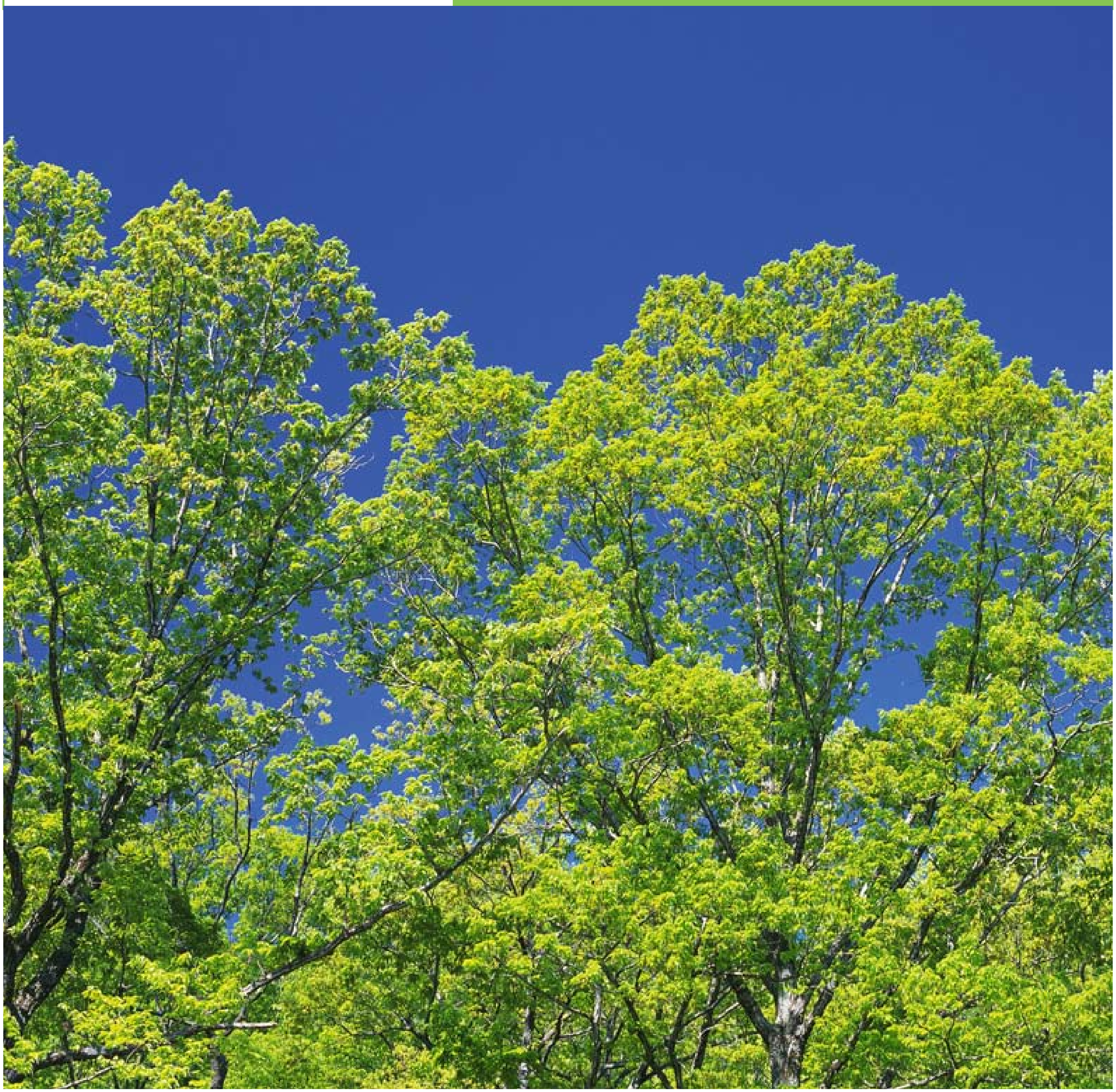
ATLANTICA BIOENERGY TASK FORCE

Summary Report



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Foreword

The Atlantica BioEnergy Task Force is a unique collaboration of stakeholders committed to the sustainable future of the forest industry across Maine, New Brunswick and Nova Scotia (the Atlantica Region). Through intensive consultation with the Task Force members PricewaterhouseCoopers has completed this cornerstone study which will act as a guiding framework for potential integrated biotechnologies within the Atlantica Region.

The Atlantica BioEnergy Task Force believes that invested industry stakeholders are best suited to implement new technologies to help stabilize the volatility within the forestry sector and to prepare the region for the emerging BioEconomy.

We have conducted the analysis in the context of active operations, energy generation and consumption, and feedstock availability in the Atlantica Region while conducting a global scan for policy and technology benchmarks. If the Atlantica Region is to be a contributor and leader in forestry BioEnergy, BioProducts and BioFuels, resources must be focused and a common vision established.

This summary report, along with the confidential technical appendices, is a discussion paper designed to foster conversation and catalyze action for the thoughtful implementation of new technologies within our existing forestry stakeholders.

Sincerely,

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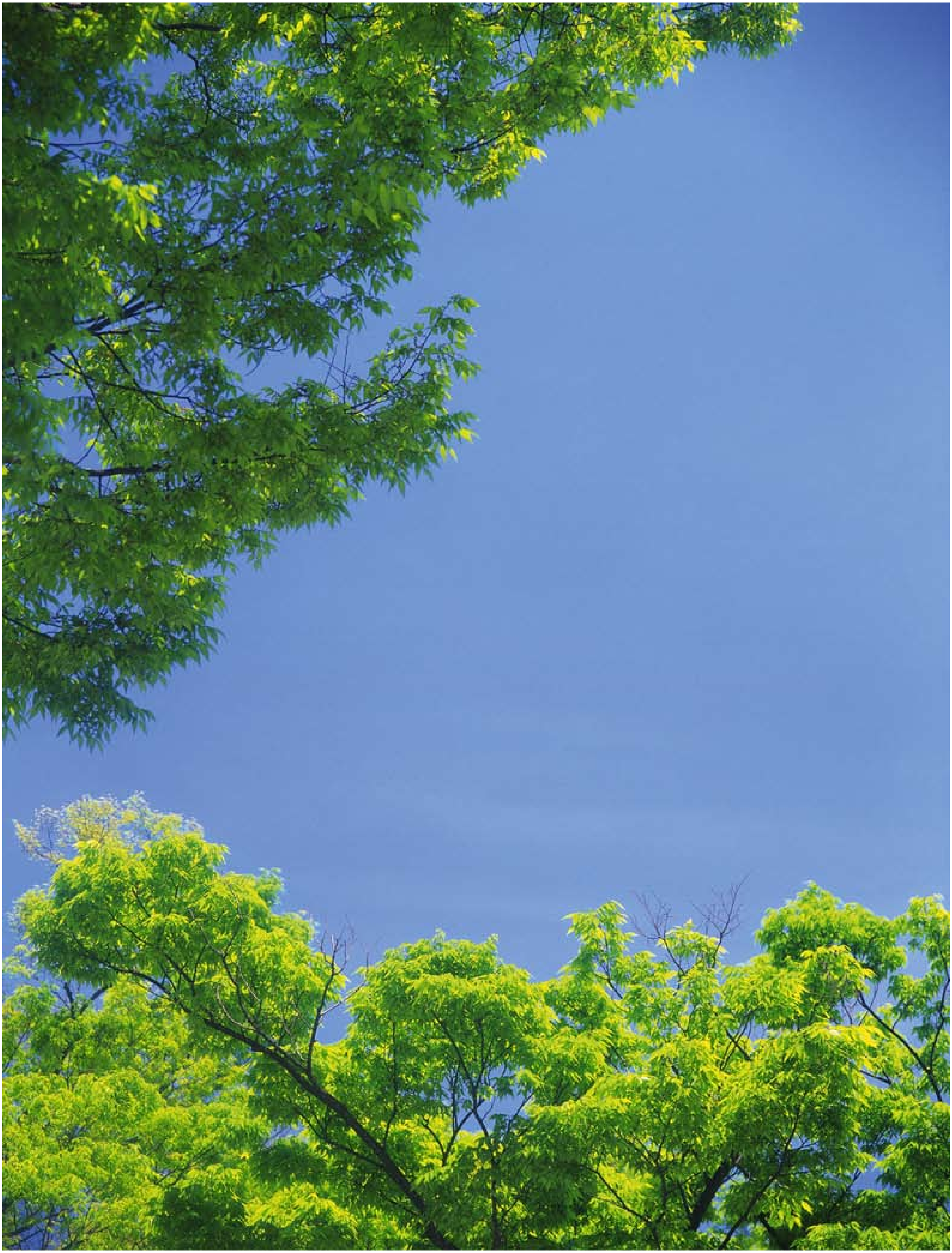
December 4, 2008



Executive Summary

The Atlantica BioEnergy Task Force was established in response to a unifying challenge – how to ensure the future sustainability and prosperity of the forest products industry across three jurisdictions: New Brunswick, Nova Scotia, and the state of Maine, which together constitute the Atlantica Region (the "Region").

The task force is comprised of regional government, industry, utilities, federal and regional organizations, and post-secondary institutions. Building on consultation within the task force, a comprehensive best practices study (the "Study") was identified as a foundational next step for the task force. As a result, PricewaterhouseCoopers LLP was commissioned to complete the Study as a cornerstone to the task force's efforts that are focused on understanding the challenges and opportunities facing the forest products industry.

As part of the study, a number of biomass technologies and renewable energy policies being used or developed around the world were evaluated for their potential impact on the Atlantica region. In the end, four technologies and a number of potential government policies were reviewed in the form of case studies. These case studies have formed the basis of the 15 recommendations made in this report.

The intent of the Task Force is to identify opportunities that will promote the use of renewable energy technologies within the Region's forest products industry. In keeping with this objective, in this Study, we are recommending actions be taken in areas of sustainable forest management, biomass management, energy policy, education, research and development, and technology implementation that will drive the Atlantica Region to the forefront of the renewable energy economy.

Vision for the Region

The Region is rich in forests and has historically depended on the forest industry to drive its economy. Recent economic pressures, such as increases in energy costs and decreases in the demand for forest products such as lumber and pulp, are but some of the factors that have affected the competitiveness of this industry. Over the past decade, the Region's competitive advantage has gradually deteriorated to a point where the industry is challenged to attract new investment. These challenges include high log costs and wage costs, as well as energy costs that are above average.

Without new investment, the business prospects for the Region's forest products sector are rather bleak leaving little scope for improving energy efficiency or developing new technologies. This could lead to an accelerated shrinkage in the Region which, in turn, could severely reduce the Region's logging sector and biomass harvesting capacity. The regional industry is therefore in a survival mode. Industry stakeholders are in the process of repositioning themselves to lead in the development of new value-added products that will complement the current range of activities. This undertaking is a major challenge requiring an exciting vision, determined leadership, and enlightened public policies. At present, there is no connected bioenergy strategy in the Region that unites the key players behind a common set of objectives.

There are opportunities to revitalize the forest industry and its competitiveness by making use of the available wood feedstock—a renewable asset—for the production of bioenergy, biofuels, biochemicals, and other bioproducts in an environmentally conscious manner and thus enhancing sustainable economic development within the Region. However, it remains unclear how much wood feedstock is actually available for use in bioproducts and at what cost this can be brought to market, which also acts as an investment suppressor to those technologies that could make the biggest difference to the forest industry.

Forest Industry Challenges

The forest products industry across the Region is currently facing challenges that include weak markets, increasing competition, proposed climate change requirements, volatility of exchange rates, and increasing energy, transportation, and fibre costs, all of which have resulted in fundamental changes in industry infrastructure and numerous mill closures. The Task Force represents the collective response to these challenges with full representation from the affected stakeholders.

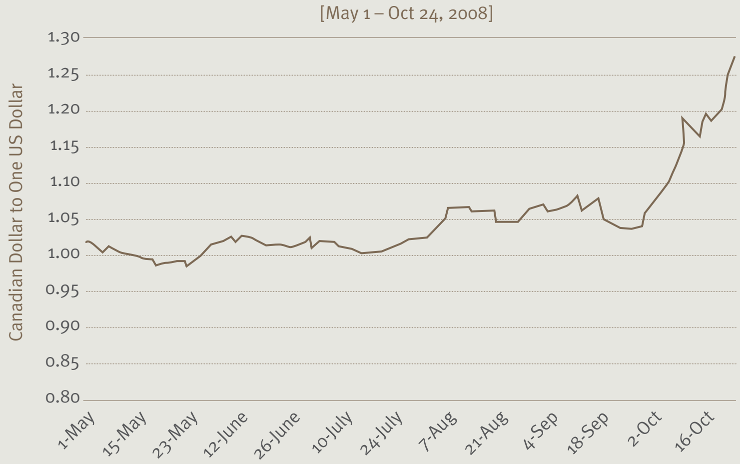
Upcoming regulatory changes focused on climate change and carbon emissions will soon require a response from industry. Anticipated responses to this global challenge will only increase the rate of change in the forest products industry and create new challenges as well as opportunities.

The volatility in the value of the Canadian and US dollars, presented in Chart 1, illustrates the challenges faced by the forest products industry. The ever-changing economic landscape presents a unique challenge to the timing of this Study. While data was being collected and observations made, the inputs were changing, some dramatically.

Nationally and globally, the challenges to the forest products industry are mirrored in the Region. Increasing globalization and downward pressure on profit margins are trends that have continued throughout the course of the Study. Overall net earnings in the forest products industry have been insufficient to cover the industry's cost of capital. As illustrated in Table 1, Canada in particular has performed poorly in relation to the Return on Capital Employed (ROCE) achieved in other parts of the world.

More recently[1], for the year-over-year six-month period to June 30, 2008, eight of the largest public companies in the United States experienced a 50% reduction in earnings; flat earnings were experienced by the six largest public companies in Europe; losses of public companies in Western Canada increased from $73M to $487M; and losses for public companies in Eastern Canada increased from $106M to $686M.

Chart 1: CAN/US Spot Foreign Exchange Rate



Source: Board of Governors of the Federal Reserve System

Table 1: ROCE by Region

	2007	2006
Canada	-0.01%	2.0%
Japan	2.5%	3.6%
Europe	4.9%	4.6%
Australia/ New Zealand	5.0%	3.8%
United States	5.5%	5.2%
South Africa	5.8%	5.2%
Asia	7.3%	7.4%
Latin America	7.8%	9.3%
Global Top 100	4.8%	4.6%

Source: PricewaterhouseCoopers LLP Global Forest, Paper & Packaging Industry Survey, 2008 Edition.

The Competitive Challenge

Investment in new wood-based power generation is beginning to accelerate. Several large projects have been announced in recent weeks by mainly non-forest products companies. In the United Kingdom, four new biomass power projects totalling 1,250 megawatts (MW) are being built, which will use 8 million tonnes per year of largely imported biomass. This is in addition to an EU-wide co-firing program that could use up to 20 million tonnes of wood fibre. Imported wood fibre will come from regions with excess supply. In the event of continued mill closures in the Region, the availability of wood fibre will increase, thereby opening the door to low-value wood exports.

However, new developments within the Region indicate government support for investments in biomass projects. An example is the recent announcement of the New Brunswick government's financial support to J.D. Irving to install biomass boilers at local sawmills that will improve energy efficiency and reduce greenhouse gas emissions.

Study Organization and Approach

The Study is organized around four key areas of focus:

- An inventory of the existing forest industry, biomass availability, and energy background in each of the Study jurisdictions;
- A global scan of available technologies and a best practice review supported by case study analysis;
- Economic analysis performed on the results of the technology case studies; and
- A global scan of public policy to support the development of renewable energy.

The Study concludes with a set of recommendations for next steps in the industry relative to the existing host conditions in the Study jurisdictions.

The Study approach was developed with two major elements in mind: to conduct a comprehensive secondary literature review and to engage with working groups made up of the Region's stakeholders who provided regional context and consultation throughout the project.

The forest products industry, bioenergy, and related technologies have been widely researched. In addition to the comprehensive secondary literature review undertaken in the areas of technology and public policy, recent studies from the Region were obtained from task force stakeholders. A review of public policy initiatives in selected jurisdictions was undertaken to determine the range of policy levers being used to support the development of bioenergy initiatives.

Technology case studies were developed in consultation with the Task Force working group. Case study results were supported by economic analysis depending on the applicability to each of the jurisdictions.

Consultation with industry stakeholders was key to ensuring the relevance of the case study selections and Study recommendations. Regular meetings were held with each of the working groups, where the analysis and findings were discussed and decisions made throughout the course of the Study. This proved to be a valuable approach to ensure the regional context was considered and incorporated into the Study.

Atlantica Region – Industry Background

The forest products industry in the Atlantica region can be considered mature and, in some cases, in a state of decline. The industry is comprised of a variety of manufacturing facilities including pulp and paper mills, sawmills, panel plants, firewood, bark mulch and bioenergy plants.

Maine

While Maine leads the Atlantica region in the implementation of biomass energy plants, the largest user of fibre continues to be Maine's pulp mills. Prices for fibre in Maine have hit record levels, with hardwood fibre prices rising 45% in the last year alone.

Maine's forestry sector is a large employer that continues to have difficulty finding trained operators.

From a transportation perspective, Maine suffers from an inefficient rail service in some locations and limited capacity on some of its main highways.

New Brunswick/Nova Scotia

Compared to Maine, Nova Scotia and New Brunswick's forestry sectors are highly integrated between the various sectors of the industry.

New Brunswick has experienced a 50% decline in solid wood sector operating levels in just two years, creating much higher costs and fewer contractors supplying sawmills across the province.

Like New Brunswick, Nova Scotia is experiencing significant declines, with sawmills operating at 60% of 2006 levels and the number of logging contractors also declining significantly.

New Brunswick and Nova Scotia have well developed transportation infrastructure, however, there are truck weight and bridge capacity issues on secondary roads.

Biomass Availability

While the production and use of biomass is evident in each of the three jurisdictions, the maturity varies between those regions. Maine has a mature biomass market for both energy and pellet production which includes the importation of biomass from New Brunswick. Smaller numbers of biomass plants also exist in New Brunswick and Nova Scotia with opportunities for expansion.

During the study it became apparent that there is not universal agreement as to the volume of biomass available to be removed from the forests, or the required forest management practices to ensure sustainable production.

Research into the existing biomass infrastructure has also revealed that there is no universal agreement as to the benefits to the existing pulp and paper industry in some areas, due to concerns about the potential impact of increased competition for wood fibre.

In Maine there is a mature biomass market and a pulp and paper industry running at full production, which means significant competition for the available wood fibre. An earlier analysis by the Maine Forest Service shows that biomass is available but will require a change in forest management practices and investment by both landowners and contractors for the fibre to be economically accessible and sustainably managed.

In New Brunswick, it is a different story: with pulp and paper facilities and sawmills running at reduced capacity there is biomass available to meet current and planned opportunities. With changes in silviculture strategies, there is the opportunity to increase biomass availability in New Brunswick, particularly with the new biomass harvesting allocations recently announced by the province.

In Nova Scotia, a similar production decline to New Brunswick means there is enough biomass available to supply both current and planned requirements. Additional hardwood biomass could be available if the low-value hardwood in Nova Scotia could be economically harvested in a sustainable manner.

Energy Background

The Atlantica region is a net energy importer with little fossil fuel production other than offshore operations in Nova Scotia. At the same time, world energy costs are rising and environmental concerns are adding a price to emissions. The forest products industry produces large amounts of energy for own-use, but in general is relying on ageing capital stock with overall energy efficiency lower than today's best practice operations. These are contributing factors to the need for a bioenergy strategy for the region.

