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Regional Challenges and Opportunities for Agricultural Biomass in Nova Scotia

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ABSTRACT Nova Scotia is currently in the process of developing a biomass energy industry, with a current installed capacity of 105MW, and a further 33.75MW due to come on-line between 2015 and 2018 under the NS Community Feed-in-Tariff (COMFIT) Program across the province. This new demand for resources by the biomass energy sector combined with the needs of existing biomass users which include heat production (residential and commercial), pulp and paper, lumber and wood production, has the potential to compound the existing issues relating to biomass sustainability within the province. This issue is already being demonstrated within the province with the largest biomass energy facility obtaining half of its feedstock from primary forest products, despite initial plans indicating that it would only be using wood waste products.

While the use of biomass contributes to the reduction of Greenhouse Gas emissions and contributes to Nova Scotia's Renewable Energy targets, a detailed understanding of this new industry, how it can move forward and where and how its biomass feedstocks will be obtained and managed needs to be undertaken. This paper looks to identify where these existing and new facilities are going to be located, what challenges they face in relation to feedstock acquisition and how the industry could meet these challenges through the use of agricultural biomass products.

Keywords: Agricultural-Biomass, Renewable Energy, Sustainability

INTRODUCTION Within the province of Nova Scotia approximately 75% (2015) of electrical energy is produced through Natural Gas (15%) and Coal (60%); this saw Nova Scotia consuming 2.8 million megatonnes of coal in 2013 (NSPI 2015), at significant cost, with the cost of coal having increased by 70% per tonne since 2004. The increasing fuel cost combined with GHG emission targets have lead the Nova Scotia Government to set targets for the reduction of energy use (Nova Scotia Department of Energy 2009), and to reduce the provinces reliance on fossil fuels by moving towards a more sustainable energy mix, through the adoption of renewable energy sources, with a target of 40% of energy produced through renewable means by 2020 (Nova Scotia Department of Energy 2010). While wind and hydro and tidal make up the largest proportion of renewable energy (10% and 9% respectively), biomass energy has an important role to play, however while there is a significant amount of forestry biomass, there is a cap on the quantity of forestry biomass available to the energy sector (Nova Scotia Government 2011b), therefore alternative options need to be explored.

The Agri-food industry employed 10,575 people, with 5,800 in primary agriculture in 2010 (Devanney and Reinhardt 2010) split across 4000 unique farms; utilizing 250,000 hectares throughout the province Nova Scotia Government 2011a). Due to the restrictions on Forestry biomass there is a need to look at other avenues for energy generation; which the agricultural sector is uniquely positioned to contribute towards. The Nova Scotia Federation of Agriculture currently have a standing policy for the encouragement, promotion and research of energy related issues for its members, and are actively pursuing and willing to expand their environmental and energy remit (Nova Scotia Federation of Agriculture 2012); this provides a good starting framework for the development of a useful and sustainable agricultural biomass industry within Nova Scotia. (Bailey et al. 2008) indicated that 83% of farmers in Nova Scotia are interested in some form of renewable energy which includes bioenergy systems, suggesting that they are willing to grow biomass crops either for on-farm use or as a saleable crop.

CURRENT BIOMASS RESOURCES Nova Scotia has extensive Forestry and while there is a significant amount of forestry biomass, there is a cap on the quantity of primary forestry biomass available to the energy sector (Nova Scotia Government 2011b) and a range of other user all vying for forestry products. As of 2013 there were 181 (140 active) 'Registered Buyer' users of Primary Forestry Products (PFP) using a minimum of 1,000m^3 per annum sharing the reported provincial PFP harvest of 3,453,087 m^3 (covering approximately 30,230ha) of which 3.6% of the total went to energy generation; up from 1% in 2012.

While there is the Forest Sustainability Regulations for NS and programs designed to replace forestry stock, only those Registered Buyers of more than 5,000m^3 of PFP are required to either undertake their own silviculture program or make a financial contribution to the Sustainable Forest Fund based upon the volume of forestry acquired per annum. In 2013, of the 141 active Registered Buyers only 25 were required to implement silviculture programs; available data does not stipulate whether the other Registered Buyers were involved in silviculture programs and how much PFP harvesting occurred that was less than the 1,000m^3, which is the threshold for reporting. 2012 data shows that of the recorded 30,230ha harvested, only 5,973ha were planted under such programs suggesting that more effort is needed to ensure sustainability (Government of Canada 2014).

