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SUSTAINABLE OPERATIONS MANAGEMENT AND BENCHMARKING IN BREWING: A FACTOR WEIGHTING APPROACH

ABSTRACT

The brewing industry has been moving towards more efficient use of energy, water reuse and stewardship, and the tracking of greenhouse gas (GHG) emissions to better manage environmental and social responsibility. Commercial breweries use a great deal of water and energy to convert one gallon (liter) of water into one gallon (liter) of beer. An analysis was conducted on sustainable operations and supply chain management at various United States and international breweries, specifically Europe, to benchmark brewery performance and establish common metrics for sustainability in the beer supply chain. The primary research questions explored in this article are whether water reclamation and GHG emissions can be properly monitored and measured and if processes can be created to help control waste (lean) and emissions. Additional questions include how we can use operations management strategies and techniques such as the Factor-Weighted Method (FWM) in industries such as brewing to develop sustainability scorecards.

KEYWORDS | Sustainability, operations, brewing, benchmarking, conservation.

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INTRODUCTION AND BACKGROUND

Fortune reported that The Beer Institute has projected that the brewing industry contributed \$252.6B to the U.S. economy in 2014 (Morris, 2015). Many breweries issue corporate and environmental sustainability reports. The number of industry reports and scholarly articles on the subject of brewing operations seem to be increasing steadily; these reports have been analyzed to determine the current state of the brewing industry and provide guidance to breweries for sustainable operations management practices. Thomas and Rahman (2006) review various wastes and strategies for sustainability in breweries in their work from *Aspect of Applied Biology* (Thomas & Rahman, 2006). One specific brewery commonly referenced, the New Belgium Brewery, has been profiled by other authors including (Hirshberg, 2008; McCorry, 2011). New Belgium has been specifically noted as being a leader in sustainable brewing. Gary Hirshberg, CEO of Stonyfield Farms and an eco-entrepreneurial pioneer, has said that Jeff Lebesch, New Belgium's co-founder "...worked harder than anybody else in the brewing industry to achieve true carbon reduction and sustainability..." (Hirshberg, 2008)." While New Belgium spends a great deal of time and effort on environmental sustainability, they also consider economic and social sustainability.

The primary research questions explored in this article include whether water reclamation and GHG emissions can be properly monitored and measured and if processes can be created to help control emissions and waste. Additional questions include how we can use operations management strategies and techniques, such as the Factor-Weighted Method (FWM), in industries such as brewing to make better managerial decisions.

METHODOLOGY

One of the objectives of this article is to analyze the environmental and corporate sustainability reports and practices of various breweries. The following breweries were reviewed: New Belgium Brewing (NBB), Anheuser Busch (AB-InBev), MillerCoors (MC), Woodchuck Cidery (WC), Heineken, Sierra Nevada, and Guinness (Diageo). This is a cross sectional sample of large international breweries and smaller "micro" or "craft" breweries. A scoring or rating system was devised for four of these breweries to compare their performance to establish baseline

benchmarks for the industry. Some of the activities and organizations supporting and encouraging sustainable operations which apply to the brewing industry include:

- The Beverage Industry Environmental Round-table (BIER)
- United Nations Global Compact CEO Water Mandate
- U.S Environmental Protection Agency's (EPA) Climate Leaders
- Regional EPA partnerships

This article outlines criteria breweries should use to establish sustainability scorecards in terms of social responsibility and environmental responsibility. This includes greenhouse gas (GHG) emissions, water conservation and reuse, energy consumption, energy intensity, and waste diversion rates. New Belgium, Heineken, AB-InBev, and Sierra Nevada were evaluated to determine scores and establish best in class benchmarks for sustainability in the brewing sector. A reporting of the scores and the implications of these findings provides an indication of what breweries should focus energies on and industry best practices. This article provides a quantitative analysis comparing the breweries based on reported data and information extending upon previous qualitative research.

LITERATURE REVIEW: SAMPLE PROFILES OF BENCHMARKED BREWERIES

The initial phase of this research involved the selection of breweries to establish common sustainability reporting. This section highlights some of these findings for three breweries.

