

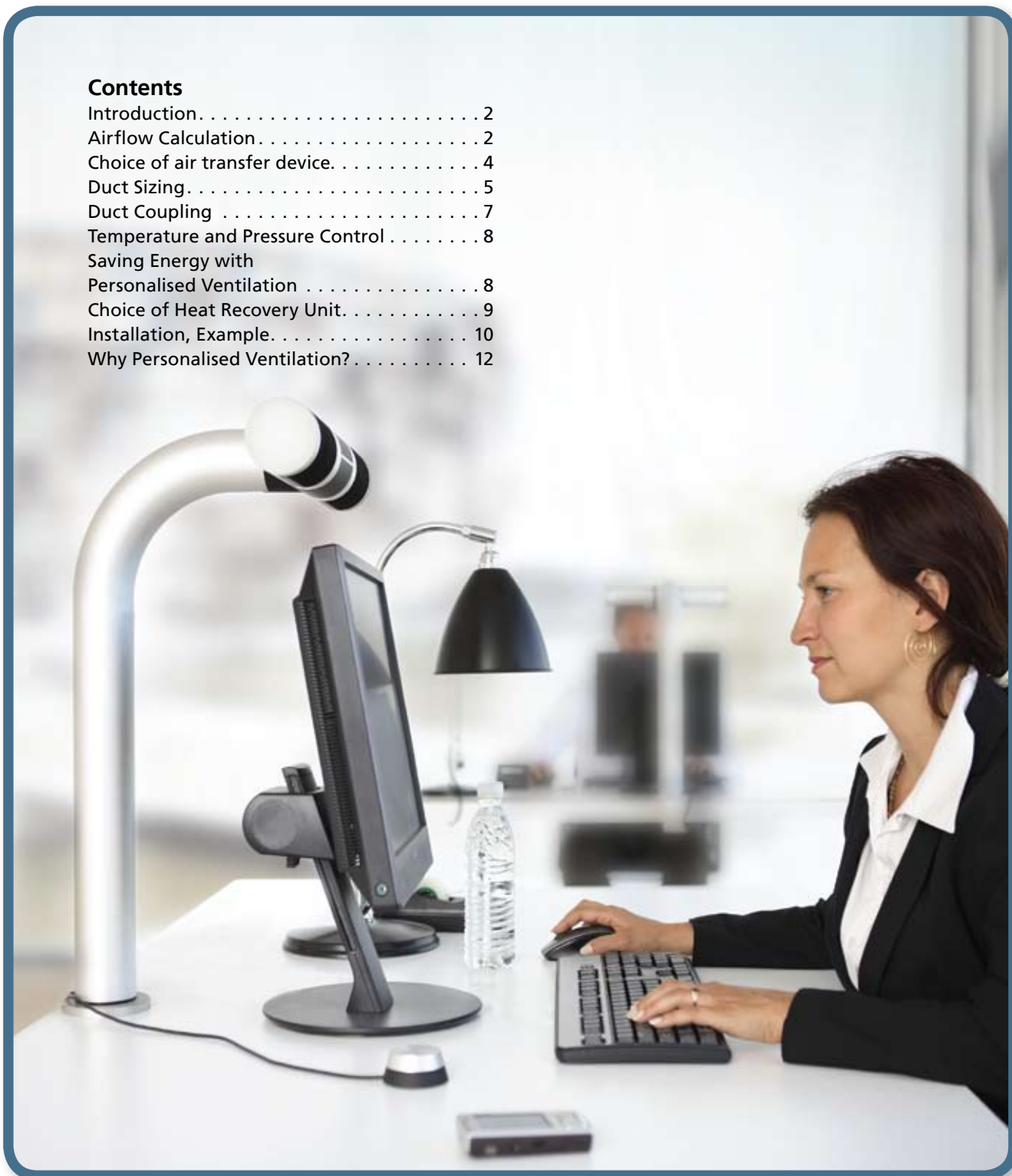
# PERSONALISED VENTILATION

Project Planning Guide for new installations



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**EXHAUSTO**

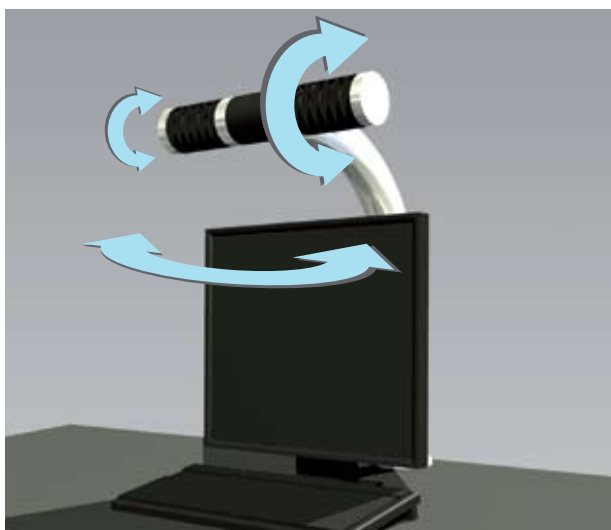
FOR A BETTER FLOW



## Project Planning of new ventilation units with Personalised Ventilation (PV)

This Project Planning Guide is intended for use in planning the installation of a new ventilation system. The ventilation unit is installed as a VAV/DCV unit.

If the individual employee is able to make adjustments to their own microclimate, they create their own indoor climate experience and, by implication, their own best working capacity and performance. Adjustments may include adjusting air direction, both horizontally and vertically, and airflow between 0 and a maximum of 10 l/s (36 m<sup>3</sup>/h), to suit the individual user. However, never more than 8 l/s is specified for each Personalised Ventilation device, as 10 l/s is only desirable for a very short interval in extreme circumstances.



*PV-AirZone-200 device. Air direction is adjusted either by moving the nozzles up/down or by rotating the device to the right/left, until the required air direction is achieved. It is important that the air comes up from the nozzles and down into the face. This ensures it breaks through the convective air current that lies along the body, and thus the face is enveloped in clean air.*



The airflow can be variably adjusted between 0 and 10 l/s (36 m<sup>3</sup>/h) using the desktop regulator.



