Beverage Industry Continues to Drive Improvement in Water and Energy Use

Beverage Industry Environmental Roundtable

2014 Trends and Observations

BEVERAGE
INDUSTRY
ENVIRONMENTAL
ROUNDTABLE

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In its eighth year of benchmarking, the Beverage Industry Environmental Roundtable (BIER) recognized a number of key insights pointing to continued efforts on the part of the beverage industry to improve water and energy usage. This continues to be the most comprehensive quantitative benchmark study of water and energy use and efficiency in the beverage industry with 2013 participation from over 1,700 facilities representing 18 member beverage companies and one industry peer across six continents. As a whole, industry water and energy use ratios have decreased year to year as production has increased – a continuation of trends observed in previous BIER studies.

This article will present results of the 2014 annual water and energy benchmarking study, revealing an improvement in the beverage industry's water and energy use ratios. Information on methodology and key definitions underpinning the study is presented at the end of the article. Table 1 below presents the water and energy use ratios for the four main facility types (Brewery, Distillery, Winery, and Bottling).

Table 1. 2014 Benchmarking Study Performance Summary[1]

	2009	2010	2011	2012	2013
Total Companies Reporting	17	18	18	18	18
Total Facility Count	1,582	1,693	1,691	1,719	1,723
Total Production (bil L)	260	287	292	304	308
Total Water Use (bil L)	796	883	812	824	812
Total Energy Use (bil MJ)	184	193	202	218	214
Water Use Ratio (WUR) (L/L)	**3.06**	**2.91**	**2.78**	**2.71**	**2.64**
Brewery (Beer Only)	*4.48*	*4.23*	*3.98*	*3.84*	*3.65*
Distillery	*37.94*	*34.99*	*35.31*	*33.85*	*37.80*
Winery	*3.79*	*4.11*	*4.74*	*3.59*	*4.09*
Bottling (All)	*2.19*	*2.10*	*2.02*	*1.99*	*1.95*
Energy Use Ratio (EUR) (MJ/L)	**0.80**	**0.78**	**0.69**	**0.72**	**0.71**
Brewery (Beer Only)	*1.25*	*1.22*	*1.17*	*1.25*	*1.23*
Distillery	*12.58*	*11.99*	*12.07*	*11.94*	*12.59*
Winery	*1.37*	*1.87*	*2.04*	*1.47*	*1.67*
Bottling (All)	*0.47*	*0.46*	*0.41*	*0.41*	*0.40*

[1] Total production and facility count differs between water and energy use, as some facilities that provided water data were unable to provide energy data.

Key study findings include:

- **The study set continues to grow each year.** The 2014 study scope includes a more "dynamic" data set by focusing on facilities that provided any data over the five year period. The intent of the expanded scope is to evaluate a more robust data set and account for the organic metrics trends associated with acquisitions, divestitures, production changes, etc. The 2014 study evaluates information from the over 1,700 facilities that provided 2013 water and/or energy use data and production volume; compared to the 2013 benchmarking study focus on a data set of 1,561 facilities for water, and 1,357 facilities for energy.

- **Positive performance with water and energy use as industry production continues to increase.** Beverage industry total production increased 18 percent from 2009 to 2013, while water and energy use ratios generally improved (decreased) over the five year period. As in previous studies, these ratio trends demonstrate that process efficiencies are being recognized as the industry continues sustainable growth.

- **Performance improvement at a facility level.** Of the facilities that provided five years of data, 75 percent of facilities achieved an improvement in water use ratio and 58 percent achieved an improvement in energy use ratio from 2009 to 2013.

Key Data Set Characteristics

- 2013 average facility production volume**: 178,726 kiloliters (kL)**
- 2013 average facility water use**: 471,414 kL**
- 2013 average facility energy use**: 125,897,399 megajoules (MJ)**
- **75 percent** of facilities reporting five years of data decreased WUR from 2009 to 2013
- **58 percent** of facilities reporting five years of data decreased EUR from 2009 to 2013

The bases for the analyses are the water use ratio and energy use ratio, which are broad indicators of how efficiently a facility uses water and energy for beverage production.

