UNIVERSITY OF CALGARY

# Sustainable Brewing: A Study of Sustainable Brewing Practices

by

Effiok Inyang Jnr

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**ABSTRACT**

The objective of this capstone project is to analyse the environmental and social sustainability practices of local breweries in Alberta. A United Nations study has projected the global population will increase from over 7 billion today to approximately 9 billion by 2050. Managing the relationship between water, food and energy is becoming increasingly critical. The recent growth within the craft brewing industry has increased employment and economic growth in Alberta, but has also raised social and environmental concerns. This report shares insights on key performance indicators and best practices of sustainable brewing, based on a literature review, content analyses and interviews with ten local craft breweries across Alberta. It develops a benchmark among craft breweries in Alberta to determine their existing sustainable practices and what they can do as an industry to improve. Findings identified several sustainability indicators: water, energy, solid waste, carbon use, and social aspects.

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# Chapter 1 **Introduction**

## 1.1 The Research Question

The research question for my capstone project is what are local breweries in Alberta doing to produce beer with less energy, water, and to recover $CO_2$. I will develop a benchmark among craft breweries to determine how sustainable they are and what they can do as an industry to improve.

## 1.2 Research Intention and objectives

This project will add to academic literature by providing a sustainable operations management benchmarking for the craft brewing industry. This project will be interdisciplinary because it will address environmental impacts (energy-use and water-use) and social impacts originating from the brewing industry.

The following objectives will be pursued within this project:

(i) Compile and synthesize relevant information about the beer industry in Canada, with a focus on craft breweries in Alberta.

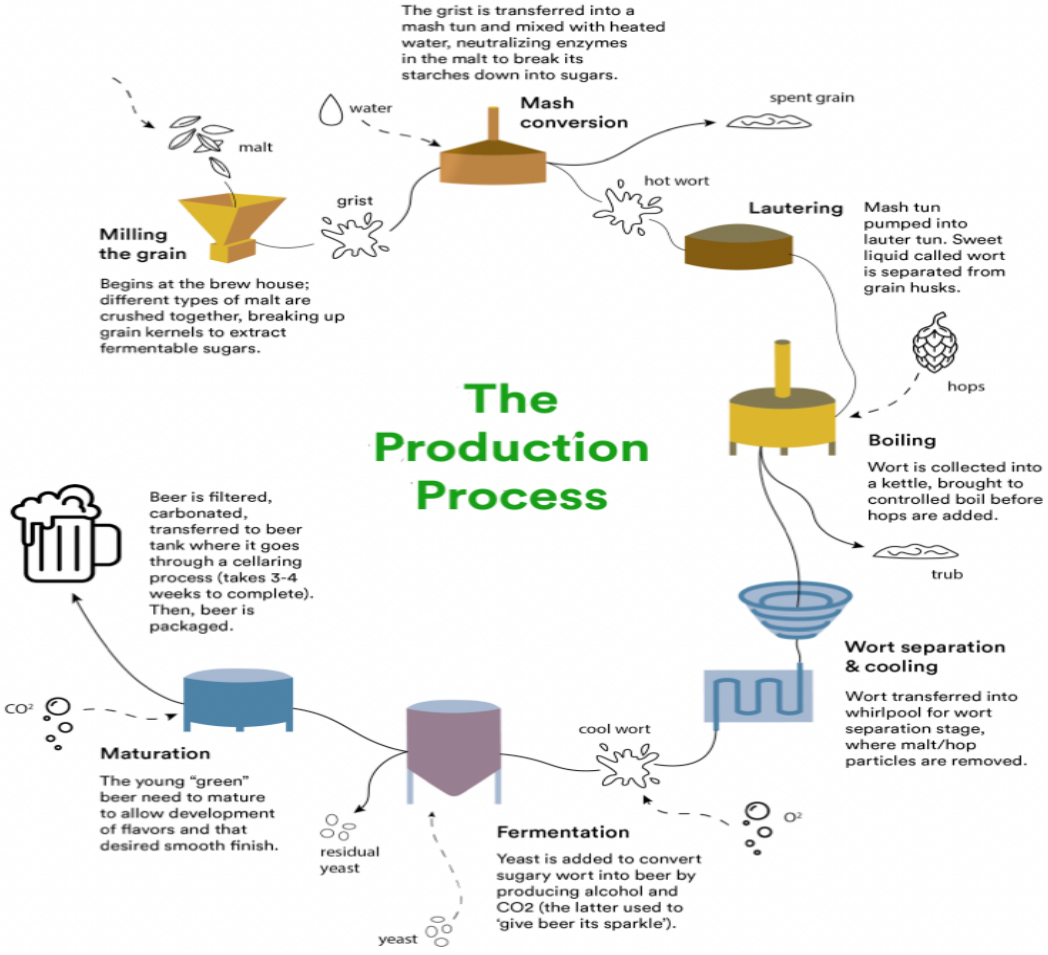
(ii) Investigate how breweries can improve energy-use and conserve water by identifying emerging information from the literature, content analysis and interviews of Alberta based craft brewers.

## 1.3 The Water-Energy-Food Nexus

At its core, the water-energy-food nexus consists of four risks: water security, food security, energy security and climate change. However, it links strongly to global governance failures, economic disparity and geopolitical conflict (Bieber et al., 2018). Threats to water security, food security and energy security are chronic impediments to economic growth and social stability. Water, energy, and food are all essential to human life and are all interconnected. Food production requires water; water extraction and distribution requires energy; and energy production requires water. Food prices are also highly sensitive to the cost of energy input via fertilizers, irrigation, transport and processing. Climate change, environmental pressures, growing economies, and growing population both exacerbate this nexus. With the global population growing to approximately 9 billion by 2050, and rapid rising per capita consumption, the water-energy-food nexus is a critical global risk that fundamentally threatens humans social and political security.

Water is vital not only for the brewing process but also for growing the crops used to make beer and to generate electricity to power breweries. Breweries must therefore tackle direct water and energy usage in their operations. The brewery industry uses mainly water, barley, hops and yeast to produce alcoholic beverages. Beer is composed of 90% water and on average in a typical brewery, five hectolitres of water is used to make one hectolitre of beer, the ratio can be as high as 10:1 in some breweries (Jaiyeola & Bwapwa, 2015). Figure 1 summarizes the brewery production process.

Figure 1: The Beer Production Process




(Cornell Sustainability Consultant, 2018)

### 1.4 Interdisciplinary Aspects

The term "sustainability" has many definitions and interpretations. The classic definition includes three pillars: environment, economic and social well-being. A sustainable brewery should strike a balance between all three pillars. Environmental sustainability is the ability to

utilize natural resources efficiently, reducing GHG emissions and minimize waste generated, and do so in a manner that can be continued indefinitely (Ness, 2018). Economic sustainability is the practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community (Tokos, Pintarič, & Krajnc, 2012). Social sustainability is the ability to support local community, and provide employees with a safe and prosperous place to work (Jones, 2018). This capstone project is an interdisciplinary project and addresses issues in the environmental, energy, and social dimensions. These dimensions are elaborated further below.

### 1.4.1 *Energy*

A brewery's energy consumption is directly proportional to their carbon emissions. The brewing process is energy intensive and utilizes huge volumes of water. To be sustainable, craft breweries should first improve their own operations before considering to improve supply and distribution chains. Energy usage, as well as, water usage and emissions efficiencies are affected by a number of variables including brewing process operations, brewing styles and recipes, building and equipment age, local climatic conditions, etc. (Kubule, Zogla, Ikaunieks, & Rosa, 2015). Energy should be a primary focus of conservation as it can lead to both cost savings and reduced emissions.

### 1.4.2 *Environmental Attributes*

To produce beer, craft breweries utilizes electricity, natural gas, and purchased non-fermentation $CO_2$. All these contribute to the overall $CO_2$ emissions from breweries. Breweries should first of all focus on improving efficiencies as a means of reducing GHG emissions. Breweries can utilize on-site renewables like solar, install $CO_2$ recovery system or substitute the use of $CO_2$. All these further reduce overall GHG emissions (Ness, 2018).

### 1.4.3 *Social Attributes*

Beer is highly connected to social environments and has an undeniable ability to bring people together. Beer conjures images of parties, festivals, sporting events, and generally social gatherings. Craft breweries support local farmers, and community by providing jobs. They support local businesses like arts and non-profits organizations. Beer has three times the economic impact of wine and spirits combined (Beer Canada, 2018). Craft breweries hold the responsibility to care for their employees and ensure the health and safety of all its employee, leading to better job satisfaction.

# Chapter 2 **Literature Review on the Brewing Industry**

## 2.1 History of Beer in Canada

Canada has always been a brewing nation. Labatt, Sleeman, Carling, Keith, Oland, and Molson are all names that Canadian beer drinkers have recognized for generations. In the early days, brewing was a domestic art, with everyone brewing at home. Beer was made for personal enjoyment and special occasions. Canada's first commercial brewery was established in 1688 in Quebec city by Jean Talon (Beer Canada, 2020). Modern brewing kicked off when John Molson established his first brewery in 1786 located in Montreal, which is today the oldest brewery in North America (Beer Canada, 2020 ). Alexander Keith & Son opened the doors to their new brewery located in Nova Scotia in 1829. John Sleeman entered the scene in Ontario in 1836. In 1840, Thomas Carling established his Brewing & Malting Company in Ontario. The Labatt name entered the scene in 1847 in Ontario and the stage was set for both the Oland and Moosehead breweries by Oland family in 1867. The Second World War, the Great Depression and Prohibition hit breweries hard and resulted in industry consolidation (Guilbert, 2016). Regional breweries either merged or were bought out by other larger brewers. The mergers and acquisitions created the dominance of a few larger breweries, making the industry more competitive. Regional craft breweries began opening in communities across Canada in the 1980s. In 1984, Jim Brickman, who is hailed as the pioneer of present day craft brewing in Canada, opened Brick Brewing Company in Waterloo, Ontario. In Alberta, Ed McNally founded Big Rock Brewery in 1985. This began the craft breweries movement in Alberta and today there are 120 breweries in the Province (Alberta Small Brewers Association, 2019)

## 2.2 Alberta's Craft Breweries Industry

Alberta's long history of beer production started with the opening of the first brewery in 1883 at Medicine Hat (Storyhive, 2016a). Calgary Brewing and Malting then opened in Calgary, Alberta in 1892. Edmonton Brewing and Strathcona Brewing were the two brewers in Edmonton, both opened in 1894. However, breweries in the Province took a significant economic hit on July 1, 1916 when Alberta implemented prohibition which led to liquor manufacturers, including breweries, to close their doors (Guilbert, 2016; Storyhive, 2016a). There were sixteen breweries operating in the Province prior to prohibition (three in Edmonton, six in Calgary, two in Medicine Hat, four in Lethbridge, and one in Fort Macleod). However, many of these breweries closed down permanently and could not reopen in 1923, when prohibition was repealed in the Province (Budynski, 2019; Weersink, Probyn-Smith, & Von

Massow, 2018). The prohibition had a serious effect on the brewing industry, and only ten breweries produced beer between 1923 and 1954. Most of the small breweries that survived prohibition were acquired by either Calgary Brewing and Malting Company or Lethbridge Brewing and Malting Company (Guilbert, 2016). These were the two major breweries for nearly four decades, up until the 1960s (Storyhive, 2016b).