In addition to Personalised Ventilation, we recommend that the room is also equipped with standard room ventilation. This is partly because the airflow from Personalised Ventilation may be anything between 0 and 10 l/s and will fluctuate a great deal throughout the day, and partly because 10 l/s ventilation will often be insufficient to remove excess heat from the room. Personalised Ventilation on its own will **not** normally be sufficient to maintain the required indoor climate **beyond** the personal zone of operation.

Room ventilation can be calculated in different ways, depending on the data available and on conditions specified.

## Airflow Calculation

The volume of air required in offices has typically been calculated as 5-10 l/s per person.

Research into indoor climate and new European indoor environment Standards DS/EN15 251 and DS/EN13 779 require a greater airflow, depending on the kind of indoor climate required and the materials used in the building concerned. In addition, the cooling requirement of the room may now also be decisive for total airflow.

### To calculate the airflow in a room with Personalised Ventilation:

The airflow depends to a great extent on the type of ventilation system selected.

In the examples on the following page, airflow is calculated for a traditional mixing system and for a system with chilled beams. Both calculations are for an office area of 60 m<sup>2</sup>/150 m<sup>3</sup> with six office workers.

The room is built using materials within the "low-pollutant building" category and the required indoor climate level is DS/EN15 251 Class 1.

## Airflow Calculation - continued

1. The cooling requirement of the building/room is calculated using, for example, indoor climate modelling software.

2. Total airflow  $q_{v-tot}$  is calculated.

### Mixed ventilation

Typical air change rate is 6–8 times an hour

$$\begin{aligned} \Rightarrow q_{v-tot} &= 150 \text{ m}^3 \times 6 \text{ times an hour} \\ &= 900 \text{ m}^3/\text{h} \\ &= (250 \text{ l/s}) \end{aligned}$$

### Chilled beams

Using typical air change rate 2–3 times an hour

$$\begin{aligned} \Rightarrow &= 150 \text{ m}^3 \times 3 \text{ times an hour} \\ &= 450 \text{ m}^3/\text{h} \\ &= (125 \text{ l/s}) \end{aligned}$$

3. Total airflow is checked against the required air quality for the room, using DS/EN15 251 table B3.

### Indoor environment class 1

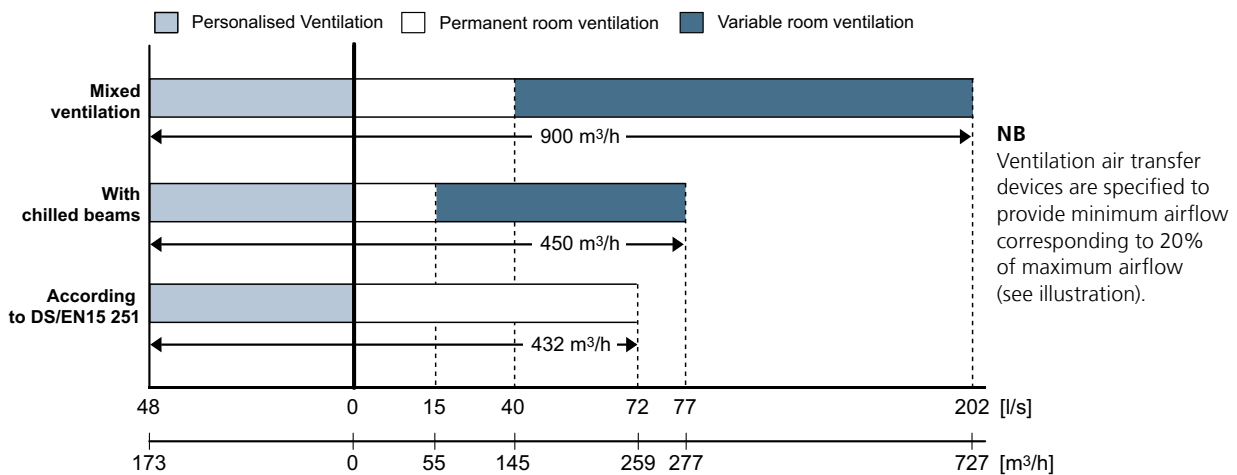
$$\Rightarrow 10 \text{ l/s per person} \times 6 \text{ persons} = 60 \text{ l/s}$$

### "low-pollutant" building

$$\begin{aligned} \Rightarrow 1 \text{ l/s} \times \text{m}^2 \times 60 \text{ m}^2 &= 60 \text{ l/s} \\ \text{Total} &= 120 \text{ l/s} \\ &= 432 \text{ m}^3/\text{h} \end{aligned}$$

4. Total airflow for Personalised Ventilation  $q_{v-PV}$  is calculated.

$$\begin{aligned} \Rightarrow q_{v-PV} &= 6 \text{ people} \times 8 \text{ l/s} \\ &= 48 \text{ l/s} \\ &= 173 \text{ m}^3/\text{h} \end{aligned}$$



DS/EN15 251:2007 Table B.3

Class	Air-flow per person l/s	Airflow relative to the pollutant emission of the building		
		Very low-pollutant building l/s x m <sup>2</sup>	Low-pollutant building l/s x m <sup>2</sup>	Non low-pollutant building l/s x m <sup>2</sup>
1	10	0.5	1.0	2.0
2	7	0.35	0.7	1.4
3	4	0.2	0.4	0.8

### Cooling requirement with mixed ventilation

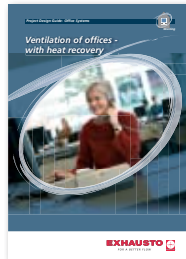
If there is a cooling requirement in a room or building due to the presence of people, machines and sunlight, airflow quantity is calculated on the minimum permitted temperature ( $t_{room} - t_{suppl} = \Delta t$ ) for the supply air transfer devices installed. When PV is utilised, the recommended supply air temperature level is no lower than 18–20°C. It is important to remember that there will usually be an air temperature increase of 2–3°C in the ducting system, which means that the supply air temperature permitted at the air handling unit will be approximately 16–18 °C.

$$\text{To calculate airflow with traditional mixed ventilation: } q_v = \frac{\text{Cooling Requirement (Watt)}}{0.33 \times \Delta t} \quad [\text{m}^3/\text{h}]$$



In addition to Personalised Ventilation, it is important to take into account the room ventilation design and to use the correct ventilation principles. The load on the room, number of people, heat from office machinery, IT equipment and sunlight, etc., must all be considered.

