



***Summary of the Proceedings of
BioEnergy Conference
and Exhibition 2008***

Prince George, B.C.
June 3–5, 2008

Table of Contents

Presenters.....	1
<i>Day 1:</i>	
Production and Market Trends	5
Production and Market Trends: An EU Perspective.....	5
US Market and Pellet Trends.....	6
Canadian Pellet Production for Worldwide Markets	6
Discussion.....	7
Market and Production Challenges	8
Overview of Biomass and Bioenergy Sources in Northern B.C.	8
Wood Biomass Heating Systems for the Greenhouse Industry	9
Energy Conversion Challenges and Emissions Issues	10
WPAC/UBC Research Partnership	11
Safety in Handling Wood Pellets	11
Wood Pellet Research Program and Summary Results.....	11
A Life-Cycle Analysis of the Canadian Wood Pellet.....	12
Resource Assessment, Logistical Simulation, and Risk Quantification of Biomass Supply.....	13
<i>Success Stories:</i>	
Industrial / Consumer	14
<i>brites</i> : An Irish Wood Pellet Experience	14
A Brief History of the New England Wood Pellet	15
Discussion.....	15
<i>Day 2:</i>	
International Perspectives on the Development of a Bioenergy Economy	17
Bioenergy and the Convergence of the Markets for Fuel, Food, and Fibre	17
Logistical Support of Biorefineries	18
A Canadian Perspective on the Future of Biofuels and Bioenergy	19
A Finnish Perspective on a Bioenergy Economy.....	20
Discussion.....	20
Toward a Sustainable Bioeconomy.....	21
Forest Fuels Reductions and Biomass to Energy: Parallel Opportunities for Public Benefit	21
Building an Index of Site Suitability for Forest Residue Removal.....	22
Toward a Sustainable Bioeconomy: A First Nations Perspective	23

Bioenergy Policy in B.C.: A Pulp and Paper Industry Perspective	24
Bioenergy Opportunities.....	25
Power Procurement and the Bioenergy Call	25
Case Study of a Medium-Sized Bioenergy Facility with Wide Application	26
Biomass Power Generation in China	27
Bioenergy: International Context and Lessons for B.C.	27
Large-Scale Biohydrogen Production in Western Canada.....	28
Bioenergy Opportunities in the Pulp and Paper and Sawmill Industries	29
<i>Day 3:</i>	
Bioenergy Technologies	30
Closed-Loop Distributed Energy and Fuel from Municipal Green Bin Waste	30
Small-Scale Heat and Power at B.C. Mills.....	31
Environmental Aspects and Bioenergy Projects	31
Biocarbon: The Biocarbon Pellet.....	32
Biofuel Production in a Kraft Pulp and Paper Mill: Evaluation of the Potential and Profitability.....	33
Future Directions.....	34
Reflections on Strategy and Policies for Developing the Pellet Market	34
Bioenergy in B.C.	35
Future Trends in Biomass Supply, Policy, and Markets	35
Discussion.....	36
Closing Remarks.....	36

Presenters

Bill Adams

Manager
Manufacturing Services
Domtar Pulp & Paper Products

Sirkka-Liisa Anttila

Minister of Agriculture and Forestry
Government of Finland
Helsinki, Finland

Doug Bradley

President
Climate Change Solutions

Peter Brand

Vice-President
Marketing and Business Development
Pinnacle Pellet Inc.

Bill Carlson

Principal
Carlson Small Power Consultants
Redding, California, United States

Dick Carmical

Founding Partner and President and Chief Executive Officer (CEO)
The Price Companies, Inc.
Monticello, Arkansas, United States

Jo Chau

Masters Candidate
Department of Wood Science
University of British Columbia (UBC)

Bruce Coxhead

President and CEO
Zero Waste Energy Systems Inc.

Irene Coyle

Research Engineer
Biomass Conversion Group
Canada Centre for Mineral and Energy Technology
Energy Technology Centre

Jill Craven

Visiting Fulbright Scholar
UBC

Dan George

President
Four Directions Management Services Ltd.
CEO
First Nations Mountain Pine Beetle Initiative

Ibrahim Karidio

Senior Research Engineer
FPInnovations

Martin Kincade

Project Manager
Power Acquisitions
BC Hydro

Gerry Kutney

CEO
Alternia Energy Inc.

Amit Kumar

Assistant Professor
Department of Mechanical Engineering
University of Alberta

David B. Layzell

President and CEO
BIOCAP Canada
Professor
Queen's University
Incoming Executive Director
Institute for Sustainable Energy, Environment & Economy
University of Calgary

Nelson Lee

Senior Project Manager
Keystone Environmental Ltd.

Larry Mason

Project Coordinator
Rural Technology Initiative
College of Forest Resources
University of Washington
Seattle, Washington, United States

Paul McFarlane

Professor and Head
Department of Wood Science
UBC

Staffan Melin

Founder and Owner
Delta Research Corporation
Research Director
Wood Pellet Association of Canada (WPAC)

Frank Miao

Vice-President
MZ Resources Group Inc.
Arcadia, California, United States

Tony Morice

Vice-President
Marketing and Operations
Marth Companies
Marathon, Wisconsin, United States

Fernando Preto

Group Leader
Biomass Conversion
Natural Resources Canada

Christian Rakos

Managing Director
proPellets Austria
Vienna, Austria

Don Roberts

Managing Director
Canadian Imperial Bank of Commerce (CIBC) World Markets

Fred Scott

Director of Business Development for B.C. and the Pacific Northwest
Pristine Power Inc.

Richard Smith

brites Business Manager
Balcas Ltd.
Laragh, Enniskillen, Northern Ireland

Shahab Sokhansanj

Founder and Director
Biomass and Bioenergy Research Group
UBC

Taraneh Sowlati

Assistant Professor
Department of Wood Science
UBC

Merja Strengell

Leading Specialist
Environmental Management Issues
Department Manager
Pulp Mill Engineering
Pöyry Forest Industry Oy
Vantaa, Finland

John Swaan

Executive Director
WPAC

Evelyne Thiffault

Post-Doctoral Researcher
Canadian Forest Service

Garth Thoroughgood

Senior Policy Advisor
Bioenergy and Renewables Branch
Electricity and Alternative Energy Division
Government of British Columbia

Steve Walker

President and CEO
New England Wood Pellet
Jaffrey, New Hampshire, United States

Day 1: Production and Market Trends

Production and Market Trends: An EU Perspective

Christian Rakos
Managing Director
proPellets Austria
Vienna, Austria

Christian Rakos described the European pellet market as being in its infancy, with a limited number of countries participating in three types of business: power, heat, and mixed goods. The market is characterized by dynamic growth, for example, in Italy, France, and Germany.

In 2006, Europe experienced a “supply crunch”; prices increased by over 60%, and pellet producers were accused of taking advantage of high oil prices. As a result, Rakos said, stove and furnace sales declined. A warm winter further reduced demand, and new production plants arose, causing a glut and rapidly declining prices.

“A sharp increase in pellet use is expected in commercial and residential sectors,” said Rakos, given that “people are upset with oil prices.” Wood pellets currently have a price advantage over oil of 65%.

In the power market, a substantial increase in demand can be expected since the “United Kingdom is finally boarding the ‘pellet train,’” Rakos said. Several countries are utilizing pellets in co-firing, and the Netherlands is building new power projects.

Rakos reviewed several challenges ahead, including the quality of pellets, stoves, and services. However, the policy front is dynamic and encouraging. The “EU directive for renewable energy is now in the ‘hot’ phase of negotiation,” he said, and the overall target is 20% renewable energy by 2020 without particular sector targets.

Rakos pointed out the differences in subsidy requirements, which are lowest for pellets for heat, compared to biomass electricity and biofuels. “Once policy-makers realize the renewable heat route is so much more efficient and cheap,” he said, “they will react.” An 18% annual increase is projected in global pellet production.

Europe’s rapidly growing market will continue to import pellets. Rakos concluded that Canada is in a strong position to become an important player in the international pellet market, encouraging Euro-Canadian cooperation.

US Market and Pellet Trends

Tony Morice

Vice-President
Marketing and Operations
Marth Companies
Marathon, Wisconsin, United States

Marth Companies refines biomass materials into pellets. Tony Morice tracked trends in energy consumption by end-use sector from 1949–2006. Biomass has played a relatively minimal role until recently; however, this could change given the “drastic” increases in liquid fuel prices in the last 12 months.

Since 2005, pellet production has increased in six Midwestern states by 700%. Unfortunately, Morice said, the perception of wood heat is that it generates pollution.

The industry declined between 2006 and 2007 by 16%, in part as a result of current economic uncertainties and lack of incentives. “We need to create additional demand and efficient utilization beyond current levels,” Morice said.

He reviewed recent legislation and emphasized that biomass heat is the only unsubsidized energy. Although pellets exceed the efficiency of other biomass fuels such as ethanol, raw materials are being drawn elsewhere with electric renewable portfolio standards, production tax credits, and liquid fuels incentives. “Growth and opportunities for the future are good for thermal heat if we can create the proper demand via parity in legislation,” he said.

The Pellet Fuels Institute (PFI) is challenged to keep new pellet producers—often “rugged individualists,” said Morice—involved and data accurate. Even so, “membership has jumped.” PFI commissioned the University of Wisconsin to examine the life cycle of pellets in terms of energy expenditures, fossil energy expenditures, greenhouse gas emissions, and process costs. The life cycle assessment study validated that wood pellet fuel is an effective way to sequester carbon. Thermal heat from biomass is 75%–90% efficient, compared to 20%–30% for electric and 40%–60% for ethanol.