While there is opposition to PFP for electrical generation from organizations including the Ecological Action Centre, Nova Scotia Woodlot Owners and Operators Association, Nova Scotia Environmental Network and others (Ecological Action Centre et al 2011), it should be noted that in 2013 of the 4.23m hectares of forestry only 0.7% was harvested. 736,800 ha of the forestry is unavailable for harvesting due to protected status (e.g. Cape Breton National Park, Kejimkujik National Park) and 604,00ha of public forest is subject to forest management agreements (Nova Scotia Government 2014), 2013 data classifies 1.4m hectares as 'Certified Sustainable' through either the Canadian Standards Association, Sustainable Forestry Initiative or the Forest Stewardship Council (Government of Canada 2014). This suggesting that while there are a large number of opponents suggesting that biomass for electricity is unsustainable, the arguments against aren't necessarily definitively provable and a large proportion of NS forestry is either protected or sustainably managed, data also demonstrates that the yearly harvested areas for the last four years (2009 – 2012) are at their lowest compared to a peak of 69,761ha in 1997.

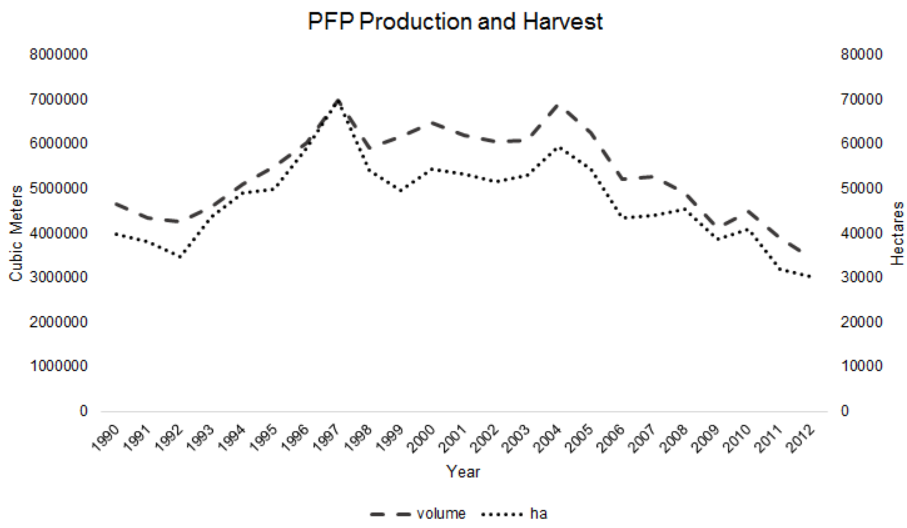


Figure 1: Harvested PFP in Nova Scotia (Government of Canada 2014)

Additionally, the province has seen the closure of several pulp and paper facilities and sawmills (Nova Scotia Natural Resources 2014) in the last number of years, therefore it could be argued that biomass for electricity can utilize the available capacity left by these facilities even with the planned increase in electrical generating capacity by 2018. While there are conflicting opinions on whether forestry biomass and in particular PFP is desirable/suitable for electricity generation and its potential impact on forestry sustainability, one avenue available to aiding the province in contributing towards a sustainable and renewable biomass energy sector is the use of agricultural biomass for electrical generation and heat production.

What is the NS Media Saying? As alluded to, the greatest concern relates to the (perceived or actual) environmental impact which has been the focus of a number of environmental/ecological organizations and the potential environmental impact has been taken up by the media, with an increasing number of articles and published statements in relation to the sustainability of PFP for electrical generation. One of the largest Biomass Facilities in the province (Point Tupper) is reported to consume between 650,000 and 750,000 green tonnes of biomass per annum(Beswick 2014). According to Nova Scotia Power, prior to the facility going online, the biomass fuel to be utilized by the facility would be from wood waste, wood that has no other commercial use due to defects or forestry residue, however in a 2015 newspaper article, NSPI stated that half of the plants requirement is being met using wood waste from Port Hawkesbury Paper, sawmills and other wood using enterprises within the province. This leaves half of the facilities fuel requirements coming from PFP either from within or out-with the province(Beswick 2015) (Silverwood 2015). Opposition to the practice of using PFP for the facility claim that it leads to a reduced availability for other operators and impacts upon recreation and forest sustainability(Beswick 2015) (International 2015) (Halifax Media Co-op 2015).

