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Best Practice	HEAT RECOVERY	CAIR-08
Application	Compressed Air Systems Waste heat recovery from air-cooled compressors	
SME sector	Industrial	
SME Sub-sector	All	
Technical description	About 80 to 93% of the electrical energy used by a compressor get transformed to heat. The temperature in the compressor room must not exceed 35°C to ensure an optimally working compression process. Thus, a cooling system for the compressor is needed. Many companies simply let this waste heat dissipate into the atmosphere.	
Recommendation for optimisation	During the compression process, heat dissipates through: • The compressor itself • intercoolers between compression stages on multistage compressors • After-cooler The waste heat can be used for various appliances, depending on the construction and cooling of the compressor (air- or water cooled). Heat recovery from air cooled compressor is especially suitable for space heating or other hot air uses. Ambient atmospheric air is heated by passing it across the systems after-cooler and lubricant cooler, where the heat is extracted from both the compressed air and the lubricant. This type of compressors often already includes heat exchangers and fans, making this a relatively cheap and simple measure to install. Waste heat of air-cooled compressors can also be used for heating water. Depending on the design of the compressor, hot water can be provided in various qualities regarding oil- or particle contamination. Especially for hot water with drinking quality, used in cantinas, chemistry or pharmacy, special heat exchangers are necessary to avoid contamination. The hot water can also be used for various other processes in industry or for space heating. Water heated by a piston compressor can reach around 50°C. Water cooled compressors can also be equipped with heat recovery for space heating, although with reduced efficiency due to an additional heat exchanger needed. About 72% of the electric power put into the compressor gets transferred to heat in the cooling liquid.	
Relevant technical considerations	For space heating, for both type of compressors through heat exchangers, water can be heated up by up to 50 K until 85°C. Note that as the compressor works not always at full load, heat recovery can only be used as support for space heating.	

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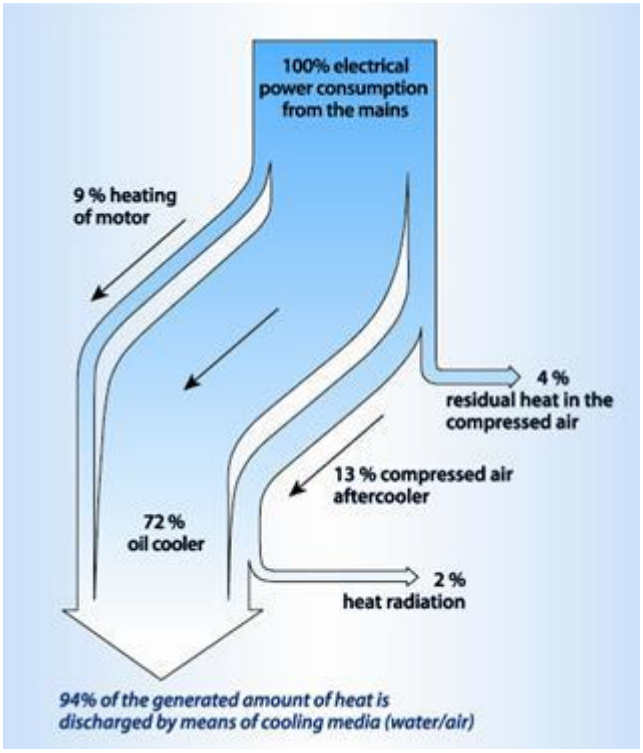
Schemes and diagrams	 Heat recovery scheme
Economics	Unit costs for a heat recovery system: 2,000-5,000 EUR
Energy savings	Savings potential of up to 94%
Economic savings	Economic savings due to the potential for energy savings. The heat recovered by a compressor with a nominal power of 90 kW operating for 2,000 hours/year is about 71.5×10^6 kcal (equivalent to the thermal energy generated by a boiler of 40 kW with a saving of 6,650 kg of methane equivalent to about 2,600 EUR)
Average Payback Time	3-6 years
Emissions	0.702 $kgCO_2/kWh_{el}$ (CO_2 emitted by production for one hour of 1 Nl/min of compressed air) This measure does not lead to further emissions
Environmental benefits	The environmental benefits are increased through reduction of CO_2 emissions due to room heating.

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Main NEBs (Multiple benefits)	☒ Environmental benefits ☐ Increased productivity ☒ Work environment/ Health/Safety ☐ Increased competitiveness ☐ Maintenance	In some cases, the ambient temperature at the workplace can be increased, resulting in a more comfortable working condition.
Replicability	This measure can be replicated, the waste heat can in fact be used for different appliances, depending on the type of construction and the cooling system of the compressor (air or water). Heat recovery systems are available for most compressors on the market integrated into the compressor package or as an external solution.	
Related measures	• CAIR-01: Optimisation of compressed air users/equipment • CAIR-02: Optimisation of the pressure in the system • CAIR-03: Switch-off of appliances in non-operational times • CAIR-04: High Level Control • CAIR-05: Sizing and type of compressor • CAIR-06: Network Optimization • CAIR-07: Reduction of leakages	
Case study	Heat recovery (Austria, 2009) • Initial Situation: the temperature of the air after the compression process lies at 140°C. The compressed air gets distributed through the network and then, depending on the end user, cooled in after coolers. • Description of the optimisation: the distribution network got split into a hot part and a cold part. In one branch of the hot part a tube heat exchanger was installed. A part of the remaining heat in the compressed air gets then used for heating the factory building. • Implementation costs**:** 47,500 EUR • Payback time: 5 years	
References	Kulterer, K., Huber J., Ruthner H., Oetiker H., Pucher C., Steinbrugger, C.: Leitfaden für Energieaudits zur Optimierung von Druckluftsystemen, klimaaktiv energieeffiziente betriebe, Wien 2015 Larrabee C.: Managing Multiple-Compressor Systems: Utilizing Controls to Improve Performance 3E Strategy, Department of Mechanical engineering, University of cape town: How to save energy and money in compressed air systems	

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	Atlas Copco, Compressed Air Manual, May 2000, available at http://www.atlascopco.com

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