“PFI needs to transition focus to US energy interests from its origins in the hearth industry to gain involvement from new mega-mill players and to increase its voice,” Morice said.

Canadian Pellet Production for Worldwide Markets

Peter Brand

Vice-President
Marketing and Business Development
Pinnacle Pellet Inc.

Pinnacle Pellet Inc. currently has four production facilities, said Peter Brand. The company produces approximately 500,000 tonnes per year and has a new plant nearing completion.

The Wood Pellet Association of Canada (WPAC) is an industry advocate. It increases awareness among the energy sectors and government, and supports research projects at the University of British Columbia (UBC).

Both production capacity and actual production of wood pellets are increasing in Canada. Although “many pellet plants get announced, few get built,” Brand said. Canada is expected to produce two million tonnes in 2008, most of which will be exported to Europe.

Brand summarized the challenges facing the export industry. These include market pricing habits, which reflect an immature industry; ocean shipping, land and storage logistics and rates; customer relations; and the financial challenges of large inventories and increasing operating costs.

Brand paraphrased John Swaan, executive director of WPAC: “If you’re in the wood pellet business ... you’re in the ‘green energy’ business.” In the context of global warming, Brand noted the results of an Ontario study: pellets were the lowest cost among fuel types to offset one tonne of carbon dioxide (CO₂). “Now that British Columbia has taken the lead, and Ontario and Quebec have just signed a cap-and-trade system, incentives will be there,” Brand said.

The pine beetle infestation has affected an area twice the size of Austria and made available 400 million cubic metres of timber volume for “non-traditional use.” Brand stated that “one of the roadblocks we face as producers in developing the local market is equipment” and getting certification to CSA standards, and he gave examples of schools and other projects with boilers in Canada. He contrasted Whistler and Austria in terms of fossil fuel and pellet reliance respectively. He noted the perception of wood as a “dirty” fuel.

In closing, Brand said prices will stabilize, and exports will grow and expand to Asia, aided by the abundance of raw material in Canada.

Discussion

A participant commented that most of the discussion had been about turning wood chips into pellets, and asked whether there are any statistics about grass pellets.

Morice said he had done a study on switch grass and a study has been done in Canada. There is data out there, he said, but he did not know the details.

Another participant noted the surprisingly good heat value, and less ash than anticipated with switch grass.

Rakos said his company is producing pellets from straw and grass for animal bedding only. They have the same heat value but are more difficult to burn, requiring specialized boilers. A number of Austrian companies are investigating this.

One participant asked where all the needed fibre is coming from for this huge growth potential.

Morice said that due to the lack of parity he had referred to, plants in the Midwest are not utilizing facilities to full capacity. This is not because they cannot access the fibre, but because it is not cost effective.

“We do import fibre already,” said Rakos, not for a lack of it but because of the increase in the market.

Market and Production Challenges

Overview of Biomass and Bioenergy Sources in Northern B.C.

Ibrahim Karidio

Senior Research Engineer
FPInnovations

Ibrahim Karidio identified four groups of biomass sources: cellulosic materials from wood residues, agricultural crops, animal wastes, and municipal and industrial solid wastes.

"B.C. has a huge land mass," Karidio said. Of the total provincial annual allowable cut, 47% comes from the Northern Interior. B.C. generates 31% of Canadian wood residues and 66% of Canadian surplus wood residues.

Karidio said straw and stover produces 1.8 million bone dry tonnes (BDT) of cellulosic biomass per year. Further, he said it is significant that 99,300 BDT of agricultural residues are produced annually, largely by hay and barley. But "agricultural production is not considered to be a big source of biomass in B.C.," he said.

B.C. is responsible for 5% of the annual Canadian production of biomass from animals' manure, with a gross revenue potential of \$32 million.

Municipal and industrial wastes were estimated using data from the Foothills Boulevard Regional Landfill in Prince George. The energy value of the recyclable portion of solid wastes handled by the landfill is 705,000 gigajoules (GJ) per year. The landfill gas collected at the site has an energy value of 56,500 GJ per year. Currently, "they basically burn it," Karidio said. "This energy could be used more usefully."

Turning to biomass conversion technologies, he stated that wood densification technology has reached commercial maturity, although there are concerns about chemicals in the ashes. For gasification, the technology to produce syngas is established in the marketplace, but "the technology to produce fuel or hydrogen is at the demonstration stage." Pyrolysis, combustion and cogeneration, and transesterification that produces biodiesel from waste oil and grease are commercially mature. Another method using wood extractives is nearing market maturity, but is facing some cost challenges.

Furthermore, the fermentation process that uses grain and cereal crops to produce ethanol is commercially mature, and the fermentation of agricultural residue is nearing market maturity. Using wood residues presents more technical challenges because "the five carbon sugars are not as easy to degrade," Karidio explained.

Referring to the economies of scale, he said that to be viable, biofuel plants must be of "significant" size; therefore they require large capital investments.

By 2010, the Canadian market demand for bioethanol is expected to be 2.74 billion litres, and the demand for biodiesel is expected to reach 610 million litres. Currently, B.C. "doesn't have enough canola to see the oil to make biodiesel."

Among the several sources of biomass and bioenergy in B.C., "cellulosic biomass is the most abundant and offers the highest potential for bioenergy production," said Karidio. Emerging

biomass conversion technologies are at varying stages of commercial maturity, and the economies of scale "make technology costs high and demand strategic financing."

Wood Biomass Heating Systems for the Greenhouse Industry

Jo Chau

Masters Candidate
Department of Wood Science
UBC

Jo Chau is a member of the UBC Biomass and Bioenergy Research Group.

The greenhouse industry is a "fast-growing and important industry in Canada," said Chau. In greenhouses, products are grown under perfect conditions, for which heat and CO₂ are the most important and expensive elements to produce. The majority of greenhouses use natural gas boilers to provide these two elements. In this system, the natural gas is combusted to provide heat, and the resulting CO₂ is injected directly into the greenhouse. This system "is very efficient." In addition, "natural gas combustion is considered one of the cleanest combustions compared to other fossil fuels," she said. But because natural gas is non-renewable and prices have been rising, the industry is investigating alternatives.

A wood biomass heating system is considered carbon neutral. The system is less efficient than one using natural gas, however, and the flue gas cannot be injected into the greenhouse, requiring the additional purchase of liquid CO₂. Biomass combustion generates fewer greenhouse gases than combusting natural gas, but the emissions may give rise to air quality concerns.

Barriers to using biomass heating systems include the high capital cost, air-quality concerns, and the long-term availability of biomass. Metro Vancouver has proposed a new bylaw that would restrict emissions from a wood biomass boiler. In addition, "as the demand goes up for biomass," said Chau, "so does the price."

Her research sought to determine the viability of using wood biomass for greenhouse heating and to identify the optimal biomass fuel mix to minimize the annual total cost. Using techno-economic analysis, Chau tried to find out "if it is feasible to use a wood biomass boiler to produce 40% of the heat demand," with the remainder met by natural gas. An advanced emissions system such as an Electrostatic Precipitator (ESP) would ensure air quality.

Comparing wood pellets and wood residues, Chau determined that most scenarios are economically feasible for all sizes of greenhouses, with the exception of a wood pellet system with an ESP, which she attributed to "the high cost compared to residue." Sensitivity analysis was conducted and delivered the same results. She said that if more than 40% of the heat is provided by wood biomass, the benefits to the industry increase.

Chau used a linear programming model to determine the optimal fuel mix. She "obtained a solution with all constraints satisfied, and the emissions are below the limits proposed in the new bylaw." Sensitivity analysis determined that results do not change if fuel prices fluctuate.

Chau concluded from her research that using wood biomass could significantly benefit the greenhouse industry.

Energy Conversion Challenges and Emissions Issues

Irene Coyle

Research Engineer
Biomass Conversion Group
Canada Centre for Mineral and Energy Technology (CANMET)
Energy Technology Centre

Irene Coyle said rising fuel prices have driven industry interest in biomass. "They want to stay in business, so they need new fuel solutions," she said. Existing negative perceptions are "largely due to some old, dirty techniques," but the implementation of standards could address this concern.

One challenge for manufacturers and operators is the variability of regional emissions standards. Monitoring requirements also vary widely and can result in increased costs for operators. Coyle presented data illustrating that sampling crews using the same methodology can still obtain different results. In addition, agricultural users fall under different, less stringent standards than commercial and industrial users. Guidelines for biomass storage are also not standardized and are not necessarily enforced, but proper storage is important for many reasons, including minimizing the risk of spontaneous combustion.

Another challenge is the lack of biomass fuel standards. "One property that is relatively standardized is the energy content," said Coyle. She presented analyses of the composition of various biomasses, alerting participants to concerns, including levels of ash and chlorine.

"Fuel properties affect the performance of your systems," she said. Despite concerns such as high moisture, impurities, contaminants, and high ash, fuel-quality standards have not been implemented. WPAC is leading the efforts being made. "With standards come a product that can be exported."

"Fuel properties and quality can have an enormous impact on emissions," she said, presenting data measuring the wide variations in particulate matter emissions from different fuels. "Fuel specifications are critical for a well-operating biomass system." In the absence of standards, "we depend on trained personnel to make up for this and inspect the fuel."

Another challenge that manufacturers and operators face is "the great importance of trained personnel," said Coyle. "Operators who are trained can see quality fuel, understand the conversion, know what good emissions mean, and can tie those things together." She suggested that manufacturers should offer training for buyers of biomass energy systems and perform remote monitoring to assist with troubleshooting.

