical conversion, EU) (Thermochemical conversion) (Link to Advanced Motor Fuels IA) (Policy issues, EU) (Policy issues, North America) (Implementation Issues)	Jim McMillan Michael Persson (Inbiocon, Denmark) Tuula Mäkinen (VTT, Finland) Axel Munack (Germany) Tony Sidwell (British Sugar, UK) Warren Mabee (Queen's University, Canada) Manfred Wörgetter (ABC, Austria)
Task Coordinators: (Coordinator, newsletter editor, webmaster) (Demonstration plant database manager)	Jana Hanova (Univ. of British Columbia, Canada) Dina Bacovsky (ABC, Austria)

INTERNATIONAL ENERGY AGENCY
AGENCE INTERNATIONALE DE L'ENERGIE



FROM 1st- TO 2nd-GENERATION BIOFUEL TECHNOLOGIES

*An overview of current
industry and RD&D activities*

RALPH SIMS, MICHAEL TAYLOR
INTERNATIONAL ENERGY AGENCY

AND JACK SADDLER, WARREN MABEE

IEA Bioenergy

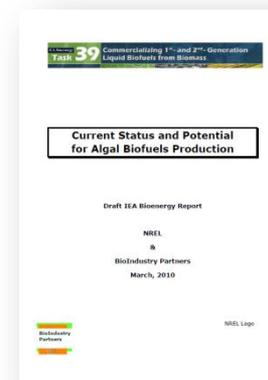
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Reports

Technical and Policy Reports



Sustainability of Biofuels



Algal Biofuels: Current Status and Potential

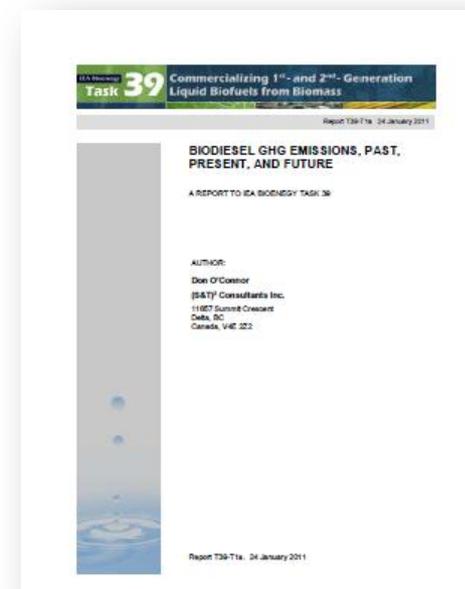
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Sample Report #1

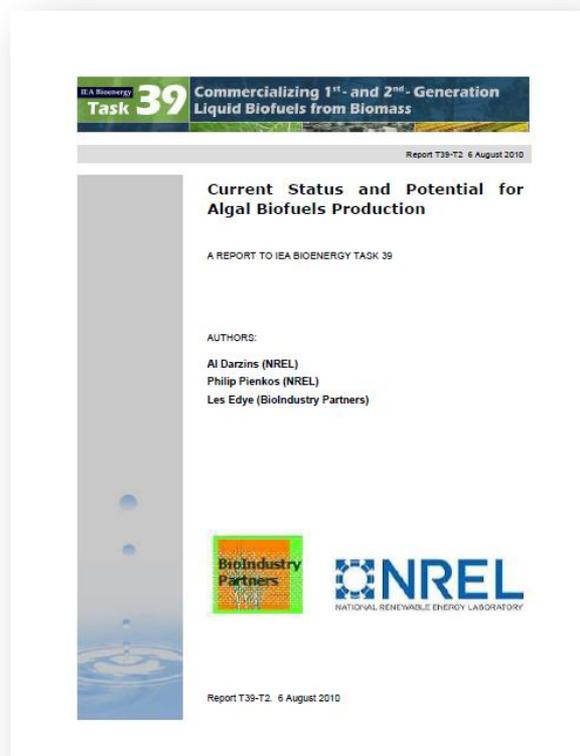
Biodiesel GHG Emissions Past, Present, and Future

■ Scope of Work

1. GHG emissions for biodiesel are estimated for the years 1995, 2005, and 2015
 2. Investigation of production parameters for specific aspects of similar feedstock - Allows for identification of GHG differences in for the same process in different countries
 3. Analysis of GHG emission estimates that have been made for biodiesel production
- Commissioned work by Don O'Connor



