Please Enjoy Sustainably:
New Ideas for Olde Saratoga Brewing Co.

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Abstract

The brewing of beer is an extremely resource-intensive process. Between importation of ingredients, the many phases of the brewing process, and distribution of the final product, the brewing industry demands significant energy and resource input. As the craft brewing industry swells, many craft brewers across the nation are attempting to mitigate their environmental impact. This paper investigates current sustainability practices and efficiency measures in craft breweries large and small, and uses the findings to inform an action research plan for Olde Saratoga Brewing Company. We inform Olde Saratoga of existing environmental initiatives and recommend feasible strategies for them to reduce energy and resource use. Our suggestions primarily stress process efficiency.

Key words: Craft brewing industry; Environmental sustainability; Energy efficiency

INTRODUCTION

Purpose Statement

The purpose of this study is to explore environmental sustainability incorporated in the craft brewing industry and present an action research plan for Olde Saratoga Brewing Company in Saratoga Springs, NY. With an understanding of existing strategies and innovations in sustainability, this project investigates and recommends potential tactics for Olde Saratoga to reduce their environmental impact while enhancing their efficiency and potential profits.

Sustainable Business

With mounting concern for the state of the environment, companies and corporations worldwide are re-evaluating their business strategies with attention to ecological sustainability (Dyllick & Hockerts, 2002). Businesses are seeking to reduce their carbon footprint by decreasing CO2 emissions, solid waste production, and their consumption of resources. Efficient management of resources has both environmental and economic benefits, and there is additional incentive from the growing profitability of accessing emerging eco-conscious markets (Gilg, et al., 2005). The incorporation of environmental consciousness into production and business models has presented a window for product specialization, allowing companies to gain a competitive edge by advertising their responsibility concerning environmental issues.

Sustainability and environmental consciousness are lumped under the broader notion of *corporate social responsibility* (Dahlsrud, 2006). Industries that derive profits from the commodification of natural resources are faced with the challenge of mitigating the impacts of their business. New regulations and policies have arisen from the growing salience of issues regarding the intersection of commerce and the environment. Many companies adhere to an environmental ethic voluntarily and are recognized for doing so. Examples of companies like this include Patagonia, Subaru, Dupont, Unicore, and Westpac.

Some businesses see compliance with environmental regulations as an opportunity. With the prioritization of efficiency, investment in renewable energies, waste reduction, and the development of more comprehensive business models, companies find themselves at a competitive advantage socially, environmentally, and economically (Nidumolu, Prahalad & Rangaswami, 2009). Being a *green business* can help a product to stand out in the marketplace, and "Maintaining a presence in the local green community helps to differentiate the firm in an increasingly crowded field" (Andreas et al., 2011). Green businesses are transcending traditional cost-benefit economics and incorporating strategies that defend their *triple bottom line* (environment, economic, and social concerns) (Elkington, 2004; Willard, 2002).

In an attempt to progress sustainably, some businesses are integrating production methods of *industrial ecology*. Industrial ecology theory aims to improve the relationship between industrial processes, market mechanisms, and the environment. The industrial ecology framework serves to "Identify and then implement strategies to reduce the environmental impacts of products and processes associated with industrial systems, with an ultimate goal of

sustainable development" (Garner & Keoleian, 1995, p. 2). Industrial ecology is a powerful tool for increasing efficiency through reduction of waste output and energy consumption (Figure 1).

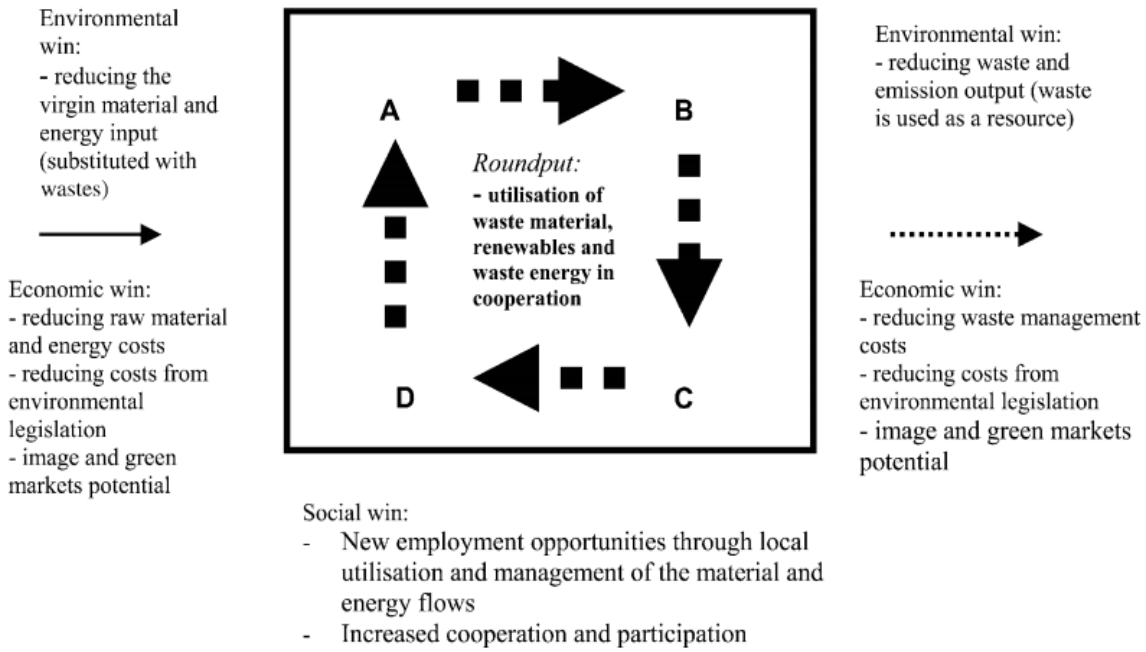

Figure 1. Social, economic, and environmental benefits of incorporating an industrial ecology model (Korhonen, 2004)

Craft Brewing Industry

The Brewers Association (2012) defines craft breweries as small, independent, and traditional. This refers to any brewery that has an annual production of less than 6 million barrels, is less than 25% owned by a non-craft brewery, and uses traditional methods of brewing in their production. All of the breweries discussed in this paper produce less than 1 million barrels annually and fall under the definition of a craft brewery.

Sustainable business models are especially instrumental when applied to resource-intensive procedures such as the brewing of beer (Figure 2). Massive quantities of water are required to produce a relatively small volume of product. For every barrel of beer produced, three to ten barrels of waste effluents are generated, with the national average around 7 barrels. (Olajire, 2012). Figure 2 provides an overview of the brewing process. The process can range in complexity from very small 10 bbl brewpubs to the industrial scale mega-breweries. The energy intensive procedure begins with the mash, where milled grains and water are combined to extract the fermentable sugars from the grain. The liquid wort (unfermented beer) is then separated from the grain and moved to the boil kettle. The grain is transferred to the lauter tun, where water is added a second time to rinse the grain of its residual sugars. The wort from this part of the process is then added to the kettle to achieve the boil volume required. Here, the wort is boiled for at least an hour and the hops are added to increase bitterness. This is the most energy intensive part of the entire process, as a significant amount of fuel is required to heat the large quantity of liquid and maintain a rolling boil. The wort is then cooled, which is usually done with

the help of heat exchangers. Cold water is pumped through coils in massive quantities to cool the hot wort to fermentation temperatures. Once cooled, the wort is moved into fermentation chambers where the beer matures and yeast are added to convert the sugars into alcohol. For lagers and certain varieties of ales, fermentation must occur at relatively low temperatures which requires further cooling. The finished beer is then either filtered or goes directly to bottling or kegging. It is important to note that sanitization represents a major source of water input throughout the entire process. The process requires a relatively large amount of solid and liquid inputs for the amount of produce produced, and uses significant energy inputs to maintain temperatures. The amount of solid waste generated during each brew session includes the spent grain from the mash, the yeast trub from fermentation, and hop debris from the boil.

