FORESTRY INNOVATION IN WESTERN NEWFOUNDLAND: LYOCELL AND DIVERSIFICATION AT CORNER BROOK PULP AND PAPER LIMITED

By Michelle Gosse

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Table of Contents

Table of Figures

Table of Tables

Abstract

The past decades have seen a decline in the production and export of both pulp and newsprint partly due to technological substitutions such as digital newspaper subscriptions and newspaper (media) apps. The potential development of a new bio-based product (lyocell pulp fluff) at Corner Brook Pulp and Paper Limited (CBPPL) is one way to build a new bio-based industry in western Newfoundland. Since its inception in 1972, Lyocell (a cellulose fiber) has been used for many applications such as textiles, hygiene products, cosmetic products, and protective clothing. This paper proposes the development of Lyocell fluff pulp for the steadily growing sustainable hygiene product market and uses a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis to determine the competitive intensity and attractiveness of this new industry.

CBPPL (and Corner Brook) are well suited for the development of a new value-driven product. CBPPL has waterfront access to an ice-free port, access to production material via 1.5 million hectares of Crown land on Newfoundland's western and central regions and partnerships with local sawmills and low-cost energy from the nearby Deer Lake hydroelectric power plant (owned and operated by CBPPL). Since CBPPL already has a chemical digester for wood pulp and access to spare storage and production facilities, the financial cost of developing a new product would be lower than creating a new facility.

This paper focuses on highlighting the strengths of CBPPL and Corner Brook as a potential site for future innovation through the development of an industrial demonstration facility where cutting-edge bio-resource innovators and researchers can test their products before bringing them to full market scale. As Newfoundland does not have a bio-economy framework in place, several recommendations to fill in policy gaps and formulate a structure for innovation which will create an open dialogue for future progress in Newfoundland will be provided.

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List of Abbreviations

Aditya Birla Science and Technology Company Private Limited (ABSTCPL)

Acordis-Akzo Nobel N.V (AANNV)

Aktiengesellschaft (AG)

American Fiber Manufacturers Association (AFMA)

Advanced Education, Skills and Labor (AESL)

Business Development Bank of Canada (BDBC)

Business New Brunswick (BNB)

Canadian Council of Forestry Ministers Innovation Committee (CCFM)

Canada Foundation for Innovation (CFI)

The Conseil de la Science et de la Technologie du Quebec (CSTQ).

Corner Brook Pulp and Paper Limited (CBPPL)

Bio-pathways Project (BPP)

Bio-pathways Project Phase II (BPPII)

Department of Advanced Education, Skills and Labor (AESL)

Department of Municipal Affairs and Environment, Newfoundland and Labrador (MAENL)

Euro (EUR)

Environmental Protection Agency (EPA)

Five Forces Model (5FM)

Forest Innovation Program (FIP)

Forest Products Association of Canada (FPAC)

Forest Sustainability Certified (FSC)

FPInnovations (Forestry Product Innovations)

FPI Paper, Packaging and Consumer Products (PPCP)

Gram per liter (gpl)

Harvard Business Review (HBR)

Harvard's Institute for Strategy and Competitiveness (HISC)

Innovation and Skills Canada (ISC)

International Organization for Standardization (ISO)

Investments in Forest Industry Transformation Program (IFIT)

Kimberly Clark (KC)

LEADER (Liaisons entre activités de Development de L'Economie Rural)

Life cycle assessment (LCA)

Ministère de l'Énergie et des Ressources naturelles (Quebec's The Department of Energy and Natural Resources) (MERN)

Municipal Affairs and Environment (MAE)

Natural Resources Canada (NRCan)

Newfoundland and Labrador Environmental Industry Association (NEIA)

Newfoundland and Labrador (NL)

N-Methylmorpholine N-oxide (NMMO)

Organization for Economic Development (OECD)

Provincial Sustainable Forest Management Strategy (PSFMS)

Pulp and Paper Canada (PPC)

Pulp and Paper Industry (PP)

Reckitt Benckiser (RB)

Transformative Technologies Program (TTP)

Sateri and Shandong Helon Textiles (SSHT)

Sexton Lumber (SL)

Smithers Apex (SA)

Smithers Pira (SP)

Statistics Canada (StatsCan)

Strengthening Rural Canada (SRC)

Strengths, Weaknesses, Opportunities and Threats Analysis (SWOT)

Sustainable Forestry Initiative (SFI)

Definitions

Air laying technology: A fluff pulp process where fiber webs are created using air dispersion, usually followed by deposition on a suction belt (Slater and Wilkes, 2013).

Bioeconomy: A set of economic activities relating to the invention, development, production and use of biological products and processes (OECD, 2009). Fluff (pulp): A type of chemical pulp made from long fiber softwoods. Fluff pulp is used for diapers, adult briefs, incontinent pads and feminine hygiene products (Nanko, 2005).

Lyocell: The Federal Trade Commission (FTC) (U.S) defines lyocell as a cellulose fiber obtained by an organic solvent spinning process where: organic solvent means a mixture of organic chemicals and water, and solvent spinning means dissolving and spinning without the formation of a derivative. The U.S FTC currently classifies lyocell under rayon (American Fiber Manufactures Association (AFMA) 2017, FTC, 2005).

Needle punching: A technique used in the non-woven hygiene manufacturing process. Here fiber bonding is achieved through the use of mechanical needling of the fiber web, leads to softer, more absorbent structures, which have a unique ability to retain and release fluid. The high wet resiliency of the fiber allows the fabrics to retain bulk in the wet state, leading to superior handling aesthetics and wiping action (Slater and Wilkes, 2013).

Rayon: A manufactured fiber composed of regenerated cellulose, in which substituents have replaced not more than 15% of the hydrogens of the hydroxyl groups. Rayon fibers are wet spun, which means that the filaments emerging from the spinneret pass directly into chemical baths for solidifying or regeneration (AFMA, 2017).

Spun lacing: A water jet entanglement method of bonding fibers (Slater and Wilkes, 2013).

Viscose (Rayon): Viscose rayon is made by converting purified cellulose to xanthate, dissolving the xanthate in dilute caustic soda and then regenerating the cellulose from

the product as it emerges from the spinneret. Most commercial rayon manufacturing today utilizes the viscose process (AFMA, 2017).

Chapter One: Introduction

Traditionally the Canadian forest sector has played an important role in Canada's economy and can be subdivided into three sectors: solid wood manufacturing, pulp and paper manufacturing and logging. Combined, these three sectors contributed $19.8 billion CAN or 1.25% of Canada`s GDP in 2013 (Natural Resources Canada, 2019). With the advent of increased global competition and the rise of the digital age, Canada`s forest sector has seen a steady decline over the last few years. Diversification or the introduction of new forest products such as Cellulose nanocrystals (NCC) created from wood pulp has allowed Canada to enter new markets in Asia (China and Japan) (Natural Resources Canada, 2018).

1.1: Newfoundland and Labrador`s Forestry Industry

The pulp and paper industry has traditionally been the backbone of Newfoundland and Labrador's forest sector since the early 20th century. Currently, Newfoundland and Labrador's forest industry is valued at $286.5 million annually and directly and indirectly employs over 5,000 men and women, in pulp and paper, saw milling, harvesting and value-added enterprises (Fisheries and Land Resources, 2019).

In 2018, the total number of newsprint shipments declined 5.8% from 2017 (by 233,884 tonnes) but the estimated value of shipments increased by 11.4%. There was a 19.7% decrease in shipments to the United States due to tariffs on imported newsprint but international shipments increased by 187% due to Kruger Inc. (a Canadian paper manufacturer) international efforts to decrease reliance on the American market (Government of Newfoundland and Labrador, 2019).

1.2.1: Overview of the Humber Valley of Western Newfoundland

The Humber Valley region is located on the west coast of NL, along the banks of the Humber river and the town of Deer Lake. The 2017-18 Humber Valley Regional Advisory Authority report indicated that as of 2016 there were seven municipalities located within the Humber Valley region, the towns of Steady Brook, Pasadena, Deer

Lake, Cormack, Reidville, Massey Drive and the City of Corner Brook (Humber Valley Regional Advisory Authority, 2017).

The neighboring region of the Bay of Islands has also played an essential part in Newfoundland's forest industry history, as many of the Corner Brook Pulp and Paper Limited (CBPPL) earliest employees resided in the Bay of Islands. The Bay of Islands includes nine communities along the west coast of NL: Cox's Cove, Hughes Brook, Irishtown-Summerside, Lark Harbor, McIver's, Meadows, Mount Moriah, and York Harbor.

1.2.3: A Concise History of CBPPL

Harold Horwood (1986) describes the development of the Corner Brook mill as quick; from the first docking of the (freighter ship) the SS Canadian Coaster in 1923 (carrying construction materials) to the first paper roll being produced in 1925, construction and production at the mill site was occurring at a rapid pace. By 1926 all the paper production machines at the mill were producing paper rolls (Horwood 1986). The speed of development causing economic inefficiency with soaring production costs and a soft global economy/market causing financing issues, in the late 1926 Newfoundland Power and Paper was looking for a new buyer- the International Power and Paper Corporation of New York (IP&P) (Horwood, 1986). In 1923, Eric Bowater became a director at IP&P, and after visiting the mill at Corner Brook three times between 1922 and 1925, Bowater decided to start up the Bowater Paper Company Incorporated which became the "sole agent for the sale of Corner Brook paper throughout the world" (Horwood, 1986).

In 1938, Eric Bowater had the opportunity to buy out IP&P's interests in NL, and on "August 18, 1938, IP&P NL was changed to the Bowater Newfoundland Paper Mills Limited" (Horwood, 1986). Under Bowater's direction, the mill saw new growth and development with the installation of paper machine Number Seven, the first mechanical pulpwood loaders in 1948 and saw the commission of a new fleet of transport ships that were fully operational by 1955 (Horwood, 1986). The newsprint glut (average demand coupled with the overcapacity of newsprint) of the 1960`s, paired with Bowater's rapid

overseas expansion, caused CBPPL to face its next crisis, the stopping of continuous operations (mill shutdowns and production cuts). By "1971 Bowater's announced they would have to shut down the Number Seven paper machine" (Horwood, 1986).

In 1983, paper machine Number Seven was officially shut down at CBPPL. The profitability of the mid-1970's came to an end in the early 1980's, due to the recession in Canada. In 1983, Bowater informed the provincial government that they were looking for a buyer (Horwood, 1986). In 1984, the provincial government announced that Kruger Incorporated of Montreal would purchase the mill (Horwood 175). Kruger has now operated CBPPL for 33 years, and the mill has seen many changes from machine upgrades to machine shutdowns, partially due to what Horwood calls CBPPL's "irregular (economic) cycle of 11 years" (Horwood, 1986, Wernerheim and Long, 2011). Horwood indicates that the global newsprint industry is cyclic, prone to "glut that is not necessarily related to general economic conditions" (Horwood, 1986).

Kruger has not been immune to the global cycles of glut, newsprint demand (soft demand), fluxing prices of materials and the performance of the Canadian dollar in the global economy (PPC, 2007). CBPPL has experienced these effects firsthand in 2007 by shuttering its oldest and most inefficient machine, and decreasing capacity at the mill (Wernerheim and Long, 2011).

1.2.4: Corner Brook Pulp and Paper Limited

Kruger Industrial currently owns and operates the Corner Brook Pulp and Paper Limited (CBPPL), the only pulp and paper mill in Newfoundland and Labrador. Kruger purchased the mill in 1984from Abitibi Bowater (who had held the mill since 1934). CBPPL currently produces

Figure 1: CBPPL (CBC 2016).

