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

Best Practice	FLOW RATE REDUCTION THROUGH VARIABLE SPEED VARIATION (VSD)	HVAC-02
Application	Optimisation of HVAC systems	
SME sector	All	
SME Sub-sector	All	
Technical description	Volume flow of a ventilation system is the volume of transported air per unit of time. The more volume flow is delivered, the higher the energy used. The energy requirements consist of: transport energy, heating/cooling energy, air humidification, dehumidification, maintenance costs. The analysis of the volumetric flow rate is therefore an important measure for the reduction of the energy costs of a ventilation system. Since many ventilation systems have been built with a rigid volume flow, the system constantly conveys a defined amount of air to the consumers regardless of the demand. But only in the rarest cases the nominal volume flow (installed volume flow) is required. A variable volume flow control eliminates the problem and achieves the greater energy savings. Many plants run all year long (24 hours a day, 7 days a week) while production or usage times may be different. When optimizing the HVAC, the first question should be which areas should be supplied and at what times. The resulting energy savings are among the simplest and most effective measures.	
Recommendation for optimisation	Practical experience has shown that the energy consumption of a ventilation system can be reduced greatly if it is adjusted to a needs-based operation. As a result, the supply air volume flow is adapted to the room conditions, which is not possible with a rigid operation of the system. To implement a variable ventilation, a control parameter is required, which is specially selected for this room and is easy to measure. Control parameters can be: • activity level (motion sensors) • number of occupancy (counting sensors) • pollutant concentration (CO_2 sensors, VOC sensors) • mixed gas sensors • infrared sensors If further emissions are known, the ventilation system can also be controlled by a sensor that measures a specific emission (e.g., CO sensors). If the heating or cooling load is completely or partially covered by the ventilation system, the following sensors	

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	are also operational (also usable in combination with other sensors): air temperature and humidity sensors. In order to process the received signals optimally, a supply system must be installed, which can implement a variable volume flow. A control of the flow according to a variable demand can be reached by: variable speed drives (VSD), damper control, inlet guide vanes control and by-pass control. Damper and by-pass have poor efficiency. Inlet guide vanes are for axial fan which are not much used in HVAC. For a VSD control frequency converters and EC motors are used (above 10 kW asynchronous and synchronous motors are used). The VSD regulates the volume flow by influencing the power of the motor that drives the fan. VSD can be retrofitted to virtually all motors. In the case of a variable demand of air flow, a demand-based variable regulation of the volume flow can achieve a saving of up to 80% compared to a rigid system that is regulated by mechanical regulation or not regulated at all.
Relevant technical considerations	To reduce the air flow rate, the minimum volumetric flow rate required must first be determined. According to EN 16798, the volumetric flow rate depends on two main parts: • minimum volumetric capacity in relation to the number of people present in the building • volumetric flow rate required to dissipate additional emissions into the environment • volumetric flow required to heat and / or cool an environment and the needs of the production process
Schemes and diagrams	The following figure shows the energy saving potential between a VSD control, damper, by-pass control and an inlet vane control. It shows the percentage energy demand for a reduction of volume flow. It shows that by a reduction of the volume flow of 50% the power consumption for a VSD controlled ventilator is the lowest in comparison to the other control methods.

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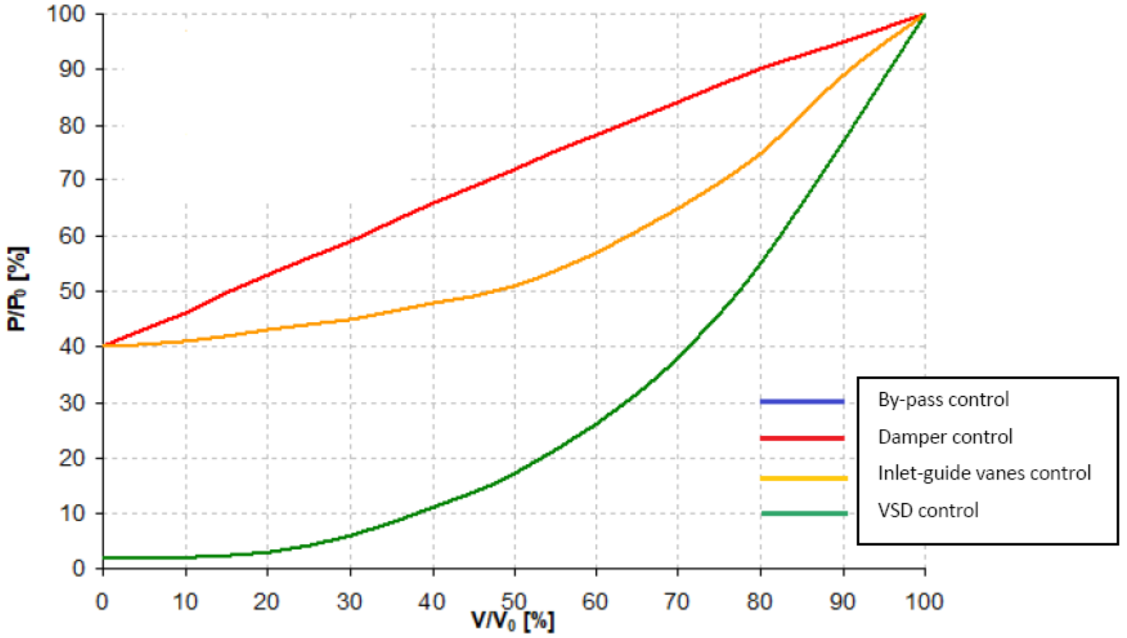

P=Effective power – P_0= Nominal Power – V=Effective volumetric flow rate – V_0= Nominal volumetric flow rate

Economics	VSD systems at approx. 500 EUR/kW
Energy savings	Energy savings are closely linked to the lower electrical power required to keep the system running (10-15% lower)
Economic savings	Reduction in electricity bills • Unit cost of CO_2 sensor: 100-200 EUR • Unit cost of motion sensor: up to 100 EUR
Average Payback Time	Less than 3 years
Emissions	Emissions depend on the characteristics of the refrigerant gas
Environmental benefits	Depending on the system configuration, the energy consumption of ventilation systems consists of electricity (for fan, air heating and humidification), gas (air heating, humidification) or solar thermal energy (heating, recuperation/moisture recovery) which can be reduced by the measure. Reduction in CO_2 emissions due to a reduction in electricity needs for cooling
Main NEBs (Multiple benefits)	☒ Environmental benefits ☐ Increased productivity ☐ Work environment/ Health/Safety

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	☐ Increased competitiveness ☒ Maintenance
Replicability	High
Related measures	• HVAC-01: Reduction of fan running time • HVAC-03: Replacement of fan • HVAC-04: Replacement of transmission system • HVAC-05: Heat and moisture recovery • HVAC-06: Reduction of pressure loss • HVAC-07: Leakage reduction of pipes • HVAC-08: Replacement of motor
Case study	Installation of frequency converters, company "SALVAGNINI MASCHINENBAU GMBH" (Austria, 2015) • Initial Situation: the production halls are supplied with air from the ceiling ventilation unit. Fans of ventilation units work at full power during operation. • Description of the optimisation: the installation of the frequency converters, the fan motors (2x1.6kW) can operate in a variable way, depending on the set-point of ambient temperature (19°C) and depending on the deviation (up to 4°C), in the range 15-50Hz. Low-speed operation allows significant energy savings. All belt drives have been converted into efficient notched V-belts and the pipes, fittings and flanges of the heating system have been insulated. • Implementation costs: approx. 3,500 EUR • Payback Time: 1 year
References	Gerstbauer, Ch., Kulterer, K., Gorbach, Ch., Brunner, W. : Leitfaden für Energieaudits von Lüftungsanlagen, klimaaktiv energieeffiziente betriebe, Wien 2013

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