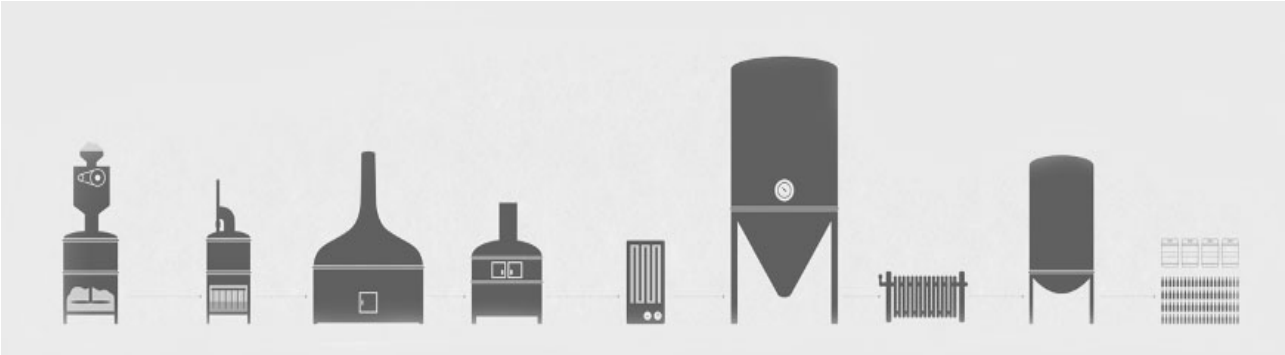

Figure 2. The brewing process. From left to right: Grain mill and mash tun, lauter tun, brew kettle, whirlpool kettle (to remove hop and protein debris), heat exchanger, fermentation tank, filtration, bright beer tank (to clarify finished beer), and bottling and kegging. Image provided by Abie McLaughlin (2014).

The entire brewing process requires a tremendous amount of energy for heating and cooling (Olajire, 2012). The process is very carefully thermally regulated, as precise temperature ranges must be achieved during different phases. The yeast is particularly sensitive to temperature change, and the difference of just a couple of degrees can change the flavor of the beer (Verstrepen et al., 2003). The specific statistics of energy use vary on type, size, and capacity of each brewery. A brewery often measures its electrical usage in kWh per barrel of beer produced. One example of a brewery that does this is Sierra Nevada, a relatively large and energy efficient craft brewery, which uses 15.3 kWh per barrel. Smaller breweries or breweries less aware of their energy usage likely have a greater kWh/barrel ratio. Table 1 illustrates the percentages of purposes and sources of electricity used in the brewing industry according to a 1997 report from the Energy Information Administration. Machine drive and process cooling represent the largest draws of energy. Boilers use a comparatively small amount of electricity because they operate on gas.

Uses	Million kWh	Percent (%)
Boiler/hot water/steam generation	59	2
Process cooling/refrigeration	943	32
Machine drive (pumps, compressors, motors)	1360	46
Facility heating, ventilation, air conditioning (HVAC)	201	7
Lighting	214	7
Other	198	7
Total	2975	100
Sources	Million kWh	Percent (%)
Purchases	2323	78
Cogeneration	644	22
Other (on-site generation)	8	0
Total	2975	100

Table 1. Uses and sources of electricity in the brewing sector (Olajire, 2012)

On top of the energy inputs that occur to produce the beer, acquiring ingredients often requires importation of goods from around the world. Grains and hops have become very specialized with the growth of the craft brewing movement, and different regions offer distinct flavor elements to the craft brewer. The availability of diverse products enhances the creative freedom of the modern brewer, but also signifies the globalization of a previously regionally unique industry (Ebneth & Theuvsen, 2008).

After brewing and fermentation, beer is bottled or kegged, sometimes pasteurized, and ultimately distributed. Breweries move product all over the country, as different regions become popularized for specific beers. Distribution, often delegated to a third party, represents another immense investment of energy. Because of the economic investment required for packaging and distribution, some breweries opt to vend their product on site. Brewpubs are breweries that distribute their product in-house, and they generally do not have to deal with challenges of distribution. The density of brewpubs has been increasing rapidly in recent years, following the trend established by microbreweries (Figure 3).

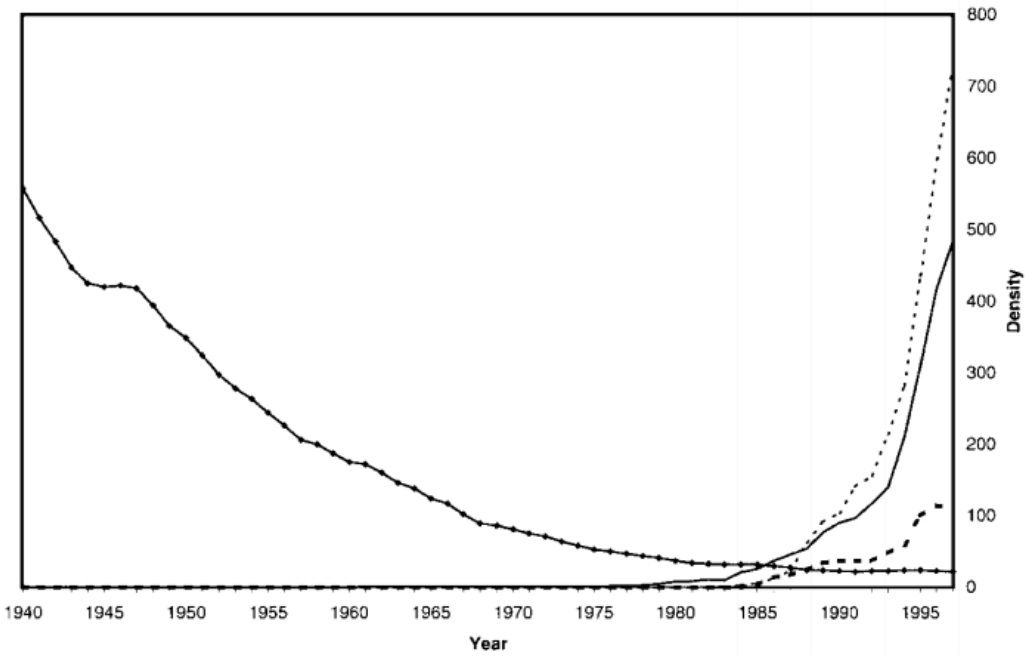

Figure 3. Major trends in the greater brewing industry. Connected dots = mass producers; solid line = microbreweries; thin dotted line = brewpubs; heavy dashes = contract brewers (Carroll & Swaminathan, 2000)

Economic Impact of the Craft Brewing Industry

In 2012, small and independent craft brewers contributed $33.9 billion to the US economy between breweries, wholesalers, and retailers (Brewers Association, 2012). This widespread industry also provided over 360,000 jobs throughout the country, with one third of these jobs directly at breweries and brewpubs. On the state level, New York craft brewing has the third highest output, grossing $2.2 billion in economic impact and employing over 20,000 people (Brewers Association, 2012).