260,000 tons of pulp per year (Government NL, 2016) and employs 675 individuals (Anderson, 2011). Newfoundland and Labrador's Environmental Industry Association (NEIA) wrote that "Newfoundland and Labrador has not been insulated from the challenges posed to the forestry industry worldwide in the 21st century: including global competitors, increased rates of recycling, the dramatic drop in newspaper circulation, and the shift from print to digital media all have contributed to the decline of the newsprint industry" (NEIA, 2016). In 2014 CBPPL and the Government of NL agreed to a repayable loan of $110 million (through a mortgage) for the use of "company debt restructuring and capital improvements" (Government NL, 2015, Bartlett, 2018).

With the January 2018 announcement of an $8.3 Million tariff on imported newsprint from Canada, CBPPL will need to diversify to become sustainable in the future. Currently, Kruger has been paying off the interest on the 2014 loan (of $110 Million), and an additional $8.3 Million in tariffs to the US would make production at the mill costlier (Bartlett 2018). If CBPPL can successfully diversify into cellulose fibers, this innovation will help the forest industry in the province transition towards a bio-economy. A bio economy is an economy that is based on the sustainable use of renewable resources (McCormik and Kautto, 2013).

1.2.5 Lyocell and Corner Brook Pulp and Paper Limited

The introduction of cellulose fiber production (lyocell) into the Humber Valley region of Western Newfoundland (the topic of this thesis) can be seen as one way to innovate the local forestry industry. The Humber Valley region has seen 87 years of forestry innovation, from the beginning of the pulping industry in the 1930's to the introduction of sustainable forestry management in the 1970's and the uncertain future of the increasing technological-digital age (CBPPL, 2017, Kelly, 2012). The proposed introduction of the lyocell process can be a way to innovate and diversify CBPPL current paper products to continue sustainable growth in the Humber Valley region (CBPPL, 2017).

Lyocell production will integrate the current forestry supply chain with the introduction of a new industry, textile manufacturing, in the market for sustainable fibers is growing by 3% per year (Lenzing, 2012). As there are no current lyocell production facilities in Newfoundland and Labrador, a SWOT analysis will be performed to identify if lyocell production can be considered a sustainable solution to diversifying CBPPL product and making the forest sector in Western Newfoundland competitive and to provide the Humber Valley region the ability to transition into a new development stage (OECD, 2010).

The overcapacity (of pulp) is a significant factor in the decline of the global Pulp and Paper (PP) industry and a prediction was made that by the end of 2017 the "global market pulp production will be at an unprecedented all-time high in human history" (Hein, 2017). Established PP facilities like CBPPL must adapt to the changing market by producing new and innovative products. Currently, bathroom tissue is the biggest growth area (for pulp), with the Chinese market demanding so much more than before. There is a growing demand for other items such as paper towels, wipes, facial tissue, and diapers, which can be produced using fluff pulp (lyocell) (Hein, 2017). "Man-made cellulose fibers provide purity, softness, and absorbency for a broad spectrum of nonwoven products. The capability to design tailor-made fibers with a certain absorbency profile will stimulate innovation in the nonwovens industry and foster the design of new and advanced non-woven products" (Einzmann et al., 2005).

1.3: Research Objectives

The research objectives for the current study are as follows:

1. To apply a case study approach concentrating on Corner Brook Pulp and Paper Limited (CBPPL) which will allow an understanding of the barriers and opportunities to introducing a new value-added product (lyocell).

2. Using a SWOT (strengths, weaknesses, opportunities and treats) framework to analyze the feasibility of introducing lyocell at the CBPPL.

3. To develop a forest industry specific innovative framework consisting of recommendations which will help the NL forestry industry transition towards a bio economy.

1.4: Overview of the Thesis

The thesis is organized as follows:

Chapter One introduces the concept of possible lyocell production at CBPPL through an analysis of the history of the pulp and paper industry in Newfoundland and Labrador and the Humber Valley region of Western Newfoundland. The second part of chapter one provides an overview of the research objectives, and an overview of the thesis.

Chapter Two provides a critical analysis of the relevant literature on the history, development and continuous change of cellulosic fibers, a description of the main global producers of cellulose fibers and information about Regional Innovation Systems (RIS).

Chapter Three Research Methods aims to (1) discuss the applied analytical framework, (2) identify and provide a rationale for the research approach and data collection procedures, (3) discuss participant recruitment and sampling strategies, and (4) identify and provide an explanation for data analysis techniques.

Chapter Four discusses the thesis, namely the challenges to and advantages of developing lyocell at CBPPL, by using a SWOT analysis. In addition, the bargaining power of buyers and suppliers of sustainable fibers, the feasibility of the creation of a non-woven value chain, start-up costs and current supply lines at CBPPL are examined.

Chapter Five provides recommendations for future research into developing a bio-economy in Newfoundland and Labrador based on innovation and diversification in the forest industry. The proposed bio-economy framework focuses on developing links around existing value-added (natural resource) products in Western Newfoundland, the Provincial Government, local and Canadian industry (including small and medium enterprises), academia (MUN, CNA and private colleges) in order to promote the emerging Canadian/Newfoundland bio-products industry.

Chapter Six provides a synthesis of the research findings by discussing the advantages and challenges to the development of lyocell in Western Newfoundland and providing the basis for the development of a bio-economy framework in NL. Finally, chapter six

provides recommendations for future research; an analysis of “The Way Forward,” provincial government program and a discussion on the lack of research on regional innovation and social perceptions of decline in NL.

Chapter Seven concludes the thesis with a summary of the research findings and recommendations for future research.

Chapter Two: Literature Review

2.1: Introduction

The current thesis is intended to demonstrate how lyocell (cellulose fiber) production at CBPPL can not only (1) diversify product output at the mill, but also (2) help foster an environment of innovation in the forestry industry on the Western coast of Newfoundland. The literature review is focused on the history, development and continuous change of cellulosic fibers industry, main global producers of cellulose fibers, provincial strategies for promoting forestry innovation in NL and the development of a Regional Innovation System (RIS). The literature review is based on a systematic search of peer reviewed articles, official government reports and grey literature (journal articles) covering the last three decades.

2.2.1: Main Global Cellulose Fiber Companies

As of 2017, there are three primary global cellulose fiber companies (for lyocell and viscose), Lenzing AG (Austria), Birla Group's Grasim-AB (India) and Sateri and Shandong Helon Textiles (China). Lenzing Ag operates two pulping facilities (in the Czech Republic and Austria), seven manufacturing facilities that produce four different cellulose fibers, lyocell, modal, refibra and viscose, with one research and development facility in Austria. Birla Group's Grasim-AB operates three viscose pulping plants in Canada: two in New Brunswick (NB) and one in Ontario (ON) with their main fabric processing site located in India (Grasim, 2017). Swan Fiber (brand) Company under Sateri and Shandong Helon Textiles of China, is "one of the largest viscose filament producers in the world with an annual viscose fiber production of 22,000 tons and 30,000 tons of lyocell" (CHTGC, 2017).

Lenzing AG markets their lyocell product as Tencel; these are fibers made from Asian eucalyptus and European beech trees (Lenzing 2017, Shen and Patel 2010). Lenzing AG operates several integrated pulp/fiber plants in Austria which operate on biomass energy. While Lenzing AG has a focus on value-based sustainability, its China-based viscose plants run on coal and local power (Lenzing, 2017, Shen and Patel, 2010). Lenzing AG

works hard to maintain transparency in their production process and has produced a Life Cycle Analysis (LCA) of Tencel (Shen and Patel, 2010) to evaluate the environmental impacts of production (Lenzing, 2010, Shen and Patel, 2010).

The Birla Group's, "About Grasim" webpage states that Grasim has the capability to offer the entire range of cellulosic fiber under the umbrella brand of Birla Cellulose. Birla Cellulose is a part of the sustainable Apparel Coalition and has positioned itself as a dependable supplier of cellulosic fibers. Grasim has ventured into the production of high-performance viscose fibers to help the company penetrate niche markets and grow further. Grasim's viscose fibers have been branded as Viscose Plus, High Wet Modulus Fibers (Modal) and the new generation Solvent Spun Fibers and Birla Excel (Grasim, 2017). As of 2019, Birla Cellulose and Grasim are in the process of developing a LCA of its current products.

China Hi-Tech Group Corporation (CHTGC) identifies, Sateri and Shandong Helon Textiles (SSHT) "Swan Brand" as part of the National Creative Cluster-Beijing (Songzhuang) Fashion Hub" which was established in 2011 to establish Beijing as a fashion (production) center (CHTGC, 2017). The hub allows SSHT access to pre- and future exports and imports of machinery and fiber, while allowing for the possibility for pilot projects for future fibers at their scientific research facility. Currently, Sateri and Shandong Helon Textiles Swan Brand viscose fibers are only produced in China and exported to other places such as "Hong Kong, South Korea, Japan, Turkey, Italy and Canada" (CHTGC, 2017). SSHT has not released a LCA, but has published a Sustainability Report (2017) as per the Global Reporting Initiative Standards (Sateri, 2017).

For this paper, I will be focusing on the cellulose fiber facilities located in North America: Lenzing AG Mobile Alabama and AV Nackawic (Birla Group) located in Nackawic, New Brunswick. Lenzing AG and AV Nackawic product diversification and transformation of facilities has enabled new economic growth to their rural regions. The possibilities for further innovations in sustainable fiber production and job creation make these facilities valuable to the study.

2.2.2: Lenzing AG, Mobile County Alabama Lyocell production facility

In 2004, Lenzing AG purchased the Axis, Mobile County lyocell facility from Acordis-Akzo Nobel N.V (who had operated the facility from 1998) to produce their trademarked lyocell fiber named TENCEL (Owen, 6). In nine years Lenzing's production output outgrew the original facility capacity and in 2013 Lenzing AG announced that a new 90,000 tons TENCEL fiber plant will be built next to the original lyocell production facility.

Figure 2: Lenzing AG, Mobile County Alabama Lyocell production facility (Made in Alabama,

Lenzing AG proposed that the initial startup-to-production for the new facility would take 24 months with an investment of EUR 150 Million (approx. $227,000,000 CAN) (Lenzing 2013). The new plant would increase the total Tencel fiber capacity in Axis by more than 50 percent by 2019 (Neider 2017). The new lyocell facility will create 168 new full-time jobs, increasing the current Lenzing AG local workforce from 120 to 288 (WKRG, 2017). Lawrence Specker of Alabama. Com (2016) reported that Lenzing currently has a "worldwide production capacity of 222,000 tons per year" and aims to increase that number by more than 50 percent in the next two years.

2.2.3: AV Nackawic, Nackawic New Brunswick

Figure 3: AV Nackawic, Nackawic New Brunswick (Environment and Climate Change Canada, 2016).

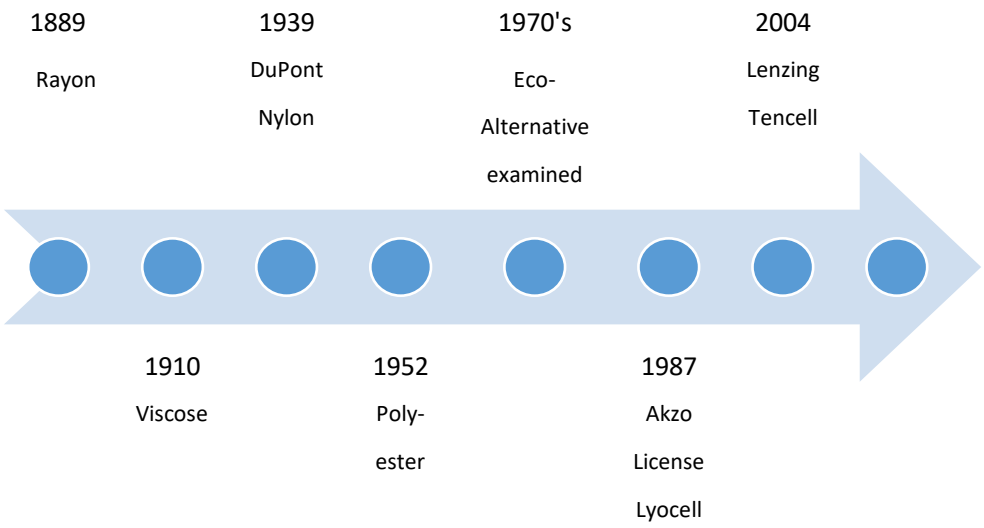
AV Nackawic Inc. has officially opened on June 15, 2006, three years after the former St. Anne Nackawic Pulp and Paper Mill filed for bankruptcy (Office of the Premier, BNB 2006). As of 2016, AV Nackawic employed 77 percent of the town's population (941 inhabitants) (Stats CAN 2016), and the mill produces approx. 500 tons of Kraft Pulp per year which are then exported to other Birla Group facilities globally (AV Group 2017). Business New Brunswick views AV Nackawic production and employment increases as a "drastic yet positive movement" in New Brunswick (BNB, 2006). In 2006, AV Nackawic's only employed 28 percent of the town's population, this is an increase of 75 percent in 10 years (BNB, 2006).

