Handbook for Sustainable Brewing Karbon Brewing Company

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Final Report

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Handbook for Sustainable Brewing

Karbon Brewing Company
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Introduction

History of the Brewing Industry

The brewing industry's history spans millennia, intricately woven into the cultural, economic, and technological evolution of civilizations. Thousands of years of brewers who refined techniques and cultivated flavours prove that brewing is both an art, and a science. Beer has changed a lot over time, adapting to different cultures and eras, with climate change becoming a big concern, it's important for breweries to find ways to be more environmentally friendly. Today, the industry evolves, embracing sustainability, innovation, and a growing demand for quality and authenticity, ensuring its enduring participation in shaping its world's future.

Improving Sustainability within the Industry

Like many other industries adjusting their current practices to both accommodate a more environmentally conscious consumer, and make sure their industry isn't left behind in the new wave of climate action and sustainability, the beer industry is no different. Small and large breweries alike are trying to reduce their carbon footprint, and overall impact on the planet. However carbon being something that historically has not been considered in the brewing process, it can be daunting to know where to start. All businesses are different and so all carbon mitigation plans will be individual. However, there are a few things that we as an industry can work on, some general carbon mitigation techniques that can be applied to most breweries. To help businesses find the path of least resistance to a sustainable brewery, we have created a manual which compiles effective solutions, with easy implementation. We as businesses need to figure out how to best update and refine our current standards. By reading this manual, you're on your way to finding the best way to do so.

What the project is about

Considerations: Small and Large Businesses

The sustainability practices of large versus small businesses will vary greatly. Small businesses are often subject to more financial pressures, limited staff, time constraints. Additionally smaller organizations are not offered information and opportunities that can be applied to their size of business resulting in a lack of a prioritization of sustainability practices (Brewers Association of Canada, 2011). Therefore a sustainable brewing handbook coming from a small business will be pertinent for spreading awareness of the opportunities to support sustainability.

By adopting sustainability practices, businesses are not solely required to uptake machinery or replace current systems. Large projects such as these can effectively reduce carbon emissions or reduce waste however sustainability can be achieved by

managing staff or the public. Much of the mechanical changes may not be effective without proper knowledge and understanding of how they can be used more efficiently. By training staff to spot inefficiencies and report them, they can actively practice sustainability. As the staff are often directly involved in these practices, it will not only prevent inefficiencies but it will also create a larger effort bringing all levels of staff together to achieve a larger goal (Brewers Association of Canada, 2011).

Finally, involving the product users can be very influential for achieving a large change that is supported by those who know and love the product. This will ensure the measures taken will not reduce the quality or the use of the end product. Ultimately, many of the measures taken have an upfront cost with an expected payback period depending on the money brought in from sales. The quality therefore cannot be compromised and should mirror the values of the end user. This will ensure there are no reductions on the demand side that could result in the sustainability measure being a costly and impractical venture.

Sustainability must be accessible in order to be successful. This means creating a handbook that can be applied across the industry that is composed of various business sizes and models. Small and large businesses must be offered solutions that are applicable to their model so they can begin to make a change and prioritize sustainability. That way real change can be achieved without compromising businesses or the environment.

End of Life Resource Use and Recycling

Current Trends

The Ontario beer industry has possessed an excellent end of life resource use system. At any beer store in Ontario you can return all containers greater than 100mls and receive 10 cents per deposit and all containers > 630mls receive 20 cents (17). The Beer Store's deposit return program is considered the most successful in North America. Its high recovery rate allows the average beer bottle to be refilled 15 times in its life cycle. This system making the waste produced a valuable raw material through return and reuse allows for a circular beer waste economy which has kept the beer industry's end of life practices sustainable for almost a century. This system started in 1927, when The Beer Store, the primary distributor for beer in the province operated a deposit-return system on its containers. On February 5, 2007, the Ontario government began refunding deposits on all beverage alcohol containers (24).

Given the long history of these systems, it's time that we as businesses need to figure out how to best update and refine our current standards. Microbreweries and bigger breweries have room to improve our current practices within and outside of the system. By gaining a better understanding of what makes this system work and what doesn't, we can maximize success in end of life and recycling in the beer industry.

