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FORESTRY497

ALTERNATIVE ENERGY POSSIBILITIES AND THE FOREST LANDSCAPE IN BC

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Abstract

In response to global pressures to reduce green house gas emissions and promote clean energy technologies the government of British Columbia has devised an energy plan to meet these demands. The plan is comprised of 55 policy actions to help steer BC Hydro and the forest and oil and gas industries. To accompany them a bioenergy strategy was also developed to identify specific ways in which the forest industry may utilize the vast devastation caused by the mountain pine beetle in the interior of BC. Additional to biomass energy, BC is well poised to take advantage of both wind and hydro energy. Although there are economic short falls to these alternative energy technologies the push towards clean, non destructive energy will make the transition necessary. Due to BC's vast landscape and the complicated diversity of ecosystems forest professionals will be integral to safely and properly utilizing the landscape and implement these energy strategies.

Key Words: Bioenergy, Bioenergy Strategy, Biomass Power, Energy Policy, Hydro Power, Wind Power.

Contents

List of Figures

INTRODUCTION

As of 2004 British Columbia (BC) relied on fossil fuels for 64% of its total energy consumption which included everything from electricity to automobiles (Evans 2008). While this is much lower than most developed nations, the current trends toward sustainability and carbon neutral energy have spurred a number of improvement initiatives. In 2007 the BC provincial government released "The BC Energy Plan: A Vision for Clean Leadership" and the "BC Bioenergy Strategy", marking an effort to increase provincial usage of biofuels to 50% by 2020. One goal of these plans is to make BC completely electrically self sufficient by 2016. At the same time the Federal government has directed funds to environmental technology as part of the economic bail-out package to mitigate the negative effects if the recent economic recession.

There are many forms of renewable alternative energy available to BC. Three of the most prominent types are biomass energy, wind energy and water or hydro energy. BC is naturally well positioned to take advantage of all of these due to its massive landscape and abundance of timber and waterways.

Biomass energy is the energy stored in plants through photosynthesis (BC Hydro 2009_a). In Williams Lake wood waste from local saw mills provides fuel for North America's largest biomass power plant (Epcore 2008). Revelstoke uses a similar facility to provide heat to several municipal buildings. With the recent mountain pine beetle epidemic which has killed roughly 80% of the Lodgepole Pine (*Pinus contorta* var. latifolia) in BC's interior and critically low lumber markets this may be one of the best options for an estimated 68 million cubic meters of dead Pine (Kumar et. al. 2005).

Wind energy is a relatively new concept to BC but in 2006 BC Hydro made an open request for proposals aptly named a "Call for Power" and subsequently entered into electricity purchase agreements (EPA's) for 3 wind farms in the province (Evans 2008). They also commissioned a report to assist private firms in developing wind energy facilities in BC. Due to its extensive coastline and unique geographical diversity, wind energy remains an untapped resource for the province.

In contrast with other energy types, hydro electric plants can be found abundantly throughout the province. BC Hydro operates 30 hydroelectric facilities which provide nearly 80% of the provinces' electricity (BC Hydro 2009_b). With the expansion of small scale hydroelectric power projects or "run-of-river" plants, hydro energy will certainly become even more popular in BC.

THE BC ENERGY PLAN

The BC Energy Plan includes "55 policy actions focused on the province's key natural strengths and competitive advantages of clean and renewable sources of energy" (MoEMP 2007_b). The actions are divided into 5 categories: energy conservation and efficiency, electricity, alternative energy, skills, training and labor, and oil and gas as summarized in *Table 1*.

Table 1: BC Energy Plan Hierarchy

Category	Groups	Actions
Energy Conservation and Efficiency		
	Conservation Targets	1, 2
	Utility Efficiency	3, 4
	Green Building Initiates	5 to 9
Electricity		
	Promotion of Clean Energy	10, 11
	Maintaining Infrastructure	12 to 17
	New Clean Energy Facilities	18 to 23
	Inter-organization Coordinating and Social Values	24 to 28
Alternative Energy		
	Promotion of Bioenergy	29 to 33
	Promotion of Hydrogen Energy	34 to 35
Skills, Training and Labour		
	No Specific Policy Actions	
Oil and Gas		
	Increasing Environmental Stringencies	36 to 39
	Offshore Drilling	40 to 42
	Enhancing Socioeconomic Benefits	43 to 47
	Increase Exploration and Development	48 to 52