AGRICULTURAL BIOMASS VIABILITY For agricultural biomass to become a viable option for producers, several conditions need to be met; Provincial support/education needs to be provided, availability of suitable land for production, reasonable proximity to a buyer (e.g. biomass power plant facility), a secure long-term contract with a buyer and for it to be economically viable to produce.

Using Short Rotation Coppice (SRC) Willow and Poplar as a biomass crop example, both have become increasingly popular biomass sources for combustion in electrical, heat and Combined Heat and Power (CHP) systems in both Europe and North America. Coppicing is the practice of planting woody crops at high density typically 10,000 – 15,000 stems per hectare, which are generally harvested every two to five years depending upon field and growing condition, for twenty to twenty-five years. Typically a wide range of yearly growth yield values have been reported, anywhere from 4 odt/ha/yr to in-excess of 15 odt/ha/yr depending on the site and the climate. While SRC is recognized as an invaluable energy resource for the bioenergy market, there are several other benefits of SRC plantations including its use in waste water and leachate treatment (Holm and Heinsoo 2013) (Duggan 2005) (I. Dimitriou and Aronsson 2011) and encouraging biodiversity (I. Dimitriou et al. 2011) (Ioannis Dimitriou and Fištrek 2014) (Sage, Cunningham, and Boatman 2006), leading to SRC being widely recognized within Europe; as such there are a number of schemes and funding grants provided to further SRC production.

Within the UK, the Biotechnology and Biological Sciences Research Council (BBSRC) have provide Rothamsted Research with over $12m in Research Grants, for various projects relating to improving yields and improving environmental tolerances in SRC to allow for use in differing European environments (BBSRC author 2015). This project is currently working in collaboration with European partners from Sweden and Germany to improve SRC willow production, yields and mapping SRC genomes ("Targeted Breeding of a European SRC Willow Crop for Diverse Environments and Future Climates" 2013). Funded by the European Commission the ROKWOOD programme is a European wide project aimed at researching the development, implementation, monitoring and utilization of SRC production across Europe. From a producer perspective across Europe there is a range of funding options available to help with the establishment and management of SRC, in the UK alone, several different financial schemes have been offered including the Bio-energy Infrastructure Scheme, Energy Crops Scheme, Scottish Forestry Grants Scheme, Energy Aid Payments and Wood Energy Business (Biomass Energy Centre Unknown). While significant research is being conducted in improving yields and trying to improve the environmental tolerances of SRC, there is also a significant amount of research looking to understand the potential for growing SRC within Europe. Within Nova Scotia, there are no support or educational schemes to aid farmers in understanding biomass crops or financial schemes to incentivize the uptake of biomass production.