2.3.1. History of Cellulose Fibers

There are two important human-made fibers: (1) cellulosic fibers, which are based on wood pulp and (2) synthetic fibers that are oil based. The human-made fiber industry was born in 19th century France when the viscose process was first discovered to create what was first called artificial silk (viscose). It wasn't until the 1930's that the market for viscose expanded and the boom for new human-made fibers started (Shen and Patel, 2010). From 1930 to 1960 synthetic fibers such as nylon, polyester and acrylic were discovered and soon replaced the market for viscose and natural fibers like cotton and wool. The overcapacity crisis in the mid-1970's, created a swing back to natural fibers like cotton, prompting many in synthetic fiber production to research new alternatives to the viscose process. From the 1980's onwards, Lenzing AG and Aditya Birla Science and Technology Company (ABST) started investigating the possibilities of cellulose fibers and in the early

1990's the Lenzing lyocell (Tencel) process was developed as a more sustainable alternative to viscose and natural fibers (Owen, 2012).

Figure 4: Timeline of synthetic cellulose fiber development (Authors own,2017)



2.3.2: The Evolving Market for Bio-Fibers

Many technological changes have occurred in the cellulosic and synthetic textile market since 1904 (Owen, 2012). In the past 127 years, textile manufacturers such as Lenzing AG (Austria) and Aditya Birla (India) have continually innovated their textile manufacturing processes to create better fibers and products with more sustainable benefits such as "reducing toxicity impacts on the local environment" (Shen and Patel, 2010). Polymer-based bio-fabrics, such as corn-based Ingeo, Sorona and Bio-PDO and wood pulp based Viscose (rayon), Modal and Lyocell have entered the fiber market as sustainable (fiber) alternatives to oil-based polymers like nylon and polyester (Burke, 2008).

Bio-fibers are defined as fibers derived from natural sources which are fully biodegradable in nature (Asokan, Firdoous and Sonal, 2012). It is important to note that "cellulose, lignin, hemicelluloses, pectin, and wax are often the main components of bio-fibers" (Asokan, Firdoous and Sonal, 2012) and that their specific strength, low density, high toughness, good thermal properties is what makes them different from most

synthetic fibers (Asokan, Firdoous and Sonal, 2012). Lenzing AG subdivides cellulose-based fibers into two categories; (1) cotton and blast fibers (cotton, flax, hemp, jute) and (2) wood-based fibers consisting of viscose, modal and lyocell (Lenzing, 2017). Lenzing AG currently produces three wood-based cellulose fibers (lyocell, modal and re-fibra), and as stated via their website on ecological responsibility: Lenzing fibers, "combine the natural wearing properties of natural fibers with the advantages of synthetic fibers" (Lenzing, 2017).

Lyocell can be seen as one way for fiber companies to diversify into new markets and that there is potential for the creation of new, innovative products from cellulose (Bischofberger, 1997). ABSTCPL of Mumbai, India works in collaboration with their fiber businesses including AV Nackawic New Brunswick, to focus on the development of new products, processes, and technologies for cellulosic fibers (ABSTCPL 2017). Lenzing AG reported in 2016 that the consumer market for cellulosic fibers was growing by 3% a year, which encourages current sustainable fiber companies to expand their production facilities into new markets, such as North America (Lenzing AG, 2012).

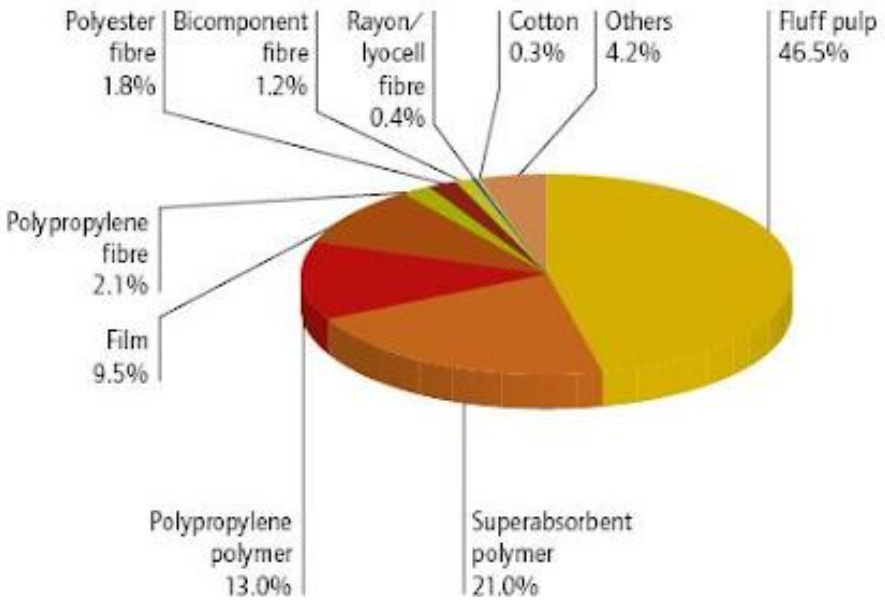
Currently, the human-made cellulose fiber industry is the world's second largest bio-refinery next to the paper industry (Shen and Patel, 2010). Growth in the cellulose fiber industry has arisen from increased global environmental awareness, technological innovation and the depletion of fossil fuels (Shen and Patel, 2010). While lyocell may cost "a third more than viscose" (rayon), Lenzing is confident that the market for lyocell will grow (Bischofberger, 1997, Burke, 2008). Bischofberger estimated that "lyocell will cover a big expectation for new products and market" (Bischofberger, 1997).

2.3.3: The Future of Bio-Fibers: Introduction of Lyocell into the Hygiene Market

There is a global trend towards disposable (non-woven) hygiene products in three major segments of the market: traditional hygiene (i.e., cloth diapers vs. disposable), medical and wipes (SP 2016). SP forecasts that the hygiene market will grow at over twice the rate from 2016 (4.4 million tonnes valued at $17.0 billion) to 2021 by 6.4% (SP 2016). Smithers Apex (SA), 2013 Future of Non-Woven report, indicates that the current market

percentages for hygiene products are as follows: “diapers and training pants (53.8%), feminine hygiene products (31.5%) and adult incontinence products (14.7%) of the global hygiene market sales in value terms (SA, 2013, Purcotton, 2017).

Figure 5: Materials Used in the Hygiene Market (Smithers Apex, 2013)



The European Disposables and Non-wovens Association (EDANA) describes disposable non-woven products in the hygiene market as single-use products. Single-use products (such as diapers) are “designed to perform only once, for a relatively short time and to deliver its performance with a minimal impact regarding raw material use and limited waste” (EDANA, 2015). SA (2013) indicates that “raw materials in single-use hygiene products can be broken into two groups: (1) raw materials (natural or human-made) used to produce nonwoven components and (2) raw materials used directly to produce hygiene products.

The first group includes mainly polypropylene polymers for spun-laid nonwovens: staple fibers polyester, polypropylene, rayon, cotton, and bicomponent fibers for carded and spun-lace nonwovens; and fluff pulp and bicomponent fibers and superabsorbent polymers for air-laid nonwovens. The second group consists primarily of fluff pulp,

superabsorbent polymers, and film used directly in diapers, training pants, feminine hygiene pads, and adult incontinence products, as well as rayon and cotton fiber used in feminine hygiene tampon production (SA. 2013).

With the increasing customer concern with sustainability in packaging and hygiene products, developing new non-polymer based non-woven products with natural absorbent fibers such as lyocell can be particularly suitable as a cotton/polymer substitute in sanitary pads, incontinence products and protection under pads (Benedetti, 2011). Several workers claim that lyocell is perfect for the growing hygiene market since it can achieve the optimum fabric characteristics from the fiber through spun-lacing, needle-punching, latex bonding, wet-laying or air-laying (this is important as most of the hygiene market is fluff pulp (Slater and Wilkes, 2013, SA, 2013). Lyocell “can also be engineered to ensure that gravitational drainage in tubs and canisters can be reduced to a minimum and ensures that the wiping layers are equally wetted out” (Slater and Wilkes, 2013).

2.4: Forestry Innovation in Newfoundland and Labrador

NL’s commercial forestry started in the 19th century with the development of sawmills to supply lumber to the growing population. It transitioned into pulp and paper industry in the late 1800’s. By the mid 1900’s there were two pulp and paper mills on the island (Heritage NL, 2015). The mills experienced a boom during the 1950’s but stagnated in the 1960’s due to Government interest in mining (Heritage NL, 2015). There has been little innovation in NL’s forestry industry since the 1970’s when the Labrador Linerboard Company set up (a short lived) corrugated cardboard manufacturing plant in Stephenville.

Hall et al. 2014 report on advancing innovation in Newfoundland and Labrador, the 2015 Canadian Council for Forest Ministers (CCFM) White paper, the 2016 State of Canada's Forests: Annual Report by Natural Resources Canada and the 2017 Forest Bio-economy Framework for Canada: Discussion Paper by the CCFM are documents that help to identify current strategies and programs for forestry innovation and development in Canada and Newfoundland and Labrador. CCFM's 2015 white paper outlines various initiatives by Natural Resources Canada (NRCan) such as the "Investments in Forest

Industry Transformation Program" (IFIT), the "Forest Innovation Program" (FIP) and the "Canada Foundation for Innovation" (CFI) programs. CCFM's 2017 Forest Bio-economy Framework for Canada report highlights the vision for the future of Canada's bio-economy sector which would include inter-governmental cooperation for the support of sustainable forest management and leadership (CCFM, 2017).

Erin Kelly's 2012 report titled "Pathways and challenges to reinventing forestry in Newfoundland" outlines Newfoundland and Labrador's forest policy and decision-making framework in the forestry sector, while the 2014 Provincial Sustainable Forest Management Strategy Report describes a framework for the sustainable use of Newfoundland and Labrador's forests. Kelly's report includes a brief overview of the history of the forest industry in Newfoundland and touches on current legislation, social values, labor markets, and forest conditions that can affect the process of innovation (Kelly, 2012). Kruger Industrial and CBPPL's 2015 Environmental Progress Report, the 2016 Sustainable Indicator Report, and the 2017 Limited Forest Management Plan Summary highlights the mill's current efforts to meet current Federal, Provincial and Global environmental targets.

The CCFM`s 2015 Forest Sector Innovation Report noted two current innovation initiatives in NL's forest industry: the Centre for Forest Science and Innovation (CFSI) and the Modeling and mapping forest structure and related fiber attributes project (CCFM, 2015). The 2014 Newfoundland and Labrador Sustainable Forest Management Strategy (PSFMS) identified that innovation and diversification is the future of Newfoundland's forestry sector.