Maine

Maine has no fossil fuel reserves or petroleum refining capacity, but has substantial renewable energy potential in the form of hydroelectric, wood-fired, and wind-powered generation.

Due to its energy-intensive forest products industry, Maine is the only New England state in which industry is the leading energy consuming sector. Compared to the national average, Maine is a relatively energy dependent and greenhouse gas-intensive state.

Maine's residential electricity use is low compared with much of the US, with 80% of the homes heating with oil. Rising costs have led to an increase in the use of firewood for home heating, which is a very inefficient use of biomass and a source of local air contamination.

Maine participates in two open electricity markets, the larger being the ISO-New England market. Wholesale prices are set based on competitive supply and demand forces. Maine has nine biomass electricity generating facilities, which receive federal production tax credits and tradable renewable energy credits.

New Brunswick

New Brunswick is an energy intensive economy that also produces greenhouse gas emissions above the national average on a per capita and GDP basis. New Brunswick has minimal coal and fossil fuel but does have refining capacity and large hydro and nuclear electricity generating facilities.

Home heating in New Brunswick is largely electric with electricity generation and transmission primarily provided by NB Power, the provincial Crown corporation. New Brunswick has no standalone biomass generation facilities, however, a significant amount of biomass energy is produced by the forest sector for their own use and one plant sells its co-generated electricity to NB Power.

New Brunswick has set a provincial renewable energy target of 10% by 2016 from new renewable sources. Renewable electricity generation is eligible for federal production subsidies while fossil fuel-based electricity generation is expected to have federal greenhouse gas emissions targets in the near term. Large industrial facilities will also be captured under the federal scheme.

Nova Scotia

Nova Scotia is the only jurisdiction in the Atlantica Region with fossil fuel production capacity. Its offshore natural gas production is shipped to New Brunswick, then on to other jurisdictions in Canada and the US. Nova Scotia imports a significant amount of coal for electricity generation.

Heating oil is the primary source for home heating with wood and electricity also being used in significant amounts.

Nova Scotia's electricity market is primarily supplied by Nova Scotia Power, a provincially regulated company. Nova Scotia has set renewable energy standards requiring 5% of energy to come from post-2001 renewable sources by 2010 and 10% by 2013. As in New Brunswick, Nova Scotia companies are subject to federal production subsidies and planned regulations.

Technology

There are several emerging bioenergy and biofuel technologies that could allow the forest products sector to reposition itself for the future. Following a review of 25 different technology options that are currently in the process of being implemented it was determined that four pose the greatest opportunity for the forest products industry in the Atlantica Region.

As part of the evaluation, reference mills typical of those found in the region were simulated to develop case studies on the real potential for these technologies.

The case studies clearly showcased the opportunity for the following four recommended technologies:

- The development of integrated biomass refineries across the Region. The basic premise is that increased thermal efficiency will generate significant energy savings and greenhouse gas (GHG) reductions in addition to increasing revenue and diversifying markets for the host mills. While the capital investment is high, the modeling showed a five- to six-year timeframe to return investment in Canada, and a return in less than four years in the US, factoring in current government incentives for each refinery. Implementing these technologies has the potential to increase the economic value by 47 – 66% over the current situation, creating 600 – 1,000 direct and indirect jobs, and reducing GHG by 60 – 90 % per project.
- The second technology involves a chemical treatment of wood chips prior to pulping for the thermomechanical pulp (TMP) process. The chips are impregnated with an oxalic acid solution prior to refining, which reduces the energy needed to produce pulp meeting certain specifications by up to 40%. Other benefits include the less bleach required, the creation of stronger fibres, the need for less shive refining, and a stronger sheet, all of which allow for reduction in the content of purchased kraft pulp that needs to be added. With no TMP newsprint mills operating in Maine, this technology favours Nova Scotia and New Brunswick. Implementing this technology increases the economic value by 5% while reducing GHG emissions by 30% per project.
- A third technology, known as value prior to pulping (VPP) for hardwood kraft mills, involves a pre-treatment of hardwood chips in order to extract a naturally occurring fermenting sugar that can be converted to value-added products such as ethanol and acetic acid. Other benefits include a reduction in the use of bleach and energy savings. Based on the current location of hardwood pulp mills in the Region, this technology favours Maine over Nova Scotia and New Brunswick. Implementing this technology increases the economic value by 10% over the current situation and creates about 190 new jobs per project.

- The fourth recommended technology is torrefaction, a thermal pre-treatment technology carried out at atmospheric pressure in the absence of oxygen. It creates a solid product that weighs 30% less than the original woody biomass but the original energy content is reduced by only 10%. The result is a clean burning feedstock with a similar calorific value to coal. When pelletized, torrefied biomass reduces feedstock transportation costs by more than 60% compared to chips and pellets, and eliminates the need for special storage space to keep the biomass dry, which reduces the costs of feedstock preparation and storage. Torrefaction could be used across the Region to create new economic activity by producing a cleaner "green" fuel. This new fuel (biocoal) could be used to offset fossil fuel use and reduce GHG emissions by the forest products industry, electricity generators, and other industries, as well as home heating, reducing the Region's overall carbon footprint. Torrefied pellets are considered to be the ideal feedstock for advanced gasification of biomass to produce gas suitable for synthesis into third-generation fuels (biobutanol) and chemical feedstock such as biomethanol, which is also the preferred pathway for producing biohydrogen. Torrefaction plants can be implemented in modules of 60,000 tons per year (t/y), producing around 40 MWt/y. They can be established either as a standalone plant or integrated into an existing surplus heat producer, such as a sawmill or power plant. The standalone option produces incremental added value of around $7 million per plant as well as 60–100 new jobs per project.

Alternative Energy Policy Framework

Governments are continually being pressed to manage the source, cost and environmental effects of energy. There is a growing movement to decrease reliance on carbon, reduce costs and increase energy independence. Many jurisdictions around the world are creating policy frameworks to manage and incentivize changes in the energy supply. At the same time there is a significant opportunity to add value to the forest products industry by adding further value through the production of green energy and the development of advanced biomass products such as biofuel and biochemicals.

Developments in energy policy and alternative energy technologies are expected to continue despite the recent volatility in energy prices. At the launch of the World Energy Outlook, 2008, the Executive Director of the International Energy Agency stated,

> *"We cannot let the financial and economic crisis delay the policy action that is urgently needed to ensure secure energy supplies and to curtail rising emissions of greenhouse gases. We must usher in a global energy revolution by improving energy efficiency and increasing the deployment of low-carbon energy."*

Current policy conditions in the Atlantica Region support the use of carbon sources to produce energy, which costs less than producing energy from renewable sources such as biomass. Without a change in policy that will support the shift from carbon-based energy to renewable energy, it is unlikely the market will respond on its own.

Selected jurisdictions from around the world were reviewed for their policy initiatives to diversify fuel sources away from carbon products. Jurisdictions were picked based on several factors including population, existing forest base and availability of biomass being similar to the Atlantica region.

It was determined that several jurisdictions have comprehensive policy frameworks that support the development of renewable energy. Of these jurisdictions, various policy levers are used to achieve renewable energy targets including:

- Forest management practices
- Legislated targets – Renewable Portfolio Standards (RPS)
- Feed-in tariffs and renewable energy certificates (RECs)
- Capital financing – loans, loan guarantees, grants, bond issues
- Research and development – loans, loan guarantees, grants, training
- Tax incentives – exemptions and credits
- Efficiency targets – industrial and vehicle emissions
- Standards and regulations – codes and permits

Recommendations

The task force has provided an invaluable opportunity for open dialogue between key forestry, energy, and government stakeholders within the Region; however, not all of the recommendations outlined below apply to each jurisdiction and not all recommendations are endorsed by all members of the task force.

These recommendations are based on a number of guiding principles that include a commitment to ensuring all biomass is used in areas with the highest value and highest energy efficiency processes, the presence of a long-term stakeholder commitment to the process, and giving priority to opportunities that add to the value and competitiveness of the forest sector industries.

In total, 15 recommendations are made in the areas of sustainable forest management, biomass management, energy policy, education, research and development, and technology implementation that will drive the Atlantica Region to the forefront of the renewable energy economy and help it become a sustainable bio-sensitive economy. The recommendations are predicated on the need for all stakeholders to take accountability for being part of the solution moving forward.

- Implement sustainable forest management strategies to improve forest growth and support landowners and contractors in developing efficient approaches to biomass harvesting.
- Complete the development of biomass removal guidelines as soon as possible and update biomass inventories on a regular basis.

- Improve the transportation infrastructure throughout the Atlantica Region to facilitate the movement of goods by all modes of transport.
- Evaluate the need to upgrade the electrical transmission and distribution lines across the Region to ensure capacity is available for new generation demand.
- Consider the following four emerging technologies for potential implementation by industry: integrated biomass biorefinery using Fischer-Tropsch technology; oxalic acid chip pre-treatment for TMP mills; value prior to pulping (VPP) for hardwood kraft mills; and torrefaction.
- Encourage New Brunswick Power and Nova Scotia Power to include biomass solutions as part of their overall federal carbon regulation strategies.
- Create a demand for biomass fuels (in New Brunswick and Nova Scotia) for use in co-generation.
- Apply energy efficiency and green electricity GHG offset measurement protocols to the Region to be used in voluntary or regulated carbon markets, such as the Canadian federal regulatory system and the Regional Greenhouse Gas Initiative (RGGI).
- Enhance the existing energy policy framework to be more comprehensive in scope and develop policy to stimulate bioenergy, biochemicals, biofuels and bioproducts produced from wood fibre.
- Ensure the eligibility of financial tools to encourage the early adoption of recommended technologies that could improve mill competitiveness and reduce GHG emissions.
- Provide fuel tax exemptions and/or production tax credits particularly for local wood-based feedstocks for renewable fuels, ethanol and biodiesel.
- Ensure that state and provincial incentive programs include eligibility criteria for biofuels, biofuel products, and biochemicals, and ensure that existing incentive programs contain eligibility guidelines that include the proposed outputs from the technology case studies such as Fischer-Tropsch liquids, ethanol, and torrified fuel.
- Develop and fund a bioenergy network for the Region, similar to the model established in British Columbia.
- Create collaborative programs across the research universities throughout the Atlantica Region.
- Fund a program in partnership with post-secondary research institutes, industry, and government agencies in the Atlantica Region to promote and build pilot plants for development of technological solutions within the Region.

Industry Background

The forest products industry in the Atlantica Region is mature and supports a variety of users such as pulp and paper mills, sawmills, specialty mills (such as those producing veneer or oriented strand board), pellet mills, firewood, bark mulch, and bioenergy plants. Table 2 summarizes the number of manufacturing facilities in the Region. Only sawmills with production exceeding 500,000 board feet were included in the table.

The following section describes the current state of the industry in Maine, New Brunswick, and Nova Scotia from a manufacturing, transportation, and logging contractor perspective.

Table 2: Manufacturing Facilities in the Atlantica Region

	Maine	New Brunswick	Nova Scotia
Pulp and Paper Mills	13	7	4
Primary Sawmills	27	61	29
Specialty Mills	2	3	1
Pellet Plants	3	2	3

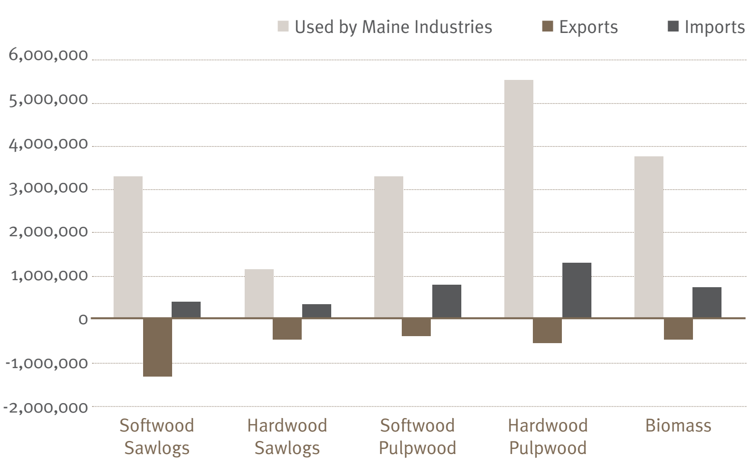
Source: Madison's 2008/09 Canadian Lumber Directory and Buyer's Guide, Random Lengths 2008 Big Book, Nova Scotia Natural Resources: Registry of Buyers of Primary Forest Products, Innovative Natural Resource Solutions, LLC

Maine

Chart 2 depicts recent estimates from the Maine Forest Service regarding wood use, imports, and exports. A total of approximately 17 million green tons is consumed by forest products producers, including existing biomass electricity generators, biomass used at forest industry manufacturing facilities, and pellet plants in the state.

The largest consumers of fibre are Maine's pulp mills, followed by sawmills and then biomass energy facilities. Maine leads the Atlantica Region in the implementation of biomass energy plants. Restrictions on the free flow of fibre in the state exist due to fibre supply agreements between some private landowners and large pulp mills. Fibre and fuel supply for pulp mills and biomass energy facilities in Maine has been tight, with mills paying record high prices in 2008 and transporting wood significant distances in order to assure supply.

Chart 2: 2007 Maine Wood Use, Imports and Exports by Product (Green Tons)



Source: 2007 Maine Wood Processor Report, Maine Forest Service

While prices can vary significantly by location, species, and other factors, pulp mills in Maine have regularly paid well above US$60 per green ton of delivered pulpwood, and a recent national report notes that hardwood fibre prices have risen by 45% in the past year alone[2]. Similarly, delivered prices for biomass fuel have recently reached record heights, with prices in excess of US$40 per green ton paid at a number of facilities in Maine and nearby New Hampshire. The prices were affected by:

- Increasing use of biomass fuel at both standalone biomass plants and in multi-fuel boilers at pulp and paper mills;
- Increasing competition for fibre from firewood and wood pellet markets;
- Weather conditions that limited the number of days that loggers could operate in the woods;
- Significant increases in the cost and volatility of diesel prices;
- A significant decrease in housing starts in the region, with an associated decrease in land clearing activity, resulting in less low-cost "opportunity wood" being on the market; and
- A high level of pulp and paper production at Maine mills (supported, in part, by a weak US dollar).

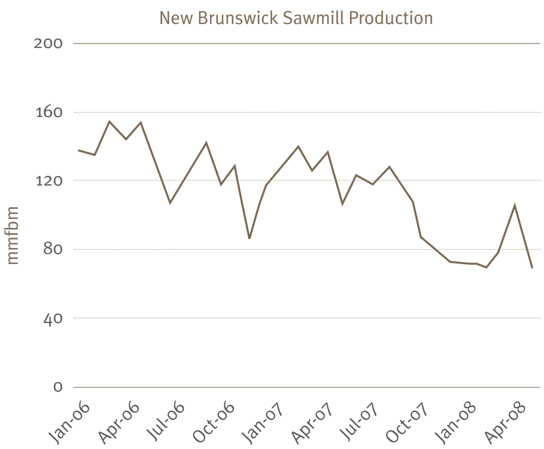
Maine's logging contractor workforce is estimated at approximately 1,120 companies, with 63% of the companies being medium to large mechanical operations. There are an estimated 120 biomass operations with chipping and grinding capacity. Contractors have reported that it is difficult to find a sufficient number of trained operators, which could be related to restricted access for Canadian workers. In the northwest region of Maine, approximately 600 Canadian workers did not have their H2B work visas renewed (Governor's Wood-to-Energy Task Force Report, September 2008). These contractor employees are responsible for harvesting approximately 25% of Maine's volume and it is unclear when this situation will be resolved.

With regard to the transportation infrastructure, the following observations can be made:

- Restrictions on truck size and weight pose problems. For example, the I-95 is limited to loads of 80,000 pounds north of Augusta, compared to loads of 100,000 pounds allowed on other Maine highways.
- Some locations suffer from inefficient rail links and poor rail service. Weight restrictions prevent 286,000-lb rail cars and double stack in some areas. Some short line sections have been abandoned.
- There are incomplete networks connecting ports to other modes of transportation.
- A private road system in the northwest and central third of the state creates key efficiency opportunities for land owners.
- Empty back-haul loads for trucks increase transport costs.

A number of analyses of Maine's forest products industry, including the Maine Future Forest Economy Project (2005), have suggested increasing the weight limit on all Maine interstate highways to 100,000 pounds and improving the integration of the rail systems.

Chart 3: Sawmill Production in New Brunswick (Millions of board feet from Jan 2006 to Apr 2008)



Source: Statistics Canada

New Brunswick

Pulp and paper operations in New Brunswick are highly interdependent with sawmills as they rely primarily on residual chips as their fibre input. Compared to Maine and Nova Scotia there is more integration within the industry as public and private companies continue to own private land, manage Crown tenure, and own sawmills and pulpmills.

The solid wood sector in New Brunswick has recently been operating at 50% of 2006 levels, which has resulted in pulp mills having to procure higher cost residual chips from further away and/or chipping pulpwood. Chart 3 depicts the declining sawmill production in New Brunswick since early 2006.

In 2006 – 2007 New Brunswick wood producers consumed approximately 10.5 million m^3. Exports and imports were relatively close at 2.9 million m^3 imported and 2.4 million m^3 exported. With the large number of sawmills that have recently been permanently or temporarily closed, these numbers would change for 2008. For example, in early 2008 it was estimated that there were 21 large contractors, (with 40% of these contractors having chipping operations) and 62 medium contractors. However, it is now estimated that the number of contractors has dropped by 50%.

New Brunswick has an extensive transportation network with no significant limitations, other than a large portion of the network consists of secondary roads.

Nova Scotia

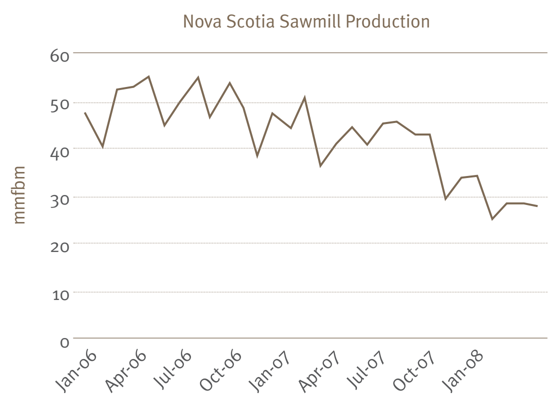
Similar to New Brunswick, pulp and paper producers are highly interdependent with sawmills as they rely heavily on residual chips as their fibre input. In Nova Scotia the pulp mills have control over some of their fibre input as they own and manage private and Crown lands, and have supply agreements with other landowners. The pulp mills can therefore trade or sell sawlogs to private sawmills for additional pulpwood, residual chips or hogfuel, assuming the local sawmills are operating.

The solid wood sector in Nova Scotia has also been operating at 60% of 2006 levels, which has resulted in pulp mills having to procure higher cost residual chips from further away and/or chipping pulpwood. Chart 4 depicts the declining sawmill production in Nova Scotia since early 2006.

The forest products industry in Nova Scotia consumed approximately 5.2 million m^3 in 2007. Imports were insignificant and exports were approximately 500,000 m^3. In 2007 it is estimated that there were approximately 400 active contractors with over 90% being cut-to-length operations. There were 8 active chipping/grinding operations prior to the decline in solid wood production. In 2008, the number of logging contractors is expected to have declined significantly due to the decline in solid wood production.

The transportation infrastructure is very well developed. Major access road construction began in the 1960s. There are ten major, active ports in Nova Scotia and continental rail access ends at Halifax in the south and Sydney in the east. The secondary road network does provide some challenges in efficiently transporting fibre to the mills. Issues include truck weight restrictions on various roads and bridges, and limitations on truck configurations.

