Is CO_2 recovery worth the investment for craft breweries?

INDEPENDENCE | Sustainability and cost-effectiveness have become essential in craft brewing. Here, CO_2 recovery has really caught the attention of the craft brewing industry. CO_2 is an essential ingredient in beer and with recent CO_2 shortages and rising CO_2 costs, breweries are seeking smarter and more cost- and environmentally friendly solutions to secure their supply. This article will feature a real-life case with real-life data for CO_2 recovery from a French brewery to determine whether CO_2 recovery is financially feasible for craft breweries.

CO_2 RECOVERY PLANTS present themselves as a smart solution. By capturing, purifying, and liquefying the CO_2 naturally generated during fermentation, CO_2 recovery secures a stable and cost-effective supply of CO_2. Dalum Beverage Equipment is a leading provider of small-scale CO_2 recovery solutions, with systems operating in a range of industries worldwide. Depending on the case, a CO_2 recovery plant has a typical return on investment of 2–3 years. In this case study, the biggest plant type "Hercules" is used and has a payback time of 1.3 years assuming a 10 percent internal rate of return.

› Basics of CO_2 recovery for craft breweries

During the brewing process, large amounts of CO_2 are naturally released as a by-product. Often this is vented into the atmosphere and wasted. A CO_2 recovery plant captures, purifies, and liquefies the CO_2 and makes it available for carbonation, packaging, or purging. This technology has been available for larger breweries for a while, but Dalum has scaled this technology down to make the investment financially feasible for craft breweries.

› Overview of system models, savings and costs

Four models of CO_2 recovery systems for different levels of beer production are available. The sizes are Micro, Craft, Senior, and Hercules. These models provide scalable options based on the brewery's output, ensuring breweries can match system capacity to their production needs.

› Understanding the costs of CO_2 recovery systems

Initial investment

The initial investment varies according to production volume. The brewery in this case required our largest plant, a Hercules (50 kg/h) plant with additional components such as a foam trap, commissioning, collection manifolds, sanitary pressure valve, storage tank, and piping. The total investment amounted to 225,320 EUR.

Maintenance costs

CO_2 recovery plants are relatively low-maintenance but do require periodic filter replacements, compressor seal and check kit replacement, inspections, and cleaning. With the purchase, clients will gain access to a maintenance page. Here clients can learn how to change filters, valves, seals, etc., and can follow a daily and weekly checklist.

A service kit designed to last two years costs 2515 EUR at this moment. Service can be carried out by the brewery, by Dalum, or by a service partner. The systems are designed for reliability, helping breweries minimize ongoing maintenance expenses.

Operational training and adaptation

Operating a CO_2 recovery system safely requires specialized training for staff, which is typically provided by the supplier during installation. Training ensures proper handling of compressed gases, maintaining both safety and operational efficiency. Training cost is typically included in installation.

Funding to decrease costs

The upfront investment of 225,320 EUR might be a hurdle for most breweries. However, multiple breweries using CO_2 recovery plants have acquired grants to help fund their investment. An example of a brewery receiving funding towards their net zero mission is the award-winning brewery Rocky Ridge Brewing Co, Western Australia. Rocky Ridge Brewing re-

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EXAMPLE FOR BULK USE ONLY, OWN TANK

Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Production hL beer	60,000	60,000	60,000	60,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
CO2 usage brewery, kg	203,925	203,925	203,925	203,925	339,875	339,875	339,875	339,875	339,875	339,875	339,875	339,875
Recovery, kg	203,925	203,925	203,925	203,925	339,875	339,875	339,875	339,875	339,875	339,875	339,875	339,875
Saving	173,829	173,829	173,829	173,829	285,715	285,715	285,715	285,715	285,715	285,715	285,715	285,715
Kg/hr, 47 weeks/yr	26	26	26	26	43	43	43	43	43	43	43	43
No inflation												
Cash flow of operations		173,829	173,829	173,829	285,715	285,715	285,715	285,715	285,715	285,715	285,715	285,715
Working capital		0	0	0	0	0	0	0	0	0	0	0
Increase in working capital		0	0	0	0	0	0	0	0	0	0	0
Capital investment		225,320										
ROI over 10 years		2,581,887										
Net cash flow	0	-51,491	173,829	173,829	285,715	285,715	285,715	285,715	285,715	285,715	285,715	285,715
PV 2018 at 2.5%	0	-50,235	165,453	161,418	258,844	252,530	246,371	240,362	234,500	228,780	223,200	217,756
Cost of capital rate	1											
NPV at 2.5%	2,178,979											
PV 2021 at IIR%	11,370	-46,810	143,660	130,600	195,147	177,407	161,279	146,617	133,288	121,171	110,156	100,141
IRR = 10%	1											
NPV (IRR = 10.0%)	1,384,026											