2.4.1: Centre for Forest Science and Innovation (Corner Brook)

NL's Centre for Forest Science and Innovation (CFSI) is responsible for the development of forest-related research programs and science capacity in the province, which is consistent with the diversified renewable resource base theme of the PSFMS (Government of NL, 2014). CFSI currently is doing ecological and economic research, including forest disturbance, climate change, ecosystem dynamics, biodiversity, and

water. “Economic themes are grouped under innovation, industry, and markets, while social themes include forest-based communities, aboriginal participation and forest values” (Fisheries and Land Resources, 2017).

2.4.2: Modeling and Mapping Forest Structure and Related Fiber Attributes Project

The 2013 Modeling and Mapping Forest Structure and Related Fiber Attribute project was a collaborative effort between various governmental and non-governmental organizations to increase the competitiveness of the Newfoundland and Labrador forest industry. "This project advanced new inventory tools and methods for modeling and mapping forest structure and related fiber attributes. This research initiative successfully mapped structure and fiber attributes at the tree, stand and landscape levels intending to integrate local and regional scale map products within the forest management inventory (silviculture, forest protection management and forest regulation development) to support decisions regarding the optimal use of the fiber resource in Newfoundland and Labrador" (CCFM, 2015).

2.4.3: Provincial Sustainable Forest Management Strategy (PSFMS)

The current PSFMS identified that it would build on the previous 2003-2013 PSFMS by creating an “era of environmentally sustainable forest management that will ensure the integrity of the province’s forests, and the sustainability of the forest sector” (Government of NL, 2014). The 2014-2024 PSFMS is founded on the continued innovative development of a diversified renewable resource base” (Government of NL, 2014). Section three of the PSFMS examines the “Sustainable Harvest Levels and the Forest Industry in Newfoundland and Labrador.” It discusses topics such as provincial investments in the forestry sector, including diversification and research, CBPPL and its biomass usage, current and future forest resource inventory and potentials for industry innovations (bioenergy, bio-refining, solid wood products, domestic forest activities, and non-timber products) (Government of NL, 2014).

2.5 Regional Innovation System

Regional Innovation Systems (RIS) are considered as instruments for social-economic development through the development of regional policies to help enhance regional growth (Lim, 2006). A RIS is seen as a set of interacting private and public interests, formal institutions and other organizations that are conducive to the generation, use and dissemination of knowledge to create policy measures in favor of economic development (Doloreux and Parto, 2019). A RIS promotes development through institutional, political and social context. This thesis proposes a comparative model of RIS through the analysis of new development trends in cellulose fibers, local knowledge of the forest industry and current forest policy.

Chapter Three: Research Methodology

3.1: Research Questions and Overview of Methodology

The overall purpose of this project is to study the feasibility of lyocell development at the CBPPL in the Humber Valley by using a case study approach based on both secondary data (literature review) and primary data collection and analysis. The current research explores both the barriers to and opportunities for lyocell production at CBPPL by using a SWOT analysis which identifies comparative advantages, costs and the bargaining power of buyers and suppliers. Based on the identified barriers, a policy framework will then be developed which may help in addressing some of the complex issues affecting forestry development in the province.

3.2: Research Questions

The central research question of the current study is:

1. Is a product diversification strategy a feasible option for CBPPL?

The secondary research questions include:

2. What are the barriers to and opportunities for product diversification at CBPPL ?

3. Can successful diversification into cellulose fibers at CBPPL promote an innovative product leading the NL forest industry towards bio-economy?

3.3: Analytic Framework: SWOT

A SWOT analysis is a matrix which identifies the strengths, weaknesses, opportunities and threats to an emerging industry by developing a better understanding of all the factors impacting the project (David, 1993) (Table 1).

Table 1: SWOT Matrix Template

Strengths Examining the advantages to lyocell development at CBPPL.	Opportunities Examining current changes in technology, government policy and social acceptance.
Weaknesses Examining the potential barriers to entry.	Threats Examining how many competitors there are in the industry.

Strengths

The analysis will examine the advantages to lyocell development at CBPPL by reviewing the competitive rivalry between existing competitors in the market and the current buyer and supplier power of CBPPL (Martin 2017, Porter, 1978, HBR, 2011).

Weaknesses

The thesis will examine the potential barriers to entry: (1) economies of scale, (2) product differentiation, (3) capital requirements, (4) cost disadvantages, (5) access to distribution channels and (6) government policy will be examined in detail (Porter, 1979, HBR, 2011).

Opportunities

The thesis will examine the current and potential opportunities for lyocell development at CBPPL including changes in technology, government policy and social acceptance.

Threats

The thesis will examine how many competitors there are in an industry, how their prices and quality compare to the business being examined and how much of a profit those competitors are currently earning. This determines if CBPPL could lower their costs even more. The threat of substitutes is informed by switching costs, both immediate and long-term, as well as a buyer's inclination to change (Martin, 2017).

3.4: Research Design: A Qualitative, Case-Study Approach

This qualitative and exploratory research uses a case study research design (Yin, 2003, Creswell, 2007). Due to the significance of Corner Brook's reliance on the pulp and paper industry, and the abundant availability of renewable forestry resources in the province, CBPPL is a unique case study that warrants in-depth analysis. How and why questions favor the use of case studies, and what questions are a justifiable rationale for conducting exploratory research – this is consistent with the research questions of the current project and supports the decision to use a case-study approach (Zucker, 2009). A case-study approach was also used to show how previous pulp and paper towns (Nackawic, NB and Axis, USA) have effectively transitioned their mills into pulp and fiber mills (rayon and lyocell).

3.4.1: Data Collection Procedures: Semi-Structured Expert Interviews

The primary method of data collection for the current project was semi-structured expert interviews (Appendix A). The semi-structured interviews involved a series of open-ended questions based on topics the researcher wants to cover: the local (Humber Valley) forestry industry and the possible implications, including barriers and opportunities of lyocell development in the region. The OECD (2014) suggests the interviews should feel like a discussion structured around two major sets of questions. The first set should be gathered from the literature, policy review, and RIS analysis. The second set should include specific questions targeted to draw out issues relevant to the topic at hand to gain a better understanding of the key players and their roles within the forest industry.

3.4.2: Interviews

All interviews for the project were conducted between June 1, 2017, and December 15, 2017. Most interviews took place at a private location of the participant's convenience (i.e., participant's office, boardroom, etc.). Each interview lasted approximately 45-75 minutes in length; a time limit was set at 90 minutes for each interview. With the permission of each participant, as set out in the informed consent process, each interview

was recorded digitally. The researcher used two recording devices for each interview, in the case that one failed. Interviews were digitally recorded to be transcribed.

3.4.3: Ethical Considerations

The researcher has followed the prescribed procedure for ethical clearance of the project. The Grenfell Campus Research Ethics Board (GCREB) gave ethical approval to this project, stating that participants in the current study faced no financial, physical, or psychological risks. All datum collected for the project were stored on a password protected flash drive, and data were organized according to each participant's pseudonym chosen by the researcher. All publications and reports resulting from this research do not use participants' names unless explicit consent was given by the individual. Additionally, all research participants were given the option to remove their data from the current project up to an official withdrawal date of January 15, 2018 set by the researcher.

3.5.1: Research Participants: Target Population

The target population for the current project was experts in the Newfoundland and Labrador forestry, product development and lyocell. These experts possessed extensive knowledge of Western Newfoundland's forestry industry, the community of Corner Brook city and CBPPL. To provide a balanced perspective, participants were recruited evenly from the following four categories: academics, government, non-profit organizations/community groups, and the private sector. The search for experts was limited to those who possessed specific knowledge on the forestry sector of Newfoundland and Labrador.

3.5.2: Overview of Target Groups in Newfoundland

Participants were only included in the study if they possessed a minimum of two years' experience working within the forest industry as described in the invitation letter. The only participants who were excluded from the project were those who were unable to communicate effectively in English, as this was the language of the investigator and the language in which interviews were conducted. The researcher invited 20 experts in total to participate in the study (a limited number of participants refused to participate – the

remainder simply failed to respond to the research invitation), ultimately interviews were conducted with 7 individuals; this consisted of one academics, two government representatives, three representatives of community groups, and one private sector actor. Only one interviewee agreed to wave amenity (former Corner Brook Mayor Charles Pender).

3.5.3: Recruitment of Participants

The data collection period for this project began on June 20, 2017. Prior to this date, an original group of 'expert' participants were identified by the researcher based on specified criteria (Section 3.5.2). The participants identified were then sent a copy of the recruitment letter via email. The recruitment letter informed participants of the objectives of the study, what would be expected of them, details regarding how results would be reported, and an invitation to participate in an interview either in-person or via telephone, depending on the participant's availability on a specified date.

As outlined in section 3.5.4, snowball sampling was an additional sampling technique employed in this study. Therefore, as additional participants were identified throughout the data collection period (June 20th, 2017 – January 15th, 2018), they were invited to participate with the recruitment letter described previously.

Once an expert agreed to participate in the study and a time and date were set for the interview, participants were then sent a copy of the interview questionnaire to familiarize themselves with the interview content. Participants were also sent a copy of the informed consent form before the interview. This form provided greater detail on the objectives of the study; what was expected of participants; a full description of the project's risks and benefits; measures taken to ensure confidentiality, anonymity, and the participants' right to withdraw; as well as a section to obtain explicit consent to participate.

3.5.4: Sampling Techniques

The primary sampling technique employed in the study was expert sampling. Expert sampling is defined as a positive tool to use when investigating new areas of research, to

garner if the further study would be worth the effort (Etikan et al., 2016). It is a purposive non-random sampling technique which allows for the deliberate choice of participants due to the knowledge the participant possesses (Etikan et al., 2016).

Snowball sampling was the secondary sampling technique used as many of my experts referred me to other experts or community leaders who may benefit from my research. Snowball sampling has been utilized primarily as a response to overcome the problems associated with understanding and sampling private firms and higher-level government employees (Sage, 2004).

3.5.5: Challenges Encountered in Securing Research Participants

The Gatekeeper Effect

Gatekeepers are individuals who have a central role in deciding the fate of those who wish to conduct social research (Broadhead and Rist, 1976). They are individuals who can get a researcher into a setting or can facilitate access to participants (Adler and Clark, 2014). The pivotal concern for the gatekeeper is reciprocity, determined by what benefits the research can offer the agency or the particular careers of the gatekeeper and other managers (Broadhead and Rist, 1976). Adler and Clark explain that gaining access to participants is an "ongoing process- as people check out researchers to figure out if they are to be trusted, and then be gradually let into parts of their organization" (Adler and Clark, 2014).

During the participant recruitment process, many organizations and individuals were emailed information letters, and a few interviews were arranged. From these interviews, two participants copied my information letter and a sample of the literature review to individuals I initially had trouble contacting. Using these individuals as "gatekeepers," I could access information and new participants that I wouldn't have been able to reach otherwise.

3.6.1: Data Analysis Techniques: Content Analysis and Disclosure Indices

This research combined qualitative data gathered from primary (interviews, emails) and secondary sources (journal articles, policy briefs, press releases) with quantitative data (statistics from Statistics Canada/Newfoundland, economic data). Content analysis (for social and environmental reporting) is best when incorporated with other research methods; attempts to combine different methods of data collection can be outlined in two broad themes: (1) use of content analysis of annual reports together with semi-structured Interviews and (2) combination of various types of information sets with content analysis and other research methods (Guthrie and Abeysekera, 2006).

3.6.2: Content Analysis

The focus of qualitative content analysis is "the characteristics of language as communication with attention to the content or contextual meaning of the text (Hsieh and Shannon, 2005). The collected data is broken up into "conceptual chunks that are then coded or named" into categories (Wilson 177). Content analysis can be divided into three subsections; (1) conventional content analysis (to describe a phenomenon when there is limited research literature), (2) directed content analysis (when prior research is incomplete or could benefit from further description) and (3) summative content analysis (to expose the contextual usage of words) (Hsieh and Shannon, 2005).

