Brewers Association

2015 Sustainability Benchmarking Report

BREWERS ASSOCIATION®

table of contents

acknowledgements

This project would not have been possible without the support of the Brewers Association (BA) Sustainability Subcommittee and the nearly 80 craft breweries that collected and shared their data so that everyone in the sector could improve and continue to grow in a responsible manner. The case studies provided, illustrate the creativity and application of sustainability best practices in the craft brewing sector. Our particular thanks go to the Sustainability Subcommittee members who provided insight and who helped drive participation by the BA membership:

BREWERS ASSOCIATION SUSTAINABILITY SUBCOMMITTEE:

Cheri Chastain – Sierra Nevada Brewing Co. (co-chair)

Katie Wallace – New Belgium Brewing Company (co-chair)

Luke Truman – Allagash Brewing Company

Casey Chartier – Bear Republic Brewing Co.

Walker Modic – Bells Brewery, Inc.

Kris Spaulding – Brewery Vivant

Ian Hughes – Goose Island Beer Co.

Saul Kliorys – Great Lakes Brewing Co.

Christian Ettinger – Hopworks Urban Brewery

Margaret Bishop – Worth Brewing Company

Marcus Powers – Zipline Brewing Co.

Chuck Skypeck – Brewers Association

John Stier – Antea Group

We would also like to thank the sustainability management consulting team from Antea® Group who collected and analyzed the data and developed the benchmarking report.

acknowledgements

Particular thanks also go to the many breweries that took the time to complete the benchmarking data tool in order to provide input for this study. The time spent to provide this data was used to identify trends and insights among the craft brewing segment that many BA members have been seeking for years. Your willingness to participate has resulted in the first ever study of its kind within this sector, and will hopefully inspire others to participate in future benchmarking efforts. We hope you find the information presented in this report of use to help inform business and operational decisions that will help continue to make your brewery more sustainable, and more profitable for years to come.

Alaskan Brewing Co.
Allagash Brewing Company
August Schell Brewing Company
Bear Republic Brewing Co.
Bell's Brewery, Inc. - Comstock
Bell's Brewery, Inc. - Kalamazoo
Beltway Brewing Company
Bent Brewstillery
Big Wood Brewery
Birdsong Brewing Co.
Black Warrior Brewing Company
Brewery Vivant
Broken Bow Brewery
Broken Compass Brewing Company
Brooklyn Brewery
Burning Brothers Brewing
Craft Brew Alliance - Kona
Craft Brew Alliance - Portland
Craft Brew Alliance - Portsmouth
Craft Brew Alliance - Woodinville
Cigar City Brewing
Creemore Springs Brewery
Dangerous Man Brewing Co.
Deschutes Brewery
Discretion Brewing
Dry Dock Brewing Co. – North Dock
Dry Dock Brewing Co. – South Dock
Elliott Bay Brewhouse and Pub - Burien
Elliott Bay Public House and Brewery - Lake City
Elliott Bay Brewery and Pub - West Seattle
Epic Brewing Company
Ethereal Brewing
Falling Sky Brewing
Figueroa Mountain Brewing Co.
FiftyFifty Brewing Co.
Flying Fish Brewing Co.
Foundation Brewing Company
Fremont Brewing
Fulton Beer
Goose Island Beer Co.
Great Divide Brewing Co.
Great Lakes Brewing Co.
Hopworks Urban Brewery
Iron Horse Brewery
Jack Pine Brewery
Jackie O's Pub & Brewery - Campbell St
Jackie O's Pub & Brewery - West Union St
Karl Strauss Brewing Company
Kettlehouse Brewing Co. - Northside
Kettlehouse Brewing Co. - Southside
Kinetic Brewing Company
Lazy Magnolia Brewing Company
Maine Beer Company
Mankato Brewery
Mike Hess Brewing - North Park
New Belgium Brewing Company
Odell Brewing Co.
Orlando Brewing
Revolution Brewing
Rising Tide Brewing Company, LLC
Sierra Nevada Brewing Co.
Standing Stone Brewing Company
Steel Toe Brewing
Stillmank Brewing Co.
Stone Brewing Co.
Switchback Brewing Co.
The Pike Brewing Company
The St. Louis Brewery - Bottleworks
The St. Louis Brewery - Taproom
Three Taverns Craft Brewery
Uinta Brewing Co.
Upland Brewing Co.
Upper Hand Brewery
Urban Chestnut Brewing Company - Grove
Urban Chestnut Brewing Company - Midtown
Victory Brewing Company
Worth Brewing Company
Yards Brewing Company
Zipline Brewing Co.

executive summary

A definition for "best in class" for craft breweries is an evolving target. Growth is ongoing and has not yet seen a leveling off point. Breweries are still opening, expanding and learning both as they go (on the job) and by seeking advice from each other or other professionals within the industry. We can draw a line today with a backward-looking data set to define "best in class" but that will change over time as the operations mature.

Increasingly, environmental stewardship is a priority for beer drinkers, brewers and future generations. Maintaining a healthy balance between stewardship, social enrichment, and economic vitality is important to the future of craft brewing. Brewers Association (BA) members have expressed a desire to benchmark key performance indicators (KPIs) on a consistent basis in order to set aggressive, but realistic, goals and targets.

Craft brewers often seek and evaluate the transfer of best practices from large global brewers. Since 2007 the Beverage Industry Environmental Roundtable (BIER) has been benchmarking more than 1,900 beverage manufacturing locations worldwide. Benchmarks are produced for the industry as well as subgroups by production type (brewery, distillery, winery, bottling). The annual benchmarking study has been a cornerstone of BIER's environmental stewardship agenda. Over the years, the study has grown to become the most comprehensive quantitative benchmark of water and energy use and efficiency in the beverage industry. Participants are able to compare their operations with that of their peers in order to understand where opportunities for improvement may exist, and to prioritize projects or initiatives for years to come. Some of the prior trends observed from BIER member benchmarking will be referenced when discussing specific use ratios and trends.

This report presents a summary of the industry trends and findings from production, cost and utility usage data generously provided by BA member breweries. We hope that other brewers will participate in the future and use this information to improve efficiencies, reduce operational costs/risks, and reduce environmental footprints.

introduction

The Brewers Association (BA) conducts and hosts a number of surveys and forums that assist the craft brewing sector in brewing the highest quality beer in a profitable manner. This first Sustainability Benchmarking Report shares additional insight on key performance indicators (KPIs) and best practices of sustainable brewers. It represents the participation of nearly 80 breweries of all sizes and regions within the U.S. Detailed monthly economic and environmental data for calendar year 2014 were collected, analyzed and trended. The insights and best practices identified from these data will assist the sector to continue to grow in a responsible manner. The purpose of the BA is to promote and protect American craft brewers, their beers and the community of brewing enthusiasts. As brewers, we acknowledge that we depend upon the natural resources and communities that make our livelihoods possible, and that threats to these systems affect our ability to brew beer.

The BA has established a Sustainability Subcommittee that serves the BA purpose by helping members continue to brew the highest quality beers in a manner that strengthens the value of our businesses, protects the environment for brewing ingredients and future generations, and enhances the lives of our workforce and the communities we call home.

Sustainability Definition

There are many definitions and interpretations of the term "sustainability". The classic definition includes three pillars of focus: economic, environmental and social well-being.

To be a sustainable business, there should be a balance between all three pillars. Economic sustainability is the ability to support a defined level of profitability and growth to continue at an acceptable rate. Environmental sustainability is the ability to use natural resources as efficiently as possible, minimize the creation of waste and pollution, and do so in a manner that can be continued indefinitely. Social sustainability is the ability to attract and retain the best employees, provide them with a safe and prosperous place to work, and give back and support the local community.

This BA subcommittee is helping to create additional business value through:

- *Direct funding and research towards sustainability related issues and solutions that drive the greatest business value for our membership;*
- *Identifying, benchmarking and sharing sustainability related best practices, tools, and resources that are applicable to breweries of all sizes; and*
- *Promoting craft brewing as a sustainable sector by showing what is possible through collaboration and uniting a cohesive voice that inspires change.*

The Brewers Association sustainability subcommittee has identified six priority actions for environmental focus:

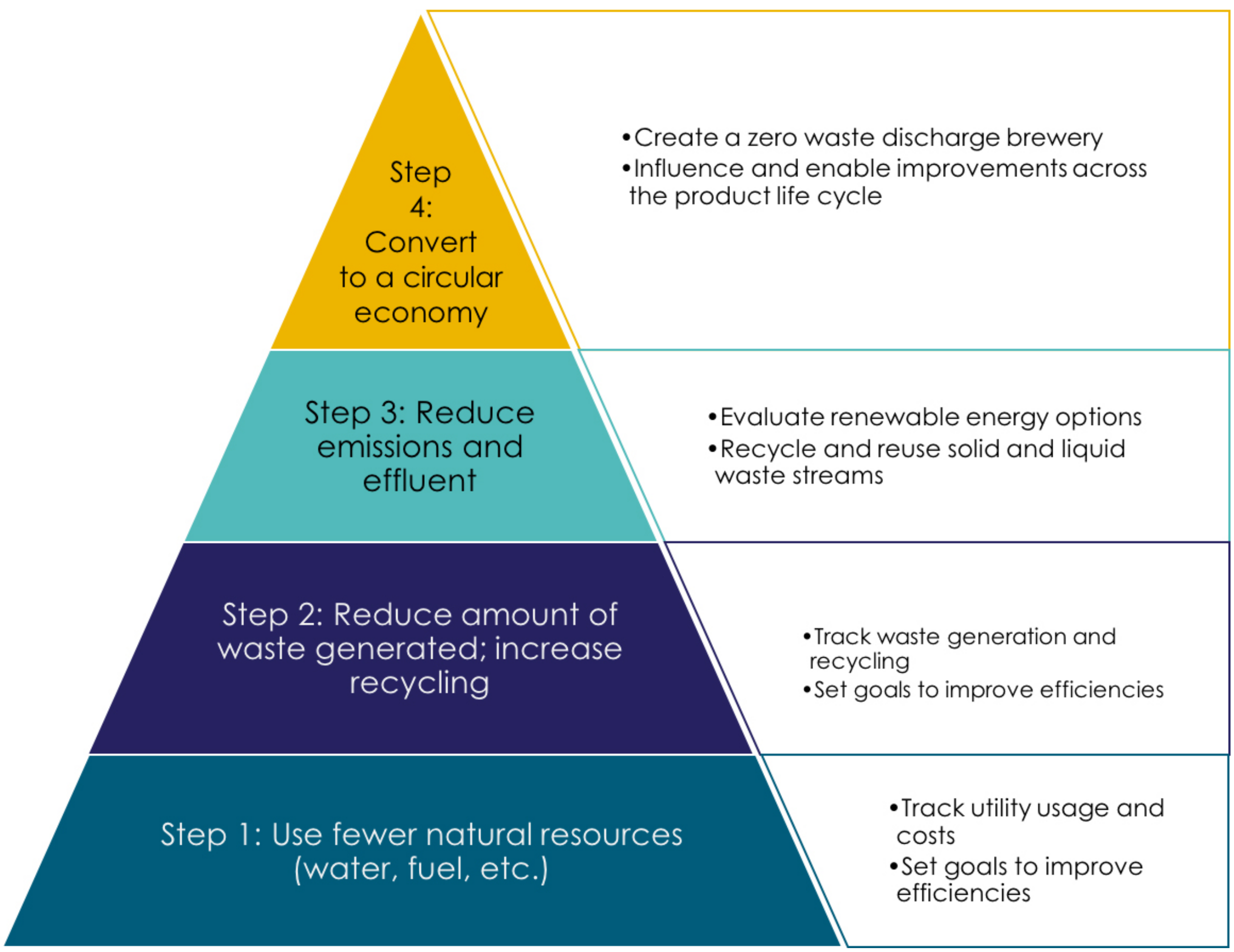
- *Improve the usage efficiency of energy, water and other natural resources*
- *Reduce the amount and impacts of waste created and disposed*
- *Protect the long-term viability of watersheds in which we operate*
- *Identify and promote more sustainable barley and hop growing practices*
- *Identify and promote more sustainable packaging options*
- *Increase member education and engagement in sustainability related initiatives*

Environmental Attributes

The environmental aspects of sustainability are the main focus of this benchmarking report. Key performance indicators (KPIs) include: fuel, electricity, water and purchased CO_2 usage efficiency; wastewater effluent, greenhouse gas emissions, solid waste disposal and recycling efficiencies. The diagram below outlines a hierarchy craft breweries can use to reduce their environmental impact in a logical progression. Through these steps, it is possible for the sector to grow in a more sustainable manner.

It is important to note the potential adverse impacts of disregarding the order of these steps. If a brewery chooses to purchase "green energy" before making efforts to reduce their natural resource usage, the impacts may nullify each other, therefore rendering the investment ineffective. To be sustainable, breweries should take steps to improve their own operations before considering steps to improve supply and distribution chains.

Usage and emissions efficiencies are affected by a number of variables including building and equipment age and configurations, brewing process operations, brewing recipes and styles, local climatic conditions, etc. We have commented on these variables throughout the report and how they may impact accurate comparisons.



Economic Attributes

The importance of balancing economic, environmental and social attributes has been outlined earlier in this report. Reducing environmental impacts at a brewery is very important, but the economics of implementation should be considered equally important. This first benchmarking study, collected both usage and cost efficiency related information. It is important for brewers to understand the costs of electricity, fuel, water, wastewater, and waste disposal before embarking upon a sustainability program. Similar to usage information, these costs are normalized on a per barrel packaged basis. Accordingly, this shows the economies of scale when comparing a small brewery producing less than 1,000 barrels to a regional brewery producing more than 100,000 barrels packaged per year.

There are obvious geographic variables to be considered in comparing cost efficiencies. The price of utilities is not only specific to a geographic region, but sometimes very specific to a community within a particular region. This variability is most evident in the price for municipal water supply and wastewater treatment. As water scarcity becomes more of a reality across the country for breweries, it is evident the cost of water and wastewater discharge will continue to increase.

Inflation can also play a part in comparing data from year to year. This report is based on 2014 actual data. This should be considered when comparing data from other years to this dataset.

Industry Market Segments

As defined by the BA, the data has been classified in three distinct craft beer industry market segments: brewpubs, microbreweries and regional craft breweries. Each of these segments will be trended and analyzed in this report.

Brewpub

A restaurant-brewery that sells 25 percent or more of its beer on site. The beer is brewed primarily for sale in the restaurant and bar. The beer is often dispensed directly from the brewery's storage tanks. Where allowed by law, brewpubs often sell beer "to go" and/or distribute to off-site accounts. Note: BA re-categorizes a company as a microbrewery if its off-site (distributed) beer sales exceed 75 percent.

Microbrewery

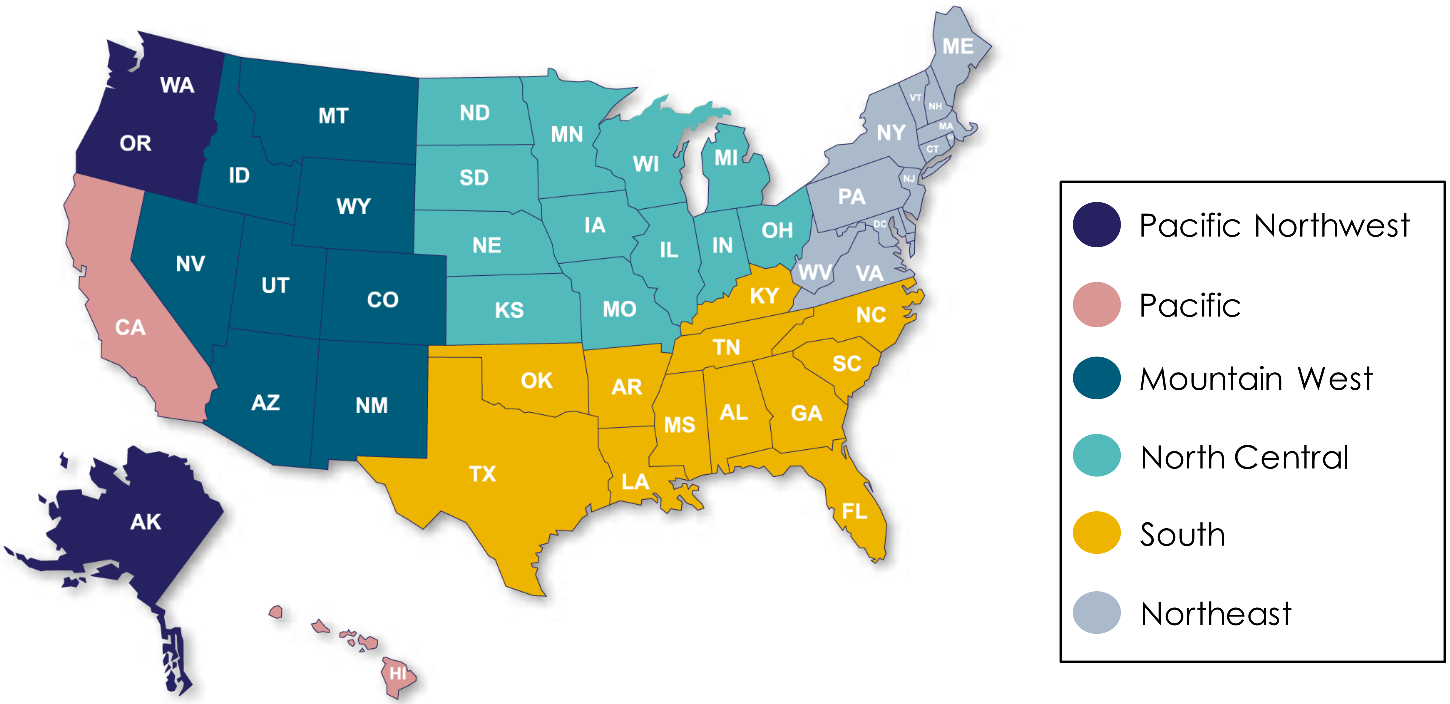
A brewery that produces less than 15,000 barrels (17,600 hectoliters) of beer per year with 75 percent or more of its beer sold off-site. Microbreweries sell to the public by one or more of the following methods: the traditional three-tier system (brewer to wholesaler to retailer to consumer); the two-tier system (brewer acting as wholesaler to retailer to consumer); and, directly to the consumer through carry-outs and/or on-site tap-room or restaurant sales.

Regional Craft Brewery

An independent regional brewery with a majority of volume in "traditional" or "innovative" beer(s), that produces between 15,000 and 6,000,000 barrels annually.

Geographic Regions

As defined by the BA, there are six distinct regional designations: Northeast, South, Mountain West, North Central, Pacific Northwest and Pacific. Each of these geographic regions will be trended and analyzed separately in this report. In addition, some non-U.S. craft breweries provided data for the study. These will be grouped in a separate geographic region for purposes of this report.



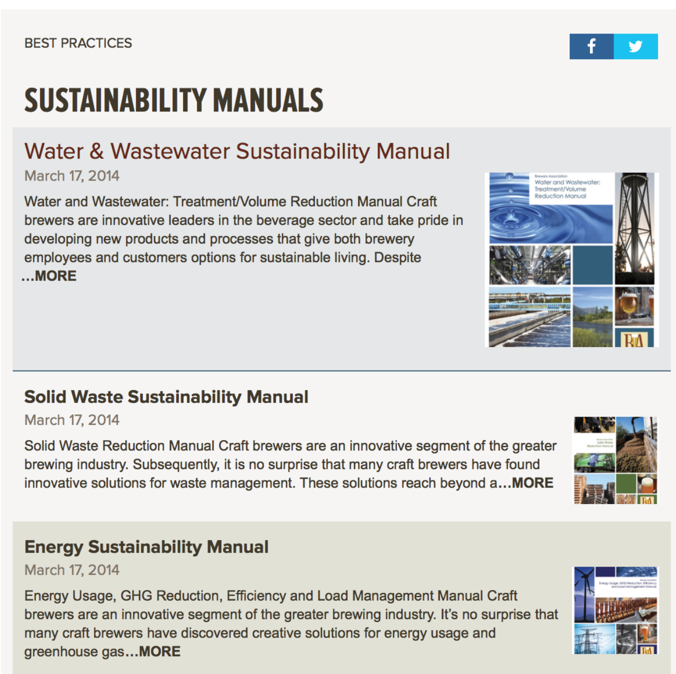
section 1:

Project Description

Increasingly, environmental stewardship is a priority for both beer consumers and producers. Maintaining a healthy balance between stewardship, social enrichment, and economic vitality is important to the future of craft brewing. BA members expressed a desire to benchmark key performance indicators (KPIs) on a consistent basis in order to set aggressive, but realistic, goals and targets.

About the Project

In 2013, the BA began working with Antea Group, a global sustainability consultancy, to create sustainability-related best practices guidance manuals and tools for brewers related to energy, water, wastewater, carbon dioxide and solid waste. Craft brewers are able to use the manuals and tools to identify strategies for improving efficiency to allow for operation and growth in a more sustainable manner.