New Belgium Brewing Company

New Belgium Brewing (NBB) is located in Ft. Collins, Colorado and uses the terminology "Alternatively Empowered" to describe their commitment to environmental sustainability (New Belgium Brewing, n.d.). Based on previous research as well as their self-reported data, they appear to be a leader in the brewing industry in terms of defining, monitoring, and acting to minimize their environmental impact. Their Corporate Sustainability Report (New Belgium Brewing, n.d.), a Sustainability Management System, and a Sustainability Blog are examples of forums of communication on the subject of sustainability located on their web-

site (<http://www.newbelgium.com/Sustainability.aspx>). The level of transparency present in the online documentation of their corporate sustainability programs is staggering. They take their commitment to the environment, social responsibility, and corporate sustainability very seriously.

The company documentation suggests that they are a very responsible company. They have set very lofty goals for their organization in terms of energy usage, greenhouse gas emissions, water usage, and recycling. Their first corporate sustainability report was published in 2007 and in 2009-2010 they reported that the only goal they had met in 2009 was their waste diversion goal, indicating an internal focus towards continual improvement in this area. While further validation and verification would be necessary to substantiate these claims, it is noteworthy that their reporting does not claim to achieve goals that they did not accomplish. Note that NBB is a privately held and 100 percent employee owned company (New Belgium Brewing Company, 2013) with no financial disclosures to the public. NBB's management and leadership seem to have ingrained environmental sustainability into the corporate culture of the organization. It has become more commonplace to exhibit a concern for the environment, and this seems to fit naturally in the brewing industry in terms of advertising and marketing; i.e., beer buyers tend to acknowledge that quality ingredients (e.g., barley, hops, etc.) make for quality beers. This can be seen from the growth of the American Craft Beer sector which has grown to be 13 percent of the overall market (The Economist, 2013) with over 2,500 craft breweries with a market value of \$100 billion (Hindy, 2014). The New Belgium brands have been able to take advantage of the environmental culture they have built and use it as a platform to market and sell their products.

Woodchuck Cidery

Woodchuck Cidery (WC) is based in Middlebury, Vermont and they take pride in the amount of water they use; one gallon of water per gallon of beer (or cider) compared to the industry average of six gallons of water per gallon of beer. They also use 100 percent recycled material and utilize local sourcing of apples to reduce transportation emissions (Woodchuck Cidery, n.d.). In addition, they are part of the Central Vermont Public Service Cow Power™ initiative which uses methane from waste to generate electricity (Central Vermont Public Service, n.d.) and they donate to the American Forests organization

(American Forests, n.d.).

There is not as much readily available documentation for WC as compared to the other two companies profiled in the section. This is likely a matter of scale; Woodchuck is much smaller than NBB and MC, so they likely have fewer resources dedicated to tracking, monitoring, documenting, and marketing their environmental sustainability efforts. As with NBB, WC's claims need further validation and verification by independent third parties of their reports. Our original research team (see acknowledgements) was unable to locate the specific goals for the organization in terms of energy usage, greenhouse gas emissions, water usage, and recycling. Their most notable brand is their name-sake "Woodchuck [Amber] Cider."

MillerCoors (MC) LLC

As a large joint venture head-quartered in Chicago, they have much larger centralized operations than either of the other two aforementioned companies profiled in this section. Miller's division offices remain in Milwaukee and Coors' in Golden, Colorado. Due to the scale and scope of their operations, public disclosures and reports are readily available. The MillerCoors financial result reports are typically released in May of each year for the first quarter results of a given year (MillerCoors LLC, 2014). Their most notable brands are Miller, Coors, Molson, and Pabst and they carry a wide array of products which they distribute and sell.

According to their 2009 Corporate Social Responsibility Report, MillerCoors "claims to recycle or reuse 98 percent of all brewery waste (Miner, 2009)." According to their 2010 Sustainable Development Report they have set a goal to use 3.5 gallons of water per gallon of beer by 2015 (MillerCoors, 2010), while NBB did not hit their 3.5 goal as of 2016 (New Belgium Brewing Company, 2016), both of which are still much greater than that reported by Woodchuck Cidery. MillerCoors is trying to reduce their energy usage by 15 percent and they are analyzing their logistical infrastructure to reduce carbon emissions associated with their transportation network.

