THUNDER BAY CEDC
COMMUNITY ECONOMIC DEVELOPMENT COMMISSION

REPORT ON THE FORESTRY BIOECONOMY IN THUNDER BAY

FOR THE THUNDER BAY COMMUNITY ECONOMIC DEVELOPMENT COMMISSION

November 2020

CAI Global

FOREWORD

This report is confidential and is intended solely for the use of the Thunder Bay Community Economic Development Commission (CEDC) with respect to this specific matter. It is not intended or necessarily suitable for any other purpose. This report is not to be published, circulated, reproduced or used for any other purpose without the prior permission of the CAI Global Group Inc. in each specific instance. We understand that Thunder Bay Community Economic Development Commission (CEDC) may use some of the findings found in this report in its marketing communications to specific potential investors. The CAI Global Group Inc. and its employees will not assume any responsibility or liability for any claims, costs, damages, losses, liabilities or expenses incurred by anyone as a result of the circulation, publication, reproduction, use of or reliance upon this report.

The comments in this report are not intended, nor should they be interpreted to be, legal advice or opinion as the CAI Global Group is not qualified to provide such advice or opinion.

As with any planning assignment, the role of this document is to estimate future events based on information available and/or provided to the CAI Global Group at the time of the report, primarily interview results, field observations, consultation with industry representatives and available published information. There are, however, a number of uncontrollable political, social and internal factors that may affect the findings outlined in this document. As a result, this document should be viewed in the context of being estimates based on information, which may or may not be influenced by unforeseen or uncontrollable events. We caution the reader that the ultimate success of any recommended initiatives listed within this report can vary significantly from the projections outlined in this report due to economic or regulatory changes, cost escalations, decisions of competing communities, the emergence of new competitors, changes in government funding programs and/or priorities or the inability of the program improvement process to achieve certain key milestones.

This report and all data herein were produced by the CAI Global Group Inc. using EMSI Data Analytics as the main source. That and other sources are included within the report in the form of footnotes and/or in the bibliography. The CAI Global Group believes the information contained herein was obtained from sources that are reliable; however, cannot guarantee its accuracy and completeness.

EXECUTIVE SUMMARY

The forestry industry in Thunder Bay and the surrounding region has historically been one of the primary private employers in the area. As newsprint and paper usage in general has declined, this has created a major challenge for the region. However, in a push for a more sustainable economy, the forestry industry is poised to adapt and prosper.

The following report of the forestry bioeconomy will offer an analysis of the different possibilities offered by developing new industrial sub-sectors which would take advantage of the vast wealth of biomass present in Northern Ontario.

Four principle sub-sectors of the bioeconomy were analysed and a SWOT analysis was performed for the region and each individual sector. In addition, a value proposition for the region, as it relates to the forestry bioeconomy, was identified based on the SWOT analysis.

The four bioeconomy sub-sectors identified were Bioenergy, Biofuels, Biochemicals and Engineered Wood. Of the four sub-sectors, Biochemicals and Engineered Wood were identified as the most promising to pursue based on a number of factors detailed within this study. The analysed sectors take advantage of Thunder Bay's main attributes which form the basis of the value proposition.

Following a thorough analysis, CAI Global is proposing that Thunder Bay's value proposition be based around four pillars: logistics, workforce, research and forestry supply chain. These not only bring together key assets offered within the region but also encompass what is necessary in order to further develop the forestry bioeconomy.

CAI Global recommends a series of actions to strengthen Thunder Bay's position in the bioeconomy sectors that were identified as more promising. The recommendations build on Thunder Bay's excellent research cluster, links with First Nations, logistics and address shortcomings in the availability of information on the wood supply.

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

TABLE OF CHARTS

INTRODUCTION

The City of Thunder Bay has a strong economic history in the forestry sector. Since the early 1900s, the forestry sector has contributed to the city's economic growth. Since then, structural changes have occurred in the sector, both locally and internationally. Threats to traditional forestry operations were followed by local stakeholder initiatives to foster growth in a new forestry bioeconomy cluster. Today, Thunder Bay is proud to be home to not only the largest sawmill east of the Rockies, but also pilot plants and research centres within the forest bioeconomy sector rooted in the region's economic structure.

The forestry industry in Thunder Bay has traditionally been dominated by lumber, pulp and paper processing. Pulp and paper primarily use SPF (Spruce, Fir and Pine) to produce pulp using chemical or thermomechanical processes to generate paper such as low-quality paper including newsprint and market pulp which is exported for further value-added manufacturing. As the newsprint market has continued to diminish, and competition from low cost off-shore market pulp production, producers in the region face challenges to maintain profitable operations.

This situation underlies the urgency of finding new ways of taking advantage of the region's forestry biomass.

The next step in the economic growth of the forestry sector is to grow new downstream sub-sectors of the forestry bioeconomy. In order to achieve its goal of optimizing its positioning to attract companies from this sector, the Thunder Bay Community Economic Development Corporation (CEDC) has mandated the CAI Global to conduct an assessment of current and future assets in the region that would assist in the development of a strong bioeconomy sector.

METHODOLOGY

In order to achieve the proposed objectives laid out to complete this study, CAI Global used the following five-step approach:

FIGURE 1: METHDOLOGICAL PROCESS

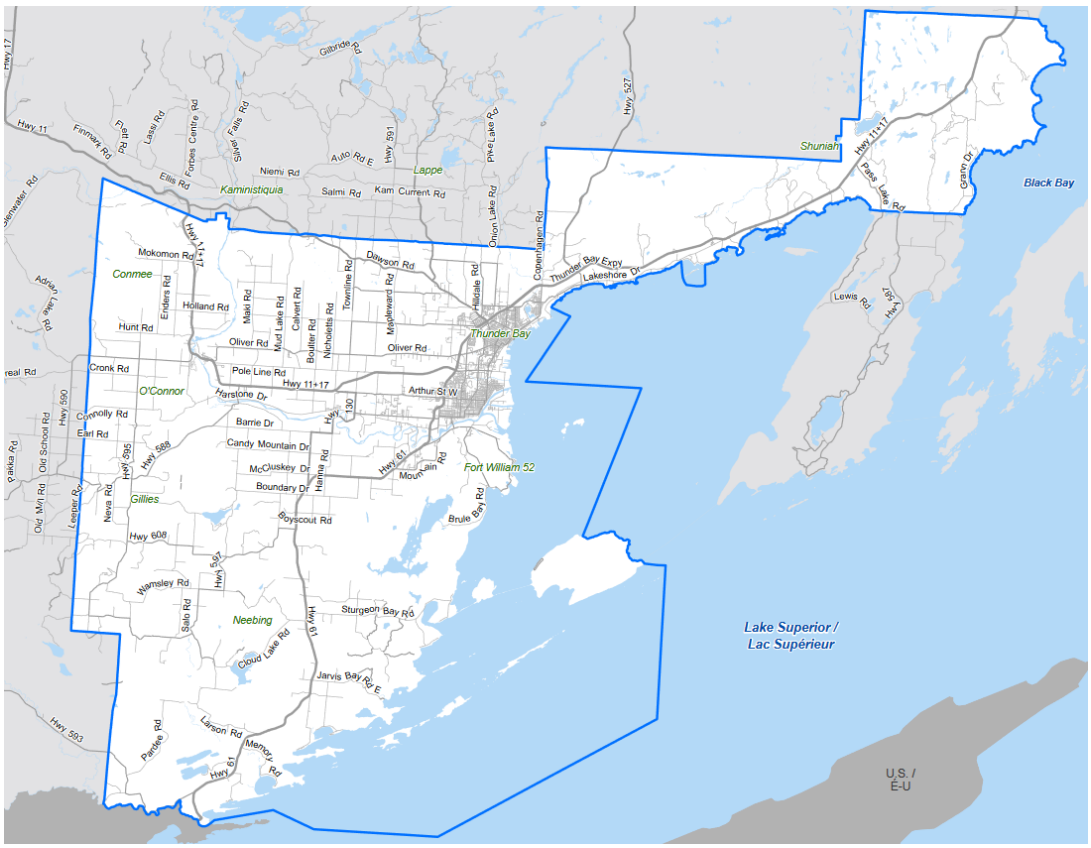
INDUSTRY ANALYSIS

Using the North American Industry Classification System (NAICS) to define the Forest Bioeconomy, the sector was determined to be represented by the following three distinct industries:

- NAICS Code 113 Forestry and Logging (incl. 1131, 1132 and 1133)
- NAICS Code (incl. 3211, 3212 and 3219)
- NAICS Code 322 Paper Manufacturing (incl. 3221 and 322)

The industry data gathered by CAI Global also abides by the NAICS system to classify business establishments according to the type of economic activity. The region of study is scaled to the Thunder Bay Metropolitan census metropolitan area (CMA), a map of which can be found below:

FIGURE 2: THUNDER BAY CMA MAP



Source: Statistics Canada (2020)

In some cases, particularly when the EMSI Economic Tool was used, the larger Thunder Bay District was used as the statistical area of study, a map of which can be found below:

FIGURE 3: THUNDER BAY DISTRICT MAP

Source: Statistics Canada (2020)

The key statistical difference in the maps is minor: Thunder Bay CMA does not include remote several communities which total approximately 25,000 additional people in terms of population. However, the vast majority of businesses (and related data such as jobs) are located in the Thunder Bay CMA.

In order to provide a relevant analysis, this study bases its evaluation on a benchmark comparing Thunder Bay to the following eight other regions:

- Sudbury, ON
- Timmins, ON
- Kingston, ON
- Sault St. Marie, ON
- Sarnia, ON
- Prince George, BC
- Saguenay, QC
- Duluth, MN

These regions were selected by the Thunder Bay CEDC.

CONSULTATIONS WITH LOCAL STAKEHOLDERS

Following the industry analysis of the sectors, CAI conducted 30 to 60 minute phone consultations with key players in Thunder Bay's forestry sector including Lakehead University researchers.

For interviews with companies, the objective was to understand their global issues, local challenges, opportunities for growth and other strategic elements. This information was used in reviewing and forecasting the potential opportunities of local businesses and was used to feed into the region's SWOT analysis and considered in the reflection on the identification of the city's value proposition.

In terms of the product analysis, CAI Global's senior consulting team spoke with stakeholders in Thunder Bay in order to understand the level of innovation that currently exists in the region and the sectors most likely to be viable in the region. This data collection assisted in finding linkages and gaps in the current local supply chain as well as providing a basis to assess opportunities and threats in the SWOT analysis.

SWOT ANALYSIS

The SWOT analysis framework is divided into two categories: internal and external. The internal factors, strengths and weaknesses, were developed primarily based on CAI Global's workforce and economic data.

The external factors, opportunities and threats, were developed based on the content of the stakeholder discussions and on futuristic data collected and analyzed by CAI Global's business analyst team. The local business community will be a valued source of data for opportunities related to sectors for development and the opportunities that arise from them. CAI's industrial data analysis was also a great source of data to identify opportunities and threats. CAI's in-depth analysis of the territory provides the project team with accurate and strategic data on regional business opportunities.

VALUE PROPOSITION ANALYSIS

CAI developed a value proposition for the region in terms of attracting investment in the forestry bioeconomy. This analysis focused on the various parameters that have been analyzed such as manpower, infrastructure, potential sites, companies in place, etc. The value proposition defines Thunder Bay's direct offer to foreign and domestic investors and the unique positioning of the community from a site selection point of view.

STRATEGIC RECOMMENDATIONS

After identifying the key aspects of the value proposition, CAI made strategic recommendations that focus on how Thunder Bay should build upon its value proposition, industrial base, assets and stakeholders (companies, pilot projects, research institute, other) to attract new investment to the region.

Recommendations focus on priority actions to be taken to take advantage of its forestry ecosystem and bioeconomy to further develop this sector. Recommendations on how to improve the existing cluster have also been made. These recommendations are based on all of the data previously collected during the sector analysis and CAI, through its internal analysis tools and private databases, was able to identify the elements that can enhance Thunder Bay's industrial offer.

THE FORESTRY BIOECONOMY

Canada's 2019 Bioeconomy Strategy, the first one ever produced, quotes the European Union's definition of bioeconomy:

> *"The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services."*[1]

This is an extremely wide-ranging definition which theoretically incorporates everything from biofuels to food and beverage processing as part of the bioeconomy. For forestry, the biomass has always been the building block. There is no forestry without the forest.

Although economic activity linked to the use of biological resources is not a new development, the enthusiasm for developing the bioeconomy is being pursued mainly because of two major concerns:

1. Pushing for sustainable (i.e. circular) economic development
2. Fighting climate change by replacing fossil fuels

In principal, a focused emphasis on the bioeconomy should bring additional circularity to the economy by producing less permanent waste. Also, the replacing goods derived from fossil fuels should curb CO_2 emissions by reducing the need to access hydrocarbons through traditional means.

For the purposes of this report, the forestry bioeconomy will be defined as "non-traditional" value-added processes to wood products: generally considered to be those which derive products beyond paper and lumber. Most of the forestry bioeconomy products aim to create substitutes to goods derived primarily from hydrocarbons such as plastics and fuel.

In the context of a forestry bioeconomy, biomass can used to generate power, produce chemicals and additives, design greener building materials, etc. Basically, to replace anything currently in use with better alternatives. In speaking with experts and reviewing literature, four main categories of likely forestry bioeconomy possibilities were examined as they were deemed the most advanced in terms of development and the most economically viable:

- Bioenergy: using biomass, sometimes from waste, to generate power on a large scale

[1] A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment, European Commission, 2018

- Biochemicals: using forestry biomass to develop industrial chemicals for use in applications ranging for food & beverage to plastics
- Biofuels: creating second generation (e.g. post-agriculturally based ethanol) biofuels for applications that include specialty fuels for aircraft and additives for gasoline
- Engineered wood: new building materials made from a mixture of wood and adhesives which could replace concrete and steel as construction materials

INDUSTRIAL ANALYSIS

The industry analysis is divided into four major sections:

- Demographics
- Industry Data
- Occupational Analysis
- Supply Chain

Each section will refer back to data obtained from both Statistics Canada and EMSI Economic Modelling.

In some sections, Thunder Bay was compared to other selected regions based on the availability of data and how comprehensive the comparison would be. As previously mentioned, the regions used to provide a benchmarked analysis are as follows:

- Sudbury, ON
- Timmins, ON
- Kingston, ON
- Sault St. Marie, ON
- Sarnia, ON
- Prince George, BC
- Saguenay, QC
- Duluth, MN

In order to compare the regions, CAI examined data from three different industries related to forestry, although not specifically to the bioeconomy as it is an emerging sector and generally classified as part of large industry groups such as chemical or plastics manufacturing. The industries are analysed at a 3-digit level by NAICS code, definitions of which can be found below[2]. The NAICS codes can range from 2 to 7 digits in length: codes with additional digits further specify specific industries within a same group (examples are available in the industry descriptions below). The three industries are:

Forestry and Logging (NAICS 113):

> *This subsector comprises establishments primarily engaged in growing and harvesting timber on a long production cycle (of ten years or more). Long production cycles use different production processes than short production cycles, which require more horticultural interventions prior to harvest, resulting in processes more similar to those found in the Crop production subsector. Consequently, Christmas tree production and other production involving production cycles of less than ten years, are classified to the Crop production subsector.*
>
> *Industries in this subsector specialize in different stages of the production cycle. Reforestation requires production of seedlings in specialized nurseries. Timber production requires natural forests or suitable areas of land that are available for a long duration. The maturation time for timber depends upon the species of tree, the climatic conditions of the region, and the intended*

[2] https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553

purpose of the timber. The harvesting of timber, except when done on an extremely small scale, requires specialized machinery unique to the industry. The gathering of forest products, such as gums, barks, balsam needles and Spanish moss, are also included in this subsector.

Activities in this category include timber tract operations, logging and gathering of forest products.

Wood Product Manufacturing (NAICS 321):

This subsector comprises establishments primarily engaged in manufacturing products from wood. There are three industry groups in this subsector, comprising establishments engaged in sawing logs into lumber and similar products, or preserving these products; making products that improve the natural characteristics of wood, by making veneers, plywood, reconstituted wood panel products or engineered wood assemblies; and making a diverse range of wood products, such as millwork.

Also included in this industry category are Sawmills and wood preservation (3211); Veneer, plywood and engineered wood product manufacturing (3212) and Other wood product manufacturing (3219).

Paper Manufacturing (NAICS 322):

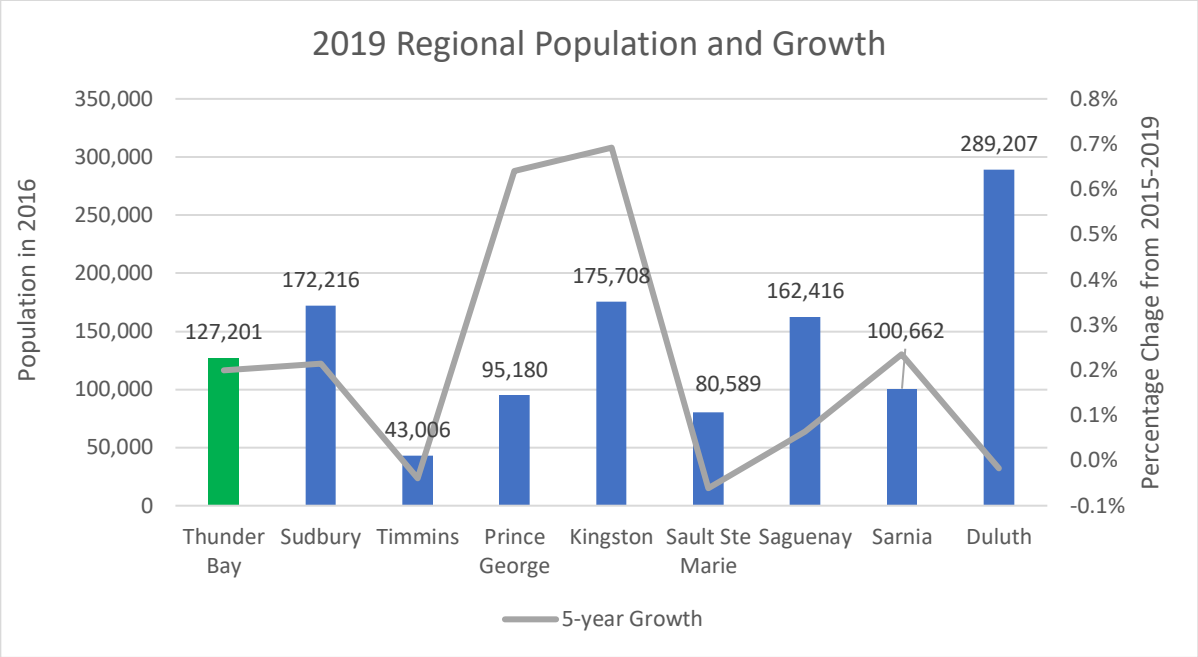
This subsector comprises establishments primarily engaged in manufacturing pulp, paper and paper products. The manufacture of pulp involves separating the cellulose fibres from other impurities in wood, used paper or other fibre sources. The manufacture of paper involves matting these fibres into a sheet. Converted paper products are produced from paper and other materials by various cutting and shaping techniques.

Also included in this industry category are Pulp, paper and paperboard mills (3221) and Converted paper product manufacturing (3222). Pulp mills would be included in this overall industry category and specifically, under NAICS codes 322112 (chemical pulp mills) and 322111 (mechanical pulp mills).

DEMOGRAPHICS

As a baseline comparison, the following graph compares the population data, including 2015-2019 growth for each region:

CHART 1: DEMOGRAPHIC COMPARISON - POPULATION



Source: StatCan, Population Estimates by census metropolitan area[3] and EMSI 2019.3 Analysis: CAI Global, 2020

As illustrated above, Thunder Bay's population is most comparable in size to Sarnia and Prince George. Duluth and Timmins are outliers in the sample. It should be noted that other regions, such as Sarnia and Kingston for instance, benefit from having additional populations immediately outside their statistical areas. This is not necessarily the case for areas such as Saguenay, Thunder Bay and Sault Ste. Marie which are relatively isolated. It should be noted that the Duluth census region incorporates populations in both Minnesota and neighbouring Wisconsin and the methodology for data collection differs slightly in the United States.

In terms of demographic growth, from 2015 to 2019, the preceding table also illustrates the differences between each region. In most of the regions analysed, demographic growth is low and, in some cases, negative (Timmins, Sault Ste. Marie and Duluth). The strongest population occurred in Prince George and Kingston, in both cases almost mirroring Canada's overall population growth of 6.1% for the same period.