The first category aims to slow the growth of electricity demand by 10 000 gigawatt hours (GWh) from the currently forecast usage for the year 2020 (MoEMP 2007_a). To reach this goal there will be great pressure on BC Hydro to not only reach but exceed current energy conservation targets. There will be additional help from all levels of planning in the province. Energy utilities, private companies, industry associations, and all levels of government including first nations are developing initiatives to become energy efficient (MoEMP 2007_a). A critical issue when considering energy efficiency is demand side management (DSM). DSM is the investment and promotion of new technologies to increase energy efficiencies at the end user level. These programs are monitored and regulated by the BC Utilities Commission and the Ministry of Energy, Mines and Petroleum Resources to ensure they are available to all BC Hydro customers.

Further actions under the category of energy conservation and efficiency include exploring the rate structure of utilities and implementing building standards for energy efficiency. These are both actions designed to reduce and shift demand for energy. BC's industrial sector faces special challenges that will be addressed by an "industrial energy efficiency program" ($MoEMP_4$ 2007).

The 18 policy actions regarding electricity may be broadly lumped into 4 groups. The first group is designed to aid BC Hydro in their goal to be energy self sufficient in providing power to all of BC by 2016. This will be accomplished by acquiring power from independent power producers (IPP's) and establishing additional small scale hydro projects. The development of 'Site C', a third major hydroelectric project in the Peace River region of BC (BC Hydro 2009_c) is also being investigated. The next set of policies regarding electricity considers the maintenance and development of infrastructure. With increasing demand and additional sources of supply, transmission efficiency will be a growing concern. The provinces' environmental goals for electrical generation comprise the next group of policies. By 2016 it is hoped that there will be zero net green house gas emissions from all existing natural gas and coal fired electricity generating facilities. Additionally, all new electricity facilities will be required to meet a zero emission standard. While meeting these goals the province is dedicated to a no nuclear power policy. For every action taken BC Utilities Commission will undertake a social and environmental cost benefit analysis (MoEMP 2007_a). The final set of electricity policies are designed to ensure that BC Hydro recognizes the variability of power supplied from smaller producers. They must then manage accordingly while continuing to procure power from them.

Alternative energy is a rapidly expanding field. The policy actions in this category of the BC Energy Plan will support clean energies with particular focus on biofuels such as biodiesel and hydrogen fuel cell technology. This will be done by establishing a clean energy fund and calling for proposals to develop biofuel power generating facilities. BC's forest resources will be the focus of this strategy, particularly mountain pine beetle killed wood and saw mill waste material. The remainder of the policies in this category focus on reducing automobile emissions. To do this, promotion of biodiesel and development of a regulatory framework and investment strategies for hydrogen fuel cell technology will be key (MoEMP 2007_a).

The remaining two policy categories of skills, training and labor, and oil and gas have little to do with the development of alternative energies or the forest landscape of BC. In regards to the former the issue is raised that many industries are facing, worker shortage. Similar to forestry and mining, the energy sector is anticipating large scale retirement of its senior staff. "This coupled with the decline in university programs dedicated to power/electricity have caused a vacuum of new graduates with the necessary skills for these highly specialized roles" (MoEMP 2007_a). As a result there are extensive programs and actions being undertaken to direct young people into the energy sector.

As for oil and gas, the BC Energy Plan devotes 19 of the total 55 policies to this industry. The focus of these actions are to increase environmental stringencies for the sector and to promote exploration. The only point which relates to the forest land base is with respect to tenure obligations. The final action of the plan is to "develop guidelines to determine areas that require special consideration prior to tenure approval" (MoEMP 2007_a). But as oil and gas tenures will generally not conflict with alternative energy production the issue is irrelevant here.

The list of policy actions that make up the BC Energy Plan "put British Columbia at the forefront of environmental and economic leadership" (MoEMP

2007$_a$). It sets ambitious goals and outlines reasonable means to accomplish them. Subsequent to the plan, the province released the BC Bioenergy Strategy. This document provides an introduction to bioenergy and an overview of how BC will reach some of the targets set in the plan.