Refer to EXHAUSTO Project Planning Guide for Offices – Working, which provides precise descriptions of the ventilation principles, control methods, choice of products and energy consumption.



[www.exhausto.com/working](http://www.exhausto.com/working)

The examples in this guide can be applied only to VAV and DCV principles.



**VAV = Variable Air Volume** Variable airflow (large/small air volume, usually achieved by means of movement sensors, timers or similar methods)



**DCV = Demand Controlled Ventilation** Demand-controlled ventilation (usually determined by temperature and/or CO<sub>2</sub>-sensor)

**One very common form of room ventilation** is the use of ceiling-mounted fittings. The ceiling-mounted fitting can be supplied either with a fixed, pre-set airflow (CAV unit) or with integrated motor (DCV unit) that automatically regulates airflow based on the temperature and/or the CO<sub>2</sub> level in the room. The example on pages 10–11 show an alternative unit where a number of pre-set mixing units are connected in a zone with a zone damper which can be controlled by a DCV unit or by a two-level VAV unit.

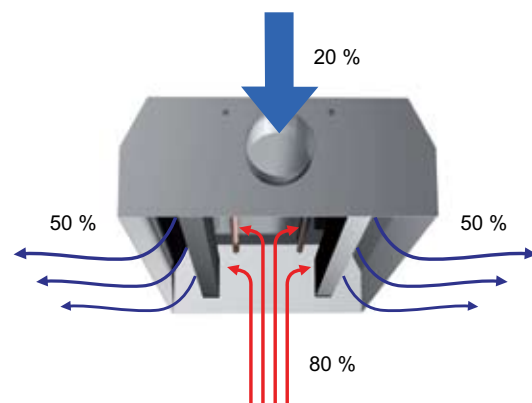
The DCV unit saves energy in periods where the burden on the indoor climate is low (no sunlight and/or few people). Potentially more energy may be saved by setting a higher room temperature and/or CO<sub>2</sub> level in the room when Personalised Ventilation is installed.

For this type of ventilation, cooling must be supplied by the primary air current from the central cooling unit/cooling coil in the duct system.



The ceiling-mounted device may be used to supply a constant airflow (CAV) or, alternatively, with an integrated motor supplying a variable airflow (DCV).

**Chilled beams are often used in a room with many heat sources (= large cooling requirement).** A supply of water for cooling is required, for example, from district cooling or similar systems. Chilled beams make it possible to supply a better cooling effect with relatively small airflows.



Chilled beams. The primary airflow from the ventilation unit is pumped at high velocity through the ventilation unit and out at ceiling level. This causes negative pressure in the beam, sucking air into and through the beam where it is cooled. The volume of air circulating through the beam will often be 4–5 times greater than the primary air so that relatively little primary airflow is used to achieve a much larger cooling effect in the room.

The quantity of primary air in the beam is either constant or variable. Room temperature is regulated by a room temperature sensor controlling the quantity of water coolant circulating in the beam.

### Air balance

If there are many PV devices in the zone, the use of volume flow zone extraction with a volume flow regulator is recommended, using a master/slave connector on a unit that measures supply air volume flow. This will ensure that airflow to and from the zone is equal.

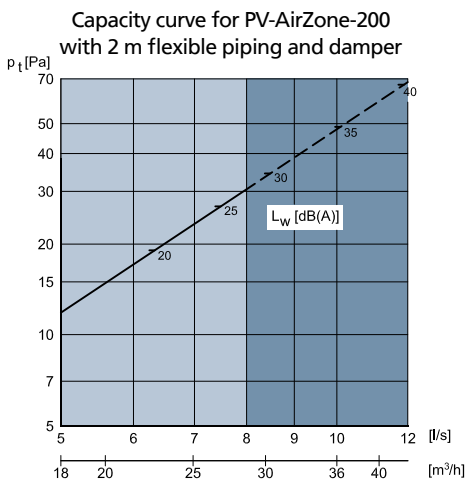
## Duct sizing at a glance

When sizing the duct system for a VAV/DCV unit, it is important to ensure more or less equal pressure in all distribution ducts and maintain the required supply airflow through the individual fittings in both room ventilation and Personalised Ventilation systems.

It is also very important to use supply air transfer devices that have more or less the same pressure loss as the Personalised

Ventilation devices (approximately 30 Pa at 8 l/s + loss of pressure in the connection duct / service column ~ 40-60 Pa).

If this is impossible due to the extent of the unit, it must either be subdivided into zones or fitted with a decentralised constant pressure control. A Lindab service column can be supplied with built-in damper and constant pressure control.