The first wave of craft breweries in Alberta was started by Big Rock Brewery in 1985. A lack of diversity in the Canadian beer market made way for the rise of craft breweries. Consolidation within the Canadian brewing industry had resulted in few breweries that only brewed pale lager (Beer Canada, 2020). Big Rock Brewery wanted to develop an English ale that celebrated the Province's malt barley and the hard water of the Rockies (Big Rock, 2020). Alberta 'brewpubs' emerged in the early 1990s with the opening of Brewster's in 1991 in Calgary (Storyhive, 2016b). The second wave of craft breweries began in the late 1990s. This wave of craft breweries included the opening of Wild Rose Brewery in Calgary and Alley Kat Brewing Company in Edmonton (Storyhive 2016c). During this time, craft breweries were plagued by legislation and taxation constraint. Lack of economies of scale was another obstacle craft breweries faced. This made it difficult for them to compete with large macrobrewers.

The number of craft breweries in the Province increased from 16 in 2012 to 120 in 2019 (Alberta Small Brewers Association, 2019; Beer Canada, 2020). The Province has introduced a number of provincial level policies in order to support and encourage the craft breweries industry. This included the introduction of graduated tax rate- depending upon the brewery's production volume. Products from craft breweries in Western Canada were taxed at different rate. This was replaced with a flat tax, and thereafter by the Province's Alberta Small Brewers Development Program (The Conference Board of Canada, 2018). In late 2018, the most recent policy change has been a reversion to a graduated tax rate by volume of sales, but for breweries from all Canadian Provinces (Weersink et al., 2018).

The Alberta Small Brewers Association (ASBA) is a non-profit organization that works towards promoting micro-brew in the Province. The ASBA's core mission is to educate the public on the benefits of local beer, celebrate local entrepreneurs, and work with the Government of Alberta to create the best brewing environment. Furthermore, the craft breweries interviewed for this capstone project often shared stories of helping other craft breweries get off the ground. The craft breweries were shown to share resources (e.g. barley,

when one brewery need it because they couldn't secure supply or needed a specific kind) and share labour. These activities showed the collaboration among craft breweries in the Province.

### 2.3 Industry Analysis

The breweries industry in Canada produces alcoholic beverages, such as beer and malt liquor as well as non-alcoholic beer, using mainly water, barley, hops and yeast. Manufacturers of spirits, wine and other alcoholic beverages are not included in this industry. A snapshot of Canadian breweries industry follow: Revenue: $6.1bn; annual growth: 1.6%; profit: $2.3bn; exports: $217.0m and 972 businesses (IBIS World, 2019). Molson Coors Brewing Company is the leading company in the beer industry controlling one third of the market (33.3%) and its main competitor Anheuser-Busch InBev (AB-InBev) has a market share of 16.5% (Statista Canada, 2020). The breweries industry in Canada has experienced strong growth over the five years to 2019, benefiting from the increased popularity of craft beer made from local microbreweries. There is a trend of consumers shifting away from the traditional light and premium beer brands that currently represent most of industry brewers sales. This has resulted in revenue and enterprise growth from a range of new craft breweries. From 2014-2019, industry revenue grew at an annualized rate of 1.6% (IBIS World, 2019). As consumers continue to shift focus away from the commercial big breweries' premium beer brands and as the craft beer market becomes saturated with microbreweries, industry growth is forecast to slow down in the next five years.

Key external drivers like per capita disposable income and per capita alcohol consumption are important indicators of beer industry growth. Per capita disposable income is expected to increase in 2020; this is a potential opportunity for the industry. However, per capita alcohol consumption is expected to grow just marginally in 2020 (Statista Canada, 2019). Other drivers like world price of grains (e.g., barley, wheat and rye) and world price of aluminium, which is a popular method for packaging beer (aluminium canning), will have significant effects on the beer industry. Increases in global price for both grains and aluminium will impose a significant cost burden on industry brewers and hamper industry profitability (Brewing & Malting Barley Research Institute, 2019). Due to higher prices of craft beer, craft breweries don't compete exclusively on price rather they emphasize seasonal flavors, limited editions and new brands to cater to a wide range of customer taste preferences.

The beer industry's larger beer brands like Molson Canadian (Molson Coors) and Budweiser (AB-InBev) are produced and marketed with the brands' cost-effectiveness in mind. Since the

craft brewers' products are geared toward connoisseurs and those who prefer more intricate styles of beer, competition from larger breweries is of little concern (Reid, 2018). In response to the growing consumer interest in craft beer styles, large breweries have acquired small craft breweries. Molson Coors acquired Granville Island Brewing Company, a craft brewery in Vancouver. Other examples are Sleeman Breweries acquiring Wild Rose Brewery, a craft brewery in Calgary and AB-InBev takeover of Mill Street Brewery, a craft brewery located in various cities like Calgary, Toronto and St. John. The most recent acquisition is AB-InBev (Labatt) acquiring Banded Peak Brewing, a craft brewery in Calgary. This recent acquisition happened January, 2020.

According to American Brewers Association (2019), a craft brewery is "small, traditional, and independent" and produces fewer than 6,000,000 barrels per year. Under the heading of craft breweries there are four distinct categories: microbreweries, contract brewing companies, brewpubs, and regional craft breweries. According to Brewers Association (2019), a regional craft brewery produces between 15,000 and 6,000,000 barrels (between 17,600 and 7,040,000 hectolitres) each year. A microbrewery produces fewer than 15,000 barrels (17,600 hectolitres) each year. Most of the breweries in Alberta are microbreweries and brewpubs. A brewpub is a restaurant/brewery that produces fewer than 15,000 barrels (17,600 hectolitres) each year, and sells 25% or more of its beer on site in the restaurant. Finally, a contract brewery is a business that hires another brewery to brew its beer.

Koroneos et al. (2005) carried out a life cycle assessment of beer production to identify and quantify the environmental performance of the production and distribution of beer. From the results obtained, many of the impact categories, beer production, packaging and bottle production are the subsystems that contribute mostly to the adverse environmental impacts of the beer production. Thus to minimize beer production's adverse environmental impacts, focus should be on minimizing the emissions produced during these subsystems. The beer industry has been moving towards more efficient use of energy and water conservation, and the tracking of greenhouse gas emissions to better manage social and environmental responsibility. Bumblauskas (2016) analysed the corporate and environmental sustainability practices and reports of various breweries. An analysis was conducted on sustainable operations and supply chain management to benchmark brewery performance and establish common metrics for sustainability in the beer supply chain. There are many investments that breweries can make to enhance energy efficiency and reduce the carbon intensity of the brewing process, such as through the purchase of dynamic wort boiling systems, enhanced insulation, heat recovery, or renewable energy systems like solar to meet energy needs, to mention just a few (Willaert & Baron,2004; Kubule et al., 2015; New Belgium, 2018).

Some breweries, like New Belgium brewery and Sierra Nevada brewery, do publish their corporate and environmental sustainability reports. These reports showcase best in class breweries and current state of the craft beer industry. Thomas and Rahman (2006) reviewed various strategies for social and environmental sustainability in breweries involving greenhouse reduction/mitigation plans in breweries as well as supply chain management. Willaert and Baron (2004) reviewed how to apply sustainable technology for saving primary energy in the brewhouse, especially in the energy intensive wort boiling process. Potential impact of energy efficiency improvements by evaluating energy consumption and efficiency at breweries has been investigated (Sturm, Butcher, Wang, Huang, & Roskilly, 2012; Kubule et al., 2015). In addition to improving water management, the treatment of process water flows and water reuse are already the focus of several research projects and technical applications (Braeken, Van der Bruggen, & Vandecasteele, 2004; Wen, Wu, Zhao, & Sun, 2010; Götz, Sven-Uwe, Ahrens, & Reimann, 2014; Jaiyeola & Bwapwa, 2015).

## 3.1 Water

Water is without a doubt the most important input in the brewing process. It is used in nearly every step of the production process. Beginning with the mineral profile of the water, alkalinity, hardness, and pH, each aspect has a significant impact on the beer produced (Barth, 2013). Water consumption varies from brewery to brewery due to variables such as brewery size, type of beer, brewing process, location and several others. Despite this, techniques exist that can help reduce water-use for craft breweries, several of which are easy to implement and have proven efficacy. Lax regulations on water usage and disposal in Alberta and Canada as a whole, have created a sense of complacency among craft breweries. Sustainable water use provides an ideal opportunity for craft breweries to reduce their environmental footprint and operating costs while improving their brand reputation (Weiser, 2017).

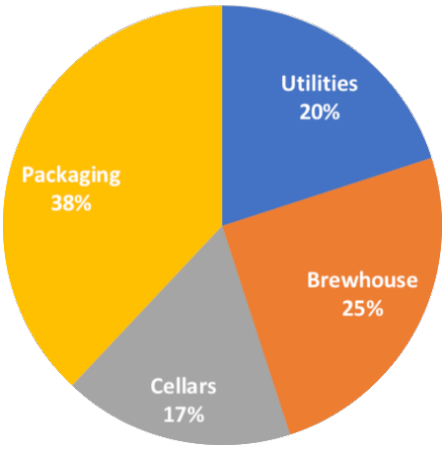
Reducing water consumption in the brewing process, as well as decreasing the quantity of wastewater produced is beneficial for the brewery, the environment and local communities. Despite significant improvement over the last decade, water consumption and wastewater disposal remain environmental and economic hurdles that directly affect breweries and the brewing process. While the availability of freshwater in Canada is decreasing, competition for water resources is increasing, coupled with the imminent effects of climate change. Sustainable breweries that are interested in long term profitability should look into water saving measures so that they won't be caught off guard by rising cost, decreasing water supplies and stricter government regulations.

### 3.1.1 *Water Consumption and Wastewater Generation*

There are four main areas where water is consumed in a brewery: brewhouse, cellars, packaging and utilities. Figure 2 shows the percentage of water use of these four departments. In addition, if it is a brewpub, ancillary operations such as food service also contribute to water usage. Breweries need to implement data management systems to best understand where water saving measures can be implemented.

There are basic questions about water usage that breweries need to ask themselves when implementing data management systems such as: what is our average water use for a given process? Are there any leaks or areas where water is being wasted? How much water are we discharging? What pollutants are in the discharge wastewater?

Figure 2: Typical Brewery Water Use per Activities




(Brewers Association, 2012)

The Brewers Association provides water efficiency opportunities and water audit data collection checklists that serve as a basis for conducting surveys on water usage. Using key performance indicators (KPIs) is a good way of assessing water usage. KPIs measure the effectiveness of a reduction program over time. Some common KPIs are the following: water used for specific end uses or volume of water used each month (Brewers Association, 2012). Once a water management program has been established and KPIs have been recorded for a significant amount of time, breweries can begin setting concrete goals for reducing water usage. The concrete steps towards reducing water use are reducing beer loss while increasing yield. Breweries can then focus on reducing direct water usage by implementing water saving strategies such as adjusting water flow, installing water-saving devices, changing to more water-efficient equipment, and reusing or recycling water could help reduce water consumption and wastewater generation in brewing process (Cornell Sustainability Consultants, 2018). Water usage and reduction best practices will be discussed further in the content analyses section, where qualitative content analyses of two sustainable craft breweries were carried out.