BC Bioenergy Strategy

The BC Bioenergy Strategy was devised out of necessity. Social and economic issues such as green house gas emissions[1] and the mountain pine beetle epidemic required immediate action. Also, goals to become electrically self sufficient and develop a long term sustainable bioenergy industry needed dynamic strategies to succeed. The Bioenergy Strategy outlined the actions currently underway and future projects designed to solve these problems (MoEMP 2008$_a$). To accompany the strategy the province has also produced "An Information Guide on Pursuing Biomass Energy Opportunities and Technologies in British Columbia" (Envint 2008).

Identification of BC's biomass resources was the first step. This included an inventory of agriculture residues, municipal waste, and forest residues with emphasis on mountain pine beetle killed wood (MoEMP 2008$_a$). The next step was to develop bioenergy projects and was where the information guide became necessary. The guide offered step by step directions on developing small scale biomass energy power generating facilities (Envint 2008). The provincial government has established a $25 million fund to support "investment and innovation in BC bioenergy projects and technologies" (MoEMP 2008$_b$). There was also another $10 million set aside to promote biodiesel production. The BC Bioenergy Strategy provides additional information and direction for non-forest projects such as agriculture and municipal waste energy production.

BC Hydro played a large role in the promotion of bioenergy with their "clean power call". In 2008 they issued a request for proposals (RFP) to develop "clean" energy projects (BC Hydro 2009$_d$) as a second phase to their "call for power", initially released in 2006 (BC Hydro 2005). This second phase "focused on existing biomass inventory in the forest industry and offered opportunities for smaller energy producers with projects that are immediately viable" (BC Hydro 2009$_d$).

The third step of the BC Bioenergy Strategy was to "strengthen BC's bioenergy network" (MoEMP 2008$_a$). Here they set the goal of "establishing 10 or more community energy projects that convert local biomass into energy" (MoEMP 2008$_b$). This phase of the plan seemed redundant as the network will naturally be strengthened by the efforts in the second step.

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[1] High levels of green house gas emissions such as carbon dioxide and methane in the atmosphere have been found to lead to global warming and climate change. As a result there is global pressure to reduce these emissions.

The fourth step called to "build bioenergy partnerships" (MoEMP 2008_a). Intergovernmental relationships along with the export of energy and technology were the main focus. This was an excellent opportunity for BC by building on the existing relationship with the United States for power sales to help maximize bioenergy market opportunities. As members of the Global Bioenergy Partnership, Canada and BC was not only able to access the most advanced bioenergy technologies but act as a global leader of environmental sustainability (GBEP). A combination of global, federal and provincial funding and support ensured BC's place as a global leader in bioenergy.

Biomass Energy

There are many varieties of biomass energy production. The term broadly refers to the use of organic matter in the creation of heat and electricity. Organic matter or biomass is any material initially created by photosynthesis. Forestry and agriculture waste, along with municipal solid waste (garbage), biosolids (sewage) and animal waste (manure) are all forms of biomass that can be used to produce energy. If these materials are left to decompose they release carbon dioxide and other gases into the atmosphere. Because of continuous replacement it is considered carbon neutral when energy is obtained sustainably by accelerating this process (Sriram and Shahidehpour 2005).

The simplest method of producing energy from biomass is through direct combustion. This is also the form which pertains most directly to forestry in BC. However, energy can also be harnessed through gasification, pyrolysis, digestion and fermentation of biomass. Gasification is the process by which a variety of combustible gases are extracted from biomass in a high temperature, low oxygen environment. A variety of biomass forms may be utilized including wood chips and other saw mill wastes (Sriram and Shahidehpour 2005). The gases produced can be used in the same fashion as natural gas or manipulated to produce gases that may be used in place of fossil fuels. Pyrolysis is a similar process to gasification. By heating the biomass to either dispose of or extract volatile gases, charcoal is produced. The charcoal or biocrude, contains the same amount of energy as the original biomass with roughly 50% of the weight. It can also be manipulated to create pyrolysis oil for use in petroleum style electricity generating facilities (Sriram and Shahidehpour 2005). Biomass digestion and fermentation both utilize bacteria and other microorganisms to chemically treat waste material. From the processes methane, ethanol and other combustible gasses are collected. Every form of biomass from plant waste to decomposing garbage in land fills can be used to produce some form of energy through these processes.