In summary, Coyle said the wide variation in air emissions standards across Canada "can be an impediment to growth." The absence of established fuel-quality standards can reinforce the negative perception of bioenergy "that doesn't need to be present." In the absence of these standards, programs must be established to train personnel.

WPAC/UBC Research Partnership

Safety in Handling Wood Pellets

Staffan Melin

Founder and Owner
Delta Research Corporation
Research Director
WPAC

Canada is primarily a bulk producer and exporter of pellets with large mills that make, on average, 56,000 tonnes per year, said Staffan Melin. When shipped in large volumes, pellets are classified as hazardous material, although wood pellets in consumer bags are benign. For example, carbon monoxide (CO) gas emissions released by pellets killed a person in the cargo hold of a ship in 2002.

A research project was undertaken to examine gas concentration on board ocean vessels. "Astonishingly high levels of CO" were found in six vessels, in addition to dangerous levels of CO₂, methane, and oxygen, Melin said. UBC launched an extensive research program to verify off-gassing in vessels. Corresponding values in closed reactors were found: after about five days, in excess of 12,000 parts per million (ppm) of CO existed—"a deadly dose."

"We have now installed a large research reactor at UBC to look at stratification," Melin said. "When we fill up the holds with layers of pellets, we may get heated zones." Heat is produced by bacteria and fungi through microbial oxidation and through chemical oxidation. Ultimately, as the temperature increases, an "exothermic situation," or explosion, can occur. This happened in Denmark and northern Sweden, where silos holding pellets burned for months. WPAC is funding fire-extinguishing research at the laboratory scale to examine the effects of nitrogen and CO₂.

Dust clouds develop during the loading of large vessels. "Inhaled wood dust is dangerous for workers," Melin said, reviewing threshold limit values for several species of trees. With high concentrations, explosions are possible.

He provided guidelines and regulations that are being developed to address these issues, as well as ISO/TC 238 standards for solid biofuels.

Wood Pellet Research Program and Summary Results

Shahab Sokhansanj

Founder and Director
Biomass and Bioenergy Research Group (BBRG)
UBC

BBRG's vision is to create a comprehensive design package for pelleting technology, said Shahab Sokhansanj. "It will contain engineering data and procedures for procuring biomass, [and for] producing and delivering pellets as a choice feedstock to the emerging bioindustry." He said he would debate the statement made earlier that morning that biomass is not a mature technology: "We need to improve the cost of production."

“We are taking a material variable in density and moisture content and making a very uniform product ... with very few manufacturing steps, compared to many intensive conversion processes,” Sokhansanj said. This process is located at rural centres and employs people close to the production of the materials.

The group’s five-year research program, “modelling of off-gassing for wood pellets,” addresses the education and training of high-quality personnel to support this emerging industry. The research investigates several topics, stated Sokhansanj, including the safe handling and storage of pellets, and off-gassing and self heating. Two students are working on spontaneous heating and ventilation. When fine, coarse, low-temperature pellets were compared with torrefied chips and switch grass, torrefied chips emitted the lowest CO.

Changes in physical properties of pellets occur with storage time. As bags of pellets are handled and stored, fines are generated, and some durability is lost. Modelling and simulation is being used to investigate the optimization of pellet production and control strategies for pellet storage.

Enhancing the quality of pellets through steam explosion and torrefaction is also being studied, as are the energetics of these methods. Torrefaction appears more promising than steam explosion.

“We’re becoming a centre for excellence in this area, and we hope to support the industry to move forward,” said Sokhansanj.

A Life-Cycle Analysis of the Canadian Wood Pellet

Jill Craven

Visiting Fulbright Scholar
UBC

Jill Craven outlined the negative perception of wood pellets as energy and noted the “need to look at the whole story” of how they are produced.

“Life-cycle analysis (LCA) is a tool to quantify the environmental burden of a process or product,” she said, and it permits comparison with other products. LCA covers the extraction and processing of raw materials, manufacturing, packaging, marketing, use, recycling, and /or disposal.

An LCA for wood pellets helps to

- Demonstrate the product as a clean alternative energy
- Recover product energy efficiency and fossil fuel content
- Aid in sustainable biomass certification
- Conduct feasibility studies for future plant design

Craven’s research focuses on the second step of the “four steps for a complete LCA”: the creation of a life-cycle inventory database.

She is studying onsite fuel consumption emissions and upstream emissions from fuel production. The functional unit is one tonne of wood pellets. Emissions information is critical, although not directly obtainable, so Craven collected energy consumption data and converted it. A range of information has been obtained, including harvesting, sawmill operation, and

transportation. Information on fuel and electricity consumption of plants, feedstock, pellet characteristics, and machinery involved in pellet processing is currently missing.

"I've learned that every pellet plant is unique, so that makes it difficult to generalize about them," Craven said, explaining the survey to obtain missing information. Preliminary results show that for Europe-bound pellets with a heating value of 18 GJ/tonne, total upstream fuel consumption is 7.8 GJ/tonne, of which approximately 50% is fossil fuel and 50% is renewable. Domestic-bound (i.e., Vancouver) pellets with a heating value of 18 GJ/tonne have total upstream fuel consumption of 5.2 GJ/tonne, of which approximately 20% is fossil fuels and 80% is renewable.

Craven recommended that site visits be conducted to complete the plant survey, that energy consumption allocation to sawdust and shavings in the mill be investigated, and that wood pellet LCAs be compared to natural gas and coal.

Resource Assessment, Logistical Simulation, and Risk Quantification of Biomass Supply

Taraneh Sowlati

Assistant Professor
Department of Wood Science
UBC

Taraneh Sowlati and co-authors Jamie Stephen, Shahab Sokhansanj, and Toni Bi researched biomass supply. Generally, in assessments of bioenergy potential, biomass supply is assumed to be constant over an extended period of time for a particular region. This assumption is not realistic in the context of agriculture, said Sowlati. "Because there has been little examination of supply reliability, we wanted to examine changes in biomass over the lifetime of a power plant." Sowlati and her colleagues also determined the delivered price of feedstock.

The Peace River region in Alberta served as a case study: it experiences boom-and-bust production and its situation is applicable elsewhere. For the resource availability analysis, Sowlati used geographic information systems and historic crop yield data to estimate average production for 10 sites in the region. From these, "we chose four sites with greater than 250,000 tonnes within a 100-kilometre radius of town." Data on grain yield from 1980–2000 was used to estimate average, minimum, and maximum production. The latter is key when considering supply for power plant or biomass processing.

Oats provided the most biomass overall, compared to barley and wheat. Biomass minima were close to zero for several sites. All crops had high and low yields in the same years; Sowlati said that "some years you may end up with no biomass if you only rely on local [sources]."

Cost variability analysis used an integrated biomass supply assessment and logistics model to simulate the harvest and transportation of biomass. Harvest cost varied from \$18–\$34 per metric tonne and was mainly affected by average biomass yield and weather conditions. Distance travelled and plant capacity influenced transport costs. Sowlati concluded that feedstock availability is a major business risk and that boom-and-bust regions are a poor choice for agriculture biorefineries.

Success Stories: Industrial / Consumer

***brites*: An Irish Wood Pellet Experience**

Richard Smith
brites Business Manager
Balcas Ltd.
Laragh, Enniskillen, Northern Ireland

Richard Smith said he would share his experiences over the last two-and-a-half years. "What we've done isn't necessarily right for here," he said, "but it worked for us."

Balcas has a number of facilities all over Europe, including a sawmill in Estonia that also produces wood for construction. A pellet plant is currently under construction in Scotland. Balcas has branded its wood pellets *brites*.

For sawmills in Ireland, "electricity is a huge cost"—up to eight times the 6 cents per kilowatt hour paid in B.C. This sparked the development of *brites*. Balcas's first residential sales were in 2006, and in 2008 "we had to import to meet the markets we'd developed," Smith said.

He displayed a schematic of the energy equation of the Balcas plants. All the waste material goes into combined heat and power. Heat dries the sawdust and generates electricity to make the pellets, and at night surplus electricity is sold back to the grid. "It's an exceptionally efficient system," stated Smith.

Balcas focuses on the residential, commercial, and "bagged" markets. The residential market is "demanding" and "requires investment," Smith said. He outlined a number of challenges and solutions. One key strategy was to design a unique, above-ground holding tank, because "people said they didn't want underground tanks in their gardens." In addition, when the task of accepting phone orders became overwhelming, Balcas created an online ordering system that both "made life dramatically easier and removed all credit risk."

The commercial market is exciting, said Smith, but there are "long development times, you have to work hard, and you need the right people." Marketing should be directed first toward certain key figures, such as architects, consultants, and developers. A hospital or a hotel with a leisure centre is "an ideal customer," he said, because "it's absolutely flat demand."

For the bagged market, focus groups were conducted to determine the ideal size of the sacks. Customers said they "don't want to lump 40-pound bags through the house Your customers will tell you, if you go and ask them," Smith advised.

"We created a market from nothing," he said.

Balcas is now focusing on the burgeoning UK market. Goals include making *brites* the primary brand of wood pellets.

In summary, Smith said that to convince customers to switch from oil and gas, which is "what they've done for generations, we have to give them confidence."