Aside from economic contribution and job creation, craft breweries also promote tourism and support local agriculture. In June 2012, Governor Andrew M. Cuomo passed three pieces of legislation in New York to keep the craft brewing industry competitive, ensuring that it will continue to support the economy and add jobs. The bill states that a brewery producing less than 60 million gallons of beer will be eligible for refundable tax credits. Both in-state and out-of-state breweries that produce less than 1,500 barrels will be exempt from the fees associated with brand label registration (Brewers Association, 2012).

Lastly, this bill created the Farm Brewery License. This piece of legislation incentivizes breweries to source ingredients locally and aims to improve New York's agricultural sector. In order for a brewery to receive the license, their beer must source 20% of hops and 20% of other ingredients locally grown or produced in New York State from now until the end of 2018. From January 1, 2018 to December 31, 2023, at least 60% of hops and 60% of local ingredients must be New York State produced, and after January 1, 2024, no less than 90% of hops and all other ingredients must be grown and/or produced in New York State. In February 2014, Governor Cuomo announced that there are currently 26 licensed farm breweries in New York. He also

announced a 133% rise in amount of microbreweries in the state, from 40 in 2011 to 93 in 2014 (Office of Governor Andrew M. Cuomo, 2014).

Sustainability in Craft Brewing

Thermal regulation, waste and effluent generation, and distribution methods have been labeled as key categories to be assessed in the ecological overhaul of a brewery (Olajire, 2012). Olajire (2012) portrays the multifaceted environmental concerns of breweries and applies the idea of *Cleaner Production* to the brewing industry. The research stresses energy efficiency, emission reductions, water and thermal recycling, and prevention of losses as broad strategies for addressing sustainability issues. Olajire (2012) argues that high-production facilities can reduce energy consumption by 20-50% without investing in new equipment.

Muster-Slawitsch et al. (2011) coined the *Green Brewery Concept* in their demonstration of energy efficiency measures across three case studies – breweries seeking to reduce fossil fuel emissions through a focus on thermal efficiency in the brewing process. The authors explain, "The Green Brewery Concept includes detailed energy balancing, calculation of minimal thermal energy demand, process optimization, heat integration, and finally the integration of renewable energy based on exergetic considerations." (Muster-Slawitsch et al. 2011). The paper provides an extensive plan for developing sustainability in breweries and is applicable to breweries of every size.

Other papers have contemplated the generation of biofuels from brewery waste products to help meet energy demands. Zupancica et al. (2012) examine the feasibility of anaerobic co-digestion of brewery yeast and wastewater for biomethane production. Sturm et al. (2012) have examined the practicality of fuel generation from bio-wastes in small-scale breweries, which have limitations unique to their size of production.

Three common sustainability initiatives of the craft brewing industry are the recycling of materials, water and heat reclamation, and the greening of energy sources. The recycling of packaging is a low cost initiative. This is one of the easiest actions a brewery can take in developing eco-friendly practices, and represents the broader goal of establishing themselves as a more sustainable company. Spent grains can be recycled at no cost by giving them to local farmers for livestock feed. Water reclamation falls into the same broader category of recycling, and addresses one of the most wasteful issues. Some modern craft breweries will repurpose wastewater to be reused later in the brewing process. For instance, water used to cool the wort can be used later for sanitization. Recycling inputs is a relatively affordable way to reduce resource use.

In contrast, the process of greening a brewery's energy sources requires high investment up front, with a long-term payoff period. Many larger craft breweries, including Sierra Nevada, New Belgium, and Uinta have made a commitment to using solar energy, wind energy, and hydrogen fuel cells to reduce energy costs and their dependence on fossil fuels. Installing solar panels on site at the brewery, or developing a plan to be completely off the grid is an expensive choice, but breweries are making the jump for environmental and economic reasons. It is becoming increasingly common to see initiatives like these across the country as environmental

consciousness grows and sustainability becomes an essential component of craft brewing business models (Kleban and Nickerson, 2011).

METHODS

The purpose of this study was to perform case studies informing sustainability initiatives in the national craft brewing movement and to devise an action research plan for Olde Saratoga Brewing Company in Saratoga Springs to help them to become a more sustainable brewery (Brydon-Miller, et al., 2003; Yin, 2009) With the findings of our comprehensive review of current sustainability practices within both mega and microbreweries and an investigation into the topics of industrial ecology and sustainable business, we were able to complete our action research plan and case studies within the context of the craft brewing movement of the United States.

Research Questions Guiding This Study

1. To what extent is the national craft brewery movement incorporating sustainability practices into their business strategies?

2. How can Olde Saratoga Brewing Company in Saratoga Springs incorporate more sustainable practices?

3. How can we help Olde Saratoga Brewing Company to increase their social prestige and economic profitability through enhanced sustainability?

Population and Setting

Saratoga Springs is located roughly 35 miles north of Albany, NY. Though the 2012 census data estimates a permanent population of 26,960 people across the 29 square miles, the city's population swells in the summer. The 'Spa City' attracts tourists with its renowned equestrian season at the Saratoga Race Course. The race course contributes significantly to the economy of Saratoga Springs, and many of the cities decisions are determined with this industry in mind. Not surprisingly, many of the major businesses rely heavily on the increase of traffic and revenue that is associated with the horse-racing season. Other major tourist attractions include the National Museum of Dance and the Saratoga Performing Arts Center. Saratoga Springs is also the hometown of Skidmore College, a liberal arts school with a student body of roughly 2500. According to the 2010 census data, over 90% of Saratoga Springs residents are classified as 'White', and approximately 3.2% are Hispanic or Latino, while 2.6% are African American.

Instrumentation, Sampling, and Data Analysis

Our research team consisted of three students, Jack Marston, LJ Combs, and Rebecca Schwartz, under the supervision of one faculty advisor, Andrew J. Schneller. The data for this study was collected over an eight-month period from 2013 to 2014 (September, 2013 to April, 2014).