As previously stated, the process of direct combustion has the greatest usage and immediate potential for BC's forest industry. This being where dried biomass is burned to produce steam. The steam is then used to produce heat, electricity, or in the case of combined heat and power (CHP) facilities, both. Companies and municipalities in BC have already begun taking advantage of biomass energy. In Williams Lake Epcore Power L.P. operates North America's largest biomass power plants. The facility produces 66 megawatt (MW) of electricity and has been operating since 1993 (IPPBC 2008). In the first 15 years of its operation the plant made use of over 600,000 tons of sawmill waste material annually such as saw dust and wood chips, that would otherwise have been disposed of in a wood waste burner. Additional benefit comes from burning mountain pine beetle wood in the plant. The combustion process ensures that methane is not released as it would be if the wood was left to decompose in the forest. Methane has 21 times the detrimental atmospheric effect of carbon dioxide (IPPBC 2008). Furthermore, since the plant opened, sawmills in the area have been able to halt use of their wood waste burners which has resulted in a 90% reduction in particulate emissions.

Figure 1: A biomass power plant that utilizes wood waste

While the Williams Lake facility was an example of how forest biomass can produce electricity, in Revelstoke a similar system has been used to provide heat to a portion of the community. Through the Revelstoke Community Energy Corporation (RCEC) the City opened a 1.5 MW 'heat only' energy facility (RCEC 2005). The RCEC initially investigated the option of a CHP facility but found it to be uneconomical. The plant received wood waste generated primarily by Downie Street Sawmills. The energy produced by this plant was used in drying kilns and heating selected community buildings. 1.6km of piping distributed the energy to the city's arena, secondary school, community center and aquatic center.

Although this biomass energy facility was much smaller than the one in Williams Lake it was the first wood residue fueled community energy system (CES) in BC. Due to economic reasons the facility was only able to use roughly 10% of the available biomass waste material. The total cost of the project was $5.3 million (RCEC 2005). Had energy prices in the province been higher a larger CHP facility may have been economically viable with a cost of $18.5 million.

Despite the facilities limitations, the community still experienced a host of benefits. As the plant was owned by the community, investors saw a 7% non-taxable rate of return. Their reliance on fossil fuels such as propane had decreased and resulted in 4,000 tons fewer green house gas emissions being produced annually (RCEC 2007). With one quarter of the local economy reliant on forestry the development of this energy facility was just one of many initiatives by the RCES to support the industry.

Since the scope of the mountain pine beetle outbreak was identified there have been a number of economic analyses completed to determine the viability of a biomass power plant in the heart of the devastation. Kumar et al. (2005) and Mahmudi et al. (2009) both identified Quesnel, BC as the optimal location. Both studies also identified a 300MW plant as the optimum facility. This size of plant had the advantage of an economy of scale. Smaller plants simply cost more per megawatt hour (MWh) of power produced.

The 2005 study found the total cost per MWh to be $61.88, nearly half of which was simply obtaining the biomass to feed the plant. In 2009 Mahmudi et al. found based on current timber supply projections biomass fuel supply fell short. Only 30% of plants fuel could be supplied from within the Quesnel Timber Supply Area (TSA) for the 20 period required to recover the half billion dollar capital investment. The remaining material would need to have come from surrounding regions, further increasing costs.

In 2008 BC Hydro charged around $50 per MWh (Hamilton 2008). Although this figure varied by region there was still a discrepancy between it and the $61.88 per MWh. By only utilizing waste material and supplying small scale needs in Williams Lake and Revelstoke biomass energy was an economic option. When looking to large scale ventures the lines become grayed. Despite the considerable gap between these values other considerations exist. Carbon credits and federal subsidies for promoting green technologies may be enough to make up the difference. At this stage even National Resources Canada is unsure whether this will be enough (Stennes et al. 2004).