Challenges

Despite the efficiency of this system there are still challenges that need to be addressed. The first challenge discovered during our literature is that labels containing polymers, adhesives, or lacquers cause difficulties in the recycling process. This is because using such materials contaminates the recycling process as the bottles become ‘mixed material items’. This impacts the materials reutilization due to the added complexity that comes with separating adhesive labels and other plastic parts. Essentially, when breweries use bottles that have polymers, adhesives or lacquers they’re more likely to be incinerated.

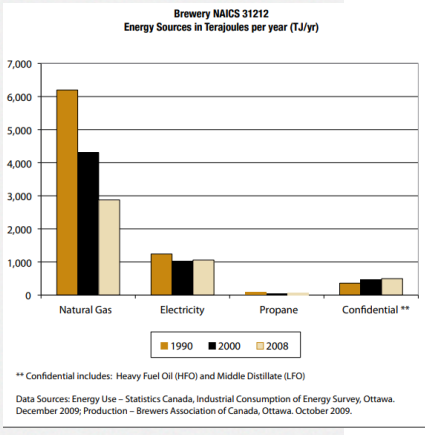
Another challenge experienced by this system is that aluminum isn’t a good food contact material. This is because the natural PH of most canned beverages is quite low and thus the drink corrodes the aluminum. Additionally, aluminum has been said to leave a metallic taste on beverages. Because of this, modern aluminum cans are not only aluminum but are lined with plastic. This addition of plastic to traditional aluminum cans adds complexity to the recycling process, and makes this a less efficient system.

While some of these challenges have tangible action steps to mitigate their negative environmental impacts, other flaws are deeply ingrained in our systems that require innovative solutions (i.e. designing of aluminum cans without plastic). While we don’t have solutions or recommendations for the latter kind of problem, we mention them to raise awareness, and hopefully reach the people that do have the solutions (or the knowledge to find them).

Energy Use Optimization

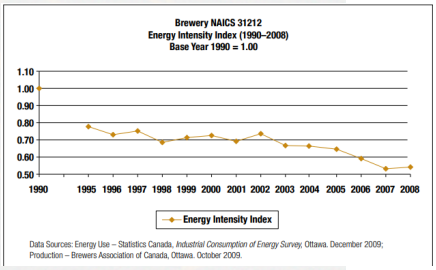
Current Trends

Beer making is a large industry as it is the fifth top beverage consumed globally. It is a highly energy intensive process that often occurs on a large scale (Shin & Searcy, 2018). Energy production in Ontario is primarily driven by renewable sources such as nuclear, hydro and wind power generation. But beer production often relies more heavily on the use of non-renewable resources such as natural gas (Brewers Association of Canada, 2011).



Changes to the type of energy consumed and the quantity are becoming more common within the industry. There is now a downward trend in energy consumption since the 1990s due to more efficient equipment and

recovery technologies to harness existing heat or energy (Brewers Association of Canada, 2011).



The purpose of reducing energy consumption is ultimately within financial interest for a brewer however it is growing in competitiveness with the demand for sustainable development and industries. This demand comes from societal and economic pressures but also from the user (Brewers Association of Canada, 2011). As the fight against climate change pressures not only the industry but the user, brewing companies are tasked with becoming more sustainable while dealing with narrower profit margins (Shin & Searcy, 2018).

Challenges

Retrofitting buildings and altering production processes can be risky and costly. There are many components to consider when looking to become more energy efficient. This is why starting small can help to build confidence and commitment among staff. When staff, in particular, management are not completely committed to the change, the transition can be hindered or abandoned part way through. The result is money is wasted and relationships are altered. In addition to this, potential issues could arise from a disproportionate or misunderstood commitment to responsibility when becoming energy efficient. As there are many ways to improve efficiency, most are based around staff training and involvement to compliment equipment and machinery. Finally, the amount of resources such as staff or money will eventually limit the options available to a brewing company (Brewers Association of Canada, 2011).