The corresponding industry-wide[2] volume-weighted water use ratio decreased over the study period, from 3.06 to 2.64 L/L. The improvement in water efficiency over the study period corresponds to industry-wide water use avoidance of approximately 125 billion liters, enough water to fill the concert hall at the Sydney Opera House in Australia over 4,900 times[3].

[2] "Industry-wide" is a collective term for the beverage industry, in this case defined by the eighteen BIER participant companies and one industry peer.

[3] *Sydney Opera House Taps Meyer Sound for Key Festival Events.* http://meyersound.com/news/2003/sydney_festival/?type=14

- **Total water and energy use increased, while water and energy use ratios generally improved over the five year period.** Analyses were conducted to determine industry water and energy use, production, and water and energy use ratios over the five year period (from 2009 to 2013). Water and energy use increased as production increased over the study period. As seen in Figure 1 and Figure 2[4], industry water use ratio decreased 14 percent, and industry energy use ratio decreased 11 percent from 2009 to 2013.

Figure 1: Industry Water Efficiency 2009 - 2013

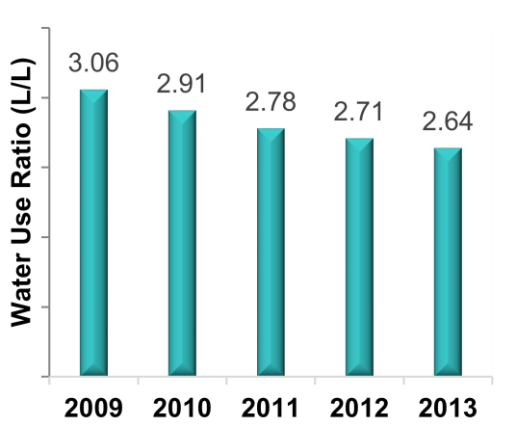
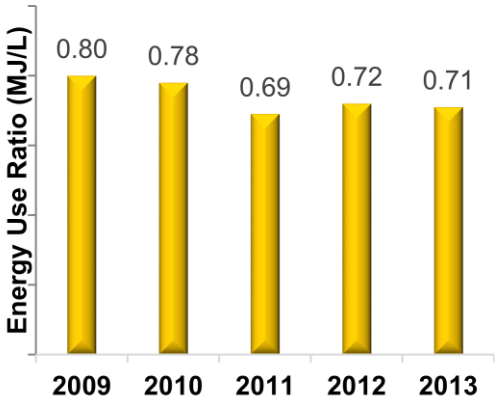


Figure 2: Industry Energy Efficiency 2009 - 2013



- **Fluctuations in performance trends among facility types.** By focusing on a more "dynamic" data set and extending the scope to a five year trend, there is more year-to-year fluctuation observed in water and energy use ratios than in past reports. The water and energy use ratios for brewery and bottling facilities improved over the five-year study period; while there was more of a fluctuation in ratios at distillery and winery facilities. These trends may be influenced by data availability, production trends, and number of facilities reporting in each year.

Further analysis was performed on each of the four facility types to identify specific trends in water and energy use. Facility types, general process steps, and associated ratio trends are described in the next sections.

[4] Note that in 2011, the number of facilities reporting energy data increased 12 percent from 2010 (as data became more available from the membership), which could attribute to the energy ratio fluctuation during this time.

Bottling

Bottling facilities were defined as:

> *Locations where concentrate, syrup, flavors/infusions, and/or bulk alcohol are blended with water and packaged into various container types. Also includes "bottled water" (see page 6). Bottling facilities also encompass facilities which receive finished bulk product (such as completely brewed beer or matured whiskey). No fermenting or distilling processes are conducted at bottling facilities.*

Bottling facilities represented the largest data set of the study, accounting for 68 percent (by volume) of the overall 2013 industry data set. For the purposes of this article, we will focus on the two largest sub-groups within the bottling data set: Carbonated Soft Drinks and Bottled Water.