To learn about the environmental movement within craft breweries nationwide, we conducted extensive research of existing literature on the topic and obtained archival data from the websites of organizations such as Brewers Association, New York State Brewers Association, and Northeast Hops Alliance. We also explored the websites of many breweries, most notably Sierra Nevada Brewing Company, The Craft Brew Alliance, Uinta Brewing Company, and Magic Hat Brewing Company, because these four breweries have established environmental sustainability initiatives and provide annual reports on their websites for the use of the public. We conducted 14 semi-structured interviews (Creswell, et al., 2003) with various brewmasters, sustainability coordinators, hops farmers, and industrial ecology professionals (Appendix B). Interviews began in February 2014 and were conducted through April 2014. Interview questions were designed to gather an understanding of breweries' perceptions of: environmental impacts associated with their methods of production, significance of taking action to mitigate potential impacts, actual strategies considered or implemented for environmental sustainability, and obstacles faced in their implementation. Ten of these interviews were with breweries: Druthers Brewing Company, Olde Saratoga Brewing Company, Craft Brew Alliance, Sierra Nevada Brewing Company, Brewery Ommegang, Saranac, Peak Organic Brewing Company, Uinta Brewing Company, St. Lawrence Brewing Company, and Paradox Brewery. Six out of ten interviews with breweries were conducted over the phone, three were conducted on site at the breweries, and one brewery requested questions sent through email, to which they responded with detailed answers and attached their 2012 Sustainability Report. Interviews with Druthers, Paradox, and Olde Saratoga were conducted on site. We also conducted an interview with hop farmer Laurie Ten Eyck, NY hop industry specialist Steve Miller of the Madison County Cornell Cooperative Extension, Eric Fitch of PurposeEnergy, and Heidi of the Fort Ann Biodigester project. All interviews were recorded using an iPhone or MacBook and the GarageBand application. Interviews were then transcribed for analysis.

On February 22, 2014, we attended the third annual Saratoga Beer Summit at the Saratoga Springs City Center featuring over 70 national breweries and approximately 3000 attendees. We attended this summit for two reasons: to survey patrons and to establish connections with national craft breweries. We handed out 100 printed surveys for craft beer enthusiasts with questions related to sourcing local hops and grains, energy and resource saving practices, and general environmental sustainability in the craft brewing movement (see appendix A). The survey had eight questions related to these topics, and participants were asked to rate their answers using a scale of 1 (strongly disagree) to 10 (strongly agree). These surveys were conducted in order to gauge the importance of environmentally sustainable brewing practices to those purchasing and consuming craft beer.

After surveying participants, we approached individual brewery's tables, explained our project, and exchanged contact information with about 20 breweries. The following week we contacted every brewery to arrange meetings. Eight breweries responded and we conducted interviews with all of them.

Qualitative Data Analysis and Limitations

After interviews were collected and recorded, they were transcribed into Word documents for analysis. We organized interview results by question for side-by-side comparison

between breweries. We also grouped efforts of local breweries into different subsets of sustainable practices. Analysis was conducted to determine the most widespread sustainability initiatives in the breweries we analyzed. The purpose of this was to help us better understand the practices of the general movement and assess the practices of local breweries in a broader context. Survey data was placed into a separate Excel spreadsheet for statistical analysis.

Limitations of this study include: number of breweries visited and/or interviewed, willingness of breweries and other informants to divulge information concerning capital specifics, time and resources available to visit regional breweries, and length and thoroughness of study. Distribution is a topic that remains relatively unstudied. There are many craft breweries in the nation that we did not contact or research. Our case studies represent a small cluster, which we used to extrapolate the current practices available. Furthermore, our modesty as students and amateurs in the brewing community withheld us from becoming further involved with our main stakeholder, Olde Saratoga. With greater expertise and knowledge of the field, our level of involvement with the brewery could expand. Instead, we took care to avoid being invasive. Much of the existing literature pertains to larger breweries.

RESULTS AND DISCUSSION

Consumer Survey

The results of the 100 surveys completed during the Saratoga Beer Summit show that craft beer consumers in the Capital Region are primarily concerned with where the ingredients for the beer they are consuming are produced. Responses are based on a scale of 1 - 10 with 10 being the highest. Environmental ethic is strong among this consumer group, as an average score of 8.16 was given when asked how important environmental sustainability was to them. A list of the statements and representative responses is found below in Table 2:

Statement	Avg. Score	Error (+/-)
Environmental sustainability is important to me.	8.16	0.17
A brewery's commitment to sustainability influences my choice of beer.	5.84	0.24
I would be more inclined to purchase/consume beer from a brewery that has a strong commitment to sustainability.	6.51	0.23
I would be more inclined to purchase/consume beer from a brewery that promotes and advertises energy and resource saving practices.	6.72	0.22
I would be more inclined to purchase beer from a local or regional brewery.	8.74	0.12
I would be more inclined to purchase beer from a brewery that uses locally sourced materials (hops and barley).	8.35	0.15

Table 2. Saratoga Beer Week consumer survey responses (n = 100)

Survey responses show that consumers are most enthusiastic about purchasing craft beer from a local brewery, and/or a brewery that uses local ingredients. A brewery's commitment to sustainable practices seems to matter less, but consumers are slightly more inclined to support a brewery that has a commitment to sustainable practices. These results are consistent with the second part of the survey, in which consumers reveal that they are willing to spend more money per six-pack on beers utilizing local ingredients and less willing to spend more money on beer produced a brewery with energy saving initiatives. 88% of respondents would be willing to spend more on beer produced with local ingredients, while 60% of respondents would be willing to spend more on beer that advertises energy and resource-conserving practices.

Compilation of Sustainability Initiatives from National Craft Breweries

Breweries across the nation are taking environmental consciousness to the next level and making significant strides in sustainability by reducing their environmental impact and in turn, saving money. The data below details the innovative initiatives implemented by craft breweries around the country today:

Recycling – glass, cardboard, aluminum, plastic

Saranac, Sierra Nevada, and New Belgium all boast recycling rates of solid waste over 98% (R. Michaels, personal communication, February 28, 2014; Sierra Nevada, 2012; New Belgium, 2013). This figure includes the donation of spent grains to farmers for livestock feed and the composting of spent hops, but these breweries also repurpose shipment sacks and other packaging materials, pallets, paper and cardboard products. Removing spent grains and yeast from the equation, Sierra Nevada still diverts 94.6% of solid waste from landfills (Sierra Nevada, 2012). They are working towards zero waste, zero landfill. Uinta ships glass, which cannot be recycled in their home state of Utah, to neighboring states to be repurposed (S. Kuftinec, personal communication, March 3, 2014).

Efficient Design – efficiency in equipment

A common initiative in breweries of all sizes is thermal recycling. St. Lawrence Brewing Company is just one example of using plate heat exchangers to cool wort before fermentation, returning heated fluids to the hot liquor tank. Plate heat exchangers are considered standard installments in the brewing process. St. Lawrence also recovers heat from the steam of the hot liquor tank and uses it to preheat water going to the hot liquor tank (K. Hebb, personal communication, March 6, 2014). Sierra Nevada captures heat from their hydrogen fuel cell generator's 750° F exhaust (Sierra Nevada, 2012). In addition to recycling heat input, Saranac uses the New York winter to help with their cooling demands. They have cellars that are not refrigerated in the winter, and have a keg cooler that is naturally cooled, drawing cold air from the outside (R. Michaels, personal communication, February 28, 2014). Sierra Nevada has a real-time electricity monitoring system in place, and has reduced their kWh/barrel from 19 kWh to 15.3 kWh in the last five years (Sierra Nevada, 2012).