A Brief History of the New England Wood Pellet

Steve Walker

President and CEO
New England Wood Pellet
Jaffrey, New Hampshire, United States

Steve Walker started his company in 1992. New England Wood Pellet has grown from a single, "little tiny mill" to a 100,000-tonne plant; a research, development, and fabrication facility called Biofuel Energy Systems; and Palmer Reload and Packaging Center, which packages product brought by rail from B.C.

Walker's next initiative is to bring boilers into the US industrial northeast commercial market. Working with companies in Austria and Sweden, he said he insists on the "need to build a market beyond just the pellet stove."

Consumers are "a fickle group of people," stated Walker. To store large quantities of inventory at the New York plant, he said the plant manager convinced the town to allow him to use the dead-end highway: "We filled the whole road with pellets."

Describing some challenges he faced, Walker said that "fire is always a good one. It only takes fuel, oxygen, and an ignition source at 2:00 a.m. to start a fire." Cost competitiveness is another one. In 1998, having borrowed \$2-\$3 million to construct his third plant, the barrel price of oil sank to \$10.

The events of September 11, 2001 and Hurricane Katrina caused consumers to panic and hoard pellets. Within a month of the hurricane, Walker's inventory was entirely sold. "We thought it was the market," he said, and the subsequent year, "we were standing there, not knowing what to do with our factories because everyone had accumulated all this fuel." Managing supply and demand and dealing with market volatility is a key challenge.

Thermal renewable energy is "the only non-subsidized fuel in the United States." Walker said there is a great opportunity to work with government to achieve parity in government support.

The regulation of CO₂ will also present a major growth opportunity for the industry. Walker stressed the importance of strong trade organizations and of working with Canadian and European associations.

Discussion

A participant asked Smith if Balcas ever "just sells energy," following the model of the Energy Service Company.

Smith said, "It's something I'd like to try" but that Balcas does not currently do this—"yet," he added.

Another participant asked if the community heating projects in Ireland have given rise to any air-quality concerns.

Smith answered that such projects have not been an issue in Ireland, but they are emerging in Scotland. He said ensuring that commercial installers can provide accurate emissions information can mitigate negative perceptions.

Asked if Ireland has any plans to pelletize peat, Smith said the current drive is to “reduce the use of peat rather than find ways of using more.”

Another participant asked if Walker was concerned about overcapacity in the US northeast.

Walker said he was, but added that 85% of pellet plants that have been built have failed. “I don’t count chickens even if they have hatched, because they don’t always last,” he said.

A participant asked Smith why the brand is called *brites*.

He said that in a competition held in six schools, a 12-year-old suggested the name. The goal in branding was to move away from perceptions of wood as a “dirty fuel.” And, Smith added, “We like to think the future’s bright.”

Day 2: International Perspectives on the Development of a Bioenergy Economy

Bioenergy and the Convergence of the Markets for Fuel, Food, and Fibre

Don Roberts

Managing Director
Canadian Imperial Bank of Commerce (CIBC) World Markets

Don Roberts said four key variables are driving the economics of biofuel production: the price of fossil fuels, the cost of the feedstock, the “plethora” of conversion technology, and regulations, which stimulate demand. These variables are in flux, which presents a dilemma for investors, who “hate uncertainty.”

Conversion technologies are at varying stages of market readiness. As “some of the best minds in science are working on this issue,” investments should not be based solely on what is currently marketable.

Roberts said there are two key guidelines for public bioenergy policy. First, it is more efficient to use biomass than biofuels for heat and electricity production. Second, when allocating public wood, pulp and paper generate a higher gross domestic product and more employment than bioenergy alone.

“One of our key challenges in using [Canada’s] abundance of wood,” Roberts said, is the expense of transporting low-energy-density wood.

Roberts described the three stages a pulp and paper mill must follow to move to biorefining and listed the key factors for success.

The convergence of food, fuel, and fibre markets is “happening for a whole series of reasons,” which are “all based on anxiety,” he said. Different countries are responding to this union in different ways. Corn-based ethanol has “exploded” in the United States. Because “the price of corn is going through the roof,” the country is turning to cellulosic ethanol. China is encouraging cellulosic ethanol rather than grain-based ethanol. Industry is responding to this convergence by creating strategic alliances, often composed of “oil and gas or chemical companies reaching out to the fellows who control the feedstock.”

The market convergence means that “the major feedstocks for food, fuel, and fibre are going to trade over time on the basis of their energy equivalency.” Increased demand placed on land use will result in rising land prices, and “you can bet there will be land-use conflicts,” Roberts said.

He outlined some of the advantages of using wood to produce biofuels, including longer storage life, which is “an important advantage over the sugar cane in Brazil.” The greatest pressure to convert forest land to bioenergy crops will be in tropical countries, where the land is so productive “you can hear [the trees] grow,” Roberts said.

Convergence has important analytical implications. Roberts advised participants to “break out of your silos.” He expressed concern that “our analytical capacity has been diminished: we don’t have the people to think about it as well as we should.”

The organizational implications of the convergence of food, fuel, and fibre markets include the need to establish “teams that cut across sectors.”

Roberts said the policy implications “depend on who you are”: a “focused fixer” or a “paradigm shifter.” Focused fixers, he explained, “think we’re pretty smart and that we can figure a way out of this.” Paradigm shifters, who are “not only on Saltspring Island,” think the solution lies in decreasing consumption and in fundamental behavioural change.

A worldwide survey found that executives in North America rated climate change as less important than did executives elsewhere. “Wake up!” Roberts said.

Once carbon trading is introduced, if the price of carbon rises to the levels required to meet the Canadian greenhouse gas targets, major trade issues could ensue. Land will be the scarce resource, and Canada’s forests will be “more valuable than people think.”

Roberts projected that the convergence of fuel, food, and fibre markets will cause the global cost curve for fibre to shift up and then flatten. As a result, regions will have to compete on variables other than “just wood,” such as access to a skilled labour force and a solid environmental record.

Logistical Support of Biorefineries

Dick Carmical

Founding Partner and President and CEO
The Price Companies, Inc.
Monticello, Arkansas, United States

Dick Carmical said America’s addiction to oil resulted in “a soap opera” rather than “an issue everybody could be united on.”

The US Department of Energy provided up to \$385 million to six cellulosic ethanol plants. “That money is one-third of what the United States will purchase today in oil and 20% of the cost of these facilities,” Carmical said. The Department of Energy also provided some small-scale grants. He listed several current cellulosic ethanol projects: “They’re all struggling as we speak.”

After the technology is created, the focus will be on “where the raw material is.” Carmical used a map to show the various sources of renewable energy in different regions of the United States.

Widening the procurement circle of biorefineries adds significant cost. This must be factored into the design of facilities. “As you make [the facilities] bigger because of the economies of scale, you’re stretching out that procurement circle,” he said.

Carmical outlined some challenges facing the US raw materials industry, and suggested some solutions. One challenge is suppliers’ trust, which could be won by ensuring a consistent market, a fair price, and long-term contracts. “Loggers don’t have the margin to support bad technology,” he said, “so new technology has to be able to pay a consistent price.”

"We've learned that the consumer is not going to pay any more for a 'green' product," remarked Carmical. Government incentives are currently inadequate: "We're asking these guys coming out of the chute to compete with Exxon."

"The linchpin in the successful new technology," he said, is producing enough biofuel to assuage dependency on foreign oil.

A Canadian Perspective on the Future of Biofuels and Bioenergy

David B. Layzell

President and CEO

BIOCAP Canada

Professor

Queen's University

Incoming Executive Director

Institute for Sustainable Energy, Environment & Economy

University of Calgary

Concerns about grain-based biofuels include their "impact on food prices and availability," said David B. Layzell, and that their capacity to contribute to liquid fuels is inadequate.

He said there are three main drivers for bioenergy: the rural economy, climate change, and energy security. In March 2008, the Government of Canada stated that its driver is the rural economy. "I think this is unfortunate," Layzell said. "Canada's policy should address energy security and climate change, and then the benefits to the rural economy will come."

Canada exports more than 50% of the energy it produces. "We are an energy superpower," Layzell said. Natural gas production is currently peaking, however, and the quantity available for export will decrease. As a result, "we will be increasingly dependent on less friendly areas of the world." Bioenergy currently comprises 5% of Canada's total energy use. "If we want it to contribute significantly to energy security and climate change, we need to start talking at a scale that will make a difference," he said.

"If we don't eat or [didn't] have fibre or wood, we could provide 22% of the primary energy needs of Canada," commented Layzell. "Bioenergy isn't the only solution to our energy problem."

There is a great potential for sustainable production of biomass, but "it is a real problem that Canada has no target for biomass." A reasonable target, he said, is 20% of energy needs by 2030.

If climate change were the main driver, wood and straw pellets would be "the biofuel of choice," Layzell said. "It's not a great investment in terms of cost," but "if half the subsidies given to oil were given to biofuels, it would be competitive."

Of the promising biomass-to-liquid fuel technologies, thermochemical conversion is "the most exciting." A study conducted by Volvo identified it as the preferred biofuel.

Straw and wood feedstocks are better than grains because of "basic biology," Layzell said. In grain crops, a large portion of the energy that is originally trapped is used to produce nutritional products. "You want feedstocks that no self-respecting insect or animal would want to eat," he explained.

To deliver on the proposed biomass energy target, Canada will need transformative bioenergy systems. Options include creating a bioenergy corridor around natural gas pipelines. Layzell suggested that instead of using natural gas, “a high-quality fuel,” for oil extraction in Alberta, “we should figure out how to move biomass through the pipelines to the oil sands.”

In conclusion, Layzell said, “We need to break down the barriers between forestry and agriculture. We’re on the same side.”