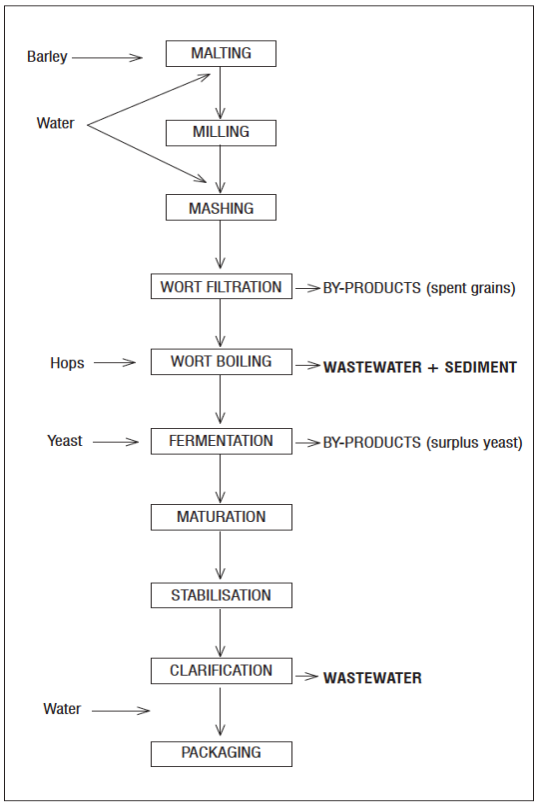
### 3.2 Brewery Waste

Brewing involves several processes during which waste is produced. Thus, there are various by-products which must be handled in an appropriate manner, whether that be through recycling, proper treatment and/or disposal. More regulations will be imposed on the breweries industry; meeting the standards of effluent quality will become more costly and multifaceted. Brewery waste can be categorized into two: (i) wastewater, and (ii) solid waste and by-product.

### 3.2.1 *Wastewater*

The brewing process produces a significant amount of wastewater due to the fact that brewing process is water intensive. For every 1 litre of beer produced, between 3 and 10 litres of wastewater is generated (Kanagachandran & Jayaratne, 2006). Understanding brewery wastewater composition is an important step in determining the ideal approach for proper treatment and disposal. Most craft breweries in Alberta discharge their waste effluent into the sewer system. The high organic nature of brewery wastewater causes oxygen in a surface water to be depleted at a rapid rate, which negatively impacts living species and biodiversity (Jaiyeola & Bwapwa, 2015). Effluent from individual process steps is variable. For example, washing bottles or kegs for beer packaging produces a large volume of effluent that contains only a minor amount of the discharged organics from the brewery. Whereas effluent from fermentation and filtering processes are high in biochemical oxygen demand (BOD) and low in volume [3% of total wastewater volume but 97% of BOD] (Olajire, 2012). Figure 3 shows the stages of beer production and the stages water is used and wastewater is produced. Table 1, shows typical ranges of brewery waste effluent, and Table 2 shows the main areas of wastewater generation.

Figure 3: Stages of Beer Production




(Jaiyeola & Bwapwa, 2015)

Table 1: Typical Ranges of Brewery Waste Effluent

| PARAMETER | TYPICAL RANGE |
|---|---|
| Water to beer ratio | 4 – 10 litre/litre |
| Wastewater to beer | 1.3 – 2 litre/litre lower than water to beer ratio |
| Biochemical Oxygen Demand (BOD) | 600 – 5,000 ppm |
| Chemical Oxygen Demand (COD) | 1,800 – 5,500 ppm |
| Nitrogen | 30 – 100 ppm |
| Phosphorus | 30 – 100 pm |
| pH | 3 – 12 |
| Total Suspended Solids (TSS) | 200 – 1,500 ppm |

(Brewers Association, 2012)

Table 2: Main Areas of Wastewater Generation

| SOURCE | OPERATION | CHARACTERISTICS |
|---|---|---|
| **Mash Tun** | Rinsing | Cellulose, sugars, amino acids. ~3,000 ppm BOD |
| **Lauter Tun** | Rinsing | Cellulose, sugars, spent grain. SS ~3,000 ppm, BOD ~10,000 PPM |
| **Spent Grain** | Last running and washing | Cellulose, nitrogenous material. Very high in SS (~30,000 ppm). Up to 100,000 ppm BOD |
| **Boil Kettle** | Dewatering | Nitrogenous residue. BOD ~2,000 ppm |
| **Whirpool** | Rinsing spent hops and hot trub | Proteins, sludge and wort. High in SS (~35,000 ppm). BOD ~85,000 ppm |
| **Fermenters** | Rinsing | Yeast SS ~6,000 ppm, BOD up to 100,000 ppm |
| **Storage tanks** | Rinsing | Beer, yeast, protein. High SS (~4,000 ppm). BOD ~80,000 ppm |
| **Filtration** | Cleaning, start up, end of filtration, leaks during filtration | Excessive SS (up to 60,000 ppm). Beer, yeast, proteins. BOD up to 135,000 ppm |
| **Bottle washer** | Discharges from bottle washer operation | High pH due to chemical used. Also high SS and BOD. |
| **Keg washer** | Discharges from keg washing operation | Low in SS (~400 ppm). Higher BOD. |
| **miscellaneous** | Discharged cleaning and sanitation materials. Floor washing, flushing water, boiler blow-down etc. | Relatively low on SS and BOD. Problem is pH due to chemicals being used. |

(Brewers Association, 2012)

### 3.2.2 *Solid Waste and By-products*

The main brewing process by-products are spent grains, turb, sludge, yeast surplus, and diatomaceous earth slurry (also known as kieselguhr sludge) from water filtration (Olajire, 2012). These various forms of by-products have unique compositions that give them different qualities and potential uses upon their production. First solid wastes to be produced during the brewing process is spent grain; which account for about 85% of the total waste generated (Briggs, Boulton, Brookes, & Stevens, 2004). In the mashing of the grains, the essential compounds used in the final beer product are extracted from the solution during the wort filtration process, leaving the bulk of organic solids behind. This organic solids is known as spent grain. It is highly nutritious and most breweries send them to local farmers so that the spent grains can be used as livestock feed (Wen et al., 2010; Barth 2013; Götz et al., 2014). For every hectolitre of beer produced, there is generally about 14-20 kg of spent grains left behind (Fillaudeau, Blanpain-Avet, & Daufin, 2006).

Turb also holds nutritional value. It results from boiling wort, where high molecular weight proteins in suspension become denatured and coagulate (Mathias, de Mello, & Sérvulo, 2014). This resulting conglomeration of proteinaceous mass is referred to as turb. For every hectolitre of beer produced, about 0.2-0.4 kg of turb is created (Briggs et al., 2004; Mathias et al., 2014).

After the fermentation process, residual yeast is produced. The mass of yeast cells can range between 1.5-3 kg for every 100 litres of beer produced (Fillaudeau et al., 2006; Ferreira et al., 2010; Olajire, 2012). Most breweries reuse this residual yeast for new batches of wort. The number of times a yeast population can be reused depends on the strain of yeast used, the wort quality and the type of beer being produced (Ferreira et al., 2010). Typical number of times a batch of yeast can be reused ranges from about 3-10 times (Mathias et al., 2014). Similar to other by-products of the brewing process, residual yeast is commonly used in the production of animal feed because of its significant nutritional value (Fillaudeau et al., 2006; Olajire, 2012). Table 3 summarizes the drivers and barriers of waste reduction.

Table 3: Drivers and Barriers of Waste Reduction

| Drivers | Barriers |
|---|---|
| Lower transportation costs | Could be capital intensive |
| Reduced waste management cost | May use additional resources |
| Potential revenue streams from reusable materials | Investment of time |
| Landfill diversion | Increased storage space |

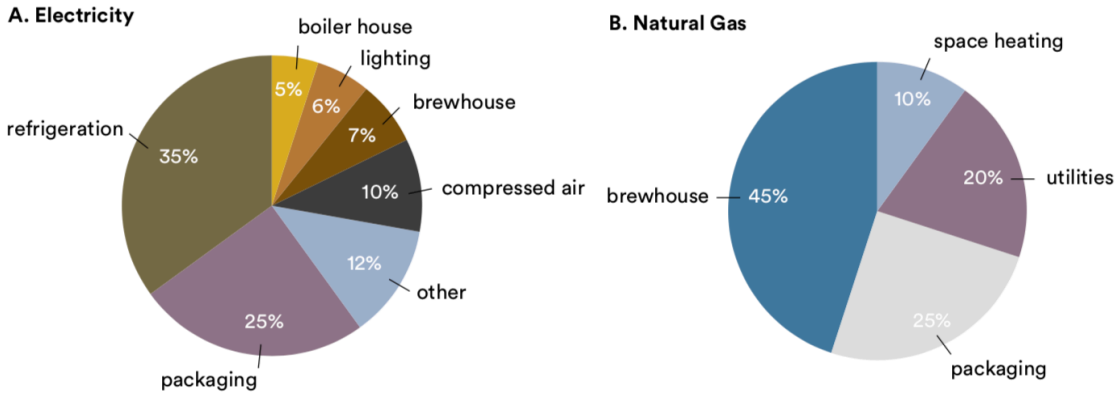
(Brewers Association, 2017b)

### 3.3 Energy

Energy usage in craft breweries varies depending on products, location and size. The smaller a brewery is, the more kWh per hectolitre since smaller volumes are not capable of offsetting the base energy necessary to brew a hectolitre of beer (Brewers Association, 2017a). Lack of economies of scale make craft breweries to be best served by reducing electricity costs via efficiency measures and determining ways to develop onsite distributed generation capacity (probably via solar). Energy does represents a large proportion of a craft breweries' operating cost. It is vital for craft brewers to discover innovative solutions for energy usage and GHG reduction opportunities at their facilities. There are many best practices that craft breweries can incorporate into their daily operations that can reach beyond energy efficiency and conservation as well as GHG reduction and lead to operating cost reduction, community initiatives and additional sources of income (Brewers Association, 2018).

The first step in managing energy cost is knowing and understanding how energy is used and where the largest users reside. Brewing consumes the largest amount of natural gas used for heating, while refrigeration generally creates the largest electrical load (Priest & Stewart, 2006; Pullman et al., 2015). Figures 4a and 4b show the percentage of energy used throughout the operation.

Figures 4a and 4b: Percentage of Energy Used in Breweries




(Source: Brewers Association, 2017a)

Electrical energy is used to power all equipment, whereas thermal energy in the form of natural gas is used to generate hot water and steam that is used in brewing and packaging, as well as space heating. Energy reduction efforts always carry the additional benefit of GHG emissions reduction, because in the brewing industry, many of the processes that consume energy will also create GHG emissions. Craft breweries should establish a brewery practice that manages energy usage to key performance indicators (KPIs) in other to improve energy reduction efforts. These KPIs should be developed and benchmarked at least monthly and annually (Brewers Association, 2017d).

### 3.3.1 *Carbon dioxide Recovery Systems*

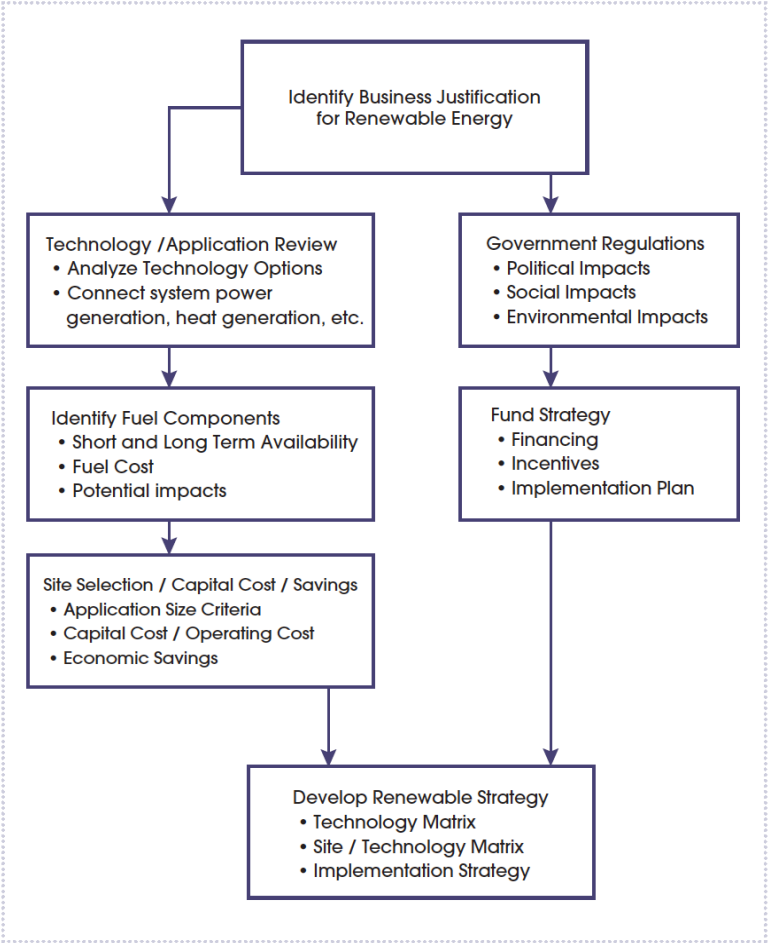
Carbon dioxide is a major by-product of brewing process, generated during fermentation, and this $CO_2$ can be vented or captured for reuse within the brewing system. Carbon dioxide is needed in the brewing process for bottling, carbonation and other uses (Willaert and Baron, 2004; Priest & Stewart, 2006; Kubule et al., 2015). So capturing the $CO_2$ gas and reusing it will provide the opportunity to improve energy efficiency and reduced GHG emission within the brewery and also lower operating cost. The brewery operation, the size of the brewery, cost to purchase $CO_2$ within a given region and the physical footprint of the brewery will determine the type of $CO_2$ recovery system that is incorporated to capture and reuse $CO_2$ (Brewers Association, 2018). The amount of $CO_2$ recovered may in some cases exceed the needs of the brewer, allowing the craft brewery to be self-sufficient in $CO_2$ production.