Water and Energy Use Ratio Drivers for Bottling Facilities Include:

- *Use of refillable containers*
- *Presence of on-site bottle blowing processes, pasteurization processes, and/or automated cleaning processes*
- *Varying water treatment methods*
- *Use of high efficiency equipment*
- *Number/type of products*

Carbonated Soft Drinks

Carbonated soft drinks are defined as:

> *Non-alcoholic, flavored carbonated beverages; this category includes colas, ginger ales, and seltzers, but excludes non-carbonated beverages such as ready to drink teas, coffees, fitness drinks, energy drinks, and juice drinks.*

Facilities included in this sub-group reported a beverage production mix (percentage of each type of beverage produced at the facility, totaling to 100) of 50 percent or more carbonated soft drinks. Figure 3 shows the boundaries of the operations where water and energy use was included in the benchmarking report.

- **Water and energy use ratios decreased over the five year period.** Figures 4 and 5 on the following page demonstrate water and energy use ratio performance[5] for carbonated soft drink facilities. Of the carbonated soft drink bottling facilities that provided five years of data, 58 percent improved water use ratio, and 48 percent improved energy use ratio from 2009 to 2013.

Figure 3: Process Map, Carbonated Soft Drinks

[5] For the purposes of this study, the following criteria apply: "water use ratio" and "energy use ratio" represent volume-weighted means; and "range" refers to the middle 80 percent of the 2013 data set.

Figure 4: Carbonated Soft Drink Water Use Ratio Performance

N=756

Range (2013) – 1.47 – 3.77 L/L

WUR Δ = -14%

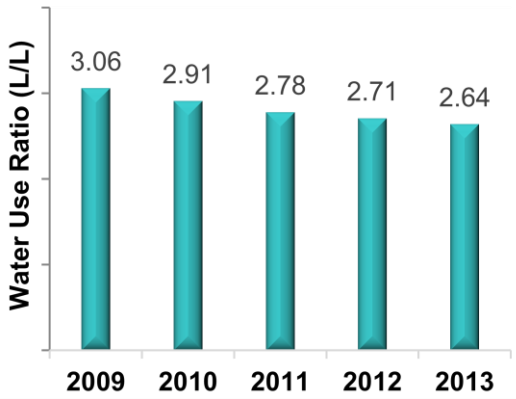
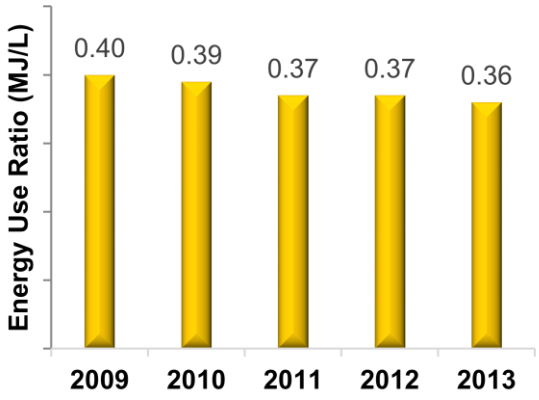


Figure 5: Carbonated Soft Drink Energy Use Ratio Performance

N=747

Range (2013) – 0.21 – 0.93 MJ/L

EUR Δ = -1%



Bottled Water

Bottled water is defined as:

> *All unflavored bottled waters including spring water, purified water (produced by distillation, deionization, reverse osmosis or other processes), mineral water, sparkling bottled water, or well water.*

As seen in Figure 6, benchmarking accounts for water treatment (as applicable) and bottling processes, and also includes product water.

- **Water and energy use ratios decreased over the five year period**. Figures 7 and 8 on the following page demonstrate water and energy use ratio performance for bottled water facilities. Of the bottled water facilities that reported five years of data, 71 percent improved water use ratio and 50 percent improved energy use ratio from 2009 to 2013.