Example of cost savings for bulk use only, own tank

ceived a 400,000 USD Coles Nurture Fund grant to accelerate its mission of becoming Australia's first Net Zero Certified Sustainable brewery.

› Potential savings from CO_2 recovery systems

Reduced CO_2 purchase costs

The total investment was 225,320 EUR. The brewery achieved annual CO_2 savings of 173,829 EUR during the first three years at 0.9 EUR/kg CO_2, becoming fully self-sufficient with CO_2. When the brewery increases production in 2029, annual savings rise to 285,715 EUR.

Break even occurs in 1.3 years at 10 percent IRR. Cost includes equipment, variable cost, and maintenance. Forecasting growth to 100,000 hl/year by 2029, their projected annual savings would rise to 285,715 EUR, giving them a simple 10-year total return on investment of over 2.5 million EUR and a net present value of around 2.2 million EUR plus residual value of the equipment.

The savings for the brewery comes from not needing to purchase CO_2 or rent CO_2 tank anymore from CO_2, at a relatively high price. The cost for a storage tank is included in the total investment.

Stability amid CO_2 market fluctuations

The CO_2 market is very volatile and has seen frequent price hikes and shortages of supply. By capturing their own CO_2 during fermentation, breweries can take control over their own supply, shield themselves from price fluctuations, and stabilize operational costs. This will create financial predictability, which is important for smaller breweries working with a tight budget.

For breweries practicing "Reinheitsgebot", having your own supply of pure CO_2 is crucial. This will ensure you that your beer is carbonated with its own natural fermentation gas, maintaining product quality. Many breweries still rely on external CO_2, which can be sourced from fossil fuels and is transported over long distances.

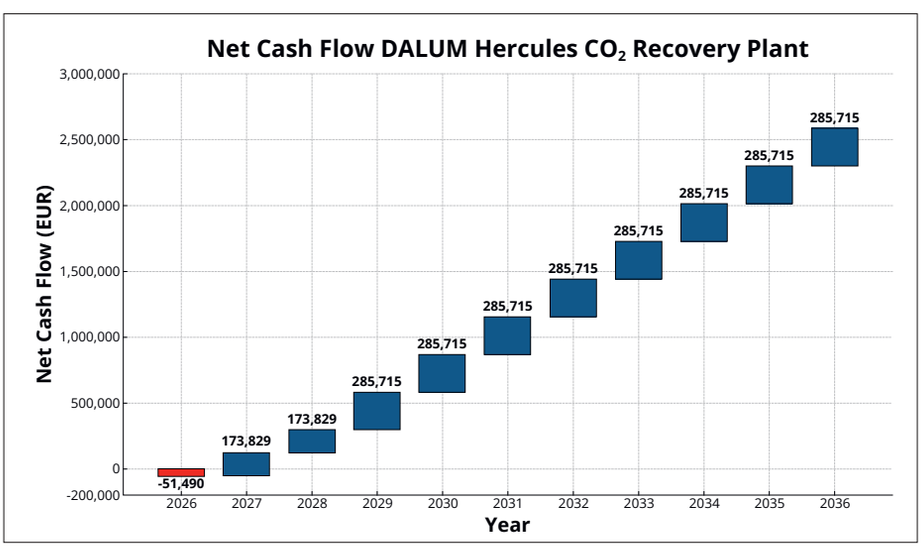
› System overview

The Dalum CO_2 recovery plant is designed for craft breweries to recover their own CO_2 from fermentation and CO_2 from shielding gas of tanks. The goal is to assist breweries control their own CO_2 supply and become self-sufficient. The process of CO_2 recovery can be split into several processes: collection, purification, liquefaction and storage.