LITERATURE REVIEW AND CRITERIA FOR COMPANY SELECTION

Scholarly and academic journals did not yield many results for articles on breweries and sustainability. As noted in the introduction, Thomas and Rahman

(2006) review various wastes and strategies for sustainability in breweries in their work from Aspect of Applied Biology (Thomas & Rahman, 2006). Improvements in sustainable production processes are documented as well, including topics such as cold chain food storage (Shashi, Singh, R., & Shabani, A., 2016); biological treatment (Driessens & Vereijken, 2003); wastewater reuse for electricity production (Wen, Wu, Zhao, & Sun, 2010); and yeast processing systems (Mensour, Margaritis, Briens, Pilkington, & Russel, 1997).

Based on the literature and the work of the preliminary research team, the following specific criteria was developed to evaluate and determine a 'best-in-class' brewery with respect to environmental impact and responsibility:

- Greenhouse Gas Reduction or Mitigation Policy
- Corporate sustainability index or measure / reporting
- Quantitative carbon footprint measure / reporting
- Process improvement initiatives (e.g., six sigma) projects focused on environmental impact
- Donations to environmental causes
- Recycling / Reuse Programs (e.g., water stewardship)
- Waste Management Programs
- ISO 26000 compliance (International Organization for Standardization, n.d.)

These criteria were deemed as important because an organization must be able to measure their impact on the environment in order to change vision, policy and procedures to make improvements. To this end, companies should strive to measure their greenhouse gas emissions (GHG) and have some form of reduction and/or mitigation policy. For example, in the case of New Belgium, they have been tracking their direct and indirect GHG emissions and had set a very lofty 25 percent reduction goal for 2015 (New Belgium Brewing, n.d.). As of 2016, they still have not hit their reduction goal (New Belgium Brewing Company, 2016).

Leading breweries in environmental sustainability should be actively tracking and reporting their carbon emissions footprint and should be specifying reduction goals as well as donating to environmentally friendly organizations. This would typically be ac-

complished through some form of process improvement initiatives. New Belgium reported their scope 1, 2, and 3 emissions in their 2016 sustainability report (New Belgium Brewing Company, 2016). It was noted that in this particular industry sector, it seems that the breweries are donating to various environmental causes; so another metric was developed to measure the organizational spending on donations and the agencies benefiting from this philanthropy. For example, MC on February 23, 2011 donated \$80,000 to benefit local river organizations (Platt, 2011) and NBB has donated more than \$6 million since the company was founded (New Belgium Brewing Company, 2014).

Recycling and reuse in the brewing process is critical due to the amount of water used. Another industry terminology for this is 'water stewardship.' For example, MC recycled or reused 98 percent of their waste in 2008 (Miner, 2009) and had three zero waste facilities in 2010 (Hincha-Ownby, 2010). Waste management is critical for breweries, in particular wastewater management, as noted above. This should be used as a common metric as well in terms of water used per gallon of beer produced. Note that traditional breweries may have a different target value when compared to other production processes such as cider brewers, distilleries, etc. One example of a stated objective in this category may be that of 'zero waste' production operations. Waste is often explored in the lean and six sigma continuous improvement methodologies (Bumblauskas, Keegan, & Meyer, 2015; Bumblauskas & Meyer, 2015).

Standardization of processes internationally is also an important consideration. For example, ISO 26000 is an international standard for social responsibility and The American Society for Quality (ASQ) had a 2011 conference program titled "Pathways to Social Responsibility," which was held June 16-17, 2011 in San Francisco, CA to address these topics (ASQ, n.d.). This conference focused on quality in the area of social responsibility including the, "opportunity to share ideas and best practices surrounding the social responsibility principles in [our] organization[s]." The use of the methods details in this article further advance the opportunity for improved environmental and social responsibility, particularly those linked to ISO 26000 reporting. The awarding of grants and donations to non-profit environmental organizations further extend the reach of breweries beyond the scope of their site specific operations.

Sustainability at New Belgium Brewing (NBB) Company

Given the overwhelming availability of publicly available information, NBB was selected to be profiled as a company to benchmark against in the industry as best-in-class. The objective of this section is to analyze the environmental and corporate sustainability of NBB to provide a framework for comparative research in the brewing industry. As previously mentioned, Gary Hirshberg, CEO of Stonyfield Farms and an eco-entrepreneurial pioneer, has said that Jeff Lebesch, New Belgium's co-founder "...worked harder than anybody else in the brewing industry to achieve true carbon reduction and sustainability...(Hirshberg, 2008)." While New Belgium spends a great deal of time and effort on environmental sustainability, they also consider economic and social sustainability as detailed in their sustainable business story (New Belgium Brewing, n.d.). Here are some of their pillars from the report:

"At New Belgium to be environmental stewards we believe we need to:

- Lovingly care for the planet that sustains us.
- Honor natural resources by closing the loops between waste and input.
- Minimize the environmental impact of shipping our beer.
- Reduce our dependence on coal-fired electricity.
- Protect our precious Rocky Mountain water resources.
- Support innovative technology.
- Focus our efforts on conservation and efficiency.
- Advocate for policies which enable restorative practices.
- Share our wealth with non-profits working to protect natural resources.
- Model joyful environmentalism through our commitment to relationships, continuous improvement, and the camaraderie and cheer of beer.
- Remember that if it's not fun, it's not sustainable! (New Belgium Brewing, n.d.)"

SUMMARY OF KEY FINDINGS AT NBB

NBB is a leader in the brewing industry in terms of defining, monitoring, and acting to minimize their

environmental impact. It did not take our original research team long to determine that they are one of the best-in class organizations in the beer sector in terms of their programs and culture minimizing environmental impact and maximizing social responsibility. Their Corporate Sustainability Report (New Belgium Brewing, n.d.), Sustainability Management System (New Belgium Brewing, Inc., 2009), and Sustainability Blog available via their website are filled with examples and programs aimed to communicate their passionate position on these topics.

A research team member of our initial report, Katie Levy-McCoy, noted that "New Belgium Brewery began when co-founder Jeff Lebesch created two home beers from Belgian inspired ingredients, Fat Tire and Abbey. Along with his co-founder and wife, Kim Jordan, New Belgium Brewing went commercial in 1991, and outgrew their basement operations in 1995 and moved to 500 Linden Street, Fort Collins Colorado, which now currently houses two Steinecker brewhouses, four quality assurance labs, kegging line, canning line, state of the art bottling line, and a wastewater treatment facility (New Belgium Brewing, 2007)."

In "Stirring It Up: How to Make Money and Save the World," Gary Hirshberg (2008) details the management team and their work in the area of sustainability. In 2000, co-founder Jeff Lebesch transitioned from CEO to director of the board naming his wife Kim Jordan CEO and later created an executive level director of sustainability position. In addition, Jeff and Kim have been actively engaged and recognized for their work by numerous state and federal agencies. They have created a workplace that is typically scored as one of the best places to work in the United States by agencies such as the Wall Street Journal and Outside Magazine (New Belgium Brewing, n.d.). Later, Christine Perich moved from COO to CEO of New Belgium, only to leave in October 2016 (Furnari, 2016) to be "temporarily" replaced again by Jordan (Klemaier, 2016).

Landscape assessment of the brewing sector

The sector is seeing massive consolidation today in terms of mergers and acquisitions. Small "craft" breweries such as New Belgium are competing with large global operations such Anheuser-Busch InBev (<http://www.ab-inbev.com/>) and MillerCoors (<http://www.millercoors.com/>)

who have the ability to leverage large supply chain networks and economies of scale. When it comes to benchmarking and norms in the beer industry, New Belgium is referenced in nearly every article our research team came across, with Sierra Nevada also commonly referenced. The most common form of pollution in the industry is water pollution. For example, in March 2011 it was reported that Starr Hill Brewery in Virginia had complaints of water pollution filed linking its wastewater to the death of wildlife in their area (Johnson, 2011).

RESEARCH FRAMEWORKS AND METHODOLOGY

The following list contains some of the external frameworks reviewed by our research team:

- Global Reporting Initiative (GRI, <http://www.globalreporting.org/Home>),
- Electronic Industry Citizenship Coalition (EICC, <http://www.eicc.info/>),
- Carbon Disclosure Program (CDP, <https://www.cdproject.net/en-US/Pages/HomePage.aspx>),
- The Sigma Project Guidelines (<http://www.projectsigma.co.uk/Guidelines/SigmaGuidelines.pdf>)
- <http://www.projectsigma.co.uk/Toolkit/SIGMABusinessCase.pdf>
- <http://www.projectsigma.co.uk/Toolkit/SIGMARiskOpportunity.pdf>,
- U.S. Environmental Protection Agency (EPA). Design for Environment (<http://www.epa.gov/oppt/dfe>),
- AccountAbility: Redefining Materiality (<http://www.accountability.org/images/content/0/8/085/Redefining%20Materiality%20-%20Full%20Report.pdf>),
- Baldrige National Quality Program. (2011-2012). Criteria for Performance Excellence. http://www.nist.gov/baldrige/publications/upload/2011_2012_Business_Nonprofit_Criteria.pdf