This research incorporates the conventional content analysis approach with a relational analysis. The pairing of a complementary relational analysis with a content analysis allows for the introduction of key relational forms in the research (descriptive, comparative, causal, reciprocal, conceptual and contextual).

Chapter Four: Findings

4.1: Introduction to Findings:

Utilizing a SWOT analysis, several challenges, opportunities and distinct advantages have emerged; these "findings" will be discussed under the following headings: (1) challenges to the development of lyocell at CBPPL, (2) bargaining power of buyers and suppliers and (3) distinct advantages of lyocell production at CBPPL.

4.2: Challenges to the Development of Lyocell as Product Diversification at CBPPL

There are several challenges to the development of lyocell in Western Newfoundland namely geographic location, limited access to new distribution channels, cost disadvantages independent of scale, medium cost of startup and (early) high costs of production (HBS, 2017).

4.2.2: Location and Seasonality

Responses of most participants have indicated that Newfoundland's location, 3,083 km from mainland Canada and only accessible by airplane or ferry is one of the challenges to lyocell development. The cost of transporting the finished product would be even higher as it must travel further to reach the consumer. Due to Newfoundland and Labradors proximity to the Labrador and Gulf currents (which bring warm and cold air/currents), the weather is mild but with short summers and long winters, the trees growth/harvesting season is limited.

4.2.3: Creation of a non-woven value chain

According to the Government of Canada's Business and Industry Profile (2012), Canada's textile industry is mainly located in Quebec and Ontario. Our textile industry "is heavily capital-intensive, uses natural, artificial and manmade fibers and filaments, and supplies a wide range of value-added products to over 150 consumers (household and industrial) in Canada and worldwide" (CAN, 2012). The Canadian Textile Industry Association

(2013) indicated that current economic pressures and global competition have caused the Canadian textile industry to make substantial changes in their operations. Canadian textile companies have moved toward value-added production in niche markets where they can take advantage of significant research and development capabilities (CTIA, 2013).

4.2.4: Access to distribution channels

Lenzing Mobile Alabama and AV Nackawic belong to pre-existing global distribution channels. CBPPL could expand from newsprint distribution channels into non-woven textile distribution with Ontario and Quebec, who have established textile industries. Ontario and Quebecs current non-woven product distribution channels are Personal Care (Infant Care, Child Care, Infant and Child Wipes, Feminine Care and Adult Care), the Consumer Tissue (Family Care) and their Business–to–Business KC Professional, Health Care and Nonwovens (Kimberly Clark, 2017, Reckitt Benckiser, 2016).

KC's 2016 Sustainability Report indicated that global forests and fibers, waste and recycling and greener supply chain were three of their 2022 goals. By 2022, KC hopes to innovate their tissue products to reduce their natural forest footprint (KC, 2016). In 2015 KC cellulose fiber purchases were derived from certified sustainable suppliers. In the past, KC has incorporated bamboo and wheat straw into their Green Harvest products. KC is "committed to reducing their impact on natural forests and is searching for alternatives to traditional sources for manufacturing paper towels and tissues" (KC, 2016). RB's goal for 2020 is to have "one-third of our net revenue generated by more sustainable products" (RB, 2016). RB products are value-checked by the Forest Trust and RB Sustainable Report for 2015 indicated that they believe in "responsibly sourcing (of) all their natural raw materials" (RB, 2016).

4.2.5: Cost disadvantages independent of scale

Since the lyocell process is different from the Kraft paper process, current CBPPL employees will have to be trained in the lyocell production processes. Employees will have to be trained to use the new technology needed for sustainable fiber filtration and

separation, new computer programs (as the lyocell process is automated) and be updated on new health and safety measures.

4.2.5.1: Cost of startup

Kruger's 2015 Trois-Rivieres conversion to a cellulose filament plant had "a $250-million price tag" (MacDonald, 2015). Lenzing AG invested EUR 275 million (approx. $412 million CAN) to expand its Mobile, Alabama lyocell production facility in 2016. The former Nackawic pulp and paper plant was purchased by Aditya Birla and Tembec in 2004. Aditya Birla spent $26.75 million in 2005 to convert the former pulp and paper facility into a viscose producing facility (Pulp and Paper 2006). In 2006, the Government of New Brunswick loaned $20 million to AV Nackawic to assist with the retrofit and expansion of the former pulp and paper mill. There is also a possibility of a partnership with FPI's Transformative Technologies Program (TTP) and NRCan's Investments in Forest Industry Transformation Program (IFIT) for funding.

CBPPL currently has access to a chemical digester (which is needed to convert the cellulose) and adjacent warehouses that can be converted into a space for lyocell production. This, paired with access to a year-round port and access to shipping/transport vessels will significantly reduce the startup costs (Participant 1, personal communication, June 20, 2017.)

4.2.5.2 Other startup costs

The Newfoundland and Labrador Industrial Approval Fees Policy (2016) states that there is a $4,500 manufacturing approval fee required for manufactures before startup (MAENL, 2016). The Industrial Compliance section of the Department of Municipal Affairs and Environment "develops and administers Certificates of Approval for the construction and operation of various industrial facilities" (MAENL, 2017). These also contribute to the cost of time spent on developing a project (Appendix B).

4.2.5.3: Certification costs and requirements

CBPPL “is (currently) certified to the International Standards Organization (ISO) Environmental Management System standard 14041:2015, Environmental Management Systems, the Canadian Standards Association (CSA) Sustainable Forest Management standard, and Forest Stewardship Council (FSC) Boreal standard” (CBPPL, 2017). According to Shen and Patel, Lenzing AG are certified by ISO 14040: 2006, Environmental Management: Principles and Framework for LCA at $160 CAN (ISO 2017) and ISO 14044:2006, Environmental Management-LCA at $215 CAN, which is required for LCA (ISO 2017, Shen and Patel 49, 59). As of 2017, CBPPL is up to date with all the necessary certifications (CBPPL, 2017) (Appendix C).

4.2.5.4: Cost of production

In 2012 it was assessed that, a new lyocell plant would cost $4500 Can per annual ton of capacity compared to $2900-$3000 Can for viscose and $2000 Can for polyester (Owen, 2012). In 2016 Lenzing Ag, Mobile Alabama facility produced 51,000 tons of lyocell at the cost of $229,500,000 Can (Lenzing 2016).

Lenzing Ag reported in 2016 that the cost of production could vary due to slight changes in the costs of raw materials. Lenzing identified that there was a drop in “crude oil and energy prices at the beginning of 2016 which led to substantial price reductions for raw materials during the entire year, while the biochemical market saw a slight decrease in the cost of Xylose and Acetic acid” (Lenzing, 2016). The favorable costs of production in 2015 allowed Lenzing's total fiber sales volume to rise by 1.4 percent in 2016 (Lenzing, 2016).

4.2.5.5: Estimated cost of Start Up

In 2005 Aditya Birla spent $26.75 million to convert the former pulp and paper facility into a viscose producing facility (Pulp and Paper 2006). According to respondants’ estimates, it would cost CBPPL $4500 to produce one annual ton of lyocell fluff pulp. To start up a lyocell production facility CBPPL would have to also pay the $4,500

manufacturing application fee, be up to date with forestry certifications ($373) and invest $121,325 for new equipment. (Appendix D)

4.3: Bargaining Power of Buyers and Suppliers

Michael Porter (2008) suggests that “buyers can be powerful if they have negotiating leverage relative to industry participants such as large volume buyers” (Porter, 2008). CBPPL should not only pay attention to large volume buyers (secondary processors) but to “intermediate customers” as well” Intermediate customers gain bargaining power when they can influence the purchasing decisions of customers downstream” (Porter, 2008), such as customers influencing the trend towards sustainable hygiene products.

Dominant suppliers on the other hand “can use their negotiating leverage to charge higher prices or to demand more favorable terms from industry competitors” (HBS, 2017). It is important to note that if there are only a few suppliers (one or two) of an essential input (wood, pulp chips), or if switching suppliers is expensive or time-consuming, the supplier group wields more power (HBS, 2017). From data retrieved from interviews and secondary data, CBPPL has a limited number of suppliers, as they obtain most of their wood supply from Crown land.

4.3.1: Bargaining Power of Buyers

Diversifying CBPPL current product to lyocell would introduce CBPPL to a new market. To compete and gain recognition from current buyers, CBPPL would have to reposition themselves as a new lyocell production facility in Eastern Canada. Persuading Ontario and Quebec’s textile mills to switch to a new product calls for patience, commitment, and a willingness to live with periods of low or negative returns while production costs are brought down, and quality deficiencies are ironed out (Owen, 2012).

According to the Government of Canada's Business and Industry Profile (2012), Canada's textile industry, mainly located in Quebec and Ontario, "is heavily capital-intensive and uses natural, artificial and manmade fibers and filaments while supplying a wide range of

value-added products to over 150 consumers (household and industrial) in Canada and worldwide" (CAN, 2012).

4.3.2: Bargaining Power of Suppliers

Crown Land- NL

Currently, CBPPL manages approximately 1.5 million hectares of Crown land (land belonging to the government of NL). CBPPL's "timber limits span from the Codroy Valley (southwest NL) to Sop's Arm (Northern Peninsula), and east to Gander (central Newfoundland) consisting of provincial Forest Management Districts 5, 6, 9, 14, 15, and 16" (CBPPL, 2017). As of 2016, CBPPL has an "annual allowable cut of approximately 775,300 m3 per year and a harvest of approximately 530,000 m3 per year" (CBPPL, 2017) (Appendix D).

Sawmills

CBPPL's 2016 report indicated that CBPPL has "sawmill exchange agreements with Burton's Cove Logging & Lumber (BCLL) and Sexton Lumber (SL). CBPPL indicates that (national) lumber prices remain high and will positively affect on the sawmill industry again in 2016-2017" (CBPPL 2017). It is important to note that "the distance from CBPPL to SL has made it economically challenging to exchange high numbers of logs with SL. Unfortunately, in 2016, the company continued to have annual allowable cut constraints in central NL and as a result, saw log deliveries from CBPPL operations to SL continued to decline. In 2018 CBPPL is expected to increase harvesting activity in central NL, which should lead to increased saw log deliveries to SL (estimated)" (CBPPL, 2017).

4.4: Distinct Advantages to Production at CBPPL

According to the expert's opinions there are three significant advantages to developing a new product at CBPPL, (1) low Energy Costs (CBPPL owns its own hydropower plant, the Deer Lake Power Plant), (2) access to Crown Land and raw material and (3) pre-existing infrastructures (chemical digester). CBPPL owns and operates the Deer Lake and

Watson's Brook power plants which provide the mill with low-cost energy (Participant 4, 8/24/17). Kruger Energy indicated that the two plants meet "approximately 75% of the mill's electric power requirements" (Kruger Energy, 2017). As mentioned in section 4.3.2, CBPPL manages approximately 1.5 million hectares of Crown land with a 775,300-allowable cut. CBPPL's partnerships with various Newfoundland based sawmills also provides access to the raw material needed (woodchips). CBPPL currently has an unused chemical digester for Kraft paper products that could be retrofitted into a digester for lyocell production (Participant 4). Participant 4 also mentioned that there are several unused buildings at the CBPPL complex that could be utilized for future lyocell production. CBPPL is also located close to the commercial port of Corner Brook that has several unused buildings that could be used for lyocell production (CBPC, 2017). In a meeting with mill management there was interest in developing lyocell and newspaper at CBPPL in the future.

4.4.1 Opportunity outlook

Lyocell development at CBPPL would allow for the development of an Industrial Demonstration Center (IDC) in Corner Brook. An IDC is a "facility where cutting-edge bio-resource innovators and researchers can test their products before bringing them to full market scale," allowing Corner Brook to become a center for innovation (NSDNR, 2015).

