



International Scientific Conference “Environmental and Climate Technologies”, CONECT 2015,  
14-16 October 2015, Riga, Latvia

## Resource and energy efficiency in small and medium breweries

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### Abstract

Resource and energy efficiency in industrial production is promoted within the European Union. For small and medium size companies, resource and energy efficiency is significant for improving both the economic and environmental performance of a company. For benchmarking and the identification of potential improvements, relevant data must be collected and comparative analysis is necessary. Since the business world is driven by competitiveness, the comparison of resource and energy efficiency in companies can motivate investments in economically and environmentally beneficial improvements. Current data and benchmarks on both energy and resource efficiency should be constantly updated. The aim of this study is to analyze and compare with benchmarks the energy and resource efficiency in the brewery sector in Latvia. To promote the approach to apply national reference data, the resource and energy consumption data is collected from four Latvian small and medium size breweries. The data were acquired on-site during personal meetings with representatives of all four breweries. Based on empirical data from breweries, specific energy, resource and water consumption indicators were calculated and normalized by production amount to compare the performance of breweries. A linear regression analysis was performed to assess how the specific factors impact the overall energy consumption. The results show that all case breweries exceed the available energy consumption benchmarks, but some of them can achieve the malt and water consumption benchmarks. The comparison of these companies, although they are of quite similar in size, shows that many more factors, other than production capacity, influence their specific resource and energy consumption. The developed linear regression models of the company's energy consumption can further be used as tools for predicting energy consumption based on those individual factors that are more significant for each of the companies.

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Peer-review under responsibility of Riga Technical University, Institute of Energy Systems and Environment.

*Keywords:* resource efficiency; energy efficiency; brewery; benchmarking

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## 1. Introduction

Resource and energy efficiency in industrial production is one of the priorities of the European Union (EU) on its route towards sustainable growth. Among others, the European Commission has defined that EU Member states should aid industrial companies to systematically measure, benchmark and improve their resource efficiency [1] and encourage energy efficiency-based savings, especially, in small and medium enterprises (SME) [2]. In this article, the SME distinction by size, turnover and/or annual balance is applied as set in Annex 1 of the European Commission Regulation No. 800/2008 [3].

The choice of brewery sector as the object of this study is consequential - as only two of 25 breweries in Latvia are large size companies, the brewery sector is saturated with small and medium companies, and it is also one of important industries in Latvia [4]. Due to their wider range of stakeholders, larger breweries tend to focus more on efficiency improvements and introducing sustainability goals in decision making [5]. Although energy efficiency technologies are being adopted by the larger companies, there is still high potential in small and medium enterprises (SME) [6]. The total production capacity of small and medium breweries in Latvia is much lower than that of large companies [7], but they are highly valued in terms of beer quality. From an environmental point of view, the specific resource and energy efficiency for small and medium breweries is lower than that of large breweries. This issue arises due to lower economies of scale, batch processes and non-continuous operation [8] and other local conditions, e.g., climate, production technology, product mix, different bottling technologies [9], brewery size, years of operation, geographical location, applied processes and equipment [10]. As competition is an important driving force in business, including breweries, benchmarking resource and energy efficiency in breweries can motivate investments for economically and environmentally beneficial improvements and innovation [5].

Benchmarking and the identification of the potential improvements requires information and data about the best practice, the resource efficiency forerunners, as well as, real knowledge of specific consumption per production unit [8]. The Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (BREF) [11] provides benchmarks for energy and resource consumption in beer production. The recommended electricity consumption ranges between 27 – 41.4 MJ/hl<sub>beer</sub>, thermal energy consumption typically ranges from 85 to 120 MJ/hl<sub>beer</sub>, typical water consumption – within the range of 4 to 10 hl/hl<sub>beer</sub>, the recommended malt consumption is 20 kg/hl<sub>beer</sub> [11]. As these benchmarks were established a decade ago and are based on data for large breweries with a capacity over 1 million hl of beer per year, they may not be relevant for current situation in small and medium breweries. Therefore, specific case studies can be undertaken and used for reference. For example, during the international ExBESS project (Expanding Benchmarking and Energy Management Schemes for SMEs), specific energy consumption was analyzed for 81 companies within 8 countries [12]. This allowed to compare specific energy consumption per production for various manufacturing sectors (i.e. dairy, bakery, meat processing, breweries, textile, laundry services) and to attain benchmarks. Sturm et al. [6] have analyzed energy efficiency in a medium size brewery in the United Kingdom (UK). They identified that the case exceeds BREF recommended values, e.g., thermal energy consumption was 160 – 180 MJ/hl and electrical energy consumption was 45 – 60 MJ/hl. On the one hand, this is attributed to the argument that BREF benchmarks are too ambitious for SME breweries that have smaller economies of scale. On the other hand, Muster-Slawitsch et al. [8] have reported results from case studies in three small and medium breweries in Austria. Although they exclude the energy required for space heating, their results for thermal energy consumption (as low as 43.6 MJ/hl for medium brewery, 104.5MJ/hl for small size brewery) are significantly lower than the BREF recommendations, which leads them to conclude that the actual best practice is performs better than what is suggested in BREF recommendations. Though these authors have widely evaluated energy consumption benchmarks, there is a lack of cases regarding resource consumption efficiency.

The literature analysis demonstrates divergent results for various cases, which can be caused by numerous factors influencing each brewery, therefore, benchmarking also should account for these local conditions. To find more suitable reference data, researchers have proposed new methods for development of energy efficiency benchmarks [9] or suggested development of specific national reference documents [13].

The aim of this study is to analyze, compare and benchmark energy and resource efficiency in the brewery sector in Latvia. To promote the approach to apply national reference documents, the resource and energy consumption data is collected from four Latvian small and medium size breweries. The resource and energy performance of the breweries is compared both among the breweries and to the benchmarks in literature. In order to compare the

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