Energy efficiency is a large topic in existing literature pertaining to the environmental challenges of the brewing industry. With so many phases in the brewing process, different pieces of equipment, and such a large energy demand, there countless measures that can be taken to address the efficiency of the different elements of the process. Refrigeration, cooling, and motor systems are central targets for electrical efficiency. Olajire (2012) and Galitsky, et al. (2003) review many different methods for optimizing equipment efficiency.

Distribution – canning and transport

Many breweries identify distribution as the greatest energy cost in the production and sale of beer. Sierra Nevada has their own distribution fleet that is partially fueled by their restaurants used vegetable oil, and they are developing a second location in Asheville, North Carolina to avoid coast-to-coast distribution (Sierra Nevada, 2012). Uinta runs their one distribution vehicle on biodiesel, and have started canning as opposed to bottling which enables them to carry 50% more product per shipment and cut CO_2 emissions. They can carry 2000 cases of cans as opposed to 1300 cases of bottles (S. Kuftinec, personal communication, March 3, 2014). Brewery Ommegang transports their product across the country via railroad and hope to create a rail from their site in Cooperstown to Oneonta to cut that leg of truck transport (L. Bennett, personal communication, March 5, 2014). Most breweries rely on third-party distributors.

Spent Grains to Farmers – used as feed

Every brewery we spoke with gives their spent grains to local farmers for use as feed for livestock. Most breweries we spoke to donate the spent grain because it is a waste removal service for the breweries. The Craft Brew Alliance is paid for their spent grains (J. Person, personal communication, March 21, 2014).

Wastewater Recycling – use of greywater and easing the load on treatment facilities

The Craft Brew Alliance Portsmouth location, Brewery Ommegang, Saranac, Magic Hat Brewing Company, and Sierra Nevada have all incorporated anaerobic digesters in their wastewater treatment process (L. Bennett, personal communication, March 5, 2014; R. Michaels, personal communication, February 28, 2014; E. Fitch, personal communication, February 28, 2014; Sierra Nevada, 2012). St. Lawrence retains their wastewater until the biochemical oxygen demand is reduced to the water treatment plant's specifications (K. Hebb, personal communication, March 6, 2014). Treatment of wastewater reduces the impact on municipal water treatment systems while reducing sewer fees.

Water Management – reducing water use ratio

Sierra Nevada monitors their water consumption in two units: barrels of water purchased per barrel of beer produced and barrels of waste water produced per barrel of beer produced. Over the last five years, their production has risen while their water purchased and wastewater produced per barrel of beer produced have fallen (Sierra Nevada, 2012). New

Belgium is installing water sub-meters so that they will be able to identify areas of waste in the production process, and has set specific goals for water reduction (New Belgium, 2013).

Biodigesters – harnessing methane and reducing waste

Saranac, Magic Hat, and Sierra Nevada harvest methane from their anaerobic digesters, which they use to help fire their boilers (R. Michaels, personal communication, February 28, 2014; E. Fitch, personal communication, February 28, 2014; Sierra Nevada, 2012). Biogas production through anaerobic digestion is not economically feasible in breweries that produce less than 400,000 barrels annually. However, this is dependent on the cost of energy and the cost of waste disposal (E. Fitch, personal communication, February 28, 2014). Saranac's annual production is roughly 400,000 barrels, but their digester produces 35-40% of the brewery's energy and paid itself off in a couple of years. The digester was implemented to reduce their peak demand, which determines the gravity of their electricity bill. They are 100% energy independent on weekends (R. Michaels, personal communication, February 28, 2014).

Magic Hat opted for a biodigester because they wanted to expand, yet were already using 90% of their municipal water treatment plant's capacity. When they upsized, they were spending a lot of money trucking waste offsite. PurposeEnergy proposed the biodigester to them, installed it at no cost to Magic Hat, and funded it through grants and a contract with Magic Hat, charging them less than they were paying to remove the waste. The amount of waste that is ultimately left to the wastewater treatment plant is 1% of what it used to be (E. Fitch, personal communication, February 28, 2014).

Alternative Energy Sources – reduce fossil fuel consumption

In 1999, New Belgium became the country's first brewery to purchase 100% of its electricity from wind power through renewable energy credits. In 2013, they decided to stop paying extra for wind and instead withhold the difference for themselves for future investment in renewable energy and energy efficiency projects on their own grounds (New Belgium, 2013). In 2001, Uinta became the second 100% wind-powered brewery, until they installed a solar array on their roof which now provides 17% of their electricity (S. Kuftinec, personal communication, March 3, 2014). Sierra Nevada is approximately 20% solar powered and 40% powered by hydrogen fuel cells (Sierra Nevada, 2012). Craft Brew Alliance's Kona location is 50% solar powered (J. Person, personal communication, March 21, 2014).

CO_2 Reclamation – reducing emissions and reusing CO2

Saranac has a CO_2 reclamation system in place with which they can capture the CO_2 produced by yeast consuming sugars, filter it of undesirable aromas, pressurize it, and reuse it. They are considering advancing the sophistication of their system so that they will be able to capture more, less refined CO_2 and produce more useable CO_2. As of now, their recaptured CO_2 is only used internally (R. Michaels, personal communication, February 28, 2014). Sierra Nevada also has a reclamation system in place (Sierra Nevada, 2012).

Many of the breweries we spoke with were interested in CO_2 reclamation. With no way to capture it, they are forced to release it and purchase packaged CO_2. Paradox, the smallest brewing operation we interviewed, invests $600 - $700 monthly in CO_2, with an annual production of only 2500 barrels (P. Mrocka, personal communication, March 2, 2014). Steve Kuftinec from Uinta reported that the technology to capture, scrub, and reuse CO_2 is only affordable for annual production near 300,000 barrels (Personal communication, March 3, 2014).

Grants – funding for efficiency

Craft Brew Alliance and Sierra Nevada received incentives and rebates from their utility companies for efficiency measures (C. Chastain, personal communication, April 7, 2014; J. Person, personal communication, March 21, 2014). PurposeEnergy received grants for the installation of their biodigester at Magic Hat, but these grants existed in lieu of renewable energy investment tax credits and production tax credits. They received an additional grant from Green Mountain Power, a Vermont based utility company (E. Fitch, personal communication, February 28, 2014). St. Lawrence Brewing Company was awarded a grant from Empire State Development for heat reclamation equipment, but hasn't seen a check yet (K. Hebb, personal communication, March 6, 2014). Brewery Ommegang received a grant for environmentally responsibly expansion (L. Bennett, personal communication, March 5, 2014). Saranac's anaerobic digester was partially funded through grants from NYSERDA and their energy company (R. Michaels, personal communication, February 28, 2014). Uinta received state and federal grants for their solar project (S. Kuftinec, personal communication, March 3, 2014). For 30 years, Sierra Nevada and Pacific Gas and Energy, PG&E, have had a partnership for energy conservation solutions. With the financial support from energy efficiency rebate programs they've been able to make various upgrades to lighting systems, machinery, appliances, and overall facility design and efficiency **(**PG&E 2011).