Chart 4: Sawmill Production in Nova Scotia (Millions of board feet from Jan 2006 to Apr 2008)



Source: Statistics Canada

2 Biomass Availability

The production and use of biomass in the Atlantica region varies between the three jurisdictions. Due to past policy development and infrastructure investment in the state of Maine there is a mature biomass market for both energy and pellet production, including importing biomass from New Brunswick. There are also biomass and pellet plants in New Brunswick and Nova Scotia with additional capacity investments planned. Existing biomass facilities are accepting municipal waste wood as another source of biomass, but the volume from these sources has been considered negligible for the purposes of this study. The harvesting of biomass for firewood use is not accurately tracked in all three regions. Estimates of firewood use in Maine and Nova Scotia have been included in this study. Estimates of firewood use in New Brunswick were not available.

While compiling the biomass inventory and consulting with the various stakeholders, it became clear that there is no universal agreement on the amount of biomass that could potentially be sustainably removed from the forests and the required silvicultural strategies that could be applied to support and/or maximize a biomass industry either for internal consumption or export. In addition, promotion of increased biomass use is not universally viewed as beneficial to existing pulp and paper manufacturers in some wood baskets, unless the impact of increased competition for fibre and the potential reduction in pulp log availability can be effectively managed. Incentives to encourage the existing industry to be early adopters of the new technologies and biomass harvesting opportunities could mitigate these concerns.

Maine

The forests of Maine consist of mixed species (spruce, fir, hemlock, cedar, eastern white pine, sugar and red maple, yellow and white birch, aspen, and northern red oak) with approximately 57% hardwood and 43% softwood. Approximately 87% of the land area is timberland, 95% of which is privately owned. The total merchantable volume is 277 million cords (693 million green tons). The Maine Forest Service estimates that 17.5 million green tons is sustainably available for harvest and industry has traditionally harvested the full amount annually.

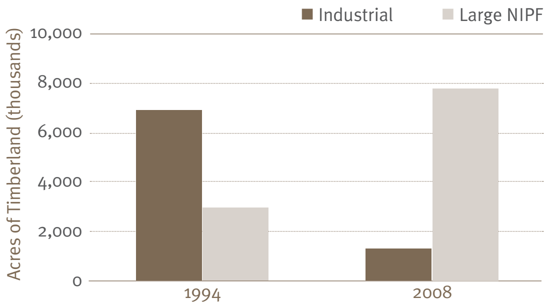
Over the last 15 years, the ownership of the forest land in central and northern Maine has largely changed from large, integrated industrial companies to large non-industrial private owners such as timber investment management organizations (TIMOs). Chart 5 depicts the significant change in ownership.

Currently 3.5 million green tons of biomass is generated in Maine. As summarized in Table 3, the Maine Forest Service estimates that an additional 5.9 million green tons of biomass (excluding imports) is available annually from aggressive removal of biomass and silviculture management. The total amount of biomass available annually is therefore about 9.4 million green tons. Constraints to accessing the full amount of biomass include the location of supply and markets; development of sustainable biomass harvesting guidelines; the effects of competition for wood resources; supply chain economics; the need for improved logging capacity; new technologies needed to harvest smaller material; and fuel costs.

Maine facilities, including standalone biomass electric generators, pulp and paper mills, and solid wood industries currently use large volumes of biomass to generate electricity and process heat and steam. Studies are underway to calculate the current biomass consumption in Maine, but it is estimated that Maine facilities used 6.3 million green tons of wood fuel in 2006. The consumption of biomass is higher than the biomass availability reported above due to the importation of biomass and the use of internally generated fuel, such as bark residues. Since 2006, biomass use has likely increased due to fuel switching at pulp and paper mills, new pellet manufacturing facilities, and the re-powering of idled biomass electricity plants.

Comparing annual consumption of 6.32 million green tons to the annual potential availability of 9.4 million green tons there appears to be enough biomass available to support investment in the technologies discussed in this report even though the level of biomass consumption has likely increased since 2006. Maine should be able to implement the new technologies without importing fibre provided Maine is able to economically access the additional biomass estimated by the Maine Forest Service as discussed above.

Chart 5: Major Forest Ownership Changes



Source: James W. Sewall Company

Table 3: Potential Additional Annual Biomass Availability in Maine

Source – Annual Supply (million green tons)	Pellet Quality Feedstock	Biomass Residues	Total Available
Additional Use from Existing Harvests	1.79	2.01	3.80
Fuel Treatment Thinnings	1.02	0.44	1.46
Intensive Management	0.42	0.18	0.60
Grand Total	3.23	2.63	5.86

Source: Maine Forest Service Report, July 2008. "Absolute Assessment of Sustainable Biomass Availability"

Table 4: Current Maine Biomass Consumption ('000 Green Tons)

Facility Type	2006 Biomass Fuel Use
Pulp & Paper Facilities	2,092
Solid Wood	579
Other	150
Biomass Energy Plants (estimate)	3,500
Total Consumption	6,321

Source: Maine Department of Environmental Protection and estimates by Innovative Natural Resource Solutions LLC

Logging contractors will need to use different equipment configurations to economically access the smaller material that would be available from fuel treatment thinnings and silviculture management. Studies from Sweden[3] and Finland[4] found that the lowest cost biomass is collected from the woods using specialized equipment and chipped at roadside. Costs declined over time as contractors and their operators gained experience using the equipment.

Much of the forest land is owned by large, non-industrial private forest (NIPF) landowners; these landowners may require economic incentives to implement the silviculture management regimes assumed by the Maine Forest Service. Traditionally, active thinning operations are used to improve the quality and quantity of sawlog material in the forest and may reduce the pulpwood component in the forest over time. Reduced levels of pulpwood may be an issue if the landowner has a long term pulpwood strategy or supply agreement.

Environmental Risks

With the increased harvesting of biomass, the environmental impacts need to be considered to avoid removing too much biomass from sensitive sites. Environmental protection is provided through existing regulations, Maine's Best Management Practices for Forestry and voluntary participation in a variety of forest certification programs. Additional research is currently being conducted into the development of specific biomass retention guidelines:

Forest Regeneration and Clearcutting – Requires landowners to notify the Bureau of Forestry prior to a commercial timber harvest. If clearcuts larger than five acres are part of a harvest, separation zones and regeneration standards must be met. Clearcuts are limited to 250 acres.

Liquidation Harvesting – This regulation seeks to substantially eliminate the practice of liquidation harvesting, defined as "the purchase of timberland followed by a harvest that removes most or all commercial value in standing timber, without regard for long-term forest management principles, and the subsequent sale or attempted resale of the harvested land within 5 years." Any harvesting on land held for five years or less must meet defined standards or exemptions, including removal of less than 50% of the basal area without high-grading, or a harvest conducted by an accredited forester or logger.

Shoreland Protection – This regulation establishes statewide standards for timber harvesting and related activities in shoreland areas. In general, timber harvesting activities in shoreland areas must protect shoreline integrity and not expose mineral soil that can be washed into water bodies, including non-forested freshwater and coastal wetlands and tidal waters. Specific provisions address retention of windfirm stands for shade in certain drainages, road construction and maintenance, and stream crossings.

Best Management Practices (BMPs) – The Maine Forest Service has developed a set of voluntary BMPs for protecting water quality during forest harvests. The BMPs include management and operational techniques that can be implemented before, during and after logging operations.

The University of Maine – The School of Forest Resources is developing "Biomass Retention Guidelines for Timber Harvesting in Maine". These guidelines—designed for loggers, foresters and landowners—are meant for field use and designed to protect forest productivity, water quality and biodiversity. With funding from the USDA Natural Resource Conservation Service and the University of Maine's Forest Bioproducts Research Initiative, this effort has benefited from a stakeholder group that provides feedback to UMO researchers. Stakeholders include conservation organizations, foresters, forest industry, loggers, landowners, and state officials. The guidelines are expected to be completed in 2008, and publication is being supported by the Maine Outdoor Heritage Fund.

Forest Certification Programs – Voluntary forest management certification programs have become a popular mechanism in Canada and the United States for landowners and forest managers to demonstrate they are managing their lands responsibly. Four of the larger programs are the Forest Stewardship Council, the Canadian Standards Association, the Sustainable Forestry Initiative, and the American Tree Farm System. All of the programs include principles and objectives for the protection of forest resources, such as water and soils, that would apply to any biomass harvesting conducted on certified lands.

Maine Summary

Due to a mature biomass market and the pulp and paper industry running at full production, there has been significant competition for fibre. The analysis by the Maine Forest Service demonstrates that biomass is physically available, but it will require a shift of silviculture management strategies in some wood baskets and investment by both landowners and contractors for the full volume to become economically accessible.

Table 5: Ownership of Productive Forest Land in New Brunswick

Owner Category	Area (million ha.)	%
Large Private Landowners	1.1	18
Public Ownership – Provincial & Federal (3%)	3.1	53
Small Private Landowners	1.7	29
Total	5.9	100

Source: New Brunswick Forest Products Association. "NB Forestry at a Glance".

Table 6: Current New Brunswick Biomass Consumption ('000 Oven Dry Tonnes)

Facility Type	Current Use	Planned or Under Construction	Total Future Demand
Pulp & Paper Facilities	775.0	165.0	940.0
Sawmills	38.9	53.0	91.9
District Heating, Commercial & Institutional	27.5	0.0	27.5
Biomass Energy Plants (standalone)	0.0	0.0	0.0
Pellet Plants	104.4	405.6	510.0
Total Consumption	945.8	623.6	1569.4

Source: Palmer, 2008. General Manager of the York-Sunbury-Charlotte Forest Products Marketing Board

Estimate of the Total Potential Amount of Available Biomass

8.96 million m3 X 0.9725* green tonnes/m3 X 0.5 ODT/green tonne = 4.36 ODT X 0.44 units of biomass/unit of merchantable volume = 1.92 ODT of biomass

* Based on NB harvest of 63% softwood (1.0417 green tonnes/m^3) and 37% hardwood (0.8547 green tonnes/m^3)

New Brunswick

The forests of New Brunswick consist of mixed species, with approximately 25% hardwood, 44% softwood, and 31% mixed stands. Approximately 85% of the land area is timberland (6.21 million hectares), of which 47% is privately owned. Approximately 86% of the crown land is forest available for harvest, but less than that amount would be operable due to policy and legal restrictions. Table 5 summarizes the amount of private and Crown ownership. From 2002 to 2007, the average harvest has been 9.54 million m^3 compared with an annual allowable cut (AAC) of approximately 11.9 million m^3. Due to market conditions there has been an under harvest of approximately 2.5 million m^3 annually, primarily on private woodlots and Crown licenses.

Unlike Maine, government agencies in New Brunswick have not yet calculated an estimate of the total potential amount of available biomass. As a proxy, work by Bonner in 1985 assists us in estimating that for every unit of merchantable volume harvested, an additional 0.44 units of biomass is generated (tops, foliage, branches and unmerchantable stems). Using New Brunswick's 2007 harvest level of 8.96 million m^3, or 4.36 million oven dry tonnes (ODT), a theoretical 2007 availability of 1.92 million oven dry tonnes of biomass from harvesting residuals could be available. The calculation is shown at the left.

For ecological and economic reasons all of the biomass cannot be removed. Therefore, using professional judgement and conservatively assuming an average of 25 – 50% of the biomass can be sustainably removed, the availability of biomass is reduced to 0.48 – 0.96 million oven dry tonnes. This estimate does not include pulplogs that are used as biomass, stumps and bark. When hogfuel generated at sawmills of approximately 0.69 million oven dry tonnes is added into the equation, annual availability increases to roughly 1.17 – 1.65 million oven dry tonnes. Table 6 summarizes the current and planned consumption of biomass.

Comparing annual consumption (planned and actual) of 1.57 million oven dry tonnes to the annual availability of 1.17 – 1.65 million oven dry tonnes at the 2007 harvest level indicates there is not enough biomass available to support investment in the technologies discussed in this report unless harvest levels increase to historical levels closer to the amount of AAC, biomass is imported, biomass exports are reduced, or silviculture strategies are implemented that would provide additional biomass volume.

Since the industry in New Brunswick is predominantly sawmill-based with pulp and paper mills relying heavily on residual chips and some pulpwood direct from the forests, a silviculture strategy to increase the quality and quantity of sawlog volume could be appropriate for this jurisdiction. The April 2008 report, "Management Alternatives for New Brunswick's Public Forest" (New Brunswick Task Force on Forest Diversity and Wood Supply), agreed with this concept and presented seven silviculture management alternatives for Crown forests focused on the production of higher quality sawlogs. The report commented that while the amount of low-quality material suitable for energy generation will decrease through time, there will be significant proportions of low-quality material in the near term.

In order to support integrated silviculture strategies with increasing biomass use, the government of New Brunswick released on November 3, 2008 a biomass policy for Crown lands that includes a procedure for assessing the impact of biomass harvesting on sustainability and forest growth, and provides a set of guidelines for selecting eligible areas for biomass harvesting. Individuals, corporations or other provincial bodies can submit proposals to access portions of the Crown biomass supply. Allocations are expected to be awarded by April 2009.

Similar to Maine, there may be specific wood baskets within New Brunswick where a higher level of pulpwood from the forest is required to support existing manufacturers and the alternative silviculture management strategies perhaps may not be appropriate. Also similar to Maine, contractors will need to re-tool their equipment to economically access the smaller wood. Given the high percentage of land held in small NIPF, there are additional costs and inefficiencies of mobilizing operations on small tenures.

Environmental Risks

There are numerous protection measures currently in place and forthcoming to ensure biomass harvesting in New Brunswick conserves resource values, including forest certification programs as described in the Environmental Risk section for Maine:

› Forest management on Crown lands is regulated by the Crown Lands and Forests Act. The Act divides responsibilities between government (Department of Natural Resources – DNR) licensees. The DNR establishes the objectives for forest management which must then be implemented by licensees. These objectives include wildlife habitat, water quality, biodiversity requirements, recreational needs, and protected areas. Private land owners in New Brunswick are subject to fewer regulations than Crown licensees but are regulated under various pieces of legislation such as the Clean Water Act, the Fish and Wildlife Act, and the Endangered Species Act, which protect water quality as well as wildlife in the province.

› The New Brunswick DNR has been working on a Crown Land Forest Biomass Harvesting Policy for the past few years. When complete (estimated by the end of 2008), this policy will become the guiding document and process for regulating biomass harvesting in the province on Crown lands. This policy builds on the work of Dr. Paul Arp from the University of New Brunswick, which identifies site-specific biomass harvest availability based upon physical and biological site characteristics and forestry parameters such as silviculture system, rotation age and annual growth rates. The intention is to risk rank forest lands in the province and legislate annual allowable harvests of biomass by licence. Policy development has been an internal process within the DNR but, according to government sources, some consultation with the forest industry, non-governmental organizations (NGOs), and First Nations has taken place throughout the process.

There is currently no specific biomass harvesting regulation for private land in New Brunswick. The New Brunswick Federation of Woodlot Owners has drafted best management practices (BMP) guidelines but these are not currently in use. The federation is awaiting the provincial Biomass Harvesting Policy before moving ahead with any further development of their policy.

New Brunswick Summary

Due to a slowing demand for solid wood, sawmills are running at reduced levels and therefore pulpmills have been using a higher percentage of whole log chips and a lower percentage of residual chips. The biomass availability analysis indicates there is enough biomass available to supply current and planned biomass requirements. More biomass will also be available in the near to medium term if the aggressive silviculture strategies studied by the New Brunswick Task Force on Forest Diversity and Wood Supply are implemented and the biomass harvesting allocations are released by the government as planned.

Table 7: Ownership of Land in Nova Scotia

Owner category	Area (ha)	% of total
Crown (Provincial)	1,530,340	28
Crown (Federal)	156,240	3
Private (industrial)	980,270	18
Private (small)	2,860,510	51
Total	5,527,360	100

Source: Nova Scotia Natural Resources: "State of the Forest Report: 1995-2005"

Table 8: Current Nova Scotia Biomass Consumption ('000 Oven Dry Tonnes)

Facility Type	Current Use	Planned or Under Construction	Total Future Demand
Pulp & Paper Facilities, including Brooklyn energy plant	460.0	290.0	750.0
Sawmills	56.7	2.5	59.3
District Heating, Commercial & Institutional	9.3	0.0	9.2
Pellet Plants	212.0	250.0	462.0
Total Consumption	738.0	542.5	1,280.5

Source: Palmer, 2008. General Manager of the York-Sunbury-Charlotte Forest Products Marketing Board & Industry Sources

Estimate of the Total Potential Amount of Available Biomass

5.25 million m3 X 1.019* green tonnes/m3 X 0.5 ODT/green tonne = 2.67 ODT X 0.44 units of biomass/unit of merchantable volume = 1.18 ODT of biomass

* Based on NS harvest of 88% softwood (1.0417 green tonnes/m^3) and 12% hardwood (0.8547 green tonnes/m^3).

Nova Scotia

The forests of Nova Scotia consist of mixed species with approximately 13% hardwood, 58% softwood, and 29% mixed stands. Legal restrictions, policy factors and private land use decisions can significantly reduce the operable area for industrial forestry by as much as 43%, according to Nova Scotia DNR. Table 7 below summarizes the amount of private and Crown ownership. The harvest in 2007 was approximately 5.25 million m^3, which was well below the average sustainable harvest level of 8 million m^3, as estimated by the Nova Scotia Department of Natural Resources. Approximately 1.3 million m^3 of under-harvest in Nova Scotia is hardwood, much of which is poor quality and could be available for a possible bioenergy solution.

Unlike Maine, government agencies in Nova Scotia have not yet calculated an estimate of the total potential amount of available biomass. As a proxy, work by Bonner in 1985 assists us in estimating that for every unit of merchantable volume harvested, an additional 0.44 units of biomass is generated (tops, foliage, branches and unmerchantable stems). Using Nova Scotia's 2007 harvest level of 5.25 million m^3, or 2.67 million oven dry tonnes, a theoretical 2007 availability of 1.18 million oven dry tonnes of biomass from harvesting residuals could be available. The calculation is shown at the left.

However, if we conservatively assume an average of 25 – 50% of the biomass can be sustainably removed, this reduces the availability of biomass to 0.30 – 0.59 million oven dry tonnes. This estimate does not include pulplogs that are used as biomass, stumps, and bark. When hogfuel, sawdust, and shavings generated at sawmills of approximately 0.25 million oven dry tonnes and approximately 0.70 million oven dry tonnes of underused hardwood are added into the equation, there is an approximate annual availability of 1.25 – 1.54 million oven dry tonnes. Table 8 summarizes the current and planned consumption of biomass.

The Nova Scotia Forest Products Association has divided the province into three regions and is currently developing regional estimates of biomass availability and biomass consumption by the pulp and paper facilities, which are the largest users of biomass. The data from the Forest Products Association could be used to improve the data shown once it becomes available.

Comparing annual consumption (planned and actual) of 1.32 million oven dry tonnes to the annual availability of 1.25 – 1.54 million oven dry tonnes at the 2007 harvest level indicates there is just enough biomass available to support investment in the technologies discussed in this report. The situation would improve further if harvest levels increase to historical levels closer to the amount of AAC or by implementing silviculture strategies that may provide additional biomass.

Similar to New Brunswick, the integrated industry structure suggests that a silviculture strategy to increase sawlog production, with a subsequent short to mid-term increase in biomass harvest levels, would make sense for this jurisdiction. The government has provided incentives to landowners to promote silviculture since the 1970s. Contractors will have to change their equipment to economically access the smaller wood as cut-to-length operations are predominant in Nova Scotia where limbs and tops are left on site during harvest operations. Given the high percentage of land held in small NIPF, there are additional costs and inefficiencies of mobilizing operations on small tenures.