Although population growth in First Nations communities, which are present in and around Thunder Bay, is strong, it does not significantly impact overall growth. For instance, people of North American Aboriginal origins number approximately 15,500 in Thunder Bay out of more than 125,000 residents: this does not include individuals in remote communities but this would likely not significantly impact growth rates given the small numbers. However, Thunder Bay is home to the largest proportion of indigenous peoples among cities in Canada[4] (approx. 13% in 2016). The strong demographic growth observed among indigenous populations may impact Thunder Bay positively in the medium-term.

[3] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710013501

[4] https://www.chroniclejournal.com/news/thunder-bay-has-canada-s-highest-proportion-of-urban-aboriginals/article_9e6fc44a-b9ae-11e7-a5c5-f7670c5741e8.html

INDUSTRY DATA

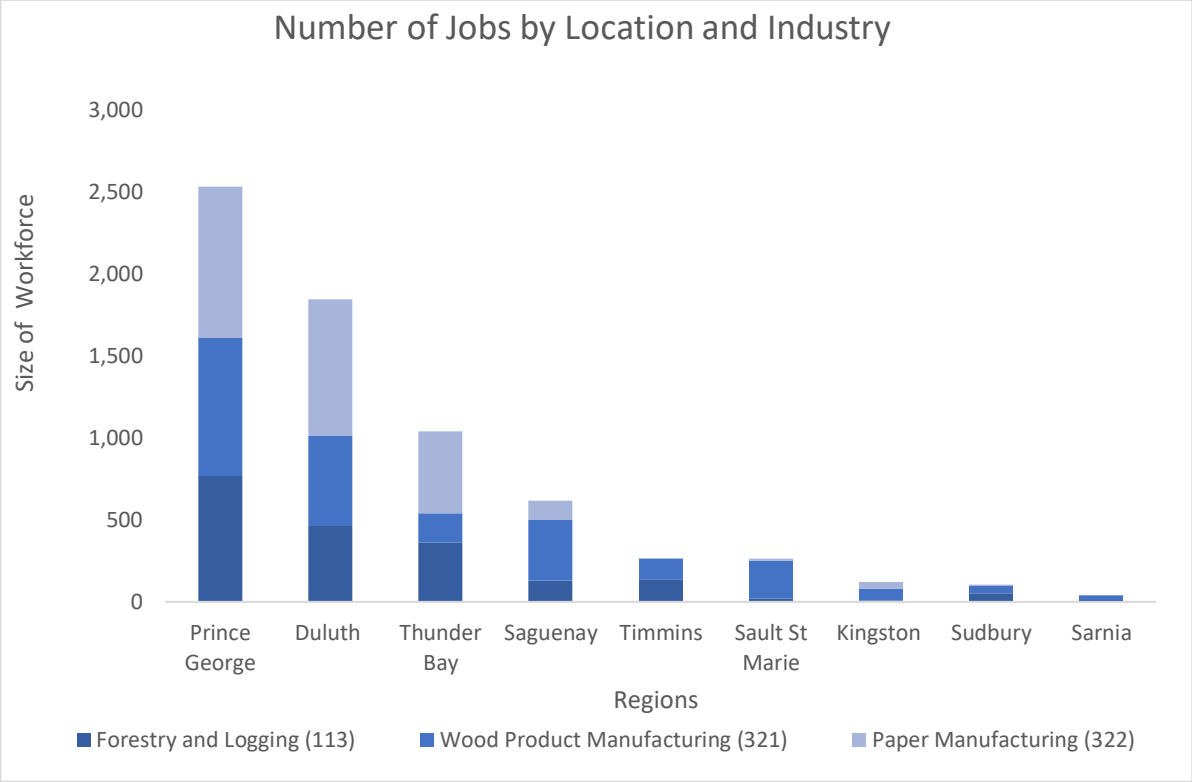
The data analysed in the following section is divided into sub-sections which includes data on employment, labour availability and concentration (location quotient).

Employment

Employment data is used as a tool for measuring industrial strength in a given region. Employment is generally used as a proxy by economists and demographers in order to study relative strengths and growth over time as it is more responsive than data points such as the number of businesses, which tend to be less accurate and up to date.

The following graph illustrates the number of jobs in each key industry for Thunder Bay and the comparison regions:

CHART 2: WORKFORCE IN TARGETED INDUSTRIES BY REGION



Source: Occupation Analysis - Emsi 2019.3 Analysis: CAI Global, 2020

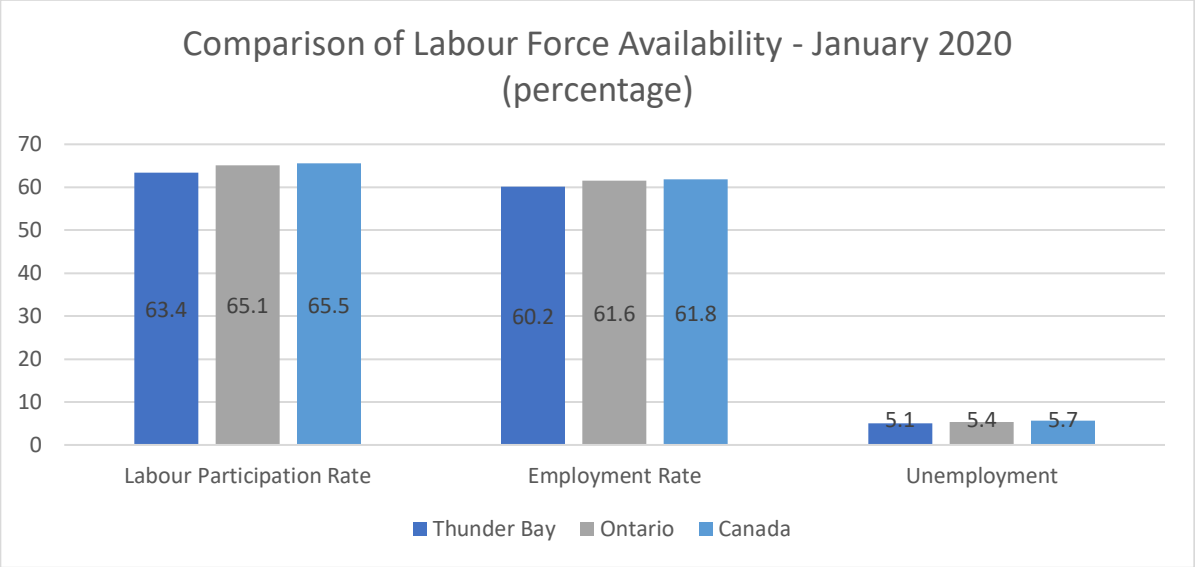
Overall, Thunder Bay compares favourably to the other regions in terms of overall job count. The only potential weakness resides in the relatively small number of jobs in the Wood Product Manufacturing industry. Overall, Thunder Bay has the third strongest forestry industry among the competitor regions.

Labour Availability

Prior to the COVID-19 pandemic, most of Canada was experiencing a labour shortage, particularly in the manufacturing sector and in regions with aging populations. The situation in Thunder Bay in January 2020 was somewhat similar to the nation as a whole but different in some key ways.

The labour force (population over 15 years of age either working or seeking work) in Thunder Bay in January 2020 was estimated to be approximately 66,400 individuals, with a labour participation rate of 63.4% and employment rate of 60.2%. Both the participation and employment rates are lower in Thunder Bay than in the Province of Ontario and Canada; the following table offers a comparative illustration of the difference:

CHART 3: LABOUR FORCE AVAILABILITY



Source: StatCan, Labour Market Indicators by selected area[5] Analysis: CAI Global, 2020

The difference between Thunder Bay and the overall economy may seem small but a 2% change in labour participation (to match Canada's rate) would equal 2,100 additional people to the potential labour force and a 1.5% change in the employment rate would bring more than 700 additional individuals into the workforce. This indicates that there is some room for improvement available and that there may be an untapped available labour pool in the region.

As an additional note, labour force participation among the Aboriginal population (as designated by Statistics Canada) in Ontario is lower than the province as a whole (63.9% vs. 65.7% in 2019)[6]. Although the aboriginal data is not specific to Thunder Bay, the First Nations constitute a significant population in the region and may also have a lower labour participation rate than the overall region. Increasing the rate among that segment of the population may contribute to increasing the available labour pool.

It is difficult to compare up-to-date labour availability between different jurisdictions for two reasons. Firstly, due to economic disruption caused by the COVID-19 pandemic, at this point it is difficult to determine the exact kind of long-term disruptions that will result (if any). Secondly, up-to-date labour market data is only available for provinces and census statistical areas (such as Thunder Bay): there is no data on labour participation rates for jurisdictions such as Prince George, BC, Sault Ste. Marie, ON and others prior to the 2016 Census.

[5] https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2017001-eng.htm

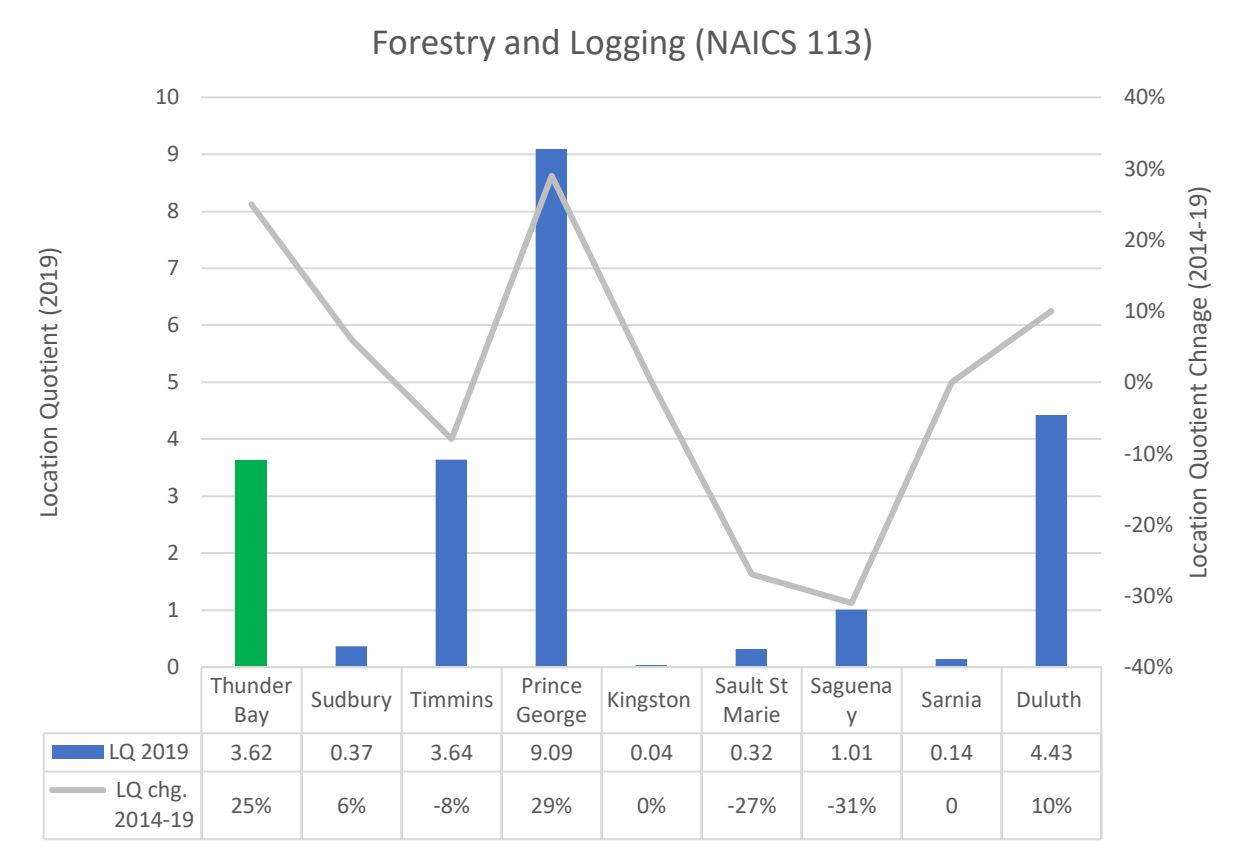
[6] Https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410035901&pickMembers%5B0%5D=1.1&pickMembers%5B1%5D=3.7&pickMembers%5B2%5D=5.1&cubeTimeFrame.startYear=2015&cubeTimeFrame.endYear=2019&referencePeriods=20150101%2C20190101

Location Quotient

One way to understand the strength of a sector in the region is to measure the talent concentration in that sector. For each of the three sectors identified, CAI Global calculated the region's location quotient (LQ) and compared it to the eight regions mentioned previously. An LQ over 1 indicates that the region has a stronger concentration of jobs in that sector than the national average (than the average for Canada as a whole).

Each target sector was analysed separately. The following table illustrates the location quotient for each region in the first industry looked at, the Forestry and Logging industry:

Chart 4: Forestry and Logging Location Quotient Analysis



	Thunder Bay	Sudbury	Timmins	Prince George	Kingston	Sault St Marie	Saguenay	Sarnia	Duluth
LQ 2019	3.62	0.37	3.64	9.09	0.04	0.32	1.01	0.14	4.43
LQ chg. 2014-19	25%	6%	-8%	29%	0%	-27%	-31%	0	10%

Source: Occupation Analysis - Emsi 2019.3 Analysis: CAI Global, 2020

Among the areas analysed, Thunder Bay had the 4th highest LQ (almost tied with Timmins, ON) behind Prince George, BC and Duluth, MN. However, the region's LQ grew faster in the past 5 years than all regions with the exception of Prince George, BC.

The following table illustrates the location quotient for each region in the Wood Product Manufacturing Industry:

Chart 5: Wood Product Location Quotient Analysis

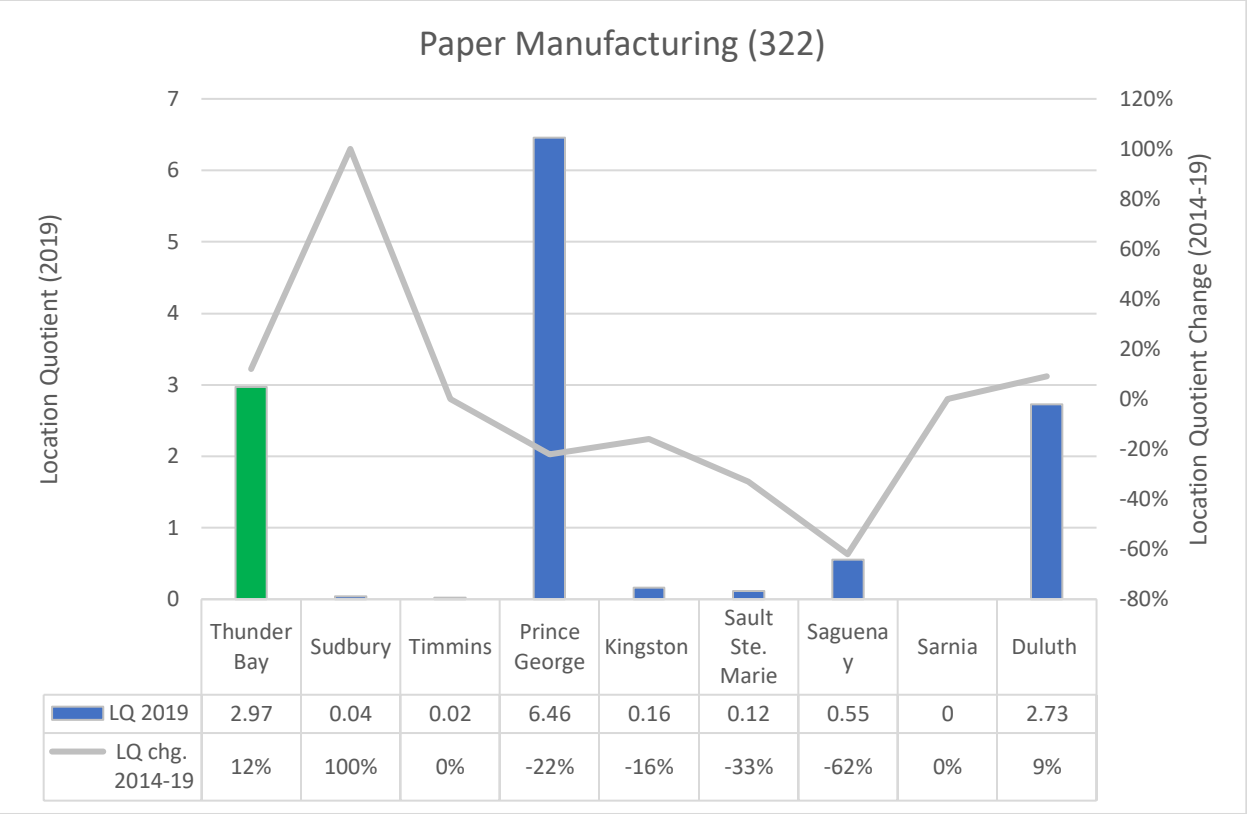
	Thunder Bay	Sudbury	Timmins	Prince George	Kingston	Sault St Marie	Saguenay	Sarnia	Duluth
LQ 2019	0.57	0.09	1.12	3.21	0.16	1.25	0.94	0.11	1.43
LQ chg. 2014-19	4%	50%	33%	-40%	-36%	36%	16%	120%	7%

Source: Occupation Analysis - Emsi 2019.3 Analysis: CAI Global, 2020

In this large-scale industry, Thunder Bay is considerably weaker than most of its competing regions: given the strength of logging and sawmills in the area, it is safe to assume that any lumber produced is shipped to other jurisdictions for further value-added production.

The following table illustrates the location quotient for each region in the Paper Manufacturing Industry:

Chart 6: Paper Manufacturing Location Quotient Analysis



Source: Occupation Analysis - Emsi 2019.3 Analysis: CAI Global, 2020

Unsurprisingly, Thunder Bay performs very well in this metric and clearly outperforms any other jurisdiction in Ontario. However, this also underlines the high level of dependence on this industry for the region.

Workforce Skills

The presence of Confederation College and Lakehead University are net assets to the region. In terms of graduates, data from 2013 indicated that Confederation College granted over 1,300 program completions (not necessarily degrees) and Lakehead had almost the same number of undergraduate degree completions. The following table summarizes the program completions:

Table 1: Program Completion (2013)

	Confederation College	Lakehead University		
	Technical Degrees	Undergraduate programs	Post-baccalaureate non-graduate programs	Graduate programs
Number of completions (2013)	1,371	1,377	511	241

Source: Emsi 2019.3 Analysis: CAI Global, 2020

In 2016 (the last year of available data), Lakehead University had a total of 1,748 degree completions (all levels) which was a decline from the 2013 data (total 2,162).

In terms of degrees that may be of use to the bioeconomy (on the manufacturing side), CAI Global isolated the following completion data from 2013 for Confederation College:

TABLE 2: SELECT TECHNICAL DEGREES (2013)

	Technical Degrees (2013)
Mechanic and Repair Technologies/Technicians	89
Precision Production	15
Engineering Technologies and Engineering-related Fields	96

Source: Emsi 2019.3 Analysis: CAI Global, 2020

The number of graduates in trades (assuming it has been stable since 2013) related to engineering and mechanic repair is positive and there is an adequate supply of these types of technicians. However, the lack of precision production degrees (which includes CNC operators) may be a weakness to address for certain sectors of the bioeconomy such as engineered wood.

2016 data from Lakehead reveals that the University graduated over 550 people with degrees that may be of interest to investors in the bioeconomy. A summary table can be found below:

TABLE 3: SELECT UNIVERSITY DEGREES (2016)

	Graduate and Undergraduate Degrees (2013)
Natural Resources and Conservation	51
Engineering	315
Biological and Biomedical Sciences	57
Physical Sciences	39

Source: Emsi 2019.3 Analysis: CAI Global, 2020

If the trend is similar today as it was in 2016, Lakehead's place as a source of skilled labour is clear. A further discussion on the strengths Lakehead brings to the region as a location for research is discussed further in this study.

OCCUPATIONAL ANALYSIS

The workforce analysis is based on data collected primarily from EMSI Data Analytics whose primary source is the National Occupational Classifications (NOC) Labour Force Survey for earnings and job estimate. The analyses conducted in this section use three tiers of NOC Code classifications (1-digit, 2-digit, 3-digit). Each tier will be referred to as occupation groups (1-digit), sub-occupation groups (2-digit), and minor occupation groups (3-digit).