Sound level dB(A) at 0.5 m with atmospheric sound dissipation in a room with 6 Personalised Ventilation devices and a room sound attenuation of 12 m<sup>2</sup>-Sabin:

$$L_{p(A)} = L_{w(A)} - 4 \text{ dB}$$

Example: 8 l/s

$$L_{w(A)} \text{ read} = 28 \text{ dB(A)}$$

$$L_{p(A)} = L_{w(A)} - 4 \text{ dB} = 28 - 4 = 24 \text{ dB(A)}$$

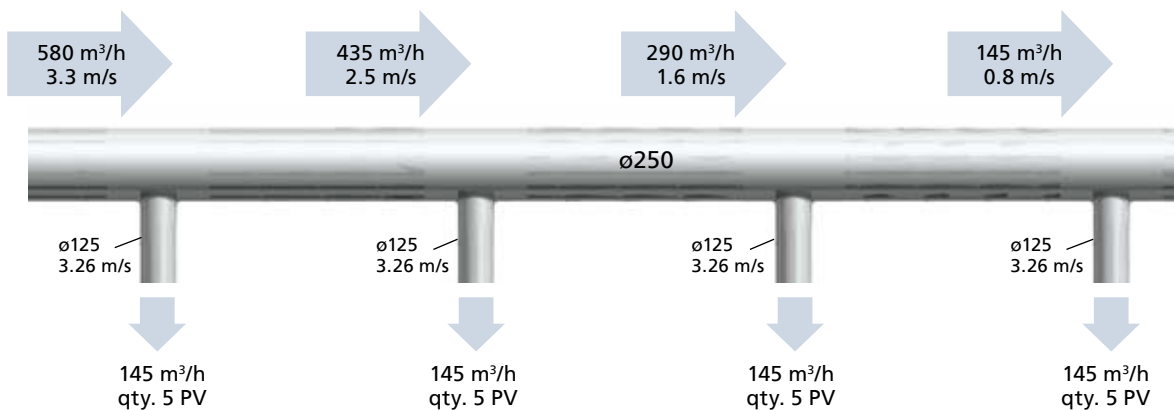
Recommended area

**Sizing the duct system.** When specifying the duct system, maintaining a minimum variation of static pressure between the first and last branches in the distribution duct is recommended. Further, reducing specific pressure loss to

approximately 1.0–1.5 Pa/m of duct is recommended to minimise energy consumption. This is best achieved using 1 of the following 2 methods:

### Method 1 - Avoid changing duct sizing

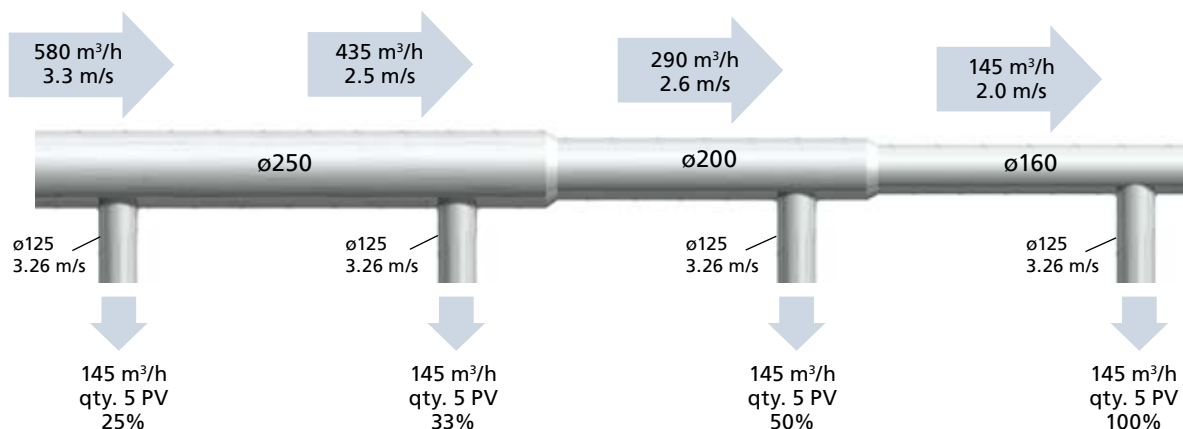
Example of sizing VAV/DCV unit with no changes in duct diameter.



## Duct sizing at a glance - continued

### Method 2 - the 30% method

The duct diameter remains the same as long as airflow in each duct branch is less than 30% of the airflow in the duct just before it. If the branch airflow accounts for more than 30% of airflow in the duct just before it, duct diameter is reduced by one size. At each subsequent branch, the duct is reduced one size.



Pressure loss in the distribution duct from the first to the last branch should not exceed 40% of the static pressure required in the duct.

### At a glance - Table

If many Personalised Ventilation air transfer devices share a single duct section, use the "at a glance" table.

Duct sizing	No. of PV devices at 8 l/s	Max. duct length [m]
$\varnothing 63$ mm	1	5*
$\varnothing 80$ mm	2	6
$\varnothing 100$ mm	3	10
$\varnothing 125$ mm	5	11
$\varnothing 160$ mm	8	16
$\varnothing 200$ mm	13	18
$\varnothing 250$ mm	20	27
Lindab $\varnothing 100$ mm ventilation service column	4	2.8
Lindab $\varnothing 125$ mm ventilation service column	6	2.8
Manifold box $\varnothing 125$ mm / 4 x $\varnothing 63$ mm	4	0.2 x 0.2 x 0.1
Manifold box $\varnothing 125$ mm / 6 x $\varnothing 63$ mm	6	0.2 x 0.2 x 0.1

\* Corresponding to approximately 2 m flexible piping

## Personalised Ventilation Duct System

Supply of air to Personalised Ventilation air transfer devices can be achieved in many different ways.




1

Lindab ø100 mm ventilation service column

Supply air to Personalised Ventilation is provided by a freestanding Lindab ø100 mm ventilation service column, which can supply max. 4 Personalised Ventilation devices.