These external frameworks generally do not make specific references to external frameworks in the brewing industry. Reporting is generally voluntary and organizations in this sector do their own reporting. The

reports seem to be well put together and comprehensive; if a company in the industry was interested in developing a sustainability platform they could review the publicly available information published by New Belgium, Sierra Nevada, MillerCoors, Diageo, etc. to guide their sustainability programs. For example, Stelios Pesmajoglou, discussed MillerCoors as an example of an organization setting voluntary intensity targets for greenhouse gas emission reduction; they set a goal of 18 percent per barrel reduction in GHG emission from 2001-2006 (Pesmajoglou, 2011).

Key Programmatic Elements and Metrics: Criteria to be Utilized

Our research team developed industry specific criteria deemed to be important in the brewing sector to help measure their impact on the environment in order to change vision, policy and procedures to make improvements. Our team developed the following criteria to evaluate our selected organizations and for the comparative analysis and benchmarking, NBB was selected to illustrate ways to measure each criteria. It is note-worthy to point out that the 2007 and 2009 NBB sustainability reports contain many, many more examples than those listed below; only selected significant contributions to each criteria are listed below. This method is commonly referred to as the Factor Rating, Factor-Weighted, or Factor Weighting Method (FWM) (Heizer & Render, 2013).

Consolidated Sustainability Criteria [Scorecard] Using FWM

A breakdown of each element in the criteria matrix is detailed in the sections below. It is assumed that each element carries an equal weight of 10 percent for each of the 10 elements and scoring for specific breweries is conducted on a 10 point scale (e.g., 0/10 = worst, 10/10 = best). For a summary of the criteria, please see Exhibit 1.

Social Responsibility

- Donations to environmental/social causes and community involvement 10%
 - In 2009, New Belgium donated \$490,000 via their local grants program (New Belgium Brewing, n.d.; New Belgium Brewing, n.d.).
 - Donate 1 percent of revenues to environmental non-profits (New Belgium Brewing, n.d.).

- Transparency / self-review process / communications 10%
 - New Belgium is very critical of their performance in their annual sustainability reports. Detailed reports can be found online at their website (2007, 2009, 2016).
- Employee sustainability culture/benefits to employees for 'green' behavior 10%
 - The alternatively empowered initiative captures the essence of New Belgium's commitment to a culture of sustainability.
 - Typically voted as a top work place for employees, including being a bike-friendly business.
- Greenhouse gas reduction/mitigation plan 10%
 - There is a detailed discussion of this below in the environmental sustainability criteria section, but the objective is to reduce their GHG emissions by 25 percent by 2015.
- Distribution efficiency 10%
 - The Climate Conservancy found that 8.4 percent of GHG emissions for Fat Tire were from distribution of their products, thus there has been a focus on reducing transportation costs (The Climate Conservancy, 2008). New Belgium is now tracking all of their scope 1, 2, and 3 emissions (New Belgium Brewing Company, 2016) from distribution of their products and making improvements to their supply chain and logistics management (New Belgium Brewing, n.d.). The latest results being reported are in their 2016 sustainability report (New Belgium Brewing Company, 2016).
 - Purchased 39 hybrid vehicles for company fleet (New Belgium Brewing, n.d.).

Total Social Responsibility component **50%**

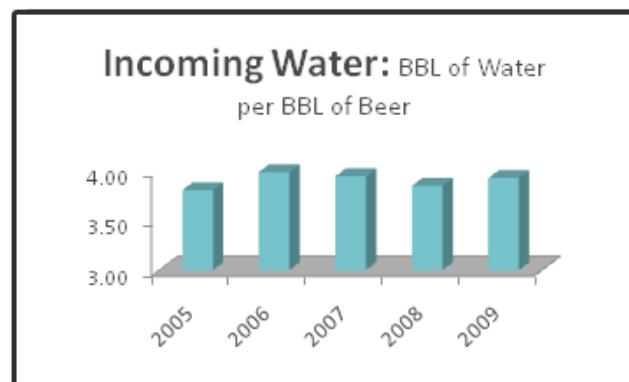
▪ Maximum Possible Social Responsibility Score = 50/50