A Finnish Perspective on a Bioenergy Economy

Sirkka-Liisa Anttila

Minister of Agriculture and Forestry
Government of Finland
Helsinki, Finland

Sirkka-Liisa Anttila provided a European and a Finnish perspective on the development of a bioenergy economy.

Member countries of the European Union (EU) have pledged that by 2020, 20% of their total energy consumption will be from renewable sources, with at least 10% of their transport fuel consumption from biofuels. To reach these targets, some countries “have to start almost from scratch.” But for those that have already invested in renewable energy, increasing the percentage “requires a lot of effort.”

In Finland, one-fifth of the total energy consumed is from wood-based fuels. The majority is derived from by-products of the forest industry. “Reaching this target requires decisive action in all renewable energy sectors,” Anttila said. “The biggest potential lies in the forests.”

The Finnish government recently adopted a new National Forest Program, which is concerned with the role of forests in energy production. Listing the advantages of wood-based energy, Anttila said the Government of Finland is particularly interested in the creation of new business and employment in rural areas. She acknowledged that increasing the production of wood-based energy will heighten the competition for wood, and a balance must be sought.

“The most suitable option for Finland to increase the use of wood for energy generation,” Anttila said, “is to increase the use of forest chips.”

Discussion

A participant said BC Hydro “insists on retaining green credits as part of the electricity price rather than allowing the proponent to retain the green credits.” He asked Roberts if this is an impediment to competition in these markets.

Roberts answered that although he is unfamiliar with the BC Hydro proposal, “my sense is that it is an impediment.” He added that “it depends who you compare yourself against. You’re light years ahead of New Brunswick, where there’s zero benefit to green energy.”

Another participant suggested that the immediate source of power to “satisfy the North American appetite” would come from nuclear power. He agreed that “solid fuels energy is the way to go,” but said there is no federal government support. “We need a strong, sophisticated lobby group in Ottawa,” he said.

In response to a question about the role the Government of Finland has played in integrating operations and procurement, Anttila confirmed that Finland exports related technology. She said cooperation with other regions is important “to achieve our common targets.”

Toward a Sustainable Bioeconomy

Forest Fuels Reductions and Biomass to Energy: Parallel Opportunities for Public Benefit

Larry Mason

Project Coordinator
Rural Technology Initiative
College of Forest Resources
University of Washington
Seattle, Washington, United States

Larry Mason has investigated the links between forest health problems and biomass to energy. “There are some real disconnects,” he said.

Washington’s Inland West is “at a high, unprecedented risk of a catastrophic crown fire,” unless fuel loads are reduced. The rhetorical problem with reducing these fuel loads is that the cost of removing small diameter fuels may exceed their market value. “But there are values other than net log returns that should be considered,” Mason said.

These other values include the public cost of fighting fires and the value of the timber that would be lost in a fire. Mason added such elements to the net present value and determined that despite the high cost of removing fuel loads, there would be a net positive return. For the Fremont and Okanogan national forests, there would be a net savings above \$1.3 billion.

Still more values must be considered, such as the worth of habitats lost, the cost of erosion, and pollutants released by forest fires. The CO₂ pollution from the 2006 Okanogan forest fire was six times the government’s climate change mitigation objective for that year. “What you begin to see is that as we hesitate to invest in forest health,” said Mason, “it indicates that we’re ignoring the true public values that are at risk.”

Forests are “uniquely important”: standing forests accumulate biomass through photosynthesis, timber used in construction retains its carbon, and when wood is used to displace petroleum, a net carbon benefit results, not merely carbon neutrality.

In Washington State, biomass is the single largest source of non-hydro renewable energy. However, biomass to electricity is “especially challenging in the Pacific Northwest,” said Mason, because of the abundance of inexpensive hydroelectricity there. But high gas prices “should make biomass more economically attractive.”

The majority of Washington’s forests are on public land. Mason advised B.C. participants to “be grateful that your federal government does not own your forest.” Contribution from public lands is essential to ensure supply certainty.

Mason outlined the Washington State government’s energy objectives and showed that they can be achieved by using wood biomass-to-liquid fuel. This would also deliver “twice the CO₂

benefit by removing materials that would otherwise be burned in the fire." He discussed the net energy balance of different biomass and illustrated that low-intensity crops like grasses and trees provide a much more advantageous net energy balance.

Pulp and paper mills are currently struggling. If support systems like low-cost loans and government subsidies were put in place, "these mills could become biorefineries," Mason said. They could "save the industry and provide us with renewable energy."

Mason emphasized that fuel loads must be reduced or they will be burned in a forest fire. "Without action, the opportunities are going up in smoke."

Building an Index of Site Suitability for Forest Residue Removal

Evelyne Thiffault

Post-Doctoral Researcher
Canadian Forest Service

Evelyne Thiffault said she would address ecological issues, although she emphasized that she believes "producing bioenergy from forest biomass is a great idea."

Forest biomass has an ecological value that must be considered, she said. If forest residues are removed to produce bioenergy, then the forest system is deprived of carbon and nutrients, and "you will impact the forest ecosystem."

Negative consequences of removing biomass from the forest system include lowering the soil's capacity to retain nutrients. Potential impacts on tree growth are not clear, but over the long term, intensive harvesting usually has a destructive effect. And if tree growth is harmed, then there is a negative economic impact. Depending on how Canada's bioenergy industry develops, those negative consequences can be prevented, Thiffault said.

The solution is not as simple as replacing the lost nutrients with fertilizer or ash. Forest systems are not only complex, but "forests already grow on soil with marginal fertility," said Thiffault. "Forest ecosystems are much more than nutrient bank accounts."

The most pragmatic solution is "to optimize the amount of harvested forest biomass against the recognized adverse effects." Most countries have determined a gradient of site suitability for residue removal and then found an indicator to express this amount. In Quebec, soil calcium concentration is used as an indicator. From this gradient of site suitability, the intensity of residue removal can be determined.

Thiffault displayed a map of Quebec illustrating that the majority of soils are of medium fertility, where 25%–50% of forest residues can be removed without affecting the functioning of the ecosystem.

Thiffault reemphasized her support for bioenergy as "a legitimate forest product," but said, "We must incorporate ecological function and sustainability into industrial development at the outset, not after the fact."

Toward a Sustainable Bioeconomy: A First Nations Perspective

Dan George

President

Four Directions Management Services Ltd.

Chief Executive Officer (CEO)

First Nations Mountain Pine Beetle Initiative (FNMPBI)

Dan George thanked the Lheidli T'enneh First Nation for "the opportunity to gather on their traditional territory."

George said his key message was articulated by Satsan, the Wet'suwet'en hereditary chief, who said, "People must understand that our activity on the land is not a result of the mountain pine beetle epidemic. It is a result of Aboriginal title and rights."

In September 2005, First Nations gathered at a mountain pine beetle conference. Discussions with B.C. Minister of Forests and Range the Honourable Rich Coleman resulted in the creation of the First Nations Mountain Pine Beetle Initiative (FNMPBI).

FNMPBI is harmonizing the various existing mountain pine beetle action plans to identify "areas of commonality to exploit quickly," and to establish management plans to ensure "the differences don't separate us further," George said.

The balanced scorecard model was used to develop a strategy. "We found that the government has incredible silos," George said. "We need a horizontal strategy that cuts across them."

After reviewing the action plans, the following themes were developed:

- Community protection
- A sustainable economy
- Ecosystem stewardship
- Engagement of First Nations and protection of cultural values

"We all want the same thing," George said. "If we start from that area of commonality, we can get a lot further a lot faster."

Provincial government, First Nations, and federal leadership gathered in February 2007 to develop an initial Community Protection Strategy Map. This map was then discussed in regional sessions that included representatives from industry, concerned citizens, and local and regional governments. The map was revised in March 2007 to include the needs identified by the communities.

The sustainable economy scorecard has three cascading strategy maps, of which the "Energy and Mining Opportunities Strategy Map is the most important for today," George said. The vision and objectives for this map can be found on the FNMPBI website, at www.fnmpbi.com.

Overarching findings of dialogue sessions included the importance of relationship-building and working together, and the need to resolve the disparity between First Nations and non-First Nation communities.

An Engage First Nations Vision Strategy Map was also created. Guiding principles for Aboriginal engagement included “ensure proposed projects show respect for cultural diversity, and acknowledge and protect cultural knowledge, practices, and protocols.” George emphasized the importance of engaging the entire community, “not just the band council.” Trust is also a central concern, he said. “We have a history of mistrust since contact.”

George outlined eight ways to reduce conflict, including seeking to understand other perspectives and recognizing the balance of responsibility. He underscored the importance of listening actively by relating his wife’s admonition, “You’re not listening; you’re waiting to talk.”

“Working with First Nations is imperative to your industry’s success,” said George. “You can quote me on that.”

Bioenergy Policy in B.C.: A Pulp and Paper Industry Perspective

Bill Adams

Manager
Manufacturing Services
Domtar Pulp & Paper Products

“Whenever you’re developing policy,” said Bill Adams, “you need to understand what success will look like.” Results of good energy policy in B.C. will include increased, cost-effective biomass power generation.

From a pulp and paper perspective, outcomes of successful policy include reduced energy usage and new capital investment to “help us retool our facilities.”

Pöyry, a global consulting firm specializing in the energy, forestry, and infrastructure and environment sectors, conducted a study that examined the impacts of bioenergy policy in six jurisdictions in Germany, Sweden, and Portugal. The study identified that support, such as investment aid and long-term incentives, is clearly necessary. There is a “true economic impact in the jurisdictions that recognize the value of renewable energy and recognize that pulp and paper is a valuable sector,” Adams said.