For details of room ventilation, see pages 10–11

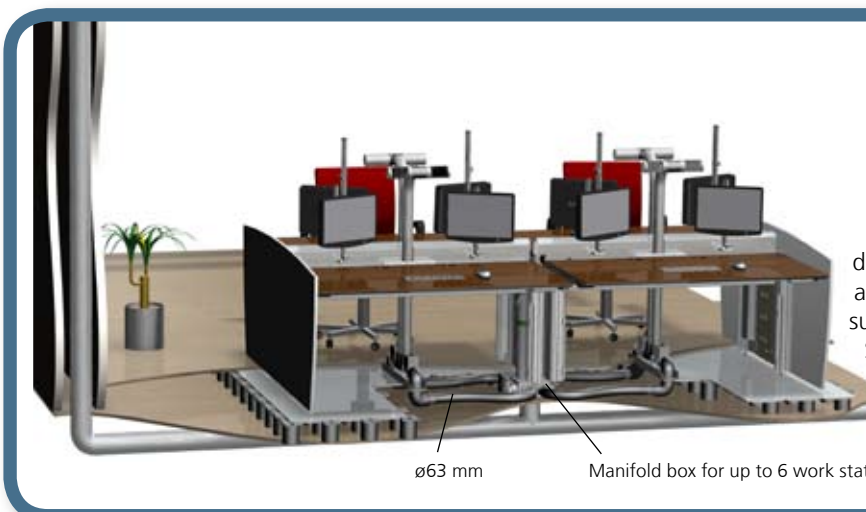


Lindab ø125 mm ventilation service column

2

Supply air to Personalised Ventilation is supplied via a Lindab ø125 mm ventilation service column, which can supply max. 6 Personalised Ventilation devices.

For details of room ventilation, see pages 10–11



3

ø63 mm

Manifold box for up to 6 work stations

Personalised Ventilation is supplied via the IT floor and then branched to the individual Personalised Ventilation devices. The system illustrated here with a two-person work station and subfloor supply is identical with the installation at SAXO BANK at Tuborg Havn in Copenhagen, Denmark. [www.saxo.dk](http://www.saxo.dk)

For details of room ventilation, see pages 10–11

## Temperature and Pressure Control

Optimum room temperature control is achieved by fitting a combined temperature/CO<sub>2</sub> sensor in the room (or in the extraction system) as part of a DCV system.

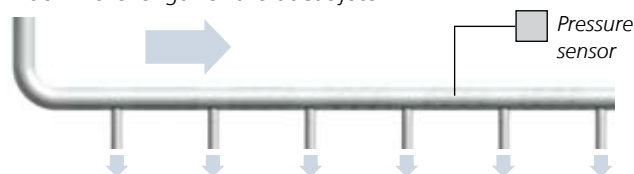
When Personalised Ventilation is utilised, the recommended level for supply air temperature is no lower than 18–20°C. It is important to remember that there will usually be an air temperature increase of 2–3°C in the ventilation ducts, which means that the supply air temperature permitted will be approximately 16–18°C.

In order to ensure the correct air quantity in all ventilation fittings, it is very important that duct diameters are accurately sized (see above) including the duct diameter in individual zones.

If EXHAUSTO guidelines are followed, the airflow variation from the first to the last air transfer device will, under normal circumstances, remain within the range +/- 15%, permitted by DS447.

Pressure controller(s) must be fitted as follows:

- If there is more than 40% variance between the pressure in the distribution duct between the first and last branch, the unit must be subdivided into zones. Each zone must be fitted with its own constant pressure control.
- The pressure sensor will most often be positioned 2/3 down the length of the duct system

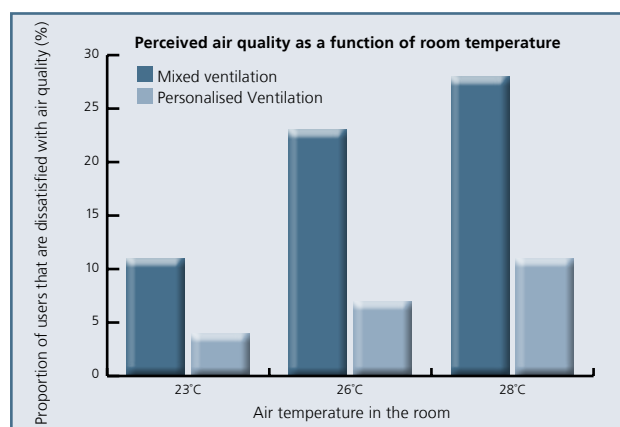


## Saving Energy with Personalised Ventilation

Once you have installed Personalised Ventilation, the principle of room temperature not being too high becomes less important. Research carried out at DTU/ICIEE\* has indicated that people working at room temperatures of up to 28 °C are no less satisfied with the indoor environment, as long as the supply air temperature to Personalised Ventilation is at 23°C or lower.

This means that it is possible to save on energy used for cooling as the need to lower room temperature is far less important when there is Personalised Ventilation. The potential savings may be calculated for the individual room, using, for example, simulation software.

**Below is a simple calculation of saving, assuming that an increase in the room's CO<sub>2</sub> concentration of 200 ppm is acceptable.**



*Perceived air quality: People are far more satisfied with Personalised Ventilation than standard ventilation. In the test, the supply air temperature for Personalised Ventilation was 23°C.*

### Example of airflow reduction/saving with Personalised Ventilation and DCV control

#### A Call Centre without Personalised Ventilation:

20 people, CO<sub>2</sub> production = 20.4 l/h x person  
 CO<sub>2</sub> level in the room = 858 ppm  
 Calculated airflow = 223 l/s (803 m<sup>3</sup>/h)

#### A Call Centre with Personalised Ventilation:

20 people, CO<sub>2</sub> production = 20.4 l/h x person  
 Acceptable CO<sub>2</sub> level in the room = 1,058 ppm  
 Calculated airflow = 160 l/s (576 m<sup>3</sup>/h)

Airflow reduction: 223 – 160 l/s = 63 l/s (227 m<sup>3</sup>/h) ~ 28% lower airflow.

It is important to measure exactly how much room temperature increases when the airflow is reduced because room temperature should only briefly exceed 26 – 27°C.