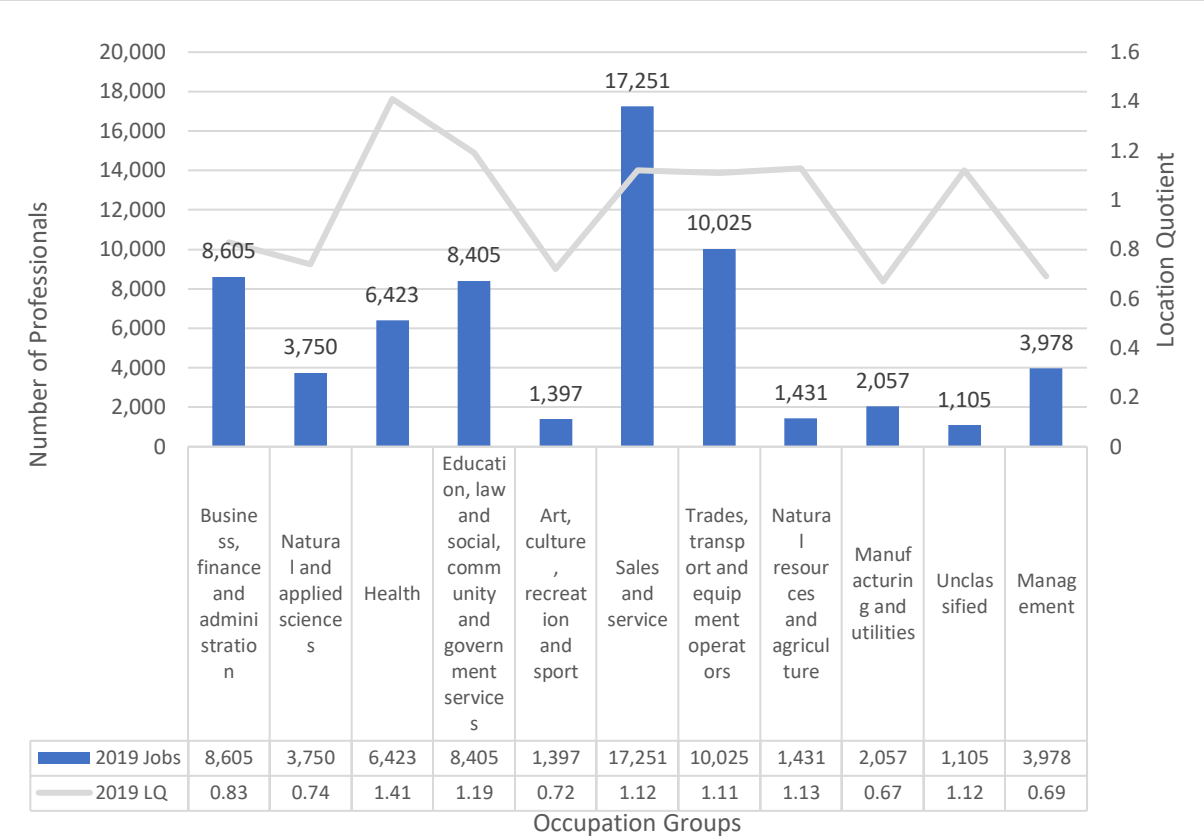
Through a series of analyses, CAI evaluated the size, concentration, and growth of Thunder Bay's workforce. CAI also conducted analyses geared to the Bioeconomy, identifying occupations that the existing industries are targeting and current hiring patterns to address the state of the cluster related industries as it pertains to the workforce. Lastly, CAI performed a cross-region median hourly wage analysis comparing how the Thunder Bay Metropolitan Area faired against competing regions in terms of labour cost.

Thunder Bay, as evidence provided by the analyses in this section, has a substantial labour pool to provide for the Forestry Bioeconomy. Major strengths among its workforce are in Trades, Transport and Equipment Operators, and Natural Resources and Agriculture Occupations. Significant growth in Manufacturing occupations is another positive in developing the Bioeconomy. Thunder Bay's most significant challenge in terms of workforce related to the Bioeconomy is in attracting and developing more talent in the Natural Applied Science occupations. The lower but competitive wages should help in attracting companies and talent to adjust for any shortages. The current job advertising post rates suggest the evaluated Forestry and Logging, Paper, and Wood Product Manufacturing sectors have risen to pre-pandemic form. Thunder Bay's workforce is an evolving asset as it pertains to developing the region's Bioeconomy.

Thunder Bay Workforce Overview

Thunder Bay has a diverse workforce pool, as illustrated in the graph below. Five of ten occupation groups have a location quotient (see Appendix A for definition) greater than one, a demonstration of Thunder Bay's superior employment concentration in Health; Education, Law and Social Community and Government Service; Sales and Service; Trades, Transport and Equipment Operations; Natural Resources and Agriculture occupations. A location quotient greater than one indicates that Thunder Bay CMA has a greater employment concentration of the aforementioned professionals than the national employment concentration. With a strong concentration of professionals in Trades, Transport and Equipment Operations, and Natural Resource and Agriculture occupations as well as a substantial amount of Business, Finance, and Administration professionals, the region is well equipped to support a Bioeconomy.

Chart 7: Thunder Bay Workforce 2019 Jobs to Location Quotient Index

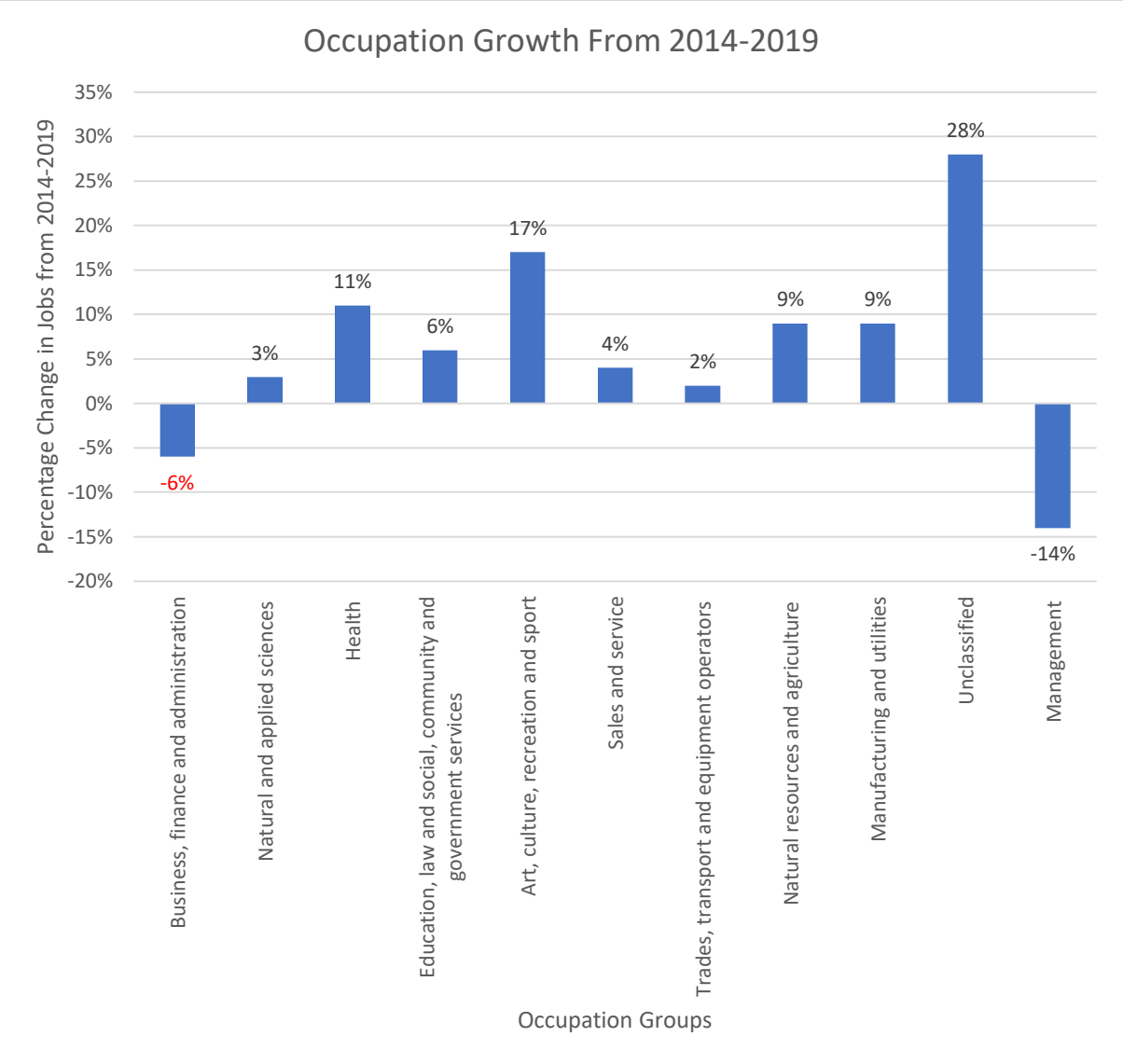


	Business, finance and administration	Natural and applied sciences	Health	Education, law and social, community and government services	Art, culture, recreation and sport	Sales and service	Trades, transport and equipment operators	Natural resources and agriculture	Manufacturing and utilities	Unclassified	Management
2019 Jobs	8,605	3,750	6,423	8,405	1,397	17,251	10,025	1,431	2,057	1,105	3,978
2019 LQ	0.83	0.74	1.41	1.19	0.72	1.12	1.11	1.13	0.67	1.12	0.69

Source: Occupation Analysis - Emsi 2019.3 Analysis: CAI Global, 2020

The CMA of Thunder Bay is limited in a few occupation groups. For positions often desired by bioeconomy sectors, such as Natural and Applied Sciences and Manufacturing and Utilities, Thunder Bay is missing professionals as compared to the national employment concentration levels (LQ scores under 1).

CHART 8: THUNDER BAY OCCUPATION GROWTH



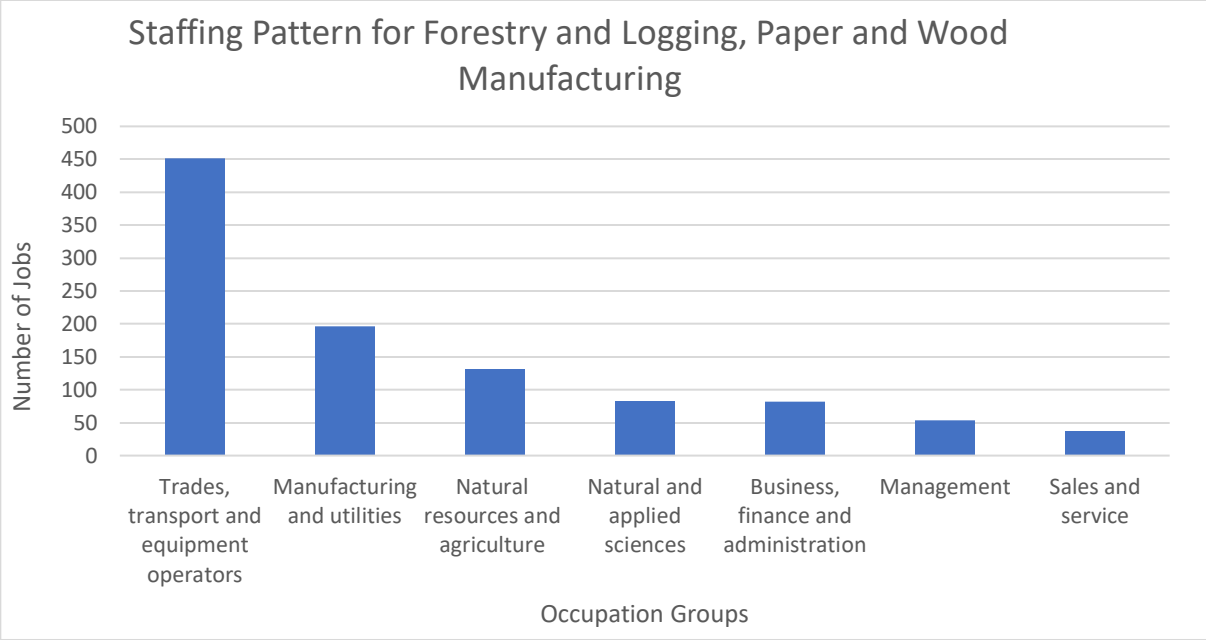
Source: Occupation Analysis - Emsi 2019.3 Analysis: CAI Global, 2020

From 2014 to 2019, the overall workforce in Thunder Bay grew by 3% with Art and Culture, Health, and Natural Resource and Agriculture, and Manufacturing occupations experiencing most of the growth. Other than Business, Finance, and Administration and Management occupations, all other occupation groups grew over the five years.

Staffing Pattern

To identify which occupations would be desired for Forestry Bioeconomy industries, a Staffing Pattern was analysed for the industries evaluated in the previous section (Forestry and Logging, Paper Manufacturing and Wood Manufacturing). Staffing patterns show the occupational makeup of an industry. The graph below illustrates the occupation groups most employed by the previously mentioned industries in the Thunder Bay CMA in 2019.

CHART 9: STAFFING PATTERN ACROSS TARGETED INDUSTRIES



Source: Staffing Patterns - Emsi 2019.3 Analysis: CAI Global, 2020

The Staffing Pattern highlights the importance of Trades, Transport and Equipment Operators (representing 44% of employees in industry group) for the industries and the Bioeconomy. Occupations in Manufacturing and Utilities, Natural Resources and Agriculture and Trades, Transport and Equipment Operators represent three-quarters of demanded professions in the three industries.

Complementary to the Staffing Pattern above, CAI conducted a Staffing Pattern for each industry at the three-digit NOC Code. The following tables illustrate the most sought-after minor occupation groups by each industry.

TABLE 4: FORESTRY AND LOGGING STAFFING PATTERN

Forestry and Logging Staffing Pattern					
NOC Code	Top Occupations	% of Total Jobs in Industry	% Change of Total Jobs (2014-2019)	Median Hourly Wages	Location quotient
731	Machinery and Transportation Equipment Mechanics (except motor vehicles)	13.30%	45%	$33.56	1.42
751	Motor Vehicle and Transit Drivers	12.20%	29%	$20.61	1.13
824	Logging Machinery Operators	11.90%	-7%	$26.90	1.45
842	Logging and Forestry Workers	7.10%	-33%	$24.79	1.7

Source: Staffing Patterns - Emsi 2019.3 Analysis: CAI Global, 2020

The Forestry and Logging industry has shifted towards more Trades, Transport and Equipment Operators occupations moving away from traditional logging and forestry workers and adopting more technical talent to operate machinery.

Table 5: Paper Manufacturing Staffing Pattern

Paper Manufacturing Staffing Pattern					
NOC Code	Top Occupations	% of Total Jobs in Industry	% Change of Total Jobs (2014-2019)	Median Hourly Wages	LQ
731	Machinery and Transportation Equipment Mechanics (except Motor Vehicles)	16.20%	-1%	$33.56	1.42
943	Machine Operators and related workers in Pulp and Paper Production and Wood Processing and Manufacturing	9.40%	-8%	$26.98	0.47
961	Labourers in Processing, Manufacturing and Utilities	5.10%	13%	$19.46	0.78
91	Managers in Manufacturing and Utilities	5.00%	-22%	$42.13	0.67

Source: Staffing Patterns - Emsi 2019.3 Analysis: CAI Global, 2020

Comparable to the Forestry and Logging industry, the Paper Manufacturing industry demands professionals with technical skills in machinery and transportation equipment mechanics. General Production Labourers are increasing in demand while the demand for Machine Operators in Pulp and Paper Production has decreased over the last five years.

Table 6: Wood Product Manufacturing Staffing Pattern

Wood Product Manufacturing Staffing Pattern					
NOC code	Top Occupations	% of Total Jobs in Industry	% Change of Total Jobs (2014-2019)	Median Hourly Wages	LQ
731	Machinery and Transportation Equipment Mechanics (except motor vehicles)	13.30%	45%	$33.56	1.42
751	Motor Vehicle and Transit Drivers	12.20%	29%	$20.61	1.13
824	Logging Machinery Operators	11.90%	-7%	$26.90	1.45
842	Logging and Forestry Workers	7.10%	-33%	$24.79	1.7

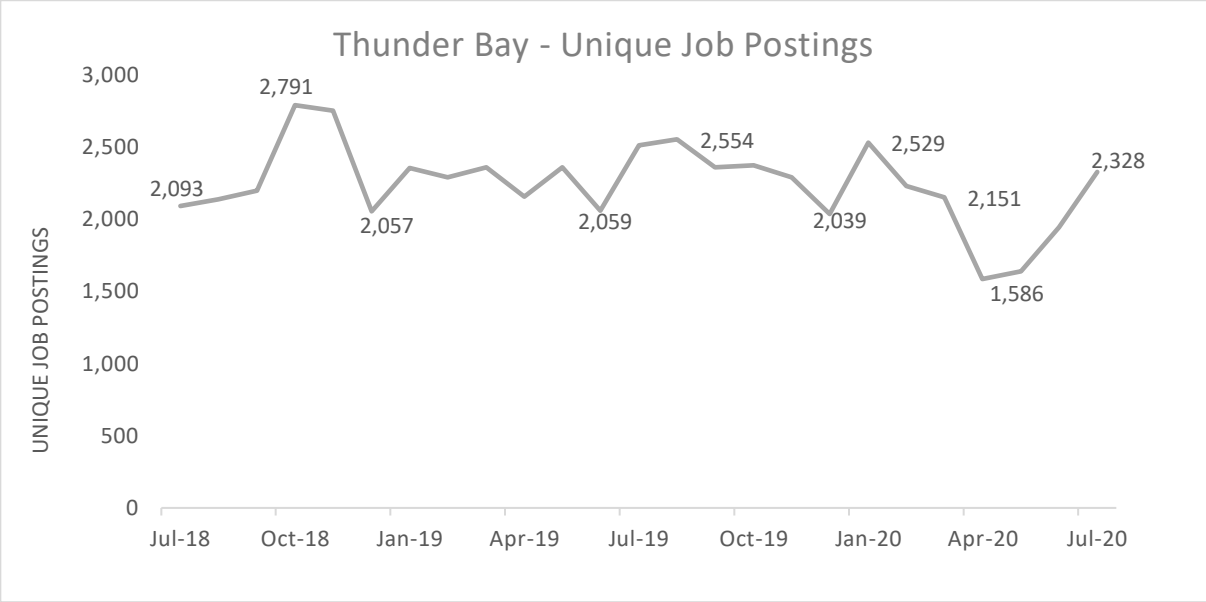
Source: Staffing Patterns - Emsi 2019.3 Analysis: CAI Global, 2020

The most sought-after professionals in the Wood Product Manufacturing are similar to the Paper Manufacturing industry. The demand for professionals with technical skills in machinery and transportation equipment mechanics remains significant. The momentum to employ General Production Labourers over Machine Operators in Pulp and Paper Production is more dramatic than in the Paper Manufacturing Industry.

Unique Job Postings

Unique Job Postings is an indicator measuring current economic activity by collecting the number of non duplicated job vacancy advertisements at a given time. By evaluating Unique Job Postings, overtime peaks, and valleys of labour demand can be identified. The graph below demonstrates total Unique Job Postings in the Thunder Bay CMA from January to April 2020 were in decline with economic closures due to the ongoing pandemic. However, since reopening the economy, job postings in July 2020 have climbed and surpassed the levels of Unique Job Postings in July 2019 and 2018.

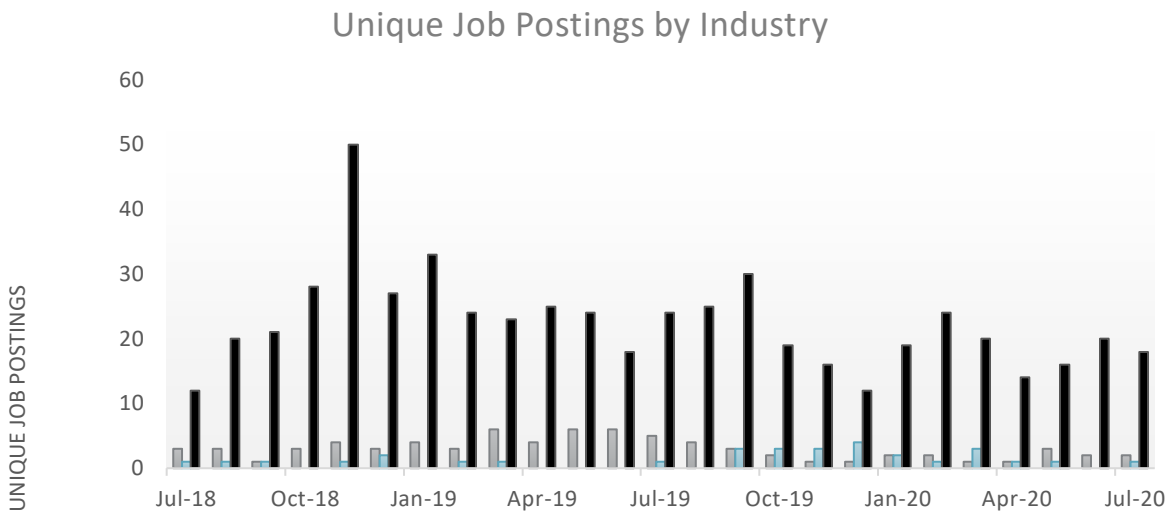
CHART 10: UNIQUE JOB POSTINGS



Source: Unique Job Postings - Emsi 2019.3 Analysis: CAI Global, 2020

The three evaluated industries (Forestry and Logging, Paper and Wood Manufacturing) had an average monthly Unique Job Posting rate of 26.7 posts per month from July 2018 to July 2020. The majority of new postings were for jobs in the Paper Manufacturing Industry. Wood Manufacturing had the lowest average posting duration, at eight days. Compared to the two other industries whose average posting duration exceeded 30 days, indicating it took longer for companies in Forestry and Logging and Paper Manufacturing industries to find the talent they needed. The table below illustrates the Unique Job Postings per month from July 2018 to July 2020.

Chart 11: Unique Job Postings by Industry



	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20
Forestry and Logging	3	3	1	3	4	3	4	3	6	4	6	6	5	4	3	2	1	1	2	2	1	1	3	2	2
Wood Product	1	1	1	0	1	2	0	1	1	0	0	0	1	0	3	3	3	4	2	1	3	1	1	0	1
Paper Manufacturing	12	20	21	28	50	27	33	24	23	25	24	18	24	25	30	19	16	12	19	24	20	14	16	20	18

Source: Unique Job Postings - Emsi 2019.3 Analysis: CAI Global, 2020

The comparison between Unique Job Postings and overall Job Growth by industry helps explain why said industry is hiring. If the change of jobs in an industry is negative, it is more likely that hires represent employment turnover and not industry growth. The table below compares the change in jobs from 2014 to 2019 in the three industries; it illustrates new Unique Job Postings in the Paper and Wood Product Manufacturing are reflective of employee turnover, while the new Unique Job Postings in the Forest and Logging are a product of industry growth.

Table 7: Change in Unique Job Postings

Group	2014 Jobs	2019 Jobs	Change	% Change
Forestry and Logging	329	363	34	10%
Paper Manufacturing	514	501	-13	-3%
Wood Product Manufacturing	188	176	-12	-6%

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

Industry Wages

Based on the analysis, the Thunder Bay CMA has lower and competitive wages compared to the other Metropolitan Areas. Analyzing the four occupation groups most common to the Bioeconomy (Natural and Applied Sciences, Manufacturing and Utilities, Trades, Transport and Equipment Operators, and Natural Resources and Agriculture), Thunder Bay finished among the lowest in median hourly wage for all four occupation groups. Lower salaries are an asset when attracting potential investors. However, the competitiveness of the wages is also vital as much lower wages may detract potential talent from relocating to the area if they know they can earn much more in another location. The table below summarizes the median hourly wage per occupation group by Metropolitan Area:

TABLE 8: INDUSTRY WAGES

NOC Code	Description	Duluth	Prince George	Timmins	Greater Sudbury	Sarnia	Saguenay	Thunder Bay	Kingston
2	Natural and Applied Sciences	$43.12	$33.39	$34.41	$33.72	$33.97	$31.06	$31.80	$32.34
9	Manufacturing and Utilities	$33.19	$31.51	$27.62	$26.45	$26.89	$28.85	$26.20	$24.90
7	Trades, Transport and Equipment Operators	$32.01	$30.69	$26.73	$26.69	$26.86	$26.42	$27.09	$24.01
8	Natural Resources and Agriculture	$23.93	$29.26	$31.67	$30.61	$20.26	$25.01	$23.50	$17.95
	Average Median Salary	**$33.06**	**$31.21**	**$30.11**	**$29.37**	**$26.99**	**$27.84**	**$27.15**	**$24.80**

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

* All wages are in Canadian Dollars

* Duluth wages were converted from US Dollars at a rate of $0.75 CA/$1.00 US

SUPPLY CHAIN

The purpose of the regional supply chain analysis is to identify Thunder Bay's strengths and weaknesses related to industry development for the three benchmark industries of Forestry and Logging, Paper and Wood Product Manufacturing. To evaluate the three industries' supply chain, CAI produced two analyses responding to the following two issues:

1) How Thunder Bay measures to the competition in terms of the supply chain
2) Which supplies derive from the Thunder Bay CMA and which do not

The first analysis is a cross-region comparison of total industry purchases for each of the three regions. The purchases amount derives from an EMSI Analytics Regional Requirements model using data collected starting in 2001 from the Canadian census and Statistics Canada Canadian Business Patterns Service. The estimates displayed in the following tables are for the year 2015 for Canadian cities and 2018 for Duluth, Minnesota.

The second analysis is a deep dive into Thunder Bay's local supply chain identifying important sub-industries to the Forestry and Logging (113), Paper (322) and Wood Product Manufacturing (321) industries, and sub-industries that are not currently located within the Census Area.

For the analyses, there are a few key definitions to comprehend before proceeding:

- **Purchases** are defined as a monetary expenditure spent by companies on products or services in a given industry.
- **In-region** is the expenditure conducted within the selected geography; in this case, the evaluated Census Metropolitan Area.
- **Imported** is any spending that occurs outside the geography chosen, in this case, outside the given Census Metropolitan Area.
- A **requirement** is a sub-industry (e.g., Support activities for forestry) where companies classified under the evaluated industry (Forestry and Logging, Paper, or Wood Product Manufacturing) would purchase products or services.

Forestry and Logging Supply Chain

For the Forestry and Logging industry, Thunder Bay ranked second amongst the competition in total purchases. While a smaller percentage of the purchases occurred locally, this indicates a dependency for external services and products. However, importing many supplies and services is similar amongst the competition with $20 million or more of total annual purchases. While second, Thunder Bay purchased half the amount of Prince George in 2015, indicating the industry size in the competing region is significantly larger.

TABLE 9: FORESTRY AND LOGGING SUPPLY CHAIN REGIONAL COMPARISON

Forestry and Logging (113)					
Region	**In-region Purchases**	**% of In-region Purchases**	**Imported Purchases**	**% of Imported Purchases**	**Total Purchases**
Prince George	$54,739,668	33%	$108,762,544	67%	$163,502,212
Thunder Bay	$26,302,499	33%	$52,271,062	67%	$78,573,561
Duluth	$8,487,233	26%	$24,051,979	74%	$32,539,212
Timmins	$11,200,344	35%	$20,492,078	65%	$31,692,422
Saguenay	$13,420,870	58%	$9,728,108	42%	$23,148,978
Sudbury	$8,347,993	68%	$3,850,165	32%	$12,198,158
Sault St Marie	$3,918,440	67%	$1,907,665	33%	$5,826,105
Kingston	$854,731	95%	$45,509	5%	$900,240
Sarnia	$0	-	$0	-	$0

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

The Support Activities for the Forestry sub-industry is the largest local asset representing 64.3% of local purchases and almost $17 million in the annual purchase amount. While some of the demanded petroleum is met within the region, the Thunder Bay Forestry and Logging industry still requires an excess of $10 million in imported petroleum purchases. The table below displays the top imported and in-region purchases for the local Forestry and Logging industry.

TABLE 10: MAIN DOMESTIC AND IMPORTED PRODUCT AND SERVICES FOR THE FORESTRY AND LOGGING INDUSTRY

Forestry and Logging (113)					
In-Region Industry Requirements	**Amount of In-Region Purchases**	**% of Total In-Region Purchases**	**Imported Industry Requirements**	**Amount of Imported Purchases**	**% of Total Imported Purchases**
Support Activities for Forestry	$16,906,706	64.30%	Petroleum and Coal Product Manufacturing	$10,052,921	19.20%
Logging	$2,992,012	11.40%	General Freight Trucking	$4,877,936	9.30%
Petroleum and Coal Product Manufacturing	$1,213,258	4.60%	Specialized Freight Trucking	$4,486,939	8.60%

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

Paper Manufacturing Supply Chain

For the Paper Manufacturing industry, Thunder Bay ranked third amongst the competition in total purchases. Similar to what was noted in the Forestry and Logging industry, a smaller percentage of the purchases occurred locally, indicating a dependency for external services and products. Importing

many supplies and services was again the trend amongst the competition. In the Paper industry, only three of eight competing regions represent significant competition including Prince George and Saguenay in Canada and Duluth in the United States. In 2015, Prince George had double the expenditures in Paper Manufacturing when compared to Thunder Bay.

Table 11: Paper Manufacturing Supply Chain Regional Comparison

Paper Manufacturing (322)					
Region	In-region Purchases	% of In-region Purchases	Imported Purchases	% of Imported Purchases	Total Purchases
Prince George	$123,919,868	22%	$441,950,107	78%	$565,869,975
Duluth	$87,092,469	25%	$266,828,058	75%	$353,920,527
Thunder Bay	$61,809,132	22%	$217,695,259	78%	$279,504,391
Saguenay	$38,222,373	42%	$52,157,957	58%	$90,380,330
Kingston	$3,752,069	48%	$4,101,129	52%	$7,853,198
Sault St Marie	$5,521,241	74%	$1,953,363	26%	$7,474,604
Sudbury	$2,479,953	84%	$455,532	16%	$2,935,485
Timmins	$654,527	78%	$179,948	22%	$834,475
Sarnia	$0	-	$0	-	$0

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

The Pulp, Paper, and Paperboard Mills sub-industry is the largest local asset representing 38.4% of local purchases and almost $23 million of annual purchases. While some of the demanded products and services from Sawmills and Wood Preservationists are met within the region, the Thunder Bay Paper Manufacturing industry still requires an excess of $33 million in imported Sawmill and Wood Preservation production and services. Logging services remain a vital local resource representing 15.4% of all in-region purchases. The table below displays the top imported and in-region purchases for the local paper manufacturing.

Table 12: Main Domestic and Imported Product and Services For The Paper Manufacturing Industry

Paper Manufacturing (322)					
In-Region Industry Requirements	**Amount of In-Region Purchases**	**% of Total In-Region Purchases**	**Imported Industry Requirements**	**Amount of Imported Purchases**	**% of Total Imported Purchases**
Pulp, Paper and Paperboard Mills	$23,721,013	38.40%	Sawmills and Wood Preservation	$33,982,113	15.60%
Logging	$9,505,725	15.40%	Electric Power Generation, Transmission and Distribution	$25,446,575	11.70%
Sawmills and Wood Preservation	$8,347,756	13.50%	Basic Chemical Manufacturing	$14,359,830	6.60%

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

Wood Product Manufacturing Supply Chain

For the Wood Product Manufacturing industry, Thunder Bay ranked third amongst the competition in total purchases. Unlike the previous two industries, Thunder Bay satisfies most of the industry expenditures locally with three-quarters of all industry expenditures occurring within the CMA. In Prince George and Duluth's Wood Product Manufacturing industry, local purchases amount to more total annual purchases, however, both respective regions import far more than Thunder Bay. In 2015, Prince George had approximately spent five times more in Wood Product Manufacturing when compared to Thunder Bay.

TABLE 13: WOOD PRODUCT MANUFACTURING SUPPLY CHAIN REGIONAL COMPARISON

Wood Product Manufacturing (321)					
Region	In-region Purchases	% of In-region Purchases	Imported Purchases	% of Imported Purchases	Total Purchases
Prince George	$195,587,556	55%	$161,101,882	45%	$356,689,438
Duluth	$30,410,690	30%	$70,125,882	70%	$100,536,572
Thunder Bay	$53,259,044	76%	$16,980,935	24%	$70,239,979
Saguenay	$45,173,405	73%	$16,872,627	27%	$62,046,032
Sault St Marie	$13,976,208	35%	$26,209,325	65%	$40,185,533
Timmins	$25,955,421	72%	$10,166,544	28%	$36,121,965
Kingston	$4,919,476	47%	$5,555,585	53%	$10,475,061
Sudbury	$4,604,227	78%	$1,286,498	22%	$5,890,725
Sarnia	$819,953	0.47	$936,864	0.53	$1,756,817

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

The Logging sub-industry has been an essential asset for all three industries, none more than for Wood Product Manufacturing representing 72.8% of local purchases and almost $39 million in the annual purchase amount. The two other vital sub-industries are Sawmills and Wood Preservation and Support Activities and Forestry. There is no one industry requirement standing above the others; Plastic Product Manufacturing, Management of Companies and Enterprises, and Forest Nurseries and Gathering of Forest Products are amongst the most desired imports in terms of imports. The table below displays the top imported and in-region purchases for the local Forestry and Logging industry.

TABLE 14: MAIN DOMESTIC AND IMPORTED PRODUCT AND SERVICES FOR THE PAPER MANUFACTURING INDUSTRY

Wood Product Manufacturing (321)					
In-Region Industry Requirements	**Amount of In-Region Purchases**	**% of Total In-Region Purchases**	**Imported Industry Requirements**	**Amount of Imported Purchases**	**% of Total Imported Purchases**
Logging	$38,773,804	72.80%	Plastic Product Manufacturing	$947,133	5.60%
Sawmills and Wood Preservation	$4,134,803	7.80%	Management of Companies and Enterprises	$825,107	4.90%
Support Activities for Forestry	$1,116,796	2.10%	Forest Nurseries and Gathering of Forest Products	$746,580	4.40%

Source: Employees - Emsi 2019.3 Analysis: CAI Global, 2020

Impact on Potential Bioeconomy Supply Chain

In terms of the supply chain for a Bioeconomy, Thunder Bay is home to some valuable assets in Logging, Sawmills and Wood Preservation, and Support Activities for Forestry to build off of and support.

Based on these industries, Prince George, with its size and available resources, offers the most competition in attracting potential Forestry Bioeconomy projects given its overall size and level of supply chain integration. Saguenay and Duluth are two other regions that can draw and develop clusters in this regard as well.

This section's conclusions should be measured with caution as the evaluation is based on economic models, and for the Canadian cities, are representative of the economy in 2015.

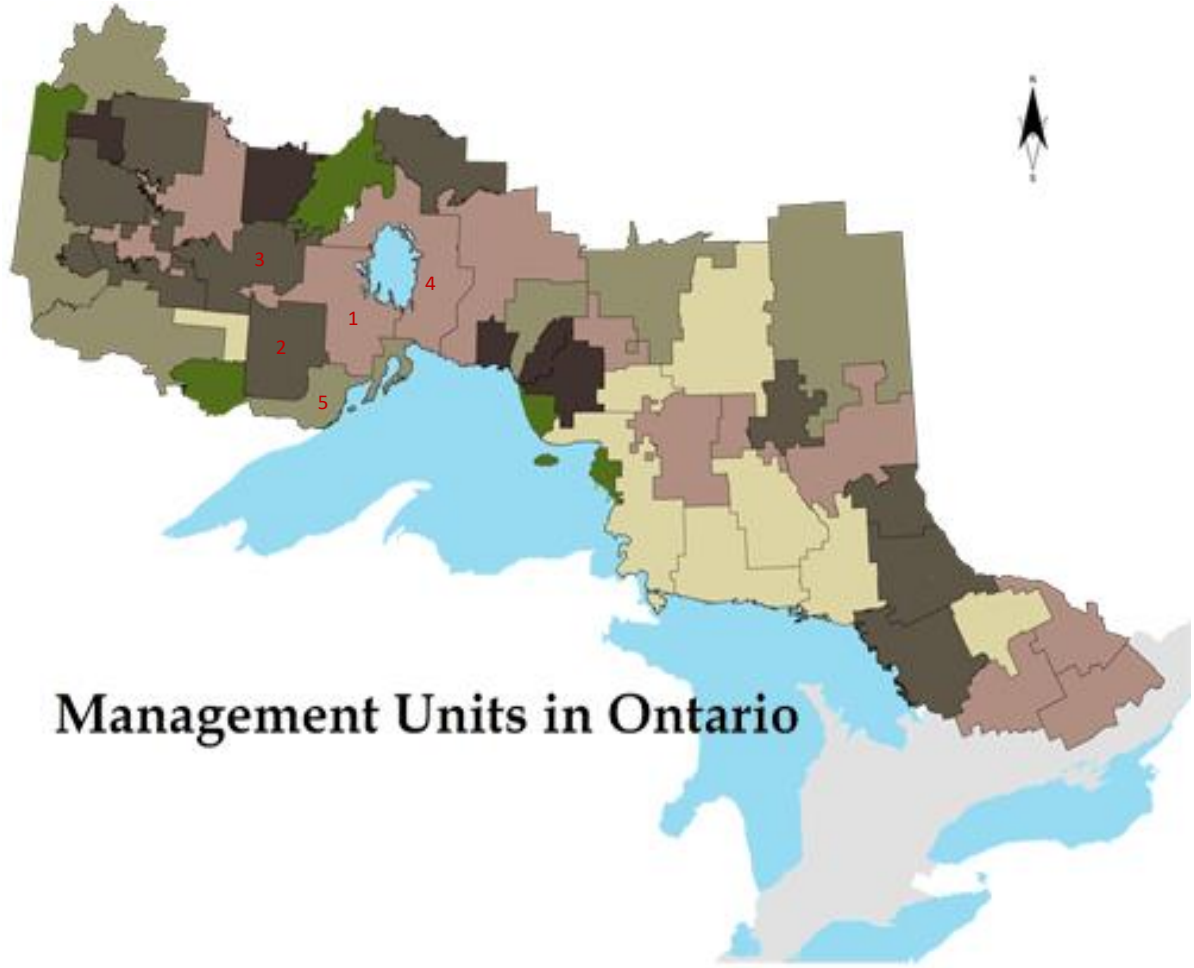
Regional Wood Supply

As part of the supply chain analysis, the availability of local wood and the specific species must also be taken into account given the importance of how supply shapes the local industries in the area.

The supply of SPF in the region has never been a problem; there is neither a surplus nor lack of supply, but there is also a significant quantity of low-quality hardwoods such as birch, poplar and cedar which are co-harvested with SPF. The co-harvesting is essentially the result of the inadvertent need to access the more valuable SPF. However, all wood harvested, even unwillingly, must be used. According to regional stakeholders consulted over the course of the analysis, there is a significant surplus of these hardwoods.

The following map represents the Forest Management Units for the province of Ontario, the most important to the immediate region of Thunder Bay are numbered:

FIGURE 4: ONTARIO FOREST MANAGEMENT UNITS



Source: Government of Ontario, Ministry of Natural Resources and Forestry (MNRF)[7]

The five highlighted Management Units are:

1. Black Spruce Forest
2. Dog-River Matawin Forest
3. English River Forest
4. Lake Nipigon Forest
5. Lakehead Forest

It should be noted that at least one facility brings in wood from as far as the Magpie Forest that is considered part of Northeastern Ontario. However, the five Management Units above are considered the most pertinent to any overview of the wood supply in Thunder Bay.

The merchantable wood currently utilized is SPF and poplar. Available wood is birch and poplar, as per the following table, which depicts the breakdown of the available wood according to the MNRF's March 2020 Report:

[7] https://www.ontario.ca/page/forest-management-planning

TABLE 15: AVAILABLE WOOD SUPPLY - MARCH 2020

Thousands of cubic meters (March 2020)	MERCHANTABLE (ONLY)							
MANAGEMENT UNIT	White birch	Cedar	Other conifer	Poplar	White/Red pine	Spruce, fir and pine (SPF)	Tolerant hardwoods	Total
Black Spruce Forest	38	16	7	-	-	-	-	**61**
Dog River-Matawin Forest	35	7	10	-10	-	-78	-	**-36**
English River Forest	62	3	11	42	-	-116	-	**2**
Lake Nipigon Forest	8	-	6	-	-	159	-	**173**
Lakehead Forest	31	4	1	88	4	62	1	**191**
Total	**174**	**30**	**35**	**120**	**4**	**27**	**1**	**391**

Source: Government of Ontario, Ministry of Natural Resources and Forestry (MNRF)

For the information gathered from stakeholders, the primary species utilized in the area are SPF, or Spruce/Pine/Fir species, and poplar. In addition, Birch and Cedar are also available in these Management Units according to the MNRF's report over a ten-year period. Negative available wood in the table indicates that there are deficits in the wood supply caused by factors such as overharvesting or situations such as forest fires.

However, there are limits to the data presented above. Several stakeholders indicated that the data used to indicate the amount of available wood is unreliable because it does not take into account pre-existing rights, wood quality or ease of access. The limits of the data are discussed further in the SWOT section of this report under *Weaknesses*.

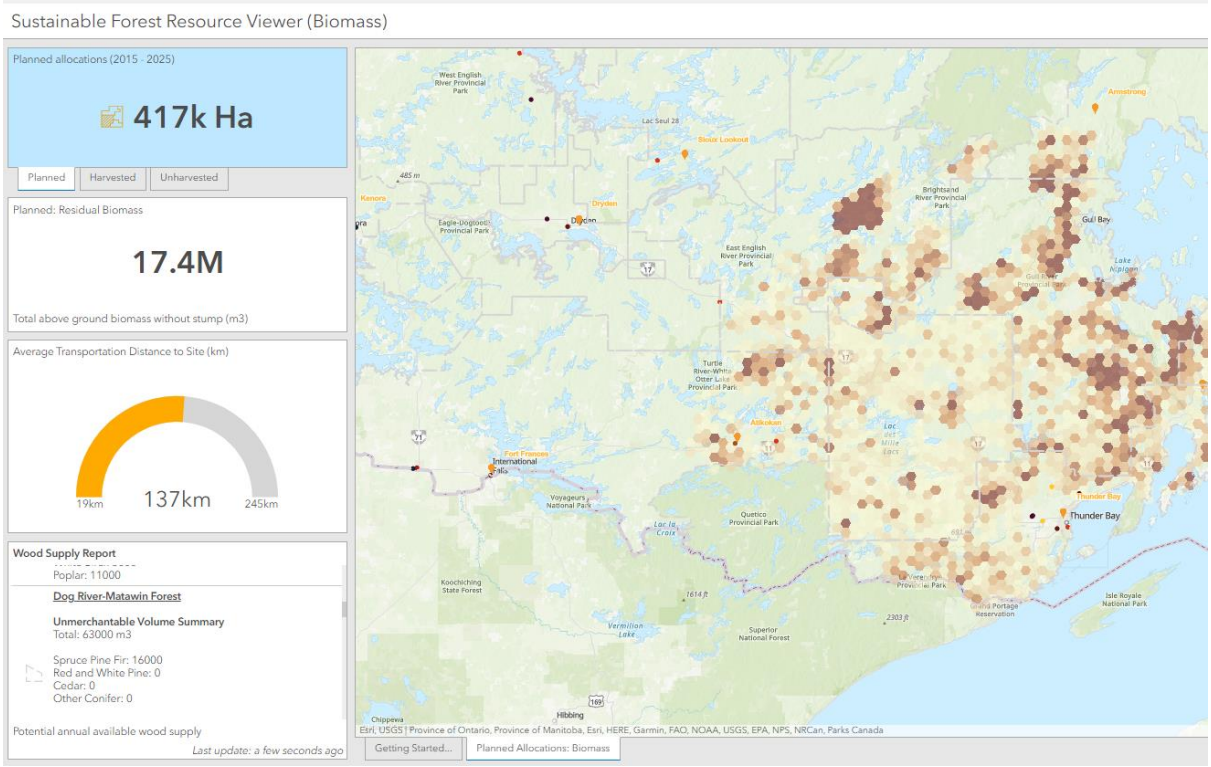
The overall assessment of the wood supply, according to stakeholders consulted and available data, characterized the region including the greater Northwest as having adequate supplies of SPF, Birch, Cedar and Poplar in the region (no significant surplus – supply vs. consumption is matched):

- **SPF**: SPF are the primary wood species available in the Northwest and traditionally the most desirable species for producers in the region. SPF is used for both the production of lumber and pulp. The supply of SPF was considered adequate by the stakeholders consulted for the needs of the processors in the region. There was no indication that there was a surplus of SPF in the region.
- **Birch**: There is a large surplus of white birch/paper birch in the region currently and this is considered to be problematic. The wood is likely merchantable, that is to say of good quality, and is not being used to its full potential. As all wood harvested in Ontario must be utilized, harvesters are obligated to find uses for birch, and other less desirable species, that are cut when accessing more desirable SPF. There is a lack of processing capacity in the region for the amount of birch that is available.

- **Cedar**: According to estimates there is a significant amount of cedar available in the region. However, according to industry in the region, the cedar is a fairly poor quality and is not likely to be used for production of end products such as lumber. Consequently, there are no industrial facilities with need for cedar on an industrial scale in the region.
- **Poplar**: Poplar is both available in significant amounts and is used industrially in the region. However, there is a surplus of available poplar for processing at this time. Much like birch, it is not the primarily sought-after wood species but it must be used if harvested.

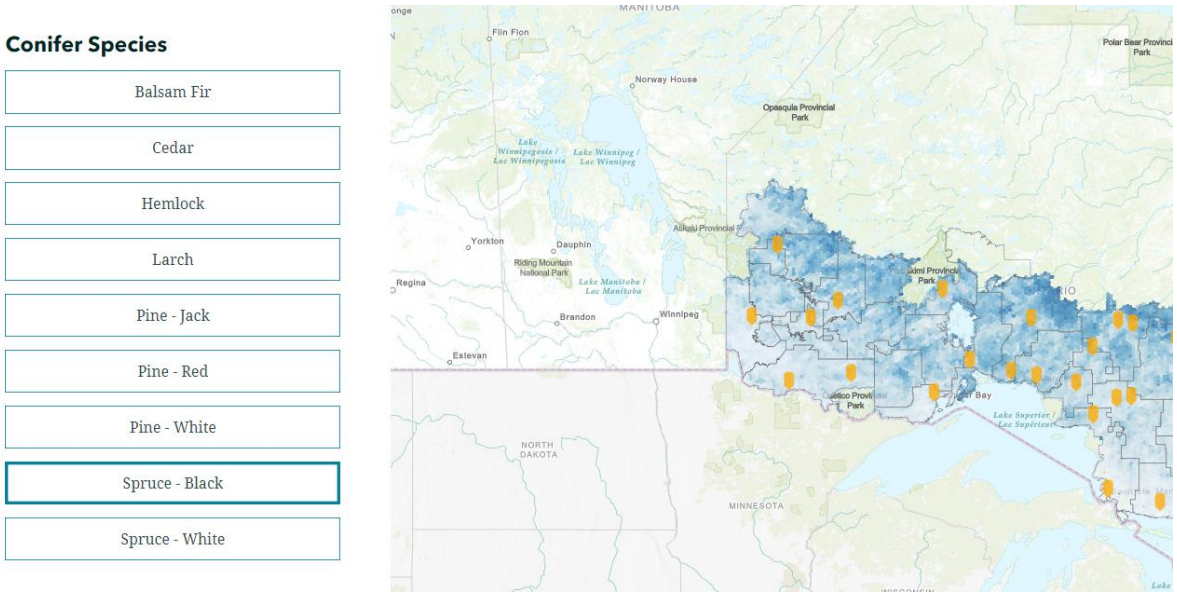
CRIBE is currently developing and testing a tool that would allow producers, processors and new entrants to the market to better understand the wood supply in the province. The Economic Fiber Supply Model is available in an advanced beta model stage but more work continues to be done, and it will need to continue to be done to refine the tool. This type of solution is a necessary step so that Ontario's forestry bioeconomy grows successfully. Some screenshots of the Supply Model (in beta) can be seen below:

FIGURE 5: ECONOMIC FIBER SUPPLY MODEL 1



Source: CRIBE (2020)

FIGURE 6: ECONOMIC FIBER SUPPLY MODEL 2



Source: CRIBE (2020)

The continued development tools and method to bring certainty and clarity to the long-term and short-term availability of wood supply.

In addition to the necessary tools, the presence of important incumbent harvesting rights holders represents a challenge for any new investor. Existing industry players in the region may not be welcoming to new investments if they are perceived as competing for the existing wood supply. For this reason, it may be necessary to get "buy-in" for new projects from existing companies, and rights holders may be called to be partners for new projects if they can be synergistically integrated into the local economy.

Forestry Situation Elsewhere

As part of the discussions with area stakeholders, a question was raised as to how the Thunder Bay region, or Northwest Ontario, compares with wood supply among competitors in a general sense.

The situation in British Columbia, particularly in the Prince George area, is considered to have a fragile wood supply because of years of intense harvesting as part of efforts to eradicate the pine beetle infestation. There have been reports of sawmill closures in the region as the wood supply has diminished and there are limited amounts of mature trees available for harvesting. The pine beetle infestation is now moving East into Alberta which will likely disrupt that province's (smaller) forestry industry in due course.

The situation in Quebec was referred to be in "equilibrium": that is to say that there was a balance between wood supply and sawmill/processing capacity. This would imply that, even if additional wood supply would be available, new processing capacity does not necessarily exist. One stakeholder did praise Quebec's forest management policies which were deemed more flexible and clearer.

There is also currently a shortage of softwood lumber in the market, due to a combination of a home renovation boom and capacity shortages caused by the COVID-19 pandemic which has spurred many jurisdictions to position themselves as areas with enough available wood supply for new projects.

However, this lack of supply coupled with increased demand will likely taper off as stability returns to the market[8].

These situations in the market and in other provinces do not represent potential threats to any forestry bioeconomy initiatives but could constitute competition within a region for wood supply that may impact the development of new downstream industries.

[8] https://www.mortgagebrokernews.ca/news/how-is-the-softwood-lumber-shortage-affecting-canadian-home-prices-and-supply-333723.aspx

CONSULTATIONS WITH LOCAL STAKEHOLDERS

As part of the report, CAI spoke with the following industry stakeholders to understand the regional dynamics and the bioeconomy:

TABLE 16: LOCAL STAKEHOLDER LIST

Name	Organization	Status
Michael Martel	Resolute Sawmill	(Spoke to Kent Ramsey)
Jason Rasevych	Anishnawbe Business Professional Association	Contacted
Mikko Koivisto	AV Terrace Bay	Contacted
Pedram Fatehi	BRI Institute	Contacted
Chris Walton	CRIBE	Contacted
Mike Barten	CRIBE	Contacted
Bill Maloney	Economic Development Lakehead University	Contacted
Jean Hamel	FP Innovations	Contacted
Stéphane Audet	KBM Ressources	Contacted
Scott Wiebe	MNR	Contacted
Scott Miller	MNR	Contacted
Gino Garritano	Orion Ecosolutions	Contacted
Kent Ramsey	Resolute Kraft Pulp Mill	Contacted
Tom Domney	SUMAC	Contacted
Colin Kelly	Confederation College	Unable to reach
Mike Belliveau	FedNor	Unable to reach
Michael Pelletier Sr	Fort William First Nations	Unable to reach
Dave Mackett	Lac Des Milles Lacs/White Sand First Nations	Unable to reach
Lucy Kwiaton	MENDM	Unable to reach

Each individual contacted was asked to:

1. Share their experiences in the regional forestry economy
2. Elaborate on what are the best approaches to the forestry bioeconomy in Thunder Bay
3. The strengths, weaknesses, opportunities and threats they perceived in the region and in the industry

Conversations lasted between 30 to 60 minutes and where undertaken by phone. In some cases, the same individual was spoken to on more than one occasion.

STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS (SWOT) ANALYSIS

As the forestry bioeconomy can be defined in multiple ways, CAI received guidance from local stakeholders as to which niche sectors could be viewed as related to the bioeconomy.

As noted for the purpose of this report, the bioeconomy includes downstream uses of forestry biomass that go beyond a first or second level of transformation such as paper or lumber production for example. The bioeconomy includes uses of wood as varied as chemicals, power generation, and advanced engineering.

In conversations with stakeholders, the most common sub-categories of the bioeconomy were identified and analysed. The following four key sectors were analysed using a SWOT methodology:

- Bioenergy
- Engineered Wood (Cross Laminated Timber and Nail Laminated Timber)
- Biofuels
- Biochemicals

A regional SWOT for Thunder Bay was developed in order to quickly identify the strengths and weaknesses in the region as they apply to all industries. However, the opportunities and threats are much more sub-sector focused and specific. As such, the study splits the SWOT into two parts:

- Regional Thunder Bay SWOT
- Sub-sector SWOTs

THUNDER BAY SWOT

The Thunder Bay region is located at a logistical crossroads for rail, pipelines, and naval shipping. As Ontario's largest northern community, it also has access to remote communities further north of the city. The region is closer physically to Duluth and Minneapolis in the State of Minnesota, and to Winnipeg than to the population centres of Southern Ontario.

In addition, as presented in the earlier sections, Thunder Bay is presently and has historically been home to major forestry industries usually linked to the pulp and paper industry. Ideally, this would lead to the development of further downstream industries in the forestry bioeconomy. A summary SWOT can be found below:

FIGURE 7: THUNDER BAY SWOT

Strengths

Research Environment

There are two primary assets in Thunder Bay related to the forestry research: Lakehead University and the Centre for Research & Innovation in the Bio-economy (CRIBE).

Lakehead University

Lakehead University, a regional university with a strong presence in biotechnology research, constitutes a major asset to Thunder Bay. The University touts its research strengths in advanced technology, biorefining, materials sciences, and natural resources. Researchers in these fields are assets as they relate to R&D work that could be undertaken by private investors locating in the region.

Lakehead is particularly well suited to research in the forestry industry and is currently working on forestry mapping and maximizing forestry usage initiatives, depending on the end-use.

The Biorefining Research Institute (BRI), established in 2008, is at the forefront of research initiatives in transforming biomass into high-end chemical products such as bioplastics, sugars, and fuels. Other industry stakeholders praised this group's research for its achievements and willingness to collaborate to advance research.

Of interest to potential investors, Lakehead is also home to specialised labs that can test various innovations and participate in product development. For instance, Lakehead can test different potential materials developed within a forestry bioeconomy such as adhesives, thermoplastics, and animal feed.

In addition, the Fire Testing and Research Laboratory is capable of testing timber building components for both strength and fire resistance. It is currently the only facility of its kind at a Canadian university.

Centre for Research & Innovation in the Bio-economy (CRIBE)

The CRIBE is an independent and not-for-profit corporation set-up to support innovation to commercialization in value-added forestry. The Center's presence in Thunder Bay is a clear signal to investors that the region is dedicated to getting more out of the provincial forestry industry.

Projects funded by CRIBE have been used to fund pilot projects in biofuels, mapping, and surveying forest resources, technology development, and anything else in line with value-added to the forestry industry.

CRIBE has been actively developing and supporting a forest bioeconomy cluster in Thunder Bay and has led investments in research and development to support this goal.

Additionally, the interaction between the different research stakeholders, including those from outside the region such as FPInnovations and the private sector, is positive, and feedback received indicates that collaboration between the different research groups is good.

FPInnovations

FPInnovations is a private, not-for-profit organization that specializes in creating solutions in support of Canada's forestry industry with an emphasis on the development of new technology. Its R&D labs are located in Montreal, Quebec City, and Vancouver.

In addition to its main labs, the organization operates satellite research facilities. In Thunder Bay, FPInnovations operates a world-class, state-of-the-art Bio-Economy Technology Centre with a focus on lignin extraction for use in both biofuels and biochemicals. The Centre itself is located within Resolute's Thunder Bay facilities.

FPInnovations work led to the development and operation of a biorefining pilot plant which was eventually scaled-up by West Fraser at a Hinton, Alberta facility.

Confederation College

Confederation College is an Applied Arts and Technology college with multiple campuses in Northwestern Ontario; the main campus is located in Thunder Bay. The average size of the student body is 6,500 full- and part-time students per year.

The College offers some key programs to the forestry industry: technical degrees related to forestry, environmental management, transportation and logistics, mechanical engineering (skilled trade), etc.

Key resources available at the College include the OPG BioEnergy Learning and Research Centre, a biomass energy generation facility which also functions as a lab and uses forest biomass primarily, and the Technology, Education, and Collaboration (TEC) Hub, which houses functioning equipment for a variety of manufacturing applications in support of tradesmanship education.

Industrial Cluster and Workforce

As previously mentioned, and demonstrated thanks to the workforce data (see previous section), Thunder Bay has a significant and skilled workforce in different forestry sectors than other jurisdictions around Canada. Forestry (cutting) and pulp & paper are particularly important in the region and represent potential assets for investors. The presence of lumber operations (by Resolute) and chipboard & particle board operations are also of importance to the region.

The presence of large industry players, particularly Resolute, also denotes the presence of an industry cluster. In the past, Resolute has worked to pursue research and development in forestry bioeconomy locally as a way of diversifying away from pulp and finding new uses for surplus low-quality hardwoods.

However, it should be noted that this can also play against investment opportunities in certain cases if a local company is too dominant. For the forestry industry, this is particularly important as Resolute is an SFL holder and its position as a major buyer and user of forestry biomass makes it almost compulsory for any new investors interested in the region.

Logistical Crossroads

Thunder Bay is located at a logistical crossroads as it is served by both Canada's Class I railways, CN and CP, and marine freight as part of the overall St. Lawrence Seaway System through the Port of Thunder Bay. In addition, major oil and gas pipelines flow through the city, which positions it as an energy corridor.

For the transport of goods, the generally agreed rule is that road transport is economically viable within 800 km of its starting location. Beyond 800 km, rail becomes a viable alternative for shipping, and beyond that still, after 1,500 km, marine shipping can be a cost-effective means of transportation[9]. This general rule is tempered by three other factors impacting shipping: mode-switching (from rail to truck for local delivery, for instance), the transport capacity of the mode of transport, and warehousing issues (ex: the need for refrigeration). In the case of rail and marine shipping, their use can be made more economically viable by shipping large quantities in bulk, something that is beyond the capacities of road transportation.

[9] CPSC Transcom Inc. (2012), Étude multimodal du transport des marchandises au Québec en appui aux plans territoriaux de mobilité durable, (Transl. *Multimodal study of goods transportation in Quebec in support of durable mobility plans*). Volume 1, p.2-57

TABLE 17: TRANSPORT RANGE BY MODE

Mode	Economically viable range (km)	Modifiers		
Road	≤ 800	Number of changes in transport modes	Capacity	Factors related to warehousing
Rail	800 - 1500			
Maritime	≥ 1500			

Source: CPSC Transcom (2012) Analysis: CAI Global 2020

For goods transported in bulk, such as wood products (incl. paper goods) and chemicals, rail and maritime transport are generally considered viable at well under the ranges quoted above. For example, a market such as Winnipeg might be considered more effectively accessed from Thunder Bay by road than rail, however, shipping in bulk and without the need for indoor warehousing renders rail shipping economical.

The CP and CN rails are both accessible in Thunder Bay and grant access to essentially all of North America. CN's access is more direct than CP's to the American Midwest and Eastern Canada, while CP is better at reaching Western Canada's interior. The distance to the Midwest markets (Minneapolis, Detroit, Chicago) is well within reach by rail, as is Southern Ontario. Rail can also be used to supply industries in the region if economically viable. Supply chain integration with industries that could supply materials for manufacturing industries in the region could be key to attracting bioeconomy industries to the area. It should be noted that this would apply to goods that could be shipped in bulk quantities. At the moment, Resolute appears to use rail for shipping and has an integrated a rail spur into its facility in Thunder Bay.

Maritime shipping through the Port of Thunder Bay can viably access markets in Southern Ontario and eastwards into Quebec and the Atlantic provinces as they are beyond the 1,500 km range. Maritime shipping is also best suited to bulk shipping of goods (such as fuel, lumber, etc.). However, the Port of Thunder Bay is not an intermodal facility (i.e., container port) and is mainly dedicated to grain shipping: in 2019, of the 9.3 million tons of goods shipped through the Port, 7.9 million tons (85%) were grain. Nonetheless, the Port represents an important asset for the region and could be further used for bulk shipping of liquid (fuels) or dry goods (wood, paper products) should it be economically viable.

The overall effect is that despite Thunder Bay's relatively remote location, especially from Ontario's population centres, it is well served in terms of transportation for bulk shipping.

Weaknesses

Remoteness and Demographics

Although Thunder Bay has a sizable population base, it remains relatively isolated geographically. Outside of its immediate area, there are no additional nearby population basins from which workforce could be brought in should employers require manpower.

Overall, the region is relatively isolated from other population centres which may make attracting new workforce more challenging. This is part of an overall trend in urbanization which has become a major

challenge for all remote and rural communities as large metropolitan areas are attracting immigrant populations which drive population growth.

Attracting additional residents from immigration would be a potential long-term solution to this problem. However, this is also highly dependent on economic growth. In addition to immigration, the possibility of better recruitment practices among indigenous communities, which have comparatively younger and faster-growing populations, could help alleviate the potential shortfall in manpower. However, the indigenous population represents a relatively small proportion of the overall population of the region.

In addition to the demographics, Thunder Bay is considerably more remote than some competitors. There are no direct flights to and from the US, particularly from the closest large city, Minneapolis, MN. Fortunately, this is not an insurmountable weakness as flights to and from Toronto are easily available for potential investors to visit the area.

Wood Supply – Uncertainty in Determining Availability

Although it may seem self-evident that a region with a significant number of forestry companies is home to a significant and available wood supply, this is not necessarily the case.

In reviewing the available data, it may appear that SPF is in short supply in the region (see Available Wood Supply table above) and that there is an abundant supply of Birch, Cedar and Poplar that could be harvested. However, the numbers above should be reviewed with circumspection. For instance, there is in fact a regional balance between SPF supply and demand in the region.

As several stakeholders made clear during the analysis of the wood supply, how the province of Ontario reports its wood supply is problematic for a number of reasons:

1) The numbers in the available wood reports represent wood supply which has been allocated through Sustainable Forest Licenses (SFLs) to a specific rights holder. The number is reported based partially on whether the wood has actually been consumed, despite the fact that the rights are held by an existing party. In other words, the cubic metres listed may not be available to a new investor. In addition, large local players, such as Resolute, hold some of these rights.

2) The wood supply numbers are based on forest growth estimates and coverage, mainly determined by satellite photography and technologies such as lidar. They do not consider the costs of accessing the wood supply that may not be currently accessible by road and require significant investment to evaluate in person. Also, the current method does not provide data on the quality of the forest biomass present.

In essence, the way wood supply is reported and managed does not allow for a long-term vision of availability. This is a key weakness to address as new investors would want to have a clear understanding of the available wood supply, which they could access as part of new investment.

Further to wood supply reporting, some criticisms of how wood supply is allocated in Ontario (by area, rather than taking into account actual harvesting volumes) were observed by one stakeholder. In this particular case, the Ontario method was compared unfavourably with how the province of New Brunswick issues its harvesting rights on Crown Lands.

Availability of Industrial Land

When evaluating a potential site for investment, it is important that jurisdictions be able to accommodate investor needs regarding industrial land with available utilities (i.e., shovel-ready sites).

A preliminary survey of the Thunder Bay region indicated several industrial parks in the immediate region, but the extent of their investment readiness was unclear upon review. In addition, pricing and utility information was not consistently available for some of the following parks:

- Innova Business Park
- Harbour Park
- Intercity Site
- Fort William First Nation
- Industrial Land Sector A
- Industrial Land Sector B
- Industrial Land Sector C

Given the presence of infrastructures such as the Port of Thunder Bay and Class I rail lines, it would be beneficial to ensure that information on the properties be available to investors.

It should be noted that some feedback received from stakeholders were negative concerning the overall cost of investment in Thunder Bay ("comparable to Southern Ontario"). However, this could not be verified independently, and Thunder Bay's labour costs were significantly more expensive important than elsewhere according to the workforce analysis.

It should be noted that improving the overall presentation of available land and its investment readiness would improve the region's positioning with investors at a minimal cost.

Business Costs – Infrastructure and Taxation

Through conversations with stakeholders, there was a sentiment that the cost of doing business in Thunder Bay was too high compared to the opportunities in Southern Ontario.

A review of comparative studies focusing on cities and towns in Northern Ontario revealed that Thunder Bay competitiveness lags behind other jurisdictions.

A study by SBCS for the Thunder Bay Chamber of Commerce in 2014[10] revealed that Thunder Bay's industrial taxation rate (for occupied land) was 5.53% compared to the average for northern cities of 4.86 % and the provincial average of 3.78 %. This Thunder Bay rate is now lower, around 4.8%, to bring it more in line with the average among its peers, indicating a sustained effort to increase competitiveness.

A 2014 study by MMK Consulting[11] concluded that business costs (which encompass more than just municipal taxation) were higher in Thunder Bay than in North Bay, Sault Ste. Marie, Sudbury, and Timmins, among others. In fact, Thunder Bay had higher business costs than Toronto, Montreal, and Winnipeg. Isolating the cost of doing in business in manufacturing also showed unfavourable results for Thunder Bay. The region did perform well in terms of Research & Development costs, which were significantly lower than in most larger cities. Thunder Bay did not perform well due to high transportation costs for land freight (rail and maritime shipping were excluded from the study) and labour costs. Also, this particular study did not take industrial land and construction into account for

[10] http://tbchamber.ca/wp-content/uploads/municipal-finance-analysis-2014.pdf

[11] https://www.investinnorthbay.ca/media/1551/final-rep-northontario_ca2014_dec08-2014.pdf

its model. It should also be noted that the current analysis does not support the notion that labour in manufacturing is significantly more expensive in Thunder Bay than elsewhere.

In addition, a report on business confidence conducted by Thunder Bay Ventures in 2019[12] indicated that although confidence was stable, several specific issues were a concern for local investors: rising business costs; lack of qualified employees; weak economic conditions; lack of leadership from the government; excessive red tape and poor quality of employees. As a caveat: these are common issues in a number of jurisdictions and reflect overall business concerns.

Continuing to compete for projects and investors with areas that can offer lower utility costs (both in terms of service costs and long timelines) and infrastructure costs should be a priority in addition to continuing to ensure that industrial taxation remains competitive.

Opportunities

Wood Supply – Underutilization of Birch and Poplar

As previously discussed in the supply chain section of this study, the supply of wood in the region is considered adequate for SPF species, but there is an underutilisation of birch and poplar, in particular, in the immediate areas surrounding Thunder Bay.

There appears to be a lack of processing capacity for birch and poplar in the area. As the principal industrial forestry processing capacity is more focused on SPF (White and Black Spruce, Jack Pine and Balsam Fir), birch and poplar are not as sought out but must be harvested as part of SPF harvesting operations. This results in an oversupply and comparative lack of processing capacity for specific species.

Because there is not enough processing capacity, the surplus of birch and poplar are problematic from a supply chain management point of view (e.g., they must be "used" once harvested). Therefore, the surplus is an important opportunity to bring in companies that may have uses on an industrial scale for these underused woods in the region.

Development of Select Bioeconomy Sectors

As part of this analysis, four downstream bioeconomy sectors were examined in order to establish separate SWOTs as industries and in relation to the assets available in Thunder Bay. An analysis of those four sectors can be found in the subsequent sections.

The analysis of those sectors indicated that the sectors of greatest interest would be biochemicals and engineered wood: further details are offered in the subsequent sections.

Threats

Long-term Health of the Pulp Market

Industrial production using forestry biomass in Thunder Bay is dominated by pulp production using SPF species. Thunder Bay's largest forestry company remains Resolute Forest Products which operates a kraft mill and newsprint mill with integrated production (the kraft mill is competitive at the moment). With a steady decline in newsprint sales, regional producers risk losing the "anchor" industry on which other parts of the regional supply chain depend. The decline in newsprint does not necessarily affect the kraft mill at the moment.

[12] http://www.thunderbayventures.com/upload/documents/tbv-business-confidence-index--2019--pre.pdf

Public Policy Uncertainty

Public policy, specifically as it relates to forestry bioeconomy, is critical to the industry's development, which was made clear through CAI's research and interactions with stakeholders. Because the forestry bioeconomy is linked to policies that address climate change (GHG emissions), industrial pollution (use of plastics), and heavily regulated industries (power generation), there must be a clear understanding that changes to regulatory frameworks that may occur could either help or hinder the development of the bioeconomy.

Among the public policies or legislation that may impact the development of the forestry economy, the following are among those that were mentioned by local stakeholders:

- **Canada Clean Fuel Standard**: This legislation will establish technical norms on the use of biofuels in Canada. The technical requirements are due to be released in the Fall of 2020 and the standards would come into force in 2020. This is likely to affect the development of biofuels from forestry biomass (including hydrogen) as the legislation will likely push to include more such fuels as a replacement for fossil fuels.
- **Single Use Plastics Ban**: The Canadian government announced its intention to ban single use plastics without specific legislation. This would both encourage the recycling of plastics (companies would have an incentive to create a circular economy) and the use of bioplastics, assuming that they were friendlier to the environment. Forestry biochemicals (and plastics) would be called upon to play a larger role in weaning the economy off the use of plastics. The specific legislation has been delayed by the pandemic.
- **Greenhouse Gas Legislation**: There are various legislative measures considered both provincially and federally which aim to reduce GHG emissions. These measures must also comply with treaty obligations to which Canada is a party. The fight against climate change will likely benefit the forestry bioeconomy (by replacing fossil fuels) but also bring an added layer of complexity. Key aspects related to carbon sequestration may not benefit the Boreal forest found in the area. Also, key industries in the region such as AV Terrace Bay and Resolute are heavy emitters of greenhouse gases: their operations would need to find a way to mitigate the amount of GHG produced every year.

All sectors of the forestry bioeconomy are heavily impacted by legislation, and some sub-sectors may come to rely heavily on public subsidies for a period of time as they become viable alternatives to fossil fuels.

BIOECONOMY SECTORS

Based on stakeholder feedback, CAI analyzed a number of bioeconomy sectors to gauge their strengths, weaknesses, opportunities, and threats as they relate to Thunder Bay and their industry as a whole.

Engineered Wood

Engineered wood is a wood product category that ranges from plywood to cross-laminated timber to transparent wood materials. This category of wood products includes any products that use adhesives to bind particles or fibres together in order to create a stronger product.

The following SWOT concentrates on an analysis of particular types of engineered wood, Cross-laminated timber (CLT), and Nail laminated timber (NLT). Both of these engineered wood categories are relatively recent innovations with increased market acceptance and high-value-added products.

For engineered wood products such as plywood, fibreboard, and particleboard, this is especially true. Estimates vary on the size of the market for CLT. According to MarketWatch[13], the global CLT market is expected to reach US$980 million by 2024 based on a growth of 9.1% per year from 2020. Other estimates place the market share of CLT in North America at 3% of the entire building market. There is likely considerable room for growth.

Engineered wood, specifically CLT and NLT, are being developed as eco-friendly solutions to construction using concrete and steel, which can be both expensive and particularly carbon-intensive during production. In addition, remote communities would rather use locally sourced materials for residential buildings and certain key infrastructure such as bridges.

While there are engineering limitations to CLT and NLT, the use of both is being pursued by governments and companies in order to use more "natural" materials. Canada (the province of Quebec specifically due to changes in the local building code), Nordic and Germany-adjacent Alpine countries are at the forefront of these developments in order to use more sustainable and local materials.

Compared to leading markets for engineered wood, such as German-speaking Alpine countries (Germany, Austria, Switzerland), North American markets are only beginning to see these products as alternatives to traditional construction methods for larger buildings. Based on that experience, there are a number of early conclusions which can be drawn about CLT and NLT markets[14]:

- Engineered wood can be used in multiple types of applications including: public buildings, apartments, offices, single and multi-family dwellings, etc.
- Successful companies that produce engineered wood also have in-house design and technological capabilities in contrast with traditional softwood lumber manufacturing where the focus is primarily on producing a few standardized products but does not require a focus on specific client/project needs.
- CLT projects may create comparatively fewer jobs than traditional forestry manufacturing due to advances in automated production methods. The projects will require skilled knowledge from all levels of production.

In terms of wood supply, SPF species, spruce specifically, are the most likely to be used for CLT although poplar and birch are used in smaller quantities and are being developed to complement spruce (for instance as a combined hybrid form of CLT[15]).

The use of SPF in engineered wood applications should not impact wood supply for pulp producers in the region as pulp producers seek different parts (chips) of the same species and would give added value to lumber production in the region.

[13]https://www.marketwatch.com/press-release/cross-laminated-timber-clt-market-2020-is-expected-to-see-magnificent-spike-in-cagr-with-global-industry-brief-analysis-by-top-countries-data-which-includes-driving-factors-by-manufacturers-growth-and-forecast-2024-2020-08-09?mod=mw_more_headlines&tesla=y

[14] Cross-Laminated Timber in North America: What can we learn? G. Schwarzmann, E. Hansen and G. Berger, International Society of Wood Science and Technology, Vol. 3(7), 2018

[15] https://www.hindawi.com/journals/amse/2019/1728258/

TABLE 18: ENGINEERED WOOD SWOT

Strengths	Weaknesses
• Low-carbon alternative to concrete and steel • Growing acceptance from the construction industry for its use • CLT has multiple applications of both commercial and residential construction, and infrastructure • CLT is generally produced using SPF species which are present in the region • Bulk shipping options in Thunder Bay (rail, maritime) can be used both to receive inputs (adhesives) and send outputs (CLT)	• More expensive production option relative to other construction materials • Process produces less waste, consequently leading to less biomass feedstock • Companies tend to locate production in downstream markets (large population centres) with prefab potential • The local supply chain for adhesives (used in production) is supplied from outside the region • Birch and poplar are not commonly used in CLT production (does not easily address oversupply of those species in the region) • Requires strong technical know-how on the part of manufacturers, including design capabilities
Opportunities	**Threats**
• New industry in North America first plants established less than 10 years ago – less competition • Building code changes to incorporate new fabrication techniques using engineered wood • Possibility of working with local researchers to develop adhesives for engineered wood from lignin sourced in the region (e.g., Lakehead U. fire testing lab) • Complementary to use of SPF species being used for pulp	• Production growing faster in the US than in Canada: reducing export potential • Attractive new industry: a great deal of competition for attracting projects • Adoption of CLT and NLT for buildings is reliant on updating building codes • Potential inability to identify skilled labour necessary for production and design

There are some potential drawbacks to pursuing projects in this industry. Firstly, many jurisdictions in Canada are also trying to attract this type of project. Secondly, CLT and NLT projects do not address the short-term surplus of birch and poplar.

Potentially, engineered wood could displace a significant portion of building materials market currently being produced with steel and concrete. Also, production in the area would complement existing pulp production and may, in the longer term, provide a market for the surplus of birch and poplar in the region.

Bioenergy

Bioenergy refers to the use of biomass for power generation. In the forestry industry, residual biomass is generally produced as a by-product of wood product manufacturing from non-merchantable wood and other biomass not used in the primary production process.

As mentioned in previous sections, the harvesting of non-merchantable woods may be done as an unwanted consequence of normal harvesting operations. Legally, any woodcut must be used, and as such, forestry companies have typically integrated power generation (ex: for boilers or heating) into their primary operations using biomass residuals.

There is also a market for biomass in power generation on a larger scale than for individual facilities' needs. Biomass power generation, from any forestry biomass, can be commercially viable in certain instances however it must complement exiting harvesting as it may not be viable on its own according to the US Department of Agriculture's Forest Service[16].

In the case of most commercial bioenergy power generation, facilities choose to function using wood pellets as they are easy to transport, standardize, and there is relatively strong market demand in Europe as part of efforts to reduce both GHG emissions and reliance on Russian-supplied natural gas.

There does not seem to be a consensus as to the best types of wood species to use in the production of energy (whether from pellets or directly): the most important factor is the amount of moisture in the wood (more moisture is equal to less efficient burning).

TABLE 19: BIOENERGY SWOT

Strengths	Weaknesses
• Thunder Bay was home to the largest biomass power plant in North America: it accounted for 50% of the province's energy biomass contribution • No shortage of unwanted birch and poplar in the region that could be used for fuel supply (should they be suitable) • Confederation College operates a biomass power generation facility, the OPG BioEnergy Learning and Research Centre	• Represents only 2% of all-electric power in Canada • Lack of regulatory push for energy production from biomass • Nonetheless generates GHG emissions • Not necessarily as viable as a standalone economic activity • Shipping costs for overseas markets will impact competitiveness.

[16] https://www.fs.fed.us/pnw/sciencef/scifi174.pdf

Opportunities	Threats
• Use of wood pellets for small scale heating applications in remote communities as replacement to diesel generation • Strong potential European export market if viable pellets can be produced	• Other renewable energy sources are more prevalent and more developed than forestry biomass • Energy strategy pursued by the provincial government prioritizes nuclear power generation. Also, the renewable power solutions being pursued, to a lesser degree, are solar and wind • Local processors are already using biomass for their own energy needs: there may not be excess capacity available for a dedicated power generation or wood pellet production plant

As a viable industry, its prospects are highly dependent on the regulatory environment: government initiatives, or lack of funding, can derail large scale power generation projects from biomass. Biomass must also compete with other sources of power such as natural gas, hydro, renewables, etc. These are well-established, greener, and sometimes cheaper alternatives.

Thunder Bay was home to one of the largest such facilities in North America which was operated as a proof-of-concept facility. Unfortunately, the facility, which was owned and operated by OPG, was recently sold and there is no indication that power generation will be restarted or that attempts would be made at making operations commercial in nature. The situation underlines how large-scale power generation is heavily dependant on matching public policy priorities, which the OPG facility no longer did.

In the case of Ontario, the provincial government is intent on refurbishing its nuclear power stations to supply energy to the province. This decision may be an insurmountable obstacle to the use of large-scale biomass for power generation.

As there is no willingness from the government to encourage this type of power generation, nor to encourage the use of wood pellets for heating in remote communities to help displace diesel generators, the potential for this type of project in Thunder Bay is low and does not seem likely to go beyond its use at individual companies as a feedstock for boilers.

In addition to the lack of public policy push for bioenergy generation, it should be noted that the local plant used imported wood pellets[17] rather than a locally produced supply. This underlines how much more advanced European markets are in pushing the use of biomass as a renewable energy source. This does not apply to the Canadian market given its easier access to other power generation renewables such as hydro-electricity and natural gas alternatives.

On a smaller scale, biomass, through wood pellets' production and use, can be a potential source of heat for remote communities and a substitute for diesel generators. However, as mentioned, wood pellet production in Canada is limited, and a production facility in Thunder Bay would likely need to sell in other markets effectively, Europe primarily, in order for a plant to be economically viable. European markets may not have an interest in importing wood pellets given that GHG emissions from transport over long distances diminish their efficiency as a "green" technology. This would also require overcoming shipping costs.

Biofuels

Biofuels can be defined as any fuel derived from biomass. Well known examples of these are products such as ethanol and biogas or syngas (including hydrogen).

Biofuels are typically derived from agricultural products on a commercial level, most commonly from corn in North America. These are considered first-generation biofuels. In theory, any biomass can be used to generate gas, liquid fuel, or other derivatives such as hydrogen. This new generation of biofuels aims to incorporate new biomass sources into the industry including from lignocellulosic sources such as forestry.

In principle, biofuels benefit from being more carbon-neutral than traditional hydrocarbons as they release carbon which had been captured in the short term (by plants) rather than carbon captured in the long term (through fossilisation).

Fuel standards play an outsized role in the development of this industry. The adoption of biofuels for industry and consumers is typically an obligation imposed by governments to encourage clean fuel standards. Unfortunately, clean fuels such as ethanol are not as cost-competitive as fuels derived purely from hydrocarbons.

Canada's new Clean Fuel Standards, for which consultations began in 2016, is expected to have technical requirements released in the Fall of 2020. It is expected that biofuels will be called upon to play some role in reducing carbon emissions. These guidelines will likely play a key role in the development of this industry in Canada, given the importance of regulation for fuel. Canada may follow the United States and Brazil which mandate minimum ethanol content in fuel, such as gasoline.

The standards will also affect the second generation of biofuels, such as biodiesel, biocrude, heating oil, and cellulosic municipal solid waste ethanol.