Food Waste and Biomaterials

Current Trends

The brewing industry is an inherently wasteful industry (Karbon, 2020). In Ontario alone, approximately 160000 tons of gains are spent annually to support Ontario breweries, consequently resulting in a large amount of food waste within the brewing industry. So, the question arises, how can a small brewery limit its waste while increasing its profit? This section will cover the research conducted to determine four ways in varying cost and complexity for breweries to maximize their organic products to increase their profit, limit expenses, and create a more sustainable company. Further, in doing so, breweries have an opportunity to ultimately have an effect on the sustainability of the brewing industry as a whole contributing to a more environmentally friendly and sustainable planet. .

To begin the goal of increased sustainability through the lens of food waste and biomaterials, one must begin in the area of shelf life. A way we can increase our knowledge of shelf life is through Life Cycle Assessments (LCAs). LCAs are simply put, a holistic assessment across the life span of organics, including organics in the brewing industry. By delving into the full spectrum of a product's shelf life, breweries can optimize the utilization of any organics and minimize the waste of organics within their brewery. Thus, increasing their profit and reducing losses to the business. Moreover, through the use of LCA, the opportunity for significant improvements in resource management and sustainability becomes a stepping stone for becoming a more sustainable and profitable company.

An innovative approach to addressing food waste within breweries entails the reuse and repurposing of food waste, making the food waste a biomaterial. This transformative process utilizes brewing waste, which traditionally has found its way to become animal feed or waste. The integration of this biomaterial from brewing waste with vegetable resin presents a promising avenue for the development of new sustainable products. Moreover, the products are virtually endless, given appropriate methods in developing the new products from brewing biomaterials. Notably, this approach offers a cost-effective solution for breweries, requiring minimal financial investment while potentially yielding substantial returns. By capitalizing on this opportunity, breweries can not only mitigate their environmental footprint but also tap into new revenue streams whether through their own company or by outsourcing their biomaterials to other companies to develop new products.

Within the vast potential of utilizing food waste and biomaterials, the ability of the creation of consumable beverages, such as kombucha. Kombucha has quickly become a popular beverage through health benefits as well as inherently sustainable practice the creating of kombucha is. Thus, allows breweries an opportunity to leverage their valuable biomaterials to their advantage by either the creation of their own kombucha or outsourcing their biomaterials to companies who create their own kombucha. By utilizing biomaterials for kombucha, breweries can use an innovative approach to meet consumer demands as well drive positive environmental and economic outcomes within the brewing industry.

Similar to other shifts to more sustainable practices, investment and work is required for effective steps forward. Such as delegating and disseminating tasks and information either within the business or through outsourcing, to build a more profitable and sustainable company. Moreover, by implementing innovative ways to recycle and reuse what historically would be waste, the door is open to increase profits all the while aiding in our battle towards a more sustainable future.

Food and Beverage Manufacturing

Current Trends

The brewing and production of beer consumes substantial amounts of energy and water resources,[24 & 9] indicating that it generally takes between 4 and 6 liters of water to produce one liter of beer. Consequently, breweries generate significant volumes of wastewater, often disposed of carelessly or merely treated in a cost-effective manner to offset their risks to both human and environmental health[20]. Meanwhile, food and beverage manufacturers are increasingly adopting innovative equipment to enhance their processes. However, there's been limited exploration into Internet-of-Things (IoT)-based water monitoring systems, which have demonstrated efficiency in monitoring other resource usages.[11]

Challenges

Achieving a lower water-to-beer ratio without compromising the product is perhaps the biggest challenge. Wastewater management, and implementation of IoT-based water monitoring systems can be costly, requiring investment in infrastructure, equipment, and staff with skills and expertise. Thus, Small, and medium-sized breweries and food/beverage manufacturers may face challenges in funding and implementing these systems. Different types of pollutants in wastewater from different breweries, therefore requiring critical examination of wastewater prior to selecting appropriate wastewater treatment. By investing in sustainable practices, leveraging new technologies, and collaborating with industry partners, breweries and food/beverage manufacturers can work together towards more efficient water management.