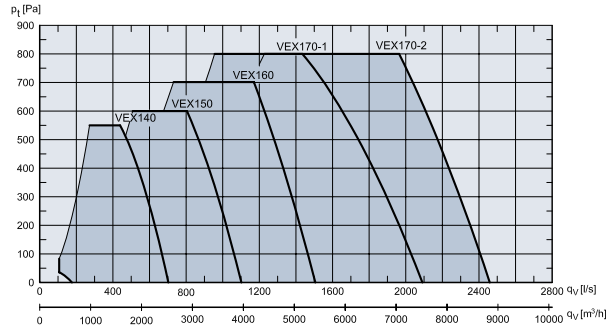
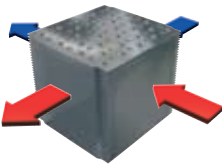
\* DTU/ICIEE - International Centre for Indoor Environment and Energy - [www.ie.dtu.dk](http://www.ie.dtu.dk)

## Choice of Heat Recovery Unit

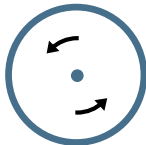
For office ventilation, one of the following types of heat recovery unit can normally be used:



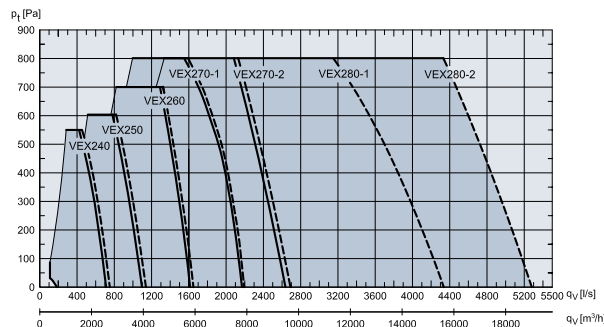
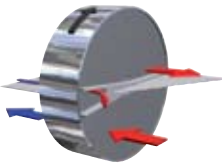
**VEX100**  
RANGE  
CROSS FLOW  
HEAT EXCHANGER



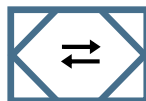
VEX100 with cross-flow heat exchanger. Separate air ducts, low investment, market-proven design and good temperature efficiency. No humidity recovery.



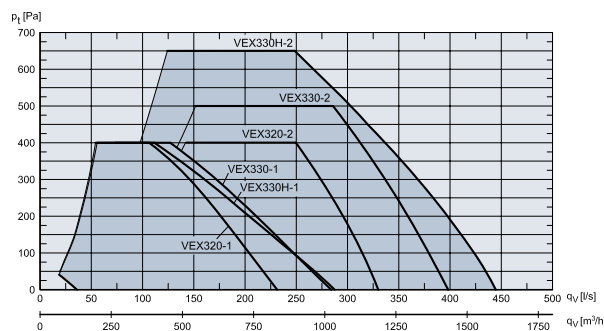
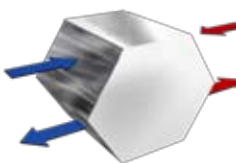
**VEX200**  
RANGE  
ROTARY  
HEAT EXCHANGER



VEX200 with rotary heat exchanger. Market-proven design, high temperature efficiency and some humidity recovery.



**VEX300**  
RANGE  
COUNTER FLOW  
HEAT EXCHANGER

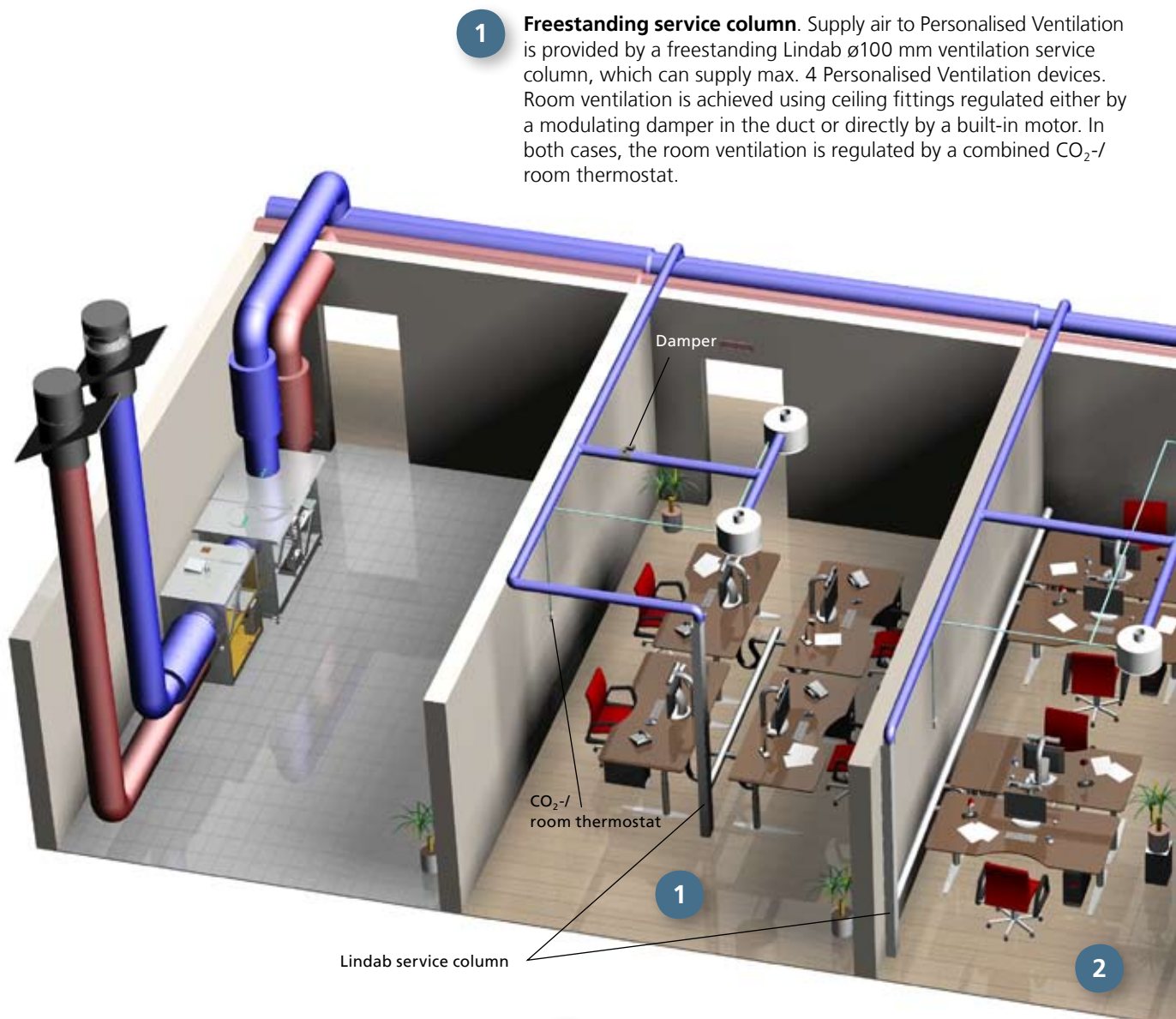


VEX300 with counter-flow heat exchanger. Market-proven principle, very high temperature efficiency, no humidity recovery, separate air ducts.

