

## Economic and Environmental Assessment of Heat Recovery in Beer and Spirit Production

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**Abstract :** Breweries and distilleries are well-known for their high water usage. The water consumption in a UK brewery to produce one litre of beer reportedly ranges from 3-9 L and in a distillery from 7-45 L to produce a litre of spirit. This includes product water such as mashing water, but also water for wort and distillate cooling and for cleaning of tanks, casks, and kegs. When cooling towers are used, cooling water can be the dominating water consumption in a brewery or distillery. Interlinked to the high water use is a substantial heating requirement for mashing, wort boiling, or distillation, typically met by fossil fuel combustion such as gasoil. Many water and waste water streams are leaving the processes hot, such as the returning cooling water or the pot ales. Therefore, several options exist to optimise water and energy efficiency of spirit production through heat recovery. Although these options are known in the sector, they are often not applied in practice due to planning efforts or financial obstacles. In this study, different possibilities and design options for heat recovery systems are explored in four breweries/distilleries in the UK and assessed from an economic but also environmental point of view. The eco-efficiency methodology, according to ISO 14045, is applied to combine both assessment criteria to determine the optimum solution for heat recovery application in practice. The economic evaluation is based on the total value added (TVA) while the Life Cycle Assessment (LCA) methodology is applied to account for the environmental impacts through the installations required for heat recovery. The four case study businesses differ in a) production scale with mashing volumes ranging from 2500 to 40,000 L, in b) terms of heating and cooling technology used, and in c) the extent to which heat recovery is/is not applied. This enables the evaluation of different cases for heat recovery based on empirical data. The analysis provides guidelines for practitioners in the brewing and distilling sector in and outside the UK for the realisation of heat recovery measures. Financial and environmental payback times are showcased for heat recovery systems in the four distilleries which are operating at different production scales. The results are expected to encourage the application of heat recovery where environmentally and economically beneficial and ultimately contribute to a reduction of the water and energy footprint in brewing and distilling businesses.

**Keywords :** brewery, distillery, eco-efficiency, heat recovery from process and waste water, life cycle assessment

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