Conclusion

As the brewing industry battles climate change and finds ways to become more sustainable for the planet's sake as well as to turn a higher profit, the need for collaboration, environmental responsibility, and prioritizing innovation through topics found throughout this handbook and more. This will ultimately drive the brewing industry towards a sustainable future, while meeting broader consumer expectations while safeguarding the planet and turning increased profit. To achieve low carbon emissions and maximum sustainability, breweries are recommended to update their practices to find their business more sustainable. Our handbook can effectively guide these efforts, covering aspects such as end of life resource use and recycling, energy use optimization, food waste and biomaterials, food and beverage manufacturing. The brewing industry's extensive history underscores its adaptability and integration into human civilization therefore, going forward, sustainability is at the forefront, prompting innovation and environmental responsibility to turn higher profit, all the while protecting our planet for future generations and continuing to create great tasting beer.

Pamphlet Pages

https://docs.google.com/drawings/d/1swlgoBshQQlfYIJAFlsT_WwDFn_zc3RrSPGrS1LZOIQ/edit?usp=sharing

https://docs.google.com/drawings/d/1hY1qVM8HXzvn6kQjW0_C1tghYsETi2mNjreJk62CMSc/edit?usp=sharing

End of Life Resource Use and Recycling

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Energy Use Optimization

Energy Use Optimization

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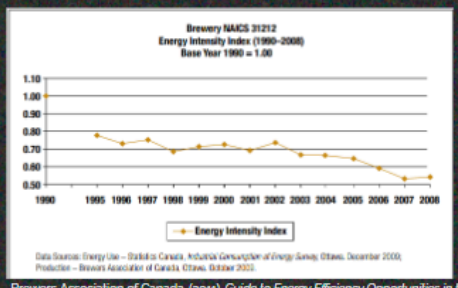
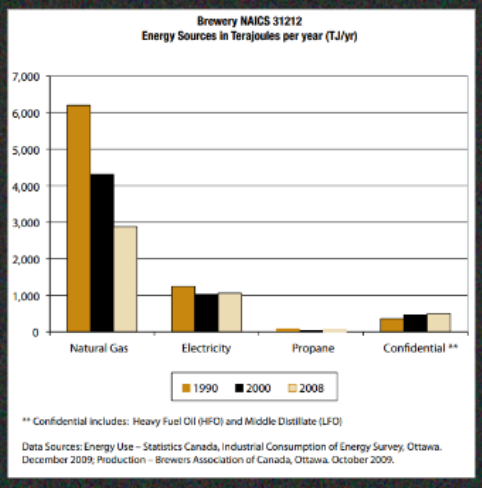


Brewers Association of Canada. (2011). *Guide to Energy Efficiency Opportunities in the Canadian Brewing Industry.*



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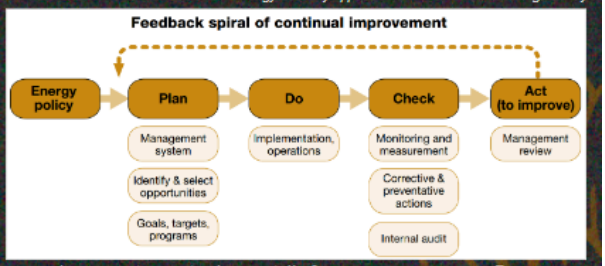

Challenges

Firm commitment to the cause is required especially from management. Staff participation and involvement is complementary to energy efficient machinery. Responsibility and commitment should also be clearly stated to all levels of staff to ensure the process can be the most efficient. Finally, resources such as limited staff or funding could lead to incomplete processes that could be more energy intensive and costly[3]