## Ventilation of office facility using Personalised Ventilation

In the example a VEX200 with rotary heat exchanger is used. This is primarily explained by the fact that most office environments require humidity recovery during winter months. This unit has a high temperature efficiency which is a great advantage when calculating energy consumption levels for new buildings. The unit must be provided with a blowout

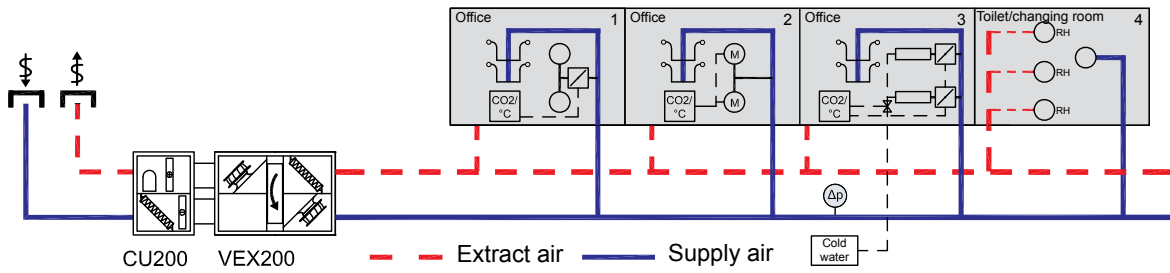
zone and a trim damper and it is very important that the unit is commissioned correctly. Where there are many toilets within the unit's area of operation, it is often advisable to use a different type of heat exchanger to avoid spreading odours.



- 1 Freestanding service column.** Supply air to Personalised Ventilation is provided by a freestanding Lindab  $\varnothing 100$  mm ventilation service column, which can supply max. 4 Personalised Ventilation devices. Room ventilation is achieved using ceiling fittings regulated either by a modulating damper in the duct or directly by a built-in motor. In both cases, the room ventilation is regulated by a combined CO<sub>2</sub>-/room thermostat.

**Technical depot.** The EXHAUSTO VEX200 heat recovery unit is very compact, runs with very low sound levels and is supplied in a variety of versions. The VEX200 can also be supplied as an integrated cooling unit (Plug and Play), regulated by VEX automation.  
**Note that a CU200 cooling unit is not usually delivered with chilled beams.**

- 2 Wall-mounted service column.** Supply air to Personalised Ventilation is supplied via a Lindab  $\varnothing 125$  mm ventilation service column, which can supply max. 6 Personalised Ventilation devices. Room ventilation is achieved using ceiling-mounted fittings regulated either by a modulating damper in the duct or directly by a built-in motor. In both cases, room ventilation is regulated by a combined CO<sub>2</sub>-/room thermostat.