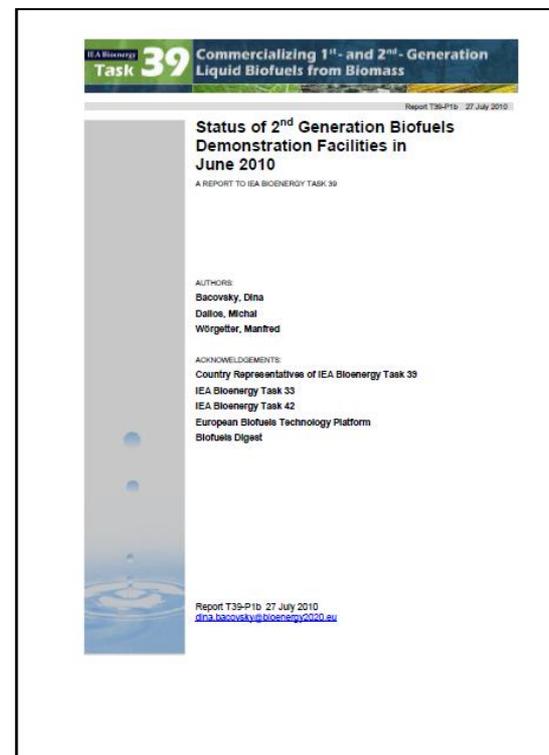
Sample Report #2 - Current Status and Potential for Algal Biofuels Production



- Processing technologies have numerous unique characteristics that merit further RD&D investment
- Despite some overly enthusiastic projections on the cost-effectiveness, microalgal oil-based biofuels are presently at the ‘proof of concept’ or pre-commercial stages of development
- Multiple potential algae production techniques, but some routes are more plausible than others.
- Studies consistently find that photobioreactor costs will greatly exceed those of raceway pond algae production facilities.

Sample Report #3: Update on Demoplants

- List of 150+ projects worldwide
 - Lignocellulosic biorefineries
 - Biochemical, thermochemical and hybrid platforms
- Continue to update facilities in database
- Other? (what other information would be useful?)



Demoplants - Database and Report

- Scope of projects under investigation comprises:

- Product
- Raw Material
- Conversion Technology
- Facility Type
- Status
- Various types of logistical and operational data
- Authors: Dina Bacovsky
Michal Dallos
Manfred Wörgetter

The scope of projects under investigation comprises:

Scope of Projects	
Product	facilities for the production of liquid or gaseous biofuels for transportation
Raw Material	from lignocellulosic biomass
	applying either
Conversion Technology	biochemical or thermochemical or biochemical and thermochemical conversion technologies
	representing either
Type of Facility	pilot or demonstration or commercial facilities
	being either
Status	planned or announced or under construction or under commissioning or operational
	and for which the project owner has provided at least the following data:
Minimum Data	project owner location of the production facility type of technology raw material product output capacity type of facility status and contact information
Optional Data	Additionally, project owners are asked to provide more detailed information, including brief technology description, flow sheets and pictures etc.

Demonstration Plants (Advanced Biofuels)



This overview has been elaborated by ABC (now Bioenergy2020+) and FJ-BLT.



Please click here for more information

Status of 2nd Generation Biofuels Demonstration Facilities

Currently, large efforts are dedicated to the production of biofuels from lignocellulosic raw materials. While only few production facilities are operational yet, many projects are under construction or planned. But which are the companies involved, where are production facilities under construction, and which technologies will be applied? In order to answer these questions, IEA Bioenergy Task 39 has collected data on pilot and demonstration projects and displays the results in a web-based, interactive map. (Click on map to obtain information)

For more information and for data upload please continue reading below the map or contact dina.bacovsky@abc-energy.at



Other Reports in Progress



4. Potential of “Drop-in Biofuels”

- Investigating the potential demand for drop-in biofuels
- Infrastructure requirements, logistical issues, marginal costs relative to conventional and advanced biofuels

5. Comparative analysis of policies in member countries

- Collection and analysis of policy support mechanisms for biofuels in Member Countries
- Requires input from member countries on most recent policy developments
- Goal: To help guide future policy development, learn from overview of shifting policy landscape

6. Energy and GHG Balance of Biofuels

- Country specific analysis of energy and GHG balance of conversion technologies, sensitive to regional and feedstocks
- Identify optimal locations, given feedstock, conversion technology and by-products
- Investigate end-products that maximize cost & environmental benefits in each region

First Nations/Aboriginal time lines

- Oral history
- 7 generational time line (Great grandparents-to-Great grandchildren)
- Putting the “basics” in life to this time frame

- Food
- Shelter, clothing, “home”
- Health
- Transport
- Energy



Acknowledgements

- Jana Hanova/Warren Mabee
- FPB/Bioenergy Group, UBC
- IEA Bioenergy Task 39
- IEA HQ Colleagues
- BERI Initiative at UBC
- Colleagues and collaborators

- Questions?



Thank You!

