# J. W. GOTTSTEIN MEMORIAL TRUST FUND

The National Educational Trust of the Australian Forest Products Industries


# DEVELOPMENTS IN THE USE OF WOODY BIOMASS FOR BIOENERGY IN CANADA AND WESTERN USA

**LIZ HAMILTON**

2009 GOTTSTEIN FELLOWSHIP REPORT

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# Joseph William Gottstein Memorial Trust Fund

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national educational Trust for the benefit of Australia's forest products industries. The purpose of the fund is *"to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products."*

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organization (CSIRO) when tragically he was killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are:

1. Fellowships and Awards - each year applications are invited from eligible candidates to submit a study programme in an area considered of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their programme. These are then distributed to industry if appropriate. Skill Advancement Awards recognise the potential of persons working in the industry to improve their work skills and so advance their career prospects. It takes the form of a monetary grant. The Trust also offers Forest Industry Scholarships to deserving undergraduate or postgraduate students studying courses in wood and forest sciences and engineering at Australian universities.

2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.

3. Wood Science Courses - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.

Further information may be obtained by writing to:
The Secretary
J.W. Gottstein Memorial Trust Fund
Private Bag 10
Clayton South VIC 3169
Australia

Liz Hamilton works for the Department of Primary Industries, Victoria as Senior Bioenergy Industry Officer, a role she has held since early 2009. Her work focuses on promoting and helping to develop the bioenergy industry in Victoria. Liz co-managed the Corangamite Farm Forestry Project for DPI and its predecessors in Western Victoria from 1994-2008 and she managed the public land plantations in the Otways from 1990-1994 as Softwood Production Planner. Prior to that she worked in various roles including rural tree growing extension and community forestry in Nepal. Liz holds a Bachelor of Science, (Forestry), degree from the Australian National University.

# Executive Summary

This report describes how and why the use of woody biomass for bioenergy is strongly supported by the Canadian and United States governments at the state/provincial and federal levels with a focus on the utilization of woody biomass from forests.

In Canada, renewable fuels including hydroelectricity contribute around 16% of total primary energy, and of this, biomass supplies 4.83% of the total primary energy. The USA currently meets about 7% of its energy needs through renewable energy, including hydroelectricity. Over half of this is provided from biomass, i.e. just over 3.5% of the total energy needs.

Canada is the world's largest exporter of forest products. In 2006, the forestry industry contributed some $CA40 billion to Canada's GDP. The global economic downturn has had a major impact on Canada's forest industry and all forest commodities are suffering. Between, 2006-2008, softwood lumber production in Canada fell from 79 to 56 million cubic metres and over 50,000 Canadian forest sector jobs were lost. Over the last several decades, the USA has also seen a decline in timber harvesting, particularly on federal lands, mainly due to successful legal and political action against federal agencies by conservationists. Both countries consider forest biomass utilisation as a playing a key role in maintaining viable forest industries into the future.

Estimates of the potential of biomass to provide future energy in the USA have indicated that bioenergy is likely to continue to be the main source of renewable energy in the USA, potentially producing up to 9780 petajoules of the USA's primary energy needs by 2035. A revised biomass inventory is currently being undertaken in the USA and early estimates suggest that around 15% of US energy needs could be met by biomass, with around 27% of this total figure coming from forest resources. Several studies have attempted to quantify the availability of forest-based biomass sources for Canada, with estimates varying widely from between 1.5-13.1% of total energy needs.

There are a number of powerful barriers to the development of the woody biomass to bioenergy industry in North America. The main barriers are cheap stationary energy and transport fuel costs, anomalies with renewable energy policies that disadvantage bioenergy, political influence by opponents of forestry and bioenergy, and high costs of harvesting and transporting biomass. To varying degrees, these barriers also exist in Australia.

Despite these barriers, growth and investment in the use of biomass for electrical, thermal energy and biofuel production in Canada and the USA is happening at a rapid pace. The development of the woody biomass to bioenergy market in North America is largely driven by a combination of factors which may include:

- Availability of abundant supplies of biomass, e.g. potentially able to produce enough bioenergy to provide 15% of US energy needs.
- The desire for energy independence and security, as mandated in policies such as the Energy Independence and Security Act of 2007 in the USA.
- The need to reduce Greenhouse Gas, (GHG), emissions at home and abroad, creating both local and export opportunities for biomass and bioenergy technologies.
- Climate change impacts and the resulting changes occurring in forests such as the Mountain Pine Beetle epidemic across the study area.
- Major issues with increasing severity of wildfires and declining forest health due to overstocked and unnaturally dense forests and woodlands.
- Air quality issues and restrictions on open burning of agricultural and forest residues.

- Declining timber industry and rural employment and the desire to reinvigorate rural North America, e.g. the USA's US$787 billion economic stimulus package under the American Recovery and Reinvestment Act, (ARRA), 2009.
- Rising energy costs and energy price spikes such as occurred in 2008.

The significance of these drivers, and the role of bioenergy in helping to ameliorate many of North America's most pressing issues, is widely acknowledged by federal, state, provincial and local governments in various ways that are supportive of the bioenergy industry. This support is most evident from the extent and variety of clearly articulated government legislation, policies, initiatives and incentives that foster the use of woody biomass for bioenergy, including:

- The Biomass Research and Development Act of 2000.
- The 2000 National Fire Plan.
- The 2001 National Energy Policy.
- The 2002 Healthy Forests Initiative.
- The 2003 Healthy Forests Restoration Act.
- MOU to Enhance Woody Biomass Utilization, between DOI and DOE, 2003.
- National Energy Policy Act of 2005.
- Forest Service Strategic Plan, 2007-2012.
- The 2007 Energy Independence and Security Act.
- The 2002 Farm Bill and 2008 Amendments in the Food, Conservation, and Energy Act.
- The 2008 Woody Biomass Utilization Strategy.
- The 2008 Biomass Crop Assistance Program.
- Woody Biomass Utilization Strategy, 2008
- Forest Stewardship Contracts.
- Community Wildfire Protection Plans.
- American Recovery and Reinvestment Act, 2009.
- Various Tax credits supporting biomass utilisation and bioenergy.

Although the production of bioenergy from forest biomass is strongly supported in many areas of US legislation, contention exists as evidenced by the current debate around the definition of 'renewable' biomass proposed in the Renewable Energy Standard of the American Clean Energy Security Act, which is currently being debated in the Senate. If passed, the current definition would exclude a wide range of woody biomass including any biomass from federal forests and a wide array of municipal wood waste – despite both state and private native forest biomass being deemed renewable in this proposed legislation. This has the potential to put existing and future bioenergy conversion facilities at a disadvantage and is contrary to the vast number of existing policies and programs that actively encourage and provide incentives to woody bioenergy removal and utilization from federal forests. Having a clearly mandated definition of what constitutes a renewable fuel may be an essential factor affecting the viability or otherwise of biomass and bioenergy production systems.

The importance of getting bioenergy policy right can be critical both to governments, existing forest and wood based industries as well as to the bioenergy industries that governments are trying to support. Problems have arisen in North America where policies, intended to encourage certain types of bioenergy development, and the financial incentives that have followed, have been manipulated and used for unintended purposes or inadvertently over-subscribed, leading to budget blow-outs and cost overruns or adverse impacts in neighbouring countries.

Of particular relevance to the Australian forest industry are the key drivers behind the increasing level of forest biomass utilization in North America, being the need to improve forest and catchment health, reduce the severity of wildfires, provide a stimulus for revitalizing rural economies and reduce air pollution and GHG emissions from open burning.

Similar to Australia, the regions discussed in this report have fire suppression policies that require all fires, other than purposely lit fuel reduction and ecological burns, to be extinguished. In North America, blanket fire suppression policies, combined with drought, climate change and a decline in forest management are resulting in forests that are out of balance with their natural conditions making them increasingly susceptible to diseases, insect attack and severe wildfires.

Whereas prescribed burning used to be the recommended tool for reducing hazardous fuels in North America, over the last decade, it has been used as just one of a suite of options for limiting the severity of potential wildfires and improving forest health. North American land managers are actively encouraged to use other techniques such as thinning and biomass removal, mechanical treatments such as removal of brush and understory fuels and post thinning, low intensity prescribed burning.

In Australia, active fuel reduction tools other than prescribed burning are rarely used. In some regions and locations of Australia, and under certain conditions, methods such as mechanical biomass removal and utilisation for bioenergy could well lead to a reduction in the costs and risks associated with undertaking fuel reduction burns as well as having numerous other social, economic and environmental benefits.

Extensive and on-going research and development in the US is proving that thinning and biomass removal can be a cost effective tool in the prevention, and reduction in severity, of wildfires under a range of scenarios. Additionally, a number of recent studies suggest that improvements to air quality, reductions in greenhouse gas emissions and positive biodiversity outcomes can result from non-burning hazardous fuel reduction options.

In North America, the importance of having broad community understanding and support for the use of forest biomass and the bioenergy industry is reflected in the money and effort invested in community education, extension and consultation programs that clearly articulate the role of bioenergy production from woody biomass. An example of this are the US Community Wildfire Plans that empower rural communities, in collaboration with fire authorities, to design and determine where and how hazardous fuels reduction programs will be undertaken in their locality.

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# 1. Introduction

The following report summarises my findings following a five-week Gottstein Fellowship program to study developments in bioenergy in British Columbia, Canada and Montana, Oregon and California, USA during Aug/Sept 2009. I focussed my study on a region where significant advancements in bioenergy development are occurring and where both the barriers and drivers for bioenergy development are similar those in Australia. This report focuses on the following areas:

- Key drivers of woody biomass for bioenergy development in North America.
- Major barriers to woody biomass bioenergy development in North America.
- Policies, programs and incentives that have evolved from these drivers, which in turn are helping;
- Development of innovative new woody biomass to bioenergy projects.
- Organisations, individuals and community extension programs that are successfully promoting and advancing the use of woody biomass for bioenergy.

The information for this report was gathered from various sources, including;

- Information gleaned through meetings and follow-up correspondence with government agency officials, foresters, farmers, bioenergy facility managers, academics and researchers with expertise in forestry and bioenergy ranging from harvesting and transport logistics, to building and operating bioenergy plants, to bioenergy policy formulation and implementation.
- Attendance at both the IEA 2009 Bioenergy, "Biofuels in a Changing Climate" conference in Vancouver, BC and the Canadian Bioenergy Association annual workshop in BC.
- Visits to various pre-commercial and fully commercialised bioenergy plants in BC and the US states of Washington, Montana, Idaho, Oregon and California.
- Numerous reports, documents and websites on bioenergy development in Northwestern America.
- Follow-up comments and edits from many of the people I visited during my Fellowship who kindly edited this report.

# 2. Overview of energy use, bioenergy and forests in Canada – focus on British Columbia

## 2.1 Canada's energy use

Canada is heavily dependent on fossil fuels such as petroleum, natural gas and coal. Natural Resources Canada, (NRCAN), estimated that Canada's primary energy usage was 12,250 petajoules (PJ) in 2005, the majority being supplied by petroleum, (37.5 %), natural gas (28.1%), coal (10%), nuclear (8.5%). Renewable fuels such as hydro, solar, geothermal and biomass contributed 16% of total primary energy. Biomass supplied 590PJ, (4.83%) of the total primary energy, making it second to hydroelectricity in its contribution to Canada's renewable primary energy. Woody residues used in power generation at pulp and paper mills contributed some 78% of the 4.83% of the biomass total, while residential fuel wood contributed 19% of the 4.83% total.

## 2.2 Forests and timber industry facts and figures, Canada

Canada has 402 million ha of forests and 600 million ha of agricultural land, (NRCan website, 2009). Canadian forests represent 10% of the global forest cover. Of this area, approximately 1 million hectares are harvested each year by the forests products industry. Most of Canada's forest

land (93%) is publicly owned; 77% under provincial or territorial jurisdiction and 16% federal. The rest is on private property belonging to more than 450,000 private landowners.

Similar to Australia, the provinces and territories have legislative authority over the conservation and management of the forest resources on provincial/territorial Crown lands. The federal government is responsible for matters related to the national economy, trade and international relations, and federal lands and parks.

Canada is the world's largest exporter of forest products; the USA is by far their largest market. In 2006, the forestry industry contributed some CA$40 billion to the GDP. However, this dropped by over CA$5 billion over 2006-2008. The forest industry's contribution to Canada's GDP is currently about 1.9%.

### 2.2.1 The global economic downturn and the impact on the timber industry

The global economic downturn has hit Canada's forest industry hard, and all forest commodities are suffering. Softwood lumber production in Canada fell from 79 million $m^3$ in 2006 to 56 million $m^3$ in 2008; wood pulp fell from 23 million $m^3$ in 2006 to 20 million $m^3$ in 2008. The severe drop in lumber production has essentially wiped out surpluses of new mill residue which is in turn making it more difficult and more expensive for pellet manufacturers and other forest biomass to bioenergy businesses to operate.

In 2006, around 800,000 jobs, both direct and indirect, stemmed from the forestry sector, comprising almost 5% of the national work force. For about 300 communities, the forest sector makes up at least 50% of the economic base. Since 2003, restructuring of the Canadian forest products industry has resulted in numerous mill closures and a decline in employment of more than 100,000 jobs, caused by the poor US housing market, declining North American newsprint demand, and the high Canadian dollar, (NRCan website, 2010[1.]). According to the Forest Products Association of Canada, (FPAC), over 50,000 Canadian forest sector jobs were lost and more than 250 mills closed between 2006-08, (Lazar, A. 2009).

The ongoing decline of the Canadian forestry sector and the need for industry re-structuring, prompted a 2008 BC Pulp and Paper Task Force study that found that strategic reinvestment and development of new policies aimed at supporting the growing demand for biomass based energy will be required to renew the pulp and paper industry, (BC Pulp and Paper Task Force 2008).

Additionally, the Canadian government announced in February, 2010 funding of CA$292.5 million to help its forestry sector develop renewable energy from biomass. This announcement coincided with the release of a FPAC study concluding that the industry needs to make dramatic changes in order to remain viable, recommending the industry capitalize on the opportunity to convert forest biomass into electricity, heat, transportation fuels, bio-chemicals for solvents and plastics and next generation bio-materials, as well as continuing production of traditional wood products, (FPAC, 2010).

### 2.2.2 The Green Transformation Program - Canada's response to the US black liquor subsidy

Another key source of government support for the Canadian forest industry has come from the NRCan Pulp and Paper Green Transformation Program, a CA$1 Billion response to the US Black Liquor Subsidy. The Program will help pulp and paper companies in Canada to make investments that improve the energy efficiency and environmental performance of their facilities by providing a

CA$0.16/litre credit for black liquor produced by their mills between January 1, 2009, and December 31, 2009. The funds must be spent over a three-year period on capital expenditures in pulp and paper mills that will improve energy efficiency, renewable power production and environmental performance.

The Green Transformation Program arose largely as a response to the US Black Liquor Program/Alternative Fuel Mixture Tax Credit (AFMTC), a tax rebate which commenced in 2005. The total payments of US$0.50/gallon, ($0.13/litre), for converting from fossil fuel to a mixture of fossil fuel and biofuel to US pulp producers under this program are expected to reach US$8–9 billion. The tax rebate was originally aimed at increasing the use of biofuel in highway vehicles. However, in 2008, US kraft pulp mills, who have traditionally produced and used black liquor, (a by-product of pulp production), for producing heat and energy, realized they could qualify for the rebate if they added some diesel fuel to it. The resulting fuel meets the tax guidelines but burns more fossil fuel rather than less, contrary to the intent of the legislation.

In addition to subsidizing US production growth in a weak global pulp market, the AFMTC has also substantially improved the financial positions of US companies which may shift the competitive balance of the North American market, making Canadian pulp production less profitable in the long run**.**

This is expected to reduce pulp production costs in the US by 60%, enough to force Canada out of global markets. The collapse of the pulp sector in Canada would also kill the market in Canada for wood chips, a by-product of making lumber that represents 30% of the revenue stream for BC's struggling sawmill industry, (Hamilton, 2009).

Despite a recently introduced Congress bill that would make this credit permanent, it is widely believed that the AFMTC would end as scheduled on December 31, 2009, (NRCan website, 2010[1.]). No decision has been made as yet.

## 2.3 The forests and timber industry of British Columbia

In BC there are 95 million ha of land of which around 60 million ha are forested. Within these forested areas, approximately 25 million ha are available for forestry harvesting. Ninety five per cent of BC's forests are owned by the government. Only 2% of BC's original forest area has been converted to non-forested land. Annual allowable harvest is around 200,000 ha/yr which is less than 1% of the forest area/yr. Historically, over the last decade, the annual cut has been around 70 million $m^3$ but this volume dropped sharply to16 million $m^3$ in 2008 and is expected to drop further to around 15-16 million m3 in 2009 due to the global financial crisis, (Snetsinger, J., 2009).

By law the chief forester must determine the sustainable cut every 5 years for their 74 forest management units – one component of the Sustainable Forest Management Framework for BC, which includes a comprehensive set of land use plans that cover 90% of the Province. BC forests are also subject to Forest Practices legislation, an independent 3rd party certification system and a comprehensive inspection and compliance program. Most of Canada's forests are certified under one or more of forest certification programs.

The BC forest sector has been particularly hard hit by the economic downturn, e.g. solid wood exports products fell 25.5% in 2008. Pulp and paper shipments dropped 26.9%, by Sept. 09, (NRCan, 2009).

## 2.4 Woody biomass resource estimates and bioenergy opportunities from Canadian forests

Industrial wood waste, especially waste from the pulp and paper industry, is Canada's most important source of biomass. Around 500 petajoules, (PJ) of bioenergy are used in the industrial sector each year. The pulp and paper industry is by far the largest industrial user of bioenergy, which accounts for more than half of the energy used in this industry.

Several studies have tried to estimate the availability of forest based biomass sources for Canada. A summary of estimates from various studies is presented in Table 2.4. However, the authors who constructed this table noted "*the estimates do not give much consideration to the extent to which harvest of forest biomass can be conducted so that biodiversity is maintained and site productivity is not affected. The need to have sustainable forest management certification schemes and an index for biomass residue harvest is essential if the positive climate change benefits of using biomass for energy are to be fully realized. Given the need to incorporate further the impact of biomass removal on soil quality, current work is being undertaken by the Canadian Forest Service and Forest Engineering Research Council of Canada (FERIC) to construct an index of site suitability for forest residue removal"*.

| **Table 2.4**. Summary table of the range of estimates of available woody biomass for Canada from various residual source streams. Author | Year of estimation | Million dry tonnes/yr | Energy equivalent (EJ/yr) (a) | % of Canada's primary Energy (b) |
|---|---|---|---|---|
| Sidders | 2008 | 44.26 | 0.80 | 5.9 |
| Bradley | 2008 | 20.23 | 0.36 | 2.7 |
| Ralevic *et al.* | 2007 | 97.4 | 1.75 | 13.0 |
| Wood and Layzell - low est. | 2003 | 51.26 | 0.92 | 6.8 |
| Wood and Layzell - high est. | 2003 | 97.13 | 1.75 | 13.0 |
| Robinson (c) | 1987 | 98.3 | 1.77 | 13.1 |
| Love (c) | 1980 | 72.9 | 1.31 | 9.7 |
| Ralevic and Layzell (d) | 2006 | 11.02 | 0.20 | 1.5 |
| a. Assuming energy content of woody biomass is 18 GJ/dry t. | | | | |
| b. Using the forecast total of 13.47 EJ/yr for 2010 (NRCan, 2006). NOTE: 1 exajoule, (EJ) = 1000 petajuoles, (PJ) | | | | |
| c. Although outdated, shown for purpose of comparison. | | | | |
| d. This is an assessment of MPB killed wood availability, determined to be 11.02 M dry tonne/yr for 20 years. It is a temporary resource and therefore is not included in the sequential order by year of publication (Ralevic and Layzell, 2006).<br>Note: Detailed accounts of Robinson's and Love's estimates are not included given that these authors combine various categories (forest and agricultural) in making their estimations. | | | | |

*Table source: IEA Bioenergy Task 31 Country Report: Canada (December, 2008) Authors Ralevic P., Karau J., Smith C.T., Richardson J.*

Woody biomass estimates included in these studies covers forest harvest residue (slash), mill residues, hog piles - (large piles of waste wood and bark that have build up over a number of years), urban waste, unharvested Annual Allowable Cut – (the portion of provincial annual allowable cut that is not utilized by the logging industry) and fire-and insect-killed wood.

It should be noted that these estimates presented in Table 2.4 do not take into account other biomass feedstocks, such as energy crop plantations or agricultural residues which would increase these resources estimates considerably.

## 2.5 Woody biomass resource estimates and bioenergy opportunities from BC forests

The BC Bioenergy Strategy, (2007) states; *"British Columbia has 50% of the biomass electricity-generating capacity of the entire country within our province."*

The Energy Plan for BC, suggests 34% of BC's biomass resource will come from Mountain Pine Beetle, (MPB), damaged forests, (*see sections 5.3.2: MPB*), and 53% from sustainable forestry, (including residues from clearing of roads and landings etc.), 10% from sustainable agriculture and 3% from municipal waste, (The BC Energy Plan, 2007). A map produced for the BC Ministry of Energy, Mines and Petroleum Resources, (EMPR), showing BC's estimated regional bioenergy potential can be found at:
***http://www.empr.gov.bc.ca/EEC/Strategy/BCECE/Documents/BC%20Renewable%20Energy%20Potential.pdf***

At the IEA Bioenergy conference, (2009), Minister of Forests and Range, the Hon. Pat Bell described the opportunities for woody biomass from normal forestry operations and MPB affected forests as making BC the "Saudi Arabia" of bioenergy! The BC Ministry of Forests and Range estimates that the twenty year supply of pine for bioenergy is around 5 million m³/year (2.1 million tonnes/year) if harvest rates of MPB-affected pine are regulated to suit a 20 year time frame. This number may still be optimistic because it does not account for possible losses to fire or wind or for the fact that BC is currently removing about 42 million m³ of pine from the inventory each year, about twice the rate the 20-year time frame would allow. Furthermore, access to older MPB-affected forests is limited due to issues with harvesting in regenerating forests and /or within mixed stands. Discussions with British Columbian foresters suggest more conservative estimates of the actual volume available are warranted, (pers. comm.).

Much of the biomass that is currently coming from BC's forests is from roadside logging slash that was traditionally heaped up and burnt. This residual wood is being sold at a royalty to the government of CA$0.25/m3. The issue now is that the biomass /bioenergy market is running out of this easily accessible resource due to the major downturn in the traditional sawmill and pulpmill industry in Canada of recent times which has seen a huge drop in the amount of residual wood being available for the bioenergy industry. MPB-killed forests are seen as a logical source of biomass.

At the current rate, the available MPB-affected pine will be harvested by around 2014. The Ministry does, however, anticipate a slowing down of pine harvest for sawlogs over the next few years. When the MBP problem dies down, there will still be around 3.7 billion $m^3$ of wood on that timber harvesting land base so there will still be plenty of opportunity for biomass production. Currently, around 1 million tonnes/yr of pellets are being produced from BC forests.

There are 203 First Nation, (the indigenous inhabitants), communities in BC, many of whom are very interested in utilising bioenergy in their communities. Many of the First Nation settlements are in remote areas where, in some instances, diesel has to be flown in to operate their power generators at considerable expense. Some of these communities are considered to be ideal for the establishment of either heat or CHP plants.

### 2.5.1 Second generation ethanol from MPB-killed forests

Long transport distances render much of Canada's woody biomass supply inaccessible or expensive to harvest and transport. The Canadians are keen to find markets for MPB killed trees that are high enough in value to warrant the cost of harvesting from these forests, especially where there are few prospects available for value adding to these damaged trees to fund their removal from the forest. *(See section 9, Case study 7 - Lignol Innovations).*

### 2.5.2 Sustainable harvest of biomass in BC

Shannon Berch, BC Ministry of Forests and Range, gave a presentation at the IEA conference titled – "*Framework for Sustainable harvest of biomass in BC"*. Up until recently, MPB damaged trees were hauled to the road side, heaped and burnt. Now, more and more, over the last few years this material is being chipped and taken to various mills and plants and used for energy production or for turning into pellets.

Potential issues regarding sustainability if forestry activities increase biomass harvesting include:

- Nutrient depletion, particularly cation displacement,
- Dead wood and organic matter,
- Cumulative soil disturbance.

Long term monitoring is undertaken as required under the Forest and Range Evaluation program to determine causal factors for forest changes etc. Various aspects are examined – 11 resource values, including soils and biodiversity. On analysis, the researchers believe that existing sustainable forest management regulations for whole tree harvesting are adequate for biomass removal. It is expected that this monitoring program should pick up what impacts more intense harvesting for biomass are having on forests.

## 2.6 Biomass power generator capacity in Canada

Table 2.6 indicates that the installed biomass electrical generation capacity across Canada in 2008, to be around 2,051 MW. However, some pulp mills closed in the 2006-07 period, shutting cogeneration capacity. Most of this electricity is used 'in house' by those industries that are generating it with relatively little going into the grid, (Andrew Lang, pers. comm.)