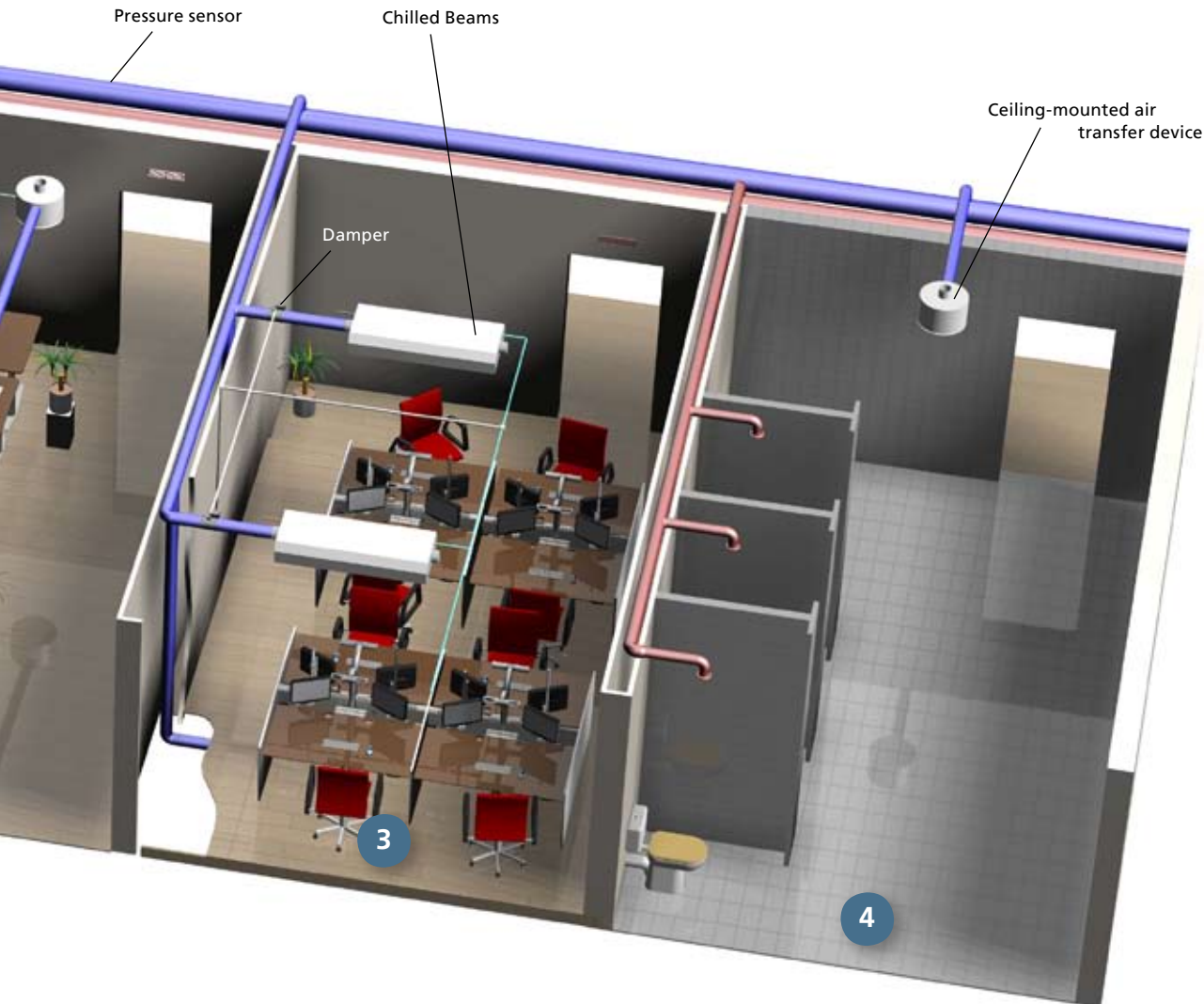


**3 Through IT floor.** Personalised Ventilation is supplied via the IT floor and distributed out to the individual PV devices. Personalised Ventilation is individually adjustable.

Room ventilation is achieved through chilled beams in the ceiling. Room ventilation is regulated by a CO<sub>2</sub> sensor, while room temperature is regulated by a temperature sensor that controls the flow of water in the chilled beams.

**4 Toilet and changing room facilities.** Often ventilated via the central ventilation unit. The airflow may be constant or variable and is controlled by humidity-regulated extractor devices.

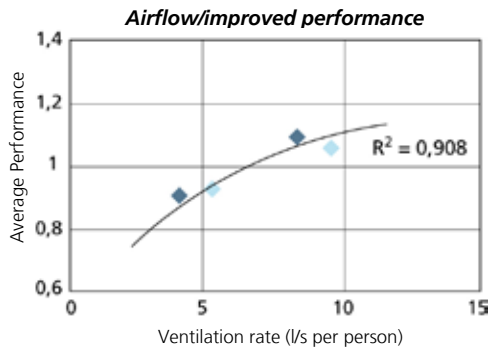
Where there are many toilets within the unit's area of operation, it is often advisable to use a different type of heat exchanger (i.e. not a VEX200) to avoid spreading odours.



## Why Personalised Ventilation?

Professor Arsen Melikov of the Technical University of Denmark (DTU) International Centre for Indoor Environment and Energy (ICIEE) has researched into Personalised Ventilation for the past ten years.

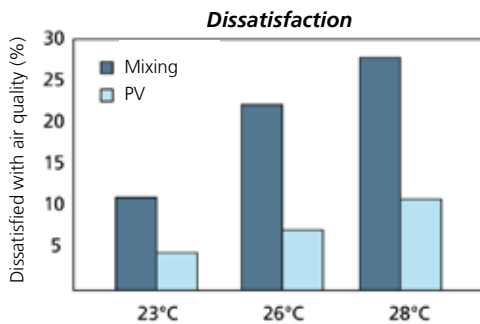
Professor Melikov's research has involved close to 500 students and more than 4,500 hours testing the characteristics of Personalised Ventilation. Some of the professor's results are illustrated below.



*Airflow/improved performance curve. Many research projects have produced interesting results about the effects of improving an indoor environment.*

*Increasing airflow from 5 l/s to 10 l/s per person has been shown to bring an average improvement in performance of more than 20%. Is providing a greater airflow per person an expensive option?*

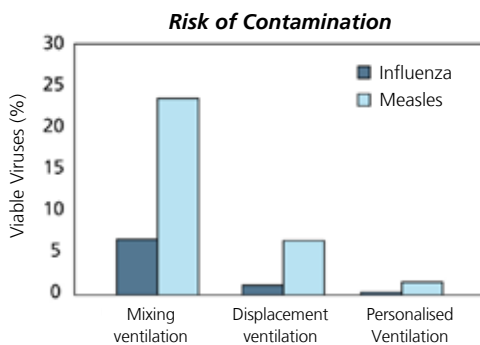
*No. Research has shown that the cost of running and maintaining technical installations in a building accounts for less than 1% of the total expenditure per employee and per work station, including salary, amortisation of buildings, etc. In fact, ensuring the correct airflow to employees is an extraordinarily profitable investment.*



*Personalised Ventilation also makes it possible to save on energy for cooling as room temperature does not have to be maintained at a low level.*

*At room temperature 23 °C, only approximately 3.5% people with PV are dissatisfied with the indoor environment, whereas approximately 11% people in mixed ventilation are dissatisfied. It's worth mentioning here that thousands of tests have shown that it is simply not possible to create an indoor environment with which more than 95% of people are satisfied. Impossible, that is, until PV was invented.*

*The light blue columns show that, at room temperature 28 °C, only about 10% will be dissatisfied with an indoor environment with PV, compared to 28% with mixed ventilation.*



*Viral and bacterial contamination between colleagues in an office depends on a great number of different factors, of which the ventilation system is just one. Here too, tests indicate that Personalised Ventilation has many advantages. The graph shows that, with PV, the spread of vital vira and bacteria between two work stations is significantly reduced.*



Source: International Centre for Indoor Environment and Energy  
ICIEE - [www.ie.dtu.dk](http://www.ie.dtu.dk)



### Facts about EXHAUSTO Personalised Ventilation

- Satisfied employees
- Superior job performance
- Sickness absence reduced
- Aesthetically pleasing installation
- Extraordinarily profitable investment
- Airflow at 8–10 l/s per person
- Constant pressure regulated system
- Compatible with VAV and DCV systems
- Recommended PV air temperature 18 °C–23 °C