### 3.3.2 *Onsite Renewable Energy*

Low carbon emission sources of energy (like solar and wind), can be used to supply or supplement the energy requirement of a brewery. The use of renewable energy will offset the cost to purchase fossil fuels and take the variable cost of energy to zero in some cases like use of photovoltaic solar panels for electricity production (Brewers Association, 2017c). However, high capital cost to purchase and install the renewable energy technology as well as the low return on capital deployed remain the biggest disadvantage to incorporating renewable energy, especially in small craft breweries (Brewers Association, 2017a; Brewers Association, 2017c; Cornell Sustainability consultants, 2018). Another disadvantage for renewable energy technologies like solar and wind are that the energy is not available on demand or can be reduced due to certain operating conditions. The sun needs to be shinning for solar technology to perform and the wind blowing for wind turbines to generate power. The best bet is using such renewable technologies to supplement the energy requirements of a brewery. A more reliable yet capital intensive renewable technology is the generation of biogas from treating brewery wastewater in an anaerobic digester which produces a methane rich biogas which can be used for electricity generation (Jaiyeola & Bwapwa, 2015; Bumblauskas, 2016; Brewers Association, 2017c).

The Brewers Association developed a flow chart that outlines the different steps and activities that need to be considered when installing a renewable technology at a brewery, as shown in Figure 5. The steps used will differ depending on type of technology and size. However, this provides a way of reviewing all aspects of the project when considering renewable energy. Renewable energy may be considered for different reasons, including: (i) reduction of environmental impacts (GHG emissions reduction); (ii) energy cost savings (lower kWh cost); (iii) hedge against future energy cost increases; (iv) electrical demand management (lower peak demand kW); and (v) energy reliability and security.

Figure 5: Energy Efficiency Evaluation Loop




(Source: Brewers Association, 2017a)

### 3.4 Social Sustainability

The presence of about 120 craft breweries in Alberta Province is a testimony to the support they receive from the local municipalities and the public. Beyond all this community support, craft breweries have to be supported by a healthy consumer base to become economically viable. A survey conducted by Cornell Sustainability Consultants (2018) with 10,000 respondents found that 57% of millennials and 24% of Gen Xers drink craft beer weekly. This shows that millennials account for the majority of craft beer consumers. Alberta brewers display a remarkable level of interfirm cooperation. This creates a sense of solidarity among craft brewers in the region. Many brewmasters help new craft brewers with sourcing raw materials (like barley, hops, etc.), operations and distribution. For example, more established brewers like Village collaborate with smaller craft breweries in the Province through an initiative called 'Village friend' (Alberta Small Brewers Association, 2020).

There are large scale events organised by local craft breweries like the Alberta Beer Week. The Alberta Small Brewers Association, founded in 2013, harnesses the strength of over 70 brewers. They host annual events like the Alberta Craft Brewing Convention and Alberta Beer Awards. In addition to these, almost all craft breweries in the Province hold theme events, promotions, or tasting on a weekly or monthly basis. These recurring small events promote local brand awareness. Craft breweries create partnerships with other local establishments, they build relationships with local arts and food and beverage businesses before even opening. These partnership with local establishments foster sales for both businesses and provide jobs within the community (Leland, 2016; Alonso, Alexander, O'Brien, 2018). A study done by Cornell Sustainability Consultants (2018) on five craft breweries suggest that focussing on development of local relationships by way of stakeholder engagement, commitment to quality, non-traditional marketing, and employee satisfaction and retention, increased sales. Many local breweries support their communities by donating to charities and public good organizations such as environmental non-profits.

# Chapter 4 **Methodology**

This chapter will examine the research approach and methods employed to find emerging concepts that will help answer the research question.

## 4.1 Research Approach

Gliner et al. (2017) defined research as, "a systematic method of gaining information". Research should be systematic and follow defined guidelines. The research approach is mainly qualitative and inductive, and is exploratory in nature. In this capstone project, both primary, and secondary research are used. The data collection methods employed within this research are semi-structured interviews and content analyses. Both methods are qualitative and inductive. Secondary research is offered through a literature review. The topic of sustainable brewing within the craft brewing industry in Alberta is not adequately addressed within existing literature to support alternative methods; hence the research is mainly qualitative and exploratory in nature.

### 4.1.1 *Qualitative Research*

Qualitative research was originally used to describe research that was not quantitative. There have been several aspects identified that has helped offer a more specific definition. Flick (2007) states that qualitative research is concerned with understanding perspectives of the participants involved. Qualitative research methods are appropriate to build understanding around a process, or connection concerning the research topic (Gliner et al., 2017). In qualitative research, the researcher has more flexibility to pursue new tangents that arise during the research process, whereas this flexibility is not possible in strict quantitative research. In summary, a qualitative research approach enables the researcher to pursue new ideas throughout the research process and the data are mainly subjective, and deals with personal perceptions (Flick, 2007). Qualitative research also allows for more in-depth questioning on a smaller sample of firms; whereas quantitative research allows more generalization to a larger sample of firms or an entire industry on a fewer number of variable.

### 4.1.2 *Content Analysis*

Content analysis is a research method that uses a set of procedures to make valid inference (Wilson, 2016). It can be quantitative or qualitative. Described by Webber (1990), "qualitative content analysis reviews information and seeks to create categories for emerging information, whereas quantitative content analysis starts with predetermined categories to analyse

information" (p.9). Content analysis results are used to draw conclusions or inferences emerging from the media under research (Wilson, 2016).

### 4.1.3 *Semi-Structured Interviews*

Another qualitative data collection method used within this capstone project is the semi-structured interviews. It may be a method employed within qualitative research deliberately constructed in an effort to achieve knowledge. Interviews are designed in different ways. They can be structured, semi-structured, or unstructured (Wengraf, 2001). Semi-structured and structured interview questions help direct the conversation, and they rely on an established list of questions. But unlike structured interviews, semi-structured interviews are more flexible, which are more conducive to qualitative research (Flick, 2007). There are different ways to conduct interviews, including in-person, online video call, or over the phone. In this capstone project, a mix of in-person interview and online video call interview (especially for the breweries outside Calgary) was used.

## 4.2 Research Process

This capstone research process is largely inductive. Inductive data collection explores and collects relevant data that are used to create theory (Wilson, 2016). Figure 6 shows each phase of research.

Figure 6: Research Process Phases.

(Author, 2020)

Phase 1: Literature Review on the Brewing Industry

The first phase consisted of a literature review concerning the Canada's brewing industry.

i.) History of beer in Canada- from the early days when brewing was a domestic art and practiced by people in their own homes.

ii.) Modern brewing- Current state of the brewing industry in Canada and emergence of craft brewing industry.

iii.) Alberta craft brewing industry- history of brewing in Alberta to the current state of the craft brewing industry in the Province.

Phase 2: Literature Review on Sustainability Practices in the Craft Brewing Industry

The second phase is a literature review concerning craft brewing industry sustainable brewing practices and how breweries can improve energy-use and conserve water by using: (i) Sustainable production processes, like $CO_2$ recovery from the beer fermentation tanks and using that $CO_2$ in beer carbonation; (ii) Energy management systems, like use of heat exchangers to recover heat from hot wort, the recovered energy can be used to preheat subsequent mash water; and (iii) Alternative technologies, like using microbes to clean process wastewater in an anaerobic digester which produces a methane rich biogas which can be used for electricity production, and installing solar panel to meet brewery energy demand.

Phase 3: Content Analyses

Qualitative content analyses of two sustainability leaders in the craft beer industry were carried out. This will help bring understanding to some of the sustainability related content publicly communicated by industry leaders. The content analyses uncovered energy themes. Selection criteria to determine these sustainability leaders were:

(i) Must be a craft brewery as defined by the Brewers Association.

(ii) The brewery must have a Sustainability Report, through their company's website that includes sustainability related information.

(iii) The brewery is widely acknowledge as sustainability leader, receiving an award as a recognition of their sustainability management efforts.

No craft brewery in Alberta met these criteria for a content analysis, reason being none of them publish a sustainability report. The two craft breweries selected are: New Belgium Brewery and Sierra Nevada Brewery, both craft breweries are in United States and they met all three criteria.

Phase 4: Interviews with Craft Breweries in Alberta

A total number of ten craft breweries were interviewed. Job titles from participants include the following: Owner, Co-founder, Production Manager, and Director of Brewery Operations. Out of the ten breweries interviewed, five breweries are located in Calgary, one brewery from Edmonton, one brewery from Lethbridge, one brewery from Canmore, one brewery from Lacombe, and one brewery from Turner Valley. All firms were contacted via email and the same email was sent to all firms. As mentioned earlier, the two ways the interviews were conducted included an in-person site visit (visiting the brewery) and online video call (via zoom). The in-person interview that required me visiting the breweries, also had a brewery tour, and I could observe the sustainability practices of the breweries. The interviews lasted approximately 30-60 minutes. All participants confirmed the accuracy of their transcribed responses. As mentioned earlier, semi-structured interviews were used has the ideal method to collect rich data from voluntary respondents during the research phase. An interview will result in higher quality, more in-depth data compared to using questionnaires or surveys. Open-ended questions were mostly used, with the interest of influencing the depth of response from participants.

Interview questions are found in Appendix A and the summary of interviews is in chapter 6. There are four different categories of questions within the interview question template. The categories of questions are as follows:

i. Size of firm
ii. Their view of Alberta craft brewery industry
iii. Existing sustainability management practices
iv. Future sustainability management practices.

Information regarding the size of the firm was collected in the first category of questions. The second category collected inside information about the craft brewery industry- talking about who are their competitors, what is the growth potential of the craft segment, etc. The third category collected information regarding existing sustainability management practices- what each brewery is doing to reduce water-use, energy-use, solid waste and social impacts originating from the brewing industry. This information was used to create a preliminary benchmark regarding existing sustainability management practice within the craft brewing industry in Alberta. The fourth category of questions asked probing questions concerning each

brewery's future sustainability management practices and what are the barriers for the brewery to engage in more sustainability management practices.