Wood pellets exist as an option for biomass energy in BC. Their focus would primarily be as an export commodity. Canadian wood pellet manufacturers already hold a strong market share in Sweden, Denmark, The Netherlands, Belgium and the United Kingdom (WPAC 2006). With growing demand and an abundance of biomass available this may be the best option. The problems in this industry relate to efficiency as current producers are working with very thin profit margins. The cost of transporting the biomass and the pellets can account for up to three quarters of the total cost (Sokhansanj 2009). The Clean Energy Research Center at UBC along with many others, are working hard to develop a competitive advantage and utilize BC’s great natural resource, timber.

Wind Energy

As a coastal region of the world, BC has an excellent potential for developing wind energy projects, but currently has no utility scale operations. Since the 2006 Call for Power by BC Hydro, three EPA's have been signed for wind farms in BC (BC Hydro 2009_e). The largest of the three was the Dokie Wind Project located 40km West of Chetwynd in the Peace region of BC. Dokie was a $400 million project that would yield 180MW upon completion. It was positioned strategically to "use existing transmission lines from the nearby W.A.C. Bennett Dam" (IPPBC 2006).

The second largest of the three wind farms will be located near Dawson Creek, also in the Peace region. There will be a total of 60 wind turbines producing a combined power of 120MW. After completion the site will have an interpretive center to "highlight regional wind energy, aboriginal heritage and community" (Alta Gas 2008). The area also provides for a number of forest tenures, oil and gas tenures, and cattle which will be available after construction is finished.

The third and smallest wind farm was the Kaien Island project located just South of Prince Rupert on BC's North Coast. The Mount Hayes Wind Farm Limited Partnership had budgeted roughly $50 million for the 27MW project. It consisted of 18 of the smaller 1.5MW turbines (Cooper-MacDonald & Culleton 2007).

Since approval, BC Hydro has received bids for many additional wind farms. One wind turbine being installed in BC of particular interest will be on Grouse Mountain. Overlooking the City of Vancouver, this project has stirred media and public concerns. Larry Pynn painted a gloomy picture of the project in the Vancouver Sun (2008), raising concerns for "denuding scenic landscapes and posing a risk to birds, bats and other wildlife." The project is set to be completed during the summer of 2009. The 1.5MW turbine will provide 25% of the resort's power requirements. With such a prominent audience this project has great potential "to showcase the benefits of alternative green energy" (Grouse Mountain Resort 2008).

Figure 2: Simulated view up "the Cut" on Grouse Mountain

In 2008 Garrad Hassan produced a report at the request of BC Hydro assessing the costs and potential for wind energy in BC. The province was divided into 4 regions that showed high potential: Vancouver Island, North Coast, Peace, and the Southern and Eastern Interior. Each of these regions had sites with investigative use permits (IUP's) held by IPP's. A general project cost analysis was completed region by region. Within the North Coast region the assessment was differentiated for onshore and offshore projects.

Predictably, project costs were found to be the least expensive in the Interior and Peace regions. Vancouver Island was the next least expensive, then onshore North Coast followed by offshore North Coast as the most expensive. Once maintenance and operating cost are included, a weighted average cost of capital of 8% was used to calculate the cost per MWh by region. The end result was a spread of values for varying wind regimes and construction costs. For average conditions, base case figures ranged from $84 to $144 per MWh. Including all values, energy produced from these projects can be expected to range anywhere from $70 to $208 per MWh.

Hydro Energy

There are two forms of hydroelectric power projects in BC. The first is the conventional hydro dam which has a massive impact on the landscape, converting a valley into a lake or reservoir. The second form of hydro projects in the province is the typically smaller run-of-river projects. These only require a small head pond to ensure water supply. Both forms of hydro project have some interaction with the forest land base, but the impacts of the conventional dams are significantly more detrimental, potentially deleting large areas from the forest land base.

The W.A.C. Bennett Dam is located in the Peace River Canyon in BC. The Bennett Dam is an excellent example of a conventional hydro project. The structure itself is 2 km long, holding back a reservoir that covers 166,000 ha (BC Hydro 2007). The land surrounding the reservoir is used for timber harvesting as the land taken up by the reservoir could have been. However, due to its large scale this dam is capable of generating 2,730 MW.