CO_2 collection

The raw form of CO_2 is collected from the fermentation tanks using flexible hoses connected to the existing tank's CIP/gas outlet and to one of the central CO_2 collection stations connection points. Alternatively, an automated CO_2 collection system using hard piping and regulation valves can be installed for some additional cost.

Each of the connection points is equipped with a bunging valve or a check valve, and a shut off valve to ensure individual and continuous system operation without risk of cross contamination. If individual fermentation pressures are needed, bunging devices must be used instead of check valves.



Net cash flow for the Hercules CO_2 recovery plant

CO_2 purification

The purification takes place in three steps before and after compression and liquefaction.

The CO_2 raw gas from the collection system is supplied to the foam trap where the foam is separated.

After the foam trap but before the CO_2 gas reaches the compressor, 90% of the impurities like alcohol, other volatiles and aerosols, are removed in the water scrubber.

After compression the gas is dried and further purified in aluminium oxide-based dehydrators, which also removes traces of remaining volatiles. The Dehydrator is duplicated and regenerates automatically by heating. If needed an activated carbon filter can be installed for H_2S removal. To remove incondensable gases, the liquid CO_2 is distilled in the patented condenser and in a small reboiler and stripper column.

Liquefaction

The CO_2 is compressed to be liquefied for rectification and compact storage and unlike conventional CO_2 compressors, the built in three stage CO_2 compressor provides up to 45 bar pressure, hence the CO_2 condensation takes place at 0–5 degree Celsius. This makes it unnecessary to use a separate CFC or ammonia cooling systems, but a glycol, ice-water or alcohol coolant system can be connected.

The dry and compressed CO_2 is liquefied in the condenser using an external coolant source and the liquid CO_2 is continuously distilled to ensure low oxygen content. Liquid CO_2 is pushed with 35–40 bar pressure to the CO_2 storage tank, where liquid CO_2 expands to the storage tank pressure and temperature. Vaporized CO_2 from the storage tank is sent back to the compressor for re-liquefaction.

› CO_2 storage and usage

A wide range of storage tanks from 100 litres to 80 tons is available and all tanks are adapted for CO_2 recovery including a high pressure storage option to reduce vaporization, flash gas return function, separate CO_2 filling line for low loses, chiller option and integrated ambient or glycol regenerable vaporizers.

Also necessary filters, regulators and safety devices for user lines can be included in the service. For breweries filling sparkling water using recovered or industrial CO_2, the recommendation is to use final polishing filters after vaporizer and line regulator as the final step before a sterile filter and usage.

Cylinder filling stations designed to integrate seamlessly with the CO_2 recovery plants and storage tanks are available. The station ensures smooth transfer of recovered CO_2 into individual cylinders for further use or distribution.

› CO_2 recovery in craft breweries

Space requirements

Smaller breweries might operate in tight spaces, therefore the CO_2 recovery plants are designed with the smallest footprint possible. The largest of the plants, the Hercules, has a footprint of 1 x 1 x 4 m and weighs approximately 700 kg.

Matching system capacity to production levels

Choosing the right system size is essential to maximize ROI. While a smaller model may suffice for current production, breweries should consider projected growth to avoid the need for costly upgrades later. Various models provide options, but scalability remains a critical consideration for future-proofing.

› Is CO_2 recovery worth the investment for craft breweries?

It is very clear from the data that CO_2 recovery is a very attractive investment for most breweries. With a proven 2–3 year break-even point in most cases and a 1.3-year break-even in this case, CO_2 recovery proves itself as an effective way for craft breweries to reduce costs, protect themselves against CO_2 price fluctuations and supply shortages, while also strengthening their brand's environmental image.

In summary, CO_2 recovery is a practical investment for many craft breweries. The financial savings, along with the reduced carbon footprint, help future-proof operations and enhance brand appeal. While the initial cost can seem high, the combination of quick break-even, reduced dependency on CO_2 suppliers, and positive environmental impact makes CO_2 recovery a compelling choice. ■