Local Ingredients – reduce impact from transport, support local economy

Peak Organic Brewing Company sources 62% of their raw ingredients from New England. They use more Vermont grown hops than any Vermont brewer, and more New York grown hops than any New York brewer (C. Theisen, personal communication, April 1, 2014). Ommegang has about 200 hop plants of 15-20 different varieties that are serving as a trial for the Cornell Cooperative's local hops research. They were able to produce a test batch from last year's harvest (L. Bennett, personal communication, March 5, 2014). Saranac recently released the New York Native, a brew using ingredients entirely from New York (R. Michaels, personal communication, February 28, 2014). Locally sourcing ingredients is becoming increasingly feasible in New York with the growth of the craft brew movement and local hop industry.

Organic Ingredients – support smaller farms, more wholesome ingredients

The only ingredient used by Peak Organic that isn't certified organic is the water they draw from Sebago Lake in southern Maine. When they started the brewery in 2006, there was only one organic hops farmer. Now there are 36. Barley and wheat need more land, but have been easier to source than predicted. Peak Organic is the largest organic brewery in the world

and the first certified non-GMO brewery. Early on, the organic label was detrimental. People thought it would taste like dirt, but with certain demographics it has proven successful (C. Theisen, personal communication, April 1, 2014).

NYS Hop Farmers

Given the consumers' value for local ingredients, we investigated the availability of New York grown hops, speaking with Laura Ten Eyck and Steve Miller. Laura and her husband Dietrich Gehring grow hops on their family's Indian Ladder Farms. Laura is also conducting research in hopes of publishing a book on growing hops in the northeast. Steve Miller is the New York Hop Industry Specialist on the staff of the Madison County Cornell Cooperative Extension.

Funding his position through grants and Ommegang's contributions, Steve Miller works closely with growers across the state. With a close eye on all corners of the hops industry in New York, Steve has a very optimistic perspective. He cites the booming craft beer movement as the catalyst for the resurgence of state-grown hops. Ten years ago, there were roughly 30 breweries in the state. Now there are over 140. Five years ago, there were only a handful of hop growers in New York, and now there are well over a hundred. At least 60 breweries are buying hops from local growers, and at least 60 hop farms are selling to local breweries. Steve attributes some of the growth to the Farm Brewery legislation, which requires licensed farm brewers to purchase a certain percentage of their ingredients from New York growers. Furthermore, there are now many more farmers planting barley, six new malt houses, three new companies with pelletizing equipment with the capacity to pelletize New York's hops tenfold, and at least ten mechanized harvesters in New York (S. Miller, personal communication, March 26, 2014).

Despite these promising statistics, the industry faces many hurdles. The major challenges for New York hops are outlined below:

Initial Startup – three years before marketable yields

Hop plants take three years to reach mature production levels. New York hops farmers are in the business to turn a profit, but many farmers have not seen a profit yet due to the fact that it takes years to pay off the initial infrastructural investments. The industry is young, and projected yields are still uncertain. Marketing a product of unknown quantities is challenging, but contracted farms are working with other farms to meet demand (S. Miller, personal communication, March 26, 2014; L. Ten Eyck, personal communication, March 24, 2014).

Equipment Availability – much is accomplished manually

To complicate the issue, new low-yield farms have not yet invested in equipment such as driers which play a decisive role in the quality of the product. For many, improvisational, homemade equipment fulfills the role for the moment. Hops are frequently harvested manually by friends and brewers. Hops of similar varieties must be harvested at the same time, which makes the sharing of mechanized equipment difficult (S. Miller, personal communication, March 26, 2014; L. Ten Eyck, personal communication, March 24, 2014).

Information Availability – specific to Northwest

There is not much documented information on hop production available. Farms have been operating for a hundred years in the Northwest, and the specifics of the trade are deeply ingrained in these farmers and not easily accessible. The success of hop strains differ according to their location, and research is still being conducted for New York specific strain results. Pest solutions are regionally specific, so existent literature on the topic is hard to apply to the Northeast. To combat the lack of information, the Northeast Hops Alliance offers integrated pest management, plant disease control, variety trials, and also provides a network to communicate issues and solutions for Northeast hops farmers (S. Miller, personal communication, March 26, 2014; L. Ten Eyck, personal communication, March 24, 2014).

Competition with Northwest – quantity, reliability, cost

Hop farms in the Northwest are 300-400 acres, while only half of New York hop farms exceed one acre. The big farms of the Northwest sell their product through merchants and brokers, while New York growers are in direct communication with breweries, which have very specific demands. Many large processing companies exist in the Northwest, and they also have advanced machinery that allow large-scale production. Hop pricing is affected by economies of scale, and the Northwest is able to produce hops for much cheaper (S. Miller, personal communication, March 26, 2014; L. Ten Eyck, personal communication, March 24, 2014).

New York hops are inevitably more expensive, but price isn't everything. Steve discussed some of New York's strengths, "I think the advantage that we have is that we've got over 130 breweries in this state and many of them are buying local hops, and one of the other things is because we are processing on a smaller scale, I think there's the possibility of growers being able to process better quality once we get everybody knowing what they're doing. . . . On a much smaller scale, I think you can keep an eye on the individual batches of hops better," (personal communication, March 26, 2014). He also told us, "It means something to consumers to know that those hops were grown five miles down the road," which coincides with our survey results (Tables 3 and 4) (S. Miller, personal communication, March 26, 2014). Laura identified another interesting point, stating that "some of the West Coast brewers are interested in what's going on in New York, because the New York hops can be the same variety of hop, but the variety in New York has different properties." New York varieties can have higher beta acids, which mean they provide more aroma (L. Ten Eyck, personal communication, March 24, 2014).

Consumer Values, Sustainability Initiatives, and New York Hops: Applying our Findings to Olde Saratoga

Olde Saratoga, New York's fourth largest brewery, is wholly owned by California's publicly traded Mendocino Brewing Company. The majority of its shares are owned by the Indian company United Breweries Group, whose beer is marketed as Kingfisher. Olde Saratoga answers to Mendocino, but operates somewhat independently. Olde Saratoga has a theoretical annual production of 50,000 barrels. As a relatively small brewery, they fall short of the current feasibility ranges for carbon dioxide reclamation systems and biodigesters. Large investments

for any project will require approval from Mendocino (M. Oswald, personal communication, March 5, 2014).

Olde Saratoga is in a transitional period under the guidance of the newly appointed General Manager Max Oswald, previously the regional sales manager. Before Max's leadership, sustainability was not discussed, and efficiency was a topic unfortunately neglected. Max has been quick to assess the pillars of successful operation: safety, quality, and efficiency. Not over-looking the first two pillars, Max is excited to address efficiency throughout the brewery. He has communicated his goals and expectations with the entire staff, instigating fundamental change in the way the team operates. He's holding them to higher standards of accountability and is promoting pride, care, and efficiency. His passionate vision for reconditioning the operation of the brewery includes "utilizing machinery at its minimum energy-wise," (M. Oswald, personal communication, March 5, 2014).

