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Fire in the woods or fire in the boiler: Implementing rural district heating to reduce wildfire risks in the forest–urban interface

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ABSTRACT

Many rural communities in British Columbia (western Canada) are at risk from wildfire. This risk will increase over time as a result of climate change because of higher average temperatures, longer growing seasons, and more intense droughts. On the other hand, these communities are also faced with rising fuel costs and a growing demand for heat as suburban population increases. The fact these communities are surrounded by forests presents an opportunity to combine community wildfire risk abatement with bioenergy development. Additional co-benefits include: (1) reduced community energy expenditures; (2) the creation of local jobs; (3) climate change mitigation; and (4) increased community energy security. Here, we present results from three pilot rural communities (Burns Lake, Invermere, and Sicamous, all of them in British Columbia) designed to evaluate the feasibility of wildfire risk abatement in conjunction with bioenergy production. Maps were created showing each community's forest–urban interface area with quantified estimates of its sustainable woody biomass resource potential under different management scenarios while monitoring ecosystem and soil health. The results and experience gained through this work has been synthesized in a calculator tool to help other communities make their own screening-level assessments. This calculator is a freely available on-line tool: FIRST Heat.

1. Introduction

Since Canada's census of 1981, there has been a clear trend for rural suburban spaces to grow in population at a rate higher than for city centres (Hirsch and Fuglem, 2006). In British Columbia (BC), western Canada, the area of the forest–urban interface has been steadily increasing over the last few years. The forest, parkland, and agricultural landscapes of BC are now scattered with buildings and infrastructure vulnerable to wildfire (Partners in Protection, 2003). As a consequence, the forest–urban interface is a region "on the edge", vulnerable to damage and evacuation orders as wildfires strike.

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Table 1 – Energy content, price and cost of fuel types in BC.

Fuel type	Unit sale	Energy content	Retail price	Typical cost in BC		LCOE
		GJ/unit sale	$/unit sale	$/GJ	$/MWh	
Natural Gas	GJ	1.0	11–19	11–19	40–70	55–85
Propane	Litres	0.0253	0.48–0.63	19–25	70–90	115–140
Electricity	kWh	0.0036	0.068–0.083	19–23	70–80	30–100
Heating Oil	Litres	0.0387	0.74–0.97	19–25	70–90	N/A
Ponderosa Pine	Cord	17.9	200–250	11–14	40–60	55–187
Wood Chips	Green Tonne	11.2	35–55	3–5	10–20	55–187
Pellets (Retail)	Tonne	19.2	175–210	9–11	30–40	55–65

Sources: Dubois et al. (2012), Ghafghazi (2011), BC Hydro (2002).

All forests in interior BC are subject to wildfire. Although these forest ecosystems are naturally resilient to fire, they are actually adapted to a specific fire regime, a combination of fire frequency, intensity, and severity (Johnson et al., 2001). However, external factors are changing natural fire regimes. For example, excessive fire suppression (Keeley et al., 1999) or tree mortality causes an accumulation of fuel and therefore increases fire occurrence and/or intensity (Jolly et al., 2012). Another example is the increase in fire frequency from direct anthropogenic sources (escaped fires, sparks, etc.) that occurs when more people live in the forest–urban interface. Direct links between climate change and more fires have also been reported (Westerling et al., 2006), and predicted for western North America (Hirsch and Fuglem, 2006; de Groot et al., 2012; Nitschke and Innes, 2013). Due to this increasing area under wildfire risk, communities around BC (especially in the interior) are implementing preventive forest management to reduce wildfire risk. These activities are generating woody biomass[1] from the reduction in stand density. Until now, this woody biomass has been removed from site and then burned in piles, so it will not fuel future wildfires.

Rural communities incur fuel prices more expensive than in cities because fossil fuels have to be transported from the main population centres. For example, weekly retail furnace oil prices per litre in Prince George (BC) have been 6.8 cents higher on average than prices in Vancouver in the 2005–2014 decade (Natural Resources Canada, 2015). Under current residential prices, propane is often at least twice as expensive as wood pellets (the most expensive form of woody biomass) and heating oil is even more expensive (Table 1). In addition, inflation adjusted fuel prices in Canada have been growing for all oil- and gas-related products (with volatility due to international events) (National Energy Board, 2011). The long-term trend for fossil fuel prices is for them to rise, putting pressure on local economies. Therefore, there are economic as well as environmental reasons to increase the use of woody biomass generated from the management of the forest–urban interface as a source of energy and thereby reduce the use of fossil fuels in these communities.

It is estimated that sustainable forestry methods in BC could produce enough woody biomass (17,145 Mg dry biomass yr^{-1}) to generate 273.8 PJ yr^{-1}, equivalent to 29.8% of the province's energy demand from fossil fuels. This estimate would be larger if the timber from trees killed by the mountain pine beetle outbreak were used, reaching a total of 28,100 Mg dry biomass yr^{-1}, (450 PJ yr^{-1}) or 49.0% of BD's energy demand from fossil fuels (ENVINT Consulting, 2011). Although these are striking figures, BC's biomass potential is far from being fully utilized. Challenges include ensuring a stable long-term supply of biomass at a fixed price and quality, accessibility to biomass material, fluctuations in transportation costs, not clear increase in economic efficiency as the heating plant increases in size, previous investments on other energies that still need to be amortized, and bias against biomass due to public perception of potential air quality issues (Renney, 2012).

The ecological context of woody biomass is an important consideration, however, because from the perspective of a forest ecosystem, there is no "waste" biomass. All forest residues are part of long-term nutrient dynamics. Research shows that removing woody biomass, traditionally left in BC's forests after harvesting, could have negative impacts on fauna (Sullivan et al., 2011) and flora (Blanco, 2012). A final environmental factor to be considered when using woody biomass as a source for district heating[2] fuel is the reduction of carbon dioxide emissions. Studies suggest that the most cost-effective solutions for reducing carbon emissions from buildings involve minimizing energy usage, maximizing efficiency, and fuel switching to lower carbon fuels (Flanders et al., 2009). Fuel switching will ultimately play a larger role than energy efficiency in reducing greenhouse gasses emissions (Simpson et al., 2007). For example, in interior communities in BC, space and water heating are among the major contributors to greenhouse gas emissions (Sheltair, 2007; Green Heat Initiative, 2010). By focusing on alternative, low-carbon heat sources, these communities can reduce their dependence on fossil fuels for heating.

The challenge for planners and local managers in rural BC is how to keep their communities safe and attractive for locals, newcomers, and visitors, while reducing safety risks, energy costs, and their carbon footprint. Together, these issues make for a complex picture as communities struggle to realize the potential of their forest–urban interface areas. A joint project involving the University of British Columbia, Community Energy Association and Wood Waste to Rural Heat Project has developed a tool called FIRST Heat. This tool is a calculator that will help local authorities, planners and

[1] Defined as the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of forest management (USFS, 2008).

[2] District heating is a system in which hot water (steam in old systems) is distributed from central stations to buildings and industries in a densely occupied area (a district, a city or an industrialized area). The insulated two-pipe network functions like a water-based central heating system in a building. The central heat sources can be waste-heat recovery at industrial processes, waste-incineration plants, cogeneration power plants or stand-alone boilers burning fossil fuels or biomass (IPCC, 2011).