Environmental Risks

There are numerous protective measures currently in place and forthcoming to ensure that biomass harvesting in Nova Scotia protects forest land resource values, including forest certification programs as described in the Environmental Risk section for Maine:

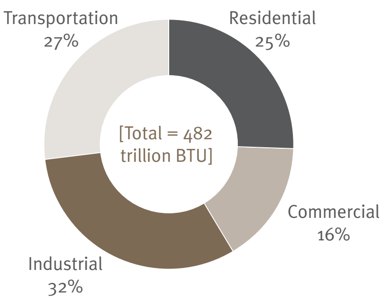
- Nova Scotia's Forests Act specifies protection measures for Wildlife Habitat and Watercourses in Section 40 of the Act. These regulations specify protection for legacy trees and habitat structure as well as watercourse protection based on watercourse size.
- The Nova Scotia Forest Biomass Working Group (FBWG) has been working to develop provincial policies and guidelines related to forest biomass production and use. Areas that have been discussed and investigated include: (i) sustained forest productivity; (ii) economic uses of forest biomass; (iii) biomass use and forest management; and (iv) biomass and carbon management. The membership of the Biomass Working Group includes representatives from government, industry, academia, and NGOs, which is meant to ensure that the broad interests of many stakeholders are addressed within the process. The first draft of this working group's report is expected by the end of 2008. The draft report will focus on identified Best Management Practices (BMPs) from other jurisdictions, and harvesting and retention policies that will meet soil productivity and biodiversity goals. These policies will likely build on Dr. Paul Arp's Nutrient Budget Modeling process, which creates site-specific biomass harvest availabilities based upon physical and biological site characteristics and forestry parameters such as silviculture system, rotation age and annual growth rates.

Nova Scotia Summary

Similar to New Brunswick, due to a slowing demand for solid wood, sawmills are running at reduced levels and therefore pulp mills have been using a higher percentage of whole log chips and a lower percentage of residual chips. The biomass availability analysis indicates there is enough residual biomass available to supply the current and planned biomass requirements. Additional hardwood biomass is available if the low-value hardwood can be economically harvested from the undercut AAC.

3 Energy Background

Chart 6: Energy Consumption in Maine by End Use (2005)



Source: EIA

Table 9: Energy and GHG Intensity in Maine

	Energy Dependence	Energy Intensity		GHG Intensity
		million BTU/ capita[1]	thousand BTU/ $ GDP[2]	tonne CO_2e/ $million GDP[3]
Maine	368	12.40	825	
USA	340	9.13	596	

[1] 2005
[2] 2005 in chained 2000 dollars
[3] 2000 in chained 2000 dollars

Source: EIA and Maine Department of Environmental Protection

The Atlantica region is a net energy importer with little fossil fuel production other than offshore operations in Nova Scotia. At the same time, world energy costs are rising and environmental concerns are adding a price to emissions. The forest products industry in general is relying on ageing capital stock with overall energy efficiency lower than today's best practice operations. These are contributing factors to the need for a bioenergy strategy for the region.

Maine

Primary Energy

Maine has no fossil fuel reserves or petroleum refining capacity, but has substantial renewable energy potential in the form of hydroelectric, wood-fired, and wind-powered generation. Maine receives its natural gas supply mostly from Canada, which is used mainly for electricity generation. Petroleum products are received from other states and abroad at three major shipping ports.

Due to its energy-intensive forest products industry, Maine is the only New England state in which industry is the leading energy consuming sector. Compared to the national average, Maine is a relatively energy dependent and greenhouse gas-intensive state.

Residential Energy

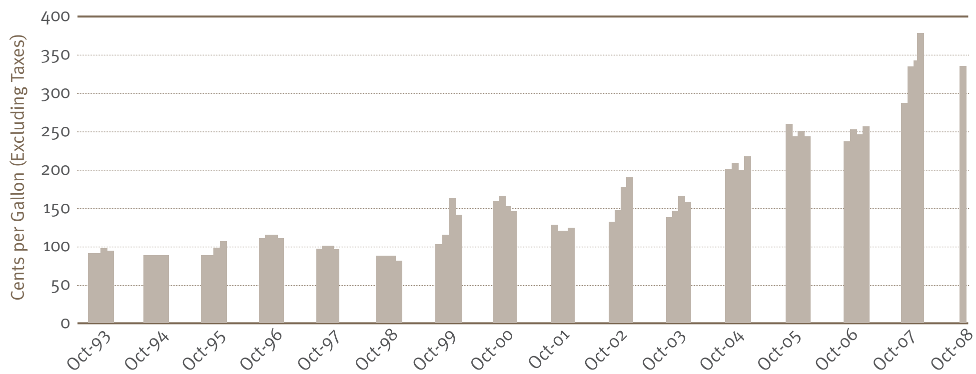
Maine's residential electricity use is low compared with the rest of the country, in part because demand for air conditioning is low during the cool summer months and because few households use electricity as their primary energy source for home heating. Instead, 80% of homes are heated with heating oil, which is a major concern as energy prices escalate. Maine is now seeing a rise in the use of firewood for home heating, which is both an inefficient use of biomass and a source of local air contamination.

Electricity Market

In Maine, generating plants are owned and operated by private generators. These generators participate in two separate electricity markets: the New England Electricity Market and the Northern Maine Independent Service Administrator (NMISA) region. The larger New England Electricity Market is located in the ISO-New England region and is comprised of Connecticut, Massachusetts, Rhode Island, Vermont, and New Hampshire, along with Maine. The electricity delivered to customers in each state flows across a regional grid and may or may not come from power plants located in that state. Lowest-priced resources are dispatched on a system-wide basis to meet the region's demand for electricity.

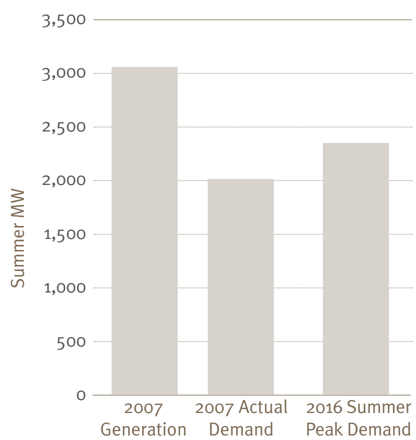
Maine's generation facilities total approximately 3,000 MW of capacity, of which 45% are natural gas-fired. This capacity exceeds projected demand for the state in the short to medium term.

Chart 7: New England No.2 Heating Oil Residential Price



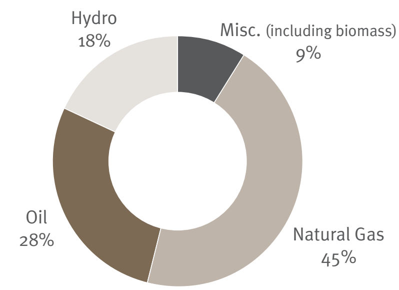
Source: EIA

Chart 8: Existing Supply & Forecast Demand for Maine in the ISO New England Market



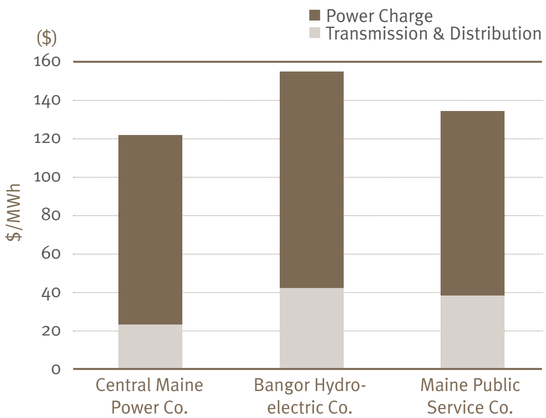
Source: ISO New England

Chart 9: Existing Maine ISO New England Electricity Market Generation Capacity



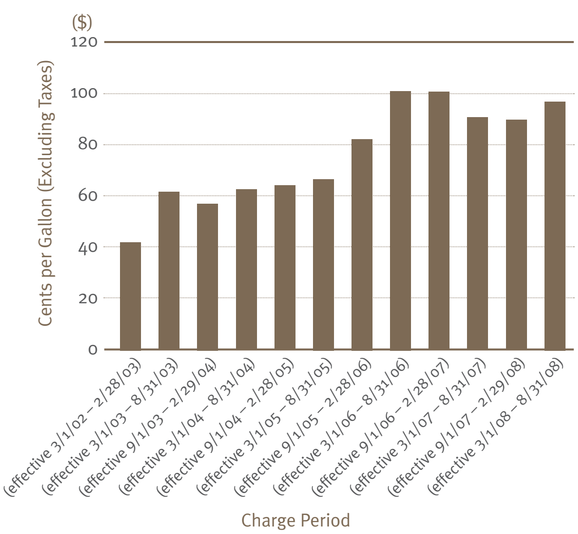
Source: ISO New England

Chart 10: Maine Electric Power Rate for Large Industrial Users (effective 3/1/08 – 8/31/08)



Source: Maine Transmission & Distribution Utilities

Chart 11: Central Maine Power Company Historical Large Industrial Electricity Rates (net of T&D)



Industrial Power

A significant amount of self-generated industrial electricity is produced in Maine, mostly in the forest products sector. While fossil fuels make up the majority of electricity generation capacity, when industrial production is factored in, hydroelectric and other renewable sources like biomass represent nearly 50% of electricity generation in the state.

Improvements in energy efficiency are crucial for the long-term survival of the forest products industry, especially in Maine where industrial power rates are high and climbing.

Renewable Power Policy

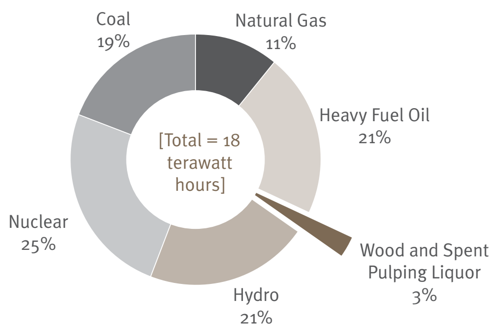
Maine also has nine biomass electricity generating facilities producing electricity throughout the state for sale in both electricity markets. Total generating capacity is approximately 270 MW. These plants were constructed and commissioned in the 1980s when, under the federal Public Utility Regulatory Policies Act of 1978 (PURPA), utilities were mandated to provide long-term contracts for renewable electricity at set "avoided cost" rates, which often turned out to be above market rates.

The majority of these contracts have expired or been bought out, and these biomass facilities instead now rely on revenues from the sale of wholesale electricity, as well as a federal production tax credit of $10 per megawatt hour (MWh), which is set to expire for existing facilities at the end of 2009. In addition, many of these facilities use combustion technology or have particular emissions controls that allow the sale of Renewable Energy Credits (REC) into electricity markets with state-imposed Renewable Portfolio Standards (RPS). Generally under such regimes, electricity suppliers are mandated to supply a certain percentage of electricity from renewable sources and meet this standard by purchasing RECs.

Maine's RPS, implemented in 1999, requires electricity providers to supply at least 30% of total retail electric sales using electricity generated by renewable resources. This standard has been met with existing supply and Maine RECs have not been at a level that encourages new, renewable generation. The states of Massachusetts, Connecticut and Rhode Island all have RPS programs that have a history of providing high-value RECs, and some Maine facilities have made investments to qualify for these programs. As a result, the REC market provides biomass electricity generators with supplementary revenue, currently in the range of $35/MWh. In addition, in 2007 Maine passed a law requiring the development of new renewable resources, increasing by 1% annually from 2008 – 2017. How much of the increased capacity will be biomass-based is unknown at this time.

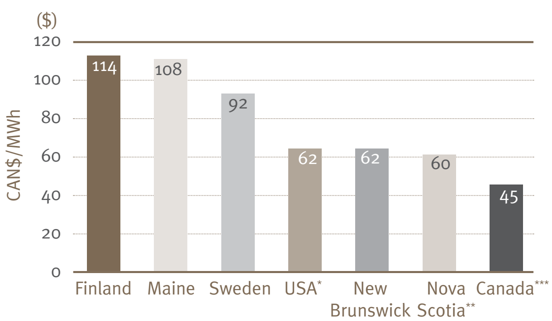
Maine also participates in the Regional Greenhouse Gas Initiative (RGGI), the first mandatory, market-based effort in the United States to reduce greenhouse gas emissions. Ten north-eastern and mid-Atlantic states will cap and then reduce CO_2 emissions from the power sector by 10% by 2018. Starting in 2009, fossil fuel-fired electric power plants will be required to purchase allowance credits through quarterly state auctions and submit credits totalling their annual tonnage of greenhouse emissions back to the state authority. This process will establish a price for carbon, making non-GHG-emitting generation relatively more cost competitive. Generators will also have the option to purchase offset credits created by non-regulated entities to the extent that their purchased allowances do not cover their actual emissions. Current rules of this system do not award offset credits to green power, but this could be considered as the system evolves. However, generators would have to decide between selling a REC credit or an offset credit, as the sale of RECs include all "non-electric attributes," including GHG reductions.

Chart 12: Electricity Generation by Source, New Brunswick (2008)



Source: Report on Energy Supply – Demand in Canada 2006, Statistics Canada

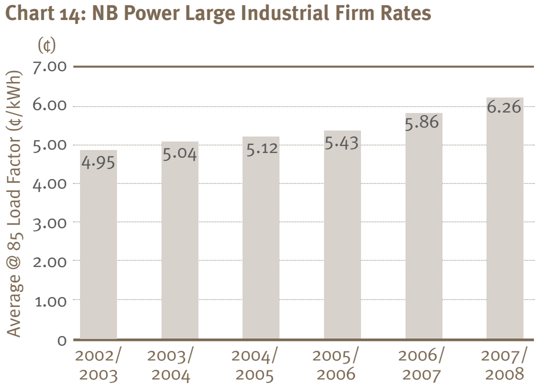
Chart 13: Average Industrial Electricity Rates



* Average of 22 "forest intensive" states
** Reflects confirmed rate offered to the Port Hawksbury paper mill
*** Average of 6 "forest intensive" provinces

Source: Competitive Energy for New Brunswick Forest Industry – Stantec Consulting

Chart 14: NB Power Large Industrial Firm Rates



Source: NB Power

New Brunswick

Primary Energy

New Brunswick is a relatively energy-intensive economy depending heavily on traditional resourced-based industries like forest products, food processing, and mining, as well as fishing and agriculture. It is also a relatively GHG-intensive province; in 2005, New Brunswick contributed 21.3 metric tons (mt) or 2.9% of Canada's total GHG emissions, while representing only 2.3% of the population and 1.8% of GDP.

The province has minimal coal and no fossil fuel production, but does have refining capacity in Saint John and significant hydro and nuclear electricity generating capacity. Coal, crude oil, and natural gas are imported from other countries and provinces via shipping and pipelines.

Home heating is largely electric, with a small portion of the province served by natural gas suppliers.

Electricity Market

The New Brunswick electricity market is primarily supplied by NB Power, a provincial Crown corporation generating and supplying electricity to customers in New Brunswick and exporting electricity to Quebec, Nova Scotia, Prince Edward Island and New England. Electricity is generated from a balanced portfolio of sources, including hydroelectric, nuclear, coal, and natural gas.

Prices

Although industrial electricity rates in New Brunswick are near the median across forest intensive regions, they have risen $13/MWh since 2002/03, a 27% increase.

Renewable Energy

There are no standalone biomass generation facilities in New Brunswick producing solely for the grid, however, a significant amount of biomass electricity is generated by forest products manufacturers for own-use; one operation, Fraser Papers, has a 38.5 MW co-generation facility producing heat for their industrial operations and selling the electricity to NB Power. New Brunswick is also home to two wood pellet plants, with another five planned or under construction. Once all facilities are operational, total production will be approximately 425,000 tonnes per year. Current output is exported to Europe.

Renewable Power Policy

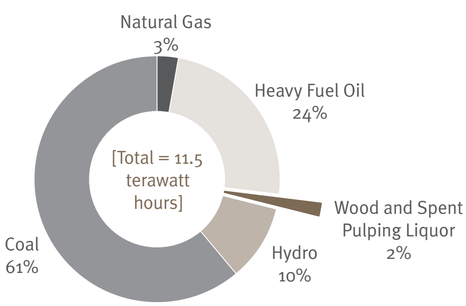
The New Brunswick government has set a provincial renewable energy target of 10% by 2016 from new renewable sources. NB Power has estimated that approximately 492 MW of energy will be produced from renewable sources including wind (387 MW), biomass (50 MW), hydro (53 MW), and landfill gas (2 MW) for an estimated annual energy production of 1,781 gigawatt hours (GWh). A call for wind power has resulted in the installation of 96 MW to be in production by January 2009. Another 213 MW of wind power will come online in January 2010 for total new renewable energy sources of 309 MW.

Federally, the EcoEnergy for Renewable Power Program provides a $10/MWh production incentive to qualifying renewable energy projects (including biomass) for up to 10 years of operation. Fraser Papers has currently applied for the incentive for a new five-megawatt co-generation operation for 2009. The federal government also has plans to invest $1.5 billion towards the expansion of biofuel production in Canada.

In addition to incentives, the federal government plans to move forward with its "Turning the Corner" strategy, which will set restrictive targets for industrial emissions of greenhouse gases and air contaminants. Greenhouse gas targets will be based on emission intensity, starting at 18% below 2006 levels by 2010 and increasing by 2% per annum until 2020. A variety of market-based compliance options will set a value for emission reductions and offsets. Fossil fuel-fired electricity generators could use fuel switching products such as biocoal to replace coal to reduce overall intensity (tonnes CO_2/MWh). Electricity produced by co-generation will have intensity targets based on natural-gas-fired electricity production

Green power generated for sale into the grid could produce offset credits, measured as the estimated emissions savings from displacing fossil-fuel-fired generation. Credits could then be sold to a regulated company or used internally if the company is regulated themselves in other areas of their operations. As the administrative rules and protocols are finalized, the market will lead to the best approaches for monetizing the value of green power.

Chart 15: Electricity Generation by Source, Nova Scotia (2006)



Source: Report on Energy Supply – Demand in Canada 2006, Statistics Canada

Nova Scotia

Primary Energy

Nova Scotia is the only jurisdiction in the Atlantica region with fossil fuel production. Nova Scotia's offshore natural gas production is transferred to New Brunswick where it is used and transferred further to other markets. Oil is imported along with coal, but the latter is used largely for electricity production.

Like New Brunswick, Nova Scotia is a relatively energy and GHG-intensive province. In 2005, Nova Scotia generated 22.7 mt or 3.1% of Canada's total GHG emissions while, representing only 2.9% of the population and contributing 2.2% to the total GDP.

Heating oil is the primary source of home heating, with wood and electricity also in significant use.

Electricity Market

The Nova Scotia electricity market is primarily supplied by Nova Scotia Power, a subsidiary of Halifax-based Emera, which also owns Bangor Hydro in Maine. The company provides 97% of the electrical generation, transmission and distribution in the province. Electricity rates are regulated by the Nova Scotia Utility and Review Board. While current industrial rates are comparable to New Brunswick in the median North American range (5.47 cents per kilowatt hour (kWh) plus demand charges), Nova Scotia Power recently obtained approval for an average 9.4% power rate increase in light of rising fuel costs.

Renewable Energy

While a large share of electricity generated for transmission is coal-based, industrial users like the forest products sector generate a significant amount of electricity from biomass for their own use. NewPage Corporation has a concept for a generation facility in Port Hawkesbury that will sell excess power into the grid starting in 2010.