Max understands that change starts with small steps. In addition to reforming the mentality of the brewery's operation and running around shutting off lights and turning down valves, he's implemented a recycling program that's saving Olde Saratoga $250/mo. in waste management charges. We asked what kind of pro-environmental projects he'd like to incorporate if money weren't an issue, and he mentioned wastewater treatment, water management, refrigeration changes, and a full third-party assessment of the brewery (M. Oswald, personal communication, March 5, 2014).

Considering Max's goals and the brewery's situation and constrictions, we drew from our research to suggest feasible and effective sustainability initiatives for Olde Saratoga. Operational efficiency is a dominant theme in our recommendations. In optimizing efficiency, the brewery can reduce resource and energy consumption and minimize waste while maximizing production and profit. Many of the initiatives noted in our findings from other breweries require significant capital investment, which would pend approval from Mendocino. Efficiency measures involve relatively minor costs and have immediate economic and environmental rewards. Savings could later be demonstrated to make a case for further investment in sustainability measures, and increased efficiency will only augment the impact of further environmental initiatives. The following suggestions draw heavily from our interviews and three of our most-utilized online sources:

- "The Brewing Industry and Environmental Challenges" (Olajire, 2012)
- "Energy Efficiency Improvement and Cost Saving Opportunities for Breweries: An ENERGY STAR(R) Guide for Energy and Plant Managers" (Galitsky, et al., 2003)
- The Brewers Association's Sustainability Tools: http://www.brewersassociation.org/pages/business-tools/sustainability-Tools

Our Recommendations for Olde Saratoga Brewing Company

Savings depend on more variables than this paper can account for. Some estimates are given from previous case studies in other breweries, but results are dependent on current practices, production scale, equipment specifics, energy costs, local climate, and other

factors. Enhanced efficiency will proportionally reduce energy consumption and utility fees, and even minor percentages of savings will accumulate over time.

Zero-Cost Strategies

Utility Management

The first step to improving efficiency is having a way of measuring it. Compile and track utility bills. Set reduction goals, and record progress. Compare utilities to previous monthly averages and set reduction goals. Share the results in the office, and celebrate successes. Savings can be difficult to predict, but they will be reflected in utility bills. Contact the wastewater treatment plant and inquire about ways to save on sewer bills. Retaining wastewater to reduce biochemical oxygen demand (BOD) might facilitate treatment and reduce charges.

Power-Off, Power-Down

Continue to promote energy savings through shutting off fixtures not in use and minimize unnecessary energy expenditures. This applies to everything: lights, equipment, hoses, forklifts, thermostats, refrigerators, etc. Energy saved is money saved, and it adds up.

Education

Spend some time with the Brewers Association Sustainability Tools. They offer a comprehensive approach to sustainability in the brewery and specific information for different sectors. They include best practices and technical savings strategies that are beyond the scope of this project, with the added benefit of experience in the brewing industry. Reach out to other breweries, and see what they're doing to address sustainability. Staff education regarding energy conservation is equally important to promote pride in the brewery and instill a sense of environmental ethic.

Refrigeration Optimization

Refrigeration accounts for 30-40% of energy use (Galitsky, et al., 2003). Make sure doors are being shut, and check door seals. Only refrigerate to necessary temperatures, raising refrigeration temperature will greatly reduce energy needs. Three millimeters of scale on condensers can increase energy demand by 30% (Galitsky, et al., 2003). Clean evaporator and condenser coils, and maintain proper airflow to evaporators. Because refrigeration draws massive amounts of electricity, any improvements in refrigeration efficiency will entail proportionally sizeable reductions in energy expenditures. Drawing outdoor air during the winter can cut refrigeration costs drastically.

Raising Output Temperature of Pasteurizer

Assess the programmed result of the pasteurization process. Check current beer-out temperatures and consider whether they are unnecessarily low. Consider not pasteurizing kegs for taproom. Consider offering unpasteurized kegs or more casques for local distribution.

Lower Operating Pressure of Compressors

One case study showed annual savings of $480 through reducing the operating pressure of one 60 HP air compressor to more closely match its maximum demand (Olajire, 2012).

Grants

National Grid and NYSERDA offer rebates and incentives for investments toward energy efficiency (NYDERDA, 2014; National Grid, 2014). The U.S. Department of Energy also supplies tax credits, rebates, and savings that are applicable (United States Department of Energy, 2014).

Minimal-Cost Strategies

Further Optimization of Compressed Air Systems

In another case study, a compromised compressed air system was patched and resulted in annual savings of $1360 and a payback of 12 days (Olajire, 2012). Compressed air leaks can waste 20-30% of a compressor's output (Galitsky, et al., 2003). A separate study realized annual savings of $445 by redirecting air compressor intake to cooler, outside air with average temperatures near 50 °F (Olajire, 2012). Check the operating temperature of the compressor, and compare it to its intended operating temperature. In one study, the installation of a simple gate valve to restrict the flow of cooling water paid itself off in 1.4 days (Olajire, 2012).

Steam Pipe Maintenance

Check steam pipes for leaks. Over the course of a year, a hissing, hardly visible steam leak can sap the energy equivalent to producing almost 200 barrels of beer, while a larger, more visible blemish leaks the energy equivalent to producing nearly 1000 barrels (Olajire, 2012). Insulate steam pipes. The insulation of just one meter of 89mm steam pipe can save enough energy in a year to produce over 100 barrels (Olajire, 2012)

Moderate-Cost Strategies

Sub-metering and Monitoring

Dividing the brewery into manageable, measurable systems will help to assess process-specific performance. Systematic monitoring has demonstrated reduction of energy costs by 4-18% (Olajire, 2012). With monthly utility bills ranging in the tens of thousands of dollars, savings of this magnitude would be thousands of dollars every month. Close attention to

resource use can also allow for a deeper understanding of kWh/bbl (kilowatt hours per barrel produced), barrels of water consumed and/or wasted per barrel produced, and the effectivity of efficiency measures. It also allows for the recognition of inefficiencies.

High-Demand Equipment Maintenance

With the help of process-specific sub-metering, high-demand processes can be fine-tuned. Even minor improvements in energy-intensive processes will have noteworthy results. Flue gas monitors can analyze boiler exhaust and allow for optimization of combustion conditions. Boilers represent the greatest energy inputs of the brewing process and are especially important to maintain properly. Reducing a scale layer by one millimeter can cut boiler fuel consumption by 2% (Galitsky, et al., 2003). Special attention to high-demand equipment efficiency can reduce peak demand.

Water Reduction and Reclamation Systems

The Brewers Association "Sustainability Tools" include reduction manuals for water, energy, and waste. See what you can do to reduce water usage.

Assessment of Motor Operations

Investigate motor operations in the brewery, and compare input to output demand. Variable speed drives (VSDs) allow flexibility in control of motor systems, tailoring input to match demand, and can reduce electrical draw by 60% (Brewers Association, 2013). Machine drive (pumps, compressors, motors) accounts for nearly 50% of electricity used in the brewing industry (Olajire, 2012), so motor efficiency should not be overlooked. More detailed information is available in Galitsky, et al. (2003) and the Brewers Association Energy Manual.