A pilot benchmarking study was conducted in 2014 using 2013 utility data from 25 craft breweries ranging from less than 1,000 to over 100,000 barrels annual production volume. The results of the pilot study were presented at the Craft Brewers Conference in April 2014. Results of the 2014 pilot study emphasized the value in tracking and trending operational data, but also highlighted the need to have representative benchmarking data in order to create real and lasting business value. Tracking and monitoring data is an important first step, but the ability to compare operations within a sector provides valuable insights for facilities to understand where improvements may be made to help drive more sustainable operations.

The BA engaged Antea Group to expand the pilot benchmarking study from the smaller initial pilot participants for 2015. The 2015 study includes 2014 utility, resource and production data from 79 breweries, representing a robust variety of production sizes, and geographic locations. Antea Group ensures trusted third-party data collection and aggregation, user anonymity and consistent use and comparison of KPIs. Participation in the study was voluntary, with requests for participation made by the BA, various state and local guilds, and by Antea Group during the Craft Brewers Conference in April 2015. Participants were asked to complete their 2014 data entry using an Excel spreadsheet and submitted to Antea Group for aggregation.

What Are the Benefits of Participation?

Craft breweries that participated in the 2014 pilot benchmarking study and target setting exercise identified the potential for significant cost savings. These savings ranged from $35,000 to $235,000 annually for small to larger craft breweries. Savings were quantified by being able to establish water and energy use ratio benchmarks based on production category. Savings were calculated by comparing the difference between current costs with costs of a target use ratio benchmark. One of the primary benefits of the 2015 benchmarking exercise was the ability to quantify the financial benefits of implementing efficiency-related projects.

All breweries that participate in future benchmarking efforts will be assigned a username and password to allow for online data entry from a desktop or mobile device. Additional benefits of participation include access to multiple queries allowing specific brewery comparisons against various production levels, geographic regions and operating configurations. Participants will be allowed to enter target usage and cost values and track ongoing monthly performance against targets.

Benchmarking Goals and Process

Craft breweries are growing at a substantial pace, but in a time when resource challenges and scenarios such as water shortages are a reality in certain parts of the United States. This fast-growing sector of our economy should take care to avoid being considered as growing in an unsustainable or reckless manner. The figure below, from the BA website, illustrates the rapid growth of the industry within the past 15 years.

This report provides a platform to share best practices and goals identified by our peers to show how we can use water more efficiently, generate less waste water and solid waste and even decrease our total energy usage including reducing greenhouse gas production.

Throughout this report the top 25% of performers may be referenced in order to share their best practices.

Efforts to produce this report stem from the agreement between the brewers to submit their data and the meticulous work of organizing, normalizing, and comparing the data. Because this process requires a great deal of organization, data was reviewed for accuracy and completeness, often with a series of clarifying questions posed to the submitters to determine what data was included in the submission and where it originated. Participants were consulted to validate data anomalies and other questions as needed.

In many cases, the preliminary identification of extreme outliers prompted discussion of the data source or a particular brewery operation with the brewery participant to help clarify or correct potentially wrong or inaccurate submissions. Data validation was an essential part of this benchmarking study as each brewery is unique in terms of their region, operations, and segments.

Allowing Fair Comparisons

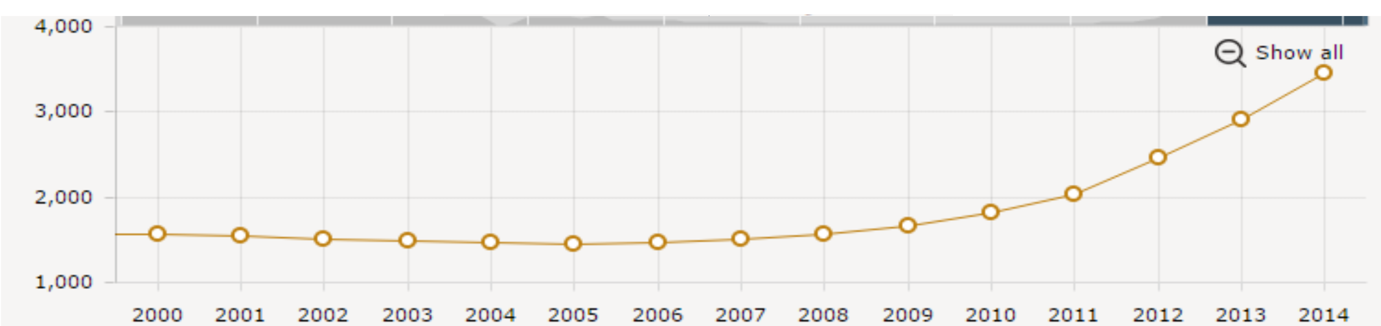
Due to the varying differences between the breweries that participated in this study, it is important to discuss how data was compared, e.g., how the following aspects were accounted for:

- Onsite cold storage vs. offsite cold storage
- Onsite food preparation (e.g. restaurant) vs. food trucks or no food
- Tasting rooms
- Onsite wastewater pretreatment
- Shared tenant buildings

Depending on applicability, some breweries may not have provided these data. For example, some smaller breweries which store beer offsite before distribution may not have been able to include the energy usage data for this offsite cold storage location. Some data came from brewpubs and some breweries have tasting rooms which use electricity and water. Still others have additional energy for their wastewater pretreatment. Even more challenging may be small breweries that lease space in shared tenant buildings where the renter determines each tenants' utility payment; so it is hard to determine actual usage. Few breweries at a smaller scale are able to sub-meter and track utility usage at smaller than the fiscal meter level.

Where possible, follow up calls were made to assure the data collected was accurate, and to determine if any other data was applicable to the study. By identifying the different market segments, it was possible to better compare production volumes, identify and, if possible, separate pub operations, and determine what information

Historical U.S. Brewery Count



was specifically brewery-based. The best effort was made to compare only breweries on the same level. As benchmarking efforts continue to evolve, more data and more granular data will help to identify better comparisons for the above differences.

Normalizing to Barrels Packaged or Taxable Beer

Environmental attributes at breweries can eventually be measured in economic variables, as evident in this benchmarking report. The cost of electricity, fuel, water, wastewater, CO_2 and solid waste were normalized on a cost per barrel scale for each participating brewery.

The standard normalizer global beverage companies use in determining intensity factors is based on barrels of product packaged. Taxable barrels (bbls) is often the easiest number to obtain from accounting and is often used for external production reporting. Packaged volume, rather than barrels brewed, is used to ensure consistency with the rest of the beverage sector. Packaged beer, "finished beer" and volume that goes straight to brite beer tanks (BBT) are all included in this category.

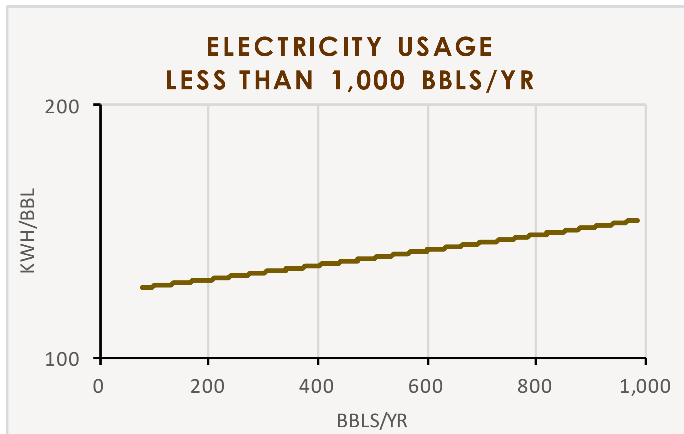
Creating Utilization Efficiency and Cost Charts

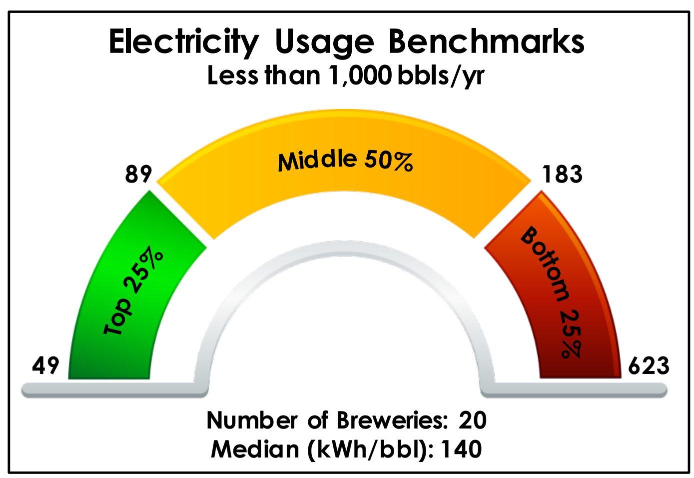
Once the data had been normalized, graphs were utilized to show comparison between breweries. This report presents efficiency charts for electricity, fuel, water, waste disposed, waste recycled, spent grain recycled, carbon dioxide usage, and greenhouse gas emissions per barrel. This data was then used to determine cost percentile charts for overall cost per barrel and averaged per each production volume group

Production Volume Categories and 2015 Benchmarking Study Participants	
1 to 1,000 bbls/yr	20 breweries
1,000 to 10,000 bbls/yr	24 breweries
10,000 to 100,000 bbls/yr	23 breweries
100,000 to 1,000,000 bbls/yr	12 breweries

Below are examples of the charts presented in the report and guidelines for interpretation.

Efficiency Charts: Many of the measured metric categories (e.g. electricity, fuel, water, wastewater, etc.) have efficiency charts that look similar to this electricity usage example graph. Each participating brewery was plotted at their kilowatt hours of electricity per barrel (kWh/bbl) against their production capacity (bbls/yr). The relative placement on the graph can show the more efficient vs. less-efficient breweries. The lower the kWh/bbl, the more efficient a brewery's operations. Charts for other metrics are plotted on a therms/bbl, lbs/bbl, etc. scale for the appropriate environmental attribute.





The above efficiency chart is supplemented with an additional benchmarking figure, such as the electricity usage benchmarks, which outlines the top 25%, the middle 50%, and the bottom 25% of performers in the appropriate production volumes. In this case, a brewery operating at 75 kWh/bbl would be in the top 25% of peer breweries. This is meant to illustrate what other breweries in the category are achieving and help stimulate awareness of efficiency capabilities so the entire industry can strive to reach the top 25% benchmark.

It is important to remember that a multitude of operational differences may exist between breweries that can account for a range of usage efficiencies. A brewery may be in the bottom percentile for electricity use because of old, inefficient motors or numerous compressed air leaks, or they could appear in the bottom percentile because of energy-intensive operations needed for lower fermentation temperatures or on-site cold storage. It is these nuances that can be discussed when evaluating operations and discussing projects for improving efficiency.

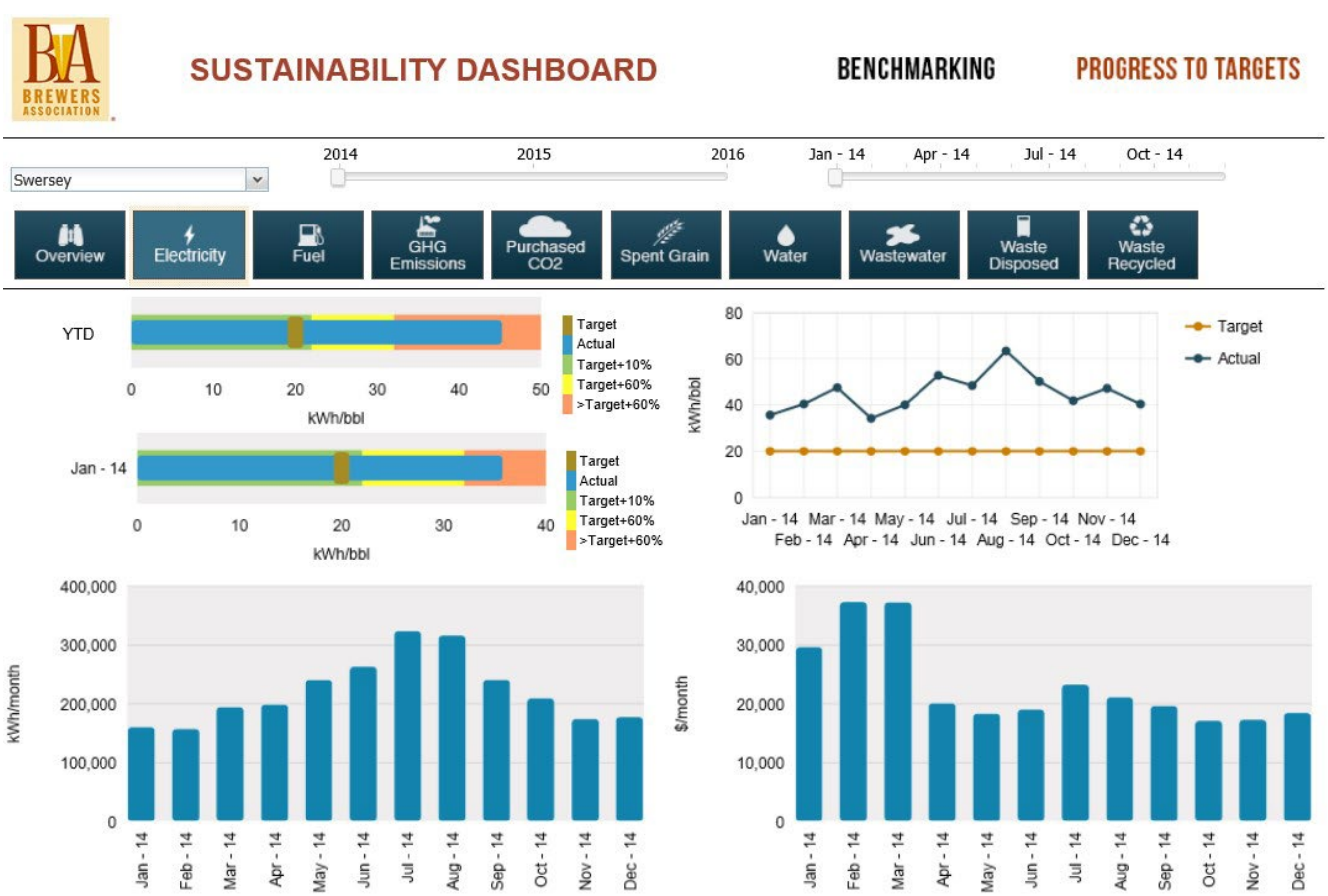
Confidentiality

This benchmarking report patterns and aggregates responses in an anonymous fashion, thereby protecting confidentiality for all participating breweries. No single brewery will be identified with their data.

Sustainability Benchmarking Tools

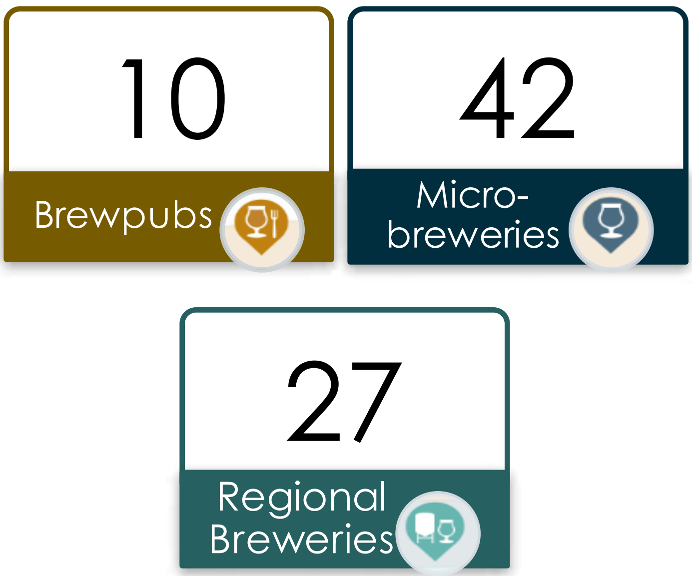
All benchmarking participants will have access to on-line sustainability benchmarking tools to see their data in graphical format. These tools allow breweries to enter data for each monthly utility bill as soon as it is received, thereby illustrating monthly trends. Analyzing these trends allow participants to monitor and validate the impact of operational changes on efficiencies and costs.

BA Sustainability Benchmarking Tools "Dashboard" View

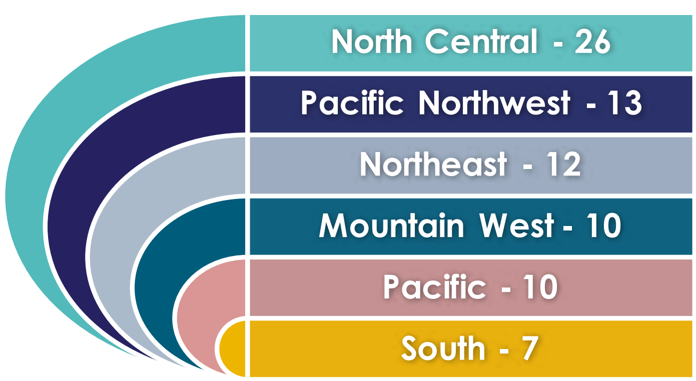


Participant Profile

Industry Market Segment Participants:



Regional Participants (excludes 1 Canadian brewery):



Why Didn't More Breweries Participate?

Of the 235 breweries contacted beginning in January 2015, many breweries declined to participate or were unresponsive to requests for participation. It is important to acknowledge the challenges associated with contacting the over 3,000 breweries in the U.S., and reaching individuals willing and able to provide operational data for this study. Those who did were often surprised with how easy the data was obtained, and how beginning to track and monitoring this data would provide significant insights into their operations. The most frequent barriers to participation cited was the lack of time. Even though most participants indicated only a couple hours were needed, many breweries were simply overwhelmed with day to day operations, expansions or other operational demands to dedicate scarce labor hours toward "another survey".

Unfortunately many breweries that indicated a desire and willingness to participate early on in the data collection process simply did not follow through. This study, as others conducted by the Brewers Association, are voluntary. As such, only a limited amount of pressure is applied to would-be participants to provide data.

Considering the potential value in participation to both the individual craft brewer and to the industry, why didn't more craft breweries participate in this first benchmarking report?

The number one reason cited by non-participating breweries was the time required to collect and input old invoices. The time required to locate and input data from past invoices directly competes with the time required for other production and marketing related demands. For breweries that were already tracking utility invoices on a monthly basis, this effort was relatively seamless and took less than 4 hours.

Given time as the primary barrier to initial participation, several enhancements have been proposed to encourage increased activity. First, brewers can start with the current month and input data as invoices are received and paid. Second, the BA is actively seeking opportunities with universities and other organizations that can supply intern level resources to collect and input data for a brewer that needs help. Finally, the 2016 rollout of the BA sustainability dashboard tool for both data input and reporting will simplify the process.

These enhancements are anticipated to increase the number of participants and make for an even more robust and complete 2015 benchmarking data set and report.

section two:

Energy Usage

Stillmank Brewing Co

Stillmank Brewing Co. is a small production brewery. They recently built a new production facility, so they provide a unique perspective on start-up efficiency. Each piece of equipment was evaluated for efficiency and functionality before investment was made. As a small growing brewery, they wanted to be aware of their costs and found they could become more efficient while saving money. Employee training is a large part of their efficiency efforts. They have started meticulously tracking their utility data, and now they are continually using the data to update their sustainability plan. Stillmank uses a 30bbl brew-house and a unique brewing schedule, so their wort production is discontinuous, but they're able to optimize efficiency using the larger system, and maximize total annual output of their current cellar capacity.

Fun Fact: After Stillmank Brewing Co. replaced fluorescent bulbs with LEDs in the brewhouse, lighting energy use was cut in half!

2.1 Industry Trends

In total, 78 breweries contributed 2014 energy data to the benchmarking study. The data in this section has been analyzed by production size to allow breweries to compare themselves to other breweries within a similar category.