Environmental Responsibility

- Water management (critical resource) 10%
 - Water management is critical for breweries, in particular wastewater. We considered the com-

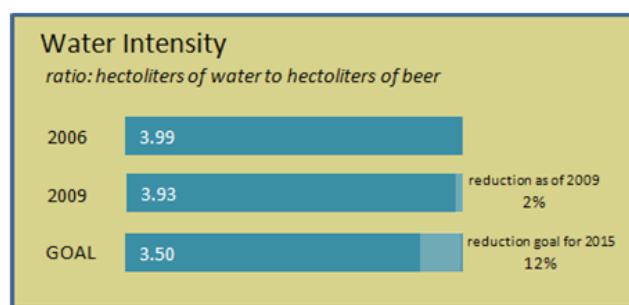
mon metric of water used per gallon of beer produced. In the case of New Belgium, it takes an average of 3.9 gallons of water to produce 1 gallon of Fat Tire beer, less than the industry average of 5 gallons of water per 1 gallon of beer (New Belgium Brewing, n.d.). Figures 1 and 2 summarize these findings.

Figure 1. New Belgium Water Usage (New Belgium Brewing, n.d.)



- 14 percent of New Belgium's electricity comes from on-site wastewater treatment plant which cleans all of their wastewater

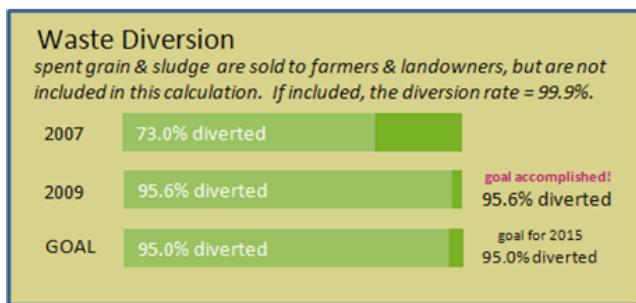
Figure 2. New Belgium Water Stewardship (New Belgium Brewing, n.d.)



- Recycling / Reuse (management of waste created) 10%
 - New Belgium's on-site Process Water Treatment Plant uses microbes to clean all production wastewater (New Belgium Brewing, n.d.). The process produces methane gas which later is recycled to produce electricity. The methane cogeneration process cleans wastewater and produces electricity (Hirshberg, 2008).
 - 50 percent of New Belgium's glass usage is from recycled sources (Goldman-Armstrong, 2007).

- The brewery recycles or resells 99.3 percent of spent grain and yeasts and have collected data to measure the waste diverted from landfills as shown in Figure 3 (New Belgium Brewing, n.d.).

Figure 3. New Belgium Waste Diversion (New Belgium Brewing, n.d.)



- 12 and 24 pack packaging are made of 88 percent recycled materials; all other product packaging is 100 percent recycled content (New Belgium Brewing, n.d.).

- Production efficiency (waste reduction) 10%
 - The “Merlin” brewing kettle is 65 percent more efficient than competitors (Hirshberg, 2008).
 - 99.9 percent of all waste was diverted from landfills as shown in Figure 3 (New Belgium Brewing, n.d.).
- Supply chain management (energy efficiency, GHG reduction) 10%
 - The energy used per gallon of beer sold has been reduced by 3% between 2008 and 2009. Furthermore the Brewery is planning to increase its energy efficiency by 25% by 2018 as shown in Figure 4 (New Belgium Brewing, n.d.). Use of heat exchangers provides for more energy efficient operations (Hirshberg, 2008).

Figure 4. New Belgium Energy Reduction Targets (New Belgium Brewing, n.d.)

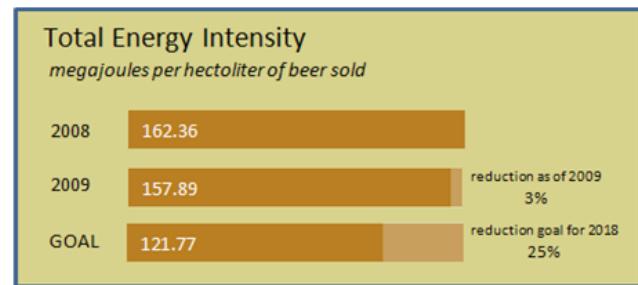
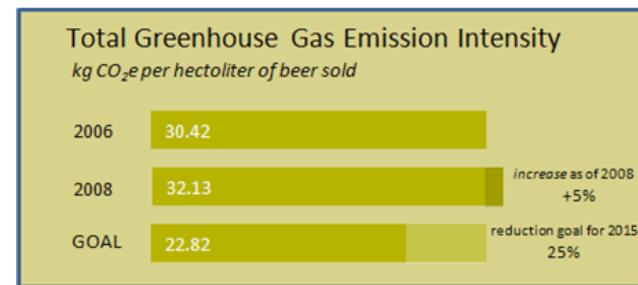