Figure 6: Process Map, Bottled Water

Figure 7: Bottled Water – Water Use Ratio Performance

N=180

Range (2013) – 1.16 – 2.28 L/L

WUR Δ = -6%

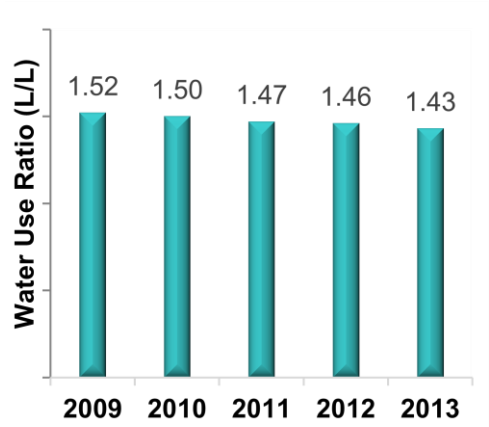
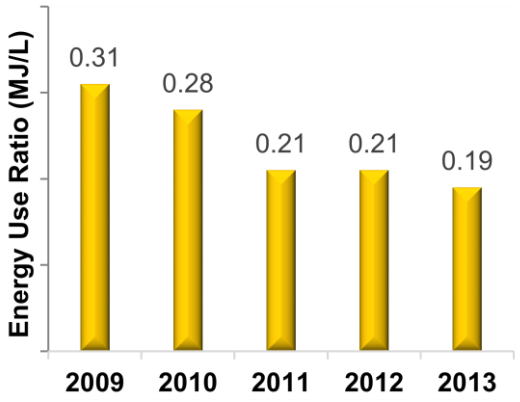


Figure 8: Bottled Water – Energy Use Ratio Performance

N=179

Range (2013) – 0.04 – 0.40 MJ/L

EUR Δ = -39%



Brewery

A brewery was defined as:

> *A facility conducting all processes after the malting process to produce beer (mashing/lautering, boiling, fermenting, aging, and packaging).*

All breweries in this study conducted bottling operations on site; a small number also shipped product off site in bulk containers to a separate bottling facility. Breweries may have also produced other beverages (carbonated soft drinks, bottled water) in addition to beer, but in all cases, the majority of beverage product mix was beer.

As seen in Figure 9, benchmarking accounted for all process steps except for upstream agricultural growth, malting and distribution of finished product.

Figure 9: Process Map, Brewery

- **Water and energy use ratio decreased over the five year period.** Figures 10 and 11 on the following page present the water and energy use ratio performance of beer only breweries. Of the breweries that provided five years of data, 89 percent improved water use ratio, and 60 percent improved energy use ratio from 2009 to 2013. The number of brewery facilities reporting energy data increased 12 percent in 2011, which could contribute to the energy ratio fluctuation during this time.

Water and Energy Use Ratio Drivers for Breweries Include:

- *Variation in brewing processes*
- *Level of cleaning process automation & use of high efficiency equipment*
- *Water use differences based on package type: small packaging (12 oz. bottles or cans) vs. larger or bulk packaging (kegs or tanks)*
- *Refillable container use*
- *Facility production volume (facilities with larger production volumes tend to report lower water and energy use ratios)*
- *Pasteurization type (the average energy use ratio for facilities with tunnel pasteurization was greater than the ratio for facilities with flash pasteurization)*
- *Prevalence of on-site refrigeration*