Referring to Don Roberts’ presentation, *Bioenergy and the Convergence of the Markets for Fuel, Food, and Fibre*, Adams said business models must adapt to the “energy equivalency factor”: fuel and fibre will trade on the basis of their energy equivalency.

Pulp mills already operate on a business model with a low return on capital, which will be exacerbated as the price of wood increases. “Carbon and energy are a key part of our operations,” said Adams.

To be viable in the future, business models in the pulp and paper sector must transform through investments in reducing onsite energy consumption, increasing the proportion of high-value energy products, and increasing overall thermal efficiency of energy production from by-products.

“Currently, there is no surplus biomass in areas where pulp mills exist,” Adams said. New fuel sources near pulp mills need to be identified. Energy generation can also be increased by investing in energy efficiency and energy conservation.

B.C. has created plans that provide the framework for reinvestment in the pulp and paper sector. It will be critical, Adams said, to establish a relationship between sawmills and pulp mills. "Pulp mills buy chips from sawmills," he said. "If we have a policy directing biomass away from pulp mills to bioenergy, it will put pulp mills in danger."

The pulp and paper industry offers the most viable opportunity to provide competitive biomass power to B.C., stated Adams.

Currently, wood pellet plants in B.C. are transporting pellets to Germany. In five years, "if we're still exporting pellets from here to Japan and Sweden, then our policy-makers [will] have failed," Adams said.

Bioenergy Opportunities

Power Procurement and the Bioenergy Call

Martin Kincade

Project Manager
Power Acquisitions
BC Hydro

Martin Kincade said the purpose of BC Hydro, a government-owned company, is "to provide reliable power, at low cost, for generations." Ninety percent of the power produced and consumed in B.C. is renewable, and energy rates in B.C. are among the lowest in North America.

To close the gap between future needs and current supply, BC Hydro needs to "buy more."

Kincade outlined BC Hydro's acquisition activities. The ongoing Standing Offer Program is designed for smaller projects with a set price and a set contract. The Clean Power Call is a competitive process for larger clean-energy projects.

The Bioenergy Call originated with the BC Energy Plan, which directed BC Hydro to issue a competitive energy call focusing on using sawmill residues and mountain pine beetle-infested timber. BC Hydro received more than 80 responses to the request for expressions of interest, which was issued in February 2007 to identify potential projects and "establish the potential scope of the opportunity." It became clear, Kincade said, "that bioenergy is an interesting product from a utilities perspective, in that it's not only energy but also capacity." He added that the overwhelming message was to "please get on with it." Challenges identified included the difficulty of projecting fuel availability beyond 15 years.

The BC Bioenergy Strategy divided the Bioenergy Call into two phases. The first is a request for proposals (RFP) that focuses on projects that do not require any changes in the tenure system and that are "viable and able to go quickly." The second phase is directed toward projects that require legislation with new forms of tenure, which the B.C. Ministry of Forests and Range has completed.

Design goals of the Bioenergy Call included creating a flexible process to handle the complexity of bioenergy projects.

The target for Phase 1 was a "significant acquisition," expected to be "around or north of \$100 million per year," said Kincade. A source of contention during this call was that

BC Hydro is not accepting flow-through on fuel-supply risk. Awards for Phase 1 are expected in fall 2008.

Phase 2 is “all about a new form of tenure” contained in *Bill 31*, which received royal assent in May 2008. Awards from this process are expected sometime in 2009.

Kincade encouraged participants to visit the BC Hydro power acquisitions website at www.bchydro.com/ipp for further information.

Case Study of a Medium-Sized Bioenergy Facility with Wide Application

Bill Carlson

Principal
Carlson Small Power Consultants
Redding, California, United States

Bill Carlson presented a case study of “how one forest products company brought together everything we’ve been talking about today.”

Freres Lumber Co. Inc., a veneer and plywood producer in Lyons, Oregon, has been family owned since 1922. To meet its needs, which included eliminating the use of natural gas for veneer drying and developing a new, non-volatile revenue stream, Freres installed a Wellons boiler, a used turbine generator, and a Wellons electrostatic precipitator. The veneer dryers were converted to steam and log vats, and the veneer dryer exhaust was captured and rerouted to the boiler to be used as combustion air. Carlson described it as “one neat little package.” Freres signed a 10-year agreement with PacifiCorp that has “on-and-off peak pricing, which is very valuable for a bioenergy facility,” he said. Freres uses hogged fuel, ply trim, urban wood, mill yard cleanup, and slash piles.

“This model would work in many other places,” remarked Carlson. It would have been even more valuable in a sawmill, which has seasonal demand. Any heavy user of fossil fuels could benefit from this system. “You can even have a third product using the exhaust heat off your boiler,” he said.

Key drivers pushing the forest products industry towards bioenergy include the rising price and uncertain future of fossil fuels, available low-value residual materials, and new volatile organic compound or hydrocarbon regulations. A vibrant carbon credit market is “developing very rapidly,” Carlson said, “and you want to participate in it as you can.”

He provided guidelines for determining the appropriate size for a bioenergy project and encouraged the industry to move in this direction. “All of the synergies favour combined heat and power,” said Carlson.

Biomass Power Generation in China

Frank Miao

Vice-President
MZ Resources Group Inc.
Arcadia, California, United States

“China is an agricultural country,” said Frank Miao. Farmers used to burn harvest waste, and the government decided to capture this energy by constructing a biomass power plant. At the end of 2006, the total biomass power generation capacity in China was approximately 2,200 megawatts (MW). The planned capacity of biomass power plants is 30,000 MW by 2020.

Depending on the size of the plant, three different biomass power generation technologies are used: gasification, direct-fired, and co-fired with other fuels. “Currently, more than 90% of biomass electricity is from direct-fired biomass power generation,” Miao said.

“Compared with other solid fuel power generation,” stated Miao, “there are two key technologies in biomass power generation”: the fuel feeding system and the boiler technology.

China has constructed direct-fired biomass power plants since 1950; biomass gasification technology, Miao said, “is not new in China.” In the 1950s, wood gasifiers “were used for irrigation in the countryside.”

Miao provided an overview of the biomass gasification cogeneration technology. Over 30 biomass gasification power generation systems have been built. “Most of the plants are small,” he said.

The Shanxian biomass power plant is highly efficient and has low emissions; in addition, “the ash from the biomass power plant is used as a fertilizer.”

Miao provided his perspective of the Canadian bioenergy challenges and explained how collaboration with China could provide solutions. China’s “large pool of highly experienced engineers” could solve Canada’s personnel shortage, and because of the 12-hour time difference, the combined efforts of engineers in both countries would provide 24-hour coverage.

“Let’s work together to make tomorrow even better,” Miao said.

Bioenergy: International Context and Lessons for B.C.

Paul McFarlane

Professor and Head
Department of Wood Science
UBC

Paul McFarlane presented a paper co-authored by W.E. Mabee and J.N. Saddler. The International Energy Agency (IEA) was founded in 1974 in response to energy concerns. IEA is a forum for energy cooperation among 26 member countries within the Organization for Economic Cooperation and Development (OECD). It interacts with non-OECD countries to enhance supply security, give advice on energy policy and regulatory reform, and promote energy efficiency and technology.

The IEA agreement that focused on bioenergy included 13 activities—for example, biomass production for energy from sustainable forestry and pyrolysis of biomass. McFarlane focused on Task 39: “commercializing first- and second-generation liquid biofuels.” Task members included many countries from the EU as well as Canada, the United States, Japan, and others. Two examples of the seven task outputs include the development of biofuel policies and markets.

McFarlane used the United States as an example of research, development, and demonstration (RD&D) and an ambitious biofuels timeline that would have biofuels displace 30% of US gas consumption by 2030. “Not every country can afford to do particular technological research,” he said. Once the technology is developed, it can be diffused.

“Note that the term ‘cellulosic biofuels’ rather than ‘ethanol’ is being used,” said McFarlane. Substantial targets require substantial resources, he added, outlining a range of multi-million dollar programs, including three research centres and small and commercial biorefinery projects across Canada.

Sweden’s “biofuel region” will be self-sufficient in transport fuels by 2020. The region brings together government, industry, individuals, universities, and the Swedish Environmental Institute.

After reviewing B.C.’s bioenergy advantages, McFarlane announced the upcoming inaugural workshop of the BC BioEnergy Network (BCBN) and explained its intended roles in developing appropriate technologies and providing leadership in RD&D.

He closed by emphasizing the role bioenergy can play in rejuvenating B.C.’s forest-dependent communities.

Large-Scale Biohydrogen Production in Western Canada

Amit Kumar

Assistant Professor
Department of Mechanical Engineering
University of Alberta

Amit Kumar, together with his colleague Susanjib Sarkar, a graduate student in the University of Alberta’s Department of Mechanical Engineering, has studied energy production in the oil sands. “When you produce bitumen, you need to upgrade it with hydrogen, mostly coming from natural gas,” Kumar said. He added that increased hydrogen supply might come from biomass depending on the results of a techno-economic assessment and comparing it with current hydrogen sources.

Three biomass feedstocks were considered: whole forest, forest residue, and agricultural residue. Currently, “95% of forest residues in Alberta are collected and burned, while wheat and barley straw are left to rot in the field,” stated Kumar.