Phase 5: Analyzing and Communicating Results

This phase focused on analysing the data and information gained through content analyses and interviews, and communicating the results. Each interview was summarized, and all responses for each brewery were compared. This is a simple method to analyse the qualitative data, which allowed themes, and relevant perceptions to emerge. Analysis was inductive and the communication of results articulate the important emerging data that are useful to answer the capstone project research question.

Phase 6: Contributions, Recommendations, and Conclusion

This was the final phase of the research. Observations emerging from the project are communicated, as well as recommendations and finally conclusion are offered.

# Chapter 5 **Content Analysis**

## 5.1 Sierra Nevada Brewing Company

Sierra Nevada Brewing Company's original brewery is in Chico, California and a second more recent brewery was built in Mills River, North Carolina. Over the years, Sierra Nevada continues to showcase increasing efficiency trends. In 2016, the brewery was awarded leadership in Energy and Environmental Design Platinum status, the only brewery in United States to earn it.

### 5.1.1 *Social Sustainability*

Sustainability is one of Sierra Nevada core values and part of that has evolved into an agriculture program. The brewery supports local farmers, knowing that they have an outlet for the produce that they are growing and knowing the brewery is committed to supporting the local food movement. Sierra Nevada accomplished their goal in 2018 to source 70% of their total ingredients locally and that translated to $1.4 million that was put back into the local farming agriculture community (Sierra Nevada, 2020). They are working on further increasing the percentage of locally sourced ingredients.

Sierra Nevada has developed a robust new employee orientation program, in order for their employees to hit the ground running on sustainability initiatives. This showcases Sierra Nevada culture and sets the expectation that all employees participate in sustainable practices both at work and in their everyday lives. There is also training for departments to enable them achieve the goals set by the brewery. These goals are tied to employee bonuses as an incentive for the whole brewery to play a key role in improving Sierra Nevada sustainability practices (Sierra Nevada, 2015).

### 5.1.2 *Energy*

Carbon dioxide Recovery and Reuse- During fermentation, the yeast ferments sugars in the wort into alcohol and carbon dioxide is also produced. Instead of the brewery to vent that $CO_2$ into the atmosphere, it installed a collection system to recover and recycle the $CO_2$ produced. By capturing $CO_2$ directly off the top of the fermenters, the recovery system dries and filters the $CO_2$ of any impurities, before it is compressed and stored. The recovered $CO_2$ is then recycled for various applications including purging and pressurizing tanks and carbonation of

beer (Sierra Nevada, 2020). This recovery and reuse of $CO_2$ eliminates truck deliveries of $CO_2$ to the facility and the associated environment and financial costs.

Heat Recovery- brewing requires a significant amount of heat, and also releases a tremendous amount of heat through cooling hot liquids, steam generation and boiling. The brewery has implemented several applications to recover and recycle waste heat instead of venting this heat energy. This is achieved through the use of plate heat exchangers throughout the facility and heat recovery systems on boilers and brew kettles (Sierra Nevada, 2015).

Indoor Energy Efficiency- the brewery has large windows and skylights throughout the facility to take advantage of the free and abundant light source from the sun. This remains the most efficient lighting available. For electric lighting, Sierra Nevada have installed motion sensors, ambient light sensors and timers to increase efficiency (Sierra Nevada, 2015).

Solar Power- Sierra Nevada installed a solar system consisting of two layout- a carport solar array and a roof top solar array. The two systems provide about 20% of the electricity needs of the brewery. The carport solar array tracks the sun throughout the day for added efficiency and was installed in 2007 and the stationary roof top solar was completed in 2008 (Sierra Nevada, 2015).

Energy from recovered biogas- Sierra Nevada's wastewater treatment process includes an anaerobic digester which generates a methane-rich biogas which is then used to produce electricity as well as used in boilers to offset the use of natural gas (Sierra Nevada, 2020). This lowers the brewery's consumption of natural gas and cost while reducing greenhouse gas emissions.

### 5.1.3 *Brewery Waste- Solid Waste*

In 2018, Sierra Nevada reported 99.6% of solid waste diverted from landfill disposal (Sierra Nevada, 2020). They continuously seek ways to eliminate process waste, like reduction of packaging through methods such as increasing the amount of recycled content in bottles, reducing the amount of cardboard needed for secondary packaging. The brewery also modifies the filtration process to eliminate filter waste. An example of the brewery's initiative of materials reuse includes- donation of large grain sacks to local bee keepers and landscaping

companies, reuse incoming packing materials for off-site shipments, and repair and reuse of broken pallets.

100% of the brewery's spent grain and yeast is recovered and sent to local farmers as supplemental feeds to their cattle (Sierra Nevada, 2015). The brewery also has an excellent recycling program that includes collection of plastic strapping, paper, wood, scrap metal, glass, shrink wrap, and cardboard. Regular audits of recycling, compost areas and trash are conducted by the brewery's sustainability department. Due to a lack of large-scale composting programs around their location, the brewery developed a HotRot composting system. The system composts waste from the brewing process and their onsite food services. The HotRot composting system can accept up to 5,000 lb of compostable waste daily (Sierra Nevada, 2020).

### 5.1.4 *Water*

Sierra Nevada has installed several new technologies to conserve their water use. They saved closed to 800,000 litres of water a year when they replaced bathroom faucet aerators. They saved almost 300,000 litres a year, when the retrofitted flush valve toilers with dual flush handles (Sierra Nevada, 2015). At Sierra Nevada, employees are consistently monitoring their water use and find innovative ways to reduce the brewery's water intensity. The brewery use sub-meters to track water use and their Clean-in-Place system has reduced the volume of water used to clean brewery tanks by about 70% over the previous procedure (Brewers Association, 2017d).

Sierra Nevada treat all of their brewing process wastewater to remove this burden from the local municipality. They installed a two-step aerobic and anaerobic treatment plant that treats and purifies all of the brewery's water produced from their brewing process (Brewers Association 2017c). As mentioned earlier, the methane generated from the anaerobic digestion is captured and used to produce electricity as well as used to fuel their boilers.

## 5.2 New Belgium Brewery

New Belgium Brewery company has two locations in the United States: the original brewery in Fort Collins, Colorado and second location in Asheville, North Carolina. Environmental stewardship has been a core value since the company's inception. As winners of the Environmental and Safety Excellence award from Schneider Electric, New Belgium stands as

a shinny example of sustainable manufacturing. To showcase their commitment, the brewery achieved certified B corp status, using business as a force of good. B corps are for-profit companies certified by non-profit B lab to meet rigorous standards of environmental and social performance, transparency and accountability (New Belgium, 2018).

### 5.2.1 *Social Sustainability*

New Belgium Brewing gives co-workers access to equity and reduce wealth inequality by giving ownership in the company. Through an Employee Stock Ownership (ESOP), 100% of New Belgium Company is owned by co-workers, and they all share in the profits each year (New Belgium, 2018). 100% of co-worker insurance premiums are covered to enable co-workers stay healthy and well. There is an onsite wellness clinic at their brewery, with a physician and medical assistants on payroll (New Belgium, 2020). These are good investments, though it doesn't always show immediate benefit, but over time they enjoy better co-worker engagement and spend much less on insurance and turnover costs. The New Belgium over 700 workers have been a driving force behind their positive impacts (New Belgium, 2020). New Belgium offers up to $500 per co-worker who participates in a volunteer program (New Belgium, 2018). This enabled co-workers to dedicate their vacation for a good cause, giving back to the community. New Belgium brewery source their ingredients locally, this partnership with local establishments foster sales for both businesses and provide jobs within the community. The brewery gift their co-workers bicycle to encourage cycling to work as a way of reducing their individual environmental footprint.

### 5.2.2 *Energy*

New Belgium brewing installed a smart grid in 2010 (Brewers Assocaition, 2017a). This enables the 2-way flow of both energy and information. They will also be able to integrate their valuable distributed generation with the city's supply and demand. In 2010, New Belgium installed 200kW of solar panels, at the time, it was the largest installation in Colorado. When not making power on-site, New Belgium buys wind power from the utility at a 50% premium (New Belgium, 2019), these methods save 8,000,000 lb of $CO_2$ each year (Brewers Association, 2018). Natural gas is used for thermal energy (that is, creating steam and heating water). New Belgium works to conserve natural gas through recovery systems, like the use of heat exchanger. It captures the steam from the brew kettle, this serves a lot of energy because the waste heat from the steam is used to preheat the incoming water and thereby reducing the energy needed to start the next batch. Their Steinecker cone-shaped brew kettle is able to

reduce the natural gas consumption using 65% less energy than traditional unit (Brewers Association 2017d), by cutting the boiling time in half. At New Belgium, they treat all their process wastewater onsite in an anaerobic digester. The anaerobic digester has a lot of microbes eating all the contaminants and they produce a methane rich biogas. Once the methane is collected, it is sent to two different co-generators. The generators make up 15% of the brewery's energy needs (New Belgium, 2018). This turns a waste stream into a source of energy. Between the solar array, cogenerators, and wind farm purchases, New Belgium has a hand in almost all of its energy.

### 5.2.3 *Brewery Waste - Solid Waste*

In 2018, New Belgium Brewing Co. diverted 99.8% of its waste from landfills (New Belgium, 2019), excluding spent grains, yeast, and wastewater treatment sludge. The spent grain is sent to the farm and the farmer feeds it to his cattle in place of virgin grain. Not using virgin grain saves 30,000 tons per year (New Belgium, 2019). This means less water for crops, less fuel for farm equipment, and fewer emissions.

Ways that the brewery worked to improve its waste systems include:

- Addition of compost collection to their offsite warehouse
- Elimination of two trash dumpsters at its malt building and process water treatment plant, and replacing them with recycling containers for mylar bags, plastic bags and super sacks.
- Diversion of compost discs, chip bags, mylar bags, super sacks and plastic bags out of landfills.

New Belgium brewery ongoing waste reduction initiatives include:

- Identifying waste opportunities where they can eliminate waste before it enters the brewery.
- Eradication of waste that the brewery sends to the landfill, by activating projects that will work to increase their waste diversion.

### 5.2.4 *Water*

Water is identified as an important indicator. They carryout water audit to understand water usage in the brewery, so as to reduce losses and improve water conservation (Brewers Association, 2012). Other project at the brewery that is aimed at water reduction includes drip irrigation of their onsite vegetable garden, recovering water after cool down, and automating a

clean-in-place system that is designed with a hot water recovery tank to recover water and heat to use on the subsequent cleaning cycle. There are also some great water saving features in New Belgium's packaging hall- the water that is used to rinse the inside of the bottles is recovered and reused on the final rinsing of the exterior (New Belgium, 2018). The brewery's onsite wastewater treatment facility pre-treat their wastewater before it is sent to their municipality wastewater treatment facility. Methane is recovered from the process and is used to fuel their boilers (Brewers Association, 2017a).

New Belgium launched a campaign to fund water stewardship efforts on the Colorado River called SaveTheColorado.org, it was launched in 2010 (New Belgium, 2018). They brewery committed $300,000 over three years to non-profit organizations, who are working to study and repair the Colorado river (which supplies almost half the water coming to Fort Collins). Several other companies and individuals have joined New Belgium in this effort (New Belgium, 2020).

## 5.3 Results of Qualitative Content Analysis

A qualitative content analysis was performed on two craft breweries (New Belgium Brewery and Sierra Neavada). Both breweries are sustainability leaders within the craft brewery industry. They both publish sustainability report through their company's website. The information collected can be organized into two categories: (i.) Indicators and commitments disclosed, and (ii.) Projects disclosed.