Figure 10: Brewery (Beer Only) Water Use Ratio Performance

N=361

Range (2013) – 3.01 – 6.27 L/L

WUR Δ = -19%

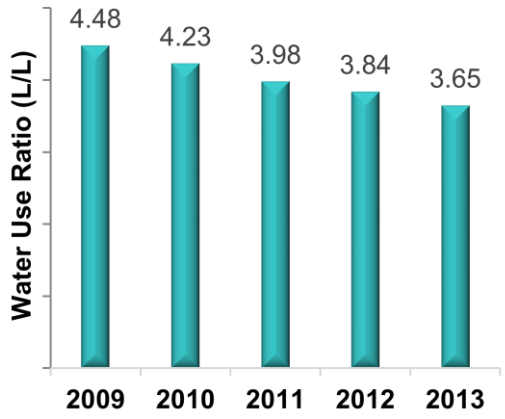
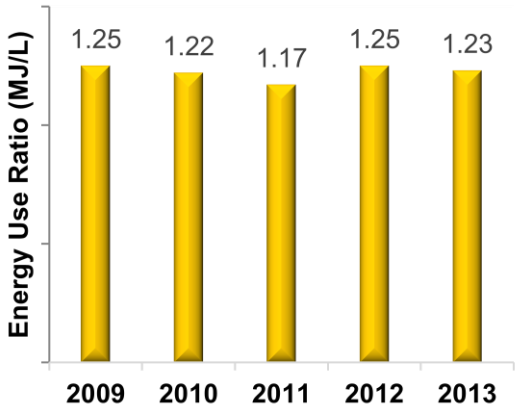


Figure 11: Brewery (Beer Only) Energy Use Ratio Performance

N=360

Range (2013) – 0.92 – 2.34 MJ/L

EUR Δ = -2%



Distillery

A distillery was defined as:

Any facility that receives agricultural inputs (grains, agave, molasses, etc.) and conducts processes (cooking, fermenting, distilling and storage/maturation) to make bulk alcohol.

Water and Energy Use Ratio Drivers for Distilleries Include:

- *Type/intensity of cooling water process*
- *Alcohol content and product mix*
- *Number and variety of products*
- *On-site bottling processes vs. offsite bulk shipment*
- *Prevalence of temperature control systems for storage and maturation*

As seen in Figure 12, benchmarking accounted for all process steps except for upstream agricultural growth, and distribution of finished product. The distillery data set includes facilities that included cooling water as part of total use and those who are unable to meter cooling water at this time.

- **Cooling Water Driver.** Distilleries had the greatest water use ratio range in the industry data set. One of the main drivers for this range was the extensive cooling water requirements of distilleries: cooling water can constitute upwards of 57 percent of total water use. As an example, a once-through cooling water system which draws from a surface water body typically uses more water than either an open recirculating or a closed loop cooling system. Additional drivers for water and energy use ratios are described in the call out box above. Of the distilleries that provided a response identifying the type of cooling water process used, 71 percent indicated that they use a once-through cooling process. These facilities reported a 2013 average water use ratio of 36.87 L/L and an energy use ratio of 14.18 MJ/L.
- **Water use ratio and energy use ratio decreased or remained relatively flat over the study period.** Figures 13 and 14 on the following page present the water and energy use performance of distilleries. Of the facilities that provided five years of data, 61 percent of distilleries show an overall improved energy use ratio from 2009 to 2013.

Figure 12: Process Map, Distillery

Figure 13: Distillery Water Use Ratio Performance

N=98

Range (2013) – 8.84 – 167.97 L/L

WUR Δ = <1%

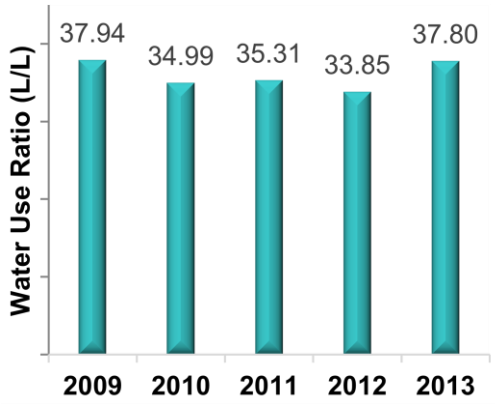
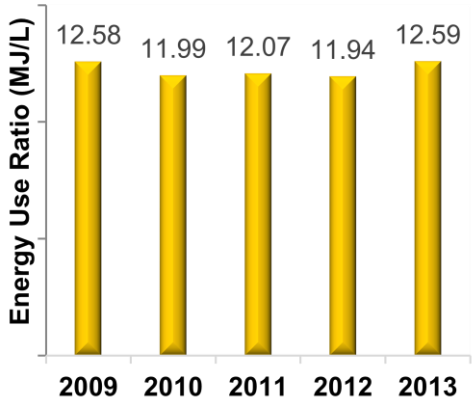