Nova Scotia currently has three wood pellet plants producing approximately 166,000 tonnes of pellets per year with two more in Yarmouth and New Glasgow in the planning stages. These plants will produce an additional 208,000 tonnes of pellets annually.

Renewable Power Policy

Nova Scotia has set Renewable Energy Standards requiring 5% of all electricity supplied to come from post-2001 low impact renewable sources by 2010 (estimated at 670 GWh per year) and 10% by 2013 (estimated at 1,340 GWh per year). The province refers to an overall target of 18.5% of electricity from renewables by 2013, but this number also includes pre-2001 renewable energy from hydro. NS Power has already contracted for 190 GWh of post-2001 renewable energy which will soon be coming online. In addition, NS Power has put out a call for approximately 25 MW of biomass electricity and expects the remaining post-2001 renewable energy to come from wind power.

Again, as in New Brunswick, federal policies are in place and planned to provide support, incentives, and penalties to encourage the increased use of renewable power, renewable fuels, and the more efficient use of power in general.

4 Technology

Bioenergy and Biochemicals: Opportunity for the Forest Industry

It is widely accepted that wood-based biomass is one of the most important sources of renewable energy feedstock, accounting for 10% of global primary energy supply. In the US and Canada, this source accounts for about 3.5% or nearly half of the total renewable primary energy supply, equating to 87 million tonnes of oil annually (IEA 2006). In addition, wood-based biomass is growing in importance as renewable raw materials for chemical products.

Based on recent capacity investment trends, the importance of wood-based biomass is set to grow as evidenced by the fact that the average value of investment in incremental bioenergy capacity (wood biomass heat and power as well as non-wood-based biofuels) worldwide over the past five years amounted to $22 billion, which equates to 26% of the total investment in renewable energy capacity. This places bioenergy second to wind as the most sought after renewable energy investment (Source: Adapted from Global Trends in Sustainable Energy Investment 2006, 2007 & 2008).

Until recently, investment in bioheat and power has been led by the EU, and investment in first-generation biofuels has been led by the US and Brazil. However, the past 12 months have seen a significant increase in interest in investments in wood-based bioheat and power as well as wood-based second-generation biofuels in the US and Canada. The value of wood-based projects being studied or implemented exceeds an estimated $3.5 billion, which could increase the demand for wood biomass by 10 million oven dry tonnes per year.

Proximity to a sustainable source of feedstock is of paramount importance to the development of a wood-based bioenergy/product economy. The Atlantica region is well endowed with a sustainable feedstock resource and is therefore well positioned to participate in the growing interest in renewable sources of bioenergy and products. However, it is essential for the orderly development of a sustainable wood-based bioeconomy to recognize:

- The reciprocal interdependency between the various end-users of wood produced from the Region's forests (logs, chips, biomass and processing residue) and
- The importance of the role that the forest-based industry will have in the development of a biomass-based industry and in meeting the sustainable feedstock supply demands that a future biomass-based industry will create.

Recognizing that the forest products sector has a vital role to play in the transformation to a wood bioeconomy, we investigated several emerging bioenergy and biofuel technologies that would allow the forest products sector to reposition itself.

Technology Selection Process

The general criteria for technologies to be considered for the case studies were that wood-based biomass be used as the main feedstock, and that the technologies under study have the potential to either be implemented at a commercial scale within the next five years, or implemented at the pre-commercial scale with the prospect of large-scale deployment within the next five years. Following these guiding principles, the approach used in the evaluation of technologies as case study candidates involved a three-phased process:

1. A global scan of existing "state of the art" bioenergy technologies,
2. The creation of a "short list", and
3. Final selections.

Only secondary data sources were used throughout the entire technology scan process.

Phase 1

The first phase of the selection process involved a global scan of potential technologies that represented the "state of the art" in bioenergy or biofuel processes, and which had secondary data sources such as an operating track record, uptime or equipment availability, product quality and specifications, as well as information regarding the scaling and learning curve potential.

This analysis resulted in a "long list" of 25 possible technology study candidates using either biochemical or thermochemical platforms to convert wood-based biomass into energy or value-added products. The "long list" of candidates represented an array of potential implementation models or pathways that included:

- Standalone plants producing heat and/or power for distribution to the grid;
- Co-located plants with other wood processing plants, such as a standalone biomass-to-liquids plant with heat/power sent to a pulp and paper plant. (This included the review of a number of combined heat and power (CHP) process designs involving smaller scale operations such as sawmills or pellet mills, however the steering group considered CHP to be an established rather than emerging technology as defined in the project scope.);
- Processes integrated into existing wood processing operations; and
- Repurposing of mothballed assets.

In addition, these technology candidates could be either totally or substantially funded by private sector investment.

Phase 2

The second phase of the technology selection process involved creating a “short list” of technologies for further consideration. To develop this “short list”, the technology candidates previously identified were assessed and reviewed in conjunction with the Technology Steering Group, from which six technologies were selected for a more detailed evaluation.

Further selection criteria and considerations used to develop the “short list” included feedstock requirements and conversion efficiencies, high-level operating and investment cost estimates for the respective technology, energy balances and carbon footprints, as well as operating performance track record and ideal technology hosting conditions for the areas in the Region.

The six technologies selected included:

1. An integrated biorefinery producing Fisher-Tropsch liquids, a diesel-type fuel with a high cetane number and containing little or no sulphur or aromatics,
2. Production of bio-oil,
3. LignoBoost,
4. Value prior to pulping (VPP) for thermomechanical pulp (TMP) (oxalic acid pre-treatment),
5. VPP for hardwood kraft pulp developed by the University of Maine, and
6. Torrefaction (biocoal).

Phase 3

In the third phase of the selection process, the six selected technology candidates were further assessed considering information produced by the Biomass and Energy Inventory Groups, which then led to the selection of four technologies that would be evaluated in case studies that suited the Region the most. An additional consideration for the selection of technologies to be used in the case studies was an understanding of the current situation in the Region and likely medium term (five years) developments in the key determinants that could influence the successful deployment of technologies in general. The criteria used in the final selection process were based on the fit within the regional context, which considered:

› Prevailing and projected forest products and energy markets,

› Regulatory frameworks,

› Biomass feedstock supply and the supply chain,

› Status of existing forest products and bioenergy assets in the Region,

› Broader infrastructure (e.g., available labour and skill level as well as academic and cross-industry collaborative research programs), and

› Technologies that could enhance the exiting operating assets in the region.

The four case study technologies selected were:

› An integrated biorefinery,

› VPP for TMP (oxalic acid pre-treatment),

› VPP for hardwood kraft pulp, and

› Torrefaction.

Overview of Case Studies

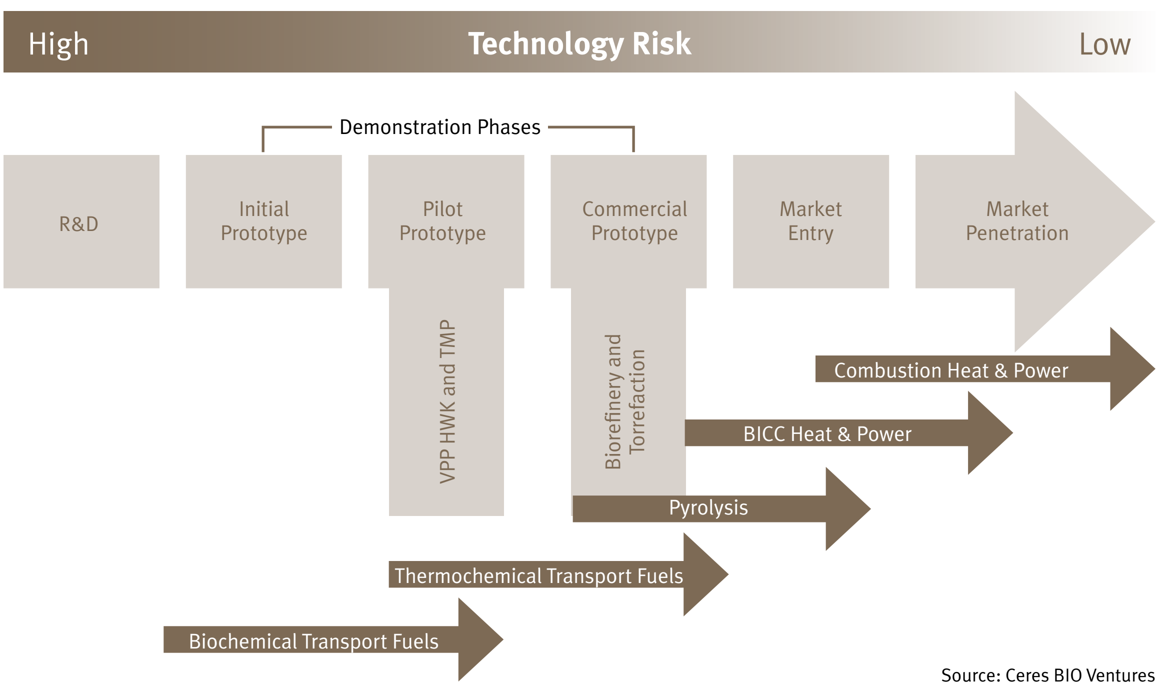
The first three technologies explored in the case studies offer opportunities for existing wood processing operations to reduce energy costs and/or generate alternative revenue streams from biofuels, bioenergy, or biochemicals.

The fourth technology evaluated, torrefaction of biomass, is "standalone" and could lay the foundation for new economic activity; it could transition the Region's forests into a world-class sustainable thermochemical-based biofuels and bioproducts industry, satisfying a substantial part of the Region's energy and chemical product demand in the process.

The two case studies involving the processing of incremental feedstock—the integrated biorefinery and the torrefaction plant—both assume the use of biomass wood waste and not primary wood supply.

As can be seen in Figure 1, each of these technologies is located in the centre of the technology risk spectrum and has either been demonstrated at the pilot or commercial levels. Based on the results to date, it can be reasonably expected that the technologies in question will be commercially proven within the next five years. Due to the varying stages of technological maturity, the technology risks inherent in two of the four technologies that are still in pilot prototype phase can be considered above average. The technology risk inherent in the remaining two technologies where commercial prototypes are operating or under construction can be considered average.

Figure 1: Current Status of Bioenergy and Biochemical Technologies



Source: Ceres BIO Ventures

In order to evaluate potential benefits, it was necessary to create reference mills that are typical of the mills currently operating in the Region. Two hypothetical reference mills were created representing the kraft and TMP processes operating in the Region. Each of these processes will be more dominant in certain areas of the Region than in others. For example, Maine operates five of the eight kraft mills, with the three Maritime mills producing pulp only. Meanwhile, three of four TMP mills operate in either New Brunswick or Nova Scotia ("the Maritimes"). As such, each of the technologies presented in the case studies may favour certain areas of the Region over others as a result of the existing assets in place in each province and state.

All case studies are based on significant assumptions and the information presented here is for illustrative purposes only. For example, given the current volatility of the US-Canada exchange rate, we assume for simplicity that the rate is at par. Formal feasibility studies would require site-specific data for precise analysis. The confidential technical appendix to this report contains sensitivity analysis on a number of metrics.

Furthermore, the estimated macro-economic impacts represent longer-term averages that could be expected under the status quo and given operating assumptions of the case studies. The impacts do not include the temporary positive stimuli that could result from the various capital investments, nor do they include "induced" economic activity derived from incremental consumer spending. Literature from other regions shows that each job created in the pulp and paper industry is responsible for an additional 4.7 jobs through indirect and induced economic activity.[5] Economic impact values vary due to differences in provincial and state economic multipliers.

Reference Mills

Reference Mill A

Reference Mill A is assumed to be a 40- to 50-year-old integrated kraft pulp and paper mill operating in Maine[6] that has been upgraded to meet environmental requirements and customer specifications. It produces printing and writing paper (uses no groundwood in the furnish) at a rate of 1,200 metric tonnes per day (mt/d) sold. The wood intake is 4,346 mt/d of "green" chips (50% moisture or 2,173 oven dry metric tonnes (odmt) of wood).

The average mill of this size employs 959 workers and supports a further 1,938 indirect supply chain jobs. Assuming an average $1,000/tonne price for paper, total output from the mill is valued at $432 million per year, contributing approximately $165 million in direct GDP and a further $98 million in indirect GDP to the economy. Taken together, five such mills operating in Maine would directly and indirectly represent approximately 2.5% of the state's GDP. It is also important to note that much of this economic activity is generated in rural communities.

Reference Mill B

Reference Mill B is assumed to be a 40- to 50-year-old integrated TMP mill operating in New Brunswick or Nova Scotia7 that has been upgraded to meet environmental requirements and customer specifications. The main product produced is newsprint made using the TMP process that is 10 – 30 years old, followed by twin wire forming. The wood intake is 2,332 mt/d of "green" chips (50% moisture or 1166 odmt of wood). The process yield is 96%, resulting in a mill paper output of 1,175 mt/d.

The average mill of this size employs 635 workers and supports a further 943 – 1,228 indirect supply chain jobs. Assuming an average $800/tonne price for newsprint, total output from the mill is valued at $338 million per year, contributing approximately $93 –$111 million in direct GDP and a further $71 –$88 million in indirect GDP to the economy[8]. Such a mill operating in New Brunswick or Nova Scotia would directly and indirectly contribute approximately 0.5% of the GDP of either of the two Maritime provinces. Again, this activity is particularly important for rural communities.

Table 10: Reference Mill Summary Table

	Reference Mill A	Reference Mill B	Reference Mill B
	Maine	New Brunswick	Nova Scotia
Product	Printing and writing paper	Newsprint	Newsprint
Process	Kraft	TMP	TMP
Fibre intake (odmt/y)	782,280	419,760	419,760
Volume of output (tonnes/y)	432,000	423,000	423,000
Value of output	$432 million	$338 million	$338 million
Value added – direct	$165 million	$93 million	$111 million
Value added – indirect	$98 million	$88 million	$71 million
Value added – total	$263 million	$181 million	$182 million
Jobs – direct	959	635	635
Jobs – indirect	1,938	943	1,228
Jobs – total	2,897	1,578	1,863
Direct/Indirect GHG emissions (tonnes CO_2e/y)	170,310/123,930	223,800/618,000	223,800/618,000

Source: PwC estimate

Case 1 – Integrated biomass biorefinery producing Fischer-Tropsch (F-T) liquids

This case study evaluates the potential integration benefits of developing a biomass biorefinery to provide heat for Reference Mill A and Reference Mill B (each representative of the Region's existing assets for the kraft and TMP processes respectively), in terms of economic and GHG benefits.

The biorefinery processes forest biomass waste into Fisher-Tropsch liquids, a diesel-type fuel. Considerable heat can be recovered from gasification, syngas cleanup, and F-T operations and "sold" to a nearby host as steam and hot water. F-T tail gas can be combusted to make additional steam. Syngas can also be sold to fuel the lime kiln but economics typically favour converting it to F-T diesel and wax.

The biorefinery will also generate "green" power, which could be sold to the mill or sold to the grid depending on local rules and utility acceptance. Typically "green" power can expect to receive some form of premium, such as a production subsidy or tax credit, REC, or a green call premium. This assumption was used as it results in a marginally better economic case.

The basic premise for this case is that increased thermal efficiency of the combined operations will generate significant energy cost reductions in addition to increasing revenue and market diversification benefits for the host mill, while not risking the operating efficiency of the host mill. Significant direct GHG reductions will also be achieved by switching the heating source from a fossil fuel to biomass.

There are other site-specific potential benefits that have not been included in the evaluation; the extent of these benefits will vary from site to site (e.g., shared facilities such as merged effluent streams and wood yards, and shared administration and maintenance).

The benefits of an integrated biorefinery versus a standalone facility are:

- Lower capital costs for an integrated biorefinery since a standalone plant requires the addition of cooling towers;
- Greater thermal efficiency (thermal efficiency defined as BTUs sold divided by BTU purchased) is achieved (i.e., 60 – 70% for an integrated operation versus 45% for a standalone operation).

The biorefinery concept has been demonstrated with detailed mass, energy balances, and engineering estimates. One of the requirements is that the pulp and paper mill can seamlessly switch back to the old source of fuel when the biomass biorefinery is not operational.

It is important to note that there are no ties to the pulp and paper mill except for the use of reclaimed heat. This is why the integrated biorefinery is not sensitive to either pulping process or paper type produced, only heat demand.

Comments on Case 1

As a technology, an integrated biomass biorefinery could be implemented across the Atlantica Region. Integrating the model biomass biorefinery defined for either of the reference mills (kraft Mill A or TMP Mill B) requires the highest capital investment of any of the technologies examined in this study. The capital investment is estimated at $380 million per project. Further issues to note regarding this technology are that asset finance providers require covenants that are extremely difficult to meet, such as 20-year feedstock supply and off-take agreements, and onerous technology supply guarantees that are costly and time-consuming. Integrating a biomass biorefinery with Mill A is estimated to have a payback of approximately six years without consideration of fuel incentives. In the case of Mill B, the payback is about 5.2 years without consideration of fuel incentives. Taking into account incentives equal to what are currently in place in the US would reduce the payback period to 3.9 years or less.

The largest economic benefit to the Region is in the maintenance of these community backbone operations and the downstream economic activities they support. Diversifying the product mix would add a greater degree of stability in the face of uncertain market activity, and increased output would add hundreds of direct and indirect jobs to the economy per mill.

Case 2 – VPP (value prior to pulping) for TMP using Reference Mill B

VPP for the TMP process is a chemical process where chips are impregnated with an oxalic acid solution prior to refining for the purpose of reducing the refining energy needed to produce a pulp meeting certain specifications. Pilot trials have shown that the application of this patented technology reduces refining energy by 20 – 40%.

Other benefits of the technology include less bleaching, stronger fibres, significantly fewer shives (less shive refining) and a stronger sheet, all of which provide an opportunity to reduce the content of purchased kraft pulp added to the paper furnish. Alternatively, pulp production can be marginally increased with the power made available by the technology.

Potential issues identified to date with this technology are the formation of calcium oxalate and its build-up within the process equipment. Scaling has not been noted in trials performed to date but build-up often requires considerable time to develop.

For the purpose of this case study, reference Mill B is used as the base case and it is assumed that the refining energy reduction provided by implementing the VPP technology will be 30%. None of the other possible benefits noted above were considered in the case study. Additional benefits could include the lowering of the mill power demand factor, which would be mill-specific and as a result not included in this case study. Heat consumption for Mill B will not change, nor will the process yield. There may be a small change to the TMP heat recovery but it is not considered here because it is complex to calculate and will not significantly impact the overall economic benefit. As such, the VPP for TMP technology has the potential to reduce the energy bill of reference Mill B by as much as $29.6 million per year.

This technology does affect existing mill operations. As this report was being drafted, mill trials were being scheduled to document the benefits and operational issues of the technology under actual operating conditions.

Comments on Case 2

The application of VPP for the TMP process has the greatest impact on the energy efficiency and indirect carbon footprint of all the technologies evaluated in this study. Integrating this technology into Mill B would allow Mill B to exceed the best practice TMP mill benchmarks for both energy cost and carbon footprint. However, the reduction in carbon footprint comes as a result of reduced purchased power, which under the current deign of the Canadian federal regulatory system, would not be counted towards an operation's regulated emissions, nor would it qualify for an offset credit. Thus, reductions would not result in a liability savings or revenue source.

It is important to note that there are no TMP newsprint mills operating in Maine. As such, this case scenario favours Nova Scotia and New Brunswick. Based on reference Mill B, the capital investment required to implement VPP using oxalic acid is estimated at $36 million. The estimated payback timeframe for this technology in Reference Mill B is less than 1.2 years.