**Table 2.6. Installed biomass power capacity across Canada, (MW) up to 2008.**

| | P&P | IPP | Total 2005 | underway 2005-08 | 2008 |
|---|---|---|---|---|---|
| BC | | | 648 | 73 | 721 |
| Alberta | 217 | 62 | 255 | 25 | 280 |
| Sask | | | 77 | | 77 |
| Manitoba | | | 23 | | 23 |
| Ontario | | | 321 | 13 | 334 |
| Quebec | 126 | 179 | 305 | 74 | 379 |
| New Brunswick | 164 | 0 | 164 | | 164 |
| Nova Scotia | | 25 | 55 | | 55 |
| PEI | | | 0 | | 0 |
| Newfoundland | | | 18 | | 18 |
| | | | 1,866 | 185 | 2,051 |

*Source: Douglas Bradley, Canada report on bioenergy, June 2009*

## 2.7 Biomass power generator capacity in BC

In 2009, there was around 800 MW of biomass electricity generation capacity installed in BC, primarily within the forest sector, with the largest biomass power plant in North America located at Williams Lake, generating 65 MW of biomass electricity. Bioenergy now constitutes more than 55% of the total electricity and steam energy used by the forest industry. A map of BC's current biomass to energy plants can be found at:
*http://www.empr.gov.bc.ca/RET/RenewableEnergyTechnologies/Bioenergy/Pages/default.aspx*

Additionally, BC produced over 1 million tonnes of wood pellets in 2008, 65% was exported primarily to Europe, 23% to the US and the rest for domestic consumption.

## 2.8 The BC Energy Plan for renewable energy development

The BC Energy Plan, 2007, includes all forms of renewable energy technologies and solutions to "green the grid" and provide remote energy, reduce energy losses, provide new jobs, investment and ultimately greater prosperity for British Columbia. The Plan includes:

- Zero greenhouse gas emissions from coal fired electricity generation.
- All new electricity generation projects will have zero net greenhouse gas emissions.
- Zero net greenhouse gas emissions from existing thermal generation power plants by 2016.
- Ensure clean or renewable electricity generation continues to account for at least 90% of total generation.
- No nuclear power.
- Achieve electricity self-sufficiency by 2016.
- Make small power part of the solution through a set purchase price for electricity generated from projects up to 10MW.
- Maintaining a competitive electricity rate advantage.
- Establishment of a CA$25 million Innovative Clean Energy Fund.

- Implement the BC Bioenergy Strategy to take full advantage of BC's abundant sources of renewable energy.
- Generate electricity from mountain pine beetle wood by turning wood waste into energy.
- Invest CA$89 million for fuelling stations and the world's first fleet of 20 fuel cell buses through a federal-provincial partnership.

As part of this Plan, the BC government released its BC Bioenergy Strategy in 2008 to:

- Establish CA$25 million in funding for a provincial Bioenergy Network for greater investment and innovation in B.C. bioenergy projects and technologies.
- Establish funding to advance provincial biodiesel production with up to CA$10 million over three years.
- Issue a two-part Bioenergy Call for Power, focusing on existing biomass inventory in the forest industry.
- Develop at least 10 community energy projects that convert local biomass into energy by 2020.
- Aim for BC biofuel production to meet 50% or more of the province's renewable fuel requirements by 2020.
- Establish one of Canada's most comprehensive provincial biomass inventories that creates waste to energy opportunities.

## 2.9 The BC Carbon Tax

In July 2008, BC introduced a carbon tax of CA$10/tonne of $CO_2$ equivalent emissions (CA$0.0234 /litre on gasoline) which was a first for North America. The broadly based carbon tax is on the purchase and use of fossil fuels in BC, such as gasoline, diesel, natural gas, heating fuel, propane and coal, and to peat and tyres when used to produce energy or heat. The tax will increase each year until 2012, reaching a final price of CA$30/tonne, (~CA$0.072 /litre at the pump). The carbon tax is revenue neutral meaning all revenues generated are returned to taxpayers through tax cuts and credits.

# 3. Overview of bioenergy and biomass resources in USA.

## 3.1 Energy use in the USA

During the mid 1950's, the US switched from being energy self-sufficient to a net importer of energy. Table 3.1 shows the ever widening gap in the US between primary energy production and consumption, and exports and imports. The US Dept. of Energy, (DOE), estimates that US energy demand will increase 26% between 2009 and 2030.

The US is a net exporter of coal, with 7% exported in 2008, around 10% of US natural gas consumed is imported, 86% of delivered uranium was of foreign-origin – mostly from Australia. The US imported about 57% of the petroleum products that it consumed during 2008. Net imports of crude oil and refined petroleum products (imports minus exports) equaled 11.1 Million barrels/day, (MMbd). According to the EIA, US dependence on foreign petroleum is expected to decline in the next two decades.

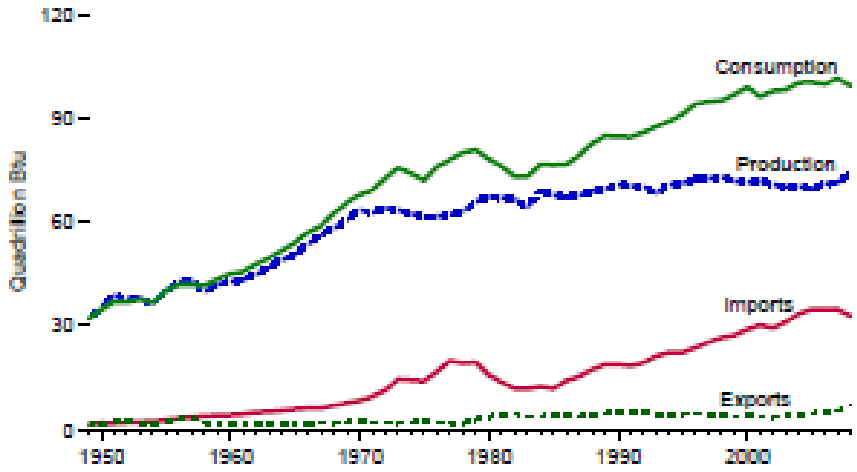
The US Energy Information Administration, (EIA), projects that net imports of US crude oil and petroleum products will decline from 12.1 MMbd in 2007 to 8.3 MMbd in 2030. Growth in total US petroleum consumption is expected to remain relatively flat out to 2030. The increase in US

crude oil production in the Gulf of Mexico and elsewhere, combined with increasing biofuel and coal-to-liquids (CTL) production, is expected to reduce the need for imports over the longer term. US petroleum import dependence is projected to fall from 58% in 2007 to 40% by 2030.

The federal Energy Independence and Security Act, (2007) set a mandate to raise renewable fuel use to 36 billion gallons, (136.3 billion litres) by 2022, *(see section 6.9).* Despite reduced gas mileage due to the lower volumetric energy content of ethanol compared to gasoline in non-optimized engines, high crude oil prices and government incentives and mandates including requirements for motor fuel oxygenates to reduce air pollution have resulted in increased consumption of ethanol and nowadays, most of the gasoline in the US has some amount of ethanol blended into it.

According to the EIA, oil consumption in the US and Canada equals almost 11.35 litres/day/ capita. Oil consumption in the rest of the OECD equals 5.3 litres/day/capita. Outside of the OECD, oil consumption equals 0.76 litres/day/capita.

**Figure 3.1. Overview of primary energy in the USA, 1949- 2008.**




Source: Energy Information Administration / Annual Energy Review 2009, EIA Website

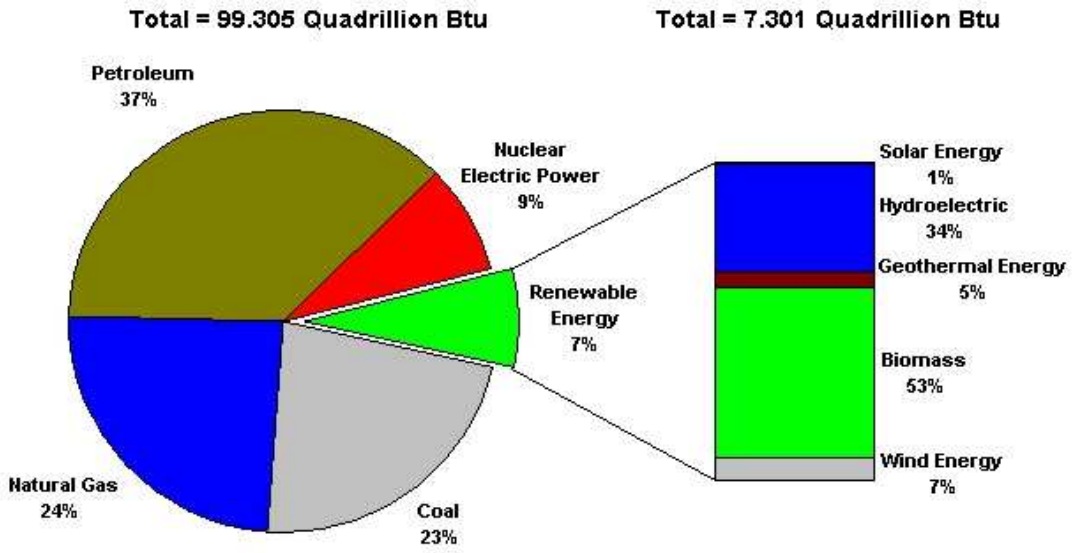
### 3.1.1. Current and projected renewable energy use in the USA

Renewable energy's share of total US energy consumption was over 7% in 2008, (Table 3.1.1.) compared to 6% in 2004. This is the highest level attained, based on EIA estimates of renewable energy back to 1949, and is due mainly to substantial increases in the use of biofuels, wind and solar energy. Biomass contributed over half of all the renewable energy consumed, greater than all the other renewables combined, including hydroelectricity. Renewable energy consumption grew by 7% between 2007 and 2008, despite a 2% decline in total US energy consumption. Total renewable energy consumption increased by 514 PJ to 7,703 PJ, (US EIA, 2010[1.]).

The new US Renewable Fuel Standard, (RFS2) requires 136 billion litres/year of biofuels by 2022 and includes specific provisions such as lignocellulosic ethanol and biomass derived diesel that pave the way for woody biomass fuel technologies, (see section xx for more detail).

According to Austrade's Chris Kneppler, (2009) during his presentation at the 2009 Bioenergy Australia conference, the U.S. is investing US$66.6 billion in clean energy, second only to China who are spending US$68.7 billion, the majority of this funding is expected to be spent by 2011. Whereas this investment in China is principally going into on-ground capacity, expenditure in the U.S. goes more towards market instruments like subsidies and grants, and for Research and Development, (Andrew Lang, pers. comm).

**Table 3.1.1. Renewable Energy Consumption in the United States Energy Supply, 2008**




*Source: EIA, Renewable Energy Consumption and Electricity Preliminary Statistics 2008, http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/rea_prereport.html 8*

The level of investment into the use of biomass for electrical and thermal energy production in the USA has grown substantially in recent years. The US EIA forecast that biomass is likely to continue to be the main source of renewable energy in the USA, producing up to 9,780 PJ of the USA's primary energy needs by 2035, which is around 50% more than the renewable energy output forecast for all other renewables combined, including hydroelectricity, (U.S. EIA, 2010[2.]).

## 3.2 The forest and timber industry of USA

Forests cover about one-third of the USA; around 304 million hectares. About 171 million hectares, i.e. 56% of America's forest land is classified as "private" land which is owned by about 10 million private owners, including forestry companies and other forestry investment companies. The other 44 % is "public" land, the bulk of which is held by four federal agencies; (Forest Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service) as well as numerous state, county, and municipal government organizations. Plantations make up around 25.5 million hectares of the total forested land.

Eastern forests cover about 155.4 million hectares and are predominantly broadleaf (74%), with the exception of extensive coniferous forests and plantations in the southern coastal region. These are largely in private ownership (83%). By contrast, about 147 million hectares of western forests are predominantly coniferous (78%) and in public ownership (57%), (US National Atlas).

By state, the total public and private land area with harvest-size timber that is not designated as undevelopable wilderness for Oregon is 38.8% forest cover, California is 17.8% and Montana is 20.6%.

### 3.2.1 Timber production

In general, domestic timber production has been declining since the early 1990s, while consumption has been relatively stable. The gap between production and consumption has been filled with rising imports. At the national level, growing-stock removals have been fairly stable over the past two decades. During 2006, they totalled 440 million $m^3$. This represents a decline of nearly 3% from 1996 and 1986.

By ownership category, private owners, who include non-industrial private forest and forest industry owners, accounted for 402 million $m^3$, or 92%, of growing-stock removals. These figures were largely unchanged from 1996 to 2006. However, National forests experienced a 54%, (12.7 million $m^3$) drop over this period, other public timber lands showed only a 1% decline in growing-stock removals. Combined, public owners accounted for only 8% of growing-stock removals.

In 2006, private lands supplied the majority (91%) of timber product output (TPO) at 338 million $m^3$. National forests supplied 11 million $m^3$ (only 3%) and other public owners provided 25.5 million $m^3$ (6%) of removals during 2006. Since 1996, total TPO has declined nearly 9% at the national level. The Pacific Coast region was the only region to have a small TPO increase of 2%.

During 2006, timber-processing facilities in the US produced nearly 78.7 million dry tonnes of wood residues, with just 1.18 million tonnes (1.5%) of that residue not utilized for a product. This represents a 5% decline in mill residue production since 1996. About 33.3 million tonnes (42.3%) of wood residue were used for fuel, 32 million tonnes (40.8%) for fibre products, and 12 million tonnes (15.3%) for other products, e.g. animal bedding, mulch, and decorative bark.

In 2006, more than 127.4 million $m^3$ of logging residue was created and left in the forest as "slash" across US forests. About 28%, or 36 million $m^3$, of this logging residue came from growing-stock sources and 72%, or 93.4 million $m^3$, came from tree tops, limbs, stumps, and other non-growing sources, (Smith et al, 2009).

### 3.2.2. The U.S. Forest Service

The US Forest Service, (USFS) is the largest forest landholder in the US and manages 155 national forests and 20 national grasslands The USFS has some type of stewardship responsibility on 80% of America's forests. The USFS has direct stewardship responsibility for 78 million hectares of national forests and grasslands across 44 states. The USFS also shares responsibility, working though State forestry agencies, for the management, protection and use of about 202 million hectares of non-Federal rural and urban forests. Work is carried out primarily through a decentralized organization of regions and research stations.

The USFS also works with private landowners, State forestry organizations, tribes, and communities in forest management, protection, and utilization objectives through a wide-range of State and Private Forestry cooperative programs.

As of 2009, the Forest Service has a total budget authority of US$5.5 billion, of which 42% is spent fighting fires.The National Fire Plan, the Healthy Forests Initiative, and the Healthy Forests Restoration Act provide the USFS with the authority to protect lives and property from wildfire and keep trees, forests, and forest ecosystems healthy and sustainable, (*see section 6*). The Forest Service has the largest forestry research program in the world.

Currently, the National Forest System mission area is engaged in the following critical focus areas; Sustaining healthy forests, Recreation, Clean water and adequate supply**, Wood for energy,** Climate change management and Informed citizenry.

## 3.3 Woody biomass resources estimates in USA

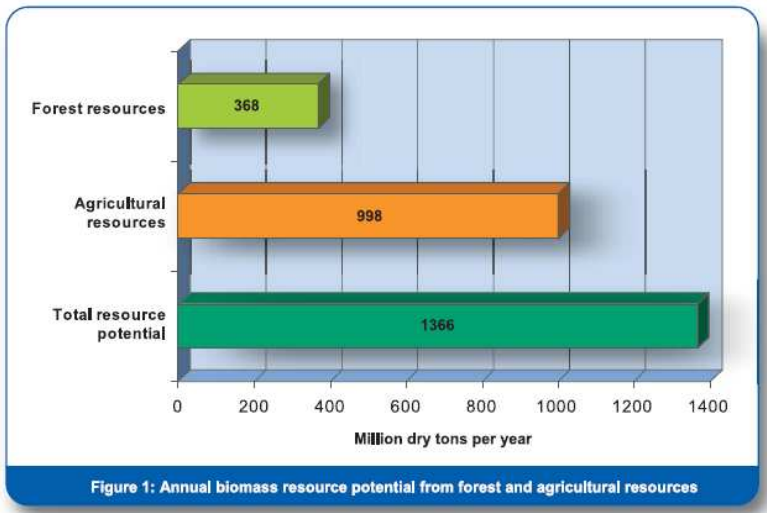
In 2005, the USDA and the DOE prepared a report "*Biomass as feedstock for a bioenergy and bioproducts industry: the technical feasibility of a billion-ton annual supply*". The purpose of this report was to determine whether the land resources of the US are capable of producing a sustainable supply of biomass sufficient to displace 30% or more of the country's present petroleum consumption – the goal set by the Advisory Committee in their vision for biomass technologies. Accomplishing this goal would require approximately 1 billion dry tons, (907 million tonnes) of biomass feedstock per year.

The report found that this goal and more could be accomplished, and that 1.3 billion dry tons per year of biomass could potentially be produced from forest land and agricultural residue alone. This would be enough to produce biofuels to meet more than one-third of the current demand for transportation fuels. The full resource potential could be available roughly around mid-21st century when large-scale bioenergy and biorefinery industries are likely to exist. This annual potential is based on a more than seven-fold increase in production from the amount of biomass currently consumed for bioenergy and bio-based products. About 368 million dry tons of sustainably removable biomass could be produced on forest lands, and about 998 million dry tons could come from agricultural lands, (Table 3.3).

These estimates of biomass are currently being reviewed and it is likely that the new estimates for potential biomass sources may be substantially lower than what this report has suggested, i.e. that the potential sustainable supply of biomass will be sufficient to displace 15% or more of the country's present petroleum consumption. (Bryan Jenkins, 2009, pers. comm).

A substantially lower figure for biomass estimates for the main forest tenure, federal forests, comes from the USFS estimate of an amount of around 2.8 million green tons of small, low-value trees available for bioenergy production from federal forests. (US Forest Service, undated).

**Table 3.3 Biomass estimates from the 1 billion tons study, 2005**




*Source: Biomass as feedstock for a bioenergy and bioproducts industry: the technical feasibility of a billion-ton annual supply http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf*

## 3.4 Woody biomass resources in three USA States

### 3.4.1 Oregon

The three primary sources of woody biomass in Oregon are wood waste generated from sawmills and wood products mills, forest biomass generated from forest logging or thinning and urban wood waste. Additionally, hybrid poplar plantations in Oregon represent a small woody biomass resource for energy production.

The DOE estimates that the annual available woody biomass resource may be as much as 8.89 million bone dry tonnes, although around 67% of the available resource is currently used for purposes other than energy production, primarily in the pulp and paper industry. About 26% of the available resource is already used for energy production which equates to about 2.3 million bone dry tonnes annually with an energy value of about 45.4PJ.

About 7% of the available resource is not being used for either energy production or other purposes. This resource amounts to about 0.6 million bone dry tons/yr of woody biomass, (0.57 million bone dry tonnes coming from economically available forest biomass). This resource is potentially available for energy production and has a gross energy value of approximately 12.66PJ.

### 3.4.2 Montana

Declining timber harvesting over recent decades, especially in the largest landownership, federal forests has impacted on the state's wood products industry. More biomass is becoming available through fire hazard reduction treatments, forest restoration and pre-commercial thinnings. *Source:http://dnrc.mt.gov/forestry/Assistance/Biomass/Documents/MT_WoodyBiomassAssessment.pdf*

From a study of Montana's forest-based woody biomass supply, (Morgan, 2009), the availability of woody biomass supply was estimated to be around 36 million dry tonnes, which represents a multi-decade supply from just 1.45 million hectares (18%) of timberlands in Montana and an even smaller proportion (5%) of total biomass on timberlands. Around 46% of the potentially available hectares are in federal forests.

### 3.4.3 California

According to the California Energy Commission, the amount of biomass considered to be available on a technically sustainable basis totals 29 million dry tonnes/yr in 2007, increasing to 36.3 million dry tonnes/yr in 2020. In 2007, the technical potential included more than 7.2 million dry tonnes/yr in agriculture, 12.7 million dry tonnes/yr from forestry, and 8.12 million dry tonnes/yr from municipal wastes, which are exclusive of waste in place in landfills and biomass in sewage. The forestry estimate may be optimistic, however, as new analyses including USFS forest biomass estimates for the state are substantially lower, (Bryan Jenkins, pers.comm.).

Dedicated bioenergy crops were excluded from the total for 2007. The technical resource generating potential from the three sources is nearly 3,820 MWe. It is estimated that by 2020, 6,800 MWe of bioenergy, equal to nearly 9% of projected statewide peak power capacity could technically be attained, as a result of resource growth and improvements in conversion efficiencies.

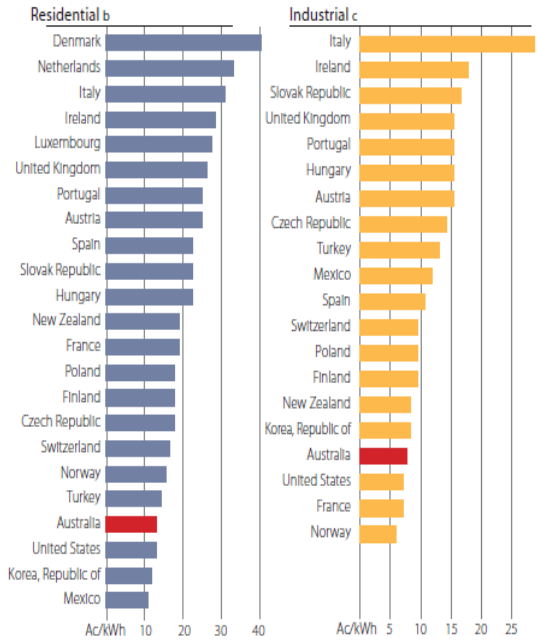
# 4. Barriers to bioenergy development in the USA and Canada

## 4.1 Cheap stationary energy

Stationary energy prices in the US are on a par with, or slightly lower than in Australia, which are some of the cheapest in the OECD, (Table 4.1.). Some exceptions to low energy prices in the US include remote areas, e.g. Alaska and Hawaii.

A barrier to bioenergy development in Canada, or in particular, BC, is very low cost hydro-electricity ($0.08/KWhr), resulting in biomass powered solutions seeming relatively expensive (the feasibility of bioenergy generally being closer to $0.15 /KWh), (Scott Stanners, pers.comm). However, relative to Europe, where electricity is closer to $0.30 /KWh, bioenergy in BC seems relatively cheap.

**Table 4.1. Comparison of Residential and Industrial power prices in some OECD countries**

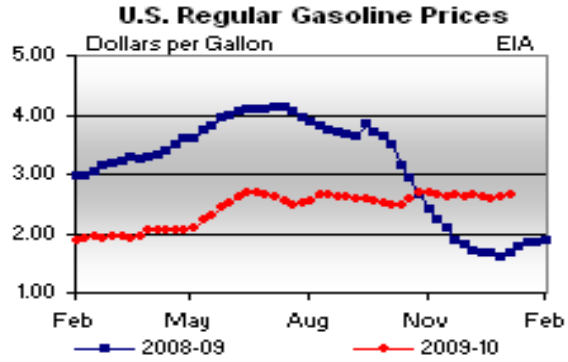



a Does not include all countries, only a sample of OECD countries has been selected. b Australian price is based on ABS residential electricity price index. c Australian price is based on ABS commercial electricity price index. This may be an overestimate of the industrial price.
*Source:* International Energy Agency, *Energy prices and taxes 2008.*

*Source: Energy in Australia, 2009, Australian Bureau of Agricultural & Resource Economics*

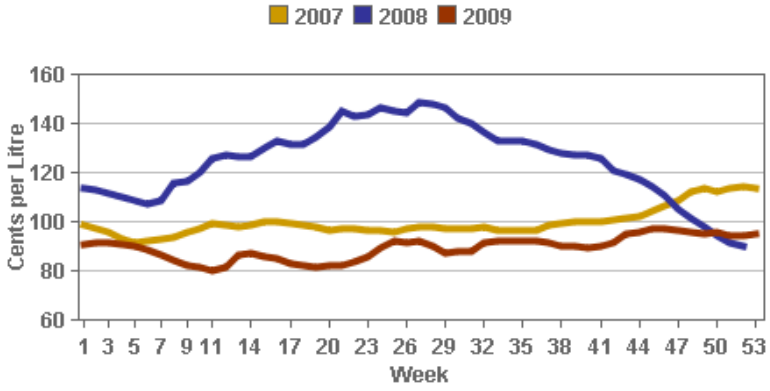
## 4.2 Cheap transport fuel costs

Canada and the USA have some of the lowest transport fuel costs in the OECD. At the time of writing, the average retail gasoline price in the US was AU$0.76/litre. Canadian gasoline prices usually sit somewhere in the middle between those of the US and Australia. These cheap fuel costs make it very difficult for biofuels to compete without substantial subsidies. Volatility in petroleum prices also make it difficult to secure long term financing for renewable energy projects due to uncertainty in market price.




*Source: EIA, (2010), http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp*

Average Retail Prices for Diesel in Canada




*Source: http://www2.nrcan.gc.ca/eneene/sources/pripri/prices_byyear_e.cfm*

## 4.3 Political constraints and policy anomalies

A number of enacted and proposed policies are, or have the potential to, adversely affect the woody biomass to bioenergy industry development, particularly in the USA.

### 4.3.1 The anti-logging lobby

A number of influential environmental groups have strongly opposed harvesting and/or active management of public land forests and have been particularly effective in stopping harvesting on federal forest lands. Over the last 20 years they have successfully litigated against the federal and state government forestry departments on various issues such as the habitat requirements of the spotted owl. This has led to widespread closure of federal forests to commercial forest operations.

Additionally, various environmental groups have expressed their concerns to Congress as to the 'sustainability' of woody biomass including concerns that federal or private forests could be deforested for renewable energy. Expanding the use of biomass from forest products, as opposed to crops, also raises concerns that it could open the door to more logging. Due to their concerns about the sustainability of woody biomass, there have been many efforts to limit the type of woody biomass that would count towards a Renewable Energy Standard. Groups such as "No Biomass Burning", lobby the federal government to exclude all biomass from being deemed a renewable energy source altogether. ***Source: http://www.nobiomassburning.org/***

### 4.3.2 The Renewable Fuel Standard and the Renewable Energy Standard – Drivers or deterrents?

The US Energy Policy Act of 2005 requires that the Environmental Protection Authority, (EPA) administers the Renewable Fuel Standard, (RFS2) - a program that requires the blending of renewable fuels into the USA's motor-vehicle fuel supply to prescribed levels. The Energy Independence and Security Act, (EISA), of 2007 has the goal of reducing US gasoline usage by 20% from 2007-2017, (*see section 6.9*).

The RFS2 program, under EISA 2007, will increase the volume of renewable fuel required to be blended into US gasoline from 34 billion litres in 2008, growing to 136 billion litres by 2022. After 2012, renewable fuel use is required to grow in volume as gasoline demand grows. New RFS2 program regulations are currently being developed in collaboration with refiners, renewable fuel producers, and many other stakeholders.

Although this sounds like good news for biomass producers, the RFS2 has a very restrictive definition of what constitutes renewable biomass. In 2007, the Congress passed a RFS2 which excluded the use of biomass sourced from federal land and most natural forests, only allowing biomass from mill residuals or private land plantations to count towards the renewable fuels mandate.

Another looming issue, with the potential to adversely affect both the forestry and bioenergy industry in the USA, again lies in the definition of "renewable biomass" in the federal governments' proposed emissions trading scheme, the American Clean Energy and Security Act of 2009, (ACES).

The ACES Bill creates a Renewable Electricity Standard, (RES) that would require large utilities in each state to produce an increasing percentage of their electricity from renewable sources. Qualifying renewable sources are wind, solar, geothermal, biomass, marine and hydrokinetic energy, biogas and biofuels derived exclusively from eligible biomass, landfill gas, wastewater-treatment gas, coal-mine methane, hydropower projects built after 1992, and some waste-to-energy projects. The proposed RES:

- Requires 6% of electricity to come from renewables by 2012.
- Requires 20%of electricity to come from renewables by 2020.
- Up to 5% can actually come from efficiency improvements.
- If a state determines that its utilities cannot meet the target, the efficiency component can be increased to 8% and the renewable component decreased to 12%.

The proposed RES, as it currently stands, is similar to the RFS, and excludes many biomass types from the current definition of renewable biomass production. Biomass types that may not be deemed renewable include:

- Planted trees established after the enactment of the ACES bill.
- Naturally regenerated trees, even if they exist within a 'plantation' established before the date of enactment.
- Naturally regenerated forests.
- Forest on any Federal Land.
- A wide array of feedstocks from Municipal Solid Waste, including waste wood, and recyclable post- consumer paper retrieved from MSW paper and cardboard products.

In California alone, around 1 million tonnes of urban wood fuel is currently converted to bioenergy each year, (Bryan Jenkins, 2009, pers. comm.).

These definitions of "renewable biomass" have generally come about through the actions of a number of environmental groups, such as the Natural Resources Defense Council, (NRDC) who have expressed their concern to Congress as to the 'sustainability' of woody biomass including concerns that federal or private forests could be deforested for renewable energy. The NRDC's Nathanael Greene, has stated that the draft ACES bill and RES is an attempt by timber and agriculture interests to weaken "the safeguards designed to ensure that we don't burn irreplaceable forests for energy." Greene predicts that if an amended definition of renewable biomass is passed to include federal forests etc, it will encourage deforestation and reduce the climate bill's 2020 target of a 17% cut in greenhouse gas emissions by as much as 6%.

The key argument being put forward against the restrictive renewable biomass is that any restrictions on renewable biomass should be based on appropriate state-specific standards and not arbitrarily associated with the land ownership classification it is sourced from. A fundamental flaw in the argument against this definition of "renewable" biomass stems from the question of why is it acceptable to define state owned native forests and private native forests as renewable yet federal native forests non-renewable?

Not surprisingly, many groups and individuals are proposing amendments to the draft ACES bill which, if passed as it is currently proposed, could potentially lead to the closure of many existing biomass plants and stymie the development of new projects. Groups such as the Biomass Power Association and the National Association of State Foresters, (NASF), are encouraging the adoption of the existing definitions such as that articulated in the existing farm Bill 2008 or the proposed Renewable Biomass Facilitation Act (H.R.1190) as the basis for a RES. This would ensure that biomass removal would be strictly regulated and that vegetation types, areas and forests of significance etc would be excluded.

The Society of American Foresters, (SAF), supported by over 60 affiliated groups, have proposed that the RES approach to defining eligible forest biomass:

- Includes renewable forest biomass from all forest types and ownerships.
- Relies on forest practices established at the state and local level, rather than creating new federal mandates, land use zoning or overly complex definitions.
- Defines sustainable practices using existing tools, such as state water quality Best Management Practices, with proven effectiveness.
- Protects wildlife, water, soils and unique places through established and trusted public processes that rely on state and local knowledge and expertise
- Allows for forest-health related harvests from National Forests and BLM lands
- Studies the impact of the RES on forest resources at the landscape level and takes corrective measures if and when they are needed, (SAF, 2009).

### 4.3.3 The low-carbon fuel standard

Another conundrum for biomass and biofuel producers is the Low-Carbon Fuel Standard (LCFS). The draft ACES bill is expected to include a low-carbon fuel standard. This would require a reduction in the greenhouse gas emissions from the nation's fuel mix.

The standard, which requires escalating use of renewable fuels such as ethanol and cellulosic fuels, hits 136 billion litres annually in 2022. It requires biofuels, to varying degrees, to have lower lifecycle greenhouse gas emissions than conventional fuels like gasoline with the eventual requirement for a 80% reduction in GHG emissions. This is disconcerting to the 1st generation biofuels producers who are wondering about how overlapping mandates between the RFS and

LCFS will play out and there is concern that conflicting policies may end up pushing production offshore. However, it is acting as a driver for the development of second generation biofuel research and development.

### 4.3.4 Cessation of Production Tax Credits

In 2004, Congress awarded five-year production tax credits to biomass facilities to encourage investment and help ensure the continued viability of the biomass energy industry. The purpose of these tax credits was to increase investment in renewable energy sources that improve the environment and benefit the economy. These tax credits are due to expire at the end of 2009. Biomass power now generates more than half of the total renewable energy produced in the US Much of this production is considered to be the direct result of the 2004 tax credits.

The combined potential negative impact of these policy and incentive changes have been documented by various groups. For example, the Biomass Power Association, (BPA), claim that if production tax credits are not extended, more than half of the US's existing biomass power facilities could be forced to shut down, resulting in thousands of job losses, (BPA,2009).

## 4.4 High cost of gathering and transporting biomass to energy conversion facilities and research on reducing costs.

In a report that surveyed over 90 key woody biomass stakeholders across the US on their perspectives of woody biomass for energy, the costs of harvesting and transporting biomass material from the field to an energy facility were seen to be the greatest challenges facing the development of woody biomass energy initiatives, (Aguilar et al, 2009).

A considerable amount of work is going into quantifying, and reducing, the costs of biomass harvesting and transport in North America. The following is an outline of the information I gathered on my trip, especially from Professor John Sessions at Oregon State University, who has studied harvesting and transport logistics in the forestry industry. I asked Professor Sessions the following questions:

*Q. "In general, where is it most economical to process biomass – in the forest or at the mill/BCF?"*

Professor Sessions quoted William D. Quigg, president of Grays Harbor Paper: "If you take a grinder out of the mill you will go broke, if you use a bundler to gather biomass to feed the grinder you'll go doubly broke!" Grays Harbor Paper has the advantage of having biomass close to roadside at less than 35 km from the mill.

Professor Sessions has examined the economics and efficiencies of processing slash and thinnings into biomass both at the mill or biomass processing facility, (BCF), and in the forest. He believes that, at longer distances it is more cost efficient to grind or chip residue into biomass at the harvest site to increase load density, but at shorter distances, such as the case at Grays Harbor Paper, or at the centre of energy plantations, the following factors make it more economical to take the unprocessed slash etc to a centralised grinding or chipping facility.

1. The fuel cost of running a large grinder on electricity to process hog fuel for biomass is around US$30/hr compared to around US$100/hr when run on diesel, i.e. in the forest.
2. If you are grinding slash in the field, an 800hp diesel grinder costs around $US300/hr to run as compared to an electric grinder at around $US200/hr in the mill. This size grinder has an output at full capacity of around 100-110 tonnes/hr. It can be difficult to keep that amount of slash up to a machine in the field without moving the grinder whereas it is easier to have trucks delivering to a central location to keep the "feedstock" up to the grinder.
3. The grinder/chipper can run 24 hr/day in the mill but not necessarily in the forest due to grinder moving time and weather unless a large satellite yard is developed.
4. More things can go wrong to slow down the output of the grinder or chipper in the field e.g. the timing of moving trucks into place under the grinder for loading, time lost by trucks waiting to be loaded by the grinder and the down time costs arising from the possibility of having to stop the grinder if trucks are unavailable for loading. Losing even a few minutes per hour is expensive if the grinder and grinder loading equipment is idle.
5. In terms of repairs and maintenance, it is more time efficient to work on a grinder or chipper machine at the mill than to have to send mobile mechanics into the field.
6. A number of trailer configurations have been developed to allow large trailers to be used on narrow forest roads, both to carry chips or slash. Several trailer manufacturers in the US and Canada offer extruded aluminium truck trailers that do not have inside or outside posts or top rails. This reduces loading time, increases capacity, reduces air resistance on the highway, reduces friction for unloading slash or grindings. In the US, previously owned top loading, end-dumping extruded aluminium trailers are available from the refuse industry. Several manufacturers offer sliding axle 14.6 metre trailers to reduce wheel base when off highway. For mountainous terrain, Western Trailers (Boise, Idaho) now offers steerable trailer axles for added trailer manoeuvrability at slow speeds. Both Western Trailers and General Trailer (Eugene, Oregon) offer containers on stinger-steered trailers similar to long-log pole trailers.
7. The unloading of biomass using the whole truck lifting system and end-dumping commonly used in the US, is quicker and generally more economical than lifting of the trailer. The high dump angle reduces difficulty in unloading slash as compared to end-dumping slash from self-unloading end-dump vehicles (such as hook-lift, roll-on/off, or drop box trucks) used to gather slash for satellite yards.
8. To avoid waiting for unloading and to permit flexibility in unloading locations sliding floors (walking or live floors) in trucks are sometimes used. The sliding floors do not need to be end-dumped. A truck of 85-90 $m^3$ capacity can be unloaded in ~ 15 minutes. These sliding floors can also be used in reverse to assist in truck loading such as loading pallets for multi-mode use or to un-jam a load (carefully). Walking/sliding floors, developed in Oregon, are sold through two companies; the Keith Walking Floor and the Hallco Walking Floor. Prices are around $US20,000 and a live floor increases vehicle weight about 1.5 tonnes.
9. At high production grinding facilities, such as a satellite yard or at a mill, where chips or grindings need to be subsequently moved by truck, a fundamental decision is whether to load directly into trucks or whether to put chips/grindings on the ground, and reload with a front end loader. Putting grindings directly on the ground eliminates the grinder waiting on trucks, but requires rehandling material. A large bucket front end loader can load 90 $m^3$ in

7-9 minutes which also increases truck efficiency by reducing waiting time. If grindings are to be put on the ground, it is preferable to have a paved area. If not some material is lost.

*Q. What is the profit margin in biomass?*

Biomass is the bottom of the bottom in terms of value hence optimizing efficiencies in harvesting, haulage and processing are particularly critical. In Oregon, a state government tax credit of US$10/green ton, (~$0.9/ green tonne), for biomass coupled with new federal incentives are necessary to make it economical for biomass to be utilized from thinning or harvesting operations if the biomass is not already at roadside and transport time is not short.

*Q. What are the other key factors necessary to make biomass production profitable?*

Professor Sessions says it is easy to lose money in biomass and that, in the western US, the only profitable (without incentives) biomass system that he has seen are those where biomass is already available at roadside, or close to it, the haul distance is within 40 km of the mill, and the biomass is ground or chipped at the mill using electricity. Biomass resulting from whole tree harvesting systems is the most economical since it is already at roadside. Time rather than distance is the main issue. The time taken to travel the distance is critical and is largely influenced by the quality of the roads and hence the turn around transport time for the trucks. Ideally, a turn around time for trucks of 2 hours should be achieved with 15-17 minutes taken to load the trucks and 15 minutes to unload. Load size is also an issue. In much of the mountainous western US trucks with double trailers and B-trains do not have access because of grade ability of the unloaded vehicle and turnaround issues.

Profitability is also influenced by the size of the cogeneration facilities. A larger facility may be able to afford to reach out farther than a smaller facility.

The Oregon Forest Biomass Working Group, through its Harvesting and Transportation Infrastructure subgroup is particularly active in establishing best practice to optimise biomass recovery to enhance forest health activities.

In Canada, there is currently more emphasis on the on-site chipping and grinding and transporting to the mill or BCF. This is attributed to the generally longer transport distances and poorer road infrastructure which necessitates the requirement to minimize weight over distance. Experience from Canadian biomass harvesting and transport trials suggests that there is no one method that suits all situations. The choice to process biomass in the field or at the mill/BCF, as well as determining which trucks are most efficient to load, transport, and unload biomass are subject to many factors including; the size of the forest residue, moisture content, contamination, machinery availability, operator skill level, road quality, season, transport distance, truck size and trailer design, storage space at the mill/BCF and government policies on forest stockpiling to name a few.

I attended two presentations at the Canadian Bioenergy, (Canbio), workshop in Vancouver, BC in Sept, 2009; "*Costs of recovering forest feedstocks today and tomorrow"* – by A.J. MacDonald, FP Innovations FERIC, and "*Process in bush vs. whole log delivery experience*" – by Doug Ens, CANFOR Pulp Limited Partnership. Both presenters highlighted that although many of the overall costs for various stages of the harvest-transport chain are able to be quantified, there are still many other factors that need to be considered in determining the most cost-effective system to adopt and

that on-going time and motion studies and research are required to determine the most efficient systems to deploy for a particular set of scenarios.

A comprehensive report prepared by the Forest Guild of New Mexico compares costs and impacts of 45 woody biomass removal projects across the USA. This study concluded that removing woody biomass can generate a profit or cost thousands of dollars per acre and that in general there is better data available on project costs than project profits. It also found that the median cost for projects that did not generate income was $625 per acre, (~$1543/hectare).

# 5. Key drivers of bioenergy development in North America and their effect on bioenergy-related legislation, policies and programs and projects

There are various factors which are driving bioenergy development in North America. Outlined below are the key drivers which are, either individually or in combination, leading to the development of legislation, policies, programs that are stimulating on-ground development of bioenergy projects, as well as extensive industry research and development.

## 5.1 The desire for energy security and rising energy costs

### 5.1.1 Energy security - Canada

Technically, Canada is self sufficient in terms of its energy needs. Hence, energy security is not as big a driver for bioenergy development as it is in the USA. Overall, Canada is a net exporter of both stationary energy and transport fuels - mostly to the USA. In 2006, 41 billion KWh were exported the USA, while 24 billion KWh were imported.

Canada's known oil reserves are estimated to be 179 billion barrels, making it second only to Saudi Arabia's. Canada is currently the 7th largest oil producer in the world with more than 95% of Canada's established oil reserves being in the form of oil sands. While conventional oil sources continue to provide more than half of crude oil production, Canadian oil sands have been the source of most of the growth in production in recent years. Canada's crude oil production has risen from 2.1 million barrels in 1997, to 2.8 million barrels in 2007. Canada produces more crude oil than it consumes and is a large and growing net exporter of crude oil. However, crude oil imports still supply more than half of domestic refinery demand. The transportation costs associated with moving crude oil from the oil fields in Western Canada to Eastern Canada, and the greater choice of crude qualities make it more economic for some refineries to use imported crude oil. Over the last decade, Canada's crude oil imports grew from 770 million barrels/day to 859 million barrels/day, (NRCan, 2008).

### 5.1.2 Energy security - USA

The US spends over US$500 billion annually on energy, (US DOE, 2009). Not surprisingly, energy security is considered to be of vital importance to the overall development and security of the USA, whose growing dependence on imported energy sources, particularly petroleum products, was outlined in *Section 3.1*.

The importance of energy security to the U.S. is articulated in the following extract from the U.S. Whitehouse website, 2009;

*"Our reliance on oil poses a threat to our economic security. Over the last few decades, we have watched our economy rise and fall along with the price of a barrel of oil. We must commit ourselves to an economic future in which the strength of our economy is not tied to the unpredictability of oil markets. We must make the investments in clean energy sources that will curb our dependence on fossil fuels and make America energy independent.*

- *Breaking Dependence on Oil. Promote the next generation of cars and trucks and the fuels they run on.*
- *Producing More Energy at Home. Enhance U.S. energy supplies through responsible development of domestic renewable energy, fossil fuels, advanced biofuels and nuclear energy.*
- *Promoting Energy Efficiency. Promote investments in the transportation, electricity, industrial, building and agricultural sectors that reduce energy bills".*

A key component of the Obama administrations' drive for energy security is the American Recovery and Reinvestment Act, 2009 which includes more than US$80 billion in clean energy investments aimed at jump-starting the economy and building clean energy jobs. (*See section 6.16*). Furthermore, the proposed ACES bill aims "*To create clean energy jobs, achieve energy independence, reduce global warming pollution and transition to a clean energy economy*".

### 5.1.3 Energy security and rising energy costs - USA

The US EIA's latest forecasts for liquid fuel and electricity prices in the US indicate substantial prices hikes for liquid fuels and natural gas and only slight increases in residential electricity prices as follows:

- EIA expects that the price of West Texas Intermediate (WTI) crude oil, which averaged US$62 per barrel in 2009, will average about $80 and $84 per barrel in 2010 and 2011, respectively. EIA's forecast assumes that US real gross domestic product (GDP) grows by 2% in 2010 and by 2.7% in 2011, while world oil-consumption-weighted real GDP grows by 2.5% and 3.7% in 2010 and 2011, respectively.

- Escalating crude oil prices drive the annual average regular-grade gasoline retail price from US$0.62/litre in 2009 to $0.75 in 2010 and $0.78/ litre in 2011. Pump prices are likely to pass $0.79/litre at some point during the upcoming spring and summer. Projected annual average diesel fuel retail prices are US$0.79 and $0.83/litre, respectively, in 2010 and 2011.

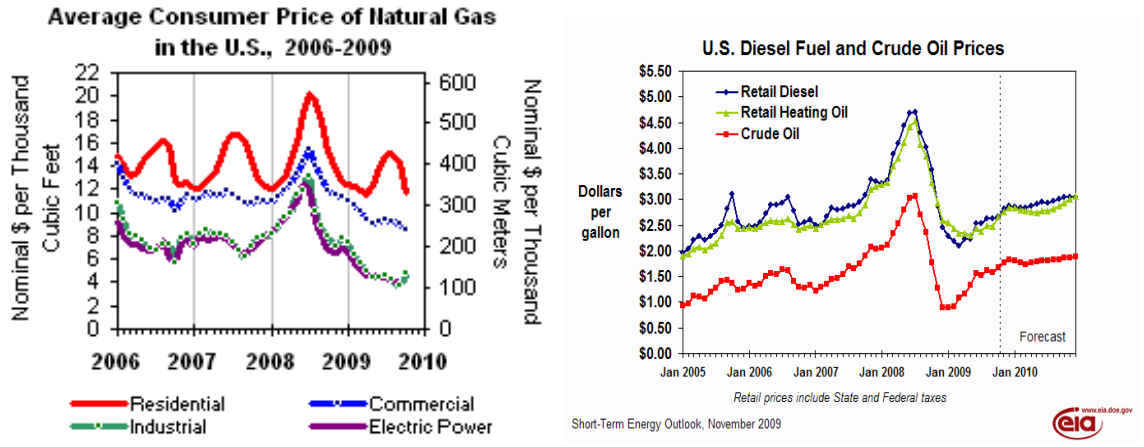
- EIA expects the annual average natural gas Henry Hub spot price for 2010 to be US$5.36/ thousand cubic feet, a $1.30/ thousand cubic feet increase over the 2009 average of $4.06/thousand cubic feet. The price will continue to increase in 2011, averaging $6.12/thousand cubic feet for the year.

- The annual average residential electricity price changes slightly over the forecast period, falling from US$0.116/KWh in 2009 to $0.115 in 2010, and then rising to $0.117/KWh in 2011.

- Projected carbon dioxide emissions from fossil fuels, which declined by 6.1% in 2009, increase by 1.5% and 1.7% in 2010 and 2011, respectively, as economic recovery contributes to an increase in energy consumption.

Natural gas prices, in particular, are forecast to increase substantially at around 50% between 2009 and 2011, (US EIA, 2010)

**Table 5.1.3 Energy price spikes experienced in the USA in 2008**




***Source:http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html***

During mid 2008, the US experienced major spike in prices for liquid fuels and natural gas, (see table 5.1.3). This was largely due to the impact of hurricanes Gustav and Ike which hit the Gulf of Mexico, which in turn lead to refinery shut downs and a large drop in gas production.

### 5.1.4 Two case studies – rising energy costs driving individuals to invest in bioenergy

Fuel price spikes like these can have a major financial impact on industries and during my discussions with business owners who had invested in, or were planning to install bioenergy plants, these prices spikes were often the key driver that convinced them to invest in bioenergy.
(*See Case studies 2 and 5, section 9: Biomax 50 gasifier at Dixons Ridge Walnut Farm and Freres' Veneer mill and 10MW CHP plant).*

## 5.2 Abundant supplies of biomass

Both Canada and the USA have abundant biomass resources. Biomass resource estimates for Canada, the USA and selected states and provinces are outlined in *Sections 2 and 3 of this report.*

## 5.3 Climate change impacts on forests

### 5.3.1 Canada

The 2009 IEA conference "*Biofuels and Biomass – a Changing Climate"* was held in Vancouver, BC. The theme reflected the intense impact that climate change is having on Canada. These impacts include rising temperatures, retreating glaciers and extreme forest fires. At the conference we were told of the escalating expenditure going into fire fighting in recent years and that BC faced its hottest summer on record.

Due to the abundant supply of cheap energy in Canada, energy security is less of a motivator than climate change, (Scott Stanners, pers. comm.).

### 5.3.2 Mountain Pine Beetle and the forests of BC

One of the opening speakers at IEA Bioenergy conference in Vancouver was the Hon. Pat Bell, Minister for Forests and Range, BC. A forester by training, Minister Bell had a sound understanding of his Ministry and the issues that forestry faces over coming decades. In his speech, the minister emphasized that the impacts of climate change are being particularly felt in BC where above average winter temperatures and a lack of the normal extended cold winter periods have resulted in massive out breaks of the endemic Mountain Pine Beetle, MPB in lodgepole pine, (*Pinus contorta*), forests across Canada and northwest USA. Minister Bell stated that the MPB outbreak was one of the strongest indicators of climate change on the planet.

The MPB has a life span of one year, during which time the beetle feeds on the sap of mature lodge pole pine, predominantly leading to death. The high level of pine deaths are resulting in major flooding and erosion problems in the Province as the "sponge" effect of the trees is lost due to the deforestation occurring from the massive level of tree deaths. Minister Bell said he is concerned that, in terms of climate change, we are close to the tipping point.

Mountain Pine Beetle has already killed 14 million hectares of lodgepole pine over the last 10 years, this equates to around 630 million $m^3$ of timber having been affected; approximately half of the available allocated lodgepole pine. According to Jim Snetsinger, (chief forester, BC Ministry of Forest and Range, Canada) by 2014 MPB is expected to kill or have killed around 15 million hectares. There are also concerns that MPB is now also being found infesting other native coniferous species, such as Jack Pine.

Initially it was thought that sawlog harvest from the killed pine was only a few years and that after that the wood quality would have deteriorated too much to be suitable for sawn timber and possibly pulp. However, it has recently been determined that the "millable life" of the MPB affected timber is 8-12 years after death - not as bad as previously expected. This provides a greater opportunity to harvest biomass from the forests as the economics of harvesting biomass is improved considerably when it is undertaken as part of an integrated harvesting operation.

The Ministry of Forests and Range produced the Mountain Pine Beetle Action Plan 2006-2011, with the objectives of:

1. Ensuring long-term economic sustainability for affected communities.
2. Maintaining and protecting public health, safety and infrastructure.
3. **Recovering the greatest value from dead timber before it burns or decays, while respecting other forest values.**
4. Conserving the long-term forest values identified in land use plans.
5. Preventing or reducing damage to forests in areas that are susceptible but not yet experiencing epidemic infestations.
6. Restoring the forest resources in areas affected by the epidemic.
7. Ensuring co-ordinated and effective planning and implementation of mitigation measures.

### 5.3.3 Mountain Pine Beetle and the forests of Montana

The Northern Region of the US Forest Service, Montana, northern Idaho and North Dakota, has been spending around $15 million a year to reduce hazardous fuels around communities, including trees killed by the MPB.

In 2009, about 2 million hectares of Montana forests had been affected by MPB infestations, up from about 0.81 million hectares in 2008. The beetles are now moving into higher elevations, where low winter temperatures used to limit their progress. Once established, the beetles are now

attacking other species besides lodgepole pine, such as whitebark pine. The epidemic has resulted in a dramatic increase in the danger of trees falling on roads, trails and recreation areas. In addition, the dead and dying trees increase the risk of fire danger.

In 2010, the USDA is allocating US$20 million to Montana to remove some beetle-killed trees, especially in areas frequented by people such as campgrounds. It will also be used to thin areas of thick stands with the smallwood thinnings going to bioenergy plants where feasible.

A new bill has recently been introduced in Montana, the Forest Jobs and Recreation Act. Part of the bill aims to mandate logging on at least 40,468 hectares, with the aim of undertaking forest restoration activities in the wildland-urban interface and specifically where MPB have hit hard.

## 5.4 The need to reduce greenhouse gases at home and abroad

Climate change and the development of legislation to reduce Greenhouse Gas, (GHG) emissions is a major driver of bioenergy development in Canada and the USA and in most of the individual states and provinces.

In the USA, the principal alternative fates for biomass residues in the absence of energy production are open burning, landfill burial, and accumulation in forests. In 1999, it was estimated that approximately half the biomass fuels used by the independent biomass power industry in the United States would be buried in landfills. Another third would be open burned. The remainder would be spread, composted, or remain as overstocked material in the forests, (Morris, 999). All of these alternatives have implications for increasing GHG emissions to varying degrees and over varying time frames.

### 5.4.1 Emissions reduction targets in Canada

The Canadian government is committed to an Emissions Trading Scheme, (ETIS). Legislation has been drafted but is not yet finalised. Unlike the USA, Canada has been a signatory to the Kyoto protocol since 2002. This committed Canada to reducing GHG emissions to 6% below the country's 1990 levels, to be achieved between 2008 and 2012. Canadian climate change policy is complex, due to the relationships between the provincial, territorial and federal governments and the differences in amounts and sources of GHG emissions across the country. For example, Alberta, rich in coal tar sands, has its own climate change plan but remains opposed to the Kyoto Protocol. BC has its own more ambitious climate action target which aims to reduce BC’s GHG emissions by at least 33% by 2020.

In many ways, federal energy policy in Canada is similar to that in Australia. Like Australia, the Government of Canada has a Mandatory Renewable Energy Target of achieving a reduction of 20% by 2020.

### 5.4.2 Emissions reduction targets in USA

The following remarks were made by President Obama at the G-8 Press Conference Room, L'Aquila, Italy, 9th July 2009.

*“I don't think I have to emphasize that climate change is one of the defining challenges of our time. The science is clear and conclusive, and the impacts can no longer be ignored. Ice sheets are melting. Sea levels are rising. Our oceans are becoming more acidic. And we've already seen its effects on weather patterns, our food and water sources, our health and our habitats.” One of my highest priorities as President is to drive a clean energy transformation of our economy…”*

The US is currently developing the American Clean Energy and Security Act of 2009, (ACES) which proposes a carbon cap-and-trade system to reduce 17% of economy-wide GHG emissions below 2005 levels by 2020, and 83% by 2050 through a variety of measures. The debate passed Congress and is now in the Senate, where political factions are challenging the passage of the bill. Similar to Australia's proposed CPRS, the ACES bill is comprehensive and complex. If passed, the ACES bill is expected to commence in 2012 with an estimated price for $CO_2$ being set at around $13/tonne; projected to rise steadily as emission limits come down, but the bill contains a provision to prevent costs from rising too quickly in any one year. More detail on how the ACES Bill relates to bioenergy is presented in *section 4.3.2*.

Also, like Australia, the ACES bill sets a national standard of 20% for the production of renewable electricity by 2020, although a third of that could be met with efficiency measures rather than renewable energy sources.

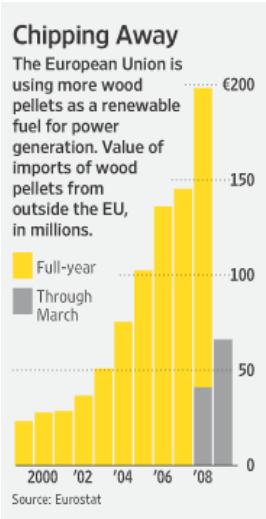
### 5.4.3 Emissions reductions at the state level

In the USA, at the individual state level, 28 states and the District of Columbia have adopted individual RES programs. California is generally regarded as the US state that is leading the way in terms of its ambitious targets and policies to cut GHG emissions. In late 2008, Governor Arnold Schwarzenegger signed Executive Order # S-14-08 that raises California's renewable energy goals to 33% by 2020 and improves processes for licensing renewable projects.

### 5.4.4 Emissions reduction targets and climate change legislation abroad and the growing demand for DBF pellets

A major driver behind the increased demand for wood pellets are European Union (EU) regulations requiring that member states use renewable fuels to generate 20% of their electricity by the year 2020. While pellets may cost more than coal, burning them is generally cheaper than powering utility plants with wind or solar power. In the first three months of 2009, Europe imported EU$92.6 million worth of pellets, an increase of 62% over the same period in 2008, according to European Union statistics, (table 5.4.4).

**Table 5.4.4 The growing EU demand for dbf pellets**




*Source: Eurostat*

Both Canada and the USA are capitalising on these growing markets. Australia, New Zealand, Argentina, Vietnam and South Africa are also shipping pellets to Europe.

The growth in demand for pellets is also coming from a growing domestic demand as renewable energy targets are adopted at the federal and state/provincial level. For example, the Province of

Ontario has mandated to phase out all coal-fired power generation by 2014 which currently accounts for over 6000 MWe a year, (Jane Todd, 2009).This is expected to drive a large new demand for forest and agricultural pellets to drive four power stations which are currently burning only coal.

Canadian pellet production has risen from 400,000 tonnes/year in 2001 to over 2.2 million tonnes in 2008, with around 80% being exported to the EU and the US and around 20% being used domestically. There is concern that the availability of mill residues, the most economical material to make dbf pellets from, is fast disappearing due to the economic downturn leading to a major decline in the timber and pulp industry and hence forest and mill residue availability, (*see Section 5.7*). However, according to the Canadian Bioenergy Association, (Canbio), president, Douglas Bradley, Canbio has identified over 27 million bone dry tonnes of forest biomass as being available, including 50 old piles of hog fuel in various locations across Canada with an estimated weight of 20.9 million bone dry tonnes that could be made available for pellet production.

In the US, the development of new pellet plants and growth in pellet production is greatest in the southern US. For example, company RWE Innogy recently announced that it will build a factory to produce pellets in Georgia, with an annual production capacity of 750,000 tonnes, which could make it the biggest and most modern of its type in the world.

Government mandates and agreements that pellets are a truly renewable energy source are essential to the increasing use of pellets in power generation and the growing global pellet trade.

## 5.5 Increasing wildfire severity and intensity and declining forest health

In recent decades, extensive research across the US has indicated that the historical practice of fire suppression and the decline in the use of prescribed burning across most of the country, has led to the development of unnaturally dense, diseased or dying forests, which, in turn, has contributed to more severe wildfires. In many forests, fire suppression has led to changes in stand density, an increase in shade-tolerant and fire-sensitive species and an increase in the amount and continuity of “ladder fuels” (i.e. fuels that enable fire to travel from ground-level fuels into the forest canopy). Furthermore, twentieth century harvest practices typically removed the larger trees, accelerating dense understory growth. Fire suppression has added to the problem by allowing dead fuels to accumulate in excess of their pre-suppression levels.

The problem is particularly evident in the federally managed forests and rangelands where reduced timber harvest activity and suppression of forest fires have caused unnaturally dense stands and a surplus of dead wood in many forests.

Currently, around 77 million hectares of Federal land in 48 States face high risk of large-scale insect or disease epidemics & catastrophic fire due to deteriorating ecosystem health & drought. In the interior West, for example, Ponderosa pine forests range from Arizona and New Mexico northward into Idaho. A century ago such a forest may have had some 62 mature trees/hectare, whereas today that same forest may stock more than 2470 trees/hectare. These trees are smaller, weaker, more disease prone, and more susceptible to insect attack than their ancestors. Such forests form huge reservoirs of fuel awaiting ignition, and pose a particularly significant threat when drought is also a factor, (BLM website, 2009).

In 2002, Arizona, Colorado, Oregon and New Mexico, each had their largest wildfires in a century. The most devastating series of wildfires in state history swept Southern California during October 2003.

This has prompted a strong movement, across fire-prone parts of the USA, towards the increased use of fuel reduction treatments such as prescribed burning and mechanical biomass removal with

the intent of reducing the risk of catastrophic wildfire and to restore wildland conditions to a more natural fire regime.

Although using prescribed burning to manage fire-adapted forests has traditionally been considered the least expensive option to reduce hazardous fuels when utilization opportunities are limited, there are many areas and times where prescribed fire cannot be used. High fuel loadings, air quality restrictions, suitable weather conditions and risk of escaped fire in the wildland-urban interface are some of the factors that limit the use of prescribed fire. Hence, selective thinning in these forests is becoming increasingly favoured as a fuel reduction method where small diameter wood or energy markets and suitable access warrant the economical removal of this otherwise unmerchantable biomass.

According to Dave Atkins, (pers. comm) several factors affect the decision to use fire as a fuel reduction tool, including:

- If the forest is too dense with ladder fuels it can be impossible to conduct a burn without it going into the crowns and killing more than is desired;
- If the trees you want to save are too small in diameter to survive a prescribed burn or are a species that doesn't have thick bark i.e. lodgepole pine or spruce;
- The challenge in some areas is the designation for management that doesn't allow the use of mechanized harvesting or roads for access and then fire is the only option, but you may still run into the above two issues.

### 5.5.1 California

Across California, 2.2 million hectares and 5 million houses are now in high fire risk areas and there has been a near doubling of the 5 year average acres of wildland burned in wildfires over 25 years. Furthermore, as communities develop and grow in areas that are adjacent to fire-prone lands into the wildland/urban interface, (WUI) wildfires pose increasing threats to people and assets. (California Forest Resources Assessment Program, 2003).

In California, the area of wildland treated through fuel reduction burning has dropped from around 40,500 hectares/year in the 1960’s to only around 4,500 hectares/yr at present. In the past this reluctance to burn was largely due to previously successful (and expensive) litigation, the state faced when previous prescribed burns escaped, (Doug Wickizer, pers. comm.). In more recent times, there have been additional factors leading to California being very active in researching alternatives to prescribed burning. Air quality and its impact on forest and human health is one factor, (*see Section 5.6*). Another major factor is that GHG emissions released from prescribed burning of forest have to be accounted for and offset in California’s GHG emission abatement scheme, the California Global Warming Solutions Act of 2006, (AB32); an ambitious GHG reduction target of reducing emissions to 1990 levels by 2020 as well as the longer-term goal of an 80% reduction of GHG from 1990 levels by 2050.

### 5.5.2 Fuel Treatment Evaluation Model

Scientists from the Pacific Northwest Research Station created an analytic system that allows forest managers to simultaneously assess fuel hazard treatment effectiveness, the location and capacity of processing facilities, and financial feasibility. The system, FIA BioSum, uses the publicly available Forest Inventory and Analysis database and provides a foundation for identifying landscapes where fuel treatments could reduce consequences of wildfire while supporting bioenergy generation.

For example, BioSum was used by researchers who applied numerous policy scenarios to an 11 million hectare, four ecosystem region of Oregon and northern California. The study concluded

that converting trees and logging residue that would otherwise have little or no commercial value into bioenergy shows promise for offsetting some treatment costs. However, results indicate that removing large quantities of merchantable trees would be necessary to achieve fire hazard reduction goals, (Pacific Northwest Research Station, 2009).

### 5.5.3 Thinning & biomass removal vs. fuel reduction burning and greenhouse gas emission reduction

Considerable on-going research across the forested states of the US is confirming that thinning with biomass removal and other fuels management measures are able to provide significant benefits in terms of reduced net emissions of GHG's.

Examining four of the largest wildfires in the US in 2002, researchers found that, for forest land that experienced catastrophic stand-replacing fire, prior thinning would have reduced $CO_2$ release from live tree biomass by as much as 98%, (Hurteau et al, 2008).

The Angora Fire of 2007 blackened 1255 hectares of forest and destroyed 254 homes in the Tahoe Basin, California. Using pre-fire data for the forest, modeling estimated that combustion emissions could have been lowered from 104 to 27 tonnes/hectare if the density of trees had been reduced from 864 to the more natural density of 148/hectare. The four forests burned by these wildfires were overcrowded and contained unnaturally heavy surface fuels. They averaged 864 trees/hectare when 123-148 trees/hectare would be natural. The model estimated that the fires released one fourth of the gases during combustion, and post-fire decay will release the remainder during the next 100 years, most of it during the next 50 years, (Thomas Bonnicksen, 2008***).***

### 5.5.4 The economics of various fire and mechanical fuel reduction techniques

Extensive research, across the US is aiming to quantify and compare the economics of various fuel management treatments against one another as well as against "no treatment" systems.

An example is a study undertaken by the California Energy Commission "Biomass to Energy", a project which modelled the scenarios of "do nothing" fire management vs. various scenarios of thinning and biomass removal for bioenergy based on 1.1 million productive forested hectares over 40 years. The findings came out in favour of thinning & removal for bioenergy and concluded that the potential avoided fire damage costs could be used to subsidise a biomass producer and make a bioenergy plant viable with biomass fuel costs of up to US$54.80/BDT. The value of the forest products made up the bulk of the resource that would be lost in the "do nothing" wildfire scenario in this model.

The Oregon Forest Biomass Working Group state that over 8.5 million hectares of Oregon's forestlands are overstocked, in Fire Condition Class II or III, and subject to catastrophic wildfire, drought stress, and insect and disease outbreaks which impact forest productivity, air quality, and the safety of rural communities. According to Western Forest Health and Biomass Energy Potential, a study prepared for the Oregon Department of Energy, the cost to the public for fighting forest fires averages about US$534 per hectare. However, the cost of a thinning operation ranges from US$123 to $370 per hectare. The cost of thinning varies and depends largely on the location and topography of the site and the type of equipment used, (Oregon GOVT, 2009).

A comprehensive report undertaken by the Forest Guild compares costs and impacts of 45 woody biomass removal projects across the USA. Removing woody biomass can generate a profit or cost thousands of dollars per acre. In general there are better data on project costs than project profits. This study found that the median cost for projects that did not generate income was US$1543/hectare. Estimates for the cost of bringing woody biomass to the roadside in the western US ranged from US$988 to $4,026/hectare depending on forest type and terrain, (Evans, 2008).

### 5.5.5 Other impacts of alternative hazardous fuel treatment

The effectiveness of fuel treatment on US wildland fires was assessed in the report *"An Assessment of Fuel Treatments on Three Large 2007 Pacific Northwest Fires."* On the three fires studied, a higher proportion of acres burned severely on untreated lands than where fuel or other vegetation treatments had been applied (prior to the fires). More recent treatments and higher-intensity treatments reduced fire behaviour and fire effects more effectively than older and less intense treatments. On all three fires, fuel treatments, which included prescribed burning, mechanical biomass removal or a combination of both, seemed to increase suppression effectiveness, (USDA Forest Service, 2007).

In 2008, the USDA Bureau of Land Management (BLM) and USDA Forest Service (USFS), completed the first year of monitoring fuel treatments at a national scale. The goal of the monitoring effort was to determine if fuel treatments are effective and if they are affecting any environmental resources. This project resulted in the report, *"Monitoring Fuel Treatments Across the Continental United States for Overall Effectiveness and Effects on Aquatic and Terrestrial Habitat, Air and Water Quality"*. Of the 118 sites monitored 71% were within the wildland-urban interface (WUI). Nearly half of the monitored treatment sites 42%, (50 sites) were treated with prescribed fire, 30%, (35 sites) had mechanical/manual treatments, and 28%, (33 sites) had a combination of prescribed fire and mechanical/manual treatment. Overall, monitoring teams reported that 99% of the hectares monitored met the fuel treatment objectives and the treatments had an overall positive effect on environmental resources, (USDA Forest Service, 2008).

### 5.5.6 White Mountain Stewardship Contract – rebuilding the timber industry through forest biomass harvesting

The White Mountain Stewardship Contract of the Apache-Sitgreaves National Forest in Arizona is a contract designed around the goal of building a small-scale woody biomass industry based on the hazardous fuel reduction and treatment programs that have expanded in the Forest since the devastating 196,800 hectare Rodeo-Chedeski Fire of 2002. For various reasons, Arizona had all but lost it's forestry industry expertise, experience and equipment over recent years and the Stewardship contract and various Biomass Utilization Grants were made available to help build a timber industry back up in the state, (*See Section 6.1.3).*

This is the largest Stewardship Contract of its kind, covering fuel reduction and treatment of up to 6,073 hectare/year for the next ten years. The contract was awarded to Future Forest, LLC, a partnership between two businesses which manufactures wood pellets for heating wood stoves. Another local business, a 3 MW bioenergy plant in Eager, Arizona is purchasing 45,360 tonnes of limbs, tree tops and small trees from Future Forest every year. Another 20 MW power plant is planned to be constructed and is expected to buy 145,000 green tonnes of biomass annually. Other new enterprises that have emerged to take advantage of the contract include a custom log home business, a post & pole operation, a chemical wood hardening company and a small-diameter sawmill.

According to a USFS report, the White Mountain Stewardship contract has been demonstrating cost savings to the US government in the range of $494-$1440/ hectare, (Bartuska, 2006).

A 2007 economic study of the stewardship contract by the Economic Development Research Program at the University of Arizona showed that there are 15 firms in the region purchasing forest products from the stewardship activities. These businesses are purchasing chips, roundwood and sawn timber. They employ 248 full-time employees. The study also found that these businesses had substantial local expenditures of around US$11 million annually, (Gibson, 2007).

## 5.6 Air quality issues and impacts on human and forest health

In certain geographical regions and air basins of northwestern America, air quality issues are driving legislation and policies that limit the frequency and type of open air burning of agricultural and forestry residues. This in turn, is encouraging land managers to look for alternative ways of disposing of residues, which in some areas, can be favourable to bioenergy project development.

Ozone, which is formed by the reaction of volatile organic compounds (VOC's) and nitrogen oxides (NOx) is the most widespread air pollutant. Ozone can be transported into an area from pollution whose source may be hundreds of miles upwind. The US Environmental Protection Agency reports that 107 million Americans, (over one-third of the countries population), live in areas that violate health standards for ozone.

In some regions, people are joining together to prepare legal actions against US Forest Service officials and State Department of Environmental Quality officials who ignore public health complaints regarding prescribed burns.

As well as being damaging to human health, ozone damage, combined with other factors such as drought, make trees more susceptible to disease, pests and fire. Ozone damage has been recorded in the Sierra National forest and the Sequioa National Forest of California where the level of trees showing symptoms of ozone damage were 35% and 45% respectively, (California Fire and Resources Assessment Program, 2003).

The cumulative impacts of prescribed burning on air quality, already compromised by transport and industrial emissions create a strong case for the use of non-burning alternatives that have the potential to achieve many of the same results as prescribed burning in US forests but without the adverse effects.

Air quality impacts on human and forest health are driving policies that encourage a reduction in agricultural, forest and urban burn-offs. In Oregon, disposal of forest residues by open burning is increasingly restricted because of concerns about air quality, public health and visibility. Alternatives-to-burning strategies are now mandated by federal regulations, and in-state smoke management programs. This is helping drive projects such as the stubble to ethanol research and pilot plant in Corvalis, Oregon. *(See Case study 6. Section 9 - Trillium lignocellulosic ethanol from stubble).*

## 5.7 Declining timber industry and rural employment

Biomass production and bioenergy plants generate jobs in the design, manufacturing and construction phase as well as on-going employment opportunities for skilled and unskilled workers as well as rural economic stimulation through provision of new, decentralised and diversified income streams. That bioenergy equates to jobs is one of the key drivers behind recent policies, favourable to the development of bioenergy in the USA and Canada, e.g. the American Recovery and Reinvestment Act, 2009 which acknowledges the fact that bioenergy from woody biomass is well recognised as being beneficial to rural communities.

As outlined in Section 2.2, Canada and, in particular, BC is suffering from the global decline in the demand for forest products over the last few years with a loss of over 50,000 Canadian forest sector jobs between 2006-08. The USA has also seen a sharp decline in the timber industry over the past few decades resulting in a loss of skills and equipment for harvesting and processing. The decline in forestry activity and hence jobs has been over a longer time period than Canada as it is related more to changes in policy that have lead to a decline in the area available for forest harvesting.

As discussed in Section 4.3.1 environment groups have been influential in halting commercial forestry in many of the USA's federal forests. Consequently, the states that I visited Oregon, Montana and California are battling to keep their timber industries viable as, in recent decades, some of the southern states such as Arizona have lost the bulk of their harvesting and milling capacity, (Dave Atkins, pers. comm.). The decline has especially been felt in California where the annual harvest, which was 5 billion board feet in 1985 is now down to 2-500 million board feet/yr, (Doug Wickizer, pers. comm).

Also, in Montana, since 1987, there has been an 88% decline in timber harvesting on federally-owned national forests, (Morgan, T. 2009**)**.

A major challenge for the bioenergy industry in parts of the USA has been the issue ensuring a reliable and consistent supply of woody biomass to justify developing new infrastructure investments, markets and re-skilling of workers. Many forests needing hazardous fuels treatments are in areas that no longer have forest harvesting skills, equipment and infrastructure hence market development options have been challenging in regions where investors have doubts about the future supply.

A report undertaken for the US DOE in 1999 attempted to estimate the value of the ancillary services provided by biomass power generation, in order to provide policy makers with a yardstick against which to judge the cost of policy interventions that might preserve the viability of the biomass power industry. The report considered wood processing, forest, agriculture, and urban wood residues and determined that 4.9 full time jobs per each megawatt of net plant generating capacity were created associated with biomass power plants, (Morris 1999). These jobs provide stability to local and regional economies and help increase the community tax base.

The Oregon Forest Resources Institute, (2006) estimated that production of 150 MW of electricity from woody biomass would create around 900 jobs and that this doesn't count for indirect job creation, which is usually in the order of 2-3 indirect jobs per direct job.

Morris, (1999), estimated that disappearance of the bioenergy industry in the USA would represent a loss of almost 12,000 rural employment positions, with serious impacts in affected regions. Many rural communities would also lose their largest source of property taxes, and would suffer other multiplier effects.

# 6. Policies, programs and incentives that encourage woody biomass utilization for bioenergy in the USA.

As outlined in the following sections, the use of woody biomass for bioenergy is strongly supported by the US federal and most state governments. The Canadian government is also very supportive of the bioenergy industry, however for this report, research of government policy and programs has focussed on the USA. Some of the many federal government legislation, policies and incentives supporting the use of woody biomass for bioenergy, include:

- The Biomass Research and Development Act of 2000.
- The 2000 National Fire Plan.
- The 2001 National Energy Policy.
- The 2002 Healthy Forests Initiative.
- The 2003 Healthy Forests Restoration Act.
- MOU to Enhance Woody Biomass Utilization, between DOI and DOE, 2003.
- National Energy Policy Act of 2005.
- Forest Service Strategic Plan, 2007-2012.
- The 2007 Energy Independence and Security Act.
- The 2002 Farm Bill and 2008 Amendments in the Food, Conservation, and Energy Act.
- The 2008 Woody Biomass Utilization Strategy.
- The 2008 Biomass Crop Assistance Program.
- Forest Stewardship Contracts.
- Community Wildfire Protection Plans.
- American Recovery and Reinvestment Act, 2009
- Various Tax credits supporting biomass utilisation and bioenergy.

## 6.1 Biomass Research and Development Act of 2000

The Biomass Research and Development Act of 2000, as revised by EPA Act 2005:

- Created the Biomass R&D Technical Advisory Committee and the Biomass R&D Board.
- Calls for the US DOE and USDA to coordinate all federal R&D as it relates to biofuels and bioproducts.
- Sets the scope for the National Biomass Initiative.
- Governs the annual USDA/DOE joint solicitation.

The Biomass Research and Development Board is an agency of the US government created by the Biomass Research and Development Act of 2000. The Board's mission is to coordinate federal research and development activities relating to biobased fuels, power, and products.

## 6.2 US National Fire Plan of 2000

The National Fire Plan, (NFP), was developed in August 2000, following a landmark wildfire season. Devastating fires sweep across western USA in 2000 and subsequent seasons, which marked a tipping point in public perceptions of forest and fire management in the wildlands.

The steadily declining level of forest harvesting and increasing areas of unthinned forest stands, especially on the peri-urban interface was thought to have been a major contributor to the severity of these fires. In recent years, wildfires occurring in overstocked forests with dense understory and many small suppressed trees create ladder fuels which have resulted in larger more intense fires consuming thousands of acres.

In an effort to reduce the likelihood of future catastrophic fires, the federal government passed the National Fire Plan legislation and the development of the 10 year Comprehensive Strategy and its subsequent Implementation Plan to further develop a coordinated strategy addressing the threats posed by wildland fire. Included in the plan was a commitment to provide grant money under Economic Action Programs (through the USDA Forest Service State and Private Forestry) to help fund pilot projects to demonstrate new uses of small diameter and underutilized woody material.

The NFP was enacted with the intent of actively responding to severe wildland fires and their impacts to communities while ensuring sufficient fire fighting capacity for the future. The NFP addresses five key points: Fire fighting, Rehabilitation, Hazardous Fuels Reduction, Community Assistance, and Accountability. The two areas of particular relevance to the forestry and bioenergy industries are outlined below.

### 6.2.1 NFP & Hazardous Fuels Reduction

In response to the risks posed by heavy fuel loads, the NFP established an intensive, long-term hazardous fuels reduction program. Hazardous fuels reduction treatments are designed to reduce the risks of catastrophic wildland fire to people, communities, and natural resources while restoring forest and rangeland ecosystems to closely match their historical structure, function, diversity, and dynamics. Such treatments accomplish these goals by removing or modifying wildland fuels to reduce the potential for severe wildland fire behaviour, lessen the post-fire damage, and limit the spread or proliferation of invasive species and diseases. Treatments are accomplished using prescribed fire, mechanical thinning, herbicides, grazing, or combinations of these and other methods. Treatments are being increasingly focused on the expanding Wildland Urban Interface, (WUI) areas.

### 6.2.2 NFP & Community Assistance

Agencies provide support for educating citizens on the effects of fire, community fire protection planning, and training and equipping rural and volunteer fire fighters. Through a variety of grant programs including Rural, State, and Volunteer Fire Assistance and Economic Action Programs, delivered by the Agencies and the State Foresters, communities can take action to live safely in fire-prone areas. Funding can be used to develop Community Wildfire Plans and apply for Forest Stewardship grants for harvesting and removal of hazardous fuels, *(See section 6.12 and 6.13).*

### 6.2.3 Case study – NFP & the Fuels for Schools and Beyond program

One program that developed as a consequence of the NFP is the Fuels for Schools and Beyond, (FFS&B) program, which commenced in response to devastating wildfires that swept through Bitteroot Valley in western Montana in 2000 destroying 71 homes and 151,020 hectares.

The opportunity provided through the grant money under Economic Action Programs inspired Dave Atkins, FFS&B program manager for the Forest Service's Northern and Intermountain regions and his colleagues with the idea for using the biomass generated from hazardous fuels thinning programs in priority fire risk to fuel a biomass boiler to heat three schools in Darby, Montana, *(See Case study 1 - The Fuels for Schools and Beyond Program, section 9).*

Additional success stories can be found on the Healthy Forests and Rangelands website - *http://www.forestsandrangelands.gov/success/stories*

## 6.3 The 2001 National Energy Policy

The National Energy Policy, 2001, recognized the importance of a diverse portfolio of domestic energy. The Policy outlined thirteen recommendations designed to increase America's use of renewable and alternative energy. One of these recommendations directed the Secretaries of the Interior and Energy to re-evaluate access limitations to federal lands in order to increase renewable energy production, such as biomass, wind, geothermal, and solar. These agencies then prepared a joint report titled "*White House Report in Response to the National Energy Policy Recommendations to Increase Renewable Energy Production on Federal Lands, August 20, 2002*".

## 6.4 The Healthy Forests Initiative, (HFRI), 2002

In 2002, Arizona, Colorado, Oregon and New Mexico, each had their largest timber fire in a century and the most devastating series of wildland fires in state history swept southern California during 2003. These fires killed 24 people, destroyed more than 3,700 homes, and burned 303,750 hectares. Alaska also set a record for areas burned in 2004.

These fires prompted an expansion of the National Fire Plan of 2000 and lead to the Healthy Forests Initiative, (HFRI), and the Healthy Forests Restoration Act, (HFRA), 2003, administered by the Department of the Interior (DOI) and the US Forest Service.

The HFI commenced in 2002 to provide administrative reforms & legislative action to expedite hazardous fuels removal. Three areas targeted under the HFI are: 1) Streamlined compliance with the National Environmental Policy Act, 2) Amended rules for project appeals, and 3) Improved Endangered Species Act consultation to expedite decisions.

Over the years, environmental assessments of proposed fuel reduction projects, that are required under the National Environmental Policy Act, often ballooned to 100 page reports taking many months to prepare. Under the HFI environmental assessments relating to fuel reduction projects now must be concise documents between 10 and 15 pages in length, thus reducing the time between proposing and implementing hazardous fuels on the ground.

After analysing over 2,500 hazardous fuels and post-fire rehabilitation projects, the departments also developed Categorical Exclusions for certain kinds of fuels treatments and rehabilitation actions meeting conditions tied to project size; location; treatment method; and compliance with existing land and resource management plans and other environmental laws. Fuels projects must be identified via collaborative processes involving state, local, and Tribal partners.

## 6.5 Healthy Forests Restoration Act, (HFRA), 2003

The HFRA contains a variety of provisions to speed up hazardous fuel reduction and forest restoration projects on specific types of Federal land that are at risk of wildland fire and/or of insect and disease epidemics. The HFRA aims to help restore healthy forest and rangeland conditions on State, Tribal, and private lands. Up to 33,060,000 hectares of land managed by the Forest Service and the Bureau of Land Management are eligible under the provisions of the HFRA which:

- ***Encourages biomass removal from public and private lands***
- Provides technical, educational, and financial assistance to improve water quality and address watershed issues on non-Federal lands.
- Authorizes large-scale silvicultural research
- Authorizes the acquisition of Healthy Forest Reserves on private land to promote recovery of threatened and endangered species, and improve biodiversity and carbon sequestration.

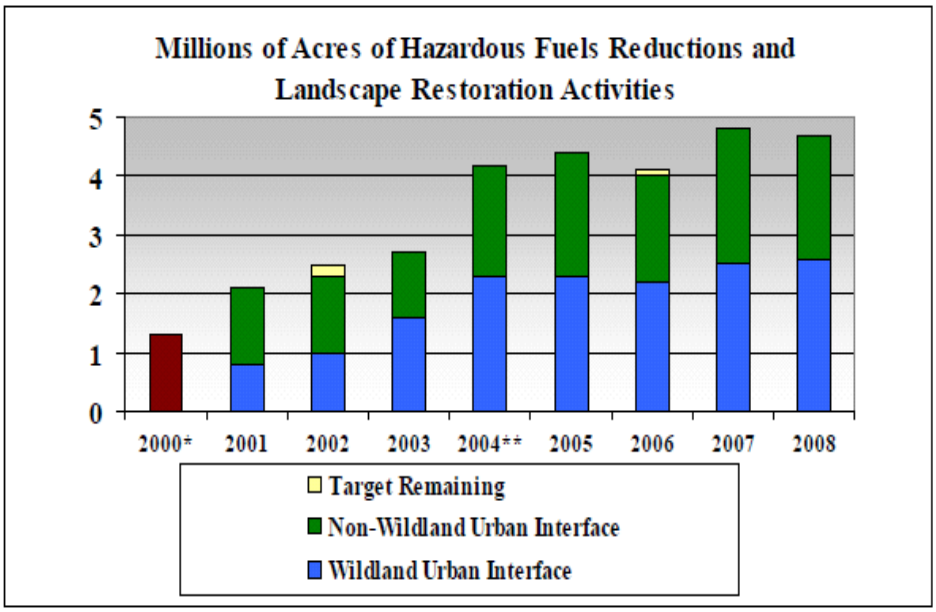
- Directs the establishment of monitoring and early warning systems for insect or disease outbreaks.

In regards to the removal of hazardous fuels, the HFRA:

- Provides authority for expedited vegetation treatments on certain types of Forest Service and Bureau of Land Management lands that: (a) are at risk of wildland fire, (b) have experienced wind throw, or ice-storm damage, (c) are currently experiencing disease or insect epidemics, or (d) are at imminent risk of such epidemics because of conditions on adjacent land.
- Provides expedited environmental analysis of HFRA projects.
- Provides administrative review before decisions are issued on proposed HFRA projects on Forest Service lands
- Contains requirements governing the maintenance and restoration of old-growth forest stands when the Forest Service and Bureau of Land Management carry out HFRA projects in such stands.
- Requires HFRA projects on USFS and BLM land to maximize retention of larger trees in areas other than old-growth stands, consistent with the objective of restoring fire-resilient stands and protecting ‘at-risk' communities and Federal lands
- Requires collaboration between Federal agencies and local communities, particularly when Community Wildfire Protection Plans are prepared.
- Requires using at least 50% of the dollars allocated to HFRA projects to protect areas adjacent to communities at risk of wildland fire.
- Requires performance to be monitored when agencies conduct hazardous fuel reduction projects and encourages multiparty monitoring that includes communities and other diverse stakeholders.
- Encourages courts to expedite judicial review of legal challenges to HFRA projects.
- Directs that when courts consider a request for an injunction on an HFRA-authorized project, they balance the short and long-term environmental effects of undertaking the project against the effects of taking no action, (HFRA website, 2009*).*

Between 2001 and 2008, Federal land management agencies have treated over 11.74 million hectares of federal lands under the HFI and the NFP, (Table 6.5). According to the Healthy Forests Report 2008 accomplishments, the effectiveness of these treatments in protecting communities and resources from wildfire has been demonstrated numerous times. Numerous studies have been conducted across the western states by both state and federal agencies that confirm this.

**Table 6.5: Healthy forests activities-acres accomplished**




* Financial year 2000 is used as a baseline for reporting as the NFP was implemented in Fin. Year 2001.

** Acres treated under landscape restoration activities were not reported prior to fin. year 2004.

*Source: USDA Forest Service, (2008).*

The HFRA includes the first statutory incentives for the USFS and the BLM to give consideration to the priorities of local communities as they develop and implement forest management and hazardous fuel reduction projects, *(See section 6.15 – Community Wildfire Protection Plans).*

The HFI and HFRA have their critics. In a study of media articles relating to the HFI and HFRA, the most commonly expressed negative beliefs included the views that they (1) are an excuse to increase logging, (2) will weaken environmental protections, and (3) will reduce public input.

## 6.6 National Energy Policy Act of 2005

The National Energy Policy Act, (NEPA), of 2005 set an incremental level of electricity purchases from renewable sources that are to reach 7.5% of national federal consumption by 2013. NEPA also set targets for the blending of renewable fuels with gasoline to be 15 billion litres by 2006, 23 billion litres by 2009 and 28 billion litres by 2012. This Act also provides financial incentives, administered by DOE, for electricity produced and sold by qualified renewable energy generation facilities. DOE has also assisted with funding for the establishment of advanced biorefineries such as US$40 million for non-food cellulosic biorefineries in Louisiana and Wisconsin.

## 6.7 MOU to enhance woody biomass utilization, 2003

In 2003, a formal Memorandum of Understanding, (MOU), titled "*Policy Principles for Woody Biomass Utilization for Restoration and Fuel Treatment on Forests, Woodlands, and Rangelands*", to encourage the use of woody biomass byproducts as sources of renewable energy, was signed between the three Departments of Energy, Interior and Agriculture. The MOU establishes consistent policies and procedures across the three agencies to support the use of these byproducts.

The MOU focuses on the use of byproducts from land management practices, such as fuels treatment and hazardous fuels reduction that reduce the rate of spread, intensity, resistance to

control and crowning potential of wildfires by reducing available fuel. Woody biomass includes trees and woody plants, including limbs, tops, needles, and other woody parts that grow in a forest, woodland, or rangeland area, that are byproducts of ecological restoration and hazardous fuel reduction treatment activities. The MOU calls for:

- Communicating to employees and partners that the harvest and utilization of woody biomass by-products can be an effective restoration and hazardous fuel reduction tool that delivers economic and environmental benefits and efficiencies;
- Promoting consideration of woody biomass utilization from restoration and fuels treatment instead of burning or other on-site disposal methods; and
- Encouraging development of new mechanisms that increase the benefits and efficiencies of woody biomass utilization.

This MOU established eight policy principles in support of woody biomass utilization, (WBU):

1. Include local communities, interested parties, and the general public in the formulation and consideration of WBU-utilization strategies.
2. Promote public understanding of the quantity and quality of woody biomass that may be made available from Federal lands and neighboring Tribal, State and private forests, woodlands, and rangelands nationwide.
3. Promote public understanding that WBU may be an effective tool for restoration and fuels treatment projects.
4. Develop and apply the best scientific knowledge pertaining to WBU and forest management practices for reducing hazardous fuels and improving forest health.
5. Encourage the sustainable development and stabilization of WBU markets.
6. Support Indian Tribes, as appropriate, in the development and establishment of WBU within Tribal communities as a means of creating jobs, establishing infrastructure, and supporting new economic opportunities.
7. Explore opportunities to provide a reliable, sustainable supply of woody biomass.
8. Develop and apply meaningful measures of successful outcomes in WBU.

This MOU led to the establishment of the federal Woody Biomass Utilization Group, (Woody BUG), in 2003, *(See section 7.1.2).*

## 6.8 US Forest Service Strategic Plan, 2007-2012

The USDA Forest Service Strategic Plan sets out a number of Goals and Performance Measures which relate to woody biomass utilization. These include;

- Reduce the risk to communities and natural resources from wildfire.
- Number of acres brought into stewardship contracts.
- Build community capacity to suppress and reduce losses from wildfires.
- Provide a reliable supply of forest products over time One Performance Measure being: Number of green tons and/or volume of woody biomass from hazardous fuel reduction and restoration treatments on Federal land that are made available through permits, contracts, grants, agreements, 2012 - Target: 2.45 million green tonnes, (USDA Forest Service 2007).

These targets are helping drive woody biomass removal activities and bioenergy development.

## 6.9 Energy Independence and Security Act, 2007

The 2007 Energy Independence and Security Act requires an increase in the use of renewable fuels and set a mandatory renewable fuel standard that requires fuel producers to use at least 36 billion gallons, (136 billion litres) of biofuels by 2022, with an increasing reliance on the use of

"advanced biofuels", i.e. using non-food feedstocks. Section 207 authorizes US$500 million for the period of fiscal years 2008 through 2015 for a grant program that:

- Shall make awards to the proposals for advanced biofuels with the greatest reduction in lifecycle greenhouse gas emissions compared to the comparable motor vehicle fuel lifecycle emissions during calendar year 2005; and
- Shall not make an award to a project that does not achieve at least an 80% reduction in such lifecycle greenhouse gas emissions.
- Section 223 authorizes US$25 million for each of fiscal years 2008 through 2010 for grants for research, development, demonstration, and commercial application of biofuel production technologies in States with low rates of ethanol production, including low rates of production of cellulosic biomass ethanol, as determined by the Secretary.
- Section 224 amends Section 932 of the Energy Policy Act of 2005 (described in more detail below) by adding "*The Secretary shall establish a program of research, development, demonstration, and commercial application for increasing energy efficiency and reducing energy consumption in the operation of biorefinery facilities.*"

## 6.10 Farm Bill, 2002 and 2008 amendments in the Food, Conservation and Energy Act of 2008

The US Farm Bill is the key legislation for federal agricultural and food policy. The Bill is amended every few years by the US Congress. This is the Bill that mandates agricultural subsidy programs. The current Bill of 2008 extends and expands many of the renewable energy programs originally authorized in sections 9006 and 9008 of the 2002 Farm Bill, which was the first farm Bill to include an energy title. The bill continues the emphasis on the research and development of advanced and cellulosic bioenergy authorized in the 2007 Energy Independence and Security Act. Title VII, of the 2008 Bill, contains numerous renewable energy related provisions that promote research, development, and demonstration of biomass-based renewable energy and biofuels.

## 6.11 Woody Biomass Utilization Strategy, 2008

The USDA Forest Service, through Woody BUG, produced the Woody Biomass Utilisation, Strategy in 2008 which aimed to increase the harvest and utilization of woody biomass and products and residues from forest and woodland health, management and restoration treatments whenever environmentally, economically, and legally appropriate.

The actions proposed allow the Forest Service to facilitate predictable supplies, foster partnerships, develop new information and tools and expand markets. Additionally, these activities promote ecological restoration efforts, help mitigate the impending effects of climate change and ultimately sustain the health and resilience of America's forests.

Although the focus of the report is on the use of woody biomass, the primary broader objective is sustaining healthy and resilient forests that will survive an environment of natural disturbances and threats such as climate change.

The WBU strategy has four goals:

- Identify and build partnerships through collaboration.
- Develop and deploy the needed science and technology.
- Help develop new and expanded markets for bioenergy and bio-based products.
- Facilitate a reliable and sustainable supply of biomass.

## 6.12 The Biomass Crop Assistance Program, 2008

Administered by the USDA, the Biomass Crop Assistance Program, (BCAP) was announced in 2008 as part of the US Farm Bill. BCAP provides financial assistance to producers or entities that deliver eligible biomass material to designated biomass conversion facilities for use as heat, power, biobased products or biofuels.

The program also aims to improve water quality through reduced water use, surface water protection, improved water quality due to decreased use of fertilizer compared to traditional crops and greater use of perennial crops, which are better for soil, air, water and wildlife. The program has two distinct parts:
1) **biomass crop establishment** which supports establishing and producing eligible bioenergy crops through project areas on contract acreage up to 5 years for annual and non-woody perennial crops or up to 15 years for woody perennial crops. *However, this part of the program has not yet been implemented.*
2**) assistance for the harvest, storage, processing and transportation of biomass materials for energy** which assists agricultural and forest land owners and operators with matching payments for the amount paid for the collection, harvest, storage and transportation of eligible biomass by a qualified BCF. The USDA will match at the rate of US$1 for $1/dry tonne paid up to ~$41/ dry tonne for up to 2 yrs. Materials not eligible for this payment include animal waste and byproducts, food and yard waste and algae. Funding has been made available for this part of the program.

Eligible materials generally include:

- Biomass from pre-commercial thinnings, or invasive species from National Forest System land and Bureau of Land Management land that:
  - Are by-products of preventive treatments that are removed to reduce hazardous fuels, to reduce or contain disease or insect infestation, or to restore ecosystem health;
  - Would not otherwise be used for higher-value products; and
  - Are harvested in accordance with applicable law and land management plans and the requirements for old-growth maintenance, restoration, and management direction of section 102 (e)(2), (3), and (4) of the Healthy Forests Restoration Act of 2003 (16U.S.C. 6512) and large-tree retention of subsection (f), or
- Any organic matter that is available on a renewable or recurring basis from non-Federal land or land belonging to an Indian or Indian tribe that is held in trust by the United States or subject to a restriction against alienation imposed by the United States, including:
  - Renewable plant material including crop residues from commodities eligible to receive payments under Title 1 of the 2008 Farm Bill, other agricultural commodities, other plants and trees; and
  - Waste material including crop residue, other vegetative waste material (including wood waste and wood residues).

As of December 2009, over 350 BCF's were deemed to meet the eligibility criteria for BCAP, (USDAFS, 2009).

BCAP had a 2009 budget of US$70 million, however, by the end of 2009, US$400 million was spent. Part of the problem was because the 2008 Farm Bill did not set a specific limit for funding the program. Another issue is that included in the eligible materials list are classes of wood fibre already used for higher value products, specifically the composite wood panels used in home construction, furniture, cabinets, doors, and flooring.

The US Composite Panel Association, (CPA) argues that if those harvesting, manufacturing, and/or delivering sawdust and wood chips are incentivized to transport them to bioenergy companies, makers of composite wood panels would disappear from the market, causing a loss of US$68 billion in annual sales and 350,000 manufacturing jobs. The CPA proposes restructuring

the program to meet its original intent by removing any wood fibre used to make higher value products from the eligible materials list.

This program was suspended in February 2010, apparently due to the cost overrun which was due to level of use, and in some cases, abuse of the program for unintended purposes (e.g. delivery of wood-chips to pulp mills which was not supposed to be included as this was normal industry activity). Proposed new rules for the program have been developed, by the USDA and a more final set of implementation standards will follow after a 60-day comment period. Once these rules are announced, applications for the program will once again be accepted.

### 6.12.1 Case study: Woodlands Biomass Plant

One of the Biomass Conversion Facilities that I visited during my study was the Woodland Biomass Power Ltd, located in Woodland, California. The plant buys in most of its fuel from local suppliers within about a 90 mile, (145 kilometre), radius of the plant, although as part of BCAP, about 10% of their biomass will be coming from further afield from forest thinning and hazardous fuel reduction projects on federal forest lands. BCAP will help cover the additional long transport haulage costs from forests in need of hazardous fuel removal up to 200 km away, (*See Case study 4, Section 9.).*

## 6.13 Forest Stewardship Contracts

Stewardship Contracts permit the US Forest Service and Bureau of Land Management to enter into long-term-up to 10 year-contracts with small businesses, communities and non-profit organizations to remove forest products such as trees and undergrowth to reduce wildfire risk and improved forest health.

Stewardship contracting allows private organizations or businesses to do the necessary thinning and remove small trees and undergrowth; as partial payment, stewardship contractors are able to keep part of what they remove. This is defined as the by-product of restoration and hazardous fuel reduction treatments including trees, limbs, tops, needles, leaves and other woody parts, grown in a forest, woodland, or rangeland.

Stewardship contractors' utilization of woody biomass includes its harvest, sale, offer, trade, and/or use. This utilization can result in the production of a range of wood products including timber, engineered lumber, paper and pulp, furniture and value-added commodities, as well as bioenergy and/or bio-based products such as plastics, ethanol and diesel.

The steadily growing number of contracts issued and the area treated is indicated in table 6.13

**Table 6.13 Indicates the number of forest stewardship contracts issued in recent years**

**Table 4: Stewardship Contracts & Agreements**

| Fiscal Year | Bureau of Land Management | | Forest Service | |
|---|---|---|---|---|
| 2003 | 2 contracts | 300 acres | 50 contracts | 14,000 acres |
| 2004 | 22 contracts | 6,000 acres | 64 contracts | 42,000 acres |
| 2005 | 58 contracts awarded | 16,000 acres | 45 contracts | 35,500 acres |
| 2006 | 57 contracts awarded | 19,000 acres | 92 contracts | 57,500 acres |
| 2007 | 48 contracts awarded | 10,000 acres | 13 contracts | 12,000 acres |
| 2008 | 41 contracts awarded | 8,000 acres | 101 contracts | 66,000 acres |
| Total | 593 Contracts and 286,300 Acres | | | |

*Not all projects in table above were authorized under HFRA.

## 6.14 Hazardous Fuels Woody Biomass Federal Grants, 2008-2010

The Hazardous Fuels Woody Biomass Utilisation Grant program aims to help improve forest restoration activities by using, and creating markets for, small-diameter woody biomass removed through activities such as reducing hazardous fuels, handling insect and disease affected forest or treating forestlands affected by severe weather events.

Goals of the 2010 grant program are the following:

- Reduce forest management costs by increasing the value of biomass and other forest products generated from hazardous fuels reduction and forest health activities.
- Create incentives and/or reduce business risk for increased use of woody biomass from priority forestlands identified either by the Forest Service or through local Community Wildfire Protection Plans (or equivalent documents) as forestlands and other areas at high risk from wildfires and in need of hazardous fuels reduction work.
- Implement projects that target and help remove economic and market barriers to using small-diameter trees and woody biomass.
- Produce renewable energy from woody biomass, including the use of new technologies. Expand working relationships between local forest products businesses and Forest Service offices.

Only high priority, mapped areas are eligible for funding, based on high fire probability, high housing density, and historically high suppression costs. Communities on the wildland-urban interface, (WUI), with Community Wildfire Protection Plans in place are given priority for funding of hazardous fuels reduction projects carried out under the auspices of the HFRA.

In 2009, the USDA Forest Service granted over $4 million to proponents of 27 Woody Biomass Utilisation proposals. Grants of between US$50,000 - $250,000 were made for a broad range of projects. Eligible projects included those which developed and/or upgraded biomass businesses, purchase of equipment for biomass harvesting and utilisation etc. Applicants in 2010 need to demonstrate at least 20% matching funds from non-federal sources for the total project cost.

In 2008, part of the delivery of the WBUG program included the provision of technical assistance to over 800 applicants across USA, (USDA Forest Service, 2009).

### 6.14.1 Case study; Eureka Pellet Mill, Montana

One project that I visited that has benefited from the WBUG program is Eureka pellet mill in Superior, Montana, (*See Case Study 3. section 9.).*

## 6.15 Community Wildfire Protection Plans

The HFRA requires that communities within the Wildland-Urban Interface, (WUI) develop Community Wildfire Protection Plans, (CWPP), aimed at reducing wildfire risk. This empowers communities to influence where and how federal agencies implement fuel reduction projects on federal lands. For example, a CWPP may designate areas in the WUI that should be thinned so that crown fires will not directly burn into communities.

The CWPP process is a collaboration between communities and local government, the local fire department and the relevant federal land management agency. Communities with CWPP's in place are given priority for funding of hazardous fuels reduction projects carried out under the auspices of the HFRA. At least 50% of all funds appropriated for CWPP projects under the HFRA must be used within the WUI. In addition to giving communities the flexibility to define their own WUI, the HFRA also gives priority to projects and treatment areas identified in a CWPP by directing federal agencies to give specific consideration to fuel reduction projects that implement those plans.

A CWPP, or similar document needs to include, at the minimum, the following elements:

1) clear evidence that the plan was collaboratively developed by local and state government representatives, in consultation with federal agencies and other interested parties,

2) **the plan identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment that will protect one or more at-risk communities and essential infrastructure,**

3) the plan recommends measures that homeowners and communities can take to reduce the ignitability of structures throughout the area addressed by the plan.

Publications such as *"Preparing a Community Wildfire Protection Plan"* 2008 and the *"Handbook for Wildland-Urban Interface Communities"*, 2004 provide useful guidance for communities on topics such as identifying and prioritizing fuels treatment and restoration projects, (USDA Forest Service, 2008).

## 6.16 American Recovery and Reinvestment Act, 2009

The US American Recovery and Reinvestment Act, (ARRA) is an US$787 billion economic stimulus package enacted by Congress in February 2009. The creation of jobs is a major determinant of where and how the money is to be spent. The measures nominally include more than US$70 billion in renewable energy and energy efficiency measures. The Act provides opportunities for the advancement of biomass technologies and projects being funded under the ARRA include:

- US$786.5 million in Recovery Act Funds in Biofuels to accelerate advanced biofuels research and development.
- Up to US$564 million to accelerate the construction and operation of 19 pilot, demonstration and commercial scale integrated biorefinery projects. The projects will produce advanced biofuels, biopower and bioproducts using biomass feedstocks at the pilot, demonstration and full commercial scale.
- Funding of up to US$5.5 million for Ethanol Blends Infrastructure and Outreach.

- Funding of up to US$85 million for Algal and Advanced Biofuels for the development of algae-based biofuels and advanced, infrastructure-compatible biofuels.

## 6.17 Tax credits

A range of federal and state tax credits are available to businesses in the USA. The Renewable Electricity Production Tax Credit, (PTC), of US$0.021/kWh for closed-loop biomass and US $0.011/kWh for open-loop biomass generation. The PTC is a per-kilowatt-hour tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. Originally enacted in 1992, the PTC has been renewed and expanded numerous times.

For the Oregon forestry and energy industries, two valuable state tax credits are helping drive development of the bioenergy industry;

- The Oregon Biomass tax credit is US$10/green tonne, (approx. $20/BDT), for woody biomass from forests. These tax credits are often a key component that keeps the forest biomass industry going, (John Sessions, pers. comm.).
- The Business Energy Tax Credit has helped grow Oregon's renewable energy industry. Businesses are eligible for a tax credit of 50% of eligible costs, up to a maximum of US$40 million. Oregon facilities that manufacture renewable energy resource equipment may be eligible for the credit, which has proven extremely valuable to offset the costs of large capital investments. Eligible costs may include the building, equipment, machinery and other expenses related to the manufacturing of renewable energy products such as solar cells and wind turbines.

### 6.17.1 Case study: Frere's veneer mill and CHP plant, Oregon

Frere's softwood veneer mill in Lyons, Oregon used the States' Business Energy Tax Credit to help fund the development of their 10 MW CHP plant, *(See case study 5. Section 9).*

# 7. Organizations, individuals and community extension programs advancing the use of woody biomass for bioenergy

## 7.1 Federal organizations

There are various government and/or industry organizations established in North America to advance the development of bioenergy. The following are examples of some of the diverse industry, government and community stakeholder groups that are driving bioenergy research, development and action.

### 7.1.1 Canbio

The Canadian Bioenergy Association, CANBIO is a national, industry-driven, non-profit organization of individuals, businesses and non-governmental organizations interested in the development, promotion and use of bioenergy. Their mission is to promote utilization of sustainable biomass for the production of biofuels, heat and power.

As an industry-driven body, CanBio lobby federal and provincial governments on matters to help develop bioenergy-specific policies, mandates and incentives. CANBIO holds 3-5 targeted

workshops and conferences each year across Canada and are active in organising trade missions to and from Europe and Asia.

### 7.1.2 Federal Woody Biomass Utilization Group

The federal Woody Biomass Utilization Group, (WBUG), was set up in 2003 as an interagency working group of technical specialists representing federal agencies whose missions relate to the goal of encouraging the use of woody biomass.

WBUG is open to all interested technical and policy specialists in the federal government working on issues related to the inventory, project planning and implementation, feedstock production, transportation, use and marketing of woody biomass. The goals of WBUG are to:

1. Reduce the cost and improve the quality of forest, woodland and rangeland restoration or hazardous fuel reduction treatments. Reduce forest restoration costs and increase the use of woody biomass as a renewable energy resource through environmentally sound actions which also provide economic opportunity in rural communities.
2. Reduce the risk of catastrophic fires through adoption of widespread WBU practices.
3. Provide a sustainable and reliable supply of woody biomass from forests, woodlands and rangelands across a range of ownerships and regions of the nation.
4. Develop and implement consistent and complementary policies and procedures that will maximize Federal efficiency and effectiveness of WBU.
5. Restore at-risk forest, woodland, and rangeland ecosystems to healthy and resilient conditions.
6. Develop sustainable, living wage jobs and appropriately-scaled industries in communities.
7. Enhance national security through clean, renewable, diversified energy production.
8. Contribute to the stabilization of greenhouse gas concentrations.
9. Develop and apply appropriate technologies and provide technology transfer to stakeholders.
10. Substantially divert biomass currently directed to landfills to higher value.

Through WBUG, both the federal government and the individual states have undertaken and documented a vast amount of research into all aspects of woody biomass utilization as a tool for hazardous fuel reduction and forest health and restoration. An example of the type of work being done by WBUG is the 2007*"Woody Biomass Utilization Desk Guide*" which provides information to help land managers plan and implement biomass projects and build small-diameter tree utilization/biomass infrastructures in their communities, (USDA Forest Service, 2007).

## 7.2 Provincial/State organizations

There are many people working to build a vibrant bioenergy industry in Canada and the USA. Outlined below are some of the individuals, groups and organizations that I met with who are key players in promoting and developing bioenergy in their states as well as influencing policy development at the local, state/provincial and federal levels.

### 7.2.1 The British Columbia Bioenergy Network

The BC Bioenergy Network, (BCBN), was established in 2008 with a CA$25 million grant from the BC government, to act as a catalyst for deploying near-term bioenergy technologies and organizing mission-driven research for the development and demonstration of environmentally sustainable bioenergy technologies.

The BC Bioenergy Network covers most types of bioenergy and has defined eight value streams to assist in the evaluation and funding of initiatives:

- Solid Wood Residues
- Pulp and Paper Residues
- Harvesting and Pelletizing (Local Use or Export)
- Agriculture Residues (Crops, Residues and Animal Waste)
- Municipal Wastewater
- Municipal Existing Landfill Waste
- Municipal Solid Waste
- Small and Large Community Heating-Electricity Greenhouse Systems.

The BC Bioenergy Network intends to develop Collaborative Development and Demonstration Centres within each of these streams to pilot and demonstrate technologies which can be replicated across the province. In most cases, these centres will involve a proponent, or owner of the project, who agrees to collaborate with a number of stakeholders interested in observing or participating in a collaborative project on a formal basis, (BC Bioenergy Network, 2009).

During my study, I visited two of the projects that BC Bioenergy Network has helped fund:

- Lignol Innovations Ltd, a biorefinery company producing lignocellulosic ethanol from MPB killed trees and wood residues has received US$3 million, *(See Lignol case study 7. section 9. for details).*
- Nexterra who develop gasification systems which are currently operating in sawmills and at the Dockside Green residential development in BC's capital city, Victoria, *(See Nexterra Case study 8. section 9. for details).*

### 7.2.2 Oregon Biomass Coordinating Group

The Oregon Biomass Coordinating Group, (OBCG), is an interagency group formed in July 2005 to coordinate agency roles in biomass market development and electricity generation as well as to provide oversight for the three biomass sub-groups, Agriculture, Forest and Urban Biomass Working Groups. These three separate groups focus on specific opportunities, barriers and solutions in their particular sector, however only the Forest Biomass Working Group is currently active.

### 7.2.3 Oregon Forest Biomass Working Group

The Forest Biomass Working Group (FBWG) was established in 2005 to meet the directives in Senate Bill 1072 and to accomplish the biomass goals in the Oregon Renewable Energy Action Plan, (REAP). Senate Bill 1072 directs the State Forester and Oregon Department of Forestry, (ODF) to take specific actions to increase the utilization of forest biomass, particularly from federal lands within the state, but also from tribal, state and private forests. The Bill is particularly concerned with the threat of catastrophic fire. REAP sets a goal of renewable sources supplying 10% of the state's electric power by 2012. This will increase to or exceed 25% of the load by 2025.

The FBWG is comprised of around 30 members from industry, government, environmental organizations, tribal representatives, non-governmental institutions, academics and other stakeholder interests. They meet every 2-3 months. Six subgroups formed to address the following key issues or needs:

- Shared Vision and Public Support
- Predictable Supply
- Harvesting and Transportation
- Biofuels
- Research and Development
- Supportive Regulatory Environment

The group's objectives are to:

1. **Coordinate**: Provide a forum for the exchange of ideas, cooperation and coordination between government agencies, non-government organizations and the private sector, leveraging the information and resources of all participants.
2. **Educate:** Educate the public, government, environmental and business interests on the opportunities and benefits of forest biomass as a source of renewable energy through integrated statewide education and consensus building.
3. **Direct and Promote:** Act at federal, state and local levels to accelerate the transference of best forest biomass management practices and energy development practices to chart a clear action plan forward, (Oregon Forest Biomass Working Group, 2009).

Projects undertaken include; production and maintenance of the FBWG website, production of a report, *State of Oregon Forest Biomass Working Group-A Report to the Governor's Renewable Energy Working Group, 2007*, commissioning of the comprehensive *Biomass Energy and Biofuels from Oregon's Forest, 2006*. The FWBG also make recommendations on legislative changes based on environmental effects of forest biomass removal.

I attended a FBWG meeting in Salem and I had follow up meetings with FBWG members including the groups Chair, Joe Misek, who told me that the perceptions of forestry and bioenergy in rural vs. urban communities are very different and that it is very important put effort into urban community education where forest management forestry issues are not often well understood and where most of the dissent is often initiated.

Having successfully undertaken many of the tasks that the group set out to do, they are now looking into preparing a strategy on thermal energy use in Oregon.

### 7.2.4 Oregon Forest Resources Institute

The Oregon Forest Resources Institute, (OFRI), was created in 1991 to improve public understanding of the state's forest resources and to encourage environmentally sound forest management through training and other educational programs for forest landowners. OFRI is funded by a dedicated harvest tax on forest products producers.

OFRI play a key role in educating the community about all aspects of forests and the timber industry, including the use of forest biomass for energy. An example of the sort of useful educational information OFRI produce is the 16 page "*Woody Biomass Energy"* booklet, (OFRI, undated). OFRI work closely with a broad range of key stakeholders to develop their outreach programs.

For example, the above document includes endorsements for forest bioenergy production from the Oregon State University, the Oregon Dept. of Forests and even the Oregon Nature Conservancy who, themselves, have undertaken a hazardous fuel reduction thinning and burning to improve forest health and wildlife habitat on their own 30,000 acre preserve in southern Oregon.

I met with OFRI Director of Forestry, Mike Cloughesy, to discuss aspects of forestry education, particularly in relation to biomass for energy. OFRI works closely with many stakeholders ranging from landholders to the timber industry and have close links with Oregon State University with whom they develop forestry outreach programs. Mike believes it is very important to develop a clear legislated definition of biomass, ***(****see section 4.3.2 for issues with the current federal Renewable Energy Standard)****.*** Mike explained how OFRI often run large community field days based around interesting new technology developments, e.g. demonstrating a new pyrolysis plant and at the same time make good use of the opportunity by discussing other important bioenergy policy issues with invited politicians and policy developers.

### 7.2.5 The California Biomass Collaborative

The California Biomass Collaborative, (CBC), formed in 2003 and is a statewide collaboration of government, industry, environmental groups, and educational institutions administered for the state by the University of California, Davis. The CBC works to enhance the sustainable management and development of biomass in California for the production of renewable energy, biofuels and products. The CBC is primarily sponsored by the California Energy Commission as well as an additional 7 agency and industry partners. The CBC is made up of 38 diverse member groups and aims to provide impartial support to its bioenergy industry stakeholders. The CBC includes members from the environment groups the Sierra Club and the Union of Concerned Scientists.

During my study tour, I met with former CBC director, Professor Bryan Jenkins, who is now the Director of the UC Davis Energy Institute. The CBC is involved in a wide range of bioenergy and biofuel activities, including:

- Provision of accurate and current information necessary to guide the formulation of bioenergy policy and legislation in California and at the federal level.
- Development of a comprehensive biorefinery model which, for one thing, will help define how the potentially competing demands of stationary bioenergy and biofuels will interact.
- Development of consistent standards for biofuels and biomass feedstocks with the aim of eventually setting a sustainability standard or standards that can be applied and compared across all other renewable, i.e. beyond bioenergy.

### 7.2.6 Timber Buy Sell and Smallwood News

I met with Montana Community Development Corporation, (MCDC), Director, Craig Rawlings in Montana, who created the extensive TimberBuySell.com website in 2002. TimberBuySell covers a wide range of functions and topics relating to forestry and woody biomass. TimberBuySell.com was constructed with the aim of finding the “highest and best” use for forest resources and was spurred on largely by the need to find new markets for “smallwood” to help finance much need hazardous fuels reduction programs in Montana’s federal forests. TimberBuySell is the only website in North America of its kind as it provides an extensive, online marketplace for North American forestry and milling equipment as well as resources such as standing timber, logs, forest residue, and mill by products-the raw materials for manufacturing, finishing, and energy production.

The website allows users to create, post, and search for information about sales of forest resources and related transactions covering core products such as standing timber, logs, forest residue, and mill by-products in the US and Canada. Additionally, the website provides free access to up to date timber industry information, including events such as trade shows and conferences, timber-related grants, and an archive of news items from the Smallwood Utilization News, (SUN).

SUN is a free weekly email newsletter that Craig compiles with the latest news and events of the week which always includes something on new bioenergy initiatives, projects or announcements. Registered members can submit news items and events which are vetted and posted by Craig.

Craig says that despite the extensive amount of information that the website provides, he is able to keep the postings up to date and publish a weekly edition of his email newsletter, Smallwood News in one day a week though it has taken 8 years to get to this point. (*Visit website:http://www.timberbuysell.com/Default.asp)*

### 7.2.7 Tom Miles and BioenergyLists website

As well as seeing four different types of gasifiers in operation in Canada and the USA, I also spent time with internationally renowned expert in bioenergy technologies, Tom Miles from Portland, Oregon. As well as running his own consultancy business, Tom has been running interactive bioenergy websites and blogs since 1996, covering topics including gasification, pyrolysis, biochar production and biomass stoves. These sites are widely subscribed to, and are contributed to by bioenergy enthusiasts from all over the world. The *bioenergylists* websites receive 1400-1500 hits/day. (*Visit websites http://bioenergylists.org, http://terrapreta.bioenergylists.org/ and http://gasifiers.bioenergylists.org)*

Tom gave me an insight into his years of experience of research and working hands on with various bioenergy systems, particularly gasification systems. Tom says that there are many companies and individuals promoting gasification technology. Many are making claims about their particular systems which are difficult to substantiate because few have been thoroughly, independently tested or, if they have been tested, they are not publishing their results for peer review. Tom believes that a gasifier needs to be operated for a minimum of 6000 hours before a manufacturer can justify their claims about its performance and capabilities – he believes that few gasifiers have been put through this kind of testing. The other grey area for many gasifier systems is that few have been adequately tested using the range of fuel types which manufacturers claim to be suitable for use in their systems. Tom believes that companies should have their gasifier performance independently tested and verified by organizations such as CSIRO in Australia. Another issue with some gasifiers is the type of syngas cleaning technologies that they use to remove tars and particles. When water scrubbers are used, the waste water can contain high levels of the carcinogen benzene, which can be difficult to dispose of safely. This is a problem with some of the simpler Indian designed downdraft gasifiers though manufacturers are apparently working to improve their systems so that the benzene can be safely disposed of by incorporating it into the biochar and re-gasifying it.

Tom also questions the claims that are being made about the quality of the biochar that is being produced by some of the gasification systems and feels that any claims about the quantities and qualities of biochar should be substantiated by following the protocols established by the International Biochar Initiative, (IBI).

# 8. Discussion

In terms of barriers and drivers that influence development of bioenergy, Australia shares many similarities with Canada and the USA. Our commonalities include abundant coal, cheap stationary energy and transport fuels, mandatory renewable energy targets, the desire to create jobs and the need to reduce GHG emissions.

One of the major areas of bioenergy development in North America, with potential relevance to the Australian timber and bioenergy industries, is the use of woody biomass from forest health restoration and hazardous fuels reduction activities. The evidence that many of the publicly owned forests of North America are in decline has been extensively researched, documented and generally agreed upon by most forest stakeholders. Decades of fire suppression, declining forest management and, in some instances climate change impacts of temperature increases and drought, have led to this trend of unnaturally dense forests which in turn is leading to declining forest health and increasing risk of intense wildfire.

Utilising woody biomass from forest health restoration and fuel reduction programs in appropriate locations has the added multiple benefits of reducing GHG emissions and improving water and air quality through reduced open air burning of forestry slash and prescribed burning activities, creating on-going jobs and stimulating rural economies. Californians, in particular, stand to benefit from non-burning methods for hazardous fuel reduction where GHG emissions from any human induced outdoor burning has to be offset as a part of their progressive climate change policies.

Innovative woody biomass utilization policies and programs, such as the US National Fire Plan, the Healthy Forests Restoration Act and forest Stewardship Contracts are designed to deliver multiple benefits for forests, catchments and rural communities. These benefits, many of which are being substantiated through long-term research, include:

- Reduction in the intensity of, and severity of destruction from, wildfires.
- Improvements to air quality for both human and forest health through a reduction in open burning of forest and agricultural residues.
- Forest management practices that restore forests to conditions more akin to their natural state with improved forest health and resiliency to pests, diseases, fire and drought.
- Ecological benefits.
- Reduction in GHG emissions e.g. when biomass is harvested and burnt under controlled combustion in power plants, as an alternative to prescribed burning to reduce hazardous fuels.
- Increased employment in rural communities through a reinvigorated timber industry and decentralised energy plants.

Despite there being a multitude of good reasons for substituting energy from fossil fuel with bioenergy from forest biomass, it is still contentious in North America as evidenced by the current definition of ‘renewable’ biomass under the USA’s proposed Renewable Energy Standard of the ACES Act. The current definition would exclude a wide range of woody biomass including any biomass from federal forests and a wide array of municipal wood waste, if passed through the US Congress. This has the potential to put existing and future bioenergy conversion facilities at a disadvantage and is contrary to the vast number of existing policies and programs that actively encourage and provide incentives to woody bioenergy removal and utilization. Having a clearly mandated definition of what constitutes a renewable fuel, may be an essential factor effecting the viability or otherwise of biomass and bioenergy production systems.

The importance of getting bioenergy policy right can be critical both to governments, existing forest and wood based industries as well as to the bioenergy industries that governments are trying to support . Problems have arisen in North America where policies, that have been intended to

encourage certain types of bioenergy development, have been deliberately manipulated for unintended purposes or inadvertently over subscribed, leading to budget blow-outs and cost overruns or adverse impacts in neighbouring countries.

Bioenergy can be one of the cheapest of the renewable energy technologies, however all the alternative energy technologies struggle to compete against the non-renewables when they are abundantly available and cheap to obtain, as in North America and Australia. Forest biomass removal for bioenergy can be competitive; generally where biomass removal is undertaken as part of an integrated harvesting operation, when transport distances to biomass facilities are minimal and transport logistics are well planned and where incentives accurately reflect the both benefits gained from biomass removal and the costs incurred from alternative forest management treatments.

The Australian government is developing an emissions trading scheme and many industries and businesses are looking for ways to reduce their GHG emissions. Under the proposed federal Carbon Pollution Reduction Scheme, (CPRS), woody biomass from public land forest residues is considered to be a renewable and carbon neutral source of energy. This definition has recently been adopted in the new Victorian Timber Industry Strategy opening the way for logging residue to be used to produce energy.

From the forest managers' perspective, bioenergy production from this forest residue or 'slash' is a logical use for this material that would otherwise be burnt on site, sending a renewable fuel source up in smoke and creating more air pollution, more GHG emissions and increasing the risk of a slash burn escaping and becoming a wildfire. Nevertheless, there are already concerns in the community that the use of forest residues will create a new market that could lead to an expansion of native forest harvesting, as was the perception of the woodchip market as it developed in Australia in the 1970's and 80's. The Victorian Timber industry Strategy's endorsement of energy production from native forest residues has been criticized by environment group the Wilderness Society, which described it as archaic. An example of the type of resistance that forest managers could meet comes from the Eden woodchip mill, SEFE, where the local community are opposing the proposal to use mill residues to generate power for the mill and the grid, despite the fact that this residual material is currently being open burnt on site at the mill and that no additional residues will be taken from logging operations.

Australian forest managers planning to develop bioenergy facilities that utilize forest harvesting residues, and/or biomass generated through trials of mechanical removal of hazardous fuels will most likely meet with resistance from the community for a range of reasons. The need to clearly articulate the benefits of utilising forest biomass to produce energy is an essential first step in gaining broad support from the community.

In North America, collaborative biomass working groups and networks, coupled with well planned public education programs, seem to be having a positive effect on raising the level of support for forest biomass removal and bioenergy production.

Collaborative consultation processes such as Community Wildfire Protection Plans, which give communities the opportunity to determine their preferred methods for hazardous fuel reduction may be a way for some Australian rural communities to develop bioenergy projects at a scale that they feel to be appropriate. The Fuels for Schools and Beyond project provides a model for small-scale bioenergy project development that is growing in scale as communities gain understanding and trust around the use of forest biomass and other wood residues to heat and cool their public facilities.

To varying degrees, Australia shares many of the barriers and drivers that are behind North Americas' rapid growth in investment in bioenergy and biofuels production, research, development

and extension. The multitude of successful, as well as failed, policies, programs and projects, that have grown out of North America over the last decade in support of bioenergy, provide a great learning opportunity for advocates of bioenergy development in Australia.

# 9. Case Studies: The outcomes from woody biomass policies, programs and incentives

## 9.1 Case study: Fuels for Schools and Beyond program and the National Fire Plan

I was fortunate enough to spend time with FFS&B program manager, Dave Atkins from the USDA Forests Service, Montana. Dave filled me in on the history of the FFS&B program and showed me around some of the 14 projects that he and his team have helped initiate since 2003. Dave also helped me understand the ins and outs of what makes small-scale bioenergy energy projects work.

In 2000, devastating wildfires swept through Bitteroot Valley in western Montana and other parts of the US. The steadily declining level of forest harvesting and increasing areas of unthinned forest stands, especially on the periurban interface combined with severe drought was thought to have been a major contributor to the severity of these fires. In an effort to reduce the likelihood of future catastrophic fires, the federal government passed the National Fire Plan legislation. Included in the plan was a commitment to provide grant money under Economic Action Programs (through the USDA Forest Service State and Private Forestry) to help fund pilot projects to demonstrate new uses of small diameter and underutilized woody material.

This funding opportunity inspired Dave and his colleagues with the idea for using the biomass generated from hazardous fuels thinning programs in priority fire risk to fuel a biomass boiler to heat three schools in Darby, Montana. 2001 marked the beginning of the Fuels for Schools program, now expanded to the name Fuels for Schools and Beyond. The idea was that, the cost of thinning hazardous fuels, which traditionally had few commercial end uses, could be partially offset by the economic return from sale of biomass.

*The FFS&B program aims to;*

- Promote and encourage the use of wood biomass as a renewable, natural resource to provide a clean, readily available energy source suitable for heat and power in public and private buildings.
- Facilitate the removal of hazardous fuels from our forests by assisting in the development of viable commercial uses of removed material.

Initiated by a partnership between the USDA Forest Service State and Private Forestry and the Bitterroot Resource Conservation and Development Area, Inc., there are currently 6 state forestry departments participating in this program with staff available to provide technical and financial assistance to interested parties in Nevada, Utah, Idaho, Montana, Wyoming and North Dakota.

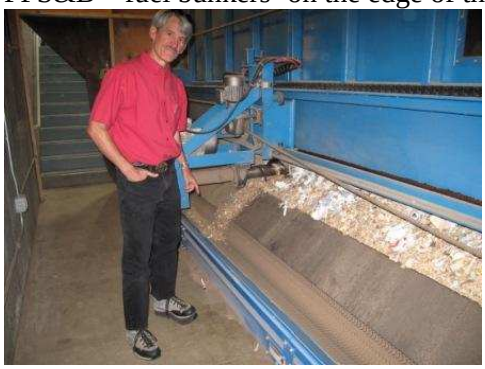
The first phase involved establishing a demonstration project in each of the region's states. Phase two involved expansion of the concept and facilitating the installation of additional biomass boilers. There are currently 17 biomass boilers operating throughout North Dakota, Montana, Idaho, Wyoming and Nevada with two more in the design or construction phase. The program is now in its third phase of transitioning out of the role as primary funder and seeking to promote the "wood to energy" concept to the private sector whilst still maintaining a strong role in technical assistance with existing projects.

In October this year I visited the Darby schools with Dave. The project involved replacement of three oil fired systems with a biomass heating systems where ground or chipped woody biomass is automatically fed from a storage bin to a boiler. High combustion temperatures result in a high-efficiency, nearly smoke-free burn with minimal operator input. This provides enough heat for the three adjacent schools which have a combined floor space of 7600 square metres. All up, the Darby system cost $US650,000. In 2008, peak output from the wood boiler was 3 MMBTU/hr, (~3 gigajoules/hr) produced by 675 tonnes of wood and saved the schools around $US90,000/yr on space heating and hot water costs (even more some years when diesel prices spike). A subsequent analysis of actual costs for a school found a payback period of 9.8 years based on 2004–2005 heating fuel values.

Two fuel storage bunkers are sited on the edge of the playground which store 36 tonnes of ground or chipped fuel, wood peelings and even the odd school text book which all go through the system with ease! Part of the learnings from designing, installing and running these systems is that they must be easy to operate and robust enough to utilise a range of fuel types and qualities. Most importantly too, Dave says, is that you must have the systems operator fully on board as well as the backing of the institution, Dave and his colleagues have also determined that an institution needs to be outlaying at least $US20,000/yr on heating to make it viable to convert it to an automated wood-fired system. Although the Darby schools have had financial assistance to convert to biomass boilers, Dave says that some institutions are now fully funding their own bioenergy boiler and combined heat/power plant conversions as the long term economic benefits are clearly obvious.

For more information about the Fuels for Schools and beyond, visit the comprehensive website: http://www.fuelsforschools.info

FFS&B – fuel bunkers- on the edge of the Darby elementary school playground



FFS&B Manager Dave Atkins and the automated fuel feed system at the Darby elementary school


Darby elementary school furnace

## 9.2 Case study: Dixon Ridge walnut farm & the Biomax 50 gasifier

Established in 1979 by the Lester family, Dixon Ridge Farms, are a vertically integrated farming operation that raise, grow, pick, hull, dry, shell, sort, store, package and sell organic walnuts. Each year they process around 685,000 kg of walnut meats which results in 910,000 kg of walnut shells that need to be disposed of.

Although current energy prices have dropped considerably during 2009, fuel prices in California soared during 2008, with propane gas prices tripling to an all time high of $0.57/litre. Concern about future fuel costs, as well as the environmental benefits of renewable power, has driven Dixon Ridge Farms to look into complete energy self-sufficiency. In 2007, the Lester's set a goal of being energy self-sufficient by the year 2012, while being carbon-neutral or negative. Another part of that goal is to make sure that this energy comes from non-food sources.

Russ Lester and his family were already selling their walnut shells to a biomass power plant for which they received between US$9-18/tonne, so they were familiar with the concept of using biomass as a renewable energy source.

In 2007, the Lester's began working with the Community Power Company (CPC) of Colorado. CPC secured a cost-shared California Energy Commission grant to place one of their BioMax® 50 downdraft gasifier systems at Dixon Ridge Farms to convert their walnut shells into electricity or heat.

CPC's gasifier converts walnut shells to a low Btu combustible fuel gas. The gasifier is also capable of converting other biomass feedstocks including woodchips and tree prunings. Project Manager, Brad Roberts reckons that a large number of agricultural residues in California such as olive pits, grape marc and almond shells would also be well suited to gasification.

The BioMax 50 gasifier produces enough syngas to fuel a generator outputting 50 KW of utility-grade electricity from around 45 kg of shells/hour. The combustible gas is then used in an engine generator to produce electricity, or combusted to produce heat for the Lester's' walnut drying system. The electricity is used to power a 1115 metre$^2$ freezer that previously cost them US$4-5,000/month to operate.

Previously, the Dixon Ridge Farm at Winters used about 34,000 litres of propane/week to fuel 6 heaters during the month-long walnut drying season. Now they use producer gas from the gasifier to displace 30% of the propane used in their heaters.

"We estimate that the walnut shells that we would normally sell for $18/tonne are worth $136/tonne when gasified and used to offset our onsite heat and electricity costs" said Russ Lester.

Brad Roberts believes that, having now clocked over 11,000 hours of operating time as of October 2009, including one endurance run where the system operated for 732 hours out of 745 hrs (>98% of the time), the BioMax® 50 has the highest availability record of any small modular gasification plant in the world. The plant is normally shutdown every two weeks for scheduled maintenance. New units being designed by CPC will have additional self-cleaning features to reduce the need for operator intervention.

The biochar, a by-product from the gasification process which is 47% carbon, is produced at the rate of around one 208 litreUS drum every 2 days. This is being added to compost and incorporated into the organic farming system. Russ and his daughter Jenny have been working on the carbon aspect of the project with UC Davis associate professor Johan Six, of the plant sciences department. Initial studies indicate that the half-life of the carbon in the biochar in the soil exceeds 1000 years. Other possible benefits of the biochar are the retention of soil nitrogen and water. These and other benefits will be the subject of future research.

The Lester's BioMax® 50, is a prototype which is tied in with various energy and agricultural research projects at University of California Davis, as well as providing valuable information back to CPC. Brad monitors the gasifiers performance, collects research data, performs CPC-designed experiments, and trouble shoots when necessary. He feels that the average mechanically minded person would be able to run the system which is getting easier to do as improvements are incorporated through his activities.

The Lester's said the biggest hurdles to energy self-sufficiency at Dixon Ridge Farms have been regulatory. Due to outdated regulations, modular biopower from biomass is not allowed to be grid interconnected on their solar net meter, even though it is recognized as a good renewable technology by the utility and the State of California. For more information visit: http://www.gocpc.com, www.dixonridgefarms.com

## 9.3 Case study: Eureka pellet mill, Superior, Montana

In September 2009 I visited the Eureka densified biomass fuel, (DBF), pellet mill in Superior, Montana with Business Development Director, Christine Johnson. Eureka Pellet Mills, (EPM) has been operating since 1988 and is one the largest producers of residential pellet fuel in the USA.

EPM uses sawdust, wood chips, whole trees, and clean wood waste to produce three grades of pellets; Premium, Standard and Industrial. The difference between pellet grades is their percentage of inorganic ash content. Premium fuel contains less than 1% of ash content, Standard fuel can have up to 3% ash content and Industrial grade may be greater than 3% ash content.

The Johnsons also own Johnson Brothers Recycle which is a pallet manufacturing and repair plant near Missoula. They also own a wood recycle yard where area residents and businesses can drop their clean wood waste, which is the ground up and transported to Superior as raw material used to make pellets.

Over the last few decades, the western Montana towns of Eureka and Superior have suffered from layoffs and shutdowns in the timber industry. EPM, who employ around 40 people at their two plants, provide both a local economic boost and a market for both urban wood waste and small and otherwise non-merchantable biomass from hazardous fuels thinning work.

Being too far from the coast to export their pellets to the big EU markets, EPM focus on the domestic and Canadian market for their sales, most of which are through large supermarket chains. The home wood heating market is the biggest user of their pellets. The Pellet Fuels Institute estimate that there are around 500,000 dbf pellet stoves in Canada and the USA. Between Canada and the USA there are over 120 pellet manufacturers.

The EPM facility feeds sawdust into a biomass fired rotary dryer to remove most of the moisture. The dried feed stock is then transferred by auger to the pellet mills. The pellets are cooled and sent to storage bins. The final step in the process is to shake out any fines before being bagged.

In 2002, Eureka was granted a National Fire Plan Economic Action grant of US$100,000 to upgrade their pellet plant and purchase a wood pellet bagging system for the retail pellet heater market, which bags 0.9 tonne of pellets every 2 minutes. The grant was also used to purchase some duct work and a cyclone at the plant. This grant helped Eureka Pellet Mills use more hazardous fuel thinnings and hire 9 new staff and establish large distribution contracts with two large supermarket chains.

EPM plant manager, Justin Johnson, has recently invented a bulk pellet silo for their wood pellet heater customers as an alternative to them having to handle lots of 18 kg plastic bags of pellets. The pellet silos can hold one ton which EPM will deliver direct to their customers. The new system incorporates a sturdy steel frame for holding the bags and a chute for manually dispensing the pellets directly into the pellet stove fuel hopper. The frame will be available for customers to buy or hire. The pellet bags, which look like large wool bales, can be manoeuvred onto the frame by a forklift or a small truck–mounted crane. According to Christine, “bulk pellet delivery systems in general are very prominent in Europe, but our system and our design is brand new. No one else in the world has developed a system like ours and we have a patent pending for it. The systems in Europe are mass, automatic feeding systems worth thousands of dollars.” One bag would be expected to heat the average household for 45 days – 24hrs/day over winter. The average household in the USA currently uses around 100-150 x 18 kg bags of pellets/year with one bag providing enough heating for around 24 hours.

In 2009, EPM received a Hazardous Fuels Woody Biomass Federal Grants worth $250,000 to help jump start their bulk wood pellet silo invention and to expand their existing pellet manufacturing business into a bulk pellet manufacturing facility.

This grant is expected to result in hazardous fuel reduction, via forest thinning and biomass removal, of around 450 hectares of forest, producing 56,800 green tonnes and employing 5-6 additional workers.

Email: eurekapelletmill@gmail.com

**Experimenting with the ideal silo design at Eureka.**
The design on the left is the original design for the bulk pellet bin. The photo on the right shows Christine Johnson with latest, patent-pending silo design that her husband, Justin has manufactured. The bin on the right is the one Eureka Pellet Mills is selling or leasing to residential and industrial customers

DBF pellet heater and Eureka premium grade pellets

## 9.4 Case study: Woodlands 25MW Biomass Plant, California

Woodland Biomass Power Ltd, (WBPL), is a bioenergy company located in Woodland, California, (about 130 km northeast of San Francisco) that has been operating since 1989. Woodland uses a variety of types of biomass to power their 25 MW plant from agricultural and forestry waste (e.g. tree prunings, nut shells, fruit pits, and timber harvesting slash) to urban wood waste (e.g. old pallets, offcuts from the building industry and demolition timber). Basically, Woodland is fuelled on waste and residual biomass that would otherwise be burned on site or dumped in a landfill.

The plant buys in most of its fuel from local suppliers within about a 145 kilometre radius of the plant, although as part of the federal government Biomass Crop Assistance Program, (BCAP), about 10% of their biomass will be coming from further afield from forest thinning and hazardous fuel reduction projects on federal forest lands. Production, delivery etc. of this biomass will be subsidised through BCAP on a matching dollar for dollar basis, up to US$40/tonne which will help cover the additional long transport haulage costs from forests in need of hazardous fuel removal up to 200 km away.

The wood is burned to make steam that turns a turbine, producing about 25 MW of electricity—enough for 25,000 homes. The plant burns up to 725 green tonnes of biomass/day made up of trucked in ground or chipped woody waste, (up to 40 trucks/day), or urban and green waste that is ground on site from the local community who can dump free of charge. Woodland employs 31 people at the plant and runs four shifts 24/7.

Woodland is one of 34 biomass plants in California and one of 6 plants in the Sacramento Valley area so at times there's a fair bit of competition for biomass in the area.

When asked what are the major issues that biomass plants have to contend with in California, Environmental Coordinator, Kirk Bingham said that fuel supply was number one at the moment. The global recession has resulted in a major reduction in new building starts and renovations, less demolitions and greatly reduced activity in the agricultural and forestry sectors which, in combination is leading to a large drop in biomass availability.

Air quality regulations are another challenge for biomass plant operators in California. In an area where smoke-filled autumn skies were once the norm, Sacramento Valley bylaws now prohibit most of the burning of agricultural residues. Kirk remembers growing up in the valley when rice stubble burning was allowed and people were virtually confined to their houses on the worst days due to the dense pollution it created.

California is now regarded as having the toughest environmental laws in the country.

California has 37 different "air" districts so the permissible level of air pollution varies from district to district based on air pollution zones designated by the US EPA derived from population, ecosystem type, and historical environmental damage. All emissions, in all districts of California have to be offset in some way, which for Woodland can include the purchase of agricultural stubble and other residues which would have previously been open burnt.

Californian laws also require all waste management organizations, (e.g. rubbish collection and municipal landfill businesses) to recycle at least 25% of all recyclable materials in 2009, increasing to 40% by 2012. Progressive Californian laws, such as those outlined above, have helped to make plants such as Woodland viable.

To meet California's tough air quality regulations, the combustor used at Woodland is a Circulating Fluidized Bed, (CFB). This type of boiler is particularly good for minimizing emissions such as $CO_2$ and NOx, but the down side is that they have to be shut down for forced maintenance much more frequently than other, more emissions intense boiler types. For example a CFB will require a 24 hour forced shutdown every 30-34 days, with a more extensive, higher cost routine maintenance shutdown every 6 months, whereas a typical grate type boiler will usually only require a routine maintenance shutdown once every 6 months.

The other advantage of the CFB's is that they can tolerate a wider range of poor quality fuel. Woodland's have tried many types of fuels and the following summarizes the good, the bad and the ugly! Almond shells are too high in potassium and have the effect of causing damaging deposits in the furnace and on boiler piping. Olive pips are good because they are heavy and generally have high heating values. Peach pips are okay. Straw was once used at the plant but high silica levels made it unviable to use. Urban waste generally has an energy output of around 6-8000BTU/lb, (14,000-18,600kilojoules/kg), compared to agricultural prunings at around 9000BTU/, (20,900 kilojoules/kg), compared to olive pips at around 12000BTU/lb, (26,400kilojoules/kg) – similar to jet fuel! Rice hulls from the regions' four rice mills where once a major biomass input for Woodlands' but they are generally less suitable for co-firing with other biomass fuels and, having increased in price in recent years, WBPL don't use them now. However, the nearby 30MW Wadham biomass power plant is designed to run almost solely on rice hulls.

When I asked how they keep 'undesirable' waste materials such as treated, lead painted or composite wood products from going through the plant, Kirk said, "We have a very specific fuel quality plan and sampling requirements. We have a tracking system for each individual supplier and a specific team to monitor the quality of our fuel."

All the ash generated from the plant is used by nearby industries for a range of end uses, especially for direct application onto farmland as being highly alkaline, 12-12.5 pH, it is useful for raising acidic soils close to a neutral pH. It is also incorporated into road and foundation construction materials.

The company is also looking to buy and convert existing coal fired power plants to biomass in California.

Various fuel types used at WBPL from olives pips to pallets

Woodlands accepts a variety of urban wood waste

## 9.5 Case study: Frere's veneer plant and 10 MWCHP plant, Oregon

With a group of foresters from the Oregon Dept. of Forestry, I visited Frères' Lumber Company veneer mill in Lyons, Oregon to see their 10 MW CHP generation plant in action. Kyle Frère, Vice President of Frères', lumber took us on a tour of the mill and CHP plant. Freres' Lumber company is a family business which operates two veneer mills, a veneer drying plant and a plywood plant and employs over 420 people.

The main incentive for installing the CHP plant was the rising cost of natural gas that they need to fuel the veneer drying equipment. On average Frères' used to spend around US$1.5 million/yr in gas (2 million therms per year, = 0.21 petajoules/yr). At current gas prices biomass is about break

even for them with gas. However, when natural gas prices rose to over $1.20/therm, as it did in 2008, the cost to Freres' skyrocketed to over US$2 million for the year. The project cost around US$24 million to install and it is expected that the pay back period will be between 5-7 years. The other aspect of using bioenergy that really appeals to Kyle is the extra jobs that they have created from the harvesting, processing and transport of the biomass. As well as utilizing their own mill residues to power the CHP plant, Frères also purchases about 60% of their biomass from a range of sources such as thinning from hazardous fuels reduction or from ground hog fuel from municipal green waste. Over summer, the mill buys in around 10–16 truckloads/day, each carrying 25.5 tonnes loads of green hog fuel. Over winter, when fuels are wet, their requirement increases to around 16 loads in addition to the mill residue they generate. Currently, a load of biomass costs about US$400, however prices regularly fluctuate, and have been as much as US$1,000/load.The total costs for biomass that Freres' has to purchase from outside suppliers is around US$1,000,000/yr. They also have a pulp log pile which, due to low prices for pulp and paper, is currently being converted into hog fuel and used in the boiler.

The plant generates about 1 truck load/ day of ash which is either put back into their plantations or used as a substitute for lime on agricultural land.

With state tax credits totalling US$12 million, Frères converted their veneer dryers to run on steam heat and installed a CHP plant in 2007 consisting of a 100,000lb/hr Wellons rotating grate biomass boiler and GE steam turbine and generator. The veneer dryer exhaust is captured and rerouted to the boiler to be used as combustion air. Residual steam from the veneer dryers is used to augment kiln steam demand. Typically, the veneer dryers' use about 30-40% of the boilers capacity and the remaining steam is used to generate electricity. The power they generate is sold into the grid for a premium "green" price.

The plant is fitted with an electrostatic precipitator, the equivalent of a high-efficiency dry scrubber. Emissions are monitored automatically at the plant and sent to the Dept. of Environmental Quality every 6 months.

Since 2007, a $9/green tonne federal tax credit for biomass purchased from federal forests has been available to lumber companies like Frères' to assist with the cost of production and transport of biomass for energy use. An Oregon business tax credit is also available. Frères has also recently qualified as a BCAP conversion facility making it eligible for the BCAP grant where the federal government matches dollar for dollar up to $40/green tonne for biomass coming from designated hazardous fuels reduction programs on federal land.

The veneer mill has been operated by the Frères' family since the early 1920's, although it was moved to its current location in the 1950's. Frères' manufacture softwood veneer, with approximately 20% of log supply coming from 6,122 hectares privately held by the company and the remainder from public timber sales and open market sources. Around 70% of the veneer produced is from plantation Douglas Fir. Logs, 10.4 – 12.2 metres in length, are bought into the mill and cut into 10 x 261 cm lengths which are then peeled into veneer. Logs are peeled down to 7.5 - 10 cm diameter. These peeler cores are re-sawn into small studs and were once used as pulp logs but with the downturn in the US and Canadian pulp and paper market, there is little value in this market anymore.

Douglas Fir log about to go through the peeler process at Freres veneer mill Lyons, Oregon.

The condenser for the turbine which collapses the residual steam back in to condensate for re-use.

## 9.6 Case study: Trillium lignocellulosic ethanol from crop residues, Oregon

In Oregon, disposal of forest residues by open burning is increasingly restricted because of concerns about air quality, public health and visibility. Alternatives to agricultural burning strategies are now mandated by federal regulations, and in-state smoke management programs.

Field burning had been widely used by grass seed farmers to clear fields for the next planting and to manage pests and weeds. The Oregon Department of Environmental Quality, (DEQ) began requiring a permit for farmers to burn their fields in 1981, but the requirements became stricter in 1988 following a multi-car accident in which smoke from field burning near Albany, Oregon obscured the vision of drivers on Interstate 5.

This resulted in more scrutiny of field burning and proposals to ban field burning in the state altogether and nowadays, State regulations give DEQ the authority to prohibit open burning anywhere in the state on a day-to-day basis depending upon air quality and weather conditions.

Burning is particularly regulated in Oregon's Willamette Valley which is the grass seed capital of the world. Oregon's Department of Agriculture (ODA) regulates field burning in the Willamette Valley under the state's smoke management program. Current law limits field burning to 26,530

hectares annually, a small fraction of the total. To minimize smoke impacts on air quality and public health, ODA uses weather forecasts to plan the time, location, and the number of acres in a burn. Willamette Valley grass seed crops, mostly ryegrass and fescue, produce around 0.9 million tonnes/yr of straw residue and Oregonians are looking for alternatives to in-field burning.

In September, 2009 I met with two of Trillium FiberFuels Inc. founding members, Chris Beatty and Steve Potochnik who are creating the process technology and equipment for converting cellulosic feedstocks into ethanol. Based in Corvallis Oregon, Trillium identified agricultural residues as a preferred feedstock due to their consistency, fine structure, low lignin content, collection infrastructure, and supportive public policy. The two main agricultural residues in their region are straw from wheat and ryegrass. Trillium has tested many types of feedstocks to date but is currently focussing on those of regional significance such as ryegrass, wheat straw and softwoods.

In 2009 Trillium was awarded a US$750,000 grant from the US Department of Energy (DOE) to scale up their test laboratory to a small cellulosic ethanol pilot plant.

Chris told me that their project has particularly appealed to local funding agencies due to the issue of burning bans and the need to find alternative uses for the seed grass residues, especially the annual ryegrass crop which has little value as a feed straw for stock, yet makes up about 30% of the total seed grass crop in the region. Growers view waste straw as a problem and with bans on burning this residue, most are currently either tilling or flailing the stubble and leaving it to break down.

Chris describes Trillium as the “dark horse” of biofuels research companies because, unlike others, Trillium is developing a xylose utilization technology that utilizes an enzymatic pathway with naturally occurring enzymes as opposed to the more typical genetically engineered micro-organism approach.

One of the key challenges to commercializing cellulosic ethanol is the utilization of pentose sugars, especially xylose. Since the utilization of xylose represents a 20-40% increase in ethanol yield per unit of biomass, it is imperative to ferment this material to achieve good economy in most cases. Several groups are trying to utilize xylose by genetically altering yeast. By taking genes from other organisms and adding them to the yeast, new metabolic pathways may be added. While this method has had some success, there are issues. The new pathways may disrupt the balance of the cell and do not allow it to thrive in an industrial fermentation environment. For refineries that produce a co-product that is fed to animals (like most corn ethanol plants), there is also the issue of having a genetically modified organism in the food chain.

Trillium has chosen a different approach that does not require a genetically modified organism. Through the use of an industrial enzyme, xylose can be converted to xylulose. While xylose is not readily fermentable, xylulose is. Their isomerization process will have applicability in many biomass conversion situations since most feedstocks have a sizable xylose fraction to be harvested.

Trillium is collaborating with various other researchers and organisations such as enzyme companies and the Oregon State University. Other aspects of the research that their partners are undertaking include evaluation of feedstock availability, logistics and multiple process alternatives.

Once the technology has been commercialised the company hopes to encourage the establishment of a biorefinery amidst the seed grass cropping area to ensure that biomass transport distances are kept to under 20 miles. **For more information visit: http://www.trilliumfiberfuels.com/**

## 9.7 Case study: Lignol - woody bioenergy based biorefinery

Lignol Innovations is a Canadian corporation based in Burnaby, British Columbia who have developed a biorefinery process to produce cellulosic ethanol, high purity lignin (HP-L™ lignin) and other co-products from woody biomass. This process is now being tested and refined in Lignol's new pilot plant which commenced operation in 2009. I met with Gurminder Minhas, Lignol's Director of Technology Deployment, when I visited their plant last September.

The Lignol pilot plant has the capacity to process 1 tonne of woody biomass/day from which it is producing 260 to 280 litres of ethanol/tonne, depending on the feedstock being processed. The focus is currently on processing wood chips from native softwood and hardwood species, particularly Mountain Pine Beetle killed Lodgepole Pine, though a range of woody feedstocks including crop stubble and even waste paper are also being tested. The plant is being operated 24hrs/day to generate engineering and design data for commercial plants, test different types of biomass and test quantities of product application.

The technology Lignol uses is based on the 'Alcell' biorefining technology that was originally developed by General Electric and Repap Enterprises for the pulp industry. Lignol's pre-treatment process uses a solvent to separate the three main biomass components, (cellulose, hemicellulose, and lignin). Lignol has modified the original solvent-based, pre-treatment process and integrated it with a patented enzymatic process to convert cellulose to ethanol. The solvent used during the extraction process is then recycled and utilized in subsequent pre-treatment runs.

The extracted cellulose and hemicellulose are enzymatically depolymerized and fermented to produce an ethanol beer which is then distilled and dehydrated to yield fuel-grade ethanol. The company's pre-treatment method produces a cellulosic substrate that is highly suitable to the production of fermentable sugars with enzymes. Lignol has successfully produced ethanol from pre-treated wood chips with results in excess of 90% of theoretical production of ethanol.

The hemicellulose carbohydrates can also be used for other applications including animal and human health. The process also separates out a very pure form of lignin – around 25% by weight. Lignin, which is also a by-product of the pulp and paper industry, has traditionally had limited commercial uses due to its low purity. Lignol's high purity lignin can be used in place of petrochemicals in a wide range of chemical applications such as phenol formaldehyde resins as well as industrial coatings and glues. Other applications of the high purity lignin products include additives to animal feeds. Recent studies done on animal production systems are showing a measurable reduction in antibiotic use when lignin is incorporated into their feed. Furthermore, there is evidence that lignin can potentially reduce methane production in ruminants. In collaboration with several British Columbia universities, Lignol are undertaking further research to develop new markets and uses for lignin. The CSIRO in Australia are also undertaking research into lignin.

Lignol believes that it is important to develop cellulosic ethanol production as part of a total biorefinery system and Gurminder explained that in a typical crude oil refinery, 75% of the end product was gasoline and 25% was in petrochemicals yet the total $ value of both outputs is equal. Hence, the viability of many bio-refineries may rest primarily on the chemicals and other by-products they produce rather than the ethanol.

The US Department of Energy estimates that cellulosic ethanol is almost four times more effective in reducing GHG emissions than starch ethanol for the same gasoline formulation. However, recent life cycle analysis studies of cellulosic ethanol indicate that the carbon footprint from producing enzymes for cellulosic biofuels can considerably increase overall GHG emissions. An encouraging feature of Lignol's process is that it uses fewer enzymes than many of the other

enzymatic cellulosic ethanol processes being developed which helps keep both the cost and the carbon footprint of the process down. With Lignol's process, the spent solvent, (black liquor), the water and the heat are all recovered and re-used.

Lignol intends to develop fully-integrated facilities at commercial scale with the intent developing multiple facilities at numerous sites across North America and to be the turnkey technology provider for each of those facilities in exchange for a license fee and carried interest in the project. Upon the completion of its current project, Lignol intends to work with one or more of its industry partners to construct the world's first commercially viable cellulose to ethanol "showcase" demonstration plant.

The project is supported by the government's Sustainable Development Technology Canada and a consortium of industry participants. Lignol, has also been offered a US$30 million grant from the US government to help build a demonstration plant in the US that will utilize between 100-300 tonnes of woodchips/day. A fully commercial sized plant is expected to use 400-2000 tonnes of biomass/day. For more information, visit: **http://www.lignol.ca/**

Left: Mountain Pine Beetle. Photo: Canadian Forest Service.
Middle: Harvesting of mountain pine beetle-killed lodgepole pine. Photo: Canadian Forest Service.
Right: Lignol's biorefinery plant

## 9.8 Case study: Dockside Green - Sustainable Urban Development Incorporating the Nexterra Gasification System

In late August 2009, I visited Dockside Green in British Columbia, Canada - a new innovative sustainable community development incorporating residential, office and commercial buildings and showcasing a host of environmentally friendly materials, sustainable energy and design features. Dockside Green is built on 15 acres, reclaimed from a former brownfield site, on the banks of the Upper Harbour area of Victoria, the capital of BC. It is the largest development of public land in the capital's history.

The Victoria City Council and developers, Windmill West and VanCity Developments, are striving to make Dockside the first greenhouse gas-neutral development in North America. The use of bioenergy is key to achieving this target.

Each of the buildings constructed at Dockside Green are designed to achieve the LEED®, (Leadership in Energy and Environmental Design), Platinum rating; the highest rating in the global standard for developing and measuring green, sustainable buildings. The first four buildings, built during phase one of the development, achieved LEED Platinum status with a world-record-setting 63 out of 70 possible points. The development has won numerous other sustainable design awards.

Dockside Green, which is currently about one-third complete will eventually include 26 buildings totalling 120,774 sq metres of mixed residential, office, retail and light industrial space. It will house around 2,500 people in three neighbourhoods.

An onsite, underground sewage treatment plant processes all of Dockside Green's sewage which is re-used for toilet flushing, irrigation and the artificial creek and pond system on site. The use of treated water is saving around 140 million litres of water/year. Green roofs are established on the residential buildings and there are 2 "living" walls which are irrigated with the treated waste water. Water saving appliances are installed in the kitchens, laundries, bathrooms and toilets. Water efficient dishwashers and washing machines are being installed to further reduce water usage.

Dockside Green incorporates other eco-friendly design features such as extensive use of salvaged timbers, renewable bamboo and cork, solar-powered street lights and garbage compactors; and a car sharing program and bike racks to encourage less use of cars.

**The Nexterra Gasification System**

A key feature of Dockside Green is the use of wood to generate all of the hot water and heating requirements of the development. BC based company, Nexterra Systems Corporation designed and built a turnkey, fixed-bed updraft gasifier with a capacity to produce 7 MMBtu/hr, (~7.35 gigajoules/hr), net of useable heat at Dockside Green.

The gasifier uses around 3,000 tonnes equivalent of bone dry waste wood/year, sized to 3 inches in diameter, which is provided by a local contractor from locally sourced, clean, urban wood waste, (which was previously going to landfill at a cost of CA$80-100/tonne). The ground waste wood is purchased for CA$20/BD tonne.

The gasifier converts the wood waste into combustible syngas, a mixture of carbon monoxide and hydrogen, which is then burned in the oxidizer. The hot flue gas is then directed to a boiler, and the hot water produced in the boiler is distributed to all the buildings at Dockside Green. One loop reticulates hot water for residential hydronic heating and another loop is used to meet residential hot water requirements.

An electrostatic precipitator cleans flue gas before releasing it out the stack. The gasifier can handle wood with a moisture content as high as 55%. Syngas runs in tandem with natural gas if needed, e.g. during routine maintenance. The system exceeds the City of Victoria's air quality standards. The mineral-rich ash generated at the Dockside facility is collected by the fuel supplier and turned into compost.

Dockside Green recently began earning carbon credits when the gasification plant was connected to a nearby hotel, to which it sells its excess heat. This helps the community offset some of the GHG generated on site through their current use of conventional electricity and the delivery of the waste wood to the plant.

Why was a gasifier chosen rather than a conventional wood boiler? The developers chose biomass gasification technology due to its ability to deliver a combination of superior performance and operational benefits above those of conventional wood boiler systems, including design simplicity, fuel versatility, reduced maintenance, low emissions, quietness and cost.

Once the Dockside Green development is completed, heating with syngas produced from biomass instead of burning natural gas will cut $CO_2$ emissions by 3,460 tonnes/year – the equivalent of taking 850 cars off the road. According to Nexterra, particulate matter from biomass gasification has been shown to be comparable to that of natural gas. Furthermore, emissions of both $CO_2$ and

volatile organic compounds are significantly lower than the guidelines set by the US Environmental Protection Agency as compared to levels resulting from the burning of natural gas.

As well as Dockside Green, this first phase of Nexterra's gasification technology has been successfully commercially deployed for heat and steam applications at Tolko Industries veneer plant in Kamloops, BC and in the USA at the University of South Carolina, Columbia campus, where a 72 MMBtu/hr, (75.6 gigajoules/hr), system converts wood residue supplied by local sawmills into bioenergy. At peak capacity the plant generates 27,215kg/hr of steam to heat the campus, as well as 1.38 MW of electricity sold to the grid.

The second stage of Nexterra's technology development involves directly firing the syngas into rotary kiln and boiler burners. The first commercial installation was commissioned at the Kruger Products tissue mill in New Westminster, BC late last year.

The third stage in Nexterra's gasification developments is combined heat and power systems, (CHP), ranging from 2 to 10 $MW_e$, that involves direct-firing syngas into General Electric's Jenbacher internal combustion engines. Pilot testing of the technology is being conducted at the company's Product Development Centre, where a 250 $Kw_e$ Jenbacher has been installed. The goal of its project with GE is to commercialize modular biomass combined heat and power, or CHP, plants in the 2 to 10MW scale.

The University of British Columbia, (UBC) and Nexterra will install and demonstrate the first of Nexterra's new CHP gasification systems at UBC's Vancouver campus, where it will provide renewable heat and electricity for the campus and provide an opportunity for bioenergy research. This new CHP system, the first of its kind in North America, will be capable of providing high net efficiencies – up to 65% in cogeneration mode and will produce 2 MW of clean, cost-effective electricity that will offset UBC's existing power consumption. This is the equivalent electricity required to power about 1500-2000 homes. The system will also generate enough steam to displace up to 12% of the natural gas that UBC uses for campus heating, thereby reducing GHG emissions by up to 4500 tonnes/year. This next-phase gasification system has also been proposed for installation at Dockside Green when it becomes commercially available.

Nexterra recently received CA$7.7 million of Canadian government and private funding to support the commercialization of the new biomass CHP power system.

Left: Nexterra's gasification plant at Dockside Green. Right: Recycled water is used to create ponds and creeks in the Dockside Green development

# 10. Glossary

This glossary aims to cover most of the terms used in the report.

**Barrel:** A unit of volume equal to 42 U.S. gallons.

**Biodiesel:** A renewable fuel synthesized from soybeans, other oil crops, or animal tallow that can substitute for petroleum diesel fuel.

**Biofuels:** Liquid fuels and blending components produced from biomass (plant) feedstocks, used primarily for transportation.

**Biogas:** A medium Btu gas containing methane and carbon dioxide, produced from the anaerobic decomposition of organic material in a landfill. Also called biomass gas.

**Biomass:** Non-fossil material of biological origin constituting a renewable energy resource.

**Black Liquor:** A by product of the paper production process that can be used as a source of energy.

**Boiler:** A device for generating steam for power, processing, or heating purposes; or for producing hot water for heating purposes or hot water supply. Heat from an external combustion source is transmitted to a fluid contained within the tubes in the boiler shell. This fluid is delivered to an end-use at a desired pressure, temperature, and quality.

**Btu (British Thermal Unit):** A standard unit for measuring the quantity of heat energy equal to the quantity of heat needed to raise the temperature of 1 pound of water by 1 degree Fahrenheit at or near 39.2 degrees Fahrenheit. The Btu is a measure by which to compare the energy content of various fuels. **One million British thermal units (MMBtu)** equals ~ 1.055 gigajoules or the amount of heat energy roughly equivalent to that produced by burning eight gallons of gasoline.

**Cogeneration:** The production of electrical energy and another form of useful energy (such as heat or steam) through the sequential use of energy.

**Exajoules, (EJ):** One exajoule = $10^{18}$ Joules.

**Generator Capacity:** The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, adjusted for ambient conditions.

**Gigawatt (GW):** One billion ($10^9$) watts.

**Gigawatthour (GWh):** One billion ($10^9$) watthours.

**Joules (J):** is the derived unit of energy in the International System of Units. 1000 joules = 0.948 British Thermal Units, (Btu).

**Kilojoule, (kJ):** One kilojoule is about the amount of solar radiation received by one square metre of the Earth in one second.

**Kilowatt (kW)**: One thousand ($10^3$) watts.

**Kilowatthour (kWh):** One thousand ($10^3$) watthours.

**Megawatt (MW):** One million ($10^6$) watts of electricity.

**Megawatthour (MWh):** One million ($10^6$) watthours.

**Methane ($CH_4$):** A hydrocarbon gas that is the principal constituent of natural gas. Methane has a 100-year Global Warming Potential of 21

**Municipal Solid Waste, (MSW):** Residential solid waste and some nonhazardous commercial, institutional, and industrial wastes.

**Natural Gas:** A gaseous mixture of hydrocarbon compounds, the primary one being methane.

**Nitrogen Oxides ($NO_x$):** Compounds of nitrogen and oxygen produced by the combustion of fossil fuels.

**OPEC:** Organization of the Petroleum Exporting Countries.

**Petajoule, (PJ):** 1 Petajoule = $10^{15}$ Joules.

**Propane:** A normally gaseous straight-chain hydrocarbon, ($C_3H_8$). It is extracted from natural gas or refinery gas streams.

**Pulpwood:** Roundwood, whole-tree chips, or wood residues.

**Quadrillion Btu:** One quadrillion ($10^{15}$) British thermal units (Btu).

**Roundwood:** Logs and other round timber generated from the harvesting of trees.

**Therm:** One hundred thousand ($10^5$) British thermal units, (Btu).

**Tons (U.S):** measurement also known as a short ton that equals 2,000 pounds = 907 kilograms.

**Tonnes: (metric tons) =** 1000 kg

**Turbine:** A machine for generating rotary mechanical power from the energy of a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.

**Watt (W):** The unit of electrical power equal to one ampere under a pressure of one volt. A Watt is equal to 1/746 horsepower.

**Watthour (Wh):** The electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electric circuit steadily for one hour.

**Wood Pellets:** Fuel manufactured from finely ground wood fibre and used in pellet stoves.

# 11. Bibliography


Aguilar, F. and Garrett, H.E., (2009), *Perspectives of Woody Biomass for Energy: Survey of State Foresters, State Energy Biomass Contacts and National Council of Forestry Association Executives*, Journal of Forestry, Sept 2009.

Andrew Lang, (2010), World Bioenergy Association Board Member, pers. comm.

Australian Bureau of Agricultural & Resource Economics, (2009), *Energy in Australia.* ISSN 1833-038. Available at www.abare.gov.au.

Bartuska, A.,(2006), *Why Biomass is Important - The Role of the USDA Forest Service in Managing and Using Biomass for Energy and Other Uses. USDA Forest Service.* Available at www.fs.fed.us/research/pdf/biomass_importance.pdf

BC, Bioenergy Network, (2009), website http://www.bcbioenergy.ca/home/index.html

BC government website, (2010), http://www.energyplan.gov.bc.ca/factsheet/default.htm

BC, Ministry of Energy, Mines and Petroleum Resources, (2007), *The BC Bioenergy Strategy*. Available at http://www.energyplan.gov.bc.ca/bioenergy/

BC, Ministry of Energy, Mines and Petroleum Resources, (2007), *BC Energy Plan: A Vision for Clean Energy Leadership*. Available at http://www.energyplan.gov.bc.ca/

BC Pulp and Paper Task Force, (2008). *B.C.'s pulp and paper sector in need of renewal – Study*. Available at http://www.pulpandpaperbc.ca/pdf/NR.

Biomass Power Association, (2009), Biomass Magazine, October, 2009.
Available at http://www.biomassmagazine.com/article.jsp?article_id=3095

Bonnicksen, T.M., (2008***)*** *Greenhouse gas emissions from four California wildfires: opportunities to prevent and reverse environmental and climate impacts.* FCEM report no. 2. Prepared for The Forest Foundation. Available at www.calforestfoundation.org/pdf/FCEM-2.pdf

Bradley, D., (2009) *Canada report on bioenergy, June 2009*, Available at http://www.canbio.ca/documents/publications/canadacountryreport2009.pdf

Bryan Jenkins, (2009),Director, UC Davis Energy Institute, University of California, Davis. Personal Communication.

Bureau of Land Management, website (2009), Healthy Rangelands and Forests Overview. Available at http://www.forestsandrangelands.gov/overview/index.shtml

California Energy Commission, (2007), *An Assessment of Biomass Resources in California.* Available at http://biomass.ucdavis.edu/materials/reports%20and%20publications/2008/CBC_Biomass_Resources_2007.pdf

California Fire and Resources Assessment Program, (2003), *The Changing California, Forest and Range 2003 Assessment.* Available at http://frap.cdf.ca.gov/assessment2003/index.html

Chris Kneppler, (2009), Senior Investment Director, Austrade, Chicago, presentation, Developing Australian bioenergy through collaboration with the United States, Bioenergy Australia conference, 2009.

Dave Atkins, (2009), Fuels for Schools & Beyond Program Manager, USFS, Montana personal communication.

Doug Wickizer, (2009), Forester, California Forests and Fire Dept., Sacramento, California. Personal communication.

Energy Information Administration, Independent Statistics and Analysis, (2010). Available at http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp

Evans, A. M. (2008), *Synthesis of Knowledge from Woody Biomass Removal Case Studies.* The Forest Guild, Santa Fe, New Mexico. Available at http://www.forestguild.org/publications/research/2008/Biomass_Case_Studies_Report.pdf. See also http://www.forestguild.org/zander.html for links to numerous other papers by this author on the subject of biomass harvesting.

Forest Products Association of Canada (2010), *Transforming Canada's Forest Products Industry* - Summary of findings from the Future Bio-pathways Project *The Future Bio-pathways Project.* Available at http://www.fpac.ca/index.php/publications/publication-viewer/392/

Gibson, L.J., (2007), *Economic Assessment Conducted for White Mountain Stewardship Contract Multi-part Monitoring.* Available at www.fs.fed.us/.../2006%20WMSP%20Economic%20Assessment%20Presentation.pps

Hamilton, G. (2009) *U.S. Senate to review black liquor subsidy*, Vancouver Sun, April 22nd, 2009.

Hurteau, M.D., Koch, G.W., Hungate, G.A., (2008) *Carbon protection and fire risk reduction: toward a full accounting of forest carbon offsets.* Frontiers in Ecology and the Environment: Vol. 6, No. 9, pp. 493-498. doi: 10.1890/070187 **.**

Lazar, A. (2009), CEO of the Forest Products Association of Canada 2009 from website http://www.unbf.ca/forestry/story1.php

Morgan, T.A., (2009), *An Assessment of Forest-based Woody Biomass Supply and Use in Montana* Prepared for: Forestry Assistance Bureau Forestry Division, Montana Department of Natural Resources and Conservation Missoula, Montana. Available at http://dnrc.mt.gov/forestry/Assistance/Biomass/Documents/MT_WoodyBiomassAssessment.pdf

Morris, G. (1999), *The Value of the Benefits of U.S. Biomass Power National Renewable.* Energy Laboratory, Report NREL/SR-570-27541, Golden Colorado. http://www.nrel.gov/docs/fy00osti/27541

Natural Resources Canada website, (2009), *The State of Canada's Forests: Annual report 2009.* ISBN: 978-0-662-46538-6. Available at http://canadaforests.NRCan.gc.ca/rpt#forests.

Natural Resources Canada website, (2008) Canadian Refining and Oil Security November 2008. Available at http://www.nrcan.gc.ca/eneene/sources/petpet/refstrarafsur-eng.php#2

Natural Resources Canada website, (2010)[1.], *Economic Monitor, (Monthly).* Available at http://canadaforests.nrcan.gc.ca/article/economicmonitor#blp

Natural Resources Canada website, (2010)[2], Average Retail Prices for Regular Gasoline in Canada. Available at http://www2.nrcan.gc.ca/eneene/sources/pripri/prices_byyear_e.cfm

No biomass burning, (2009), website http://www.nobiomassburning.org/

Oregon Forest Biomass Working Group, (2009), website www.oregon.gov/ENERGY/.../Biomass/OBCG-FBWG.shtml

Oregon Forest Resources Institute, (undated) *Woody Biomass Energy* booklet. Available at http://www.oregonforests.org/assets/uploads//Woody_Biomass.pdf

Oregon Government website, (2009), Forest Health and Biomass Energy home page. Available at http://www.oregon.gov/ENERGY/RENEW/Biomass/forest.shtml

Pacific Northwest Research Station, (2009), B*ioenergy from trees: using cost-effective thinning to reduce forest fire hazards*. Available at http://www.fs.fed.us/pnw/sciencef/scifi117.pdf

Ralevic P., Karau J., Smith C.T., Richardson J, (2008), *IEA Bioenergy Task 31 Country Report: Canada* Available at http://www.ieabioenergytask31.org/IEA_Bioenergy_Task_31/IEA%20country%20Report-%20Canada%202008-%20Dec.%202008%20Final.pdf

SAF, (2009), Letter to House Energy and Commerce Committee Leadership, May 2009. Available at http://www.safnet.org/fp/documents/house_ltr_67_grps_res_definition.pdf

Scott Stanners, (2009), Director of Research, BC Bioenergy Network, (pers. comm).

Smith, W.B., Miles, P.D., Perry, C.H.., Pugh, S.A., (2009), *Forest Resources of the United States, 2007*. Gen. Tech. Rep. WO-78. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. Available at http://www.nrs.fs.fed.us/pubs/7334

Snetsinger, J., (2009) – (presentation from Jim Snetsinger Chief forester, BC Ministry of Forests and Ranges), IEA, Bioenergy Conference, BC, Canada, 402 million ha of forests 2009.

State Foresters Association, (2009), Letter to NASF Letter: *Waxman/Barton - toward a renewable biomass definition* (April 20, 2009). Available at by smccrearyhttp://www.stateforesters.org/node/1205

Todd. J., (2009), Presentation by Jane Todd, Program Manager, Ontario Power Corporation at the Canbio workshop, Vancouver, BC, Sept. 2009.

U.S. DOE website, (2009), Available at http://www.energy.gov/energysources/index.htm

U.S. Energy Information Administration, (2010) Independent Statistics and Analysis from website http://www.eia.gov/

U.S. Energy Information Administration, (2010), Annual Energy Outlook Early Release Overview. Available at: http://www.eia.doe.gov/oiaf/aeo/overview.html

U.S. Energy Information Administration, (2009), Independent Statistics and Analysis – Natural gas. Available at http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html

USDA Forest Service, (undated) - *An Overview*. Available at http://www.fs.fed.us/documents/USFS_An_Overview_0106MJS.pdf

USDA Forest Service, (2007), *An Assessment of Fuel Treatments on Three Large 2007 Pacific Northwest Fires*: A report to Fire Directors Ken Snell and Carl Gossard, Pacific Northwest Region, USDA Forest Service, and Oregon State Office, USDI Bureau of Land Management, December 2007.

USDA Forest Service, (2007), *USDA Forest Service Strategic Plan: FY 2007–2012. Goals and Objectives for Fiscal Years 2007–2012.* Available at www.fs.fed.us/publications/strategic/fs-sp-fy07-12.pdf

USDA Forest Service, (2007), *Woody Biomass Utilization Desk Guide.* Available at http://www.forestsandrangelands.gov/Woody_Biomass/documents/biomass_deskguide.pdf

USDA Forest Service, (2008), *Monitoring Fuel Treatments Across the Continental United States for Overall Effectiveness and Effects on Aquatic and Terrestrial Habitat, Air and Water Quality*. Available at http://www.forestsandrangelands.gov/plan/documents/BLM-FS_MonitoringFinal.pdf

USDA Forest Service, (2008), *Community Guide to Preparing and Implementing a Community Wildfire Protection Plan, August 2008.* Available at www.forestsandrangelands.gov/communities/index.shtml

USDA Forest Service, (2009), *Healthy Forests Report, 2008.* Available at http://www.forestsandrangelands.gov/reports/documents/healthyforests/2008/healthy_forests_report_fy2008.pdf

USDA Forest Service, (2009), *Healthy Forests and Rangelands website, HFI and HFRA.* Available at http://www.forestsandrangelands.gov/overview/index.shtml

USDA Forest Service Woody Biomass Utilization website, (2009), Available at http://www.fs.fed.us/woodybiomass/

USDA Farm Services Agency, (2009), Biomass Crop Assistance Program. Available at http://www.fsa.usda.gov/FSA/webapp?area=fsahome&subject=landing&topic=landing

U.S. National Atlas, *Forest Resources of the United States*. Available at http://www.nationalatlas.gov/articles/biology/a_forest.html#one

U.S. Dept. of Agriculture & U.S. Dept. of Energy (2005), *Biomass as feedstock for a bioenergy and bioproducts industry: the technical feasibility of a billion-ton annual supply.* Available at http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf

U.S Whitehouse website, (2009) Available at http://www.whitehouse.gov/issues/energy-and-environment

U.S. EIA website, (2010). Short term energy outlook. Available at http://www.eia.doe.gov/emeu/steo/pub/contents.html

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