Figure 14: Distillery Energy Use Ratio Performance

N=98

Range (2013) – 4.95 – 31.78 MJ/L

EUR Δ = <1%



Winery

A winery is described as a facility where the scope of processes includes:

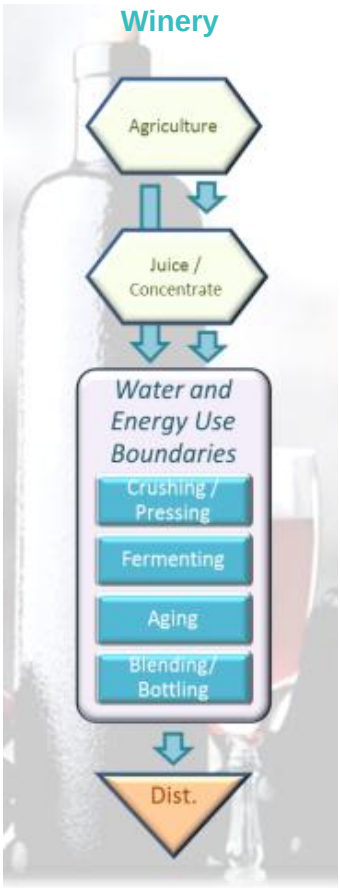
The crushing and pressing of grapes, fermentation, storage/aging and bottling of product.

Wineries accounted for less than 1 percent (by volume) of the industry data set. As seen in Figure 15, benchmarking accounted for all process steps except for upstream agricultural growth, juice/concentrate and distribution of finished product.

Water and Energy Use Ratio Drivers for Wineries Include:

- *Variations in the wine making process*
- *Types of inputs used (concentrated juice, grapes, both)*
- *Prevalence of temperature control for the aging process*
- *Use of high efficiency equipment*
- *Type/blend of product*

Figure 15: Process Map, Winery



- **Water use ratio and energy use ratio generally increased over the study period.** As seen in Figures 16 and 17, water and energy use ratio among wineries generally increased from 2009 to 2013 with fluctuation from year to year.
- **Total production increase.** There was a notable production increase from 2011 to 2012 - 58 percent of wineries increased production during this period. Of the wineries that provided five years of data, 48 percent reported a decrease in water use ratio and 40 percent reported a decrease in energy use ratio from 2009 to 2013.

Figure 16: Winery Water Use Ratio Performance

N=29

Range (2013) – 1.86 – 43.25 L/L

WUR Δ = 8%

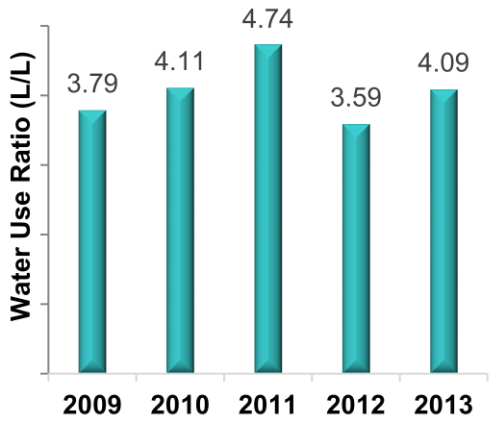
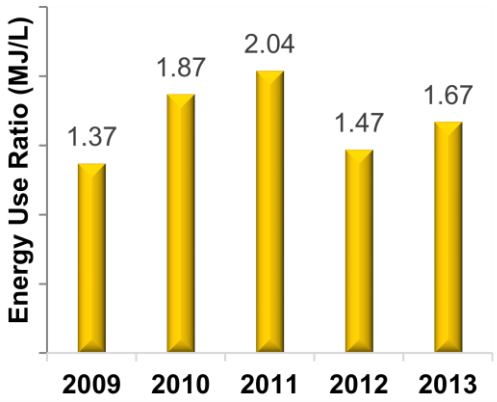


Figure 17: Winery Energy Use Ratio Performance

N=29

Range (2013) – 0.72 – 27.94 MJ/L

EUR Δ = 22%



Water Scarcity Evaluation

The 2014 report included an evaluation of water use relative to water scarce/water stressed geographies, using the World Business Council for Sustainable Development (WBCSD) Global Water Tool[6] and the World Resources Institute (WRI) Aqueduct Water Risk Atlas[7].