Local Advertising Campaign

Our surveys show that consumers prefer local beers. A summer advertising campaign celebrating Olde Saratoga's connection with the Saratoga community could remind both tourists and locals of the brewery's proximity and freshness. Surveys also show that consumers are more inclined to purchase beer produced with local ingredients. Investigate opportunities to use (and advertise the use of) New York hops. The Northeast Hops Alliance is a good place to start. An advertisement campaign could also strengthen regional pride in the Olde Saratoga brand.

High-Cost Strategies

Energy Audit

Arrange for a third-party comprehensive energy audit to assess brewery operations and identify opportunities for improvements and savings. The Brewers Association and Washington State University Energy Program provide a 99 question Energy Auditor Checklist if you would prefer an internal assessment.

Hire a Sustainability Coordinator

Creating a full-time position would ensure constant attention towards sustainability in the brewery. A sustainability coordinator could track the success of implemented strategies, acquire funding from grants and incentive programs, and explore future projects such as renewable energies or biodiesel distribution.

Advanced Heating and Cooling Systems

There is a range of sophisticated heat recovery systems that surpass the understanding of this paper. Closed-loop cooling with a cooling tower can save enormous quantities of water. For more information, refer to Galitsky, et al. (2003), Olajire (2012), and the Brewers Association manuals.

CONCLUSIONS

While we believe that our suggestions are thorough, a better understanding of Olde Saratoga's brewery-specific operating processes is required to tailor a more comprehensive solution. Our time and experience with Olde Saratoga was neither long nor technical, and for this reason we can only offer a limited range of suggestions. This contributes to our suggestions of conducting a third party energy audit, or looking into hiring a full time sustainability coordinator. The brewery's ownership by Mendocino Brewing Company provides another interesting obstacle that we did not have the time or resources to investigate. Under the ownership of another brewery, which is in turn owned by a multinational corporation, there are a variety of challenges to implementing sustainable solutions. A more comprehensive study of the brewery would involve working within the brewery itself and fully understanding the entire process, from importation of ingredients to the ethics of employees. In the absence of such an assessment, there are a number of tools available from other breweries and organizations that provide breweries with the information needed to achieve a more sustainable livelihood.

While some of the larger sustainability projects at other craft breweries may seem daunting, it is important to understand that small steps towards achieving a more sustainable future will pay off in the long run. Sustainability does not need to be considered independent of topics such as quality and safety, but rather as an integrated business ethic that is incorporated into decision-making. The savings discussed in this paper are based on case studies and for this reason may seem intangible without proper metrics for measuring their direct effects at Olde Saratoga, but it is certain that any small changes that increase energy efficiency in the brewing process or the building will add up and save a significant amount of money. There is so much that can be done with relatively little input; it simply depends on a willingness to change and a personal investment in the future of the brewery.

There are a number of benefits to implementing sustainable initiatives in the brewery aside from just saving money. It is important to understand that efficiency savings go hand in hand with a reduction of the environmental footprint of the brewery, and can be marketed either way. It is our belief that the implementation of more sustainable practices and energy saving will also help to instill a sense of pride in employees, as reduction goals can be met and celebrated as

they are achieved. This provides the opportunity for employees involved in every part of the process to work together to achieve a shared and tangible goal.

If Olde Saratoga is to implement the strategies mentioned above and achieve a more sustainable business model in the future, the social impacts will be interesting to follow. In a town where local ingredient use is growing rapidly and a state with a booming hop industry, tapping into the locavore movement of Saratoga Springs could be a beneficial strategy for Olde Saratoga. Future studies regarding the marketing success of the use of local ingredients could be extremely informative for breweries looking into the potential for using local ingredients. The new Farm Brewery legislation provides ample opportunity for measuring the success of using local ingredients, as many breweries are incorporating this into their business strategies.

It is important to realize that the investigation of sustainable initiatives is only useful if the changes are important to both the executive staff and the general employees. The success of many of these initiatives relies on management priorities and a commitment to sustainability. We believe that the brewery has already made remarkable steps, beginning with attitude change regarding waste and efficiency. It is this bottom-up change that will ultimately be necessary if the brewery is to see any significant change.

We believe that by taking the right steps and considering sustainability and local production as a part of their business model, Olde Saratoga has the potential to see increases in revenue and overall success of the brewery. Saratoga Springs is home to a demographic that takes pride in local businesses, and we know that the potential is there for Olde Saratoga to tap into this market in a more significant way. We are confident in the current leadership of Olde Saratoga and excited to see what will come.

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APPENDIX A: Survey given to Saratoga Beer Summit attendees

Environmental sustainability is important to me.

Strongly Disagree — Neutral — Strongly Agree
1 2 3 4 5 6 7 8 9 10

A brewery's commitment to sustainability influences my choice of beer.

Strongly Disagree — Neutral — Strongly Agree
1 2 3 4 5 6 7 8 9 10

I would be more inclined to purchase/consume beer from a brewery that has a strong commitment to sustainability.

Strongly Disagree — Neutral — Strongly Agree
1 2 3 4 5 6 7 8 9 10

I would be more inclined to purchase/consume beer from a brewery that promotes and advertises energy and resource saving practices.

Strongly Disagree — Neutral — Strongly Agree
1 2 3 4 5 6 7 8 9 10

I would be willing to spend more money on a 6 pack of beer from a brewery that promotes and advertises energy and resource saving practices (please circle one).

YES NO

I would be more inclined to purchase beer from a local or regional brewery.

Strongly Disagree — Neutral — Strongly Agree
1 2 3 4 5 6 7 8 9 10

I would be more inclined to purchase beer from a brewery that uses locally sourced materials (hops and barley).

Strongly Disagree — Neutral — Strongly Agree
1 2 3 4 5 6 7 8 9 10

I would be willing to spend more money on a 6 pack of beer from a brewery that uses local ingredients (please circle one).

YES NO

In my opinion, the three most important environmental sustainability initiatives a brewery can implement are:

1. _____

2. _____

3. _____

APPENDIX B: Interviews conducted

Person	Position	Company	Type	Date of Interview
Julia Person	Sustainability Coordinator	Craft Brew Alliance	Brewery	3/21/2014
George de Piro	Brewmaster	Druthers	Brewery	3/3/2014
Max Oswald	General Manager	Olde Saratoga	Brewery	3/5/2014
Ken Hebb	Owner	St. Lawrence	Brewery	3/6/2014
Larry Bennett	Marketing Director	Ommegang	Brewery	3/5/2014
Paul Mrocka	Owner	Paradox	Brewery	3/2/2014
Craig Theisen	Co-Owner	Peak Organic	Brewery	4/1/2014
Rich Michaels	Brewery Manager	Saranac	Brewery	2/28/2014
Cheri Chastain	Sustainability Coordinator	Sierra Nevada	Brewery	4/7/2014
Steve Kuftinec	Co-Owner	Uinta	Brewery	3/3/2014
Steve Miller	Senior Resource Educator	Madison County Cornell Cooperative Extension	NYS Hops Specialist	3/26/2014
Laura Ten Eyck	Farmer/Author	Indian Ladder Farms	Hops Farmer	3/24/2014
Eric Fitch	Founder and CEO	PurposeEnergy	Industrial Ecology	2/28/2014
Heidi		Fort Ann Biodigester	Industrial Ecology	3/31/2014