The proposed development of lyocell at CBPPL has the potential to promote transition towards bio-economy in NL. Within the proposed NL bio-economy (Chapter five) forestry products are converted into consumer and industrial products, such as Lyocell through investments and marketing of biotechnologies and the expansion of green employment opportunities (NRCan, 2018, NB Forest, 2013).

4.4.2 Threats to development

Currently NL does not have any policies relating to the development of a potential bio-economy. The Government of Germany indicated in its 2014 National Policy Strategy for the Bio-economy report that there is the danger of "developing a fragmented policy

environment with incoherent framework conditions and possible conflicts between goals at the initial development of a new technology. There must be communication between politics, business, science and civil society at the beginning stages to minimize the risks of conflict" (Government of Germany, 2014). Recommendations for the development of a bio-economy in NL will be discussed in section 6.4.

4.5: SWOT Matrix

Table 2: SWOT Matrix

Strengths Low energy cost, access to Crown land and raw materials, access to year-round seaport, pre-existing infrastructure (digester).	Opportunities Innovation via IDC, development of a bio-economy in NL.
Weaknesses Location and seasonality, costs (transportation and start up), limited access to distribution channels, limited textile manufacturing in Canada.	Threats Lack of bio-economy policy in NL.

Chapter Five: Scenario for a Potential Bio-economy Framework for Newfoundland

One of the working hypotheses of this thesis is the product diversification at CBPPL, through introduction of lyocell production, has the potential to promote a transition to bio-economy in the province. The bio-economy is "an economy where the basic building blocks for materials, chemicals, and energy are derived from renewable resources" (NB Forestry, 2013). Within the proposed NL bio-economy forestry products are converted into consumer and industrial products, such as Lyocell through investments in biotechnology, successful marketing of biotechnologies and the promotion of green employment opportunities through the NL department of Advanced Education, Skills and Labour. Here technical bio-developments would make the conversion of biomass more efficient, boosting industry and exports within Newfoundland and Labrador (NRCan, 2018, NB Forest, 2013).

For a potential bio-economy to succeed in NL, collaboration and communication between multiple layers of government, private and public industry, academia and the public are required. The public will have to become informed about the economic potentials for sustainable development within the province. Public support for the development of the bio-economy will be of benefit for the development of future sustainable business ventures within NL.

Figure 6: Proposed Bio-Economy Framework (Author's Own Concept, 2018)

The proposed bio-economy framework for NL focuses on a collaborative approach around existing value-added (natural resource) products in Newfoundland, (Porter, 2008).ween the Provincial Government, local and Canadian industry (including small and medium enterprises), academia (MUN, CNA and Private colleges) in order to promote the emerging Canadian/Newfoundland bio-products industry. By building on Newfoundland's renewable natural resources and existing industry and (rural) community networks, a framework for the development of Newfoundland's bio-economy can be utilized.

The proposed bio-economy framework for NL will include various public and private sector actors including the Departments of Advanced Education, Skills and Labor, Municipal Affairs and the Environment, Tourism, Culture, Industry, and Innovation, private business owners and investors and the public. For the proposed bio-economy framework to succeed, support is needed from the various actors, support from members of government (MHA's, Ministers and the Premier), academia (research and technological development), investors (private or government) and small and medium enterprises (including sawmills, transportation companies and local entrepreneurs). All these actors become stakeholders in a process of social value creation (Mazzucato, 2018), which can lead not only to the financial success of the enterprise which has diversified by introducing a new product (lyocell), but also to achievement of broader social and

environmental goals for the province, giving it a more sustainable ‘competitive advantage’. Seen in the light of the stakeholder theory of business (Freeman et al, 2010), the success of the framework depends not only on the global demand for forest bio-products but the coordination of marketing and promotion of green industry in NL.

The CCFM has created four pillars of sustainable forest bio-economy in 2017, on which the policy design of NL’s proposed bio-economy is based, including the community, the supply of forestry products, the demand for the bio-product and support for innovation (CCFM, 2017).

It is through the development of a bio-economy framework that lyocell production at CBPPL will most likely succeed. The marketing and promotion of green industry in NL to Canada and the rest of the world would allow CBPPL access to the domestic and global markets for lyocell.

The four pillars of support for the potential bio-economy are adapted from the CCFM 2017 “Bio-economy Framework for Canada” discussion paper. The CCFM paper identified that community, support, supply and demand and support for innovation are important for the success of the proposed bio-economy. The four pillars are discussed below. The example policy measures are adapted from the CCFM paper and have been modified to reflect the current situation in NL.

Pillar 1: Community

It is essential to recognize the role of the public through the establishment of two objectives: the advancement of green employment through a partnership with local SME and the Department of Advanced Education, Skills and Labor and the promotion of partnerships with Qualipu First Nations as indigenous peoples understand the intrinsic value of the local forest and can pass that knowledge to others.

Example policy measures:

· Provide skills development to ensure workers can participate in the emerging bio-economy.

· Work with the municipalities within the Bay of Islands to reduce the reliance on newsprint production.

Pillar 2: Supply of forestry products and bioproducts

The CCFM suggests that private woodlot owners can participate in the bio-economy by offering flexible and innovative approaches to the supply of fiber (CCFM, 2017). Partnerships with Federal, Provincial and private landowners and established and growing forestry companies within NL will be important in the success of the proposed bio-economy. To ensure the success of the potential bio-economy, new quality standards and certifications as per the Sustainable Forestry Initiative (SFI, 2015) will be put in place to ensure forestry organization's compliance with the green industry. The SFI 2015-2019 Chain-of-Custody Standard applies to any organization that sources, processes, manufactures, handles, trades, converts or prints on forest-based products (SFI, 2015).

Example policy measures:

· Develop cross-jurisdictional platforms to increase the efficiency of commercializing new bio-products.

· Promote the development of classifications for biomass and enhance the forest inventory.

Pillar 3: Demand for the bio-product

Demand goes beyond the global need for sustainable bio-products. To properly manage NL's potential bio-economy, the public as consumers first needs to be aware of the benefits of going green. Public campaigns through the Departments of Advanced Education, Skills and Labor, Municipal Affairs and the Environment and Tourism, Culture, Industry, and Innovation will raise public awareness and create a local demand for NL's bio-products.

Example policy measures:

· Create a media campaign to educate the public about the benefits of the bio-economy.

Pillar 4: Support for innovation

For NL's potential bio-economy to succeed, support (financial, material, research) is needed from both the private and public sectors. The creation of an industrial demonstration facility in Corner Brook (supported by federal and provincial private investors) would allow new entrants to the bio-economic access to financial and material support (including researchers). The CCFM suggests that the creation of research hubs or clusters will create stronger links and partnerships between firms and government within the region (CCFM, 2017).

Pillar 4.a: The development of Financial Mechanisms

The CCFM Forest Bio-economy Framework (2017) noted that "financing the forest bio-economy requires significant capital investments and knowledgeable, strategic partners" (CCFM, 2017). The Business Development Bank of Canada provides financing for small and medium enterprises, while the FIP (Forestry Innovation Plan), CWFC (Canadian Wood Fibre Center), and IFIT (Investments in Forestry Industry Transformation) provide funding for investments in forestry industry transformation.

Example policy measures:

· Communicate the advantages of investing in CBPPL's future lyocell production.

· Develop a bio-economy hub to create access to data and resources (technical demonstration facility: section 5.1).

· Develop provincial funding programs for the commercialization of future bioproducts.

5.1: Possibility of an industrial demonstration facility (IDF) in Corner Brook

The port of Corner Brook is a sheltered, deep-water port that is accessible year-round. The Port of Corner Brook Corporation (CBPC) explains that this makes Corner Brook well suited for shipping and industrial activity. Building on the IDC model in Brooklyn, NS, the port of Corner Brook could be positioned for the development of an industrial demonstration facility (IDF) in partnership with CBPPL.

The IDC described an IDF as an “industrial demonstration facility where bio-resource innovators and researchers can test their products before bringing them to market” (NSDNR, 2015). While the IDC gathers access to raw materials from the Brooklyn Power Plant, the proposed Corner Brook IDF could access materials (wood fiber, biomass) from the nearby CBPPL and have access to low-cost energy from the Deer Lake power plant.

According to one of the interviewed experts the proposed IDF will have access to a “1200-foot main berth (and minimum dockside depth of 30 ft), so the port can accommodate very large vessels. The high capacity (53 ton) fixed pedestal crane enables loading and offloading of various cargo, including containers. The port facility also includes a ro-ro ramp and several portside buildings (which can be leased)” (CBPC, 2017). The Corner Brook Port “is also directly connected to the Trans-Canada highway via a four-lane arterial road which provides easy access to the highway and connection to the Deer Lake Airport which is 50 km from the port” (CBPC, 2017).

5.2: The LEADER Model

José María Díaz-Puente, Adolfo Cazorla-Montero and Ignacio de los Ríos-Carmenado (2009) explain that the LEADER (Liaisons entre activités de Development de L’Economie Rural) model is like a “relationship among the agents of a territory (both public and private) for elaborating and carrying out a collective strategy (Díaz-Puente, Cazorla-Montero, and los Ríos-Carmenado, 2009).

The LEADER model is one way for the Government of Newfoundland to promote sustainable development, notably the development of the bio-economy. The LEADER approach would allow local rural areas to assume greater control of sustainable development by reorienting development around local resources and by setting up structures to sustain the local development momentum after the initial government intervention (Dargan and Shucksmith, 2008)

5.3: Focus on Education and Training

Heather Hall et al. recognized the need for "a better connection between postsecondary institutions and industry" in Newfoundland and Labrador (Hall et al., 2014). The revitalized innovation in Newfoundland, the development of specialized courses and programs in business, management, sustainable development, innovation and leadership at MUN and CNA will help provide a new generation of innovative scholars. Collaboration is needed between government apprenticeship certification programs, post-secondary Co-op and internship programs, secondary schools (high schools), the (NL) Department of Advanced Education, Skills and Labor (AESL) and local industry to promote sustainable industry and the emerging bio-economy as future job opportunities.

The 2017 SRC (Smart Rural Communities) analysis of Newfoundland and Labrador rural areas identified that low education and lack of skills stems not only from low participation rates and transitional youth, but the long distances between rural communities and education centers play an essential role in low education rates. SRC noticed that the "level of schooling declines as the distance between rural areas and population centers increases" (SRC, 2017). The SRC believes that increasing and tailoring education and training opportunities (both secondary and post-secondary) to work specific to rural areas may help retain youth and increase human capital. This would also help improve the capacity of local populations to support local businesses, adding to each community's economy.

Newfoundland's Department of Advanced Education, Skills and Labor (AESL) currently offers employment and financial assistance for those looking for work, including funding for (re) training programs such as adult basic education and short-term training courses. AESL also offers online workshops to employers and individuals including workshops on labor market information, management, and business diversity. It is essential to include AESL in the promotion of current (and future) post-secondary bio-economy related programs such as MUN's Master of Environmental Policy, Masters of Boreal and Agricultural Sciences, Global Engineering Certificate program, Process and Ocean and Naval architectural engineering programs. Example also include, Grenfell Campus' Bachelor in Environment and Sustainability and B.Sc in Environmental Sciences and

CNA's diploma and certificate programs in Forest Resources, Wildlife Management, Geomatics, and Engineering.

5.4: Focus on a collaboration between Academia, Government and Industry

When Hall et al. conducted their 2013 "Innovation Summit" in St. John's, participant discussion highlighted five critical gaps in provincial innovation: (1) a lack of awareness, knowledge and culture of innovation, (2) a lack of collaboration and strategy between key stakeholders in the current Quadruple Helix Innovation System (business, community, postsecondary education and government), (3) a lack of business and management skills necessary for innovation, (4) a policy disconnect between business and government and (5) a lack of government policy towards innovation (Hall et al., 2014). To solve these issues, Hall et al. suggested the use of Research and Innovation Strategies for Smart Specialization (RIS3)" (Hall et al. 2014).