### 5.3.1 *Indicators and Commitments Disclosed*

New Belgium brewery and Sierra Nevada both identified the following significant sustainability indicators: water, energy, and solid waste (Sierra Nevada, 2015; New Belgium, 2018). Both breweries offered specific data for aspects that were reported on. Efficiency ratios, and total values were offered for energy, air emissions, water, and waste. They both communicated commitments to sustainability from top level decision makers (Sierra Nevada, 2015; New Belgium, 2018). Both breweries identified commitments to employee welfare, and to local communities ((Sierra Nevada, 2015; New Belgium, 2018)).

### 5.3.2 *Project Disclosed*

Sierra Nevada and New Belgium identified multiple projects on environmental performance, projects to support employees and local communities ((Sierra Nevada, 2015; New Belgium, 2018). Both breweries identified projects on energy usage and reduction, like replacing existing lighting with more efficient lighting, carbon dioxide recovery and reuse and use of heat exchangers for heat recovery ((Sierra Nevada, 2015; New Belgium, 2018). Both breweries identified projects on community outreach. They established partnerships to support local community, conservation organizations and charities (New Belgium, 2020; Sierra Nevada, 2020). Both breweries identified projects on water conservation and wastewater treatment. Like treating their wastewater in an anaerobic digester, and projects established to improve water-use include- automating the clean-in-place system and reusing and recycling water ((Sierra Nevada, 2015; New Belgium, 2018). Both breweries identified on-site renewable projects. Like installation of solar arrays on their brewery building's roof and recovering the methane-rich biogas from their wastewater treatment facility and used the methane to fuel their boilers and produce electricity (Sierra Nevada, 2015; New Belgium, 2018).

### 5.3.3 *Conclusion*

New Belgium and Sierra Nevada Brewery are both sustainability leaders within the United States craft brewing industry. The content analyses research results have communicated significant emerging concepts regarding potentially relevant sustainability indicators. This has help bring understanding to some of the sustainability related content publicly communicated by sustainability leaders within the craft brewing industry.

# Chapter 6 **Summary of Interviews with Craft Breweries in Alberta**

## 6.1 Alley Kat Brewing Company

Alley Kat Brewing Co. is a craft brewery located in Edmonton, and it was established in 1995. The brewery has a daily production of 50 hl and annual production of 8,000 hl. The brewery brand portfolio is six (6) core beers and other seasonal beers.

From questions about the Alberta craft brewing industry, these were their views. Although there are competition among craft breweries, especially in bars for tap handles, the more people who drink craft beer the better for the industry. Generally, there is a togetherness among craft brewers, and they try to help each other out in any way they can like giving out malts and hops to breweries that couldn't secure ingredients, or help out with technical issues. They believed that more breweries will still open, but not at the rate it was happening before, and also few breweries have closed down.

Sustainability Practices

The brewery have been keeping track of their utilities for years. By becoming more sustainable and following industry best practices they have seen a reduction on their energy use and water use. The brewery water-to-beer ratio in 2015 was 6 hl/hl, that is 6 hectolitres of water to make 1 hectolitre of beer. Their year 2019 ratio was 4.8 hl/hl. Some of their sustainability practices to conserve water include- efficient method of rinsing tanks, recovery of hot water from the brewery process by using heat exchangers, and fixing leaking faucets. The brewery installed an air-rinsing system in their canning line to get the dust out by ionizing the air, this waterless method conserves water. The brewery has changed all its lighting to LED to save energy. The brewery's energy provider is Bullfrog, which is one of Canada's leading green energy provider. Regarding their spent grains, it is sent to local farms to be used as animal feed.

From questions regarding the barriers stopping craft breweries from engaging in more sustainability practices, their response was that small breweries don't have a huge expenditure budget to invest in technology. They focus more on best practices to become more sustainable. Due to the size of most craft breweries in the Province, technologies like $CO_2$ recovery system is not meant for breweries their size, it is made for larger breweries and industries. These new technologies are also very expensive and payback time of such technologies can be more than

10 years. The barrier of installing solar panel is that most craft breweries don't own the building they are in and they will need to get permission to set up solar on top of the building.

### 6.2 Brauerei Fahr

Brauerei Fahr is an award-winning brewery, established in 2017 and based in the town of Turner Valley. The brewery has three (3) core beer brands and four (4) seasonal beers. Dr. Fahr, a University of Calgary alumnus, earned his PhD as a biomedical engineer. The brewery's 2019 annual beer production was 1,400 hl. They are aiming at doubling their annual production this year.

Sustainability Practices

The brewery has an air compressor and an onsite nitrogen generator. The nitrogen is used for purging of tanks instead of $CO_2$. So this reduces truck deliveries of $CO_2$ to the facility and the associated environmental and financial costs. The nitrogen is generated onsite; so this lowers costs, reduces gas waste, on-demand supply, and downtime. It is an investment with a payback time of 2-3 years, this will save the brewery money in the long run.

Their empty grain bags are sent to where they are all recycled into a tote or shopping bags, so they are not ending up in the landfills because they are being reused. The brewery's spent grains are picked up by a local farmer to be used as animal feeds. The brewery's residual yeast can be used as biofertilizers for hay fields and there are many hay fields in Turner Valley.

The brewery utilizes two stage heat exchanger. The first stage cooling with water, the second stage cooling with coolant, such as glycol. The water in the first stage is recycled as brewing water after heat exchanging.

Regarding using $CO_2$ recovery system in the brewery, the size of the brewery and the amount of $CO_2$ produced during the fermentation process is making utilizing $CO_2$ recovery not worthwhile, plus it is a $500k capital intensive investment. But the brewery is interested in installing solar panels on their roof. Also considering installing solar thermal systems and when the brewery expands and gets bigger, they can look into having an anaerobic digester to treat brewery wastewater and utilize the methane-rich biogas to fuel their boilers. As a brewery, their goal is to be carbon neutral and they believe it can be done.

### 6.3 Blindman Brewing Company

Blindman Brewing Co. is a craft brewery based in Lacombe, Alberta and was established in 2015. The brewery produces about 8,000 hl annually and about 30 hl per batch. The brewery sells 90% of its beer offsite (in liquor stores, bars & restaurants) and only 10% onsite in their taproom. The brewery produces eight (8) core beer brands, and few seasonal beers.

From questions about the Alberta craft brewing industry, these were their views. Although there is competition between macrobreweries and microbreweries, the major competition craft brewers have is among themselves. Overall beer consumption has been declining in volume, due to the increase in popularity and consumption of wine and spirits. Though the industry will continue to see more craft breweries established in the Province, there are also craft breweries closing, but there will be more openings than closures.

Sustainability Practices

The brewery is engaging in some sustainability initiatives around energy efficiency and water management. They measure and monitor their water usage using flowmeters, they also measure electricity and natural gas usage. The brewery typical water-to-beer ratio is between 4-5 hl/hl, and it is mainly cleaning that has the highest percentage of water use. They have had energy assessment done to find ways to reduce their energy use. They have changed all their lighting to LED. They use heat exchanger to recover waste heat and reuse in the brewing process. Blindman brewery has a recycling program of reusing their plastic beer can holders (called PakTech) and have an incentive for consumers who return the PakTech to the brewery. Their brewery's spent grains are sent to local farmers to feed their livestock.

Going forward they are looking at installing a solar thermal technology on their roof. Brewing is one of those few industries that need more heat during the summer than the winter, because more beer is made in the summer. So there is generally need for more heat in the summer and the heat usually is from burning natural gas. So the advantage of installing solar thermal to heat up the brewing water is the reduction of natural gas usage.

This fall, the brewery will be starting an employee ownership plan, where all the employees have an opportunity to own part of the business and in 10 years, the firm will be 100% employee owned.

### 6.4 Banded Peak Brewing Company

Banded Peak Brewing is located in Calgary and was established 2016. The brewery was recently acquired by Labatt Breweries in January 2020. The brewery's 2019 annual beer production was 3,000 hl. The brewery produces 5 core beers, 2-3 seasonal beers, and also some one-offs. So at a given point in time their portfolio is between 7-12 beer brands. One of the advantage of the Labatt acquisition is growing their capacity from 3,000 hl annual production to 25,000-30,000 hl capacity brewery in the next 5 years. The acquisition provided Banded Peak the opportunity for growth. They can also get access to their distribution channels and sale force.

From questions about the Alberta craft brewing industry, these were their views. There is still lots of room for growth in craft and lots of room for new players to enter the market. There has been a big shift in the last five years towards cans as the most preferred form of packaging by craft brewers.

Sustainability Practices

Banded Peak measures and monitors their water use and energy use, and compares it with their monthly production volumes, so as to have a metric to work from and see if they are doing better and reducing their water use and energy use. The brewery water-to-beer ratio is between 5-7 hl/hl. Banded Peak spent grains goes to local farmers to be used as cattle feed.

As a small craft brewery, it was tough for the brewery to invest in technologies like installing solar panel, wastewater treatment facility, and $CO_2$ recovery systems. Another advantage of their partnership with Labatt is they can now focus more on sustainability and make it a priority.

### 6.5 Grizzly Paw Brewing Company

Grizzly Paw Brewing Co. is located in Canmore, Alberta and was established in 1996. The brewery's beer production is around 5,000-10,000 hl annually. The brewery produce soda drinks along with their portfolio of beer brands. The brewery has 7 core brands and several seasonal beers, taking their total portfolio to around 10-15 brands.

From questions about the Alberta craft brewing industry, these were their views. New craft breweries opening in the Province is not really a threat, because it increases the interest of the customers, so it is over all good for the industry in that it increases the visibility of the craft

brewery industry. In Canmore, there are four craft breweries and two craft distilleries, so it is not as crowded as it is in Calgary. The craft brewers in Alberta are generally collaborative and they tend to help out each other and there are several collaboration beers that's been happening, where a group of breweries come together to make a new brew.

Sustainability Practices

The brewery does have an environmental committee that looks for innovative ways the brewery can reduce their environmental footprint. The brewery does monitor and measure their water use and energy use. The whole brewery is on LED lighting and their green energy provider is Bullfrog Power. The brewery utilizes heat exchangers to recover waste heat during production. The brewery has an advanced recycling program; its waste gets separated into seven different waste stream and so there is a lot of waste that gets recycled. The brewery has a waste diversion rate of 95%. Their spent grains goes to local farms to be used as animal feeds or to be composted. The brewery is considering installing solar panel in the future.

### 6.6 Theoretically Brewing Company

Theoretically Brewing Co. is a craft brewery based in Lethbridge, Alberta and was established in 2015. The brewery as an annual production of 500 hl, it is the brewery with the smallest capacity out of the ten breweries that are collaborating with me on my Capstone Project. The brewery has six (6) core beer brands, and the brewery is constantly experimenting with new beer styles.

From questions about the Alberta craft brewing industry, these were their views. In the marketplace, there is a little bit of competition between the craft brewers because they are constantly competing for the same shelf space and tap handles in bars. But the craft brewery industry as a whole tends to band together to take on the big microbreweries. The more craft breweries there are that eat into the market share of microbreweries like Molson Coors and Labatt, the better for the craft brewing industry. In Lethbridge there are three operational craft breweries, so it is not as crowded as it is in Calgary.

Sustainability Practices

The brewery identifies energy and water as significant sustainability indicators. The brewery is a 100% electric brewhouse, no natural gas is used, so there is focus on their energy consumption. Regards to energy efficiency, they have upgraded all their lighting to LED. The

brewery is very conscious of their water consumption, they have an efficient clean-in-place system and they do a lot of water recapture of the system to use as cleaning fluid down the line. The brewery water-to-beer ratio is 7 hl/hl, they recycle water as much as the possibly can. The brewery has a hydroponic system in their taproom, so their wastewater is utilized in the hydroponic system. The brewery's spent grain is picked up by local farmer to use as animal feed in their farm and the remaining spent grain is sent to a biodigester.