Breweries with production volumes greater than 100,000 bbls/yr reported lower unit costs and appear to be more cost efficient than breweries producing less than 100,000 bbls/yr. This is an indicator that breweries realize an economy of scale when producing more than 100,000 bbls/yr of beer. Breweries with a higher production volume may also have fewer recipes and therefore could have a more automated processes, which can allow for fewer change-overs and therefore fewer start-up and shut-down cycles. There is also a large variation and distribution of electricity and

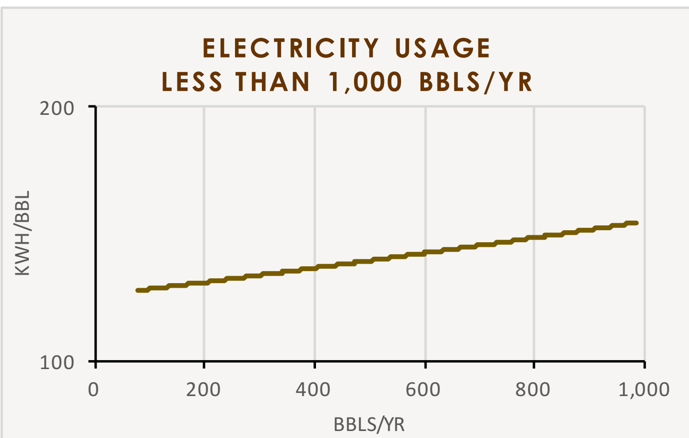
	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	20	24	22	12
ELECTRICITY				
Average Annual Usage (kWh)	101,891	232,171	981,536	5,515,386
Average Unit Cost ($/kWh)	0.13	0.12	0.12	0.10
Average Cost Efficiency ($/bbl pkgd)	20.11	7.04	3.25	1.91
Average Usage Efficiency (kWh/bbl pkgd)	177.89	58.88	26.64	18.39
FUEL				
Average Annual Usage (therms)	6,788	15,525	78,023	466,121
Average Unit Cost ($/therm)	1.52	0.84	0.89	0.82
Average Cost Efficiency ($/bbl pkgd)	12.39	3.31	1.89	1.29
Average Usage Efficiency (therms/bbl pkgd)	10.99	3.94	2.12	1.59
TOTAL ENERGY				
Average Annual Usage (MJ)	740,992	1,694,623	8,465,096	50,474,797
Average Usage Efficiency (MJ/bbl)	1,202	430	230	172
Average Usage Efficiency (MJ/l)	10.25	3.66	1.96	1.46

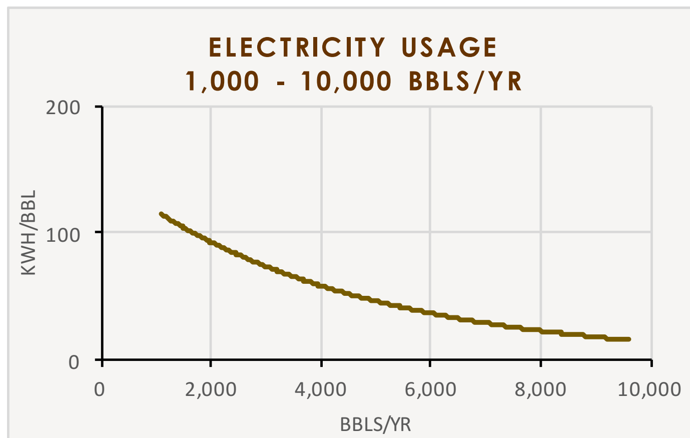
natural gas use apparent for facilities with a production of less than 1,000 bbls. This could be process-driven, and a number of factors can influence this usage at a facility level. Examples of drivers include:

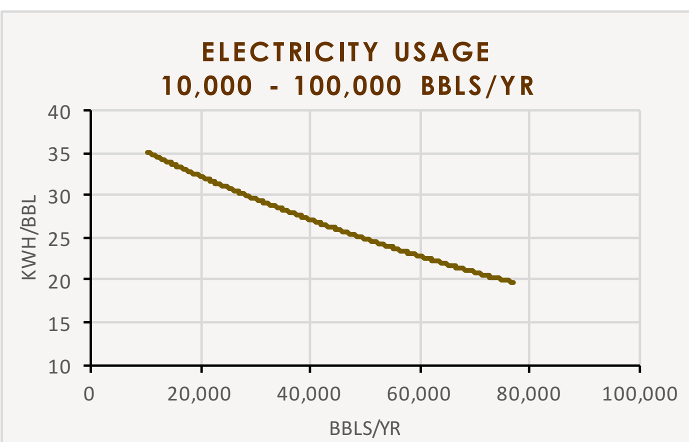
- variation in brewing process (fermentation, finishing, pasteurization (flash and tunnel), packaging, cellar and finishing);
- fewer recipes allow for less changeover of labels and packages
- using high efficiency equipment
- more recipes, requiring more changeover, which requires more cleaning
- small breweries may have less available square footage for items like hot liquor tanks or heat recovery equipment, which increases energy demand for water heating
- breweries with open floor plans and pub operations may increase cooling demands in the pub/ customer areas during warmer months as brewing operations heat the space

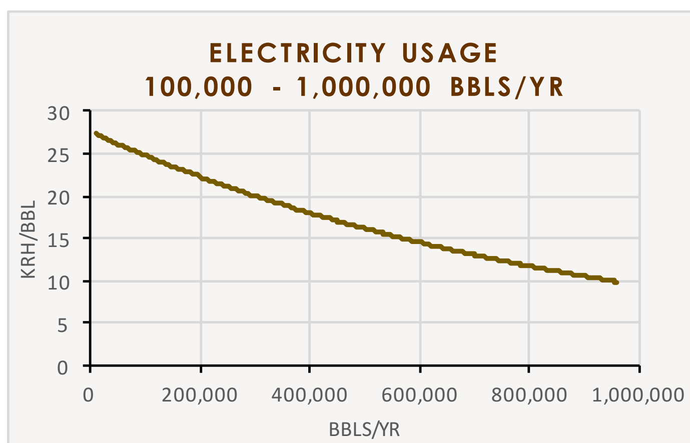
The graphics below present electricity and fuel usage data for the industry. Generally, as total bbls of beer packaged increased, total energy (electricity and fuel) usage per barrel of beer decreased.

Electricity Efficiency by Size Category

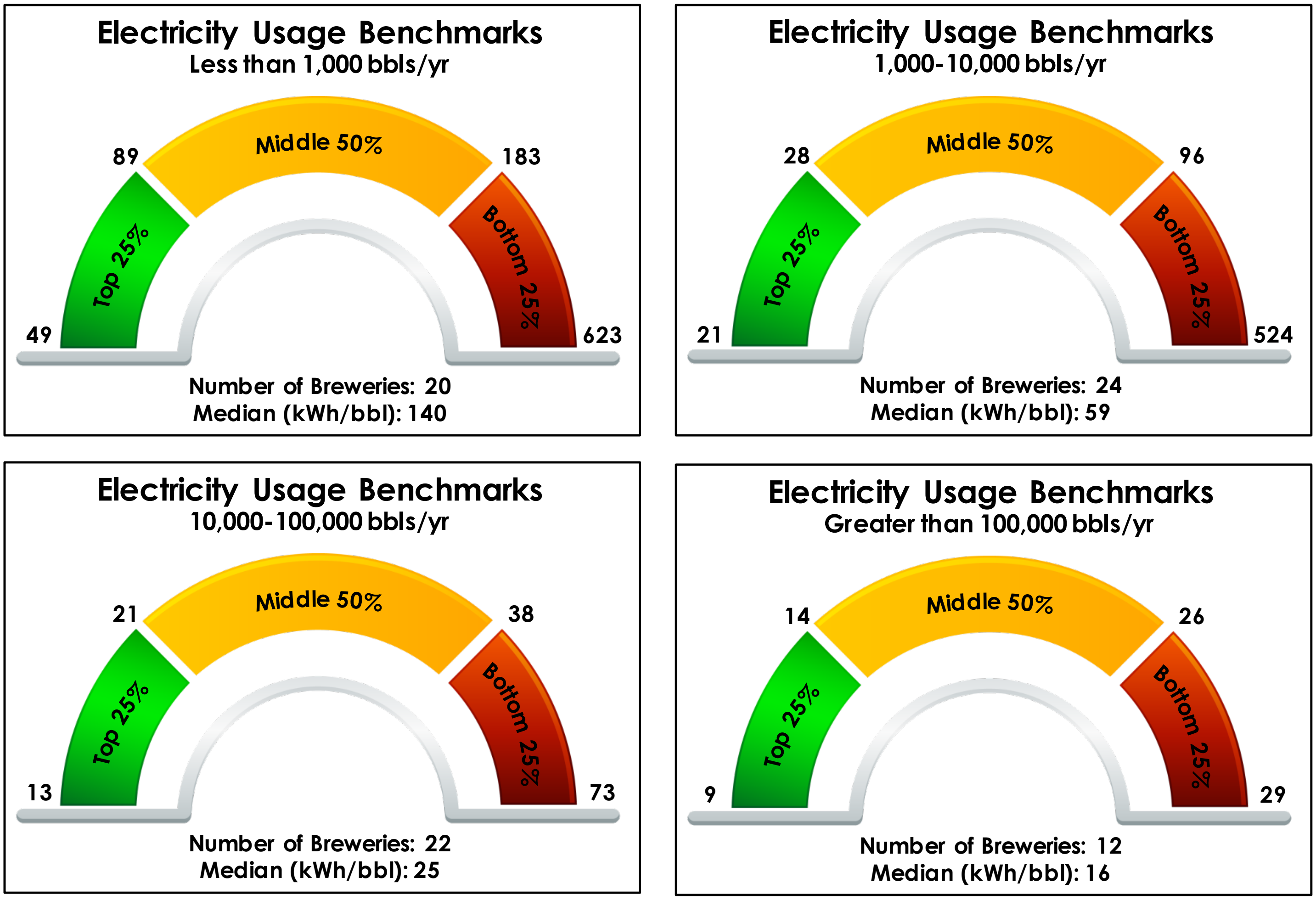








Electricity Efficiency Distribution by Size Category



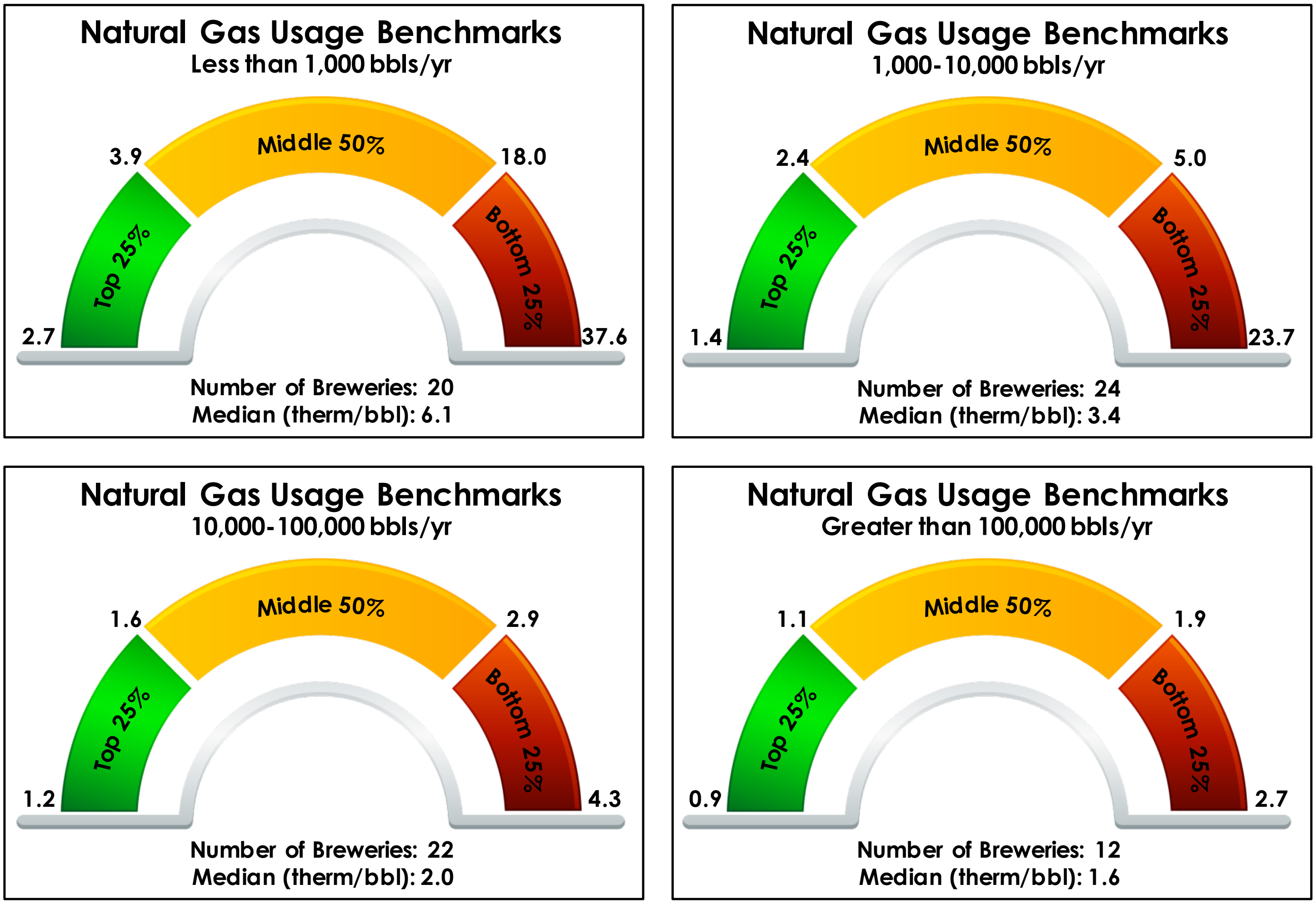
2.2 Pub Operations vs Brewery

Six breweries provided separate energy (electricity and natural gas) metering data for both brewery and pub operations. Breweries reported a wide range of energy use from pub operations ranging from 4% to 83% of total energy used. The BA "Brewpub" segment typically includes breweries that operate a restaurant or taproom, which is generally not metered separately and can artificially inflate up a brewery's Energy Usage Ratio (EUR). Breweries with larger restaurant or foodservice operations will have a considerably larger energy demand from the extra lighting and from heating and cooling demands of the customer space and foodservice preparation areas.

2.3 Green Power and Renewable Energy

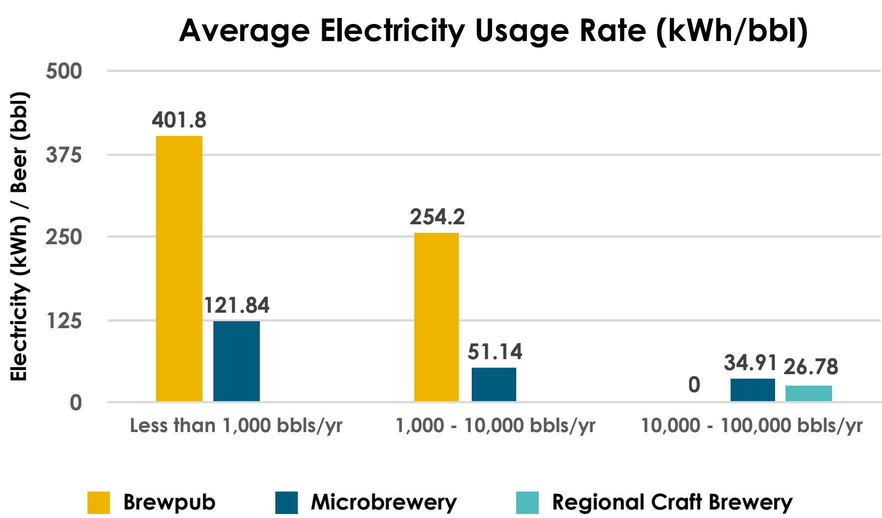
Across 78 breweries, 11 reported using onsite renewables for electricity generation. As production size increased, the prevalence of onsite renewables also increased, but the amount generated onsite did not follow that trend. Brewery onsite generation accounted for 0.3% to 68% of total kWh used at those facilities and generated a total of just under 10.5 million kWh. Four breweries reported using onsite renewables for fuel generation, which generated between 2% and 34.7% of total therms used at those facilities. Larger breweries are more likely to spend capital on renewable investments and wait for the payback period. Smaller breweries may not immediately be able to make these

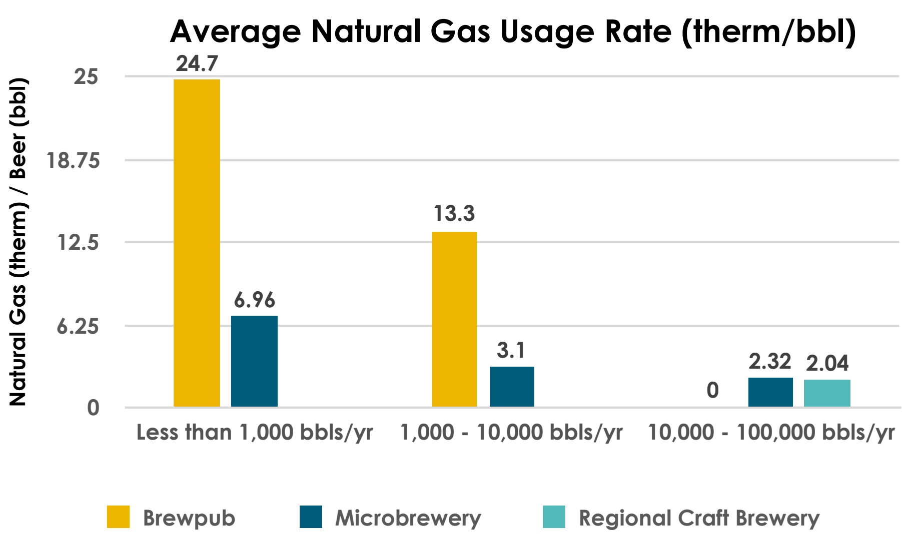
Fuel Efficiency Distribution by Size Category



kinds of investments, as there are other demands for quality improvement and growth. Incentives are often available for renewable energy projects through local, state and federal funding sources to help reduce the cost and payback of these projects.

Renewable Energy is not the only source of sustainable energy available to breweries. Installing solar panels can be costly, especially for small breweries just starting out. There is an option to purchase green power to help offset emissions from operations. Six breweries reported purchasing green power in 2014, meaning their electricity came from sustainable sources such as wind or solar. Four of these breweries purchased 100% green power while the other two purchased 60-75%. There is an extra cost to purchase this green power ranging from $229 (at 1% of the total electricity cost) to $1.5 million (100% of the total electricity cost). Most breweries are focused on energy efficiency first, then consider paying a premium to purchase green power.





Bear Republic Brewing Co.

Bear Republic Brewing Co. provides unique perspective on both water and energy savings. This brewery has challenged the industry norm when it comes to cold stabilizing in fermentation at 32°F. Bear Republic indicated refrigeration at 36°F doesn't adversely impact their product, and it cuts down on their electricity usage. Bear Republic also utilizes push-button timers and flow meters on all points-of-use to make water use a conscious choice. They save ½-1 gallon of water per barrel of beer by making water use less convenient. This is a small capital investment that saves a great deal of water over the long run.

Fun Fact: Bear Republic employs a plant historian to maintain and monitor the utility data and make sure the brewery is making strides to become even more sustainable as their production continues to grow! Despite a cap on water usage, Bear Republic has continued to increase production by becoming more efficient at all levels of production.

section three:

Water and Wastewater

3.1 Industry Trends

In total, 71 breweries contributed 2014 water data to the benchmarking study.

	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	16	20	23	12
Water				
Average Annual Water Usage (gal)	327,860	1,052,306	6,833,691	46,776,160
Average Unit Cost ($/1,000 gal)	9.23	3.61	5.01	3.78
Average Cost Efficiency ($/bbl pkgd)	5.83	0.96	0.93	0.56
Average Usage Efficiency (bbls/bbl pkgd)	16.72	8.61	5.98	4.58
Wastewater				
Average Annual Cost ($)	1,976	8,414	78,661	275,139
Average Cost Efficiency ($/bbl pkgd)	3.37	2.13	2.31	1.14

Breweries with production volumes greater than100,000 bbls/yr reported lower unit costs and appear to be more cost efficient than breweries producing less than 100,000 bbls/yr. This indicates that brewers realize an economy of scale when producing more than 100,000 bbls/yr of beer. Breweries with a higher production volume may also have more automated processes, which can provide for tighter control of the amount of water used for cleaning and sanitization. There is also a large variation and distribution of water use apparent for facilities with a production of less than 1,000 bbls. This could be process-driven, and a number of factors can influence this usage at a facility level. Examples of drivers include:

- production run lengths
- frequency of product change-overs
- if only producing primarily one recipe, less cleaning is required
- continuous change in recipes requires more cleaning, change in packaging, etc.
- amount annual beer production
- smaller breweries tend to prepare food as well as beer accounting for additional cleaning of restaurant related items

The graphs below present water usage performance data for the industry. Generally, as total bbls of beer packaged increased, total water usage per barrel of beer decreased.

3.2 Pub Operations vs Brewery

Only four breweries provided separate water metering data for both brewery and pub operations. Though this data set is limited, breweries reported a wide range of water use from pub operations ranging from 6% to 53% of total water used.

The BA "Brewpub" segment typically includes breweries that operate a restaurant or taproom, which is generally not metered separately and can artificially inflate up a brewery's water use ratio (WUR).

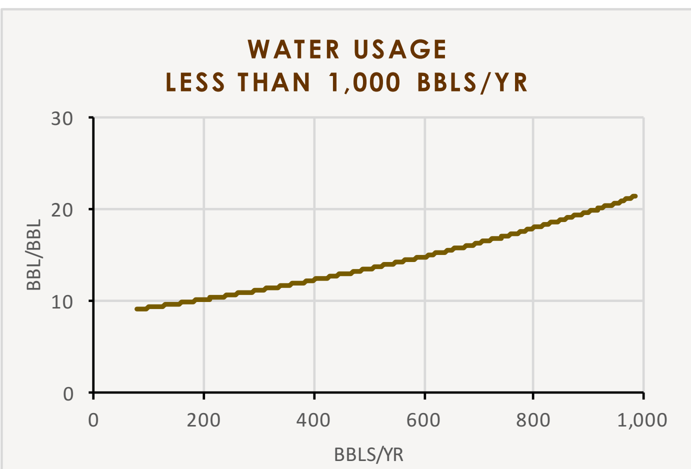
- (water use ratio) WUR will tend to be much higher at brewpubs because of the increased demand from the "pub" (i.e. restaurant) side of the operation
- A sub-meter on the brewery side would help determine true WUR for brewing side only
- The brewpub designation for production volumes 10,000-100,000 bbls is basically squeezed out by classification

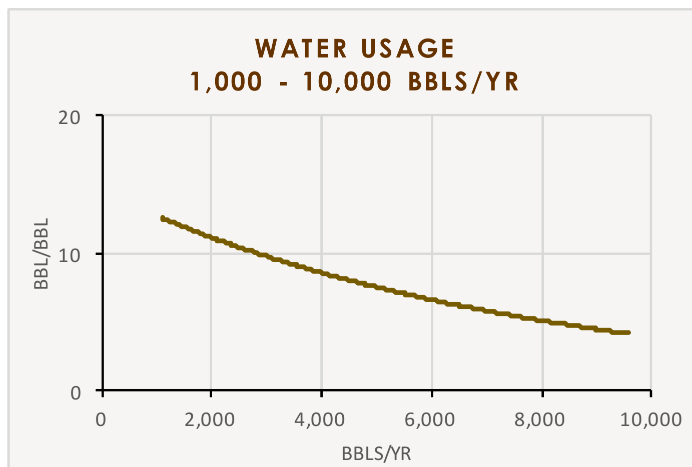
Yards Brewing Company

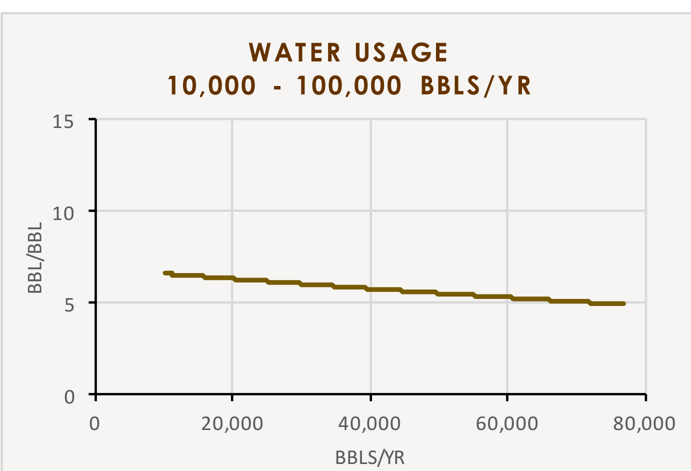
Yards Brewing Company sets an example as a sustainable, larger production brewery. They are an urban brewer based in a major city, so space constraints are a concern. This forces them to be efficient in terms of equipment layouts and configurations. They brew continuously for three to five days which allows them to be more efficient in heating and cooling equipment and water. They have a 40,000 square foot facility, and they do not significantly control the climate in the brewery which reduces their energy usage.

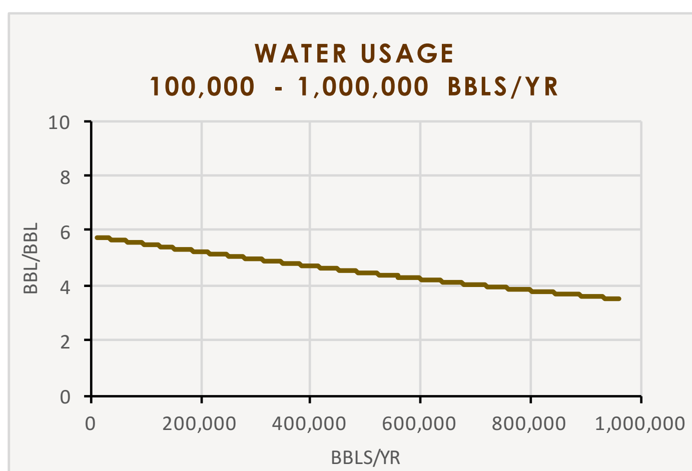
Fun Fact: Yards Brewing Company saves water by using ozone for external sanitation of floors, rooms, etc. This reduces their chemical usage, and in turn, decreases their water usage!

Water Efficiency by Size Category

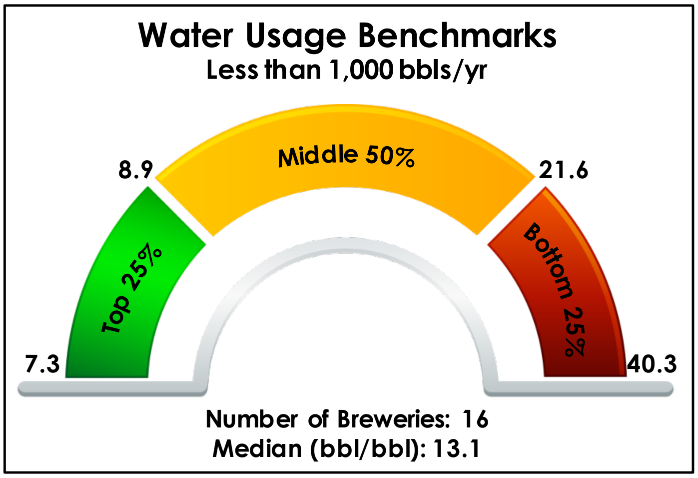


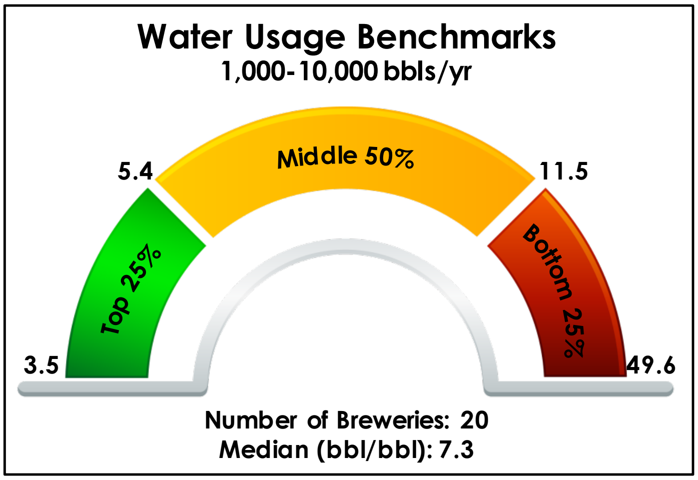


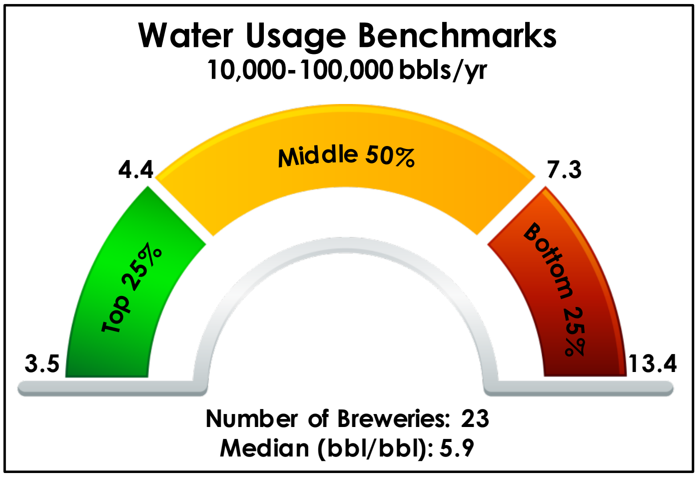


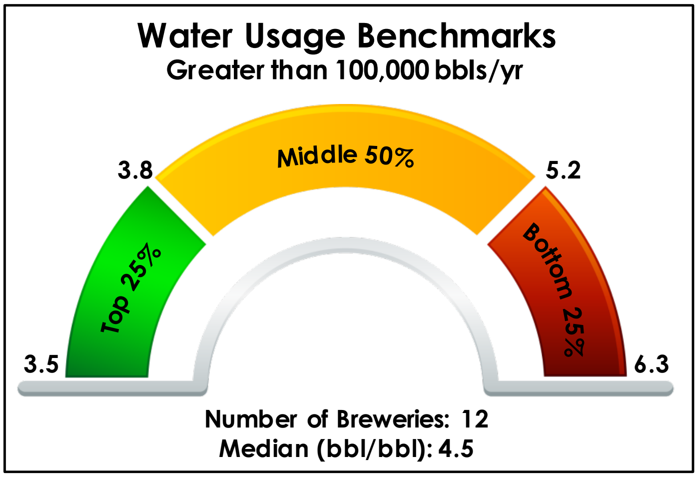


Water Efficiency Distribution by Size Category









3.3 Wastewater

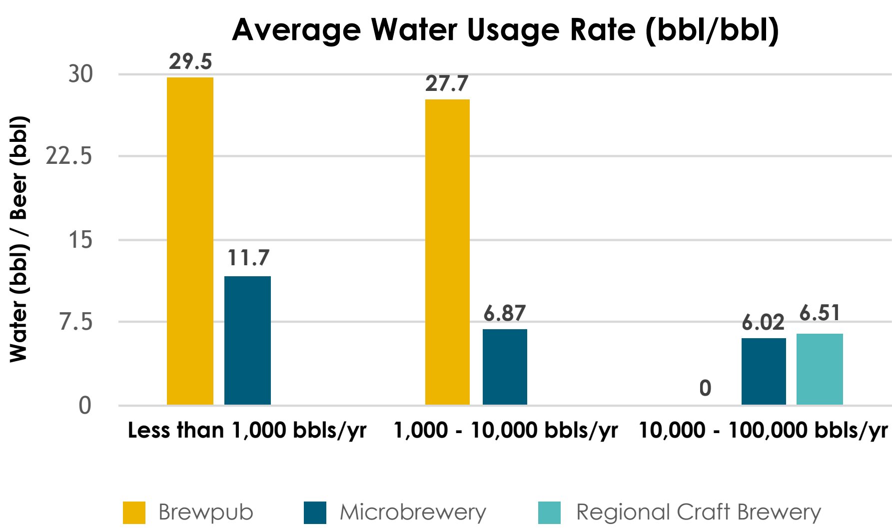
Wastewater was an area where few participating breweries provided data. No breweries in the 1-1,000 bbls/year production range provided data on wastewater, either in a measured volume or cost. Four breweries in the 1,000-10,000 bbls/yr production range provided only total cost and volume data.

Because of the limited data provided from breweries in the 1,000 - 10,000 bbls/yr production range, few insights can be provided for operations within this category. Limitations on data tracking, collection or analyses can range from no or limited wastewater surcharges for lower-volume operations, breweries operating in leased facilities paying "hidden" wastewater costs via monthly lease payments, to a simple misunderstanding of utility bills.

The Wastewater to Water Ratio estimates wastewater volume based upon measured water usage. For breweries that do not measure wastewater volume flow, this range of values for the various production categories can be used to approximate wastewater volume.

Breweries currently looking for opportunities to avoid or lower wastewater surcharges can evaluate the average $/bbl surcharges and unit costs to determine the cost effectiveness of employing pretreatment options. Locality and individual municipal fee structures play a large part in driving cost ratios, as breweries located in or near large metropolitan cities more often paid a higher cost for wastewater disposal. Breweries that employed some form of pretreatment saw a clear reduction in the average per-barrel disposal cost. For purposes of this study, "pretreatment" refers to strategies employed to reduce biological oxygen demand (BOD) or total suspended solids (TSS) on-site versus large solids removal or pH neutralization.

	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	4	12	10
Reporting Breweries with On-Site Pretreatment	0	1	2
Wastewater Discharge (w/o pretreatment)			
Average Annual Discharge Volume (gal)	957,693	6,051,437	27,547,209
Average Wastewater/Water ratio (gal/gal)	0.81	0.73	0.55
Wastewater Charges (w/o pretreatment)			
Average Annual Flow Charge ($)	Insufficient data	45,200	110,565
Average Annual BOD Surcharge ($)	Insufficient data	53,823	187,100
Average Annual TSS Surcharge ($)	Insufficient data	8,518	70,632
Average Annual Flow Cost ($/bbl)	Insufficient data	1.43	0.67
Average Annual Cost BOD Surcharge ($/bbl)	Insufficient data	1.70	0.90
Average Annual Cost TSS Surcharge ($/bbl)	Insufficient data	0.30	0.32
Wastewater Cost Analyses (w/o pretreatment)			
Average Annual Unit Cost ($/1000 gal)	Insufficient data	20.25	11.10
Average Cost Efficiency ($/bbl)	2.13	2.31	1.14



The most frequently employed pre-treatment strategies consisted of lower-cost techniques like solids screening and filtration. Yeast, trub and smaller volumes of spent grain can be diverted and land-applied, used for compost or disposed as solid waste. These lower-cost and often less energy-intensive practices may be attractive to breweries with space or capital constraints.

Birdsong Brewing Co.

Birdsong Brewing Co. has not purposely "set out" to minimize their water use, yet they were a top performer in their production category. They says it's the "little things" that matter when it comes to efficiency, like catching extra beer in a bucket during packaging to save the floor from getting sticky and dirty, which reduces floor washings. Their facility has a ¾" water line which in turn results in a low gallon per minute flow, so the less water they use, the faster they can fill their tanks. When the brewery needs to preheat water, they make a point of reaching and maintaining the desired high temperature right at the time of use in order to save on energy.

Fun Fact: Birdsong Brewing uses a simple 33 gallon bin to collect additional wort from spent grain. This results in additional extract yield and reduces wastewater loadings to the sewer!

section four:

Carbon Dioxide

4.1 Purchased CO_2

In total, 60 breweries contributed 2014 purchased CO_2 data to the benchmark study.

*This average does not include those breweries that use 100% self-generated carbon dioxide.

As illustrated in the graphs below, there is no clear overall trend between the production categories in terms of carbon dioxide usage and efficiency. Breweries with production volumes greater than 100,000 bbls/yr report lower unit costs, but do not appear to be more cost efficient than breweries producing less than 100,000 bbls/yr. This could indicate that brewers use different amounts of carbonation or different types of equipment when packaging different kinds of beer. There are also a few breweries that use carbon dioxide for their line pushes, which increases usage. The indistinct trend could be product- or process-driven, and a number of factors can influence this usage at a managerial or facility level. Examples of drivers include:

- Beer styles - carbonation vs. bottle conditioning or nitro use
- Production run lengths and changeover frequency
- Filling and packaging equipment type
- Tank and line purging
- Racking with CO_2 vs. pumps

Rising Tide Brewing Company

Rising Tide Brewing Company runs their brewery to mimic actions at home – "yaou wouldn't turn a faucet on and walk away to do something else." They use sensors on their packaging line to limit bottle sanitizing only when bottles are present, to prevent uncontrolled use of water and chemicals. This limits the time the sprayer is operating and saves water. They also operate motion sensors on their brewhouse lighting to limit electricity usage.

Fun Fact: Rising Tide impresses the importance of efficiency awareness upon employees, so much so, that employees have come up with ideas to help the brewery be more efficient that the brewery has implemented. One example is they changed their keg cleaning procedure to mimic their acid wash tank cleaning procedure after an employee suggested it!

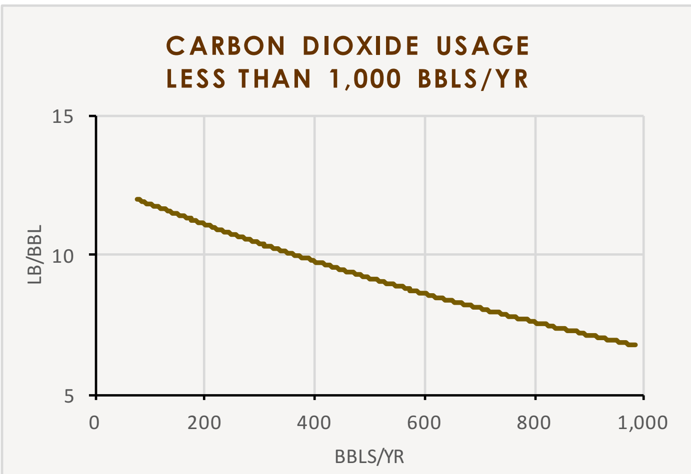
	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	12	19	17	12
CO_2				
Average Annual Purchased Usage (lbs)	4,875	23,481	328,824	2,088,711*
Average Unit Cost ($/lb)	0.33	0.32	0.17	0.09
Average Cost Efficiency ($/bbl pkgd)	3.09	0.27	0.48	0.52
Average Usage Efficiency (lbs/bbl pkgd)	9.35	5.95	8.92	7.60

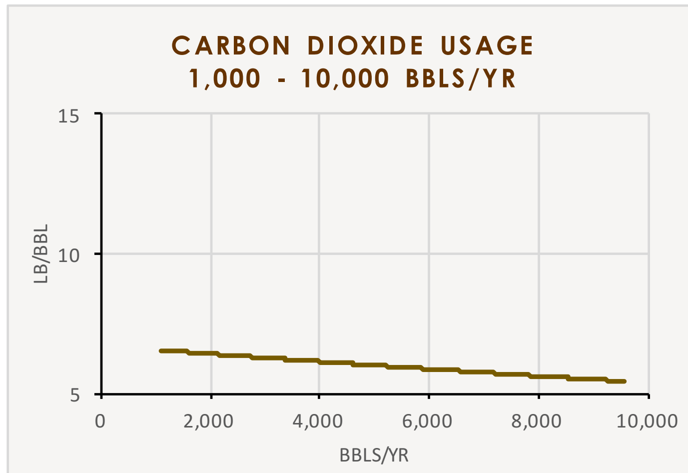
**This average does not include those breweries that use 100% self-generated carbon dioxide.*

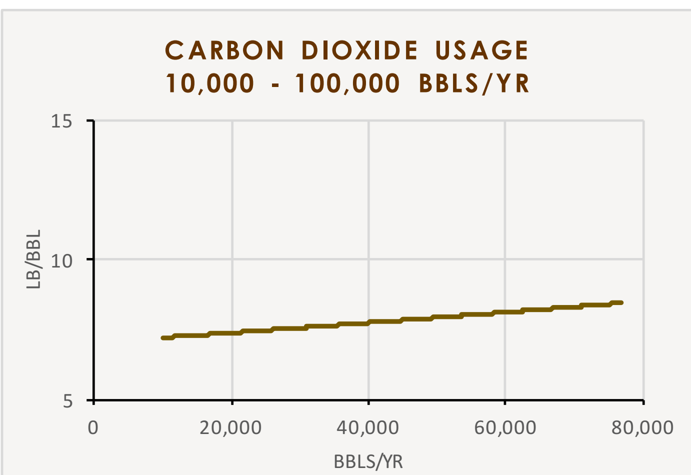
4.2 Captured and Reused CO_2

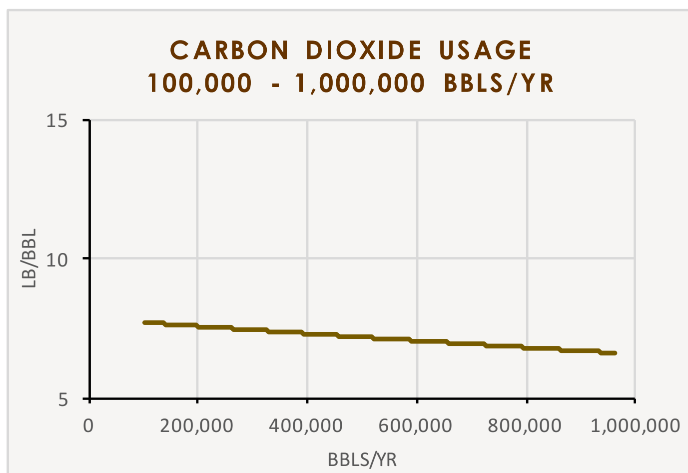
Two breweries in the >100,000 bbls production volume category reported data for their capture and reuse of CO_2. These breweries generate and capture 100% of the carbon dioxide required in their brewing process, which saves money and reduces their CO_2 emissions. Even though these are large breweries in terms of production volume, it is possible for microbreweries and small production volume breweries to invest in carbon dioxide recovery systems to capture and reuse CO_2. EPA estimates a 2-3 year payback period for a recovery system for small production breweries. CO_2 capture and reuse opportunities, however, should be evaluated on a facility-specific basis. Numerous other capital expenditures for efficiency-related projects may have a shorter return on investment.

Carbon Dioxide Efficiency by Size Category

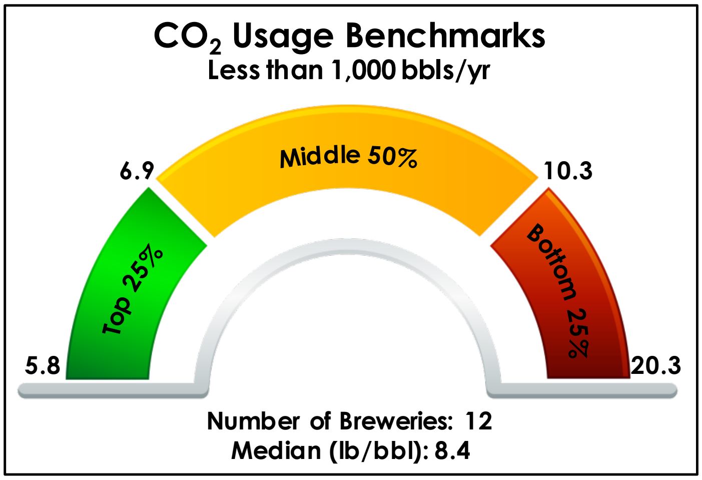


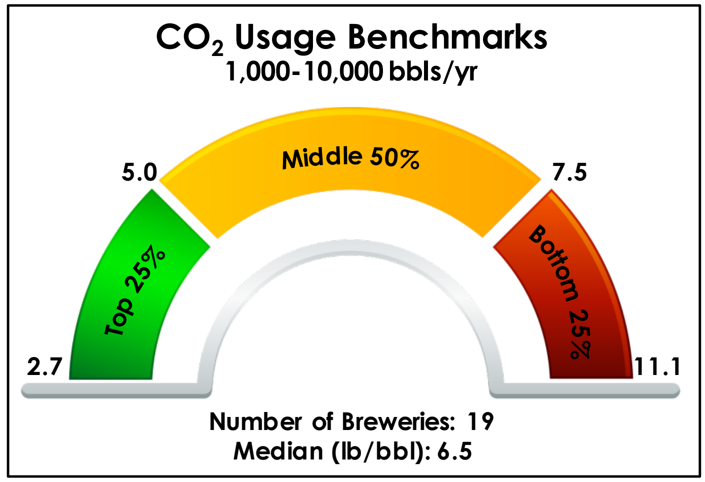


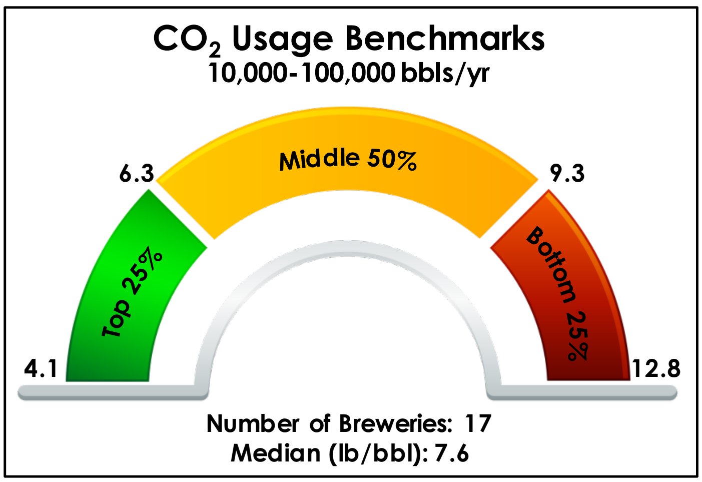


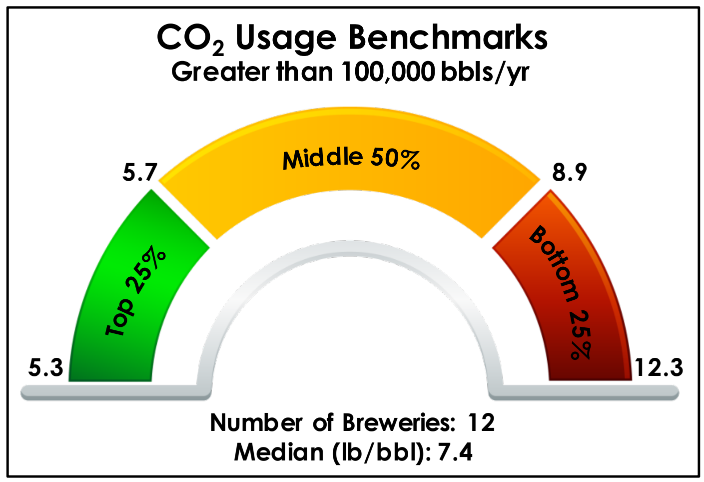


Carbon Dioxide Efficiency Distribution by Size Category









section five:

Solid Waste Generation, Disposal and Recycling

	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	5	11	9	10
Solid Waste Generated				
Average Total Generated (lbs)	36,700	42,595	115,965	1,144,519
Average Generated Efficiency (lbs/bbl pkgd)	47.18	10.80	3.15	3.40

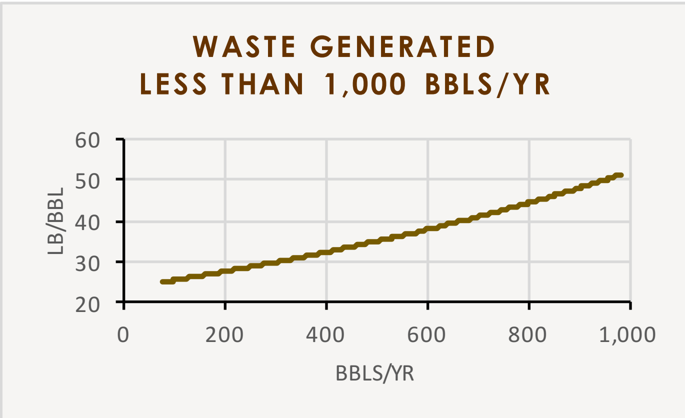
In total, 40 breweries contributed 2014 solid waste data to the benchmarking study. The measured weight or volume of solid waste was difficult to obtain for most brewers. Utility billings from trash haulers and recyclers typically do not indicate a recorded weight or volume of material. Usually billings are expressed in terms of dumpster or bin size and pick-up frequency. Most brewers do not keep records of how full the bin was at pick-up and/or the hauler typically does not physically weigh the waste upon collection. However, brewers that participated in the study were able to make some estimates of volume and convert to weight using published waste density factors. Although these estimates may not be as accurate as other measured KPIs, they represent a reasonable first attempt by the sector to characterize solid waste.

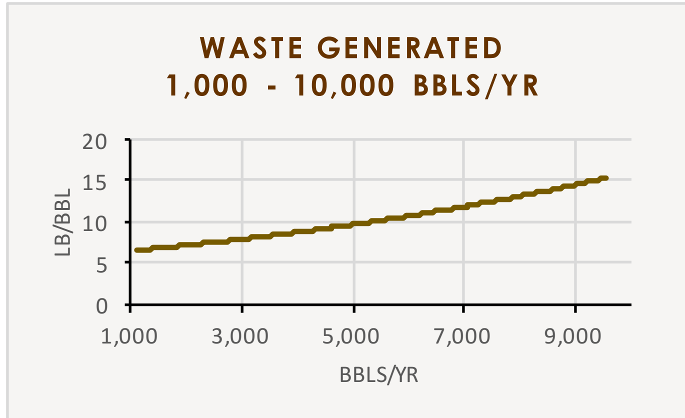
5.1 Solid Waste Generated

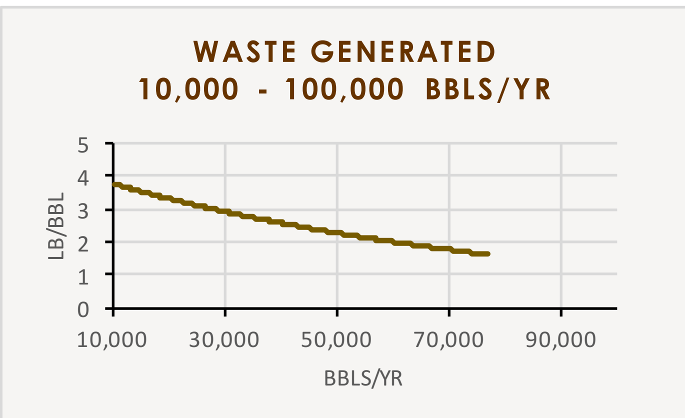
Waste disposed and waste recycled (excluding spent grains) were summed to estimate the total solid waste generated. A true measure of sustainability is to first eliminate waste from being created, then to look for ways to reuse or recycle.

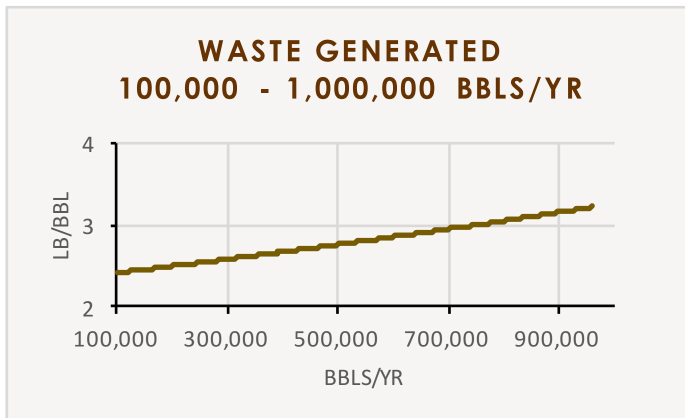
The following graphics estimate the amount of waste generated at the various production size ranges.

Waste Generated by Size Category

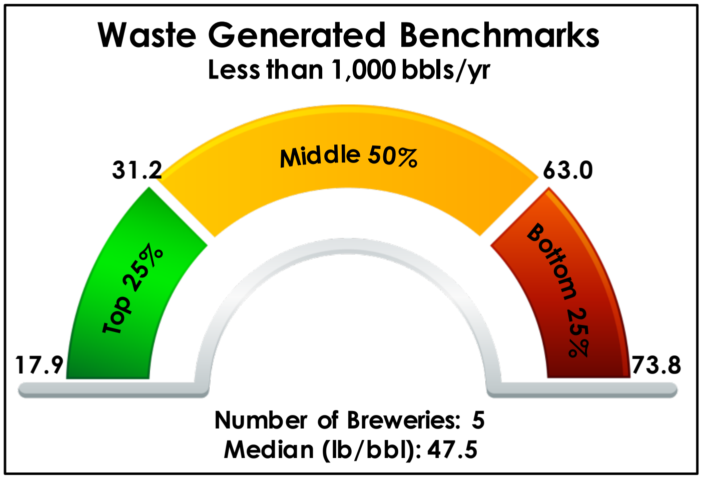


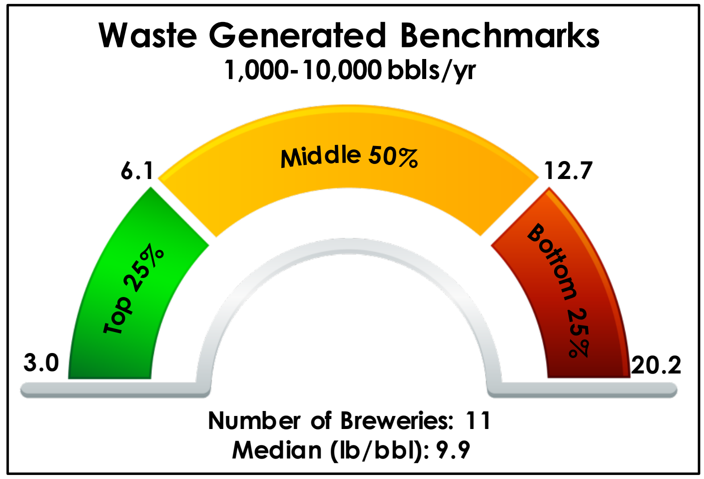


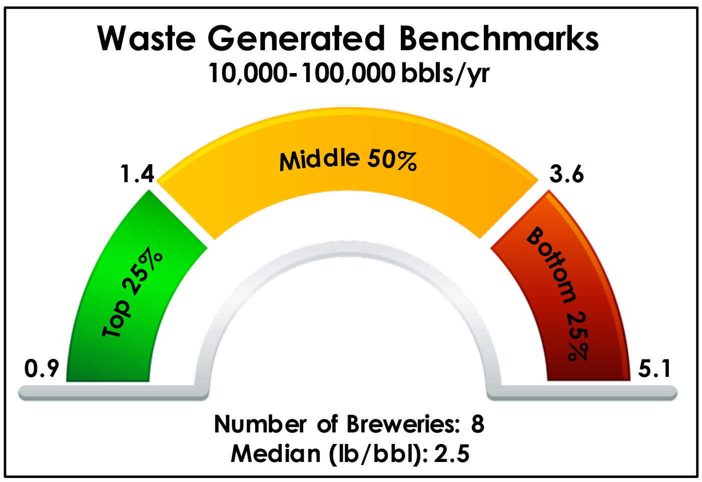


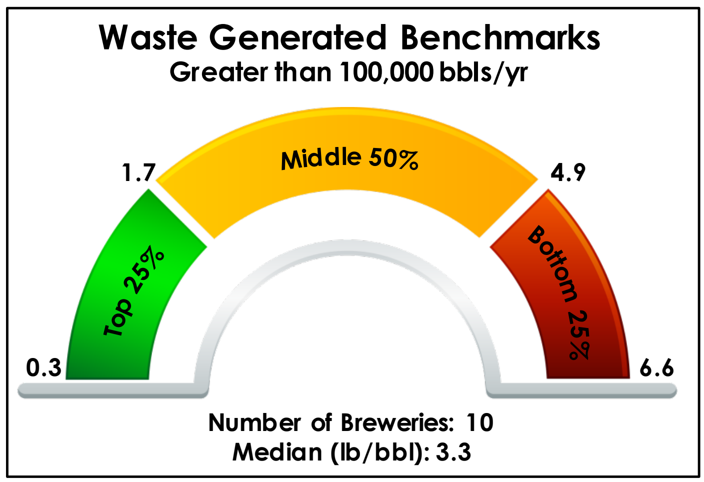


Waste Generated by Size Category









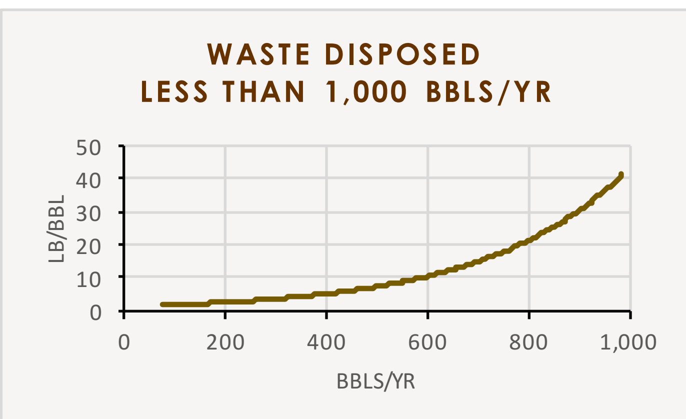
5.2 Solid Waste Disposed

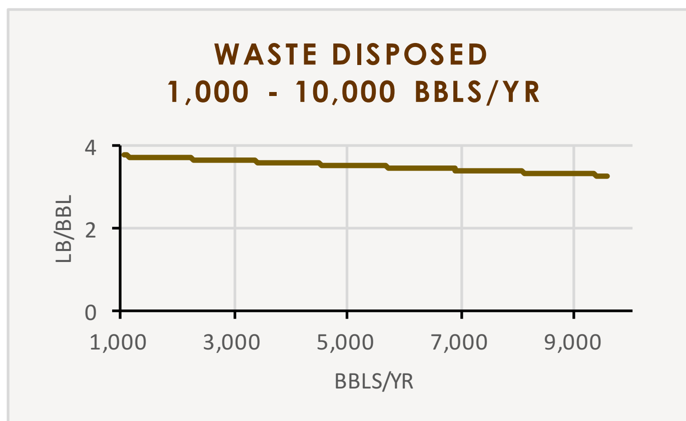
Participants in the study most frequently provided cost data from standard volume-based billings from their waste hauler. This data is typically based on a pre-determined frequency of waste removal of fixed-volume waste containers or dumpsters. Waste disposal costs are based on frequency of waste removal from a known-volume container rather than a cost structure based on the actual weight or volume disposed. One strategy employed by several breweries in the study is to perform a waste audit, whereby solid waste from the facility is physically inventoried and weighed over a representative period in order to determine the actual weight to use for a true pound-per-barrel calculation. Cost savings may be realized by requesting smaller waste containers or less-frequent removals. In some cases it may be possible to negotiate a weight or volume-based rate, depending on the location and waste disposal vendor.

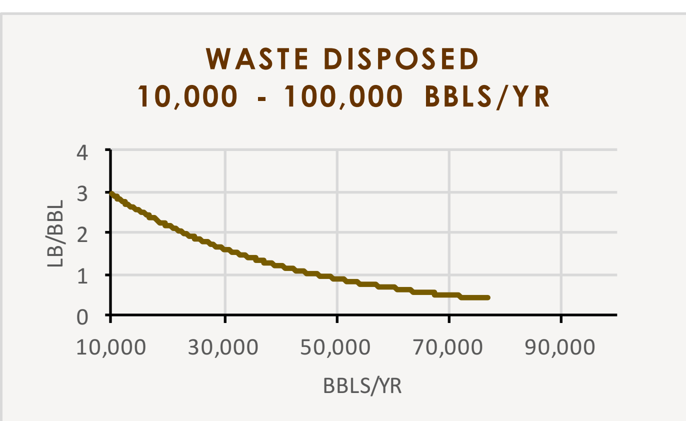
The graphics estimate solid waste disposal data for the industry. Generally, as total barrels of beer packaged increased, disposal cost per barrel of beer decreased.

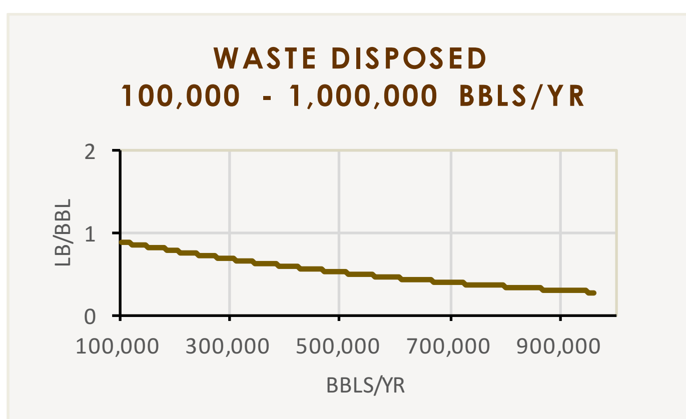
	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	5	11	9	10
Solid Waste Disposed				
Average Total Disposed (lbs)	20,940	16,219	50,068	253,359
Average Unit Cost ($/lb)	0.22	0.16	0.15	0.09
Average Cost Efficiency ($/bbl pkgd)	2.23	0.64	0.20	0.08
Average Disposal Efficiency (lbs/bbl pkgd)	24.95	4.11	1.36	1.14

Waste Disposal Efficiency Distribution by Size Category

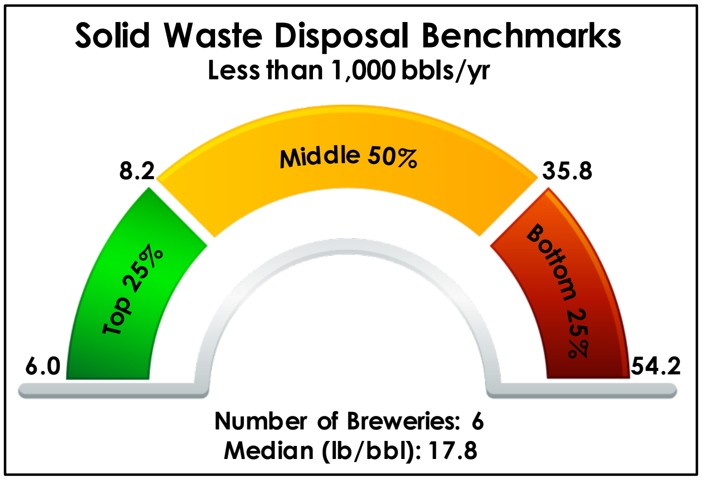


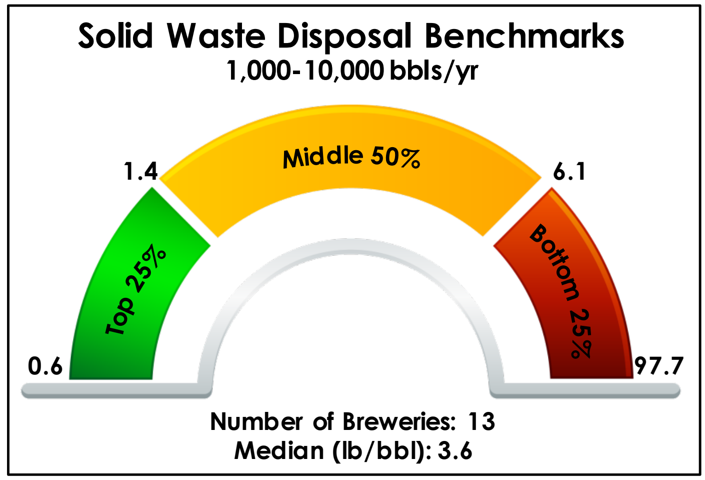


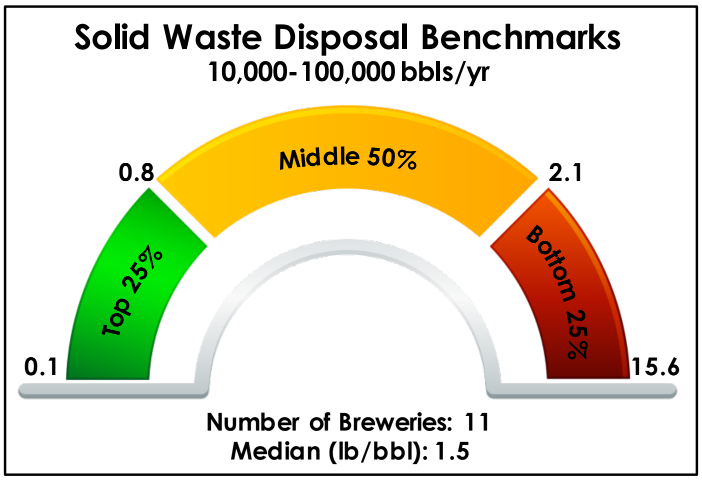


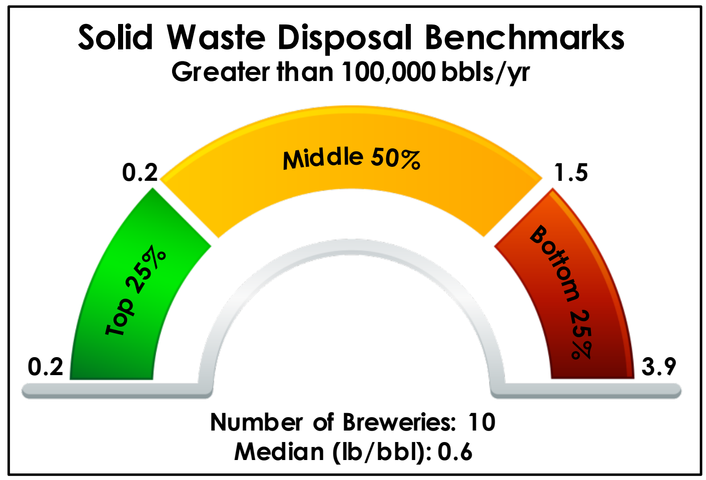


Waste Disposal Efficiency Distribution by Size Category









5.3 Solid Waste Recycled

In total, 35 breweries contributed 2014 recycling (excluding spent grains) data to the benchmark study, and 39 breweries contributed 2014 spent grain recycling data to the benchmark study.

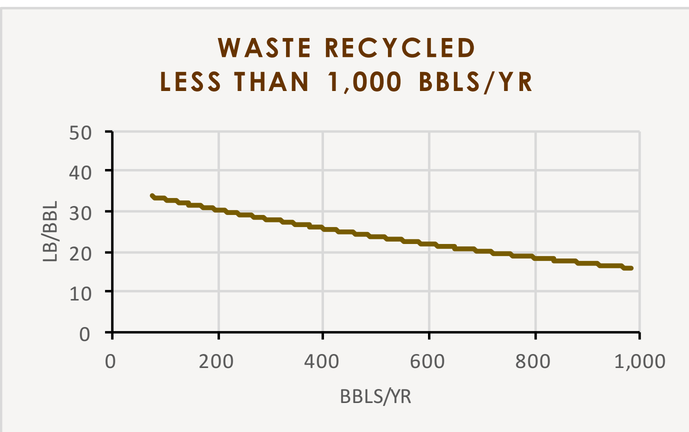
As seen in the above table, there is no clear overall trend between the production categories in terms of recycling and efficiency. Examples of drivers include:

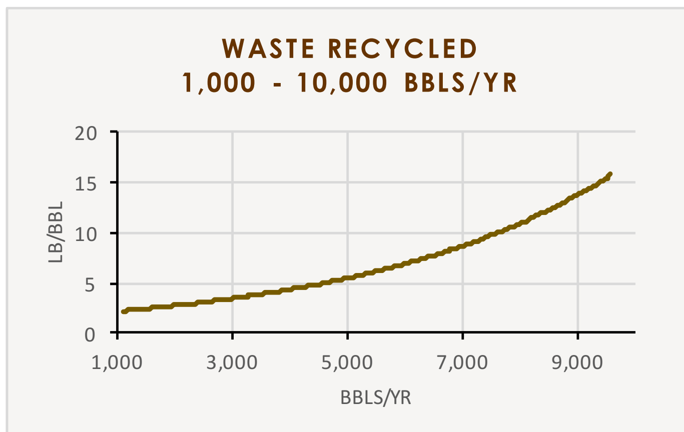
- Availability of recycling programs in certain regions
- Amount of recyclable materials generated at the facility
- Recycling behavior of patrons at facilities

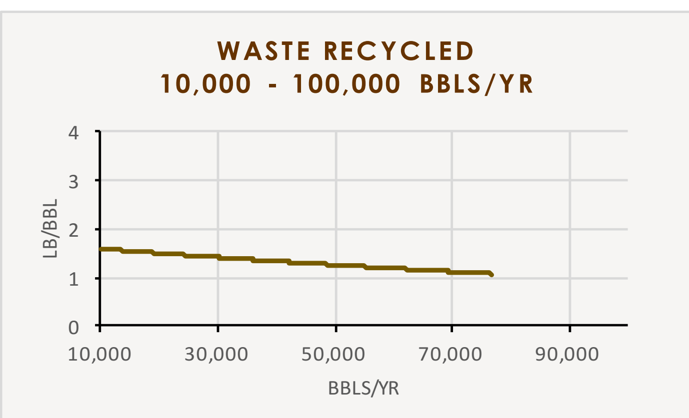
However as production size increases, breweries typically generate higher recycling revenues. These higher revenues may stem from the productions utilizing a greater amount of raw materials and implementation of cost effective programs to increase facility recycling. An example of the program would be drafting a recycling contract with a waste management contractor to establish a set amount of recyclable materials the contractor will receive each month. Recycling programs are easily implemented with waste management contractors, and it could be as simple as renting an additional dumpster. When possible, it is always best to reduce the usage of raw materials first. Then a brewery should reuse any potential materials at the facility or find a new use for them outside of the brewery. After these steps, all other materials should be recycled as possible to save the need to harvest more resources.

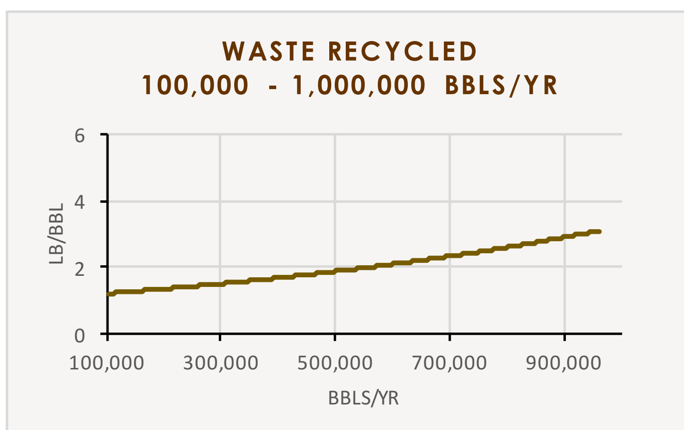
	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Solid Waste Recycling (excluding spent grains)				
Total Breweries Reporting	5	11	8	10
Average Total Recycled (lbs)	15,760	26,376	65,897	891,160
Average Total Revenue less dumpster rental cost ($)	-	16	564	8,940
Average Revenue Efficiency ($/bbl pkgd)	0.00	0.00	0.02	0.02
Average Recycling Efficiency (lbs/bbl pkgd)	22.23	6.69	1.79	2.26
Spent Grains Recycled				
Total Breweries Reporting	5	12	11	11
Average Total Recycled (lbs)	54,662	381,308	3,319,603	29,816,564
Average Total Revenue ($)	0.00	0.00	2493	115026
Average Revenue Efficiency ($/bbl pkgd)	0.00	0.00	0.07	0.43
Average Recycling Efficiency (lbs/bbl pkgd)	76.74	96.69	90.09	77.33

Waste Recycled Efficiency by Size Category

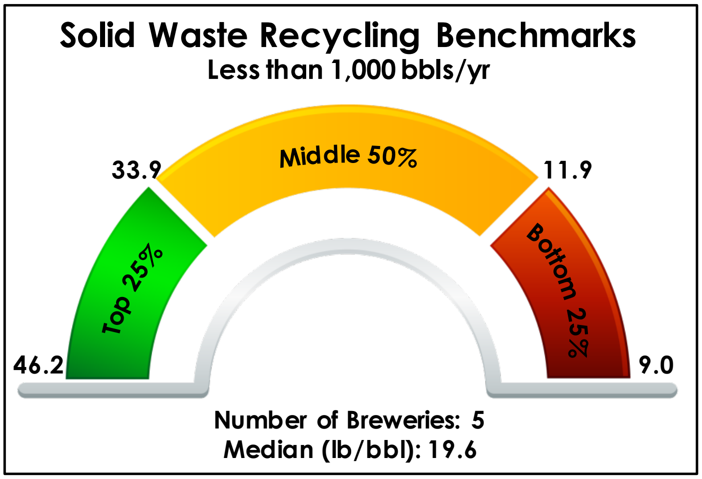


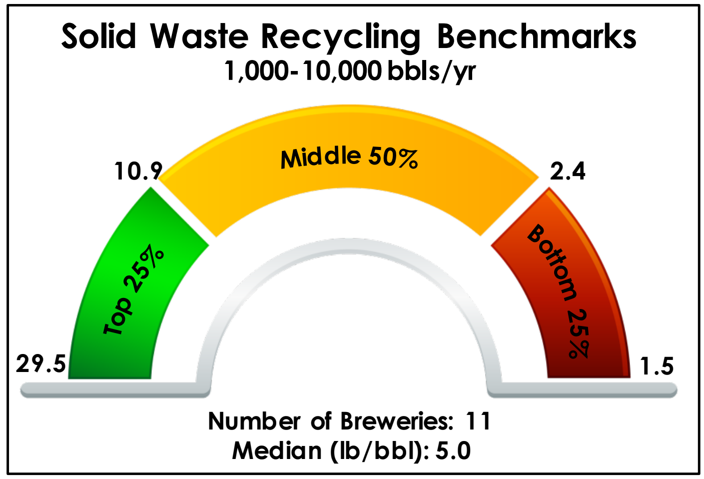


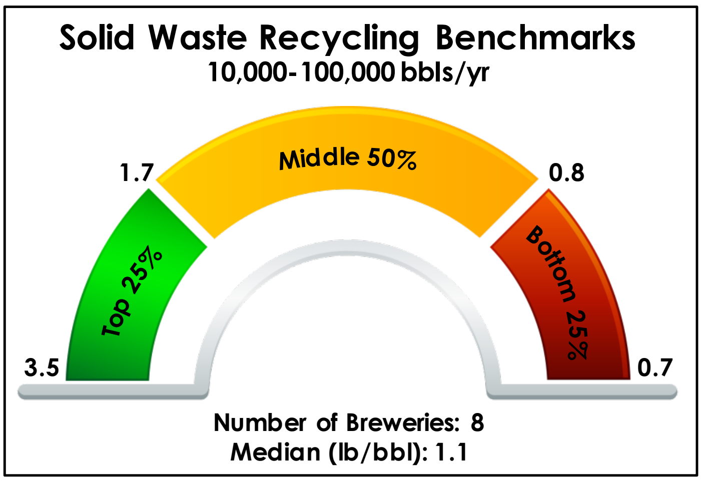


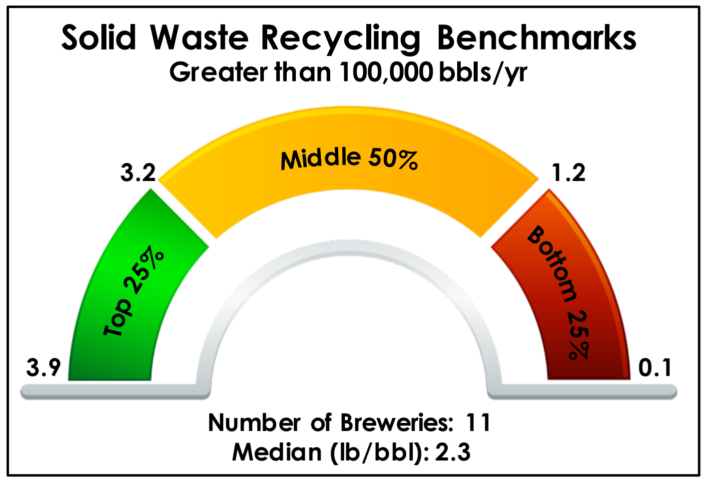


Waste Recycled Efficiency Distribution by Size Category

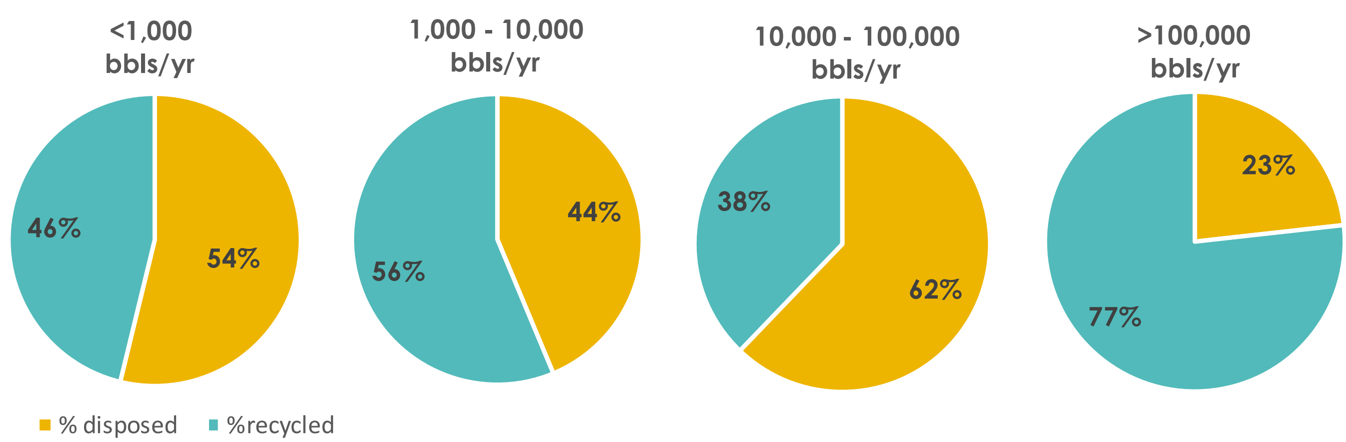








Percentage Waste Recycled vs Disposed by Size Category



5.4 Spent Grain

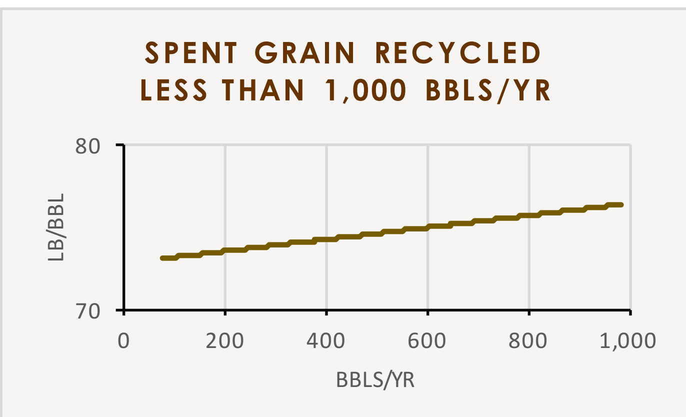
Another form of raw material that is very easily recycled is spent grain. The average amount of wet spent grain generated was approximately 80 lbs/bbl, regardless of size category. Most of the reported data was from calculations done at the brewery versus actual weight measurements. A total of 39 breweries reported their recycled spent grain for 2014. However, of these 39 breweries, only 12 breweries reported earned revenue from this practice. Donating spent grain to local farmers is a common practice among the breweries which did not report earned revenue. This practice can save valuable product from waste and can save breweries money by limiting waste costs. Recycling spent grain to local farmers also lends to increasing the sustainable aspects of brewing.

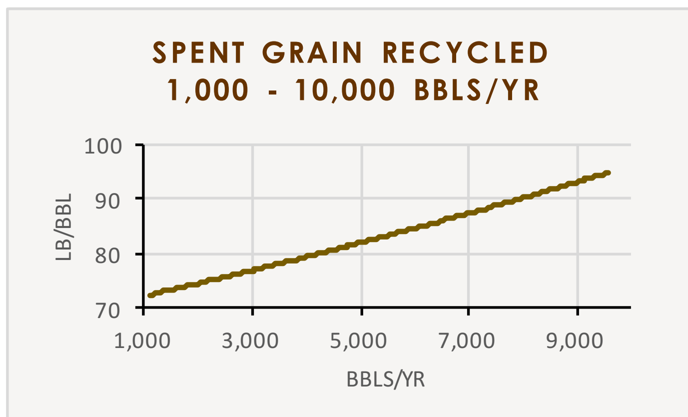
Maine Beer Company

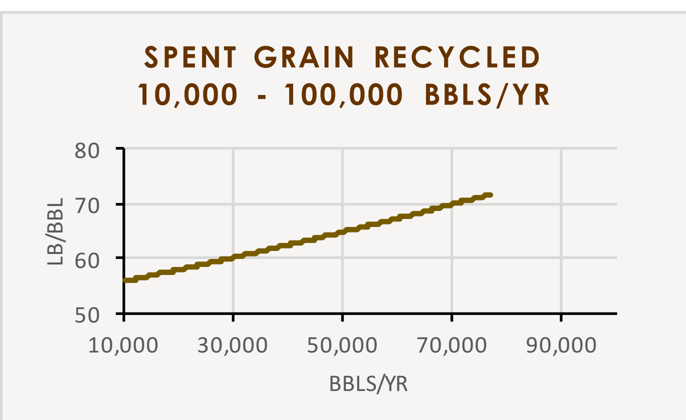
Maine Beer Company's mission is to "Do What's Right" and they have proven it by reinvesting profit in sustainable initiatives every year. Maine Beer Company is a member of Brewers for Clean Water and 1% for the Planet. Their facility utilizes LED lighting and radiant heat. In 2015, Maine Beer Company installed solar panels that can offset half of the brewery's electricity consumption. The brewery pre-heats brewing water by running hot wort through a heat exchanger saving on heating energy. They have even developed standard operating procedures (SOPs) to show employees how much water should be used to clean and rinse to avoid wasting water. They don't just let the water run until equipment is presumed rinsed. Company culture drives sustainability forward.

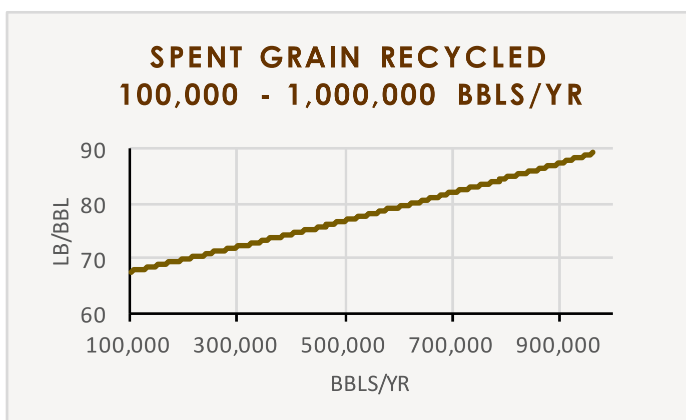
Fun Fact: Maine Beer even provides a public dashboard on their website to show their real-time utility usage!