5.5: Research and Innovation Strategies for Smart Specialization

Mikel Landabaso (2012) in a presentation for the United Nations Economic Commission for Europe explained that RIS3 is mainly about how the policy process selects and prioritizes fields or areas where a cluster of activities should be developed by letting entrepreneurs discover the right domains of future specializations.

There are six steps to RIS3; (1) analysis of regional potential for innovation-driven differentiation, (2) design and governance that ensures participation and ownership, (3) elaboration of an overall vision for the future of the region (Western NL), (4) selection of priorities for RIS3 and defining the objectives, (5) describing the policy mix and creation of roadmaps and action plans and (6) integration of monitoring and evaluation mechanisms.

A strategy based on the RIS3 concept could help define the potential for lyocell development at CBPPL by recognizing its economic potential within Western NL. Lyocell development in Western NL could be one of the action plans for the development of the bio-economy in NL (Appendix E).

Chapter 6: Discussion

The study set out to explore the possibility of lyocell development at CBPPL and has identified barriers and potential benefits to the incorporation of lyocell production at CBPPL (and in Corner Brook) The introduction of lyocell at CBPPL should be a process based on stakeholder collaboration and support. Successful diversification at CBPPL could be a first step in transition to bio-economy in NL. The following recommendations can contribute to a cultural shift that can then pave the way for product differentiation at CBPPL.

From the research findings, several policy approaches for the development of a Bio-Economy Framework for NL were indicated. The general theoretical and empirical literature on this subject in the context of NL is inconclusive in the emerging bio-economy discourse. The central research question of the study was:

- Does the current competitive environment for cellulose-polymers support the conversion of the Corner Brook Pulp and Paper mill?

Secondary research questions:

· What are the barriers and opportunities for product diversification at CBPPL using the SWOT analysis framework?

· Can successful diversification into cellulose fibers at CBPPL promote an innovative culture leading the NL forest industry towards bio-economy?

The sixth chapter of this study will re-examine the importance of the problem at hand; discussing why it is essential for CBPPL to diversify its product and contribute towards the emerging Canadian bio-economy. Secondly, the chapter will acknowledge the limitations of the study. Thirdly, the chapter will reconsider the theoretical and policy implications of the study providing some policy recommendations. Finally, the chapter will conclude with recommendations for future areas of research.

6.1: Significance of the Problem: Corner Brook's Reliance on the Pulp and Paper Industry

Corner Brook has been a "paper making town" for 94 years. Since the mill's opening in 1923, Corner Brook's pulp and paper mill has been producing newsprint. The only major innovations at the mill have been for the improvement of the papermaking processes. The new millennium has seen a decline in the production and export of both pulp and newsprint due to technological developments such as digital newspaper subscriptions and newspaper apps.

Janet Newbury and Katherine Gibson (2014) inferred that the decline of the Canadian pulp and paper industry has left many "single industry towns such as Corner Brook with what they perceive as major material and symbolic challenges to redevelopment" such as strong community ties and symbolic attachments to physical structures, such as CBPPL's mill house (Newbury and Gibson, 2014). Jan van der Borg and Antonio Paolo Russo (2005) explain that culture "is accumulated, experienced and rooted in the DNA of a community." This statement proves that these material and symbolic challenges can prove to be tough barriers to economic redevelopment (Van der Borg and Russo, 2005). The citizens of Corner Brook are proud of their connection with CBPPL, which has embodied a way of life for many families, creating the phenomena of "multi-generation millworkers who enjoyed work for life" (Participant 2, 7/24/2017). While the inhabitants of Corner Brook are aware of the decline of the pulp and paper industry, there is still a communal hope that CBPPL will withstand the changes and persevere.

Newbury and Gibson suggest that the downsizing in the pulp and paper industry most often leaves a void in "all single industry resource towns," which leads to the question of "what happens now?" (Newbury and Gibson, 2014). Here, single resource communities like Corner Brook must engage and educate their citizens in the new opportunities for future sustainable developments.

6.2: Limitations of the Study

The following section will acknowledge and explain the limitations of the study including longitudinal effects, implications of self-reported data, access to expert participants, and a lack of prior research studies on the topic.

Longitudinal effects

Due to the short data collection period (June 2017-December 2017), a SWOT analysis was conducted, and secondary research on the possible development of lyocell was conducted. Due to the time constraint, only a few experts in the field of bio-materials, pulp and paper industry and NL forestry sector could be interviewed. Due to this limitation, the data collected may not be representative of the state of the process of diversification at CBPPL and the transition to a bio-economy over a more significant period.

Self-reported data

As this research included several questions that may have been considered socially sensitive to the respondents, the chance of a socially desirable response (SDR) occurring was high. SDR is defined as "the tendency for people to present a favorable image of themselves on questionnaires and in interviews as the response to socially sensitive questions (Van der Mortel, 2008). To combat the likelihood of SDR occurring, respondents were informed before the interview of the possibility of anonymous reporting, to preserve their identity.

Access to experts

As described in Chapter Three, difficult access to potential expert participants emerged as a limitation of the study. Twenty experts in total were asked to participate in the study however only seven experts responded (one academics, two government representatives, three representatives of community groups, and one private sector actor). Due to the time restraints of the study, no new experts could be contacted.

Lack of prior research

While research has been conducted on the decline of the Canadian pulp and paper industry, there is limited research on the development of bio-fibers as alternatives to pulp and paper in Canada. There is also a lack of peer-reviewed social science and policy research on the development of a bio-economy for NL. For these reasons, the researcher had to rely primarily on governmental sources of information, as well as peer-reviewed evidence from other jurisdictions (B.C, Alta., ON, QB, NS, Finland).

6.3: Synthesis of Research Findings

The study used a primarily qualitative, case-study approach, to understand the potential for lyocell development in Newfoundland and Labrador. Secondary research has been done using scholarly articles, government documents, press releases and quantitative data from Lenzing Austria and Stats Can. Expert elicitation was also utilized as the primary form of data collection, in total seven expert interviews were conducted with balanced representation from academia, NGOs, government, and the private sector. Interviews were organized allowing participants to discuss competitive rivalry, supplier power, buyer power, the threat of entry and threat of substitution implications of developing lyocell at CBPPL. Data, in the form of interview transcripts, were analyzed through content analysis with two significant themes emerging; (1) challenges to the development of lyocell at CBPPL and (2) distinct advantages of production at CBPPL.

6.4: Policy Recommendations

Based on the findings of the study, a of policy recommendations was developed including educational, legislative, economic, and consultative components. The recommendations are intended to assist policymakers to develop more sustainable policies for the development of NL's bio-economy based on sustainable forestry innovation. The five policy recommendations are summarized below:

6.5.1: The Establishment of an Industrial Demonstration Center in Corner Brook

As mentioned in section 5.2, the proposed Industrial Demonstration Center in Corner Brook will be a "facility where cutting-edge bio-resource innovators and researchers can test their products before bringing them to full market scale" (NSDNR, 2015). The IDF will access materials (wood fiber, biomass) from the nearby CBPPL and energy will be supplied from the Deer Lake hydropower plant. The establishment of an IDF will foster collaboration and innovation between the principal actors (NL government, the federal government, academia) within the bio-economy.

6.5.2: Create a Working Group on the Bio-Economy

A "Working Group for the Newfoundland and Labrador Bio-Economy" (NLBE) should be established with the aim of supporting information and policy coordination between various government departments and business sectors and organizations within the province. The NLBE should work in tandem with the Federal Governments Federal-Provincial-Territorial (FPT) Bioproducts Working Group and the Bio-economy Interdepartmental Working Group (BIWG) to identify areas to develop and innovate in NL. The FPT "explores potential benefits and key challenges facing the bioproducts sector both federally and provincially" while the BIWG "brings together federal departments and agencies to improve coordination and highlight opportunities for collaboration" (Agriculture and Agri-food Canada, 2015).

6.5.3: Development and Implementation of a Provincial Media Campaign on the Emerging Bio-Economy

The implementation of a multi-media campaign that highlights the critical sectors of NL's emerging bio-economy will be a way to educate the public on the opportunities and current government resources for the emerging bio-economy. Kate Kenski and Natalie Jomini Stroud (2006) explain that the "Internet has the potential to increase efficacy, knowledge, and

participation amongst the public as it enables citizens to interact with public officials by providing accessible information to citizens" (Kenski and Stroud, 2006).

Social media platforms such as YouTube, Twitter and Instagram are often used by organizations to engage with the public. Meena Jha, Sanjay Jha and Liam O'Brien (2017) defined social media as a tool. Social media is "a multiplier of resources where more audiences can be reached with fewer resources" (Jha, Jah, and O'Brien, 2017). NL's Multi-Materials Stewardship Board (MMSB) launched a successful social media campaign in 2015, through the development of RethinkWasteNL.ca, a "website that offers citizens easy access to information on everything they need to know about managing waste in each region of NL" (Government of NL, 2015).

6.5.4: Conduct Public Consultations on the Future Development of NL Bio-Economy

In 2016, Innovation and Skills Canada (ISC) held public consultations on the current state of innovation in Canada. Over a six months period, 100,000 Canadians were reached through social media platforms (Twitter, Reddit, and Quora) and 28 innovation roundtables were held in various communities across Canada. The ISC roundtables included "representatives from each of the provinces and territories, members from the private sector, universities and colleges, not-for-profit organizations, indigenous leaders and social enterprises" and covered various topics on innovation and skill development (ISC, 2016). The ISC consultations uncovered "three priority areas Canadians felt needed investment to drive the economy, especially during a period of slow economic growth; people, technology and companies" (ISC, 2016).

Using the 2016 ISC innovation consultations as a model for the future development of NL Bio-Economy, roundtable consultations can be held in the eleven census regions of NL: St. John's, Burin Peninsula, South Coast, St. Georges, Humber District, Central, Bonavista, Notre Dame Bay, Northern Peninsula, Labrador and Labrador Nunatsiavut. A social media consultation through Facebook, Twitter, Reddit, and Quora) can be run simultaneously to reach a broader audience.

6.5.5: Develop and Implement New Bio-Economy Targets for NL

Currently, the government of NL has focused its attention on strengthening the economic foundation of NL through the enhancement of access to Crown Lands for agricultural purposes (food security), implementation of a regional innovation system (pilot projects) and introducing a new procurement Act to expand current opportunities for businesses. The new legislation and regulations for the Procurement Act "will take into consideration: innovation and contribution to local economic growth, best value for money, social, economic and environmental priorities, purchasing efficiencies and the scaling of goods and services procurements" (The Way Forward, 2016). The province is also making improvements to the natural resource sector through the establishment of a significant investment projects unit, improvements in roads and the advancement of regional collaboration strategy (The Way Forward, 2016).

Paul Stuart, Stephanie Jean, Frederic Clerc, and Virginie Chambost in a presentation at the 2015 "New Leaf" conference introduced the "Fast Pyrolysis Unit" as a potential new target for NL Bio-economy (Stuart et al., 2015). According to Stuart et al., Fast Pyrolysis Units are plants that convert biomass (woodchips) into liquid (pyrolysis oil) via a chemical process. Stuart et al., also focused on potential opportunities to solve current issues (food security and unemployment) by stating "due to the scale of a (Fast Pyrolysis) plant, there could be a focus on the development of value-added products" and the use of by-products, such as steam (for heating a greenhouse) and activated carbon from the char (Stuart et al., 2015).