- **The industry is making improvements in areas where stress is expected to increase in the next 11 years.** Of the 1,723 facilities analyzed, 29 percent operate under extremely high to medium-high stress conditions. These facilities account for approximately 37 percent of the representative 2013 production volume.

Figure 18: Facility Improvement vs. 2025 A1B Scenario

Projected Climate Change Scenario 2025 A1B	Number of Facilities	% Reporting WUR Improvement, 2009 - 2013
Exceptionally More Stressed	23	70%
Extremely More Stressed	285	82%
Severely More Stressed	245	80%
Moderately More Stressed	71	79%
Drier but still Low Stress	92	84%
Near Normal Conditions	581	70%

- **Use of the WRI Aqueduct Water Risk Atlas tool.** Facilities were positioned against baseline water stress conditions and the International Panel on Climate Change (IPCC) projected 2025 climate change scenario A1B. Figure 18 presents an analysis of where efficiency improvements are being realized relative to the projected 2025 water stress conditions based on IPCC Climate Change Scenario A1B[8].
- **WBCSD roughly defines water scarcity on the basis of annual renewable water supply per person[9], denoting five levels of availability.** Precise facility location data was available and used for water scarcity mapping for all of the 1,723 facilities reporting five full years of water use data to the study. As seen in Figure 19, 153 facilities operate under extreme water scarcity and 163 facilities operate under water scarce conditions. These facilities comprise approximately 18 percent of the production volume represented by the facilities with available scarcity data. The majority of facilities in each water scarcity category reported an improvement in water use ratio from 2009 to 2013.

Figure 19: Facility Improvement vs. Water Availability

Annual Renewable Water Supply per Person (m3/person/year)	Number of Facilities	% Reporting WUR Improvement, 2009 - 2013
< 500	153	75%
500 - 1,000	163	77%
1,000 - 1,700	180	72%
1,700 - 4,000	286	80%
> 4,000	468	76%

[6] World Business Council for Sustainable Development Global Water Tool (2012): http://www.wbcsd.org/web/watertool.htm
[7] World Resources Institute Aqueduct Water Risk Atlas (2011): http://insights.wri.org/aqueduct/atlas
[8] IPCC Scenario A1B – a realistic projection of the future incorporating rapid economic growth, population growth that peaks mid-century, and introduction of efficient energy technologies that are balanced across all energy sources (e.g. not reliant on just one energy source, like fossil fuels). WRI Aqueduct Drought Severity Interpretive Guidelines (2011): http://docs.wri.org/aqueduct/freshwater_sustainability_analyses.pdf
[9] Annual Renewable Water Supply Per Person - Indicates the average annual renewable water supply per person for individual river basins as of 1995. http://www.wbcsd.org/web/gwt/GWT_Datasets_2011_Upgrade.pdf

Benchmarking Next Steps

Since the first benchmarking study in 2007, BIER has gained exceptional insight into process drivers, performance trends and figures that members continue to share with stakeholders and peers. The benchmarking study has provided value to members as a means to assess water and energy use performance amongst peers and a basis for target setting at a facility level.

During the October 2014 BIER Steering Committee meeting, the group elected to move to a biennial benchmarking study (every two years). BIER also hopes to move toward incorporating carbon emissions into future studies.

Acknowledging the importance of transparency, BIER plans to continue publishing results of the benchmarking study to external stakeholders on a biannual basis.