Spent Grains Recycled Efficiency by Size Category

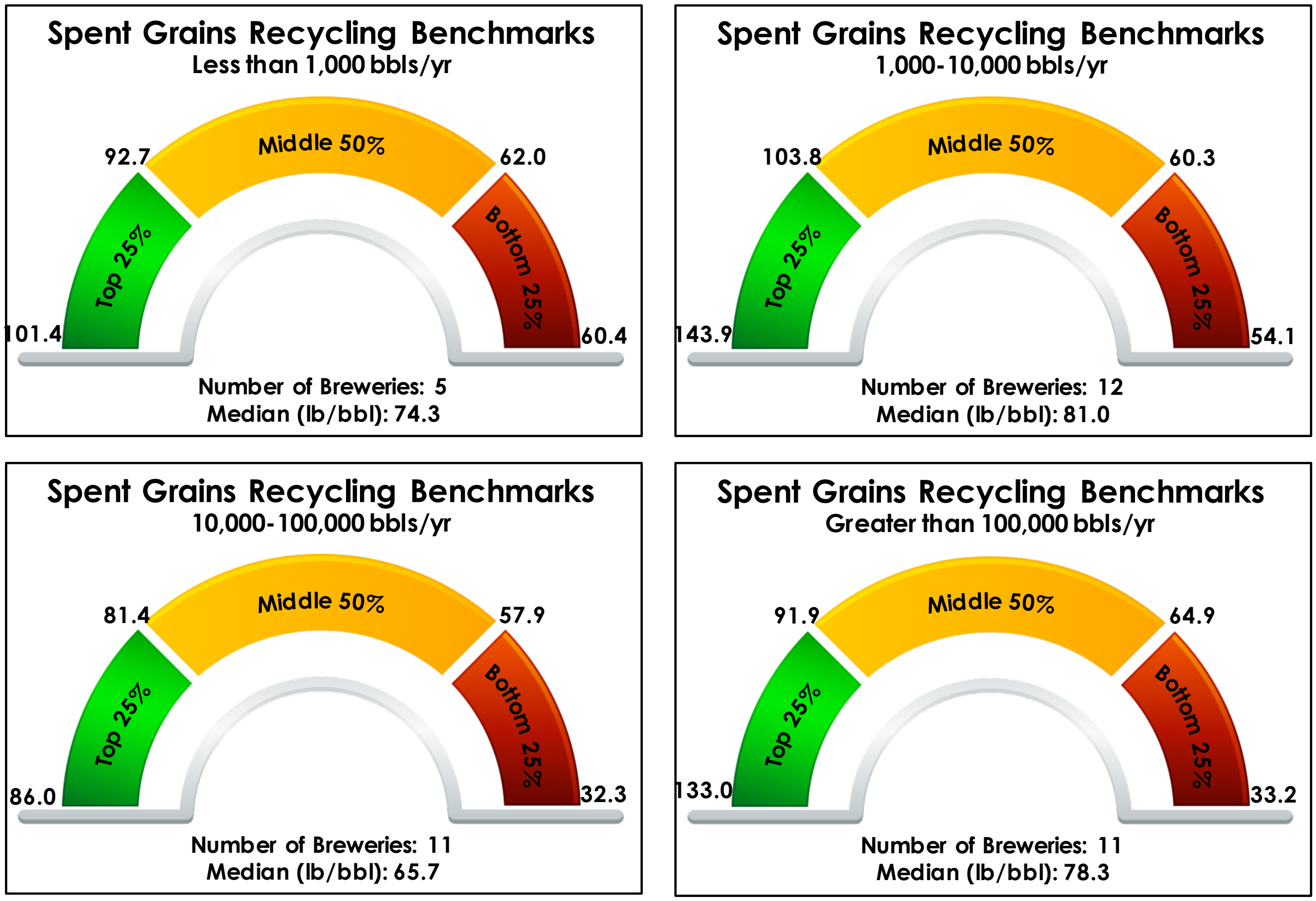








Spent Grains Recycled Efficiency Distribution by Size Category



Figueroa Mountain Brewing Co.

Figueroa Mountain Brewing Co. brews 22 hours a day, seven days a week on a 15-barrel brewhouse. They are "efficient by necessity" because their system is their production limiting factor. For example, water doesn't have an opportunity to cool down because they brew back to back, to back. The brewery sets a top priority on equipment maintenance and employee education in order to run efficiently. All equipment is constantly inspected for leaks or maintenance issues. "Education on sustainability for all employees is the key to being sustainable." In fact, it's not uncommon for the brewery to have friendly competition around who uses the least amount of water.

Fun Fact: Figueroa Mountain does not have air-conditioning in their brewery or tasting room. They utilize night time cold air, fans, and concrete foundation to keep rooms cool during the day. They also optimize natural light and skylights to save energy on lighting.

section six:

Greenhouse Gas Emissions

	Less than 1,000 bbls/yr	1,000 - 10,000 bbls/yr	10,000 - 100,000 bbls/yr	Greater than 100,000 bbls/yr
Total Breweries Reporting	20	24	22	12
Greenhouse Gas Contributions				
Natural Gas Combustion (lbs CO_2/bbl)	143.72	76.03	29.25	20.75
Non-Fermentation CO_2 (lbs CO_2/bbl)	5.61	5.13	6.20	6.12
Electricity (lbs CO_2/bbl)	199.64	130.63	34.79	19.65
Total Annual Efficiency (lbs CO_2/bbl)	348.97	211.79	70.24	46.52

In total, greenhouse gas (GHG) emissions were calculated for 78 breweries in the benchmarking study. Total GHG emissions are estimated based on the amount of natural gas combusted at the brewery, the amount of CO_2 purchased and the amount of electricity purchased. These calculations provide an approximation of Scope 1 and Scope 2 GHG emissions using standard factors from the Guidelines for National Greenhouse Gas Inventories and U.S. Environmental Protection Agency eGrid factors. Biogenic CO_2 emissions created from brewery fermentation are not included in these totals.

The above table details an overall decreasing trend between the production categories in terms of total GHG efficiency. A reason the less than 1,000 and 1,000-10,000 bbls/yr production groups have higher lbs CO_2/bbl can be attributed to brewpubs; some of the brewpubs had the highest electricity contributions to GHG emissions due to the extra demand at those facilities. Non-fermentation CO_2 (purchased CO_2) does not play a significant role in the overall GHG emissions One of the most important factors in terms of GHG emissions is the energy grid where a brewery receives power. Each state has different sources of energy, such as coal, oil, natural gas, etc. If the state has a high percentage of coal creating their energy, the brewery would have higher greenhouse gas emissions. Colorado and Missouri have the highest greenhouse gas e-grid factors, thereby increasing these breweries greenhouse gas emissions. Examples of greenhouse gas contribution drivers include electricity and fuel usage efficiency and:

- Brewpub operational demand
- using high efficiency equipment
- carbon recapture processes
- energy grid and brewery location

Jack Pine Brewery

Jack Pine Brewery offers a smaller brewery's perspective to sustainability. They have one pump running the brewhouse, an on-demand water heater instead of a hot liquor tank, and a direct-fired natural gas system. The brewery invested in a new chiller which is properly sized; they find this new chiller is very efficient and they are now running on much less water use. Since their production is smaller, they utilize manual labor for shoveling out the mash tun and cleaning. They even operate manual spray hoses so employees know when they run water, and they try to stop any running down the drain.

Fun Fact: Jack Pine Brewery uses groundwater with a year round temperature of 50°, which saves them energy on their chilling water!

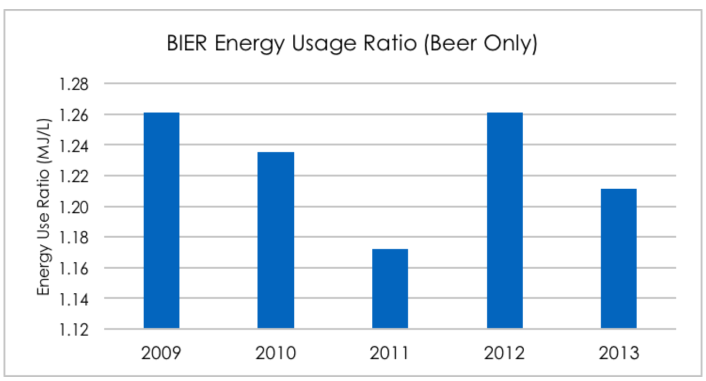
section seven:

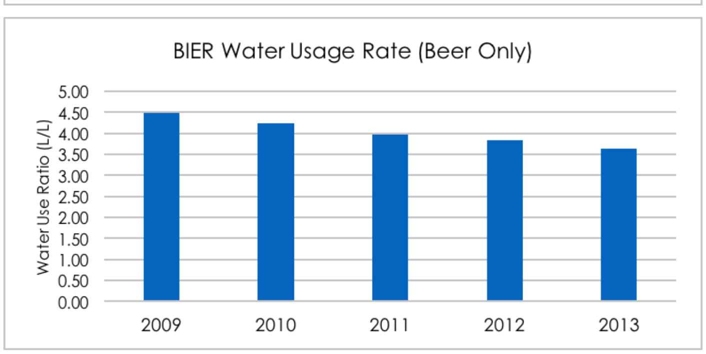
Comparisons

7.1 Global Brewing Comparisons

In the 2013 data BIER benchmarking study, global energy use ratios (EURs) among breweries decreased 2 percent from 2009 to 2013. Of the breweries that provided five years of data, 60 percent improved their energy use ratio from 2009 to 2013. Brewery facilities reporting energy data increased 12 percent in 2011, which could contribute to the EUR fluctuation during this time.

Global water use ratios (WURs) among breweries in the BIER benchmarking decreased 18 percent from 2009 to 2013. Of the breweries that provided five years of data, 89 percent improved water use ratio from 2009 to 2013. In addition, 63 percent of breweries decreased their WUR consistently from 2011 to 2013.



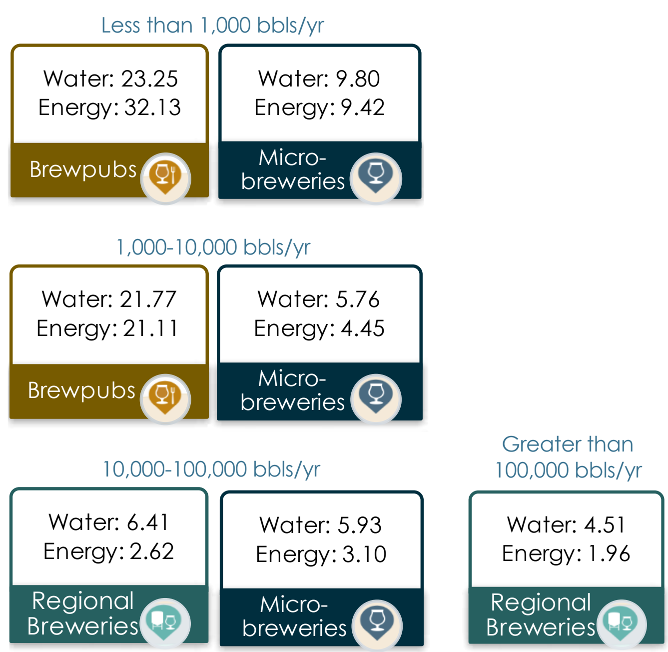


These data are from breweries around the world ranging in production from 20,000 to 14,000,000 bbls per year. Results are presented for total energy usage (fuel + electricity) in units of Mega Joules of energy per liter beer packaged. Water usage efficiencies are presented in units of liters of water per liter beer packaged. When comparing these values against smaller craft brewers, the efficiencies of scale become very evident.

7.2 Craft Brewer Market Segment Comparisons

The following graphics reflect usage efficiency data from participating craft brewers presented in metric units of liter per liter (L/L) for water and Mega Joules per liter (MJ/L) for energy.

Market Segment Water Usage Ratio (WUR) and Energy Usage Ratio (EUR)



- Regional Breweries are present in the larger production size breweries, but there is no clear trend when comparing this market segment to others. Economies of scale are also present as the Greater than 100,000 bbls/yr Regional Breweries had lower WUR and EUR than the 10,000-100,000 bbls/yr breweries. At the 10,000-100,000 bbls/yr production level, Regional Breweries have a lower EUR but a higher WUR. This may indicate Regional Breweries are aware of energy usage in lighting, climate control, and production heating and cooling.

- Microbreweries are present in three of the production size categories, and it is clear the usage rates are lower than Brewpubs. Microbreweries increased in efficiency as the production sizes increased, with the exception of WUR between the 1,000-10,000 bbls/yr and 10,000-100,000 bbls/yr groups. As production size increases, Microbreweries can be compared to Regional Breweries, which one would intuitively think economies of scale would begin to play a role. However, in the 10,000-100,000 bbls/yr group, the Microbreweries and Regional Breweries did not differentiate usage rates to form a clear trend.

- Brewpubs are present within two of the production size categories, and they have the highest WUR and EUR among the three market segments. This is due to their high demand of water and electricity on the pub side of the operations. Economies of scale are present as the Brewpubs in the 1,000-10,000 bbls/yr have lower usage rates than the <1,000 bbls/yr breweries.

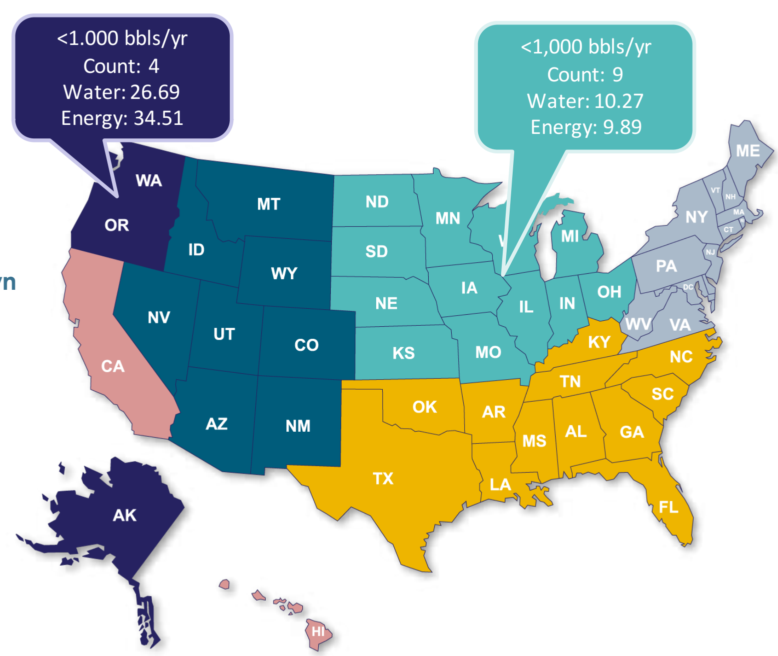
7.3 Geographic Comparisons

Below are figures of the regions with depictions of the count of the reporting breweries, their production size, and the average WUR and EUR. When the regions were analyzed to determine if climate impacted energy use, heating degree days and cooling degree days were accounted for in each brewery's zip code. As the number of heating degree days increased, average natural gas usage per barrel also increased. As the number of cooling degree days increased, the electricity usage per barrel stayed relatively flat, possibly suggesting many breweries may not utilize climate control in the form of air conditioning. There are cases where breweries trap night-time air in their facility to keep cool during hot days by letting air in at night and closing doors and windows during the day. Other facilities utilize industrial and ceiling fans to circulate air on hot days. Some facilities may not even utilize any climate control method and simply open their tap room up to the outside.

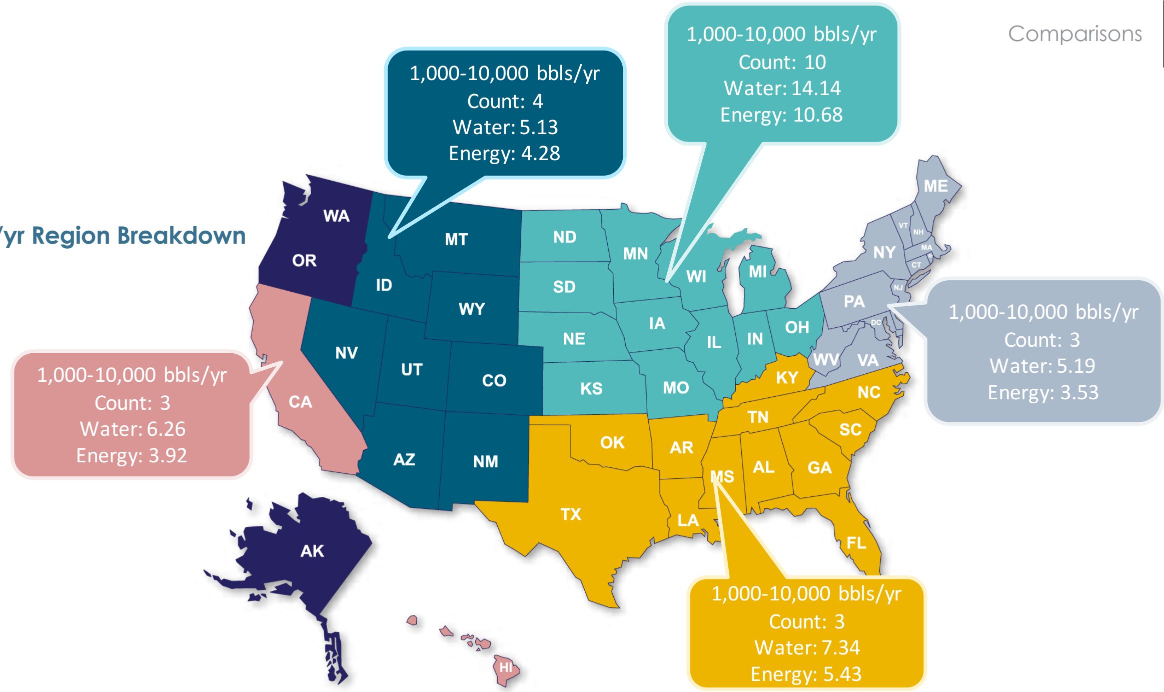
Regional Water Usage Ratio (WUR) and Energy Usage Ratio (EUR)

Regions without information did not have enough reporting facilities.

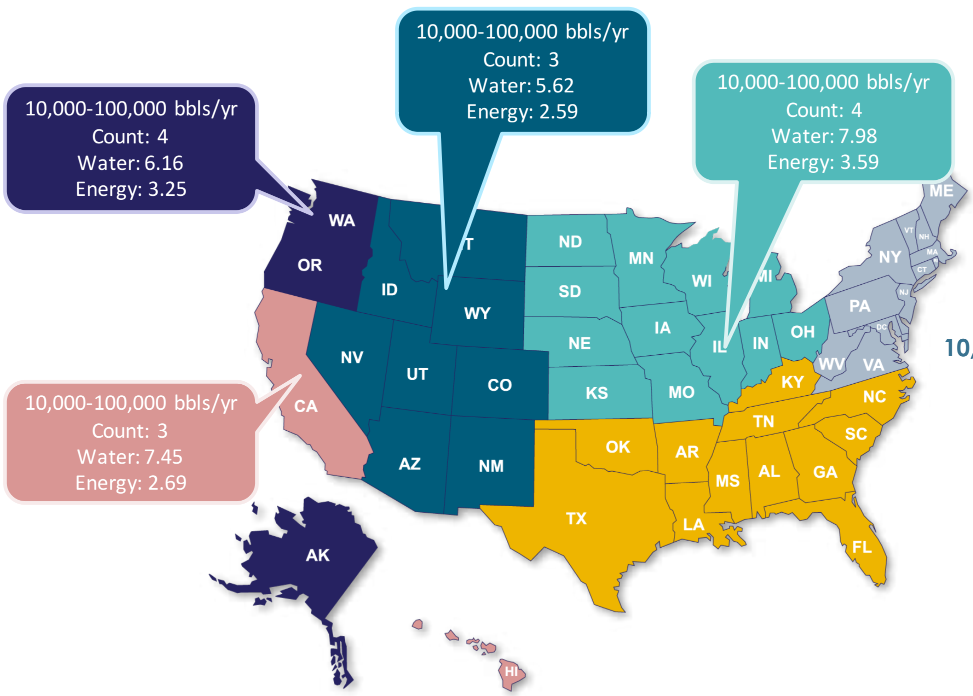
<1,000 bbls/yr Region Breakdown



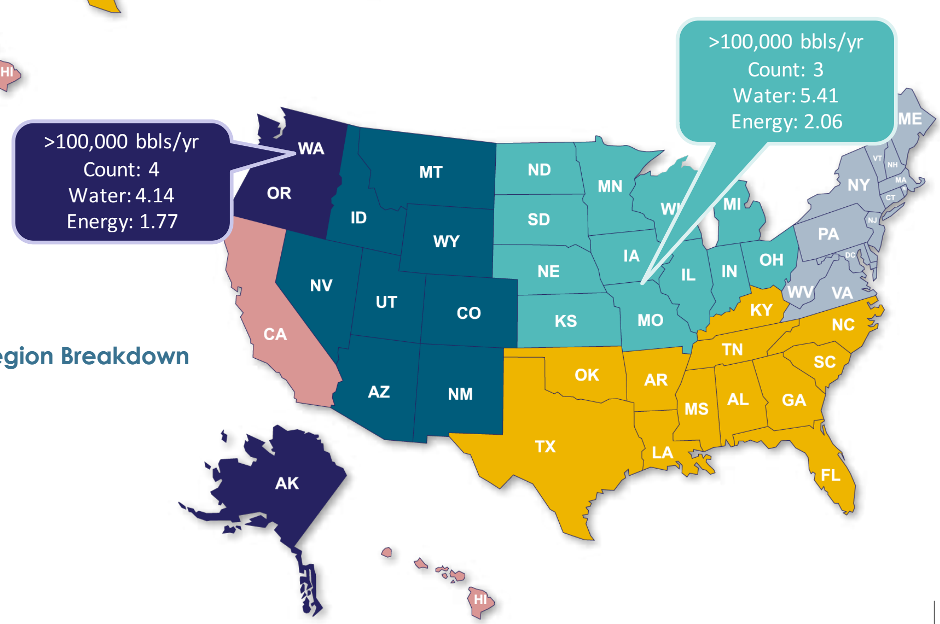
1,000-10,000 bbl/yr Region Breakdown



10,000-100,000 bbls/yr Region Breakdown



>100,000 bbls/yr Region Breakdown



Northeast: There was only enough data to analyze this region in one production category. The Northeast had the lowest EUR out of all the regions for the 1,000-10,000 bbls/yr group and had one of the lowest WUR as well. Some of these breweries had a higher number of heating degree days where natural gas heat usage may have increased, so the low EUR speaks to the breweries efficiencies.

