This project has received funding from the European Union's H2020 Coordination Support Action under Grant Agreement No. 894356.

Best Practice	OPTIMISED CONDENSATE RECOVERY	STEA-07
Application	Steam systems	
SME sector	Processing and manufacturing industries	
SME Sub-sector	Food processing, paper, and cardboard manufacturing sectors, pharmaceutical, chemicals, distilleries, etc.	
Technical description	Condensate is produced after the steam has transferred part of its thermal energy, the latent heat, and condensed to water. The condensate still has a significant amount of thermal energy (typical temperature range: 75°C – 100°C) which can be put to further use by a condensate recovery. The recovered condensate therefore has economic value because it: • Reduces the energy required in the deaerator • Reduces make-up water • Reduces chemicals for water treatment • Reduces quenching water needed for sewers • Can be used as flash steam resulting in less produced steam needed	
Recommendation for optimisation	• Recover as much condensate as possible: optimizing condensate recovery starts by evaluating the current amount of condensate returned based on different header levels. The amount of available condensate results in the amount of steam which is used in indirect heat exchange processes and condensing turbines. Condensate recovery depends on following factors: - contamination levels - cost of recovery equipment - cost of condensate piping There is commercial technology available that can monitor the contamination levels in condensate in real-time and dumping the condensate if the contamination exceeds certain levels. The cost of recovery equipment and piping depends on the physical location of the end-use and the boiler. Condensate receivers can serve as local collection point and reduce the costs of individually pumping condensate back. Condensate contains a significant amount of energy that can account for 10% to 30% of the initial energy contained in the steam. Feeding the condensate back to the boiler can result in a 10% to 20% decrease in fuel demand. • Recover condensate at the highest possible thermal energy: a higher condensate return temperature implies less heating required in the deaerator, which directly	

	translates to energy costs savings. The condensate recovery temperature can be increased by repairing leaks in pipes and steam traps and by insulating the piping. However, the returning of high temperature condensate could result in operational problems such as unwanted flashing in the condensate return lines. • Flash high pressure condensate to make low pressure steam: condensate still contains a lot of thermal energy and can be flashed to produce low pressure steam. The typical pressure range for live steam is 4 to 15 bar, whereas low pressure steam after flashing typically has a gauge pressure of 0.5 bar. Depending on the location and proximity to the headers or end-users, the low-pressure flash steam can replace live steam on the low-pressure header. The amount of steam flashed can be between 5% and 30% of the consumed live steam, resulting in potential fuel saving of 5% to 30%. This optimization opportunity, however, will need a solid thermodynamic steam system model to evaluate the true economic impacts and using. • Vented vs. Pressurized Condensate Recovery: there are two types of condensate recovery systems: vented and pressurized systems. Vented systems recover the condensate in an open-to-atmosphere tank, resulting in a relevant amount of energy being lost due to flashing to the atmosphere. However, their configuration is simple and therefore they require much lower investment costs than pressurized systems. The recovered water can be used as boiler make-up water, pre-heat or in other hot water applications. In pressurized systems the condensate is kept above atmospheric pressure throughout the recovery process. This allows condensate recovery at higher temperature than with vented systems, resulting in more energy that is recovered. Additionally, a larger amount of water can be reused since no flash steam is vented to the atmosphere. However, these systems are more complicated and involve more design considerations. For example, the condensate transport piping must be sized for two-phase flow of steam and condensate. This results in higher investment costs. The recovered condensate is typically used for direct feed to boiler and flash steam recovery applications.
Economics	Approx. 15 EUR/m per insulated pipe to bring condensate into the boiler Approx. from 300 EUR for steam traps
Energy savings	Energy savings ranging from 10 to 30%
Economic savings	Savings with a pressurized condensate recovery system: approx. 10-12% of the fuel
Average Payback Time	Less than 3 years If no condensate recovery was previously installed the payback time is less than a year. The savings come from lower fuel costs, lower costs for make-up water and treatment and lower costs for sewage.

This project has received funding from the European Union's H2020 Coordination Support Action under Grant Agreement No. 894356.

Emissions	70 mg NOx/Nm3 Exhaust-related emissions from steam generation systems	
Environmental benefits	Reduction of CO_2 and NO_x gas emitted	
Main NEBs (Multiple benefits)	☒ Environmental benefits ☐ Increased productivity ☒ Work environment/Health/Safety ☐ Increased competitiveness ☐ Maintenance	Lower fuel demand leads to less air pollution. In addition, water consumption can be lowered through optimized condensate recovery. Condensate recovery can also limit steam clouds to reduce atmospheric condensate discharge noise, improving the working environment.
Replicability	High	
Related measures	• STEA-01: Reduction of energy demand	
Case study	Heat recovery system for energy efficiency company Boehringer Ingelheim RCV GmbH & Co KG (Austria, 2016) • Initial Situation: the steam production was fully functional and in perfect condition considering when it was installed. The steam production plant consisted of two boilers with a maximum capacity of 5 t/h and a feed water treatment plant. Steam is used in production processes and to humidify the air of the ventilation system. There was no energy use of condensate, which was collected in open tanks. In addition, steam was discharged into the environment. In 2015, the steam plant's natural gas consumption was 1,363,605 m³. • Description of the optimisation: the intervention includes the optimization of different components of the steam system and the final use of the equipment. - Feed water tank: The feed water tank has been replaced and a dearer has been installed. - Use of ventilated steam: Previously ventilated steam is used in a heat exchanger to pre-heat the feed water for the boiler. This results in reduced fuel consumption. - Condensate recovery: condensate with a temperature of about 120°C is now used to pre-heat the boiler supply water. - Steam traps: since the steam traps present showed an increasing rate of losses, new ones were installed. - Replacement of the humidifier for the ventilation system: the consumption of steam, and therefore of energy demand, has been reduced by installing new humidifiers that have a lower condensation rate.	

	- Process optimization: a smaller amount of wastewater must be heat-treated with steam due to an automatic bypass of parts of the wastewater from the Cleaning in Place (CIP) process. The total annual energy saving amounts to 3,497 MWh. • Implementation costs: not available • Payback Time: not available
References	Blessl and Kessler, 2017, Energieeffizienz in der Industrie, Springer Vieweg, DOI: 10.1007/978-3-662-55999-4 TLV International Inc.: Introduction to Condensate Recovery, https://www.tlv.com/global/TI/steam-theory/introduction-to-condensate-recovery.html, visited: 20.03.2019 TLV International Inc.: Condensate Recovery: Vented vs. Pressurized Systems, https://www.tlv.com/global/TI/steam-theory/vented-pressurized-condensate-recovery.html, visited: 21.03.2019 Spirax Sarco GmbH: Grundlagen der Dampf- und Kondensattechnologie, Konstanz 2014 Spirax Sarco Limited: Online tutorials, https://beta.spiraxsarco.com/learn-about-steam, visited: 20.03.2019 CRES, ISNOVA: STEAM UP WP4: TRAINING MATERIAL PREPARED BY CRES Kulterer, K.: STEAM UP Evaluation of Audits, Wien 2018 Kulterer, K.: klimaaktiv Leitfaden für Energieaudits in Dampfsystemen, Österreichische Energieagentur im Rahmen des Programms des Lebensministeriums, Wien 2017 Statistik Austria, 2019, Nutzenergieanalyse für 2017 Kulterer, K.: klimaaktiv Messleitfaden I, Österreichische Energieagentur im Rahmen des Programms des Lebensministeriums, Wien 2015

This Best Practice was developed by the Impawatt Project (GA No. 785041) and adapted for the GEAR@SME Project (GA No. 894356)