Again, the macro-economic significance of this scenario is to improve the profitability of the mills and maintain their backbone economic presence in the communities and surrounding areas in which they operate. However, theoretically, reduced demand for power could have negative downstream employment effects. That being said, such impacts would be small in comparison to the closure of a mill.

Case 3 – VPP (value prior to pulping) for a hardwood kraft pulp mill

VPP for the kraft process is only applicable to mills pulping hardwood species. VPP is a process that involves the treatment of hardwood chips prior to pulping in order to extract a target percentage of hemicellulose, a fermentable sugar, without undue damage to either the physical properties of the fibre or pulp, or the final pulping yield.

One of the VPP technologies for a hardwood kraft pulp mill considered in this case study was developed at The University of Maine (UoM). UoM developed an extraction process while American Process Inc. has developed process patents. The process extracts about 10% of the bone dry weight of wood. The extracted fraction can then be converted to value-added products including ethanol and acetic acid. The extraction process does not affect overall fibre properties or yield. It is reported that roughly 45% of the hemicellulose weight removed can be converted to ethanol (e.g., every 200 pounds of hemicellulose extracted will yield about 90 pounds of ethanol).

Another VPP technology developed by Empire State Pulp and Paper Research Institute (ESPRI) at the University of New York in Syracuse claims to be able to extract roughly 20% of the bone dry weight of hardwood as hemicellulose. This ESPRI VPP technology causes some minor strength and yield loss which is more than offset by higher profit from the extra ethanol produced.

With either of the kraft VPP technologies (UoM or ESPRI), there exists a challenge in fermenting the extracted hemicellulose to ethanol, as hemicellulose from hardwood consists primarily of five carbon sugars that require newer fermentation technology. The smaller percentage of six carbon sugars can be fermented with conventional technology such as brewer's yeast.

Other potential benefits not included in this case study are the reduction of evaporator fouling, increased bleaching efficiency, and energy savings because of faster chip impregnation with pulping liquor.

In both VPP processes for a hardwood kraft pulp mill, the recovery boiler will be unloaded (but to different degrees), which will reduce the on-site power generation. Laboratory studies and process designs indicate that the loss in energy production is roughly equal to the reduction in process energy requirement to pulp the wood and this result has been used in the case analysis. Consequently, the kraft VPP technology has no impact on carbon emissions.

Comments on Case 3

The number of sites in the Region where the VPP for kraft mill technology can be considered is not clear. At the time of drafting this study, the VPP technology had only been tested for the hardwood kraft pulping process. There are eight kraft mills in the Region but most run both hardwood and softwood. Based on the existing assets, this technology would favour Maine over Nova Scotia and New Brunswick. Using Reference Mill A criteria, it is estimated that implementing VPP in a hardwood kraft mill would require an estimated capital investment of $68 million. Without considering the value of the ethanol that can be produced and used as an incentive, it is estimated that the potential payback timeframe is 3.4 years.

Under the Case 3 scenario, marginal output for the mill would increase by approximately $28 million, or 7% of current operations. As such, the main economic significance again would be to improve the financial stability of existing operations and maintain their economic presence.

Summary of “Bolt-on” Technology Case Studies

A comparison of key financial, environmental, and economic impacts of the three “bolt-on” case studies is presented below.

	Case	1A	1B		2		3
	State/Province	Maine	New Brunswick	Nova Scotia	New Brunswick	Nova Scotia	Maine
	Mill type	Kraft	TMP	TMP	TMP	TMP	Kraft
Financial	Capital Costs	$380 million	$380 million	$380 million	$36 million	$36 million	$68 million
Financial	Increased Revenues ($/mt output)	$343	$325	$325	$0	$0	$78
Financial	Decreased Mill Energy Costs ($/mt output)	$8.20	$8.25	$8.25	$70	$70	$0
Financial	Total Net Cash Benefit ($/mt output)	$146	$174	$174	$70	$70	$50
Financial	Anticipated Payback with Incentives	6 years	5.2 years	5.2 years	1.2 years	1.2 years	3.7 years
GHG	Direct Mill GHG Reductions (tonnes CO_2/mt output)	0.278 (71%)	0.296 (91%)	0.296 (91%)	0 (0%)	0 (0%)	0 (0%)
GHG	Indirect Mill GHG Reductions (tonnes CO_2/mt output)	0 (0%)	0 (0%)	0 (0%)	0.627 (30%)	0.627 (30%)	0 (0%)
Economic	Incremental Direct Jobs	16	16	16	0	0	10
Economic	Incremental Indirect Jobs	975	644	614	(104)	(85)	182
Economic	Total Incremental Jobs	991 (34%)	660 (42%)	629 (34%)	-104 (-7%)	-85 (-5%)	192 (7%)
Economic	Incremental Direct Value-added	$64 million	$74 million	$74 million	$30 million	$30 million	$19 million
Economic	Incremental Indirect Value-added	$61 million	$45 million	$47 million	$(19 million)	$(21 million)	$8 million
Economic	Incremental Direct & Indirect Value-added	$125 million (47%)	$119 million (66%)	$121 million (66%)	$11 million (6%)	$9 million (5%)	$27 million (10%)
Risks/Oppotunities	Technological	Biomass gasfication for power generation is well established, however cleanup of the gas for fuel and chemical production and the synthesis of gas into liquid fuels at a smaller scale is still to be proven at a commercial scale.			• Potential formation of calcium oxalate H14 within the process equipment • Less bleaching, stronger fibres, significantly fewer shives, and a stronger sheet		• Challenge in fermenting the extracted hemicellulose to ethanol • Reduction of evaporator fouling, increased bleaching efficiency • Energy savings
Risks/Oppotunities	Commercial	• High capital investment cost • Need for long-term fibre supply • Demand for F-T liquid produced			• No current monetization of indirect GHG reductions available		• Demand for ethanol produced

Case 4 – Torrefaction (third-generation biomass feedstock)

Torrefaction is a thermal pre-treatment technology carried out at atmospheric pressure in the absence of oxygen. It occurs at temperatures of 200 – 300°C where a solid uniform product is produced. In the process the initial weight of the woody biomass is reduced by 30% but the original energy content of the matter is reduced by only 10%. The 30% of the biomass that is lost is converted into torrefaction gas that contains 10% of the initial energy content and is used to provide process heat.

Torrefied pellets have a very low moisture content and a high calorific value when compared to fresh woody biomass. Torrefaction upgrades the energy density, hydrophobic nature, and grindability properties of biomass compared to ordinary wood chips or wood pellets, as shown in the table below.

The technology has been around for about 70 years and has been used at relatively small scale (~20,000t/y) to produce a smelting additive, as well as to increase the durability of hardwood floors.

A variant of torrefaction technology is being developed by ECN (Energy research centre of the Netherlands). As this report is being drafted, ECN and Chemfo, a clean technology venture group, are building a 70,000 t/y plant in the Netherlands using the BO_2 process technology developed by ECN. The plant will be producing by 2009, as will a further three plants using similar technology that are currently under construction. Torrefaction by means of the ECN process has been chosen for this case study as it has the most extensive publicly available operational testing data.

A major benefit of torrefied pellets is that logistics costs can be reduced to 50 – 66% of the costs involved for first-generation wood pellets, with significant benefits in terms of feedstock preparation and storage.

A further consideration regarding the biomass torrefaction technology is the elimination of the need to dry and reduce the particle size of the biomass prior to densification as is required for second-generation biomass pelletizing technology. In second-generation biomass pelletizing processes, steam conditioning is applied to soften the biomass fibres. Following densification, the bio-pellets are cooled down. However, when torrefaction is considered, steam pre-conditioning is not required since torrefied biomass is fragile.

The power consumption for size reduction following torrefaction is reduced by around 70 – 90 % compared to second-generation biomass pelletization. As well, pelletizing the torrefied biomass not only increases the mass density but also the energy density. A further benefit of torrefaction over second-generation biomass pelletization is that bark can be incorporated into the feedstock and the resulting pellets used for residential purposes. If second-generation biomass pellets contain bark, their use is limited to industrial scale boilers because of particulate emission standards.

Table 11: Comparison of energy density and moisture content of various forms of pre-treated biomass feedstock

	Bulk density kg/m³	Energy density GJ/m³	Moisture % mass
Chips	200	7	25
Pellets	650	11	8 – 10
Torrefied Pellets	750	18	‹3
Bio Oil*	1,200	17.0 – 20.6	25

Source: Chips/pellets: Department of Science, Technology & Society Utrecht University, the Netherlands, *Bio-oil. Dynamotive Inc

Comments on Case 4

As a technology, torrefaction could be used and implemented across the Atlantica Region. As well, torrefaction could create new economic activity for the Region by producing a clean and "green" fuel. This new fuel (biocoal) could be used to offset fossil fuel and reduce the carbon footprint. In the Maritimes, where electricity generators and other industries will likely have intensity targets imposed on them by regulation, the substitution of biocoal for traditional coal represents a large potential liability cost savings. However, in Maine, should torrefied pellets be used for home heating, there would be no such internalized carbon reduction value for the end-user. In this case, some form of production subsidy would be required to capture the environmental benefit.

Based on current technology, economies of scale are maximized at a plant module capacity of 60,000 mt/y. Larger plants can be developed by adding extra modules. A 10% operating cost disadvantage is incurred by smaller plants (down to 15,000 t/y).

The capital investment for torrefaction is estimated at $4.9 million for a plant capable of producing 60,000 t/y, with a payback timeframe of between 0.9 and four years, depending on the output product mix. The four-year payback relates to supplying a coal substitute (e.g., co-firing), while the 0.9 year payback is achievable if torrefied pellets are sold as a substitute for heating oil. For illustration purposes only, if output is valued at an energy equivalent to that of coal, a torrefaction plant of this size operating in New Brunswick could generate at least $7.4 million in output, $5.8 million in direct and indirect GDP, and add 56 direct and indirect jobs to the region. The exact effects would depend largely on the number and size of operations in the Region, as well as the ultimate value of the product.

The case study relates to a standalone plant, however the technology lends itself to being integrated with surplus heat producers such as sawmills or biomass power plants, which could reduce both capital and operating cost by up to 20%. Consequently, plants of various sizes can be situated very close to the source of the biomass (either forest or mill residue) to minimize the cost of inbound logistics. The energy and mass densification of the biomass therefore takes place near to the source, reducing feedstock transportation, storage, and preparation cost by up to 70% compared with forest chips.

Table 12: Torrefaction Case Study Summary

Case 4 – Marginal Impacts	60,000 mt/y Torrefaction Plant Maine	60,000 mt/y Torrefaction Plant New Brunswick	60,000 mt/y Torrefaction Plant Nova Scotia
Capital Cost	$4.9 million	$4.9 million	$4.9 million
Benefits	New Products: Torrefied Pellets	New Products: Torrefied Pellets	New Products: Torrefied Pellets
Simple Payback – coal replacement	4 years	4 years	4 years
GHG reductions – coal replacement	0.7 tonnes CO_2e/MWh	0.7 tonnes CO_2e/MWh	0.7 tonnes CO_2e/MWh
Anticipated new direct jobs	6	6	6
Anticipated new indirect jobs	101	50	58
Total anticipated new jobs	107	56	64
Total wages and salaries	$3 million	$2 million	$2 million
Anticipated incremental direct GDP	$1.6 million	$1.6 million	$1.6 million
Anticipated incremental indirect GDP	$4.9 million	$4.2 million	$4.2 million
Total anticipated incremental GDP	$6.5 million	$5.8 million	$5.8 million

Environmental Risks of the Case Study Technologies

As three of the four technologies reviewed in the case studies involve add-on technologies to existing assets for the principal purpose of improving energy efficiency, it is difficult to estimate the environmental impact these will have on the host facility. Each asset within the Region will have varying constraints regarding its effluent treatment facility. These will be based upon the type of effluent treatment facility being operated, the permit capacity of the existing facility and the jurisdiction in which the asset is being operated.

As well, each asset will have to deal differently with the atmospheric emissions produced by these add-on technologies. At a high level, it is possible to suggest that VPP for hardwood would have little impact on the effluent treatment plant or on atmospheric emissions, as the process yield is not expected to change nor is the amount of biomass to be processed by the asset. Regarding VPP for TMP, although the amount of biomass being fed into the process remains unchanged, the pre-treatment of chips using oxalic acid could possibly have an impact on the effluent treatment plant as some of the organic material may be dissolved by the impregnation process. Results to be published from the pending trials using oxalic acid should provide some clarification regarding this issue. It is plausible to consider that an integrated biorefinery might have an impact on the effluent treatment plant because the amount of biomass entering the asset would nearly double. As for atmospheric emissions, there should be little change; however, the biorefinery will need to monitor atmospheric emissions for VOCs and other compounds.

The fourth technology, torrefaction, should reduce atmospheric emissions when compared to second-generation biomass pelletization, as the amount of particulate matter emitted by the torrefaction process is lower.

Alternative Energy Policy Framework

Policy drivers include climate change and the need to reduce greenhouse gas emissions, the desire for economic development as well as the need to address energy security and price volatility issues.

It is clear that the members of this Task Force are looking for solutions that will add value to existing forest products industries in the region, by seeking out bioenergy opportunities that are complementary to those operations, not in direct competition with them.

The Atlantica Region is somewhat unique for several reasons: our mixed forest stands, the high degree of private land ownership and the integrated nature of our forest industry operations. Pulp mills, sawmills, and harvesting operations are highly interdependent.

The Role of Government in Setting Public Policy

Governments are currently faced with the growing need to control the source, cost, and environmental effects of energy. To decrease the reliance on carbon sources, reduce costs, and increase energy independence, many jurisdictions are developing and implementing comprehensive public policy frameworks to manage and incentivize changes in the energy supply. At the same time, a significant opportunity exists to revitalize the forest industry by adding further value to the production of forest products, through the production of green energy and advanced biomass products such as biofuels and biochemicals. The public policy frameworks being developed aim to maximize the economic development benefits from the forest, encourage the development of reliable and diversified supplies of renewable energy, and contribute positively to climate change initiatives such as reducing greenhouse gas emissions.

In the present market economy in the Atlantica Region, the cost of generating energy from carbon sources generally remains less than the cost of producing energy from renewable sources such as biomass. Without a policy environment that supports the change from carbon-based energy to renewable energy, it is unlikely the market will respond on its own. Changes in the regulatory environment at the federal level and renewable energy targets at the state and provincial levels suggest further opportunity for comprehensive policy initiatives that will support the needed investment in renewable technologies. Two factors are critical to support the investment in new technology: the policy environment must reduce investment risk and support the transformation from carbon-based fuels to renewable energy.

Current renewable energy policy and targets in Atlantica jurisdictions

Renewable energy policy for each jurisdiction is based on the need to diversify fuel sources away from carbon products. The recent volatility of oil prices and concerns over the security of supply are pressing reasons to consider diversification to alternative energy sources. In addition, each jurisdiction has identified other benefits of diversification including economic development benefits for rural areas, improved environmental health, and reduced GHG emissions.

Public Policy Review of Selected Jurisdictions

The objective of the public policy section of this study was to review selected jurisdictions and report on initiatives that are supporting the development and use of biomass for renewable energy. Jurisdictions were selected based on several factors including population, existing forest base and availability of biomass, renewable energy (including electricity-generation and fuels), mix of chemical and mechanical pulp mills, existence of demonstration projects underway in the jurisdiction, implementation of a public policy framework, support programs, length of time policy has been in place, and relative success of the policies.

In addition to the selected jurisdictions, policy examples from other jurisdictions have been included to demonstrate certain initiatives.

Jurisdictions reviewed included the following:

Texas	Germany
Oregon	Austria
Wisconsin	Denmark
British Columbia	Sweden
New Zealand	Finland

In Table 13, selected characteristics of the jurisdictions are presented to provide a sense of the activity undertaken around the renewable energy sector. Data is not available for all jurisdictions.

Of these jurisdictions, descriptions of policies in Germany and Wisconsin are provided as examples of comprehensive policy frameworks. Germany's primary policy lever, the Renewable Energy Feed-in Law, now replaced by the Renewable Energy Sources Act (EEG), has been in place since 1991 although previous legislation to support renewable energy was enacted in 1985. Prior to the announcement in the spring of 2008 of an updated and expanded policy framework, Wisconsin had in place various policies supporting renewable energy. What makes the Clean Energy Wisconsin plan unique is the comprehensive nature of the policy initiatives announced. The plan provides recommendations and policy initiatives that take into account business and job development, affordable renewable technology, improved energy efficiency, and engaged communities.

Comprehensive Policy Framework

A comprehensive policy framework supports the development of renewable energy through a suite of policy levers that support both demand and supply. In our review, several jurisdictions were observed having a comprehensive policy framework that provided integrated policy levers focused on achieving the renewable energy targets from a variety of renewable sources. Policy frameworks included combinations of the following policy levers:

Forest management practices – silviculture, land ownership, harvesting	Research and development – loans, loan guarantees, grants, training
Renewable portfolio standards (RPS) – electricity, heating, and fuels	Tax incentives – exemptions for renewable fuels, capital investment, research and development, production subsidies
Feed-in tariffs , renewable energy certificates (RECs), quota obligations	Efficiency targets – industrial and vehicle emissions
Capital financing – loans, loan guarantees, grants, bond issues	Standards and regulations – building codes, permits

Table 13: Summary of Selected Characteristics for Jurisdictions Reviewed

Jurisdiction	Population (millions)	GDP, $USD (billions) 2007	Renewable fuel targets	Renewable electricity targets
Canada	33.3	1,326.4	5% – 2010 (gas) 2% – 2012 (diesel)	None set
New Brunswick	0.8	25.1	None set	10% – 2016
Nova Scotia	0.9	30.7	None set	18.,5% – 2013
British Columbia	4.4	179.1	5% – 2010 (diesel)	90% – 2010
United States	301.6	13,811.2	36 billion gallons – 2022	None set
Maine	1.3	48.1	None set	40% – 2017
Oregon	3.8	158.2	10% – gas 2% – diesel	25% – 2025
Wisconsin	5.6	232.3	None set	25% – 2025
Texas	23.9	1,142.0	None set	10,000 MW – 2025
New Zealand	4.0	129.4	10% – 2020	90% – 2025
Germany	82.4	3,297.2	10% – 2020	18% – 2020
Austria	8.3	377.0	10% – 2020	34% – 2020
Denmark	5.4	308.1	10% – 2020	30% – 2010
Sweden	9.1	444.4	10% – 2020	49% – 2010
Finland	5.3	246.0	10% – 2020	38% – 2020

Since 1997, the EU has provided a comprehensive framework that sets out targets to increase the overall share of renewable energy consumption.[9] Included within the framework are provisions to undertake periodic measurement of the progress member countries are making towards renewable energy targets. In response to the targets, member countries have implemented comprehensive policy frameworks at the national level. As the renewable energy industry develops, revisions to existing policies have occurred, including resetting targets to higher percentages of renewables.

In comparison to the EU, North American jurisdictions have fewer examples of comprehensive policy frameworks in place to support the development of renewable energy. This may be a result of North American jurisdictions favouring market-based programs rather than implementing programs requiring significant investment from government. Currently, without the benefit of a comprehensive framework, existing legislation and policies appear to be ad hoc and fragmented. Few, if any, take into consideration policies to support accessing biomass from the forest for use in bioproducts, bioenergy, or biochemicals.

In the past year, comprehensive policy frameworks that take into consideration the forest industry and its potential contribution to renewable energy are being adopted in British Columbia and Wisconsin.