Figure 3: Artistic rendition of the W.A.C. Bennett Dam

A new large scale hydro project is in the planning stages for the Peace River. 'Site C' as it's being called will be smaller than the Bennett Dam. Current designs show this dam to be 1.1 km long and holding back a reservoir of 5,340 ha (BC Hydro 2009_f). The smaller scale results in a smaller power generating capacity of 900 MW. Should this dam be constructed, not only will forest and agriculture lands be eliminated but families and a variety of other infrastructure will need to be relocated.

Run-of-river projects have been the result of BC Hydro's Call for Power. They utilize the natural flow of a river to generate power, only developing a small head pond to maintain water supply. BC Hydro has identified over 8000 potential sites for these projects. Further investigation and expense will be up to private companies or IPP's to determine whether or not these sties are able to produce power economically.

On viable sites, construction and maintenance is the responsibility of the IPP. A fee is paid to the crown annually for both the water license and lease of the land on which the generating facility sits. These are private facilities that are contractually obligated to sell their power to BC Hydro for periods ranging from 15 to 40 years (IPPBC 2009). The systems work by creating a small head pond, which allow for the free flow of water. A small portion of the water is harnessed with a pen stock. The water then moves down hill through a pipe to a power generator before flowing back into the stream. As a result of their small scale, these projects have a significantly reduced impact on the land base than that seen with large scale conventional hydro dams. However, their capacity is significantly reduced, most of which are targeted to produce 49MW. This is to avoid additional regulations associated with 50MW facilities (Peter 2009).

FIGURE 4: INTAKE STRUCTURE FOR A RUN-OF-RIVER PROJECT

As of September 2008 there were 35 run-of-river projects operating in BC with many more in the investigation or development stage. The power generated by these projects was sold to BC Hydro at an average rate of $87 per MWh. The figure varied from project to project as development approval was based on a bid process. The actually cost of generating power was closer to the $2 to $3 dollar range per MWh, but once capital recovery was included the cost rose to the $87 figure (IPPBC 2009).

An issue has arisen with all privately owned facilities in BC, be it hydro, wind or biomass. Once the capital recovery costs have been paid off by the customers and the contract to sell power to BC Hydro has matured, the facilities are fully owned by private companies but have essentially been paid for by BC Hydro customers. At such a point the power may be sold to whomever at any price, potentially netting large profits to the company. Had BC Hydro paid for and installed the facilities as with the Bennett dam power prices could be reduced or profits could be used to expand publicly owned infrastructure.

Utility Energy Cost Summary

In 2009 BC Hydro is the primary electricity provider in BC. With the exception of a few remote areas and large industrial facilities they provided all the provinces electricity. The rate they charge is variable due to a complex energy trading market place. The involvement of foreign investment and energy agreements with the United States further complicated the calculations. Here a standard value of $50 per MWh was used to compare the alternative energy options.

With new power generating installations capital recovery was often the greatest cost. The biomass power plants looked at for utilizing mountain pine beetle wood require an initial capital investments in the neighborhood of half a billion dollars to produce 300MW. With this technology however, transportation of biomass was the greatest portion of the cost. The total cost per MWh for power from this facility would be just over $60. For wind power, initial investments reached as high as $400 million with the Dokie project to produce 180MW. And the total cost per MWh could be anywhere from $70 to over $200. For the large scale hydro projects such as 'Site C' total costs per MWh can be as low as $42 (Calvert 2007). Where for small scale run-of-river projects the all inclusive cost was just under $90 per MWh on average.

When comparing these figures it can be seen that when moving away from conventional hydro projects the result would be an increase in electricity prices. However it can be argued that these alternatives are much less invasive and result in a lower impact on the land base. Instead of submerging forest lands to create a reservoir, timber harvest along with most other land uses could continue.

Conclusion

In all likelihood the future of energy production in BC will be a combination of the above technologies. These changes reflect attempts to best utilize the landscape while decreasing human impact. Biofuels and pellets will be more commonly produced from forest biomass in order to decrease waste and diversify the markets for BC forests products. Policy mechanisms are already in place on both the energy and forestry sides to ensure this happens. Furthermore, this will all be driven by increasing social pressures to reduce emissions and maximize the value of the land base. Due to complex interactions within BC's forests, forest professionals will begin to see an increasing demand for their knowledge. Foresters will be on the front line for the inevitable shift from utilizing forests for timber value to a broader resource and energy potential.

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