Benchmarking Methodology / Facility Level Data Set

To establish the data set, each of the 18 member companies (and one industry peer) submitted up to five years (2009, 2010, 2011, 2012, 2013) of facility-specific data as described below:

- **Total Water Usage (kL):** all water used by the facility (including bottling and industrial water) from all sources used for activities as identified below:

Includes water used for:

- Facility-level beverage production and packaging (accounts for water contained in product)
- Cleaning/sanitizing processes
- Cooling waters
- Heating waters
- Sanitation
- Landscaping
- Stormwater captured for aforementioned activities

Excludes water used for:

- Return water (underground water returned to the aquifer, recharge area, or natural drainage basin without significant modification).[10]
- Concentrate, syrup or flavor production
- Agriculture
- Production of raw materials (plastic, glass, etc.)
- Shipment of raw materials
- Distribution of finished product
- User consumption purposes (e.g. addition of ice cubes, spirits dilution, etc.)

- **Total Beverage Production (kL):** the volume of finished product generated at a facility or by a company. For facilities that produced alcoholic beverages, the actual volume of product (not scaled for alcohol content) was represented in the beverage production total.

- **Water Use Ratio (L/L):** a calculated ratio of the total water usage to total beverage production at

[10] Return water use is most frequently associated with the bottled water industry. A constant flow is maintained for microbiological purposes; displaced water which does not enter the facility is returned to the watershed as defined above. Other industries with a similar arrangement for private water resources may also exclude return water from their total water use.

Benchmarking Methodology / Facility Level Data Set
each facility.
• **Total Energy Use (MJ):** All energy consumed on site from all sources used for activities including but not limited to: facility operation, beverage production, cleaning/sanitizing processes, bottling processes, pasteurization, cooling, sanitation, etc. Energy use includes purchased/ sourced energy from off-site sources including on-site power generation; but does not include energy combined through heat and power systems to avoid double-counting. The study details energy quantities derived from the billing point ("fence line") and from use of renewable energy sources located on site.
• **Energy Use Ratio (MJ/L):** a calculated ratio of the total energy usage to total beverage production at each facility.
• **Facility Type:** designated as brewery, distillery, winery, or bottling based on primary process enacted at each facility.
• **Beverage Product Mix (%):** percentage breakdown of the different beverage types produced at each facility. For purposes of this study, ten beverage types were identified: beer, bottled water, carbonated soft drinks, distilled spirits (high-proof), distilled spirits (low proof), juice – not from concentrate, juice from concentrate, non-carbonated beverages, wine, and other.
• **Facility location:** continent, nation, latitude and longitude.

Methodology Notes

It is important to note that the benchmark represents an **amended data set** – facilities were permitted to submit revisions for 2009, 2010, 2011 and 2012 data, and facilities are added or removed based on acquisitions and divestitures within the individual participant companies.

Participants also submitted supplemental process information for their facilities (e.g., package type, cooling water use, pasteurization type) to evaluate trends observed during data analysis.

The bases for the analyses are the **water use ratio** and **energy use ratio**, which are broad indicators of how efficiently a facility uses water and energy for beverage production. The annual study, including data collection, analysis, verification, and reporting, has been managed by Antea®Group, a third-party consultant, since the study's inception.

For the purposes of this study, four types of beverage production facilities were identified: bottling, brewery, distillery and winery. While all water and energy uses at these facility types (including water and energy used for employee services, on-site landscaping, etc.) were included, non-manufacturing facilities, such as office buildings and warehouses, were excluded from the study.

Facility type was determined by the primary process conducted at each facility. Further, bottling facilities were broken down into additional sub-categories based on product mix, to account for the various product types processed at bottling facilities. All facilities reported a beverage product mix, or a percentage breakdown of the different beverage types produced at each facility.

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About the Beverage Industry Environmental Roundtable

The Beverage Industry Environmental Roundtable (BIER) is a technical coalition of leading global beverage companies working together to advance environmental sustainability within the beverage sector. BIER aims to affect sector change through work focused on water stewardship, energy efficiency and climate change, beverage container recycling, sustainable agriculture and eco-system services. For more information, visit www.bieroundtable.com.

Facilitated by: