Gear@SME
Saving energy together

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

Best Practice	REDUCTION OF COOLING LOAD AND FREE COOLING	COOL-01
Application	Cooling systems	
SME sector	Industrial	
SME Sub-sector	Breweries, industrial pastry, refrigeration, etc.	
Technical description	The need for cooling depends on two factors: • the heat load defined by the need for process cooling/storage • heat gains produced by multiple heat sources. The greatest heat gain for cold rooms is due to the hot air passing through open doors. This normally represents 30% of the total heat gain of a cold room. This measure does not reduce the cooling load but allows to meet the cooling needs with reduced energy consumption. How to limit energy consumption? • Reduction of thermal loads inside warehouses • Reduce heat contributions through openings • Wall insulation • Implementation of free-cooling systems	
Recommendation for optimisation	• Switching off cold rooms and freezer rooms • Reducing the heat form storage and stock throughput • Reducing the heat through doors • Insulation of the walls • Reducing heat gain from machines and personnel • Reducing heat gain from lighting • Control of the door heater • Optimisation of defrosting control (for freezing and cooling up to 3°C) • Implementation of free cooling Application of free cooling technique Free cooling indicates the direct use of an external source, typically air, but can also be water, when its temperature (and humidity in case of direct external air use) allow its use directly (e.g., introduction of external air without any treatment) or indirectly (treating the air or exchanging heat with air or other heat carriers) with a lower energy consumption of the HVAC or cooling system. It is typically used in HVAC (Heating Ventilation and Air Conditioning) systems but can be also exploited to assist cooling for industrial applications. New HVAC systems usually are designed to allow free cooling, while other systems or older ones can often be modified to exploit free cooling. The most suitable environment for Free Cooling is a combination of a cold or mild climate zone and the need of cooling energy for most	

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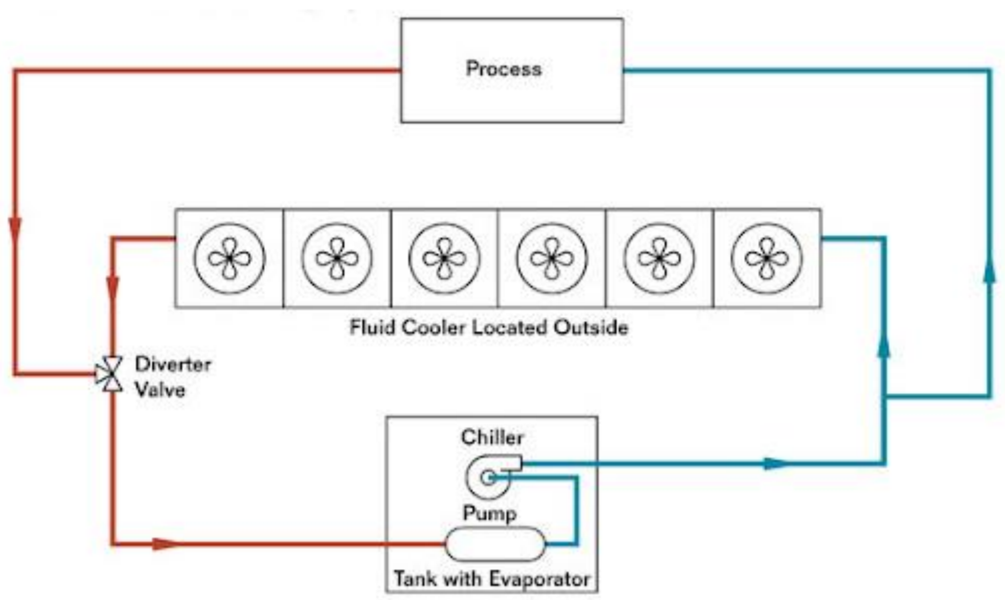
	of the year. This encompasses many manufacturing industries, such as food and beverage ones, but also other kind of facilities like data centres and spaces where constant temperature and humidity levels must be maintained (clean rooms, cold rooms, areas of hospitals, etc.)
Relevant technical considerations	With the implementation of a free cooler, ambient air or cooling water can be used directly to cool the secondary refrigerant circuit (e.g., products, processes)
Schemes and diagrams	 Free cooling system Traditionally HVAC and cooling systems utilises a chiller to generate the cooling required for processes or HVAC application. Free Cooling systems, instead, aim to reduce or even bring to zero the energy required by chillers. These systems can be added to air-cooled or water-cooled electric chillers and activate when the temperature of the external source has an appropriate value.
Economics	Approx. 2,000 EUR/kW for a new cooling system
Energy savings	• Switching off cold rooms and freezer rooms • Reducing the heat form storage and stock throughput: - Comparing the recommended cooling temperature with the actual may reveal a saving potential by increasing the process- or storage temperature. • Reducing the heat through doors: - strip curtains: energy savings of 9% for cooling and 13-24% for freezing

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<tr><td></td><td colspan="2">

<li style="list-style:none">- automatic doors: energy savings of 8% for cooling and 12-23% for freezing
Insulation of the walls:
- retrofitting of existing systems mostly does not pay off
Reducing heat gain from machines and personnel:
- Efficiency measures concerning machines include switching off, if not needed, and controlling the power, if possible
Reducing heat gain from lighting:
- energy savings consist of the reduced cooling load plus the reduced energy consumption of the lighting itself
Control of the door heater:
- energy savings of 3% for cooling – 6% for freezing
Optimisation of defrosting control:
- energy savings of 2-3% from the total energy demand of the cooling system
Implementation of free cooling:
- energy savings up to 80%

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<tr><td>Economic savings</td><td colspan="2">The economic savings are closely linked to the reduction of electricity used to power the cooling system</td></tr>
<tr><td>Average Payback Time</td><td colspan="2">

Less than 3 years for reduction of thermal contributions
About 10 years free cooling for industrial applications

Payback Time for the measures yielding a reduction of heat gains (and therefore heat load) for cold rooms is typically less than 2 years.</td></tr>
<tr><td>Emissions</td><td colspan="2">Emissions depend on the characteristics of the refrigerant gas</td></tr>
<tr><td>Environmental benefits</td><td colspan="2">Reduction of CO_2 emissions due to a reduction in electricity needs for cooling</td></tr>
<tr><td>Main NEBs

(Multiple benefits)</td><td>☒ Environmental benefits
☐ Increased productivity
☐ Work environment/ Health/Safety
☐ Increased competitiveness
☒ Maintenance</td><td>A Free Cooling system, together with the energy savings can offer different benefits, such as:

Reduced water consumption
Reduced operational costs
Reduced carbon footprint: lower greenhouse gas emissions
Reduced maintenance costs: longer equipment life

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<tr><td></td><td></td><td>One of the most important voices can be seen in the reduction of maintenance costs. In fact, usually, Free Cooling chiller plants have a longer lifecycle compared to traditional chillers because of the reduced number of operation hours of the compressor during the year.</td></tr>
<tr><td>Replicability</td><td colspan="2">Medium</td></tr>
<tr><td>Related measures</td><td colspan="2">

COOL-02: Compressor control
COOL-03: Increase and decrease in evaporation and condensation temperature
COOL-04: Efficient fans and regulation
COOL-05: Loss reduction
COOL-06: Heat recovery

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<tr><td>Case study</td><td colspan="2">
Case study #1
Installation of a new chiller, company "Etiketten Carini GmbH" (Austria, 2016)

Initial Situation: the cooling system used a chiller with a cooling capacity of 238 kW. Since free cooling was not available with this system, considerable electrical power was required to maintain sufficient cooling of the machines, even at low ambient temperatures. The amount of electricity needed for cooling was 280,586 kWh/year
Description of the optimisation: the chillers have been replaced with two new ones with a power of 118 kW each. The new cooling system offers the possibility of free cooling that allows sufficient cooling with minimal electricity consumption during the winter season. The electricity requirement for cooling has been reduced to 154,321kWh/year, allowing energy savings of 126,500kWh/y.
Implementation costs: 126,500 EUR
Payback Time: 11.9 years

Case study #2
Installation of a new chiller, food industrial plant (Central Europe)

Initial Situation:

Inlet air flow: 60,000 Nm^3/h
Annual energy cooling consumption: 600,000 kWh/year
Average electricity price: 0,10 EUR/kWh
Annual economic energy expenditure for cooling: 60,000 EUR/year

Description of the optimisation: the choice between exploiting air or water is determined by several factors, such as the availability of water and its cost, the available space for a chiller, the cost of electricity and the period in which free

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	cooling can be used. In general, water-cooled chiller and free cooling compared to air-cooled ones and occupy less space. Food & Beverage industries require several kinds of cooling, such as the temperature control to reduce the bacterial load and the quick freezing/cooling of pre-cooked of frozen foods. The cooling systems could help to increase the productivity, without lowering the all-important organoleptic properties of the finished product such as taste, colour, and smell. free cooling has the objective to reduce chiller energy consumption: it can be done via a (higher) direct intake of external air, via a chiller with a built-in free cooling coil or via a free cooler working in series with a chiller. The latter, usually, should be more efficient, due to the larger surface area provided by the air cooler. Inlet air flow: 60,000 Nm^3/h Energy savings: 100,000 kWh/year Energy economic savings: 10,000 EUR/year • Implementation costs: 15,000 EUR • Payback Time: 1.5 years
References	Kulterer, K., Mair, O., Horvath, C.: Leitfaden für Energieaudits in Kältesystemen, klimaaktiv energieeffiziente betriebe, Vienna 2017 ICCEE, Energy efficiency measures: best practices: https://iccee.eu/energy-efficiency-measures-best-practices/

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