Figure 5. New Belgium GHG Emissions (New Belgium Brewing, n.d.)



- New Belgium Brewing Company worked with The Climate Conservancy to complete a greenhouse gas life cycle assessment for a six-pack of the brewery’s flagship Fat Tire beer. Their assessment concluded that only a minor portion (5% or 172 g of CO2e) of the carbon footprint can be attributed to the brewing process. The remaining 95% are distributed among raw material cultivation and distribution (48%, 1531g of CO2e) and downstream distribution costs (47%, 1484g of CO2e) for a total carbon footprint of 3,188 grams of CO2 equivalents (g CO2e) (The Climate Conservancy, 2008). Our research team located carbon footprints for other common household goods for comparison:
 - Fat Tire: 7.03lb of CO2 per six pack
 - According to National Dairy Holdings, a gallon of milk has a carbon footprint of 6.19 to 7.59 lb. A gallon of laundry detergent carries an environmental footprint of 31 pounds; and a small sedan has a carbon footprint of 97,000lb. (Ball, 2009).
 - According the Wall Street Journal, Timberland advised that flip-flop sandals have a footprint of 22 to 44 lbs., shoes 66 to 132 lbs., and hiking boots 154 to 198 lbs. while Patagonia advised the carbon footprint for one of their jackets is 66 lbs. (Ball, 2009).

- New Belgium is at the forefront of assessing carbon footprints of products in the brewing industry. This could lead to an increased visibility of energy usage in this industry similar to the labeling used by companies such as Timberland (Figure 6).

Figure 6. Timberland Boots Energy Usage Label (Background Stories, 2008)

Our Footprint Notre Empreinte	
Environmental Impact Impact sur l'environnement	
Energy to Produce: (per pair)*	2kWh
Énergie utilisée (par paire)*	2kWh
Renewable energy (Timberland-owned facilities):	5%
L'énergie renouvelable (sites appartenant à Timberland) :	5%
Community Impact Impact sur la communauté	
Hours served in our communities:	119,776
Nombre total d'heures données :	119,776
% of factories assessed against code of conduct:*	100%
% d'usines évaluées pour leur conformité au code de conduite :*	100%
Child labor:*	0%
Main-d'œuvre enfantine :*	0%
Manufactured Fabriqué à	
Shingtak, China Shingtak, Chine	
* metrics based on global footwear production for 2005	
* informations fondées sur production totale de chaussures en 2005	
FOR MORE INFORMATION VISIT WWW.TIMBERLAND.COM/CSRREPORT POUR PLUS D'INFORMATIONS : WWW.TIMBERLAND.COM/CSRREPORT	

Table 1. Sustainability Comparison Based on 2008 and 2016 Reporting and Data.

Company name	New Belgium as of 2016 (goal for 2018)	New Belgium 2006- 2008 (goal for 2015)	Heineken ¹ (goal for 2020)	ABInBev	Sierra Nevada
L water/L beer	4.0	3.99 (3.5)	5.1 (3.7)	3.5 ³	5.8
GHG emissions kg (CO2/ hL)	15.95	Revised 18 (14) Original 32.1 (22.8)	10.4 (6.8)	NA	NA
Energy consumption (kWWh/bbl)		16.95	NA	NA	16.45
Energy Intensity (MJ/hl)	130 (146)	162 (121) ²	175	NA	NA
Waste diversion rate (%)	99.8	99.3	NA	NA	99.6
Waste diversion rate (%) <i>excluding spent grain</i>	98.09	73.3 (95)	NA	NA	92.9

1 – Includes soft drinks, cider and water in the denominator

2 – Goal for 2018

3 – Based on 2009 data

- Energy procurement (incorporation of renewables) 10%

- All of New Belgium's energy has been 100 percent met by wind power since 1999 which is estimated to have eliminated 28 million pounds of CO2 emissions from 1999-2002. (Hirshberg, 2008)

Total Environmental Responsibility component 50%

- **Maximum Possible Environmental Responsibility Score = 50/50**

Total Social and Environmental Responsibility Score 100%

- **Maximum Possible Social and Environmental Responsibility Score = 100/100**

FINAL RESULTS AND COMPARATIVE EXAMPLE

Table 1 provides a summary of the key metrics for brewing sustainability for four organizations: New Belgium, Heineken, Anheuser Busch – InBev (ABInBev), and Sierra Nevada.