Model assumptions for hydrogen yield from biomass include the following:

- Hydrogen yield depends on, among other things, feedstock size, moisture content, ash content, the gasification reactor type, the catalyst, and tar formation.
- Yield is assumed to be 7.8 weight% of dry biomass feedstock for whole-forest residue and forest residue.

- Hydrogen yield from straw is assumed to be 7.3 weight% of dry straw (high ash content).

The study examined the steps involved in harvesting to estimate the cost components: delivered fuel cost, capital cost, operation and maintenance cost, and other costs, such as storage, ash disposal, and site recovery.

Kumar estimated the optimum size of the biohydrogen plant, noting that as plant size increases, "capital cost goes down, but transportation cost goes up because of economies of scale. If you look at total cost, there is a size at which the cost of production is minimal at optimum size."

For a gasification plant of 2,000 dry tonnes per day, the production cost in dollars per kilogram was \$1.53, \$1.72, and \$2.01 for whole-forest, straw, and forest residue respectively. Using the hydrogen fuel transportation method, the delivered cost of biohydrogen was about \$2.5 per kilogram of hydrogen. This is higher than that for natural gas, which is currently less than \$1 per kilogram. However, "with natural gas prices increasing, biomass may become competitive," said Kumar.

Bioenergy Opportunities in the Pulp and Paper and Sawmill Industries

Fernando Preto

Group Leader

Biomass Conversion

Natural Resources Canada

Fernando Preto said the Canada Centre for Mineral and Energy Technology (CANMET) Energy Technology Centre in Ottawa is "not a fundamental research lab.... We help industry develop technologies." The Biomass and Renewables Group "took a different approach, asking, 'What's the converted value of one dry tonne of wood?'" Preto's team made a number of assumptions about pellet-generated heat, power, and combined heat and power (CHP) respectively. He estimated values of \$86, \$124, and \$181 respectively. "For the latter [CHP], we have commercially available technologies," he said.

Pulp mills generate huge quantities of residues that they use, Preto said. Sawmills have two categories, large and small, both of which can potentially produce enough of their own power and heat. For small mills, "it's very expensive—that's the reason more people don't do it." Stationary engineers are necessary and expensive and "below 10 megawatts (MWe) of production. It's hard to justify the manpower."

"Gas cleanup is an issue" for gasification, said Preto. Nexterra and Enerkem Technologies Inc. are examples of leading gasification companies in Canada. He noted two other successful units in Denmark and Austria, but said they too were "very expensive."

The biomass integrated gasifier combined cycle (BIGCC) has a 40% efficiency rather than 20% and is the "hope for the future," obtaining a value of \$230 per tonne," said Preto.

Biomass pyrolysis scale-up continues to be a challenge. However, it is being used by a number of companies, including Alterna Energy Inc.'s pilot plant in McBride, B.C. The value of wood is difficult to calculate since there are many unknowns.

Gasification for liquid fuels is also promising. It can produce ethanol with a value of \$263 per tonne. "But if you look at pulp," said Preto, "it's still the best bang for the buck based on current prices" at \$280 per tonne.

All sawmills can generate their own power, but there is not a readily available commercial technology for small ones. Pulp mills can increase the value of products per tonne of wood input with a large BIGCC, Preto noted. Thus “the moral of the story is go BIGCC or go home.”

Day 3:

Bioenergy Technologies

Closed-Loop Distributed Energy and Fuel from Municipal Green Bin Waste

Bruce Coxhead

President and CEO

Zero Waste Energy Systems Inc.

“I’m going to take you down a path called ‘anaerobic digestion,’” said Bruce Coxhead.

“In Toronto we have a disaster brewing—and that is the Green Bin Program.” Coxhead said that in municipalities, “even after a Green Bin Separation Program has been implemented, they still have to ship the waste.” However, local green waste “can be used in anaerobic digesters to convert the solids into 70% biomethane by volume,” he said. “This biomethane can be purified to pipeline quality and used directly in stationary power applications, or compressed and dispensed for use in municipal fleet vehicles ranging from converted light-duty vehicles to refuse and transit vehicles.”

Coxhead said, “I took this idea to Toronto and was told to go away In Europe they are way ahead of us: they banned liquids, extending the life of landfills and protecting the surrounding environment.”

The technology for anaerobic digestion was developed in Thunder Bay and “runs at -45 C and in eight feet of snow,” Coxhead said. “Anaerobic digestion is like making wine in your basement.” An airtight container is used to produce methane gas from feedstock, including manures, field crops, and restaurant waste. He said that compared to the large farm systems in Europe, “we have taken a modular approach” with no residual *E. coli*. Individual tanks are 10 feet in diameter and can utilize multiple waste streams that have different retention times. “If there are problems with a tank ... the whole system does not all go down at once,” he said.

Examples currently online include a manure digester in Ottawa and a digester in the Niagara region working with wineries. Use of heat from a digester can offset the use of electricity in greenhouses.

Anaerobic digestion is a practical solution for various kinds of wastes, with an ROI of two years and carbon credits, said Coxhead.

Small-Scale Heat and Power at B.C. Mills

Fred Scott

Director of Business Development for B.C. and the Pacific Northwest
Pristine Power Inc.

Fred Scott introduced the B.C. Bioenergy Network (BCBN) as an alliance between Pristine and Nexterra Energy Corp. BCBN is a network of 15–20 individuals, with 10 MW power plants located across B.C. at mill operations in forest communities. Nexterra has developed a proprietary gasification technology that “takes wood waste material and [produces] clean burning synthetic gas or syngas,” Scott said. The benefits of this technology include simple design, low operation and maintenance costs, fully automated operation, fuel flexibility, and low-grade stack heat.

The system is “very versatile, compared with conventional beds, which are very sensitive to fuel” with both high and low moisture content. Lignins and toxins are burned in the process to produce low emissions that are suitable for the city, as in a current Victoria condominium project, Scott said.

He mentioned the new relationship with First Nations and a number of partnerships, including those with the Cheslatta Carrier Nation and the Burns Lake Band. The latter project is called *Ditni Yoh*, which is Carrier for “Thunder House.” It is “a place of reconciliation where they can go to resolve their differences and celebrate their relationships,” said Scott.

Other key social objectives addressed through BCBN include clean renewable bioenergy, remote community electrification, electricity self-sufficiency by 2016, alternative energy technology, greenhouse gas emissions reductions, environmental stewardship, and healthy air quality.

Among a range of economic and environmental benefits that Scott discussed, the Burns Lake community will benefit through approximately 20 jobs during construction and 10 during operation, and the elimination of two beehive burners that produce particulate air pollution. A community recycling depot will collect wood-based materials. The process will remove standing bug kill and replant new trees that sequester carbon and capture surface water runoff.

Bioenergy’s “time has come,” said Scott. It is competitive, green energy produced with a proven technology that can help stabilize communities.

Environmental Aspects and Bioenergy Projects

Nelson Lee

Senior Project Manager
Keystone Environmental Ltd.

Nelson Lee emphasized the “need to involve an environmental professional” early and throughout the project cycle. “Otherwise you can get blindsided with what you don’t know.” He reviewed five project cycle stages.

The concept stage involves project definition, due diligence, and approvals. Keystone worked with Balanced Power Engineering Inc. to examine the feasibility of bioenergy production from wood waste. “If you deal with environmental issues [at this stage], you will open yourself up to funding opportunities and tax credits,” Lee said.

Due diligence includes understanding stakeholders and special interest groups, for example, and whether projected emissions will be accepted by the community. Lee said that site selection should involve an environmental professional early on; depending on the site, challenges may vary.

Approvals through the B.C. Environmental Assessment Agency or through the Canadian Environmental Assessment Agency can take 15–21 months. For projects under 50 MW, environmental analyses are optional. Since projects are context dependent, a professional can decide whether an atmospheric assessment is advisable, said Lee.

At the project design stage, Lee applies “environomics,” which he defined as “insightful environmental management to create economic success.” For example, the price of carbon credits could have “significant influence on your projects.” Long-term vision is necessary to avoid additional costs in the future. “We make millions per year because at the design stage, people did not make appropriate decisions to deal with pollution.” External influences, such as permit requirements, must also be addressed.

Construction, operations, maintenance, and closure stages also have aspects that can be aided by an environmental professional. For example, “BC Hydro will pay you \$3.10 per MW hour if you achieve ecocertification, but you need an environmental management strategy that is certified,” Lee said. This involves auditing and continual improvement.

At the closure stage, the land value of your project can be captured if you “demonstrate to institutions that your land is clean.”

Biocarbon: The Biocarbon Pellet

Gerry Kutney
CEO
Alternia Energy Inc.

Referring to the “notorious graph of increasing carbon dioxide levels in the atmosphere,” Gerry Kutney said the “bioenergy field for the pulp and paper industry has been important for decades, but the general population has only shown interest recently.”

Kutney demonstrated the key role vegetation plays in the carbon cycle, with a graph showing the annual fluctuation of the total level in the atmosphere from the seasonal growth of biomass. He said that something useful needs to be done with pine beetle kill wood before it decomposes and releases its carbon dioxide.

Kutney quoted MLA John Rustad, from February 20, 2008: “B.C. is considered to be the Saudi Arabia of the world when it comes to the potential for bioenergy.” Energy density is the key, Kutney said, noting that “if you double energy density, you reduce fossil consumption for transport by half.”

He summarized the sources of bioenergy as gasification, pyrolysis oil, ethanol, wood pellets, and biocarbon pellets. Kutney stated that although “wood pellets are truly a remarkable substance,” biocarbon pellets have energy density similar to coal and ethanol.