Climate Change Policy

The Canadian and prospective American federal governments are proposing climate change initiatives that will significantly affect existing renewable energy policy. Both national policies feature proposals for emission targets to reduce GHG emissions which could result in a North-America-wide carbon market. A brief description of each national proposal follows.

Canada

In June 2008, the Canadian federal government passed the requirements for renewable content for ethanol and gasoline. The new requirements prescribe 5% renewable content in gasoline by 2010 and 2% renewable content in diesel fuel and heating oil by 2012.

The proposed federal climate change initiative is intended to regulate large final emitters (facilities producing over 100 kilotonnes of CO_2e/a) of greenhouse gases on a GHG-intensity basis, and to establish a carbon offset program that would complement the large final emitters regulations by allowing their compliance through the purchase of offsets.

These regulations will require an 18% initial GHG intensity reduction of large final emitters built prior to 2011 with a 2% reduction target thereafter.

The plan will account for 50% of the federal government's emissions reduction targets and the remainder will be achieved through transportation legislation, technological investment, efficiency programs, and clean energy development.

United States

The Energy Independence and Security Act of 2007 was signed into law with the directive to improve vehicle fuel economy and help reduce the United States' dependence on oil. The intention to increase alternative energy supply is supported by the Renewable Fuels Standard (RFS), which requires fuel producers to use at least 36 billion gallons per year of renewable fuel by 2022. Of this amount, 21 billion gallons is required to be from advanced biofuels.

President-elect Barack Obama has pledged to implement a cap-and-trade system that would reduce emissions substantially in the coming decades. He has also stated that a major effort is needed to create an international scheme that will unify Canada, Europe, Australia, Japan, and the United States into a global climate change system. In addition, he intends to ensure that developing nations—particularly China, India, and Brazil—are included in an international climate change plan.

Canadian and U.S. Policy Initiatives

The following section outlines existing policy initiatives that could be used to support the implementation of the proposed technologies described in the previous section of this report.

Canadian Federal Programs

The Scientific Research & Experimental Development (SR&ED) tax credit is a federal program designed to encourage businesses, including small and start-up companies, to do work that advances technology to develop new or improved products or processes. SR&ED provides foreign-owned companies with a non-refundable tax credit of 20% of qualified expenditures, and unused amounts can be carried forward 20 years. Qualified expenditures must meet the specified advancement, uncertainty, and content criteria. A 15% refundable tax credit against provincial income taxes is also available for New Brunswick and Nova Scotia. Higher refundable credits are available for a Canadian-controlled private corporation (CCPC).

Canadian Renewable and Conservation Expenses (CRCE) is a program intended to encourage investments in energy efficiency and renewable energy projects. CRCE includes intangible expenditures for the pre-production development phase of projects along with asset Classes 43.1 and 43.2, and provides investors with the opportunity to claim accelerated income tax deductions in respect of their investments in qualifying assets. In order to qualify for CRCE, Class 43.1 or 43.2 assets must already be either in place or under development.[14]

ecoENERGY is a comprehensive initiative to provide clean energy through energy efficiency and renewable sources of energy. One aspect of the program is to provide financial assistance for the generation of renewable energy. Eligible projects can receive $10 per MWh for the first 10 years of qualifying renewable energy projects.

ecoEnergy for Biofuels is another program under the ecoENERGY umbrella that provides recipients with an incentive rate of $0.10 per litre of renewable fuel produced for renewable alternatives to gasoline and $0.20 per litre for renewable alternatives to diesel produced for the first three years. The incentive rate is then reduced as market conditions develop in response to the emerging industry. The underlying intention of the program is to provide producers with a more secure investment climate.

NextGen Biofuels Fund™ is a $500-million fund administered by Sustainable Development Technology Canada (SDTC) that will support up to 40% of eligible project costs or $200 million, whichever is less, for the establishment of first-of-kind large demonstration-scale facilities for the production of next-generation renewable fuels (cellulosic ethanol and biodiesel). The contribution will be repayable based on free cashflow over a period of 10 years after project completion.

US Federal Programs

The Volumetric Ethanol Excise Tax Credit (VEETC) is an excise tax credit in the amount of $0.51 per gallon of pure ethanol (minimum 190 proof) blended with gasoline. The credit is available to ethanol blenders registered with the Internal Revenue Service who have produced and sold, or used, the qualified ethanol mixture as a fuel in their trade or business.

The Federal Renewable Electricity Production Tax Credit (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. The tax credit amount for open-loop biomass facilities is $0.01/kWh with an in-service deadline of December 31, 2010. The duration of the credit is generally 10 years after the date the facility is placed in service. In addition, the tax credit is reduced for projects that receive other federal tax credits, grants, tax-exempt financing, or subsidized energy financing. For open-loop biomass facilities placed into service before August 8, 2005, the tax credit expires in 2009.

The Department of Energy (DOE) administers several programs that support the research and development of biofuel products. For fiscal year 2008, $186 million was appropriated for the entire biomass program, with another $179 million requested in the fiscal year 2008 budget. Programs include the Biomass Research & Development Initiative, biorefinery project grants, loan guarantee programs, and the Cellulosic Biofuels Production Incentive.

US State Programs

The Maine Biofuels Production Tax Credit is an income tax credit of $0.05 per gallon for the commercial production of biofuels for use in motor vehicles or otherwise used as a substitute for liquid fuels. The credit is available to certified producers of ethanol, biodiesel, or methanol derived from biomass. A taxpayer claiming this credit must receive a letter from the Commissioner of Environmental Protection that certifies the biofuels produced during the taxable year are eligible for the tax credit. For biofuels blended with petroleum or other non-biofuels, the credit is allowed only on the biofuels portion of that blend. Any portion of unused credits may be carried over for the succeeding 10 taxable years.

In the following sections, best practice examples of policy initiatives determined through the review of selected jurisdictions are provided. These policy initiatives support the findings of previous sections of this report, especially the implementation of the technology case studies.

Policy Initiatives to Support the Use of Forest Biomass

Both British Columbia and Wisconsin have released comprehensive framework strategies that include policy initiatives for forest management to encourage the use of wood fibre as feedstock for renewable energy production. Other benefits identified included business and employment opportunities in rural communities and reduction of GHG emissions.

British Columbia – British Columbia's Climate Action Plan and Bioenergy Strategy acknowledge the importance of the forest industry to BC's economy and identify opportunities to leverage the forest industry through expanding forest use to include renewable energy. Policy initiatives outlined in the strategy that could transform the existing forest industry include the following:

- Convert wood waste and trees killed by the mountain pine beetle into renewable energy which would create economic development opportunities for rural communities, encourage new investment and innovation and move British Columbia towards energy self-sufficiency.
- Maximize the potential and capacity of British Columbia forests beyond traditional timber use by introducing uses for the forest in energy production and carbon storage.
- Allocate $10 million to support pulp and paper energy efficiency initiatives as well as support for the development of new technologies.
- Establish $25 million in funding for the BC Bioenergy Network.
- Increase the number of BC Hydro calls for biomass power.

Wisconsin – Clean Energy Wisconsin is the state's plan for energy independence. Included are policy initiatives that will use existing forests and timberland, of which Wisconsin has approximately 16 million acres, for use as feedstock for cellulosic ethanol production. Using the forests as a source for fuel is recognized as an opportunity to encourage economic development in rural communities, especially in the northern areas of the state. As well, the addition of bio-refineries to existing pulp and paper mills has been identified as an opportunity to strengthen and diversify the paper industry.

Under the governor's leadership, proposals to change current forest practice management are being discussed throughout the state in consultation with the Department of Natural Resources and private landowners. Proposed changes would see the development of forest crops developed to substitute for carbon fuels in electricity generation and transportation use.

Policy Levers to Create Market Demand for Renewable Electricity

In the Atlantica region, Renewable Portfolio Standards (RPS) are realized through legislation and form the basis for a public policy framework for renewable electricity generation. RPS are found in most jurisdictions and are used to stimulate a renewable electricity market by taking the form of a market share requirement or quota obligation. In addition to the RPS, other policy levers are used to stimulate the supply of renewable electricity. Feed-in-tariffs, tradeable renewable energy certificates (RECs), standing offer programs, and utility calls for green power all provide mechanisms to encourage the supply of renewable electricity. Each of these policy levers is described below with examples taken from the jurisdictional review.

Feed-in Tariffs

Feed-in tariffs guarantee the price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators. The price is set by legislation and the cost difference between the retail price and the feed-in-tariff is typically spread over utility customers.

United States – Under legislation from the Public Utilities Regulatory Policies Act (PURPA), utilities were required to purchase power from non-utility power producers or independent power producers for less than what it would have cost the utility to produce power (avoided costs). PURPA has been credited with providing opportunities for the development of renewable energy generation capacity. The weakness of the legislation became apparent when utilities were committed to pay the higher prices for electricity established in independent power producers' long-term contracts even when current spot market prices were considerably lower. PURPA is now considered an unworkable policy model because of its long-term price contracts and the uncertainly of electricity spot market prices.

Germany – Germany's Renewable Energy Feed in Law (REFL) was established in 1991 and provides a legal framework for the electricity sector regarding certain renewable energy sources. The Act has since been replaced by the Renewable Energy Sources Act (EEG) and amended several times, most recently in 2007, to reflect the evolving renewable energy market. Germany's feed-in tariff is considered to be the best practice example for this policy because of its stepped tariff design. Under this program, renewable energy generators receive a guaranteed price per megawatt from the start of a facility commission extending for 20 years. The guaranteed price declines in value in a step-wise progression. The principle behind the program is to provide certainty and reduce risk for the renewable energy generator but provide enough motivation for continuous improvement as technology improves and operating costs decline over time. The feed-in tariff is adjusted based on the plant size and source of energy with a restriction on biomass installations with a maximum capacity over 20 MW. The range of tariffs available for biomass or CHP installations with a maximum capacity between 5 – 20 MW are 80.3 €/MWh to 109.9 €/MWh.

Standing Offer Programs

Ontario – Ontario's Standing Offer Program has been designed to promote renewable electricity generation projects that deliver value to the Ontario ratepayer. It is intended to encourage operators of small renewable energy generating facilities of no more than 10,000 kW to contribute to Ontario's electricity supply.

Operators enter into a contract with the Ontario Power Authority, after which they receive $0.11/kWh for electricity delivered for a 20-year payment period.

Call for Green Power

Ontario – In 2004, the Ontario Power Authority issued a request for proposal for 300 MW of renewable power from projects exceeding 10 MW. Contracts were awarded to successful bidders at negotiated long-term prices based on a reverse auction system. Bids were accepted in order of offer price, up to and including the last megawatt of the call.

Renewable Energy Certificates (RECs)

RECs, also known as green tags or tradeable energy certificates, are a tradeable commodity that can be purchased or sold for each unit of electricity that is generated from a renewable energy source. Funds generated by the sale of RECs can go towards new and existing renewable energy projects.

New England has one of the most robust and complex Renewable Energy Certificate (REC) markets in the country, driven in large part by Renewable Portfolio Standards (RPS) in Massachusetts and Connecticut in existence for over five years. Maine, New Hampshire, and Rhode Island all have recently adopted robust RPS standards; the impact of these newer programs is not yet known.

In order to qualify for participation in these markets, a biomass facility in Maine must be able to provide or import power into the ISO-New England grid, meet certain strict emissions limits (MA and CT), and use specified "advanced" electricity generation technologies. Investments necessary to meet these standards have been made at a number of Maine biomass power plants, and several Maine biomass plants currently sell RECs to utilities in Connecticut and Massachusetts that are mandated to purchase an increasing amount of their electricity from qualified renewable sources. RECs can trade on an open market or through bilateral contracts, and have price caps of $55 per REC (MWH equivalent) in Connecticut and $50 in Massachusetts (in 2003 dollars, a current price cap of $58.58). REC prices can change quickly based on perceived supply and demand, and have been as high as the price cap and as low as $2 in the past several years; current pricing is roughly $35.

Texas – Tradeable RECs are used in Texas by state-wide electricity retailers to purchase the lowest cost renewable resources from renewable energy generators. At the end of 2007, there were 56 REC generation accounts with an installed capacity of 4,600 MW, of which 19.7 MW were some type of biomass.

The objectives of the REC program in Texas are to ensure the means exist for the state to achieve a target of 10,000 MW of installed renewable capacity by January 1, 2025; provide for a renewable energy credits trading program by which the renewable energy requirements may be achieved in the most efficient and economical manner; encourage the development, construction, and operation of new renewable energy resources; protect and enhance the quality of the environment in Texas through increased use of renewable resources; and ensure that all utility customers have access to energy generated by renewable energy resources.[10]

RECs represent one MWh of metered electricity generated at a certified renewable energy facility. In 2007, 10.1 million MWh of energy was generated by renewable energy sources, a 43% increase compared to 2006. Electricity retailers are responsible for satisfying the renewable energy goals by buying and retiring RECs based on their pro rata share of state-wide retail energy sales. Other features of the policy include the long-term commitment to the program, penalties for non-compliance, and provisions for banking credits.

Voluntary initiatives that complement the RECs include fuel mix labelling, which allows tradable RECs to be used in emissions trading to validate emission reductions. RECs can also be used towards RPS goals and authentication for green pricing.

Sweden – Sweden uses a quota obligation to create demand for electricity certificates. Since the electricity certificate system was launched in May 2003, approximately 400 new installations have been built with expected production of renewable electricity of around 2.1 terawatt hours (TWh) per year. A quota obligation is an annual obligation on the part of electricity suppliers to hold electricity certificates corresponding to their sale and use of electricity during the previous calendar year. For every megawatt hour of renewable electricity produced, electricity producers receive a certificate which can then be sold. By selling these certificates, the producer receives extra income in addition to the sale of electricity thereby increasing opportunities for new or expanded renewable electricity production. The program has been renewed until 2030 and will rotate older and new renewable energy producers using a phased-in approach.

Policy Levers to Encourage Biofuels Production

The use of biofuels as a substitute for carbon sources is a prime driver behind research and development activity in renewable energy. Research and development into second-generation biofuel production indicates that benefits of adopting the technology will enable the use of cellulosic biomass from wood fibre sources and reduce GHG emissions. As the types of biofuel feedstocks diversify and become available, increases in the number of policy initiatives are occurring. In the same manner as renewable portfolio standards, biofuel standards are also being implemented by many jurisdictions.

The most commonly used policy levers to promote the development and use of biofuels are excise tax exemptions, production credits, distributor or wholesale credits, retail outlet incentives, infrastructure payments, vehicle rebates and incentives, fuel rebates, and mandatory or voluntary blending targets.[11]

United States – In addition to the federal biofuels tax credit, biofuels production tax incentives are also available at the state level and are based on value per gallon with restricting criteria being a dollar value cap or number of years production allowable. For example, New York state offers a biodiesel production tax credit of $0.15 per gallon of biodiesel up to a maximum of $2.5 million. Additionally, Montana offers a biodiesel production tax credit of $0.10 per gallon for increases of biodiesel production over the first three years of production.

Mandates for blending ethanol with gasoline and biodiesel with diesel are becoming common with some US states. Blending mandates for biodiesel typically start with 2% biodiesel fuel by volume with escalation of mandated percentages over time.

Germany – The Biofuels Quota Act 2007 requires fuel suppliers to sell a minimum quota of biofuels and offers tax privileges through 2012 for blended biofuels sold above the quota, and tax privileges (through 2015) for E-85 and second-generation biofuels used for transport.

Creating Greater Certainty for Investment

In this study, new technologies have been identified that would either create value-added products from biomass or improve the efficiency of existing mills. Investment in these technologies could help ensure that the current forest industry would continue to operate and generate economic activity. The alternative could be industry collapse because of mill closures, with subsequent effects experienced throughout the supply chain. The creation of a policy environment that provides for a long-term commitment to renewable energy policy with access to flexible financing tools will provide greater certainty and reduce investment risk.

The ability to access project financing will determine whether the technologies are actually implemented. While we can assume that mill owners will have their own sources of credit, additional capital will be needed, especially in today's tight credit environment. New capital will likely come from external investors who will want to reduce their risk through the certainty provided by the government's commitment to renewable energy.

At the US federal level, the Renewable Electricity Production Tax Credit for biofuels was recently renewed for an additional two years. The tax credit is an important policy lever that provides incentives for financing to ensure project profitability. Unfortunately, this policy lever is short-term and requires continual renewals, thereby creating uncertainty and increasing investor risk.

Because the proposed technologies are new and are in the process of commercialization, it will be important for investors to be assured that the respective governments support the technologies. The risk associated with the projects can be somewhat mitigated by government participation in capital financing. While various support programs already exist within the Region, they may need to be supplemented. A review of financing tools used across the selected jurisdictions indicated the availability of low-interest loans and grants as described below.

Germany – Large subsidized loans are available through the Reconstruction Loan Corporation as part of the Environment and Energy Efficiency Programme. Low-interest loans are provided to private companies and public private partnerships for terms extending from 10 to 20 years. Interest rates are typically below market rate, with up to 50% of project financing available. Between the time of program inception in 1990 up to 2005, approximately €10.7 billion has been extended.

The General Fund for Renewable Energy Sources (RES) provides direct subsidies for the installation of biomass plants for heat production smaller than 100 kW at €52 per kW up to a maximum of €2,046 per installation. The program also provides loans with low-interest rates for the installation of biomass plants for heat production greater than 100 kW and installation of biomass plants for combined heat and power production. The German government allocated over €265 million between 1994 and 2003 for this program.

Wisconsin – A US$150 million grant and loan program has been announced by Governor Doyle for purposes of ensuring Wisconsin becomes a leader in renewable energy. It is anticipated this investment will leverage approximately $1 billion in private investment and create new jobs.

Policy Levers – Energy Efficiency Programs at the Community Level

Policies to promote energy efficiency were observed in almost every jurisdiction reviewed and often are highlighted as a key priority for energy strategies. Energy efficiency policies are used to encourage industry, communities, and residents to adopt new ways of thinking about and using energy. Education campaigns that are part of energy efficiency programs are often instrumental as a method of introducing information about renewable energy sources to the public. Energy efficiency can begin with government purchasing programs, requirements for public buildings, and government vehicle fleets. Energy efficiency strategies are then more easily extended to other industrial, commercial, and residential uses. Typical energy efficiency policies observed during our review included some of the following:

› Programs to educate and engage communities and residents to identify energy efficiency opportunities

› Building-code, vehicle, and equipment standards review

› Programs for training and certification in retrofit and new building contracts

› Development and delivery of comprehensive efficiency programs

Güssing, Austria – Considered to be a best practice example, Güssing, Austria began its transformation to a 90% renewable energy community by implementing energy efficiency policy for all government buildings. Güssing is located within a district of approximately 27,000 inhabitants. Over a 15-year period, the community has been able to achieve reduction in carbon emissions of 90%. In the early 1990s, the town ordered all public buildings to stop using fossil fuels. In 1998, the community installed a combined heat and power plant that supplied the whole city with green electricity and heat from biomass. A new renewable energy industry has been created, with 50 companies employing more than 1,000 people producing heat, power, and fuels from biomass.

Case 1 – GERMANY: Summary of RES markets and policy[12, 13]

Background

The goals of the German energy policy are to ensure energy security, competitiveness and environmental sustainability, including climate stability.

Germany has enacted the following regulatory framework in connection with the use of renewable resources and climate change:

- Energy Tax Act
- Biofuels Quota Act
- Renewable Energy Act (EEG)
- Market Incentive Programme for Renewable Energies

This has created a stable policy framework that has stimulated continuous growth of RES (Renewable Energy Source) in the electricity (RES-E), heat (RES-H) and biofuel sectors. The main policy driver attributed for the strong development of RES has been the German Renewable Energy Act. Specific policy tools used to develop each area include the feed-in tariff system to encourage electricity generation from renewable sources, the market incentive programme which encourages renewable heat production and the biofuels tax exemption to support the development of the biofuel sector.