[17] https://www.canadianbiomassmagazine.ca/advanced-energy-5410/

TABLE 20: SWOT BIOFUELS

Strengths	Weaknesses
• Slight competitive edge in forestry & logging and paper manufacturing – poplar trees* (high growth rate, low input, sugars are easy to extract) • Strong research presence in the region in order to work on optimizing lignin-based biofuels (parallel to research into biochemical opportunities)	• Far from the chemical cluster in Toronto GTA, Sarnia-Lambton and East Ontario (lack of refineries) • Feedstock supply limited to forestry biomass: no access to switchgrass, corn stover, paper products, etc. • Lack of specialized workers in the chemical field (e.g., chemical engineers) • Difficult to ship through pipeline because it absorbs water very quickly and erodes pipes, therefore relies on rail and truck transportation • The industry lacks clear supply chains of feedstock-to-refinery for second generation biofuels
Opportunities	**Threats**
• Higher requirements for renewable fuel in North America create export opportunity • Small-scale production could be funded through research grants • Low cost to produce and low carbon footprint (90% less GHG emissions than gasoline production) • US Forestry Industry is not investing in the bioeconomy, decreasing market competition (opportunity for Canada to be an industry innovator in North America) • Canadian Clean Fuel Standard will likely mandate added use of biofuels, thus making them more competitive	• High cost of R&D and infrastructure: Iogen (Ottawa) invested over $500 million in R&D and demonstration. Commercial plant to cost Woodland Biofuels (Sarnia) over $150 million • Low crude oil prices make biofuels uncompetitive • There is a surplus of ethanol facilities in the United States: past failures in this industry create skepticism

For the Thunder Bay region, the immediate opportunity would be to use the forestry industry as a biomass source for fuels, gases, and potentially downstream future fuels such as hydrogen. While fuels from forestry biomass are in development, they face competition from both traditional fossil fuels and biomass from agricultural biomass. As such, the development of a biofuel industry in the region would

face a highly competitive environment. A 2009 study by Sims et al.[18] established that for first generation biofuels, crude oil prices would have to be able $70-80/barrel (Brent Crude oil is trading at around $40/barrel currently).

Further to the industry's competitive situation, the COVID-19 pandemic has caused further drops in oil prices, which have impacted ethanol producers. As estimated in April 2020, the number of idled ethanol facilities reached 30% of US plants[19].

Stakeholders that were consulted by CAI also identified that further research was needed in order to identify which species and sections are best-suited for development as biofuels. For the moment, biofuels derived from lignin sources are not as efficient as those commonly derived from sugars and starches[20] because of the necessary pre-treatment needed for processing. Although there is potential in the industry, only a handful of companies in Canada have attempted to produce commercially viable amounts of biofuels from forestry biomass (ex: Iogen of Ottawa and Woodland Biofuels of Sarnia). Essentially, there is still research to be done in the field for which Thunder Bay could potentially attract small scale, start-up research projects into second-generation biofuels. For this same reason, it is difficult to gauge if the surplus birch, poplar, and cedar would be efficient sources for a biofuel facility.

Supply chain logistics for the second-generation of biofuels have also been identified by M. Valdivia *et al.*[21] as lacking compared to those for first-generation fuels. The emphasis on generating biofuels from "waste" may help to complexify supply chains and will be an additional obstacle to overcome for the development of this bioeconomy industry.

That being said, a potential investor to the region was contacted by CAI in order to understand a biofuel project that is being developed in Thunder Bay. The project itself would develop a biodiesel and jet fuel refining facility which could use both forestry and agricultural biomass in addition to wood-based construction waste. This would be the first step in establishing a supply chain for biofuels. It should be noted that the technology to produce these biofuels is based on work done by an Italian university rather than research done locally.

The opportunity to develop biofuels in the Thunder Bay region is considered only moderate given the significant obstacles and the overall poor market conditions for established biofuels such as ethanol.

Biochemicals

Biochemicals can be defined as any chemical derived from biomass (as opposed to fossil fuels). Biochemicals is a very broad category and links to other specific categories of products such as biofuels (which are discussed in a separate section). In the context of the Thunder Bay region, biochemicals generally refer to chemicals and products such as sugars and bioplastics that could be derived from wood, and specifically lignin.

In terms of processing, biochemicals can be produced using two general methods:

---

[18] An overview of second generation biofuel technologies, Bioresour Technol 101, Sims et al., https://pubmed.ncbi.nlm.nih.gov/19963372/

[19] https://www.startribune.com/nearly-one-third-of-ethanol-plants-idled-including-four-in-minnesota/569826142/?refresh=true

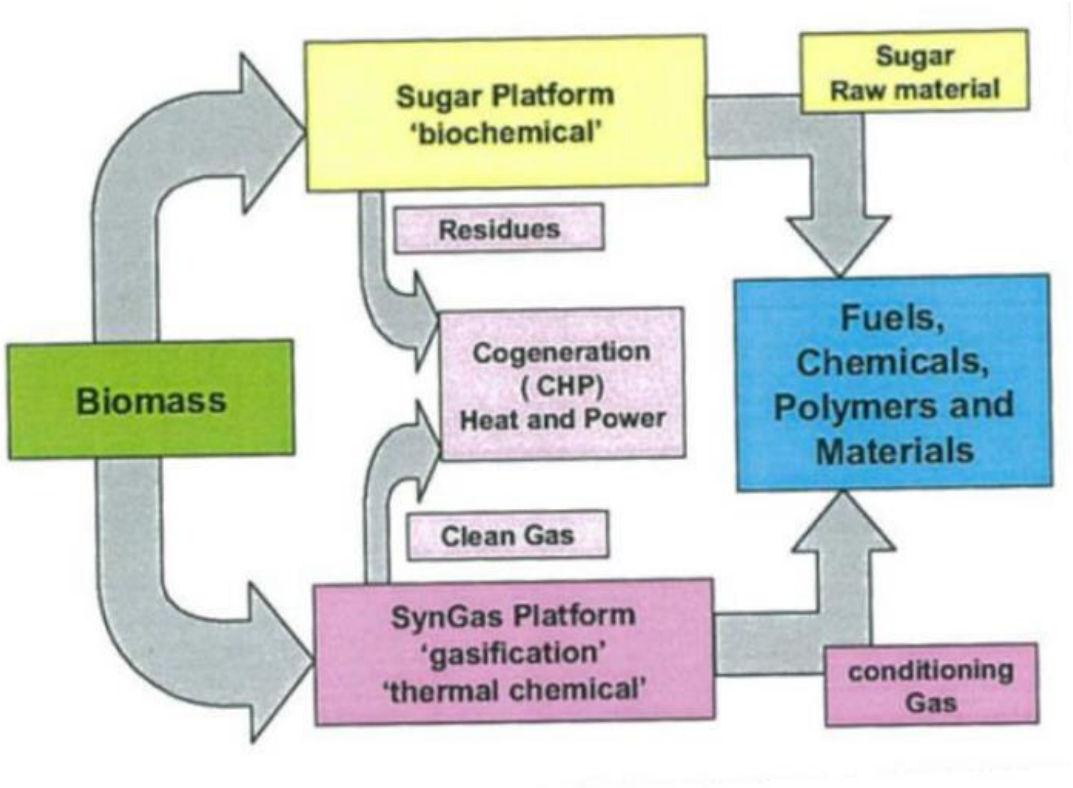
[20] Lignocellulosic Biomass Transformations via Greener Oxidative Pretreatment Processes: Access to Energy and Value-Added Chemicals, Front Chem 6, 141 (2018), W. Den et al.

[21] Biofuels 2020: Biorefineries based on lignocellulosic materials, Microb. Biotechnol. 9(5), 2016, M. Valdivia et al.

- Biochemical: biological processes used to separate biomass components (ex: sugar-to-ethanol)
- Thermochemical: thermal treatment to produce syngas/bio-oil (ex: biomass gasification)

From either of these processes, multiple chemicals, polymers, fuels, etc. can be produced. Biochemical and thermochemical processing is not an either/or choice: both can be combined to create value-added chemicals, as illustrated in the illustration below:

FIGURE 8: SYNERGISTIC BIOCHEMICAL AND THERMOCHEMICAL PROCESSES



Source: IETS TCP, https://iea-industry.org/ (courtesy of Scott Miller, MNRF)

Biochemicals offer the possibility of biodegradable products and improving sustainability. However, integrating biochemicals into the existing supply chains can prove challenging for a number of reasons. For one, there are cost and reliability issues with introducing existing chemicals into the marketplace. Also, chemical production is remarkably complex: it is not just necessary to refine or produce a single chemical but rather to have a viable market for what may be leftover or discarded. Similarly, the forestry industry's need, particularly in pulp, to add value to non-merchandisable woods that are co-harvested and unused biomass. Supply chain integration will remain a major challenge for any biochemical production.

To some extent, biochemical production is already part of the forestry industry. For years, pulp producers have produced turpentine and tall oil as by-products of their primary production, and there continues to be a push to find new uses for other or similar by-production. However, these are by-products and not primary drivers of investment.

The presence of Lakehead University's BioRefining Institute is well-positioned to assist in the development of lignin-based biochemicals and is already working closely to do so. A number of

stakeholders were very enthusiastic about the excellent research quality and collaboration possible with Lakehead's different research groups.

In addition, Lakehead University and FPInnovations are well-positioned to assist and drive innovation and research into biochemical refining. The refining of biochemicals from wood products, including from surplus low-quality hardwoods available in Thunder Bay, has already been undertaken in pilot plants. The technology is viable and can produce value-added goods such as sugars and complex chemicals which could become significant.

A pilot project undertaken by FPInnovations and Resolute in Thunder Bay for the development of commercial biorefining is a good example of what can be achieved by including new value-added processes to the forestry industry. The pilot plant used to recover lignin from black liquor was funded by NRCan, the Government of Ontario, and CRIBE; an example of a collaborative research initiative undertaken in the region. However, although the pilot plant remains integrated into Resolute's facility, the process was scaled-up to a commercially-viable degree at West Fraser's pre-existing Hinton, Alberta facility.

Because of the flexibility of biochemical refining (e.g., the process can be designed to take advantage of whatever feedstock is available, assuming the technology exists or is developed), it is possible that any type of wood species could be used to produce biochemicals, implying two things:

- Biochemical production could be suited to match the surplus wood species available in the area (birch, poplar, cedar)
- A production/refining process must exist or be developed as a precondition to a commercial operation

From a policy perspective, governments push for the development of biochemicals to replace chemicals refined from hydrocarbons. An effort to help to reduce GHG emissions and, in the case of plastics, reduce overall pollution from non-biodegradable sources. The government of Canada's intention to ban single-use plastics may exempt bioplastics, which may spur the need for a new supply chain of bioplastics.

TABLE 4: BIOCHEMICALS SWOT

Strengths	Weaknesses
• Lakehead University and FPInnovation laboratories are a leader in product exploration and market innovation • Large supply of poplar, cedar, birch, and other hardwoods • Commercially viable applications for producing bioplastics from wood exist • Pilot projects for biorefining have already taken place in the region	• Local private sector's reluctancy to adopt and gravitate towards the development of lignin • Chemicals derived from wood have yet to be adopted widely, and thus they are not necessarily considered to have been "accepted" by the market • Integrating new types of biochemicals into existing production processes can be problematic • Projects in this field may be small-scale and more research than production focused
Opportunities	**Threats**
• Deriving value from a surplus of less merchandized tree types (e.g. birch and poplar) • Canadian government plans to ban the use of single-use plastics starting in 2021: bioplastics likely to be exempt	• Highly competitive environment for attracting projects in this field: Quebec is currently a pioneer in developing biomass alternatives • Chemicals derived from fossil fuels are cost-effective as long as the price of crude oil remains low compared to forestry biomass

It should be noted that biochemical projects are more likely to be smaller in scale due to their need to integrate with existing supply chains and that value-added chemicals do not necessarily require large facilities. One stakeholder gave an example of a 12,000 sq. ft. facility as the lignin-based chemical production facility's potential size. Scaling is an issue with this industry as small-scale refining has been shown to be viable for multiple applications but to produce in commercially-viable quantities is both risky and capital-intensive.

There is also an issue in regards to the "credibility" of the chemicals produced in biorefining. Because biorefining aims to displace existing chemicals in use throughout industrial supply chains, there is resistance to switching to new suppliers that are using new production methods and have not yet been subjected to years of generalised industrial use. For specialty chemicals, which may include anything from food additives to fertilizers to lubricants, the need for precision in manufacturing and the degree of purity necessary for safety are barriers to the development of biochemicals.

Lastly, low crude oil prices affect the viability of biochemicals: cheap oil makes for cheap plastics and other value-added chemicals that are refined from hydrocarbons.

At the very least, the prospects for this industry as a source of start-ups and research projects are high.

Industry Recommendations

Of the four bioeconomy industries that were analyzed, each presented different advantages and disadvantages. The following table is a summary of the principal strengths and weaknesses of each sub-sector:

TABLE 21: INDUSTRY RECOMMENDATIONS SUMMARY

Sub-sector	Potential	Key Strength	Key Weakness	Actions
Biochemicals	High	- Research excellence in the area and pre-existing experience with pilot projects - Could fit within the existing forestry industry	- Projects are generally small-scale in nature and focused on research	Ensure private-public coordination with research centres in area and be aware of funding opportunities from FedNor and NRCan for pilot projects
Biofuels	Medium	- Wood supply and research excellence in region	- Competition from fossil fuels - Biofuels from forestry have not yet been developed	Monitor forthcoming Clean Fuel Standards from Federal government for changes which may signal significant shift in need for biofuels from forestry biomass
Engineered Wood	High	- Position as logistics hub - Growing demand - Complimentary with pulp industry	- Does not address oversupply of birch and poplar	Understand wood supply in the area and long-term availability for potential investor. Promote excellence of transport links in region. Work with Confederation College and Lakehead U. in development of both bio- adhesives and ensuring local workforce has access to design training
Bioenergy	Low	- Wood supply of residual matter is high - Possibility of use of wood pellets for heat generation in remote communities	- There is no willingness on the part of the provincial government to develop or fund biomass power generation	Without provincial support for large scale biomass, the only opportunities for this sub-sector may be to work with remote communities to develop heating systems that use wood pellets produced from biomass rather than the commonly used diesel generators

The potential for each sub-sector is relative and dependent on some outside factors. Also, the "Action" suggested in these cases assume that investor-readiness best-practices are already in place in Thunder Bay.

VALUE PROPOSITION

A summary of the stakeholder consultations, SWOT, and industry analyses, the value proposition summarizes Thunder Bay's direct offer to foreign and domestic investors and the unique positioning of the community from a site selection point of view. This value proposition will be focused on the attraction of foreign and domestic investors related to the forestry bioeconomy.

CAI has identified four cornerstone assets to form Thunder Bay's bioeconomy value proposition:

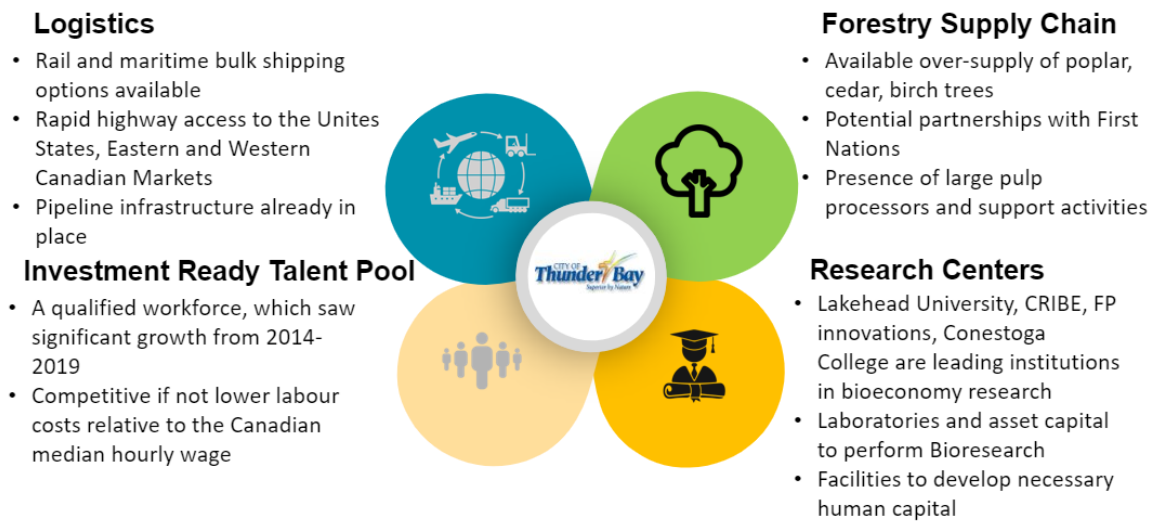
- Logistics
- Forestry Supply Chain
- Investment Ready Talent Pool, and
- Research Centres

Thunder Bay's existing logistic and utility infrastructure to transport commodities in and out of the region is one of its greatest assets. The ability to transport the materials effectively by water, rail, and road offer potential investor connections to reach downstream markets and access to pertinent materials in their supply chain. The existing pipelines offer market access and the potential to develop the biofuels industry.

Supply, supply, and supply are key drivers and great assets in developing an upstream dependant bioeconomy. Emerging industries in biochemicals and fuels offer opportunities to merchandise difficult to market hardwoods such as birch and poplar in the region. The presence of an existing Forestry Sector (both important processors and support activities) provides the industry with an established foundation on which a bioeconomy can expand upon. The presence and ambition of the First Nations is the area, while challenging for investors, is also a net strength of the region; the vision of entrepreneurs in these communities will help drive growth. Working with First Nations can also help improve community acceptance of projects.

Thunder Bay also possesses a wealth of human capital suited to satisfy potential investor needs. The region can develop future talent geared towards the Bioeconomy through its existing educational institutions. The innovative potential of local research institutions offers the region of Thunder Bay the opportunity to support research and development for current and future private-led projects.

FIGURE 9: VALUE PROPOSITION



IDENTIFICATION OF BUSINESSES

In this section, CAI Global has listed 25 companies the CEDC should target to develop Thunder Bay's local Bioeconomy. The list comprises companies specialised in Engineered-Wood Production (e.g. cross-laminated timber manufacturers), Bioenergy, Biofuels or Biochemistry activities.

Common characteristics of the companies is having a recorded history of investment of at least one project of over $10 million USD over the last 10 years, and have headquarters located outside of Canada.

The companies listed for the most part have a history in investing in North America with one company (Stora Enso) having invested in a plant in Atlantic Canada over the last 17 years.