The final step was to quantify the scoring matrix for each organization as provided in Exhibit 2. In addition, strengths and weaknesses for each brewery were also reported and have been partially removed in this version of the article. The strengths and weaknesses were qualitative summaries used to justify the quantitative scores determined by the research team based on the reported data as of 2011.

FUTURE WORK

The data and findings from this study are for data as of 2016 for the United States region and should be expanded to include additional regions (e.g., Europe,

Asia, South America, etc.) and scale (e.g., microbreweries vs. large commercial breweries). More specifically, a consulting project conducted for Diageo (Guinness) in 2012 can be incorporated into future research work in terms of the efficiency and sustainability of the maturation portion of the brewing process. This project made use of the six sigma method for continuous improvement. There is a need to validate and verify the additional self-reported data and claims by working with individual breweries, such as what was done herein with New Belgium. This work provides an industry overview and methodology for measuring sustainability and environmental performance in the brewing industry.

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- Bryan Simpson, New Belgium Brewing

To illustrate the developed sustainability criteria, this article frequently references the 2009 New Belgium Sustainability Story (Report) for benchmarking purposes. The 2007 Sustainability Report is available here: <http://www.newbelgium.com/files/shared/07SustainabilityReportlow.pdf>. The 2016 Sustainability Report is available here: <http://www.newbelgium.com/docs/default-source/sustainability/2016sustainabilitybrochure.pdf?pdf=sustainabilityreport>.

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Exhibit 1. Research Team Selected Criteria for Sustainability

- **Social Responsibility**
 - Donations to environmental/social causes and community involvement
10%
 - Transparency / self-review process / communications
10%
 - Employee sustainability culture/benefits to employees for 'green' behavior
10%
 - Greenhouse gas reduction/mitigation plan
10%
 - Distribution efficiency
10%
- **Total Social Responsibility component**
50%
- **Environmental Responsibility**
 - Water management (critical resource)
10%
 - Recycling / Reuse (management of waste created)
10%
 - Production efficiency (waste reduction)
10%
 - Supply chain management (energy efficiency, GHG reduction)
10%
 - Energy procurement (incorporation of renewable)
10%
- **Total Environmental Responsibility component**
50%

Total Social and Environmental Responsibility Score 100 %

Exhibit 2. Consulting Team Selected Criteria for Sustainability**NBB Score (100/100):**

- Weaknesses: Water management-'09 at 3.93 water use per hectoliter and 3.5 goal for 2015 ;
- Strengths: wind power for electricity and co-generation of methane for heat; LCA on 6-pack of beer production; 95.6% waste diverted as of '09

Heineken (83/100):

- Weaknesses: Water management, 2010 water consumption dropped to 4.5 hectoliters, they have a 25% reduction goal by 2020.
- Strengths: Company is buying fridges that use environmentally friendly hydrocarbon refrigerants, LED lighting, energy management systems. Goal of 50% reducing in energy from cooling by 2020.

ABInBev (71/100):

- Weaknesses: need to conduct full LCA on operations in order to identify cost savings associated with their light weighting of packaging and implementing a more formal Supplier assessment/GHG innovation program like Walmart; only has 8% alternative energy sources. Bio-Energy Recovery Systems (BERS) captures methane from water leftover from the brewing process to produce steam.
- Strengths: Water management and reduction efforts provide an overall 8.5% reduction from '08 to '09 and 4.3 water use per hectoliter production in '07 to 3.5 in '09; met goal of 5% GHG reduction by 2010 early, so further reduction commitment of 15% by 2013.

Sierra Nevada (83/100):

- Weaknesses: Water Management, Transparency, Quantitative Sustainability Indices.
- Strengths: Renewable Energy, Supply Chain, Community intervention, Energy and Waste Management.