The brewery's future sustainability projects will be looking into water reclamation and heat reclamation systems. They want to recapture water and reuse it within the facility. They are looking at installing heat exchangers to recapture the waste heat. Because they are an electric plant, they are looking at installing solar panels on their roof, so they can generate their own power. The brewery works with Environment Lethbridge, in the small business energy efficiency program, where the brewery set goals with them and Environment Lethbridge holds the brewery accountable for meeting those goals. The brewery monitors and measures their water usage and monitors leaks in partnership with Environment Lethbridge. Environment Lethbridge assists the brewery in carrying out research and informing the brewery of incentive programs that are available to them. Environment Lethbridge does all the sustainability research and the brewery makes all the changes they recommend.

### 6.7 Cold Garden Beverage Company

Cold Garden Beverage Co. is located in Calgary, Alberta and was established 2017. The brewery's 2019 annual beer production is 2,600 hl and the brewery sells 80% of their beer onsite in their taproom and 20% sales offsite. The brewery has 8 core beer brands and between 2-6 seasonal beers. The brewery currently sells beers in kegs and growlers, but are looking at canning their beer starting this fall.

Sustainability Practices

The brewery does monitor and measure its water use and all brewery's lighting is LED. All the brewery's spent grains are sent to local farmers to be used as animal feeds. The brewery considers exploring installing solar panel on their patio roof. The brewery is also exploring a steam boiler that is fed with the brewery's spent grains. There is a reactor being explored that the spent grains will be used as fuel. This will reduce natural gas consumption in the brewery and its an innovative waste to energy technology. This will enable the brewery to move towards zero waste.

The craft brewery industry in Alberta or Canada as a whole is still in its infancy. Once the brewery becomes more of a mature model, then its start looking at more efficiencies. Right across Alberta and Western Canada the craft brewery industry is in their infancy, so everyone is still trying to dial in their core business, like expanding their capacity, and then the natural progression is to start looking at cost savings and sustainability practices. That is why no craft breweries tend to have a sustainability report.

### 6.8 Annex Ale Project

Annex Ale Project, located in Calgary, was founded in 2015. A small brewery for big talk, bold plans and potential adventure. They make 15 hectolitres at a time and have over 280 hectolitres of cellar space, with a beer portfolio of 4 core brands and 4 seasonal beers.

Sustainable Practices

They are taking a major look at sustainability in the way that they produce their products. They are consistently monitoring their water use and find innovative ways to reduce the brewery's water intensity. The brewery use flowmeters to track water use and their Clean-in-Place system has reduced the volume of water used to clean brewery tanks. Their typical water-to-beer ratio is 5hl/hl; they also recover and reuse water where possible. They monitor their energy use and find innovative ways to reduce their energy consumption, like using LED lightings and recover and reuse waste heat during the brewing process.

In addition to sourcing of raw materials like malted barley locally, the company sends its spent grains from the brewing process to farms to be used as animal feeds. They are converting to renewable electricity through Bullfrog Power. It will allow them to reduce their $CO_2$ footprint by 60 tonnes for 2020. That is roughly 40% of their current load.

They are also considering the following environmental initiatives: installing solar panel to meet their energy demand; $CO_2$ sequestration from their boiler and fermenters; changing their packaging to use less plastic; a grain silo for bulk malt purchases and redesigning their delivery routes to use less fuel; as well as exploring ways they can minimize water consumption.

### 6.9 Wild Rose Brewery Ltd.

Wild Rose Brewery Ltd. is one of the most popular craft brand in Calgary. It was started in 1996 and is by far the biggest brewery interviewed for this study, with about 21,000 hectolitres per year, typically between 60hl – 80hl per batch. The brewery's water to beer ratio is 5 hl/hl.

They were more than enthusiastic to participate in this study and gave insight on the Sleeman Breweries acquisition and their mandate to be more sustainable. Sleeman Breweries, the third-largest brewer in Canada officially acquired Wild Rose Brewery, so they are now under the Sleeman's umbrella, while Sleeman Breweries is under the Sapporo Breweries umbrella. Even though Wild Rose Brewery remains a craft brewery, they are no more an independent craft brewery. The advantages of this acquisition for Wild Rose is the economy of scale, having access to resources, wider distribution and a lot of technical knowledge.

Sustainable Practices

Wild Rose Brewery like other craft breweries source 100% of their malted barley, hops and other raw materials locally and they send their spent grains from the brewing process to farmers to use it as animal feed.

Some of their other sustainable practices include the following: use of heat exchangers to recover heat from hot wort. The recovered energy can be used to pre-heat subsequent mash water or for washing purposes. This minimizes water-use and energy-use in the brewery. Another sustainable practice is the capturing of $CO_2$ from the beer fermentation tanks, therefore skipping the carbonation process, though this only happens in the production of their unfiltered beer. They have two large grain silos where they store their bulk malt purchases. Buying in bulk is not only economical- it's eco-friendly as well, because it minimize transport pollution.

They are also currently introducing cardboard packaging to replace the plastic rings used on its multipack cans. The new packaging is 100% recyclable, compostable and sustainably sourced. This will help the brewery get rid of 100 tons of plastic per year. They recognize the negative effect single-use plastic is having on our planet, so they are creating eco-friendly solution that eliminates plastic while still meeting consumer demand.

### 6.10 Dandy Brewing Company

Dandy Brewing Co. was incorporated in 2014; the brewery is located in Calgary. The company has ambitious growth plans, and their beer will soon be on tap in other Provinces and even beyond. Growing a company sounds like an obvious goal, but there are more than a few breweries who are not interested in growth. Different breweries have their own goals, some are bent on growth, and some aren't. However, for Dandy Brewing, growth is incorporated in the business plan. The company makes1500 litres (15 hectolitres) small batches of beer; they use a mobile canning company to package their beer rather than setting up their own packaging line. The company's portfolio of beers include- five (5) core brands, four (4) seasonal and some special recipes.

From questions about the Alberta craft brewing industry, these were their views. They don't see the big breweries like competition, rather other craft breweries are in a way having a healthy competition to get market share. It is actually the big breweries that see the craft breweries has a competition, because they are losing market share to craft breweries. They also mentioned that the strength of craft brewers are the increase in desire for local goods. As many brewers interviewed for this study echoed, people want to know the who, the where, and the how behind their consumption decisions, including beer. The main reasons for growth in the craft beer industry, is that craft breweries are local, small and they try to be stewards of their communities and the environment.

<u>Sustainable Practices</u>

A few sustainable practices at the brewery include sourcing for their raw materials, like malted barley locally and their spent grains from the brewing process are sent to farms to be used as animal feeds. They are planning to purchase their energy from an energy provider that sells renewable sources energy (Bullfrog). The brewery tends to conserve water by recovering and reusing water where possible. The brewery's future sustainability projects includes installing solar panels, increasing the percentage of their waste diversion from landfill, and becoming a more efficient brewery.

# Chapter 7 **Interview Results and Analysis**

Within this chapter, the results from interviews with craft breweries will be disclosed. The analysis will focus on identifying key elements, and emerging themes communicated through interviews.

## 7.1 Interviews with Alberta Craft Breweries

The semi-structured interview questions have four distinct categories that consider different topics. The categories are (i) size of the firm, (ii) their view of Alberta craft brewing industry, (iii) existing sustainability management practices, and (iv) future sustainability management practices. The perceptions and knowledge shared by participants brought considerable insight into the interests of craft breweries regarding sustainability. The responses from each category of questions will be considered to communicate and analyse the rich data collected through the ten interviews. The interview questions are found in Appendix A.

### 7.1.1 *Size of the Firm*

All ten craft breweries interviewed have numbers of employees in the 1-50 employees category. This already shows the size of operations in Alberta craft brewing industry. Compare this to big craft breweries in the United States like Sierra Nevada Brewing Co. and New Belgium Brewery with 500-1,000 employees. Next, was a discussion about each brewery's annual volume of beer production. Table 4 summarizes the size categories of participating breweries, this shows the size of operations in Alberta craft brewing industry.

Table 4: Size Categories of Participating Breweries

| Size Category | Number of Breweries |
|---|---|
| Below 5,000 hl | 6 |
| 5,000 – 10,000 hl | 3 |
| Over 10,000 hl | 1 |

Compare this to Sierra Nevada and New Belgium annual beer production of 1.4 million hectolitres and 1.1 million hectolitres respectively (New Belgium, 2020; Sierra Nevada, 2020).

Big Rock Brewery, the biggest craft brewery in the Province, has an annual production of 201,577 hectolitres (Big Rock, 2018).

### 7.1.2 *Alberta Craft Brewing Industry*

The passion of craft brewers is at the heart of the craft beer industry along with an evolving clientele. One of the things observed about craft beer customers is that they like to have a bit of an adventure; it's an experience for them when they drink a craft beer. There are stories behind the beer, there are real people behind the craft beer. All participants offered great insights into the dynamic beer industry, and offered their perspective on the relationship between craft breweries and the macrobreweries. They offered insights into the origins of craft beer and what the perceived trajectory of the industry was in its infancy.

Brewers are competing against an increase of wines, and distilled spirit manufacturers. They have slowly seen the demographics moving away from beer towards wine and spirits. Craft breweries are undoing this big problem; in that craft beer is creating excitement and interest in beer again. The different styles and different flavour profiles is what has ultimately pushed people to be very interested in craft beer. All participants believe the craft segment is still growing and they foresee new craft breweries opening up in the Province, but not at the rate it did in the last five years. There is a societal trend towards small, local, handcrafted goods, which fits nicely into the ethos of craft beer.

Many participants cited in this report did not overtly express concern about the threat from large brewers. Though many large brewers are investing in the craft flavours, they are either creating brands or are acquiring already successful craft brands. With regards to competition among craft breweries, though they acknowledge competitions especially in bars for tap handles, there is a togetherness among craft brewers, and they try to help each other out in any way they can. Craft brewers do collaborate; different craft breweries do come together to make collaboration beers.

### 7.1.3 *Existing Sustainability Management Practices*

This category provides knowledge on existing sustainability practices within the craft breweries in Alberta. One has to know what is currently being done to manage sustainability or improve sustainability performance. There are commitments from the craft breweries to engage in sustainability practices. Though some have no designated position to manage

sustainability, there is commitment to sustainability management from top-level decision makers. Some craft breweries do track some metrics through quality management. Some do measure their energy use and water use, and track their $CO_2$ usage. They identified water, energy, carbon use, and solid waste as important sustainability indicators. Utility bills were identified as a source of data collection by all participants. Some breweries identified in-house flowmeters to track water usage. But most breweries don't track wastewater volume. Below are the emerging sustainable practices gathered by the interviews with craft brewers that craft breweries are engaged in.

#### 7.1.3.1 *Energy*

Energy Efficiency: For electric lighting, most breweries have upgraded all their lighting to LED.

Green Energy: As a way of reducing their emissions footprint and support the growth of renewable energy, most breweries purchase their energy from green energy provider like Bullfrog Power.

Heat Exchanger: Most participating craft breweries utilizes heat exchanger to recover and recycle heat. It is an energy efficient brewery equipment designed to quickly raise or lower the temperature of wort or beer. Hot wort at approximately 95°C is run through a heat exchanger, where it is cooled by cold water and/or a refrigerant coming along the reverse side of the plate in the opposite direction. The wort becomes cooled (e.g. to 12°C) and ready for fermentation, and the cold water is heated to perhaps 80°C and is returned to a hot water tank, ready to be used in the next brew or elsewhere in the brewery.

#### 7.1.3.2 *Water*

Water Saving Strategy: Most breweries focus on reducing direct water usage by reusing or recycling water, monitoring and measuring water usage and fixing leaking faucets.

Clean-In-Place System (CIP): Most breweries use a CIP system, which is generally more efficient than manual cleaning. It reduces water consumption and high level of automation is possible.