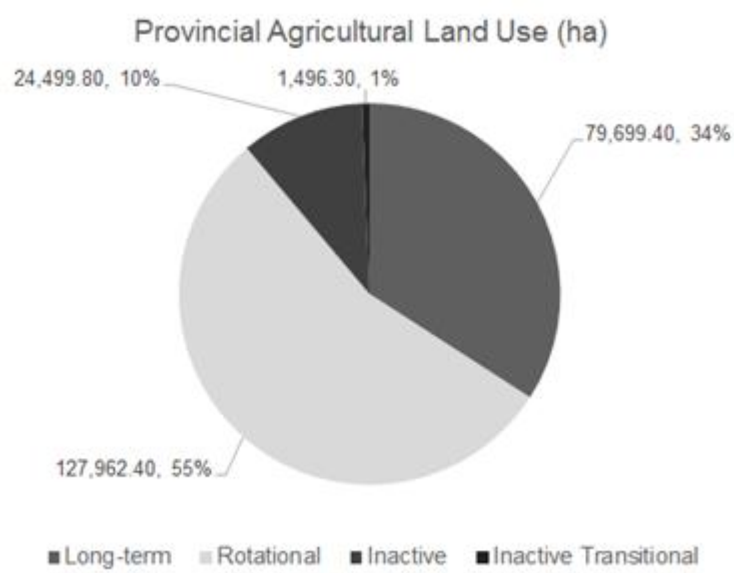
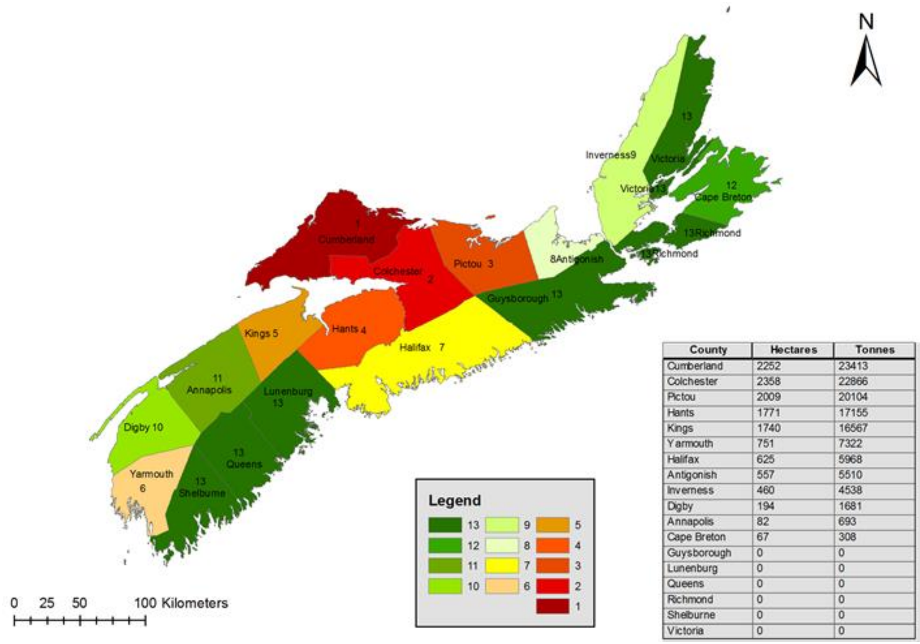


Figure 2: Agricultural Land Use (Nova Scotia Government 2015)

Considering the availability of suitable land, one suggested option would be to utilize inactive land within the province of which a large portion is considered marginal land (Figure 2), with it is estimated that there is approximately 24,500 ha of inactive land out of 250,000 hectares of agricultural land. Based on available GIS data for land classes (drainage, slope, stoniness, water table) and soil characteristics, types and quality (Natural Resources Canada 1981) (Natural Resources Canada 2000) and agricultural land usage (Nova Scotia Government 2015) a Hotspot Analysis can be performed to identify quantity of suitable inactive land



County	Hectares	Tonnes
Cumberland	2252	23413
Colchester	2358	22866
Pictou	2009	20104
Hants	1771	17155
Kings	1740	16567
Yarmouth	751	7322
Halifax	625	5968
Antigonish	557	5510
Inverness	460	4538
Digby	194	1681
Annapolis	82	693
Cape Breton	67	308
Guysborough	0	0
Lunenburg	0	0
Queens	0	0
Richmond	0	0
Shelburne	0	0
Victoria	0	0

Figure 3: Nova Scotia Inactive Land Hotspot Analysis

in relation to field-to-field proximity, in relation to road access and to approximate potential yields (Short Rotation Coppice) based upon land class and soil characteristics. Basic analysis suggests that the most viable county for production within the province would be Cumberland County with 2,252 potentially available hectares with a potential 23,413 tonnes/year, followed by central Nova Scotia counties, however there are six provinces where there is no suitable inactive land for production.

In relation to proximity to buyers, Nova Scotia currently has five community-feed-in-tarriff (COMFIT) plants in operation or soon to be in operation, plus the NSPI 60MW facility in Port Hawkesbury and 30MW Brooklyn Facility. Based upon the location of the five COMFIT facilities, using only inactive land (using SRC Willow as an example crop) as a source of feedstock production, and considering a 75km radius for acquiring their feedstock, from a biomass plants operational perspective; the plants cannot meet their feedstock requirements, compounded by range overlap.