A revision of the feed-in tariff system took effect in August 2004 lowering the tariffs for wind on-shore, increasing tariffs for biomass electricity and geothermal electricity, and introducing a feed-in tariff for the refurbishment of large hydro facilities.

RES Targets

Germany has a binding RES EU Directive target of 18% of renewables in final energy demand by 2020.

Germany's national RES-E target by 2010 is 12.5% of gross electricity consumption and 20% by 2020. In June 2008, the German government passed a package of measures of which the central element is to double electricity generated by combined heat and power technology (CHP) to 25%.

No targets have been set for RES-H although proposals for a Directive from the EU are under review.

National indicative targets for biofuels amount to 2% in 2005 and 5.75% in 2010.

Status of the Renewable Energy Market

The renewable energy market in Germany is mature showing large growth rates even at high penetration rates. Particularly, in terms of wind energy utilization, Germany contributes about 50% of Europe's wind capacity with 27.2 TWh generated in 2005. Improvements to the policy framework for the use of bioenergy have lead to the acceleration of the development of solid biomass and biogas in particular in the electricity sector. Biomass electricity including biogas and the biodegradable fraction of municipal waste is the third most important RES-E source with about 12.4 TWh of electricity generated in 2005. Solid biomass experienced an average annual growth of 32% increasing from 505 GWh in 1997 to 4,647 GWh in 2005.

Germany's photovoltaic applications experienced an average annual growth of 72% over the 1997 to 2005 time period generating 1.28TWh. Furthermore the increased feed-in tariffs for geothermal electricity lead to significant activities in terms of project development.

Main Supporting Policies

RES-E

The main promotion schemes for RES-E in Germany are the following:

Renewable Energy Act (EEG) 2004

The feed-in tariff system is financed by electricity consumers. The respective grid system operator pays a fee for the electricity fed into the grid. The costs are then apportioned to all grid system operators across the country and passed on by them to electricity customers.

To take account of advances in technology and resulting improvements in economic efficiencies, the tariffs for most renewables are digressive in structure resulting in lower annual payment rates.

The revised EEG provides for additional fees (bonuses), if the electricity is exclusively produced from self-regenerating raw materials, combined heat-power, or if the biomass was converted using innovative technologies (e.g., thermal chemical gasification, fuel cells, gas turbines, organic Rankine systems, Kalena cycle plants or Stirling engines). The bonuses can be used cumulatively. Specific incentive include the following.

Biomass and Biogas

Basic tariff level (up to 20 MW): 80.3 – 109.9 €/MWh. The tariff is reduced annually by 1.5% with the duration of payment available up to 20 years.

Reduced tariff for waste wood: 37.2 €/MWh

Reduced tariff for landfill gas, sewage gas: 63.5 – 73.3 €/MWh

Additional payments are available for:

- The use of untreated biomass: 40 – 60 €/MWh
- CHP-applications: 20 €/MWh
- Innovative technologies: 20 €/MWh
- Use of wood combustion: 25 €/MwH

Hydro (up to 5 MW): 66.5 – 96.7 €/MWh. The duration of payment is up to 30 years. Lower feed-in tariffs are also offered for modernized large hydro plants with up to 150 MW capacity fulfilling certain requirements.

Geothermal: 71.6-150 €/MWh. The tariff is reduced annually by 1% from 2010 onwards with the duration of payment available up to 20 years.

Wind (Onshore): 81.9 €/MWh initial tariff for at least five years after installation. The reduction in tariffs will depend on the system yield and could reduce to 51.7 €/MWh. The annual tariff reduction by 2% begins in 2008 with payment duration up to 20 years.

Wind (Offshore): 91.0 €/MWh initial tariff for at least twelve years after installation. The reduction in tariffs will depend on the system yield and could reduce to 61.9 €/MWh. The annual tariff reduction by 2% begins in 2008 with payment duration up to 20 years.

Photovoltaic: 379.6 – 542.1 €/MWh with an annual tariff reduction of 5% except for open space installations which is 6.5%. The duration of payments extends over 20 years.

RES-H

Under the Market Incentive Program, investment incentives are offered for RES-H, which are particularly effective for solar thermal and small scale biomass heat generation. Funding for the program comes from the additional eco tax revenue paid by renewable energy power plants. In 2005, approximately €659 million was directed into the programme.

The program primarily serves the expansion of heat generation from biomass, solar power and geothermal energy. In the residential sector, the program is focused on promoting solar thermal collector systems and biomass heaters (pellet systems and wood gasification boilers). Plants which use solid biomass and geothermal energy are supported, in part with district heating systems

Grants are restricted to solar thermal applications and to heating systems that use solid biomass. If innovative technologies are used, an additional bonus is provided.

Low-interest loans (1% to 2% below market rates) are provided for geothermal heating stations, geothermal power stations, large biomass systems and large solar thermal applications. The level of support ranges between 10% and 40% of the investment with credit terms between 10 and 20 years. Administration of the loan program and debt release is the responsibility of the Reconstruction Loan Corporation (Kreditanstalt für Wiederaufbau, KfW).

Biofuels

The Biofuels Quota Act imposes requirements on fuel suppliers to sell a minimum quota of biofuels and offers tax privileges (through 2012) for blended biofuels sold above the quota and tax privileges (through 2015) for E-85 and second generation biofuels used for transport.

The quota can be met either by mixture or pure fuels. Oil refineries will be required to mix 5.25% biofuels in fossil fuels by energy content starting in 2009. From 2010 the biofuel blending level will increase to 6.25% and remain fixed at that level until 2014.

Research & Development

The Fifth Energy Research Program sets the framework for public R&D support in energy technologies at large. Included in the program is support for the development of renewable energies. Funding support is provided through project-based funding, institutional support related to renewables and the promotion of networks for basic research in renewable energy and energy conservation.

Budget allocations for this program:

- 2005 – €129.76 million
- 2006 – €131.77 million
- 2007 – €137.08 million
- 2008 – €143.74 million

Key Factors

Continuity and stability of the policy framework as well as current high feed-in tariffs for renewable energy applications combined with reasonable investment incentives and loans have generated a considerable RES market.

Case 2 – WISCONSIN – Clean Energy Wisconsin[15]

Summary of Strategy

Announced in spring 2008, the state of Wisconsin is pursuing a comprehensive strategy to plan for energy independence. The objective is to promote an affordable, renewable, and diverse energy supply, target investments in job creation and new business opportunities, promote energy efficiency, and use renewable fuels to reduce environment impacts. Goals for the strategy include:

- Generate 25% of state electricity and 25% of transportation fuel from renewable fuels by 2025
- Capture 10% of the market share for the production of renewable energy and bioproducts
- Become the national leader in renewable energy research

To achieve energy independence, the state is planning to invest in four strategic areas: business and job development, the development of affordable renewable technologies, a reduction in overall energy consumption through improved energy efficiency and the engagement of communities in order to reach the 25% goal by 2025.

Renewable Energy Sources from Forests and Timberland

With 16 million acres of forests and timberland, Wisconsin considers this natural resource to be a competitive advantage in the development of new renewable energy technologies. As part of the strategy, the intent is to use sustainable forestry principles to maximize the use of forest residues while opening new markets for northern communities and businesses.

Policy Tools

Policy tools and investment being implemented to develop supply and demand of renewable energy:

- Wisconsin Energy Independence Fund is a ten-year, $150-million grant and loan program intended to support the development of new technologies in renewable energy. The investment is expected to leverage $1 billion and create new jobs.
- Emerging Industry Skills Partnership is a $850,000 grant program to encourage industry, technical colleges, and workforce development boards to develop training programs for jobs in renewable energy industries.

- The Biodiesel Production Tax Credit is a state tax credit equal to 10 cents per gallon for biodiesel fuel producers that produce at least 2.5 million gallons of biodiesel per year. Effective in 2009.
- The Ethanol and Biodiesel Fuel Pump Tax Credit is being offered to service stations that install or retrofit pumps that dispense fuel containing at least 85% ethanol or 20% biodiesel.
- Biomass market development is a program that will partner the state government with farmers and loggers to develop farm and forest crops that can be developed into substitutes for coal electricity generation and transportation fuel oil. To support sustainable forests, new forest guidelines for harvesting wood biomass for fuel generation will be implemented.
- A biomass commodity exchange would match renewable energy demand with biomass supply. The viability of setting up an exchange is being investigated by a consortium of utilities, private businesses, Focus on Energy, and the Office of Energy Independence.
- The Great Lakes Bioenergy Center at the University of Wisconsin-Madison received a $125-million research grant from the US Department of Energy to create the Great Lakes Bioenergy Research Center to research advanced biofuels.
- Focus on Energy is the state's energy efficiency and renewable energy program. Wisconsin utilities are required to contribute 1.2% of their annual operating revenue for efficiency and renewable energy programs. The initiative is expected to generate $75 million of revenue in 2009 for investment in energy efficiency and renewable energy projects for business, industry, and consumers.
- Wisconsin Energy Independent Community (WEIC) Partnerships is a voluntary program between the Office of Energy Independence and individual communities. Communities are encouraged to meet the "25 by 25" goal, thereby reducing fossil fuel consumption, improving building efficiencies, and undergoing energy audits. Grants are available in 2009 for five to seven communities to inventory their energy use and develop plans to meet the "25 by 25" goal.
- The Renewable Portfolio Standard is based on 10% of all electricity sales coming from certified renewable resources by 2015. Interim standards require a goal of 6% of electricity sales coming from renewable resources by 2010.

6 Recommendations

The task force has provided an invaluable opportunity for open dialogue between key forestry, energy, and government stakeholders within the region; however, not all of the recommendations below apply to each jurisdiction and not all recommendations are endorsed by all members of the task force.

The guiding principles for these recommendations include the following:

- All policies to be developed must ensure that biomass flows to the highest value uses and highest energy conversion efficiency processes, and that those processes result in the greatest GHG offsetting capability per unit of biomass.
- Supporting policies should ensure that program guidelines indicate a long-term commitment (15 – 20 years), which will decrease risk and increase investor certainty.
- The use of biomass to add value and maintain the competitiveness of existing forest sector industries should be given priority.

The recommendations in this section provide direction for the Atlantica Region to become a bio-sensitive economy. The recommendations take into account the need for the existing forest industry to be operating and contributing economically to the Region. Therefore, the underlying premise of the recommendations is for the bio-economy to build upon and expand the existing forest industry base.

Sustainable Forest Management

1. **Implement sustainable forest management strategies to improve forest growth and support landowners and contractors in developing efficient approaches to biomass harvesting.**
   - Silviculture policies should encourage implementation of forest management programs that will support existing manufacturing and maximize biomass removals at sustainable levels. For example, the April 2008 report "Management Alternatives for New Brunswick's Public Forest" (New Brunswick Task Force on Forest Diversity and Wood Supply) presented a variety of silviculture management alternatives that should be considered. In addition to forest health benefits, forest management programs will generate increased biomass from thinnings, which will require investment in specialized equipment and training to maximize efficiency and minimize costs when harvesting smaller material.

2. **Complete the development of biomass removal guidelines as soon as possible and update biomass inventories on a regular basis.**

   › In order to attract new capital investment, good inventory data based on standardized measurements will be required. Challenges include obtaining data for public and private lands, understanding the impact of firewood consumption on biomass availability, and completing biomass removal guidelines that will provide a better understanding of the level of biomass that can be sustainably harvested. Biomass allocation policies such as those recently announced in New Brunswick could also be developed for public lands in Maine and Nova Scotia.

Transportation Infrastructure

3. **Improve the transportation infrastructure throughout the Atlantica Region to facilitate the movement of goods by all modes of transport.**

   › There are multiple reports and working groups currently assessing the strengths and weaknesses of intermodal transportation in the region. For example, the "Maine Future Forest Economy Project (2005)" recommended increasing the weight limit on all Maine interstates to 100,000 pounds and improving the integration of the rail systems. In addition, the Transportation Committee of Nova Scotia's Forest Products Association reports that their network of secondary roads has weight restrictions on various roads and bridges, and limitations on truck configurations that inhibit the efficient movement of fibre.

Transmission and Distribution Systems

4. **Evaluate the need to upgrade the electrical transmission and distribution lines across the Region to ensure capacity is available for new generation demand.**

   › Existing transmission and distribution systems within the Atlantica Region are able to handle existing electrical generation. However, future increases in demand for energy and subsequent opportunities to export renewable generation could strain the capacity of the grid. An evaluation of the Region's transmission and distribution system would identify the system upgrades needed, amount of investment required, and recommended timing of implementation.

Technology

5. **Consider the following four emerging technologies for potential implementation by industry:**

   › Integrated biomass biorefinery using Fischer-Tropsch technology, which could benefit assets across the Atlantica Region.

   › Value prior to pulping (VPP) for hardwood kraft mills, which could favour Maine.

   › Oxalic acid chip pre-treatment or other pre-treatment option (VPP for TMP mills), which could benefit New Brunswick and Nova Scotia

   › Torrefaction, which could provide a foundation for transitioning the Region's forest industry into a world class sustainable thermochemical-based biofuels (biocoal) producer. Implementation of torrefaction technology would provide the Region with opportunities for optimizing the thermal efficiency of the supply chain, as it offers co-location opportunities with sawmills or CHP plants, as well as the flexibility for standalone capacity.

The policy recommendations to support the implementation of these technologies are embodied in these recommendations.

Greenhouse Gas Strategy

6. **Encourage New Brunswick Power and Nova Scotia Power to include biomass solutions as part of their overall federal carbon regulation strategies.**

   › Under the proposed federal Regulatory Framework for Greenhouse Gas Reductions, each of NB Power and NS Power's large fossil fuel-based electricity generating facilities will be required to reduce emissions intensity (tonnes of CO_2e/MWh generated). Switching a proportion of coal for biocoal at coal-based generation facilities could be a low-cost compliance option. Given the minimal need for technology upgrades for fuel-mixing, if biocoal was priced at the same rate as coal based on energy content, the GHG reductions could in theory be achieved at no incremental cost (with economic development benefits as well).

   › Having a long-term contract with a major consumer like NB Power or NS Power would significantly enhance commercial viability for a proposed torrefaction operation.

7. **Create a demand for biomass fuels (in New Brunswick and Nova Scotia) for use in co-generation.**

   › Co-generation of heat and power using biocoal can achieve the highest thermal efficiency for biomass. Targeted utility calls for co-generated biomass electricity, where the heat is used for industrial or residential heating and the electricity is sold to the utility for general transmission, could incent efficient use of biocoal and create sufficient demand for commercial production. Such an approach would need to be sequenced with the start-up of biocoal production capacity and be formulated in collaboration with potential generators and biocoal producers.

8. **Apply energy efficiency and green electricity GHG offset measurement protocols to the Region to be used in voluntary or regulated carbon markets, such as the Canadian federal regulatory system and the Regional Greenhouse Gas Initiative (RGGI).**

   › Many existing GHG voluntary and regulatory markets contain offset rules that allow greenhouse gas reductions from non-regulated activities to be used for compliance.

   › In anticipation of Canadian federal regulatory requirements, New Brunswick and Nova Scotia biomass-based electricity generators could begin to implement the use of offset credits.

   › In Maine, the current RGGI system provides offset credits for commercial building energy efficiency improvements, but not at industry sites. Pulp and paper producers should work with RGGI regulators to include mill emission reductions measurement protocols as part of the offset system.

Market Development

9. **Enhance the existing energy policy framework to be more comprehensive in scope and develop policy to stimulate bioenergy, biochemicals, biofuels, and bioproducts produced from wood fibre.**

   › At present, policies to support the development of a biofuels market are either fragmented or have yet to be implemented. Development of the policy framework should assess the impacts on the forest industry. Policies could include:

   › Develop a renewable fuels standard (RFS) to encourage jurisdictional production of second-generation or advanced biofuels. The RFS could require a percentage of fuel consumed within the jurisdiction to come from renewable fuel. For example, blending a certain percentage of bioethanol with gasoline and/or blending a certain percentage of biodiesel with diesel could be regulated.

   › Develop a biofuels transportation market by considering incentives to encourage infrastructure investment such as the conversion of service station pumps.

Financial Support

10. **Ensure the eligibility of financial tools to encourage the early adoption of recommended technologies that could improve mill competitiveness and reduce GHG emissions.**
11. **Provide fuel tax exemptions and/or production tax credits, particularly for local wood-based feedstocks for renewable fuels, ethanol, and biodiesel.**
12. **Ensure that State and provincial incentive programs include eligibility criteria for biofuels, biofuel products, and biochemicals, and ensure existing incentive programs contain eligibility guidelines that include the proposed outputs from the technology case studies such as Fischer-Tropsch liquids, ethanol, and torrified fuel.**

Regional Collaboration to Develop a Bioenergy Industry

13. **Develop and fund a bioenergy network for the Region, similar to the model established in British Columbia.**
    - › One of the functions of the bioenergy network would be to introduce a second-generation biofuels public awareness, research, education, and training program throughout the Atlantica Region based on shared goals that would include the increased production and use of locally produced biofuels. Incentives should be designed so they do not provide advantages to any one sector at the expense of another.
14. **Create collaborative programs across the research universities throughout the Atlantica Region.**
    - › The collaborative network should provide opportunities that will link industry with academia such that there are opportunities to explore technical solutions for the use of wood-based biomass for bioenergy, bioproducts, and biochemicals. Examples of research programs include:
    - › Increase the focus of current academic and collaborative research programs with industry on thermochemical platforms, in particular pyrolysis for the gasification of torrefied biomass.
    - › Establish a Gasification Bioenergy and Product Park that would be funded by a consortium of partnering organizations and individuals from across the Region. Partners could include utility companies, equipment suppliers, chemical companies, forest researchers, academics, federal, state, and provincial agencies, and industry.
15. **Fund a program in partnership with post-secondary research institutes, industry, and government agencies in the Atlantica Region to promote and build pilot plants for the development of technological solutions within the Region.**
    - › Building pilot plants is a signal to the investment community and other industry partners of the commitment held within the Region towards developing bioenergy, bioproducts, and biochemicals. Importantly, a pilot plant provides the opportunity to test the technology before major investments are made. Because the recommended technologies are emerging in nature and not fully commercialized, pilot plants are one method to mitigate risk.

Attachment A: Stakeholders and Advisors

Atlantica BioEnergy Task Force Stakeholders and Advisors

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6 Note: Values are reported in US dollars in relation to Reference Mill A.

7 Note: Values are reported in Canadian dollars in relation to Reference Mill B.

8 Value range due to differences in provincial economic multipliers.

9 A review of the current state of bioenergy development in G8 +5 countries, p. 241

10 Renewable Energy Program, ERCOT, https://www.texasrenewables.com/recprogram.asp.

11 Coleman, Brooke R., et al, A Northeast Regional Biofuels Action Plan, prepared for The Henry P. Kendall Foundation, Boston, 2008.

12 Renewable Energy Country Profiles, European Commission, DG Energy and Transport http://ec.europa.eu/energy/res/publications/doc/2008_03_progress_country_profiles_en.pdf.

13 International Energy Agency, Global Renewable Energy Policies and Measures, Renewable Database

14 Guidance for what qualifies for classes 43.1, 43.2 and CRCE can be found in the *Class 43.1 Technical Guide and Technical Guide to Canadian Renewable and Conservation Expenses.*

15 Clean Energy Wisconsin, a Plan for Energy Independence, Spring 2008.