South: There was only enough data to analyze this region in one production category. This region had the second highest rates out of all the regions. This region experienced some of the highest numbers of cooling degree days which in turn could raise the EUR through air conditioning use.

Mountain West: This region has similar WUR and EUR compared to other regions. However, they do have the lowest EUR for the 10,000-100,000 bbls/yr group, and they have the lowest WUR for both the 1,000-10,000 bbls/yr and 10,000-100,000 bbls/yr group.

North Central: This region has high rates due to brewpubs for the <1,000 bbls/yr and 1,000-10,000 bbls/yr groups, but the region still has the highest rates in the 10,000-100,000 bbls/yr group. Energy rates may be high due to this region having the highest number of heating degree days, but WUR could improve for each production size.

Pacific Northwest: This region has the highest WUR and EUR for all regions and all production groups, due to the higher number of brewpub respondents. This production group could focus on trying to increase efficiency to become closer to other regions' usage rates. As the production size changes, the Pacific Northwest region rates are closer to other regions.

Pacific: For a region that is threatened by drought, the Pacific breweries have high WUR when compared to some of the other regions. More steps should be taken to try and reduce the WUR to be the leader for all regions. The EUR is the second lowest of the regions for both 1,000-10,000 bbls/yr and 10,000-100,000 bbls/yr groups which indicates the region can still improve but is more efficient with electricity and natural gas usage.

7.4 Energy Usage vs. Total Degree Days

The benchmarking data set does not contain a representative level of data in order to create a strong correlation to energy use as a function of total degree days (heating plus cooling degree days). This section is included in the report to acknowledge the importance of geographic location (total degree days) when conducting usage efficiency comparisons.

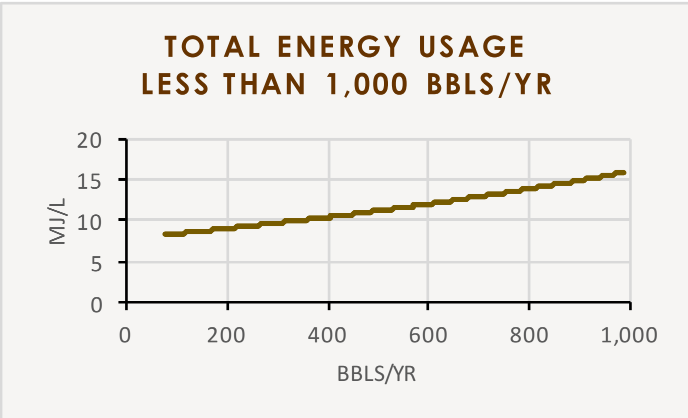
In all the data sets from contributing breweries that provided separately-metered energy data for both brewery and pub operations, only two reported larger electric or natural gas usage from pub operations. Overall across all production categories, it is clear that the brewing and production side of operations is the greatest total energy user, which explains why the effect of degree days is small for the larger breweries. However, as brewery size decreases and pub size increases, the contribution of pub operations to total energy use will be greater and an effect of degree days may become more apparent. This will become more evident in areas of the country where the number of total degree days is more extreme.

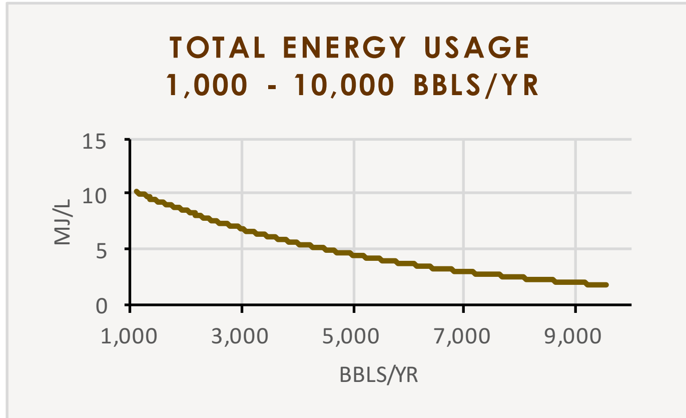
As cooling degree days increase (warmer climate), a greater energy use will be required for users such as comfort cooling (pub), chilling and on- or off-site cold storage. As heating degree days increase (cooler climate), a greater energy use will be required for users such as comfort heating (pub), water heating as incoming source water temperature increase and temperature control for larger barrel-aging areas.

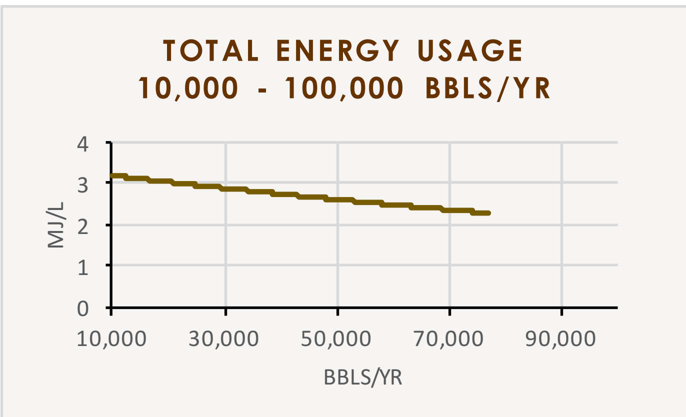
These direct weather correlations become less relevant for breweries that utilize hot liquor tanks and heat recovery. Also, brewpubs would have, percentage wise, a higher contribution of space heating versus brewing in their natural gas usage. Larger breweries can have more than 70% of their natural gas usage dedicated to making steam.

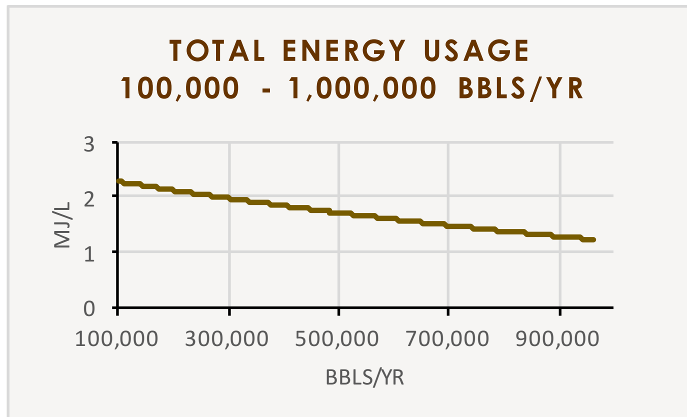
It is expected that this section will become more representative and insightful in future benchmarking reports as the number of participating brewers increase.

Total Energy Usage by Size Category









U.S. Energy Information Administration

The U.S. Energy Information Administration (www.eia.gov) defines heating and cooling degree days as the comparison of the outdoor temperature to a standard temperature of 65°F. The more extreme the temperature, the greater the number of degree days. A higher number of degree days will require more energy for space heating or cooling. Hot days are measured in cooling degree days and cold days are measured in heating degree days.

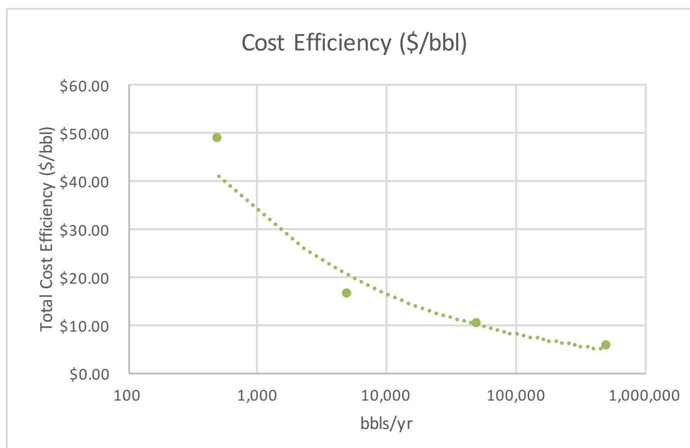
section eight:

Average Costs per Barrel

When considering the overall utility cost per barrel packaged, there are numerous factors that contribute to cost variability that need to be considered when making brewery to brewery comparisons. Many of these variables have been presented throughout this report and can include factors such as beer styles and brewing schedules, restaurant/taproom operations, on-site wastewater pretreatment. Other factors that are subject to less control and influence by the brewery include municipal rate structures, proximity to major metropolitan areas and the influence of geographic factors that affect water supply, and the generation of electricity as well as climate. One benefit of benchmarking is that the influence of any one of these variables is lessened when similar operations are compared with each other in order to identify trends.

Average Total Cost Efficiency ($/bbl)

Less than 1,000 bbls/yr	$48.36
1,000 - 10,000 bbls/yr	$15.96
10,000 - 100,000 bbls/yr	$9.97
Greater than 100,000 bbls/yr	$5.38

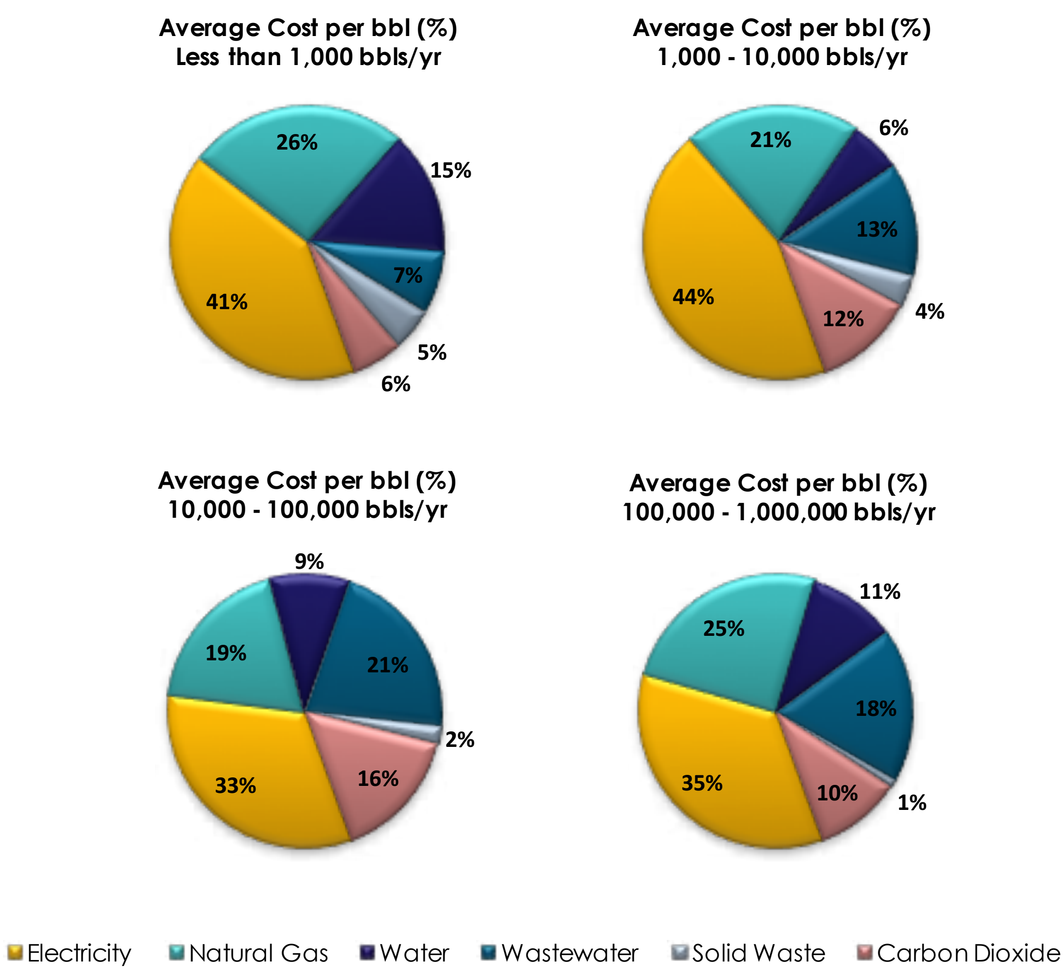


The Total Cost Efficiency is presented as the average combined total of all utilities benchmarked in this study, including electricity, natural gas, water, wastewater, solid waste and carbon dioxide.

Though data for wastewater, solid waste and CO_2 was not consistently reported to the same level as water, electricity and fuel, sufficient data existed to determine an approximate average cost per barrel for utilities across all production categories. In all categories, electricity is clearly the majority utility expense, ranging from 33% to 44% of total utility costs. Caution should be exercised, however, not to focus too strongly on only one area of improvement as utility usage is often commingled in various processes. It is more critical to focus on the various production processes and inventory utility users throughout the brewery in order to understand where the greatest opportunities for improvement may exist. The simplest example of this concept is water, which requires energy for transfer and heating, energy for processing throughout the brewing and packaging cycle, and finally sometimes even additional energy for treatment prior to disposal. The actual cost of water as a percent of your utility bill does not reflect what you actually pay to pump, amend, heat, transfer and dispose of it.

The charts below illustrate the average cost per barrel as a percentage of total utility costs.

Average Cost per Barrel (%)



section nine:

Benchmarking Next Steps

Many breweries that participated in this study expressed their appreciation that a source for benchmarking data for utilities such as this was being developed. It was encouraging to see many of the study participants provide a great level of detail, and even more encouraging to engage with breweries of all sizes that had a desire to see what areas of operations they could be performing better in.

Many breweries elected not to participate for a variety of reasons. Most centered on the lack of resources to locate and input historical and current utility billing information. Those that allocated time to this effort saw the value in doing so and many have already reaped the cost savings of lower utility bills. However, it did take some effort to establish at least a twelve month baseline of monthly data. Going forward, these breweries will input utility data as it comes in, creating a much easier and less time consuming process.

Greater participation in future benchmarking efforts will increase the confidence in which insights and trends identified during data review can be attributed to the craft brewing sector. A brewery's own participation in benchmarking can create the motivation for the development of internal operating procedures or efficiency-related programs. It can also help support and augment existing programs for breweries that already have strong internal processes and are looking for next-level opportunities to keep the cycle of continuous improvement going.

The release of the BA on-line sustainability benchmarking tools in 2016 is expected to significantly increase the number of benchmarking participants in the future. The sustainability benchmarking tools will provide easier and less time consuming data entry and allow users to trend monthly utility billings and set reduction goals. This report is also anticipated to generate additional interest in benchmarking. Many brewers could not conceptualize the value in providing data and elected not to participate. Hopefully, the insights provided in this report will encourage others to join this important effort to make craft brewing more sustainable.

We challenge each brewer to evaluate their own data against these benchmarks and develop a roadmap to becoming more sustainable. Developing a baseline around these initial KPIs, setting realistic improvement targets, empowering employees to act and implementing projects will not only realize more profitability through cost reductions, but will also create a lighter environmental footprint. In summary, a more sustainable brewery.

section ten:

Key Contacts

Benchmarking allows comparisons and also enables sharing of best practices. Many of the best practices used by breweries in the benchmarking study have been identified and catalogued in the BA Sustainability Manuals located on www.brewersassociation.org. Brewers are encouraged to download and use these manuals to their fullest extent.

Several benchmarking participants expressed an interest in making direct contact with breweries that are top performers in order to learn and discuss their successes and challenges.

Usage KPI	bbls pkg/yr	Brewery
Water (bbl/bbl)	<1,000	Stillmank Brewing Company
		Broken Compass Brewing Company
		Jack Pine Brewery
		Burning Brothers Brewing
	1,000 - 10,000	Birdsong Brewing Company
		Rising Tide Brewing Company
		Beltway Brewing Company
		Jackie O's Brewery - Campbell St
		Maine Beer Company
	10,000 - 100,000	Iron Horse Brewery
		Fremont Brewing Company
		Bear Republic Brewing Company
		Allagash Brewing Company
		Creemore Springs Brewery
		Switchback Brewing Company
	>100,000	Craft Brew Alliance - Portland
		Alaskan Brewing Company
		Odell Brewing Company

Individual breweries have not been identified in this report in order to maintain confidentiality of efficiency and cost data. However, we have contacted the breweries that are in the top 25% performers for their permission to identify them in the list below. They have encouraged others to contact them directly to share improvement ideas.

Usage KPI	bbls pkg/yr	Brewery
Electricity (kWh/bbl)	<1,000	Upper Hand Brewing Company
		Jack Pine Brewery
		Dangerous Man Brewing Company
		Stillmank Brewing Company
		Ethereal Brewing Company
	1,000 - 10,000	Fulton Brewing
		Maine Beer Company
		Figueroa Mountain Brewing Company
		Rising Tide Brewing Company
		Kettlehouse Brewing Company - Northside
		Jackie O's Brewery - Campbell St
	10,000 - 100,000	Bear Republic Brewing Company
		Fremont Brewing Company
		Switchback Brewing Company
		Yards Brewing Company
		Revolution Brewing Company
		Uinta Brewing Company
	>100,000	Craft Brew Alliance - Portland
		New Belgium Brewing Company - Colorado
		Deschutes Brewery
		Deschutes

Usage KPI	bbls pkg/yr	Brewery
Fuel (therm/bbl)	<1,000	Ethereal Brewing Company
		Broken Compass Brewing Company
		Stillmank Brewing Company
		Jack Pine Brewery
		Broken Bow Brewery
	1,000 - 10,000	Kettlehouse Brewing Company - Southside
		Figueroa Mountain Brewing Company
		Birdsong Brewing Company
		Rising Tide Brewing Company
		Maine Beer Company
		Jackie O's Brewery - Campbell St
		Kettlehouse Brewing Company - Northside
	10,000 - 100,000	Fremont Brewing Company
		Karl Strauss Brewing Company
		Bear Republic Brewing Company
		Yards Brewing Company
		Great Divide Brewing Company
		Iron Horse Brewery
	>100,000	New Belgium Brewing Company - Colorado
		Craft Brew Alliance - Portland
		Sierra Nevada Brewing Company - California

Usage KPI	bbls pkg/yr	Brewery
Purchased CO_2 (lb/bbl)	<1,000	Bent Brewstillery
		Jack Pine Brewery
		Falling Sky Brewing
	1,000 - 10,000	Birdsong Brewing Company
		Mike Hess Brewing
		Kettlehouse Brewing Company - Southside
		Beltway Brewing Company
		Beltway
	10,000 - 100,000	Switchback Brewing Company
		Karl Strauss Brewing Company
		Dry Dock Brewing Company - North Dock
		Upland Brewing Company
	>100,000	New Belgium Brewing Company - Colorado
		Odell Brewing Company
		Craft Brew Alliance - Portsmouth
		Bell's Brewery Inc. - Comstock

web links

- BA Sustainability Guidance Manuals: https://www.brewersassociation.org/tag/sustainabilitymanuals/
- BA Benchmarking Project Announcement: https://www.brewersassociation.org/industry-updates/participate-in-the-brewers-association-sustainability-benchmarking-project/
- Production Data: https://www.brewersassociation.org/statistics/national-beer-sales-production-data/
- U.S. Breweries: https://www.brewersassociation.org/statistics/number-of-breweries/
- IPCC GHG Emission Factors: http://www.ipcc-nggip.iges.or.jp/public/2006gl/
- US Environmental Protection Agency eGrid Factors: https://www.epa.gov/energy/egrid-faq
- BIER 2014 Benchmarking Study: http://www.bieroundtable.com/benchmarking-coeu