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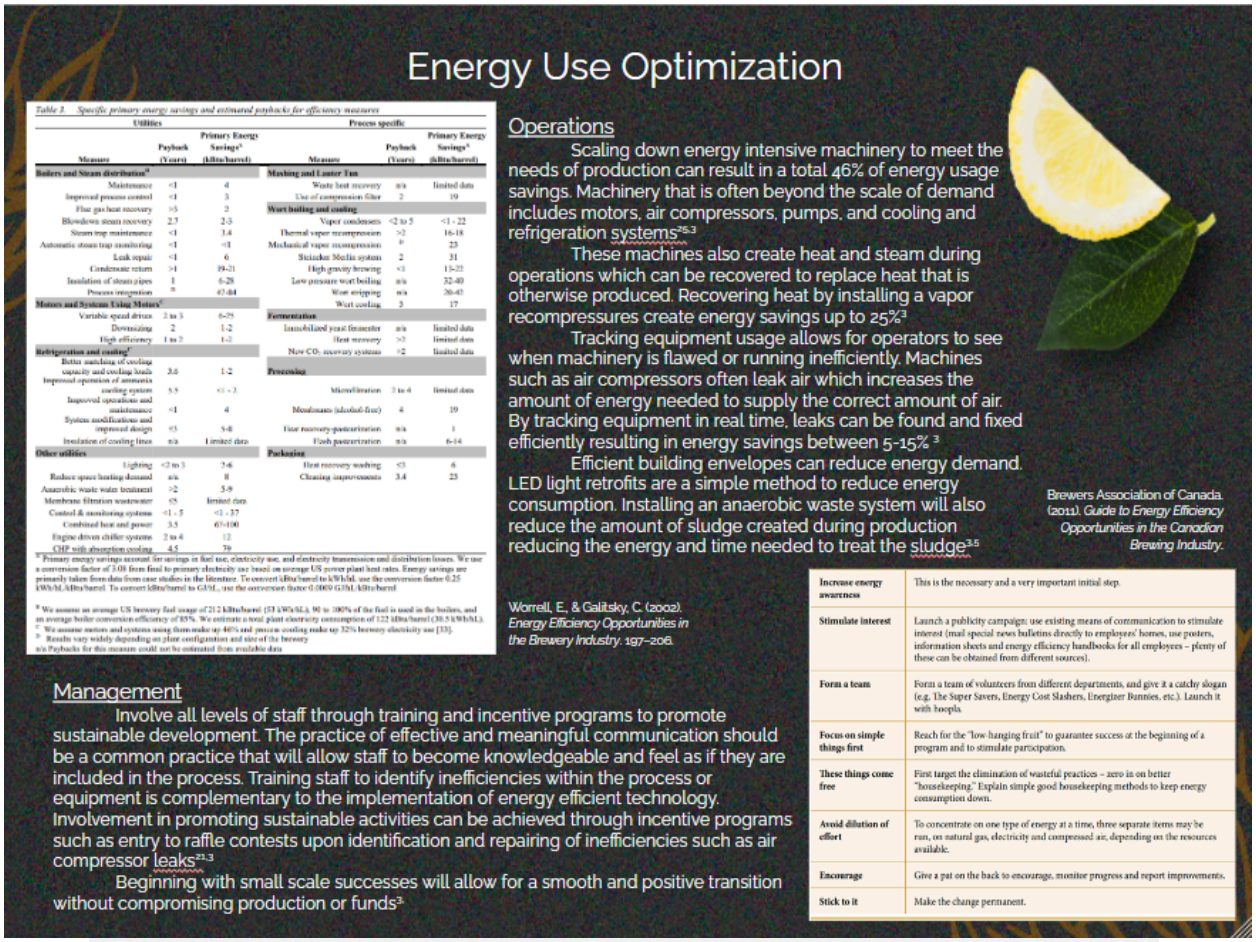

Table 3. Specific primary energy savings and estimated paybacks for efficiency measures