TABLE 22: COMPANY PROSPECT LIST

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Kronospan	Kronospan manufactures and distributes wood-based panels which are used in many everyday products such as flooring, furniture and timber-framed houses. Its wood-based panels are manufactured in 28 locations across the world and is represented in 24 countries. The company produces particleboard, medium density fibreboard, laminate flooring, resins for wood-based panels and oriented strand board. It also produces melamine-faced panels, worktops, wall panels, window sills and speciality and decorative paper.	Engineered-wood	$1.53 bn (2017)	11,000 +	https://www.kronospan-worldwide.com/	Cyprus

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
UPM-Kymmene	The Bio-industry leader operating a number of divisions: Pulp, Timber, Biofuels, Energy, Label Materials, Specialty Papers, Communication Papers, Plywood, Biocomposites, Biochemicals, Biomedicals, and Forestry sectors. UPM produces graphic papers, including magazine papers, newsprint, fine papers and specialty papers to publishers and printers, as well as merchants and paper converters. It is also involved in the generation of electricity through hydro, nuclear, condensing and wind power generation; and distribution of electricity.	Engineered-wood; Biochemicals; Bioenergy	$10.20 bn (2019)	18,700 (2019)	www.upm.com	Finland
Egger Group	Egger Group, a family company, has about 17 plants across Europe. The company has worldwide customers in the furniture industry, wood and flooring retailers, as well as DIY markets. Egger products are made of wood-based materials (chip-boards, oriented strand board and medium-density fibreboards) as well as timber. It is a full-range supplier for the furniture industry, interior design, wood construction and wood-based flooring (laminate, cork, and design flooring) industries.	Engineered-wood	$2.80 bn (2018)	10,000 (2018)	www.egger.com	Austria

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Metsä Group	Metsa Group, together with its subsidiaries, provides wood products, pulp, fresh fibre paperboards, tissue and cooking papers, and wood supply and forest services. It operates through five segments: wood supply and forest services, wood products industry, pulp and sawn timber industry, paperboard industry, and tissue and cooking papers. The company offers wood products for construction, industrial, and distributor partners; bleached softwood and birch pulp under the Botnia brand for the production of tissue papers, paperboards, and specialty products; and wood to produce energy.	Engineered-wood	$6.00 bn (2019)	9,300	www.metsaliitto.com	Finland
Sodra	Sodra Skogsagarna ekonomisk forening produces and sells sawn and planed timber goods, interior products, paper pulp, and biofuel. The Sodra Skog segment trades in wood raw materials and biomass fuel; and provides forestry services to members. The Sodra Cell segment produces bleached sulphate market pulp for the production of fine paper, printing paper, tissue, and specialty products. The Sodra Timber segment manufactures sawn and planed timber products, primarily for construction and other building applications.	Biofuel; Engineered-wood	$1.78 bn (2014)	3,100	https://www.sodra.com	Sweden
Texas CLT	Texas Cross Laminated Timber provides cross laminated timbers, for use in a variety of applications. It offers prefabricated panel of wooden boards fastened together perpendicularly to one another, with structural adhesives, providing advantages over the construction “strength” materials in terms of weight, expediency, structural integrity, and environmentally. The firm is based in Arkansas, US.	Engineered-wood	Unknown	Unknown	http://texasclt.com/index.php/about/	United States

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Katerra	Katerra is a technology company seeking to redefine the construction industry. The company combines expertise in design, material sourcing, manufacturing, logistics, technology and construction to provide a single integrated offering. The company was founded in 2015. Katerra has a CLT manufacturing factory in Washington State, US.	Engineered-wood	$1.70 bn (2019)	8,000	https://www.katerra.com/	United States
Hasslacher Norica Timber	Hasslacher Norica Timber operates as a supplier of sawn timber, solid wood material, laminated timber, cross-laminated timber and solid structural timber for modern timber constructions. It was founded in 1901 and is based in Sachsenburg, Austria.	Engineered-wood	$500 m (2019)	1,700	https://www.hasslacher.com/company	Austria
Binderholz	Binderholz produces and sells timber products. It offers basic-products, such as lumber, profiled timber, softwood lumber, solid wood panels, glulam beans, dimension lumber, surfaced lumber, and horse litter solutions. The company also provides densified biofuels, including pellets and briquettes, and bio fuel composites. In addition, it offers construction solutions for single-family house, residential, commercial, industrial, public and municipal, and tourism buildings.	Engineered-wood; Biofuels	$266.90 m (2016)	2,530 (2018)	www.binderholz.com	Austria

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Sterling Lumber	Sterling Lumber manufactures and supplies lumber products. The company's product line includes access mats, composite mats, crane matting, marine-barge floating matting, outrigger pads, specialty crane mats, and transition mats. It also provides matting solutions, such as timber mats, construction mats, access mats, crane mats, mud mats, composite mats, hardwood mats, and cross-laminated mats for temporary access to remote and non-remote site locations. In addition, the company offers pre-owned and warehoused dragline mats, timber mats, barge mats, excavator mats, crane pads, skidder bridges, and platform mats. It serves industries, including civil construction, oil and gas pipelines, wind power, marine construction, electrical transmission distribution networks, and power plants. The company was founded in 1949.	Engineered-wood	$100m-500m	100-500	https://www.sterlingsolutions.com/	United States
SmartLam	SmartLam is a pioneer in cross laminated timber production in North America. The company was founded in 2012.	Engineered-wood	$100m-500m	100-500	https://www.smartlam.com/	United States
Stora Enso	Stora Enso Oyj provides renewable solutions for the packaging, biomaterials, wooden constructions, and paper industries worldwide. The company operates through five divisions: Consumer Board, Packaging Solutions, Biomaterials, Wood Products, and Paper. It serves packaging manufacturers, brand owners, paper and board producers, publishers, retailers, printing houses, converters, joinery, and construction companies. Stora Enso Oyj was founded in 1998.	Engineered-wood	$11.12 bn (2019)	26,000	https://www.storaenso.com/	Finland

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Virdia (HCL CleanTech) a subsidiary of Stora Enso	Virdia develops extraction technologies for the conversion of cellulosic biomass to refined fermentable sugars and lignin. The company offers Cold Acid Solvent Extraction process, which converts cellulosic feedstock, including plantation/industrial wood, energy crops, and agricultural residues into sugars and lignin. The company changed its name from HCL CleanTech in March 2012. As of June 2014, it operates as a subsidiary of Finland-based Stora Enso.	Biochemicals	$100M (2020)	51-100	https://www.storaenso.com/en/sustainability/circular-bioeconomy	Israel
Drax Biomass	Drax Biomass was established to develop and operate manufacturing facilities to produce wood pellets from sustainable biomass for onward use in the generation of renewable power. The company is a subsidiary of Drax Group, a major electricity generator in the UK with a commitment to producing renewable power. Drax Biomass is currently based in Burlington, Massachusetts and is to relocate its United States headquarters to Atlanta, Georgia.	Bioenergy	$5.85 bn (2019)	201 to 500	www.draxgroup.plc.uk	United States
Enviva	Enviva, a midstream fuel supplier, provides sourced wood pellets and other processed biomass to power generation and industrial customers in the United States and Europe. It offers renewable woody biomass, including wood pellets, which are used for co-firing in pulverised coal and fluidised bed energy plants, biomass energy plants, combined heat and power plants, and industrial-scale public and private heating; and wood chips for applications, such as pellet stock, biomass energy plants, and combined heat and power plants.	Bioenergy	$573.7 m (2018)	1000+	www.envivabiomass.com	United States

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Abengoa Bioenergy	United States-based firm Abengoa Bioenergy was acquired by Spanish engineering firm Abengoa in 2002. Abengoa Bioenergy owns three plants in the US and another couple in Europe. The company's primary product is fuel-grade ethanol, which, when blended with gasoline, raises oxygen levels and reduces exhaust emissions of pollutants such as carbon monoxide. As part of a search for new revenue streams, Abengoa Bioenergy launched a research and development subsidiary that works in partnership with universities and other companies to develop improved processing technology for ethanol.	Bioenergy, Biofuel	$1.41 bn (2018)	15,000 working for Abengoa (parent company) (2019)	http://www.abengoa.com/web/en/index3.html	Spain
Zilkha Biomass Energy (NextGen Biomass technologies)	Zilkha Biomass Energy generates power from woody biomass. It operates a direct-fired biomass-fuelled gas turbine unit that powers commercial and industrial facilities. The company produces energy from Zilkha Black Pellet, a waterproof biomass pellet that is transportable like coal. Zilkha Biomass Energy was founded in 2004 and is based in Houston, Texas.	Bioenergy	$50.00 m (2019)	200 +	https://www.zilkhabiomass.com	United States
MVV Energie	MVV Energie is an electricity, gas and water power company. It is one of Germany's largest operators of waste and old timber incineration plants. The company's strategy is focused on an environmentally friendly future. MVV Energie was founded in 1999 is based in Mannheim, Germany.	Bioenergy	$4.09 bn (2019)	6,200	www.mvv-energie.de	Germany

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
The Navigator Company (Portucel Soporcel Group)	The Navigator Company manufactures and markets pulp and paper products in Portugal. It operates through Market Pulp, UWF Paper, Tissue Paper, and Other segments. In addition, the company generates electricity from biomass, a renewable source of energy. The Navigator Company also exports its products to approximately 130 countries worldwide. It was formerly known as Portucel and changed its name to The Navigator Company in February 2016. The company is headquartered in Setubal, Portugal.	Bioenergy	$1.56 bn (2019)	3,000	www.thenavigatorcompany.com	Portugal
Millipore Sigma	Millipore and Sigma-Aldrich are life science and high technology companies that develop, manufacture, purchase, and distribute various chemicals, biochemicals, and equipment products worldwide. The companies were both bought by Merck KGaA (the German based conglomerate) in 2010 and 2014 respectively, and in 2015 they formed to create Millipore Sigma which provides chemical products, reagents, and kits and services which are used in scientific research, including genomic and proteomic research, biotechnology, pharmaceutical development, and diagnosis of disease; and as key components in pharmaceutical, diagnostics, and high technology manufacturing.	Biochemicals	$5.90 bn (2017)	Approx. 20,000 employees	www.sigmaaldrich.com	Germany
Akola ApS	Akola ApS, through its subsidiaries (Linas Agro Group, Mestilla) trades agricultural products. The company trades grains; oilseeds, oilcake and oilmeals; leguminous crops; vegetable oils; and lignin biofuel. It also provides grain storage facilities and supplies agricultural machinery. The company was incorporated in 2000 and is based in Copenhagen, Denmark.	Biochemicals	$893.70 m (2017)	2,272 (2017)	http://mestilla.lt/en/thinking.html	Denmark

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Arbiom	Arbiom manufacturers C5 and C6 sugars and lignin products to bio-based chemicals and materials industries. The biorefinery uses non-food biomass as the input for manufacturing glucose (a C6 sugar), xylose (a C5 sugar), and lignin.	Biochemicals	$1m-$10m	11-50 employees	www.arbiom.com	United States
BorregaardLignoTech (Orkla)	LignoTech manufactures and markets wood-based speciality chemicals including lignin. The company was formerly known as Holmen LignoTech and changed its name in 1990. The company is based in Sarpsborg, Norway. LignoTech operates as a subsidiary of Norway-based Orkla.	Biochemicals	$1.2 bn (2018)	11,000	https://www.lignotech.com/About-us	Norway

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Burgo Group (Gruppo Marchi)	Burgo Group produces and distributes coated and uncoated papers worldwide. In addition, the company generates power through natural gas, thermoelectric, hydroelectric, thermal, and biomass power plants; purchases and sells electric power for industrial end-users and wholesalers; trades on organised electric power markets; and trades and sells gas to medium and large-scale customers. Further, it offers technical and technological assistance services for maintaining plants; constructs miscellaneous mechanical components; processes forestry products; and provides factoring services. Additionally, the company provides pulp, which is used to produce a range of products comprising coated and uncoated graphic papers, technical papers, and products for hygiene use; and lignin sulphonates used in concrete, cement mixtures, surface-active agents, carbon black, mineral granulation, emulsions, colorants, bonders and resins, soil stabilization, tanning, ceramics and fire-bricks, industrial detergents, anti-parasite products, slurry conditioning, water treatment and conditioning, and mineral flotation fields. The company operates as a subsidiary of Holding Gruppo Marchi.	Bioenergy; Biochemicals	$1.40 bn	4,500 (2012)	www.burgo.com	Italy

Company Name	Investing Company Description	Business Activity	Revenue (USDm)	Number of Employees	Website	HQ Location
Novozymes	Novozymes, a biotech company, engages in the production and sale of industrial enzymes, microorganisms, and biopharmaceutical ingredients worldwide. It also provides a portfolio of enzymes for application in biofuel production; recombinant products and technologies to the medical device and drug delivery market. In addition, the company offers household care enzymes for use in cleaning solutions.	Biofuels; Biochemicals	$2.19 bn (2018)	6,450 (2016)	https://www.novozymes.com/	Denmark

Source: FDI Markets 2020

TABLE 23: PROSPECT COMPANY FOREIGN DIRECT INVESTMENT FIGURES (2003-2020)

Company Name	No. of Total Projects since 2003	Total Capex USDm (in Current Search)	Total Jobs Created through Projects	Date of Last Project	No. of Projects in North America
Kronospan	50	$6.5 bn	14,260	2020	2
UPM-Kymmene	77	$16.3 bn	31,630	2020	11
Egger Group	18	$2.8 bn	3,500	2017	0
Metsa Group	21	$1.9 bn	2,410	2020	0
Sodra	2	$89 m	121	2017	0
Texas CLT	1	$24 m	60	2017	1
Katerra	3	$238.5 m	336	2019	2
Hasslacher Norica Timber	1	$23.9 m	60	2019	0
Binderholz	5	$249 m	666	2018	0
Sterling Lumber	1	$30 m	150	2018	1
SmartLam	2	$23.5 m	100	2019	2
Stora Enso	63	$10 bn	13,203	2020	1 (in Canada)
Virdia (HCL CleanTech)	8	$660 m	736	2014	8
Drax Biomass	9	$152.9 m	391	2019	9
Enviva	12	$796 m	918	2019	12
Abengoa Bioenergy	10	$1.6 bn	827	2011	7
Zilkha Biomass Energy	2	$114 m	107	2014	2
MVV Energie	3	$540 m	100	2017	0
The Navigator Company (Portucel Soporcel Group)	4	$6.5 bn	586	2014	1
Merck KGaA	103	$5.8 bn	12,163	2020	17
Akola ApS	2	$42 m	428	2018	0
Arbiom in partnership with Norske Skog Golbey	1	$102 m	40	2015	0
Orkla	44	$902 m	2,945	2019	10
Burgo Group	2	$62.6m	Unknown	2017	0
Novozymes	12	$452 m	820	2018	5

Source: FDI Markets 2020

RECOMMENDATIONS

Based on the value proposition, area assets and factors influencing foreign investment, CAI Global recommends the following six priority strategies to base its action plan on as a means to catalyze the development of the forestry bioeconomy in the Thunder Bay region:

1. PRIORITIZE TWO SUB-SECTORS: ENGINEERED WOOD AND BIOCHEMICALS

The most promising bioeconomy sectors to pursue in the forestry bioeconomy are **engineered wood** and **biochemicals**. The reasons are laid out in detail the previous sections of this study.

To summarize, these specific sub-sectors have been prioritized because of a combination of factors of how they fit very well within Thunder Bay's ecosystem in terms of the region's strengths, assets and value proposition. Also, both engineered wood and biochemicals are poised to experience more rapid growth then bioenergy, and operate in a less competitive market then biofuels.

2. ADDRESS WOOD SUPPLY SHORTCOMINGS

The analysis of the supply chain revealed that Thunder Bay has an excellent supply chain for its local forestry industry. However, one key weakness must be addressed in order to develop and promote the region: **wood supply**.

As outlined in several sections of this study, wood supply in the region, as it is presented in MNR data, does not paint an accurate portrait of the wood supply available on a long-term basis. For new investors seeking certainty in the forestry industry, there needs to be an easier understanding for investors as to the quality and quantity of wood supply, the ease of access and of who holds the harvesting rights.

CAI Global recommends that Thunder Bay work with CRIBE to develop and perfect their Economic Fiber Supply Model (presently in Beta testing) in order to ensure that critical and easy-to-use data is available to potential investors.

Additionally, CAI also recommends that projects which could address the oversupply of birch and poplar in the region be prioritized as to increase the chances that new projects will be synergistic with the existing industrial ecosystem rather than competing for resources with existing companies.

3. CREATE AN EDUCATIONAL ECOSYSTEM

Theories of cluster development and innovation zones all point to the importance of strong linkages between the industrial sector and educational institutes. Universities are the home of new ideas, but a concerted effort is necessary to ensure pertinent and collaborative R&D, the commercialization of ideas and the transfer of technology through training. Thunder Bay must continue to leverage its world-class resources at Lakehead University as a means to develop the forestry bioeconomy of tomorrow. Specifically, the university's resources should be leveraged by:

- Ensuring strong collaboration between new investors and specialized researchers at the University;

- Making use of the University's assets, specifically its labs, by encouraging links to the industrial bioeconomy and forestry sectors, and using it in the promotion of the region to new investors;
- Working with Confederation College and Lakehead University to ensure that programs needed for specific programs in the bioeconomy remain relevant:
    - For biochemistry and biofuels there already appears to be excellent base which likely does not require improvement;
    - For engineered wood, investors may want that any new subsidiaries have some in-house design capabilities: an architecture and design program, centered around the use of CLT, would be an asset to the region.

4. INVOLVE REMOTE COMMUNITIES AND FIRST NATIONS

Thunder Bay is recognized as the largest metropolitan area in Canada with the largest population of First Nations individuals as a percentage of the population. As such, Thunder Bay should continue its work to ensure First Nations are consulted and "buy-in" to new expansion projects and the use of forestry biomass as a source of development projects. First Nations have been at the forefront of new entrepreneurial endeavors in the region and there is clearly a push for the development of business that will benefit the community:

- Consult with First Nations when investors are identified and make clear to new investors that good relations with local partners would be positive for any project;
- Harvesting rights held by First Nations must be understood and new investors must have an understanding as to how they will need to interact, and potentially partner, with local entrepreneurs that will want to benefit from the windfalls of new economic development.

5. INVEST IN LOGISTICS IMPROVEMENT

Although Thunder Bay is at a crossroads for rail, road and maritime shipping, there could be additional improvements to those services in terms of investment readiness for new and existing investors:

- The Port of Thunder Bay is well positioned but heavily specialized in grain transportation:
    - Working with the port to evaluate if other types of merchandise (bulk engineered wood, biochemicals, etc.) could transit through the port and the volumes it could accommodate;
    - Evaluating if a new investor willing to use port facilities would require investments in infrastructure.
- The presence of two Class 1 rail lines in the region is a net advantage:
    - The development of industrial land with direct access to rail spurs from either of the two rail providers would be a strong addition to the region's industrial infrastructure;
    - Ensuring cooperation from rail providers in terms of the volume and costs of shipping in the region is also recommended.

6. INVEST IN NEW TOOLS FOR PROSPECTING TO BECOME INVESTOR READY IN THE COVID AND POST-COVID ERA

Investor-readiness is crucial to any community that seeks to bring in new investors, particularly with a new industry that will complement an existing one. In the past seven months, the limits on travel imposed due to the COVID-19 pandemic have brought about changes in how investors are courted and how site visits are conducted. Because of this new normality, economic development organizations find themselves having to adjust how they prospect and meet with potential investors. The 14-day quarantine imposed by the Canadian government will make travelling from overseas challenging and is added to the already existing risk perceived. As such, about 2/3 of site visits in North America are occurring virtually. Thunder Bay must adapt in the following way:

- Upgrade its online tools for a presentation of the region and real estate that gives the audience a feeling of being there in person
- Prepare for virtual site visits including adhoc real time or videotaped tours of the region and real estate (using technologies such as go-pro and drone);
- Be prepared to see a decrease in FDI and disruptions in the supply chain and look for prospecting opportunities within that context.

APPENDICES

APPENDIX A - DEFINITIONS

Location Quotient

A location quotient (LQ) is a measurement of concentration in comparison to the nation. An LQ of 1.00 indicates a region has the same concentration of an industry (or occupation) as the nation. An LQ of 2.00 would mean the region has twice the expected employment compared to the nation and an LQ of 0.50 would mean the region has half the expected employment in comparison to the nation.

Place of Work (POW)

The Place of Work is a method of data interpretation used to evaluate occupation data. The place of work compiles data based on the number of occupations or jobs in a given occupation group or industry sector occur in a given geographic location.

Place of Residence (POR)

The Place of Residence is a method of data interpretation used to evaluate occupation data. The place of residence compiles data based on the number of residents in a geographic location are working in specific occupation or job.

Shift Share

The shift share analytic sheds light on the factors that underlie regional employment growth. Shift share examines three factors that underlie employment growth. National Growth is growth due to the overall growth or contraction in the national economy. Industry Mix Share is the growth attributable to the specific industries being examined (based upon national industry growth patterns and the industry mix of the region). Local Competitiveness is the remaining growth or contraction that is attributable to regional factors. A positive number here indicates a productive advantage in this industry (that may be due to superior technology, management, labor pool, etc.).

What is NAICS?

The North American Industry Classification System (NAICS) is used to classify business establishments according to the type of economic activity. The NAICS Code comprises four levels, from the "all industry" level to the 4-digit level. The first two digits define the top-level category, known as the "sector," which is the level examined in this report.

What is NOC?

The National Occupational Classification (NOC) system is used by Federal statistical agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data. All workers are classified into one of about 500-unit groups according to their occupational definition. To facilitate classification, unit groups are combined to form about 150 minor groups, about 40 major groups, and 11 broad occupational categories.

Example

3: Health occupations (Occupational group)
32: Technical occupations in health (Sub-occupation group)
322: Technical occupations in dental health care (Minor occupation group)
3222: Dental hygienists and dental therapists (Occupation)

APPENDIX B - SOURCES

Industry jobs data is from EMSI Analytics. EMSI's job counts data are based on the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) dataset. With each QCEW update, EMSI releases a new datarun. Even though QCEW is released quarterly and EMSI updates accordingly, EMSI's job counts are annual estimates, not quarterly estimates.

It is worth noting that QCEW occasionally revises historical data several years back, which can cause historical job counts to change even though the QCEW quarters contributing to the job counts for the year in question are no longer changing.