Air-rinsing System: One of the participants mentioned the brewery uses an air-rinsing system in their canning line to get the dust out by ionizing the air. This eliminates the need for water rinsing.

Water-to-Beer Ratio: Typically, the water-to-beer ratio of most breweries is 5 hl/hl. That's five hectolitres of water to make one hectolitre of beer. Among the participating breweries, the lowest water-to-beer ratio was 4.8 hl/hl and the highest 7 hl/hl.

#### 7.1.3.3 *Solid Waste*

Spent Grains: Virtually all breweries interviewed send their spent grains to local farmers to be used as animal feeds.

Recycling Program: Most breweries have an excellent recycling program; the brewery waste gets separated into different streams and there is a lot of waste that gets recycled. One of the breweries mentioned sending their empty grain bags to where they can be recycled into tote or shopping bags. All these recycling program increase waste diversion from landfills.

#### 7.1.3.4 *Carbon Use*

Nitrogen Generator: One of the breweries has an onsite nitrogen generator. The nitrogen is used for purging tanks instead of $CO_2$. This reduces truck deliveries of $CO_2$ to the facility and the associated environment and financial cost.

#### 7.1.3.5 *Social Sustainability*

As mentioned earlier, there is togetherness among craft brewers, and they try to help each other out in any way they can. They also seems to know each other. During the interviews, if another brewery was mentioned, the interviewee often knew the people in that other brewery by name. Alberta brewers display a remarkable level of interfirm cooperation and this creates a sense of solidarity among craft brewers in the region. There is also a close relationship between craft breweries and local businesses. From discussion with craft brewers, most of their raw materials are sourced locally; this benefits local businesses. They also build relationships with local arts and food businesses. This partnership with local establishments foster sales for both businesses and provide jobs within the community. Craft breweries organize social events in their communities, they hold theme events, promotions, or tasting often. Large scale events are also organized by the Alberta Small Brewers Association.

One of the participating brewery will be starting an employee ownership plan, in which all the employees have an opportunity to own part of the business, through an Employee Stock Ownership Plan (ESOP). The brewery aspire to be 100% employee owned.

### 7.1.4 *Future Sustainability Management Practices*

Generally, craft breweries focus more on best practices, as a way to become more sustainable, than investing in sustainable technologies. Some of the barriers stopping craft breweries from investing in bigger technology, like installing solar panels and anaerobic digesters, is the huge capital, long payback period, lack of expertise and the size of the brewery. Below is the summary of these technologies and feedback from participants.

$CO_2$ Recovery System

Due to the size of most craft breweries in the Province, the $CO_2$ recovery system is not meant for breweries their size, it is made for larger breweries and industry. The production capacity of most craft breweries in Alberta is small compared to large craft breweries like Sierra Nevada and New Belgium, so they generate relatively low $CO_2$. This will make the payback time of such technology to be more than 10 years. It cost $500K to install a $CO_2$ recovery system; this is highly capital intensive for local breweries.

Wastewater Treatment (Anaerobic Digester)

As mentioned earlier, anaerobic digester are used to treat brewery wastewater and their methane rich gas can be recovered and used as fuel for boilers. The response from participants regarding this technology is same as the $CO_2$ recovery system. It is capital intensive; their brewery is too small at the moment to invest in such technology and it has a long payback period. Most of them will only consider this technology when their brewery expands and gets bigger. They also mentioned lack of expertise as a barrier, one of the participating breweries has just five employees that brew, package and run their taproom.

Solar Energy

Among the huge capital investment technologies, solar energy was generally more appealing to most craft breweries. Most of them considered installing solar PV on the roof of their buildings and some considered solar thermal technology to heat up the brewing water and

reduce use of natural gas. The barrier of investing in solar technology is that most craft breweries don't own the building they are in.

### 7.2 *Conclusion- Emerging knowledge from breweries*

Excellent quality data was collected through interviews with the ten participating craft breweries. The following important concepts and perceptions have emerged:

- Energy, water, solid waste, carbon use, and social aspect are important sustainability indicators.
- There is significant room to improve sustainability practices.
- Most breweries could not afford capital intensive sustainable technologies.
- There is interest from participants to become more sustainable.
- Craft breweries focus more on industry best practices, than investing in technologies.
- No craft brewery has considered treating their wastewater.
- Craft breweries are looking at investing in solar energy.
- There is comradery and collaboration among craft breweries and the local community.

# Chapter 8 **Conclusion**

## 8.1 Conclusions

A definition for “best in class” for craft breweries is an evolving target. The craft brewing industry in Alberta has grown rapidly over recent years. This growth is still ongoing as breweries are still opening, expanding and learning both as they go and by helping each other and seeking advice from professionals within the industry.

This report shares insight on key performance indicators (KPIs) and best practices of sustainable brewers. It also represents the participation of ten breweries within Alberta, in sharing their existing sustainable practices and their future sustainability projects. Five sustainability indicators was identified, which includes: water, energy, solid waste, carbon use, and social aspects. New Belgium and Sierra Nevada breweries have created overarching best practices to improve the efficiency of the brewing process that small craft breweries can strive for. Craft breweries across Alberta have the potential to improve the efficiency of brewing processes, with the implementation of sustainable brewing techniques.

The major barriers that craft breweries faced in the implementation of sustainable technologies have been identified. They include a financial resource barrier, time, and knowledge barrier. This capstone project did provide an informative view of Alberta’s craft brewing industry and their sustainability practices. The literature review, content analyses, and interviews all identified and shared brewery best practices that are driving best in class performance metrics.

## 8.2 Contributions

This capstone project research has made contributions to academic knowledge by developing a benchmark among craft breweries in Alberta to determine the existing sustainable practices and what they can do as an industry to improve. Several sustainability indicators were identified- water, energy, solid waste, carbon use, and social aspects. Findings identified that there is significant room for Alberta’s craft breweries to improve their sustainability performance. Craft breweries in the Province do have interest in sustainability.

## 8.3 Recommendations

### 8.3.1 *The Sustainability Journey*

As a craft brewery matures, certain aspects of the business will become more efficient. This period of learning can be a particularly vulnerable time for a new craft brewery. The faster the craft brewery can master the learning curves associated with their products, the faster they can become profitable and efficient. Reviewing industry best practices publications and information sharing can quickly aid craft breweries in taking early actions with immediate payback. One of the first thing on a craft brewery's "to do" list should be optimizing operational performance. They should begin by carrying out water, energy, and solid waste audits and install metering capabilities.

### 8.3.2 *Green Power and Renewable Energy*

Before looking at renewable energy, craft breweries should first work on improving efficiencies within operations. After improving operational efficiencies, a renewable energy feasibility screening can be conducted. A simple way to determine the basic potential of renewables at a brewery is conducting an initial technical and economic feasibility screening.

Macrobreweries like Labatt and Molson Coors are more likely to invest in renewables and wait for the payback. New small craft breweries may not at the moment be able to make these kinds of investment in renewables, as there are other demands for growth and quality improvement. Renewable technologies are not the only source of sustainable energy that is available to craft brewers. It can be costly for small craft breweries to install solar panels, but they do have an option to purchase green power to help offset emissions from operations. Four craft breweries out of the ten participating breweries purchase green power from Bull Frog, which is a leading green energy provider. This means that the breweries' electricity come from sustainable sources such as solar or wind.

### 8.3.3 *Wastewater treatment*

Craft breweries in the Province don't track wastewater volume, and they do not treat their wastewater. Wastewater disposal still remains an environmental and economic hurdle that directly affect breweries. With 120 craft breweries operating in the Province, you can only imagine the havoc they are making on the municipal wastewater treatment plants. Its just a matter of time before there will be strict restrictions or surcharges.

Sierra Nevada brewery is located in California that has a water crisis. This tends to push them to find innovative ways to reduce their water consumptions and also treat and recycle their wastewater. Whereas in Canada, water cost is cheap; all utilities in general are relatively cheap. You know the saying “necessity is the mother of invention”; it might take only the Provincial Government to push breweries to become more sustainable through regulations and surcharges, and through providing incentives to help reduce cost of sustainable technologies for breweries to treat their wastewater, as well as reduce their energy use and GHG emissions.

### 8.3.4 *Carbon dioxide Recovery System*

No craft brewery in the Province reported that they capture and reuse $CO_2$. It is the larger craft breweries like the Sierra Nevada and New Belgium that capture and reuse $CO_2$. Aside from the high cost of installing a $CO_2$ recovery system, it is possible for craft breweries with small production volume to invest in the $CO_2$ recovery systems, it will only take a longer payback period. The $CO_2$ recovery system, however, should be evaluated on a facility-specific basis. Breweries should look at other innovative technologies, with lower cost and shorter return on investment- like the use of onsite nitrogen generator. Nitrogen is used in purging tanks instead of $CO_2$; this reduces the $CO_2$ use in the brewery. One of the participating breweries does have an onsite nitrogen generator.

### 8.3.5 *Employee Culture*

An employee culture of operating with environmental stewardship in mind and a core focus on sustainability should be formed. A robust new employee orientation program should be developed, in order for their employees to hit the ground running on sustainability initiatives. There should also be training for departments to enable them to achieve their sustainability goals.

## 8.4 Limitations and Recommendations for Future Research

This capstone project had some limitations. Limitations impacting research will be revised and future research suggestions will be made.

All stakeholder groups were not considered in this research. Interviews were limited to ten breweries out of 120 breweries in the Province. Other emerging data were from content analyses and literature review.

Future research may be directed towards identifying best practices in relation to the size of brewery. From the interviews with craft breweries, they talked about their size of operations. The small size of breweries create barriers for implementing some sustainable projects like $CO_2$ recovery systems, rendering them not feasible. Identifying sustainable projects that match different brewery sizes would be helpful to guide craft breweries through growth.

Future research may also be directed towards getting quantitative data from breweries and using a sustainability benchmarking tool to analyze breweries' natural resource consumption. To achieve this, they need the support of Alberta Small Brewers Association.

Future research may be focused on the economic attributes. Looking at the environmental and social attributes at a brewery is very important, but the economics of implementation is equally important.

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**Appendix A: Interview Questions**

Category 1: Size of the Firm

i. Number of employees
ii. Annual volume of beer production

Category 2: View of Alberta craft beer industry

i. What threats do craft breweries face?
ii. Who are your competitors?
iii. What makes a successful craft brewery?
iv. There is a trend of big breweries acquiring small craft breweries (e.g. Sleemans acquire Wild Rose, Labatt acquire Banded Peak) what's your take on the matter?
v. What is the growth potential of the craft segment?

Category 3: Existing Sustainability management practices

i. What are the current sustainability practices, that your Brewery is currently doing? Do your brewery do any of these:

- Solar panel installation
- Using an anaerobic digester to treat brewery wastewater and using the produced methane rich gas for electricity production?
- $CO_2$ Sequestration from fermenters?
- Changing packaging to use less plastics, etc.?

ii. Do you reuse yeast?
iii. What do you do with the spent grains, and residual yeast?
iv. How does your brewery dispose of wastewater? (Do you treat it?)
v. What's the energy consumption of your brewery (kWh/hl)
vi. What's the brewery water-to-beer ratio?
vii. What's the brewery wastewater-to-beer ratio
viii. What's the wastewater-to-beer ratio?
ix. Does your brewery measure/monitor water use?

x. From where does your brewery purchase energy (energy provider)?

Category 4: Future sustainability management practices

i. What are the future sustainability practices your brewery wants to look into? (Sustainability goals)
ii. What is the drive for your brewery to focus on sustainability? Garner a good public image, save money long term, concern for the environment?
iii. What are the barriers stopping your brewery not to engage in more sustainability practices?