Utilities		
Measure	Payback (Years)	Primary Energy Savings[a] (kBtu/barrel)
Boilers and Steam distribution[b]		
Maintenance	<1	4
Improved process control	<1	3
Flue gas heat recovery	>5	2
Blowdown steam recovery	2.7	2-5
Steam trap maintenance	<1	3.4
Automatic steam trap monitoring	<1	<1
Leak repair	<1	6
Condensate return	>1	19-21
Insulation of steam pipes	1	6-28
Process integration	[b]	47-84
Motors and Systems Using Motors[c]		
Variable speed drives	2 to 3	6-75
Downsizing	2	1-2
High efficiency	1 to 2	1-2
Refrigeration and cooling[c]		
Better matching of cooling capacity and cooling loads	3.6	1-2
Improved operation of ammonia cooling system	5.5	<1 - 3
Improved operations and maintenance	<1	4
System modifications and improved design	<3	5-8
Insulation of cooling lines	n/a	Limited data
Other utilities		
Lighting	<2 to 3	2-6
Reduce space heating demand	n/a	8
Anaerobic waste water treatment	>2	5-9
Membrane filtration wastewater	<5	limited data
Control & monitoring systems	<1 - 5	<1 - 37
Combined heat and power	3.5	67-100
Engine driven chiller systems	2 to 4	12
CHP with absorption cooling	4.5	70

Process specific		
Measure	Payback (Years)	Primary Energy Savings[a] (kBtu/barrel)
Mashing and Lauter Tun		
Waste heat recovery	n/a	limited data
Use of compression filter	2	19
Wort boiling and cooling		
Vapor condensers	<2 to 5	<1 - 22
Thermal vapor recompression	>2	16-18
Mechanical vapor recompression	[b]	23
Steinecker Merlin system	2	31
High-gravity brewing	<1	13-22
Low pressure wort boiling	n/a	32-40
Wort stripping	n/a	20-43
Wort cooling	3	17
Fermentation		
Immobilized yeast fermenter	n/a	limited data
Heat recovery	>2	limited data
New CO_2 recovery systems	>2	limited data
Processing		
Microfiltration	3 to 4	limited data
Membranes (alcohol-free)	4	19
Heat recovery-pasteurization	n/a	1
Flash pasteurization	n/a	6-14
Packaging		
Heat recovery washing	<3	6
Cleaning improvements	3.4	23

[a] Primary energy savings account for savings in fuel use, electricity use, and electricity transmission and distribution losses. We use a conversion factor of 3.08 from final to primary electricity use based on average US power plant heat rates. Energy savings are primarily taken from data from case studies in the literature. To convert kBtu/barrel to kWh/hL use the conversion factor 0.25 kWh/hL/kBtu/barrel. To convert kBtu/barrel to GJ/hL, use the conversion factor 0.0009 GJ/hL/kBtu/barrel

[b] We assume an average US brewery fuel usage of 212 kBtu/barrel (53 kWh/hL), 90 to 100% of the fuel is used in the boilers, and an average boiler conversion efficiency of 85%. We estimate a total plant electricity consumption of 122 kBtu/barrel (30.5 kWh/hL).

[c] We assume motors and systems using them make up 46% and process cooling make up 32% brewery electricity use [33].

[d] Results vary widely depending on plant configuration and size of the brewery

n/a Paybacks for this measure could not be estimated from available data

Increase energy awareness	This is the necessary and a very important initial step.
Stimulate interest	Launch a publicity campaign; use existing means of communication to stimulate interest (mail special news bulletins directly to employees' homes, use posters, information sheets and energy efficiency handbooks for all employees – plenty of these can be obtained from different sources).
Form a team	Form a team of volunteers from different departments, and give it a catchy slogan (e.g. The Super Savers, Energy Cost Slashers, Energizer Bunnies, etc.). Launch it with hoopla.
Focus on simple things first	Reach for the "low-hanging fruit" to guarantee success at the beginning of a program and to stimulate participation.
These things come free	First target the elimination of wasteful practices – zero in on better "housekeeping." Explain simple good housekeeping methods to keep energy consumption down.
Avoid dilution of effort	To concentrate on one type of energy at a time, three separate items may be run, on natural gas, electricity and compressed air, depending on the resources available.
Encourage	Give a pat on the back to encourage, monitor progress and report improvements.
Stick to it	Make the change permanent.

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Food and Beverage Manufacturing

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Food Waste and Biomaterials

https://docs.google.com/drawings/d/1t4uLs2P_puTH-7zPamaRbm25StezTgdd9lyiQz7HsY0/edit?usp=sharing

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