Chapter 7: Conclusion

The proposed introduction of the lyocell process can be a way to innovate and diversify CBPPL current paper products to continue sustainable growth in the Humber Valley region (CBPPL, 2017). Lyocell production will integrate the current forestry supply chain with the introduction of a new industry, textile manufacturing. As there are no existing lyocell production facilities in Newfoundland and Labrador, a SWOT analysis was performed to identify whether lyocell production can be a sustainable solution to diversify CBPPL product and provide the Humber Valley the ability to transition into a new development stage (OCED, 2010).

Utilizing participant interviews, several challenges, and distinct advantages have emerged. The gatekeeper effect (access to local experts) is the largest challenge to research into lyocell development. The second challenge is NL's short harvesting season, geographic location and access to raw materials as well as limited access to new distribution channels and suppliers. The cost disadvantages independent of scale, medium cost of startup and (early) high costs of production may also be deterrents to lyocell production at CBPPL. However, there are three significant advantages to developing lyocell at CBPPL, (1) low Energy Costs (Deer Lake Power Plant), (2) relatively easy access to Crown Land and raw material and (3) pre-existing structures (chemical digester).

Based on the knowledge gaps identified in the study, the following areas are recommended for future research: (1) an analysis of "The Way Forward," and (2) a study on the social perceptions of pulp and paper decline at CBPPL. As mentioned in section 6.5.5, "The Way Forward" was introduced in 2016 as NL's (sustainable) vision for economic development. While less than two years have passed since the introduction of this provincial program, further analysis of these newly proposed sustainable strategies should be undertaken to identify their strengths, weaknesses, and opportunities for improvement.

Based on the findings of the study (see section 6.4), five policy recommendations were developed. They aim to inspire policy decision in support of promoting the transition to

bio-economy in the province, starting with innovative use of the rich forestry renewable resources of the province. These recommendations include (1) the establishment of an Industrial Demonstration Center in Corner Brook, (2) the creation of a working group on the bio-economy, (3) the development and implementation of a Provincial media campaign on the emerging bio-economy, (4) conduction of public consultations on the future development of NL bio-economy and (5) the development and implementation of new bio-economy targets for NL.

There has been little academic work done on regional innovation strategies for rural NL. To date, work has focused on independent regions (i.e., Northern Peninsula) rather than on collaborative efforts to connect resources in NL distinctive rural regions. There has not been a study done on how the declining output at CBPPL has affected the city of Corner Brook since 2011 (Anderson, 2011). However, this report was focused more on the social-economic aspects of the company itself rather than the social impacts of declining output on the population of Corner Brook. A study on the social effects of the CBPPL declining output will emphasize how resource-dependent communities react to the changes in global economic patterns.

Introduction of cellulose fibre production at CBPPL through a collaborative process of social value creation involving all stakeholders of the area (industry, government, research, academia, community) is a difficult but not impossible task. It can set CBPPL on a sustainable development path and can be a first step toward a needed transition to bio-economy in NL, by using NL resources in an innovated manner.

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Appendix A

Interview questions

Introduction Questions

- Could you please tell me your name and how you are involved in the local forestry industry?
- How long have you been involved in Newfoundland's forest industry?
- Do you know about the history of CBPPL? Could you explain what you know.

Barriers and Opportunities

- Do you know what lyocell is?
- What do you think are the barriers to lyocell development at CBPPL?
- Are there any opportunities for product diversification at CBPPL?
- Would the local population be accepting of producing a new product at CBPPL?

Diversification

- Could you tell me your thoughts on developing a bio-economy in NL?
- Can successful diversification into cellulose fibers at CBPPL promote an innovative culture leading the NL forest industry towards bio-economy?

Table 3: Participants

Academic	Government	Community (Group)	Private Sector
Expert in Lyocell	Minister of the House of NL Assembly (MHA) Department of Forestry	Head of Indigenous group Mayor of Corner Brook Entrepreneur group	Manager of CBPPL

Appendix B

Table 4: Aprox. Cost of equipment as of 2017

Item	**Company**	**Cost (estimate)**
NMMO solvent (500 G)	Sigma Aldrich	$1,125.00
Dry Wet-Jet spinning	Toray	$200 per head
Cutter	Wuhan Golden Laser	$80,000
Fiber opener	Sail	$20,000
Non-Woven Baler	Novo Technology	Aprox $20, 000

Appendix C

CSA: Sustainable Forest Management standard (CAN/CSA Z809-16)

The CSA requires independent third-party audits by sanctioned registration organizations that belong to the Standards Council of Canada. CSA's Forest Management website states that "Recertification audits are required every three years along with annual surveillance audits" to keep the certification (CSA, 2017). Price Waterhouse Coopers LLP (Corner Brook and St John's) and SAI Global (Montreal and Toronto) offer CSA standard registration) (CSA, 2017).

FSC: National Boreal standard (FSC-NBS-2004)

The FSC: NBS-2004 developed and accredited by the FSC in 2004 as "as a basis for certifying forests within the Canadian boreal forest" (FSC, 2004). FSC: NBS-2004 consists of "ten principles and 56 criteria, that have been customized to reflect conditions in the Canadian boreal forest; compliance, tenure, indigenous people, community relations, benefits from the forest, impacts, management plan, monitoring and assessment of high conservation forests and plantations" (FSC, 2004). SAI Global and KPMG (St. John's) offer certification.

FSC: Chain of Custody Certification (FSC-STD-40-017)

The FSC-STD-40-017 "standard provides requirements for how to verify, track, and mix forest fibers of different types and sources so that only forest products that meet FSC's requirements can carry an FSC Claim and FSC logo" (FSC, 2017). The FSC-STD-40-017 also offers manufacturers a unique FSC code, which can be found on their FSC products that can be tracked through the supply chain (FSC, 2017).

Appendix D

Figure 7:CBPPL Limits (CBPPL, 2017)

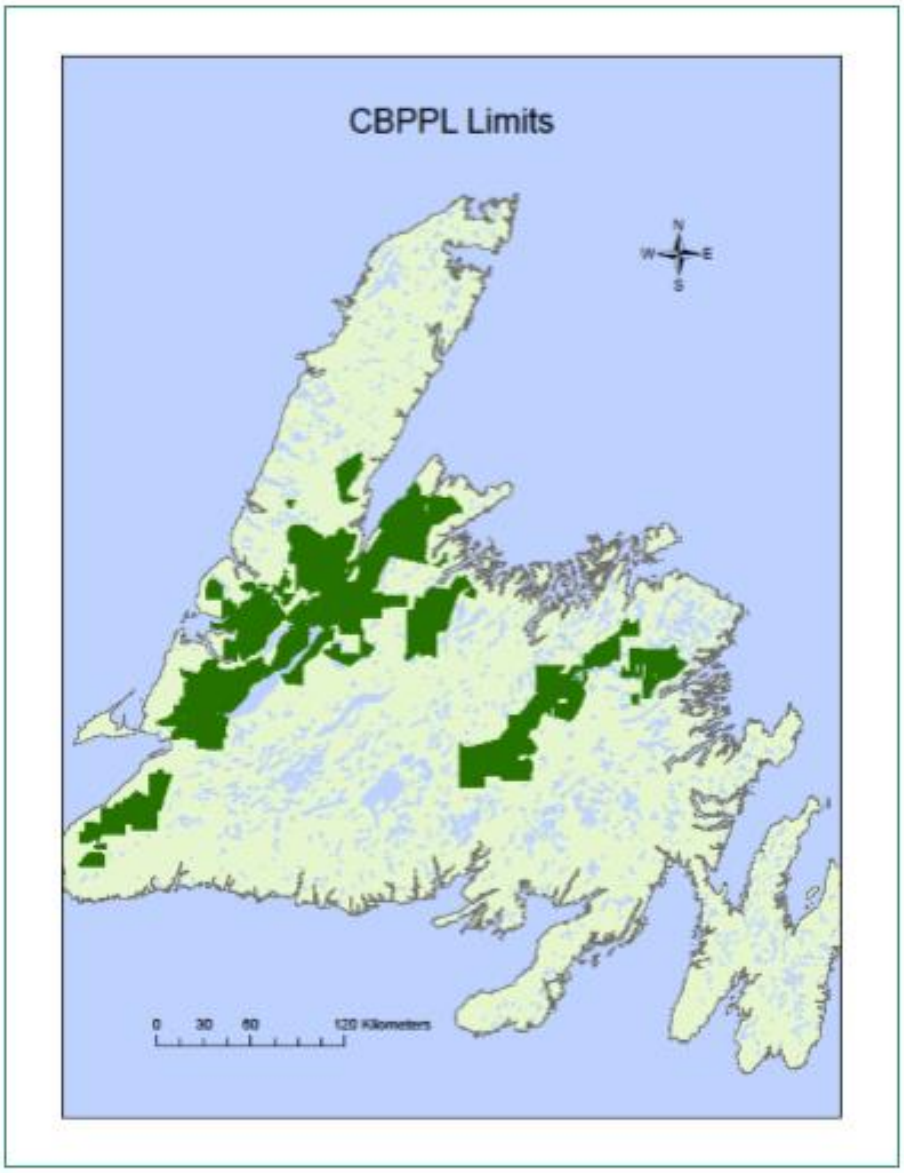
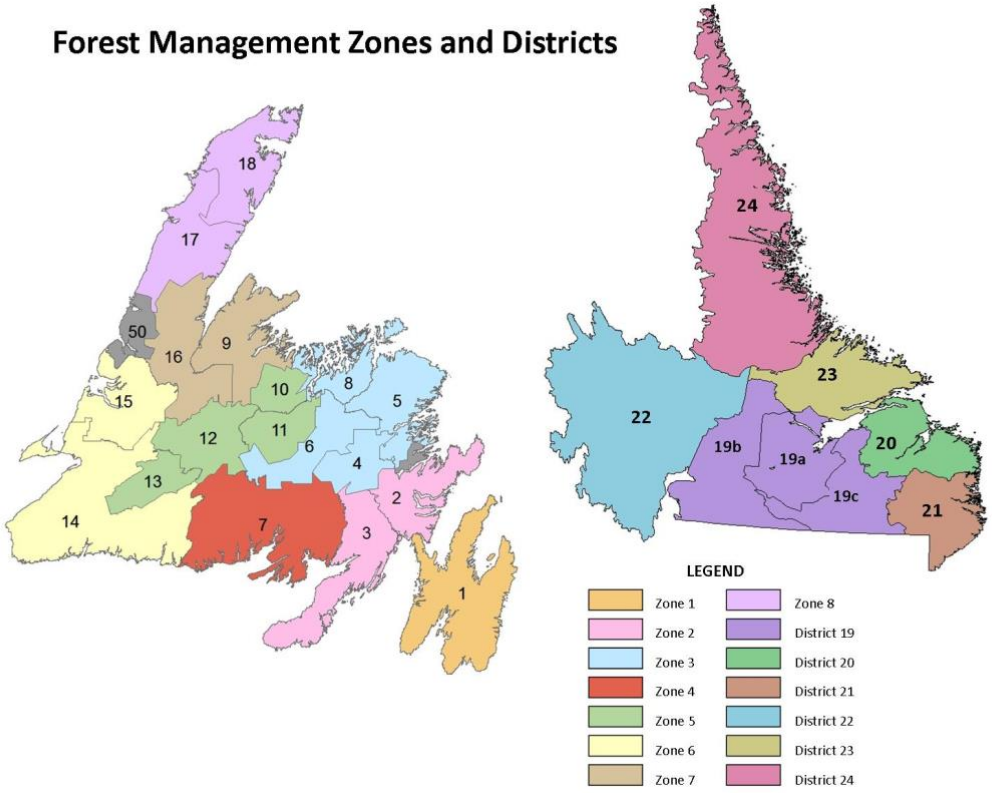


Figure 8: Forest Management Districts in NL (Government of NL, 2018)



Appendix E

Figure 9: Research and innovation strategies for smart specialization (RIS3)