Biocarbon can be used to create bioenergy, as activated carbon for a range of medicinal uses and water filtration, and for agriculture. “*Terra Preta*” refers to the intentional use of charcoal in soil, and it accelerates plant growth.

The state-of-the-art carbonization technology controls the conversion of biomass to produce carbon, heat, and electricity. Alterna Energy Inc. originated in South Africa, where macadamia shells were utilized as feedstock. Kutney showed a schematic of the first potential plant in Prince George—a modular system where each unit will produce about 5,000 tonnes of biocarbon.

Biofuel Production in a Kraft Pulp and Paper Mill: Evaluation of the Potential and Profitability

Merja Strengell

Leading Specialist
Environmental Management Issues
Department Manager
Pulp Mill Engineering
Pöyry Forest Industry Oy
Vantaa, Finland

“Our team popped up” to address the main goal of greenhouse gas reduction through the production of biodiesel at kraft pulp and paper mills (KPPM), said Merja Strengell.

Strengell summarized future challenges for integrated biorefineries and biofuel plants. Challenges include competition for raw material; process technology, which “doesn’t exist yet at the industrial scale”; the complex process setup; demanding energy and process integration; and the market supply and demand relationship for multi-production, wood paying capability, and optimal use of biomass.

Strengell described two studies. The first evaluated the constraints and benefits of integrating biofuel production with a KPPM. This study looked at liquid biofuel production in the global context and the potential share of wood-based biodiesel. It evaluated the constraints of biomass availability and the number of suitable production sites.

Forest residues were generally chosen as raw material. Whether target levels set by government will be met in future depends on biomass availability and the number of suitable biodiesel production sites. Some countries have enough of the former but not of the latter, and some, such as Finland and Sweden, have enough of both.

Profitability was modelled for four cases: North America, Latin America, Scandinavia, and Southern Europe. Each case had different types, sizes, and ages of pulp mills. The maximum investment cost for an internal rate of return of 15% was modelled, as was wood-paying capability.

The second study evaluated the technology and profitability of an integrated forest biorefinery.

Biodiesel production integrated with a pulp mill offers benefits, compared to a stand-alone biodiesel production plant. “An important precondition for the integration is the ability to utilize the excess heat of the process,” Strengell said. A biodiesel plant’s optimal capacity is determined by the availability of low-cost forest residues and by the possibilities for utilizing the excess heat. Finally, profitability is strongly dependent on the market price of biodiesel.

Future Directions

Reflections on Strategy and Policies for Developing the Pellet Market

Christian Rakos

Managing Director
proPellets Austria
Vienna, Austria

Christian Rakos shared “a few observations, reflections regarding strategy, and considerations regarding policies for developing the pellet market.”

He outlined what he described as the popular goals of a bioenergy strategy:

- Use as much biomass as possible, as fast as possible.
- Use biomass in the most technically challenging way.
- The ultimate priority is carbon dioxide reduction.
- Use biomass in every energy market.

“I’d like to challenge some of these approaches,” said Rakos.

He said that in the future, biomass will be used in a context of energy scarcity rather than energy abundance. Predicted oil and gas shortages suggest that by 2030, 50% less crude oil and gas will be produced. “That means half the amount of everything we’re using,” Rakos said. “I believe that energy scarcity will replace CO₂ as a key issue in years to come, and that will change the way we look at bioenergy.”

Rakos projected that current wasteful patterns of energy use will change in the future. Specific kinds of energy will be restricted to their most appropriate markets. Oil can be used most efficiently for transportation, and biomass should be predominantly used for heating.

To make bioenergy a success in the heat market, the lack of awareness among consumers, media, investors, and professionals must be addressed. “Policy-makers have not yet grasped that heat is a form of energy,” Rakos said. It has been demonstrated in Europe that significant financial incentives must initially be established. These can be allowed to decline predictably, which will “speed up market development.” These subsidies can also be tied to product quality regulations. In addition, regulatory bodies need to be informed that pellet heating systems have extremely low emissions.

A consistent standard of high-quality fuel and a high-quality service industry must be established. “Training of professionals is a very important pre-condition to get it right,” Rakos said. In Austria, bioenergy installers are educated and certified.

Supply systems must be reliable and stable, Rakos said. The system must include significant storage capabilities to respond to demand fluctuations and to stabilize prices.

Rakos announced that proPellets Austria will offer a week-long training course for planners and consultants on how to set up community heating schemes. He encouraged anyone who is interested to attend.

Bioenergy in B.C.

Garth Thoroughgood

Senior Policy Advisor
Bioenergy and Renewables Branch
Electricity and Alternative Energy Division
Government of B.C.

Garth Thoroughgood said the 2007 Throne Speech provided a strong mandate for greenhouse gas reduction that was reiterated in the 2008 Throne Speech. The 2007 Energy Plan announced a \$25 million Innovative Clean Energy Fund and included the implementation of a bioenergy strategy. The 2008 budget included a carbon tax and investment in greener choices.

But it was legislation passed in 2008, including new forms of tenure, that “demonstrated that the government was serious,” Thoroughgood said. B.C. is also developing its own cap-and-trade regulatory system.

Thoroughgood outlined some highlights of the BC Bioenergy Strategy, released in January 2008. Key points include establishing a comprehensive provincial biomass inventory and aiming for B.C. biofuel production to meet at least 50% of the province’s renewable fuel requirements by 2020.

“Bioenergy isn’t new in B.C.,” Thoroughgood said. Using a map to illustrate the number of bioenergy facilities in the province, he said, “Currently, B.C. leads Canada in wood bioenergy production.” An integrated solar and biomass facility installed in Nakusp, B.C. this year heats Nakusp Secondary School.

“A number of initiatives are under way to assist bioenergy projects,” Thoroughgood said. These include a feasibility study for biogas upgrading and a grid injection in the Fraser Valley, and a microalgae feasibility study.

Future directions include the development of solid fuel, liquid fuel, and gasification, with “biorefining being the ultimate goal.”

In conclusion, Thoroughgood said “partnerships and research” are important for the future of bioenergy in B.C.

Future Trends in Biomass Supply, Policy, and Markets

Doug Bradley

President
Climate Change Solutions

Doug Bradley determined in a 2005 study he conducted with B.W. McCloy that the majority of Canada’s annual mill residue surplus was produced in B.C. Although the recent decline of the US housing market has reduced the demand for lumber, which has reduced the quantity of residue being produced, “the housing market is cyclical,” he said. “It will go back up.”

The study identified that a large percentage of mill residue is used in gardening. “A tremendous volume of potential fuel is being used in gardens,” Bradley said, “and I think that’s a tremendous crime.”

A number of events since 2005 have altered the distribution of surplus mill residue. In eastern Canada and in Saskatchewan, the burning of mill residue is not allowed, "so we've been piling it up." Bradley displayed a photograph of one hog pile—which he jokingly called "Mount Kilimanjaro"—that contains 1.5 million green metric tonnes (GMT) of material. If the hog piles are mined, then both Ontario and Quebec have a greater annual mill residue surplus than B.C. However, if usable roadside harvest residues are also included, then B.C. far surpasses the other provinces.

On average, mill residue sold for \$15 per BDT in 2006 and 2007. The estimated cost of forest biomass is as high as \$46 per BDT for harvest residue. But through improved efficiency of collection systems, new innovations, improved equipment, and standardization, that cost will likely fall to \$37 per BDT in 2012.

Two elements currently restrict the development of small heat and power projects. First, "antiquated" legislation requiring the constant presence of a steam engineer raises costs. "Having that wage there craters the economics of any project," he said. Second, the time frame to respond to an RFP is usually too short for biomass heat and power.

Policies must be created "that are going to work where the rubber hits the pavement," Bradley said. "The RFP process has been largely a failure." Incentives must be established for renewable heat, not only for power. And the current two-year environmental assessment period is "way too long," he said.

Bradley projected that the European market for bio-oil from fast pyrolysis will expand. Discussing the opportunities offered by the European market, he said there are 70 co-firing power plants near European ports, and "they all want biomass."

Discussion

A participant asked Bradley if the enormous hog piles frequently catch fire.

He responded that not only have the hog piles not burned, but only the top metre of the pile is usually too contaminated to use.

Closing Remarks

John Swaan
Executive Director
WPAC

John Swaan delivered the closing remarks.

Swaan said the feedback he was most pleased to receive was that the people involved in the conference were friendly and fun. "That's what bioenergy people are," he said. "We're a feel-good industry."

He highlighted the need to secure feedstock supply and asked, "Is there enough to go around? Industry wants to hoard it." Swaan emphasized the importance of finding a good energy balance rather than focusing on carbon footprints. Environmental issues will also be important as the industry develops.

In North America, “we always seem to think [combustion] is harmful, in spite of the carbon neutrality,” Swaan said. Conversely, “in Europe, the bioenergy industry is perceived to be the saviour.”

Appropriate policies must be developed, resources must be explored, technology must be developed, and relationships must be established. “We need to get ourselves out of these silos,” Swaan said.

Although the conference was designed to answer participants’ concerns, questions, and opinions, Swaan expressed hope that participants were “going away with more questions than were answered.”

Asking participants to provide feedback on the conference, Swaan said that when he had complained about his porridge as a child, his mother would tell him, “If it doesn’t meet your expectations, lower them, or get involved and make your own damn porridge.”

Bringing the conference to a close, Swaan thanked all those involved for contributing to its success and invited them to return for BioEnergy Conference and Exhibition 2010 from June 1–3, 2010.