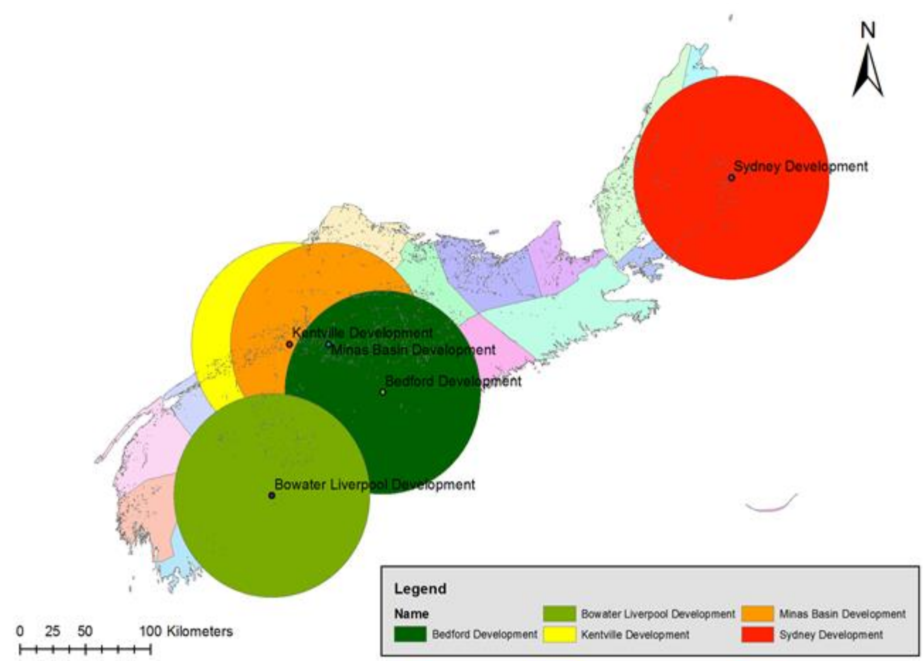
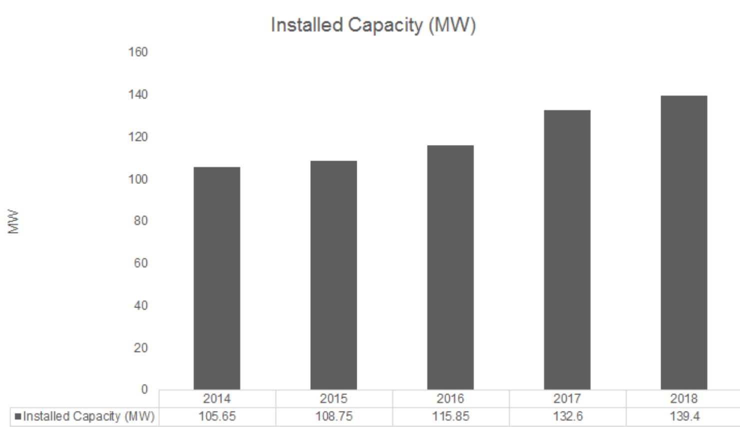


Figure 4: Biomass Plant Location and 75km feedstock acquisition radius

While, this is not necessarily favourable for biomass facilities, from a producer point of view, it would indicate that even although producers as a group could not meet the required quota, there is a clear possibility that a significant contribution could be made.

Discussions with local land owners have raised a number of issues in relation to the economic viability of growing biomass crops including long-term commitment and profitability. High yielding energy crops require long-term investment in setting aside land for production, where both SRC and Miscanthus can expect to have a 20-25 year life-span. Therefore growing these crops requires a long-term purchasing agreement with a buyer to ensure the economic viability of production. One biomass company within the province has committed to utilizing Miscanthus as part of its fuel mixture, with it planning on leasing 10,000 acres (4,046 ha) up to 200km from the plant and paying a base rate of $35 per acre and offering a sliding dollar top-up scale in relation to the distance to the facility ($35/acre if within 40km, $5/acre if between 81-100km from the facility) plus various other top-ups depending on land treatments not required (ProFarm Energy Inc 2015). In addition the land owner will not be required to maintain or perform any agricultural activities on the leased fields, with the company hiring or contracting farmers to undertake any work necessary. However to date, no other biomass plant facility has put out a call for agricultural crops, which will hinder the production of agricultural biomass.



Name	Generating Capacity (MW)	Tonnes Required
Bedford Development	11	77088
BoWater Development	3	21024
Kentville Development	6	42048
Minas Basin Development	10	70080
Sydney Development	6	42048

Figure 4: Installed Capacity and New Developments

WHERE ARE WE NOW? The biomass industry as a whole in Nova Scotia is still fledgling, however it is set to grow within the next several years. Based upon 136 COMFIT applications, twenty-two applications for biomass facilities have been granted (this value includes CHP, biogas and Municipal Solid Waste) to date throughout the province. This will take the existing installed biomass generating capacity from 105 MW of in 2015 to an estimated 139.4 MW by 2018. Currently the COMFIT program is closed to new applications as of early 2015, however an announcement will be made in the Fall of 2015 and is expected to resume the program. The production of agricultural biomass is limited within the province, however there are a number of private individuals who are engaged in producing SRC Willow as well as a number of Miscanthus trials across the province.

The province does however face a number of challenges in relation to the capacity for the province to expand biomass energy facilities and renewable energy technologies through Independent power producer schemes (IPP), with Nova Scotia's Electrical Infrastructure aging and in need of an upgrade. NSPI is in the process of maintaining and upgrading the grid infrastructure, with a forecasted $281 Million to be spent on transmission systems for load growth, system reliability and for renewable energy integration between 2015 and 2019 and $421.6 on distribution systems focusing on load growth and reliability between 2015 and 2019 (NSPI 2014).

The expansion of biomass energy and renewable energy facilities/technologies through either an NSPI development or via an IPP development will be limited until grid capacity is increased. Currently there is an estimated 298 MW of available grid capacity throughout the province, however the greatest capacity is within Halifax Regional Municipality with 209 MW available of which the majority can be found within Halifax and Dartmouth. Ranking second is the County of Cape Breton, where the grid capacity is found to be an estimated 24.9 MW; this capacity can be found within the city of Sydney and surrounding environs. With a population of 1 million and a relatively dispersed population, the funds necessary for increasing the rate of infrastructure improvements is not available due to NSPI being unable to increase electricity rates, with a 3% increase seen in both 2013 and 2014. With the closure of several large power users, of which significant revenue were taken and the increase in coal prices, the extra costs associated have impacted Nova Scotia consumers. This is further compounded by emissions targets and a need for energy security leading NSPI to heavily investing in Renewable Energy Technologies and associated infrastructure, which will see rates increase in the short to medium term (NSPI 2015).

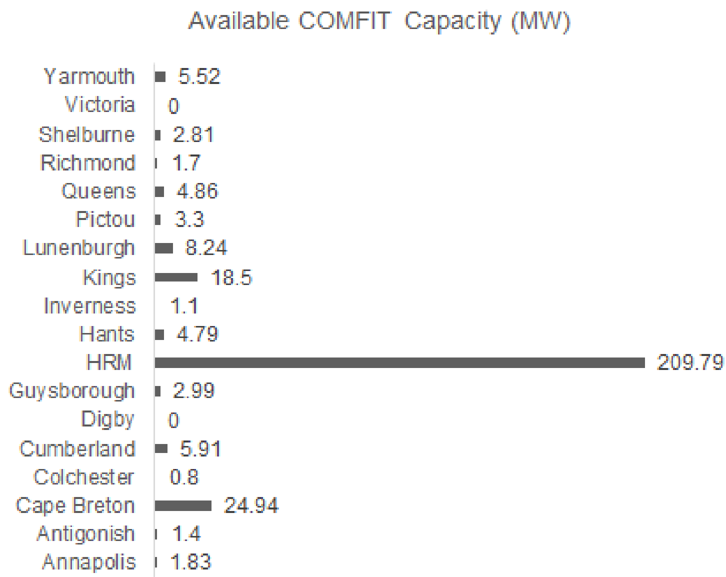


Figure 5: Available COMFIT capacity

Another issue facing the province is a lack of clear policy in relation to biomass; a significant number of Canadian Provinces have adopted biomass/energy strategies (PEI Department of Environment, Energy and Forestry 2008) (Northwest Territories Environment and Natural Resources 2010) (Ministry of Energy, Mines and Petroleum Resources 2008) (Corscadden, Biggs, and Thomson 2014) and are utilizing biomass for electrical generation. It has been highlighted by the Canadian Bioenergy Association that the Atlantic provinces in particular are suffering from a significant number of regulatory issues that are preventing the expansion of biomass and neither is there any clear indication of a Regional Bioenergy Group or Network that can advocate, coordinate and help develop the industry (Volpe and Thompson 2012). However, despite there being no clear Biomass Network at the moment, there have in recent times been meeting organized by the department of agriculture and other groups to try and establish such a network.

CONCLUSION Nova Scotia has the potential to develop the biomass industry, with there being a clear indication of new biomass plants being commissioned under the COMFIT program suggesting that there will also be an increasing demand for biomass feedstocks within the province. With the large quantities of Forestry being consumed, the use of fast growing energy crops such as SRC willow or poplar and Miscanthus offer a fast growing, replenishable option, that while it cannot produce on the scale of traditional Forestry, it can make a significant contribution towards smaller scaled biomass power stations. However for this to happen there needs to be a clear indication from energy producers that they are willing to offer long-term contracts to land owners and their needs to be a concerted effort by an organization such as a regional biomass network in conjunction with the Departments of Agriculture Energy to educate land-owners about energy crops.

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APPENDIX

Land Capability Class	Terminology	Reclassified Value
1	No Significant Limitations For Crops	7
2	Moderate Limitations For Crops	7
3	Moderately Severe Limitations For Crops	6
4	Severe Limitations For Crops	5
5	Very Severe Limitations For Crops	4
6	Perennial Forage Crops Only	3
7	No Capacity For Crops	1

Figure 6: Land Class Example

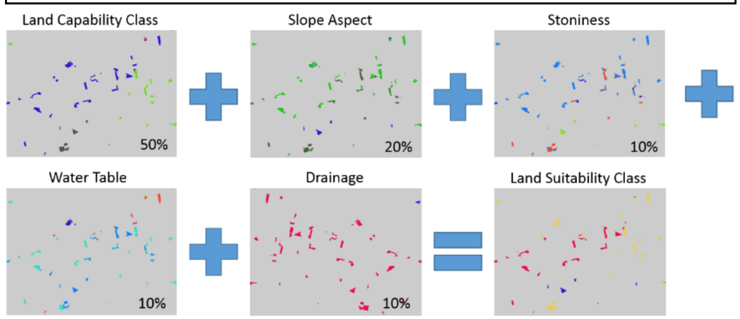

Figure 7: Weighted Analysis Example

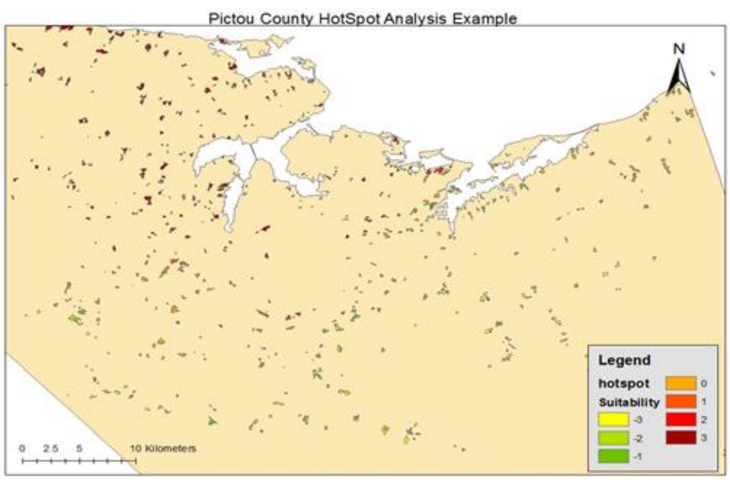

Figure 8: Hotspot Analysis Example

Weighted Analysis Process To identify field suitability, Weighted Overly was performed. Weighted Overlay is a useful tool to solve spatial multicriteria problems including site selection. Weighted Overlay functions through assigning values to each of the different attributes in a given GIS layer using a common scale. This analysis used a 1-7 scale with 7 being the most preferable and 1 being the least. Figure 6 shows an example of the reclassification used.

Having assigned values to each attribute in each GIS Raster Layer, each Layer is assigned a weighted values (with the total weighting summing 100%) This then allows certain attributes to be considered to have a higher impact than another layer, with the output being the result of the weighted calculation. The output is similarly on a scale of 1-7, with 7 being the most preferable. Figure 7 shows the different layers and how each layer was weighted.

Hotspot Analysis The purpose of the Hotspot Analysis is to identify statistically significant areas where close proximity occurs between polygons with high values. In this case the Hotspot analysis identified fields with high suitability values (values 3 and 2) that are in close proximity to one another. Considering Figure 8, looking at the top left of the image a number of the polygons are red, and looking at the centre of the image the polygons are largely pale green or yellow. This indicates that the top left has fields with higher suitability rating and in close proximity to one another than those in the centre of the image that are more dispersed and have a lover suitability rating.

This data and data from the other Counties was taken and used to rank the different provinces in terms of highest number of suitable sites that are within distance to one another and the quantity of biomass available.