Operational optimisation measures for companies: Ventilation

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Adapt the operating times for the ventilation to effective usage

If rooms are ventilated (intensively) outside of usage hours or if the air seems “stale”, these are signs that the operating times set for the ventilation are not optimal.

Action

Adapt the operating times of the ventilation system to the effective demand and room usage. Outside of usage times, switch the ventilation system off entirely, or reduce it.

Requirement

The ventilation system control must have a timer programme.

If the ventilation can be switched off every day from 8 pm to 6 am, its energy consumption will decrease by 40 percent

What to do

1. Record the initial situation

Note the current settings for the timer programme in the logbook (plant journal).

2. Determine the usage times

Ascertain when the individual rooms are used. This is the basis for the ventilation system’s operating times.

3. Set the operating times

- When usage begins, switch the ventilation system on. If the air quality is already giving rise to complaints, switch the system on for 15 minutes to a maximum of 30 minutes before usage begins (this is known as “pre-flushing”).
- When usage ends, switch the ventilation system off immediately. Post-occupancy ventilation makes no sense in most cases.
- Depending on the required airflow, the ventilation system can be switched on and then off at intervals of 15 minutes (intermittent operation).
- If a room is only used by a few people for a certain period, the system’s power can be reduced (e.g. from level 2 to level 1), or intermittent mode can be switched on.

4. Note, observe and correct

- Note the new values in the logbook.
- Observe the users, pay attention to complaints and correct the set values as necessary.

Costs – effort

- Your own labour (recording usage times, setting the timer, updating the logbook): approx. 2 hours per ventilation system (monobloc)
- Air quality measurement (CO_2, air humidity): CHF 200 per measuring point

Please note!

- In buildings that are ventilated via the windows, the operating times of the ventilation system can be reduced additionally outside of the heating period.
- Important: the usage time is often not the same as the actual period of presence. Users are frequently present in the rooms before the official attendance time.
- Record every adjustment of the set values in writing.
- Use a timer programme to switch the ventilation system off entirely in summer (do not blow any warm air into the rooms) and during public holidays and (works) holidays.
- Night-time cooling in summer is significantly more effective via window ventilation than with the ventilation system.

Additional explanations

Considerations regarding usage

The following questions will help you to specify usage:
- Which rooms does the ventilation system supply?
- How is the room used?
  - Office, meeting room, laboratory, etc.
- How intensively is the room used?
  - Occupancy throughout the day
- Are the rooms' usage times known?
  - Weekdays, weekends
  - Public holidays, works/company holidays

Which tasks does the ventilation system perform?
- Hygiene ventilation
- Room cooling or heating
- Humidification or dehumidification of the supply air

Pay attention to the air quality

It is difficult to make generally valid statements about optimal indoor air quality because people react differently to air pollution. Nevertheless, CO_2 content and air humidity are good indicators for assessing air quality. For this reason, they should be verified by measurements. As regards CO_2 content, the IDA values (IDA = Indoor Air) provide good guidance:
- Less than 800 ppm: high air quality (outside air)
- 800 to 1000 ppm: medium air quality
- 1000 to 1400 ppm: moderate air quality
- More than 1400 ppm: low air quality

For the purposes of air quality and energy consumption, ventilation in offices should be switched on when the CO_2 content is 1000 ppm

If it is impossible to guarantee the required air quality, the operating times of the ventilation or the airflow must be gradually increased again. The air quality should also be checked once or twice during the heating period, at intervals of 10 to 12 weeks.

Operating times for the ventilation system

A rule of thumb states that the ventilation system operates only when the room is in use:
- A post-occupancy operating period is not required;
- A short pre-occupancy operating period (pre-flushing) may be appropriate.

Example: usage times, office A

Work starts 6:30 am, work ends 6:00 pm
- Ventilation ON: Monday to Friday: 6 am to 6 pm
- Ventilation OFF: Monday to Friday: 6 pm to 6 am
- Ventilation OFF: weekends, public holidays, works holidays

Example: usage times, office B

(level 1 = gentle, level 2 = intensive)
Work starts 6:30 am, work ends 6:00 pm
- Ventilation level 2: Monday to Friday: 6 am to 8 am
- Ventilation level 1: Monday to Friday: 8 am to 1 pm
- Ventilation level 2: Monday to Friday: 1 pm to 3 pm
- Ventilation level 1: Monday to Friday: 3 pm to 6 pm
- Ventilation OFF: Monday to Friday: 6 pm to 6 am
- Ventilation OFF: weekends, public holidays, works holidays

Example: usage times, school classroom

School begins 7:30 am, school ends 5:00 pm
- Ventilation ON: Monday to Friday: 7 am to 5 pm
- Ventilation OFF: Monday to Friday: 5 pm to 7 am
- Ventilation OFF: weekends, public holidays, school holidays

Additional information

- "Ventilation and air conditioning systems – general principles and requirements", SIA standard 382/1 (charge payable), www.sia.ch
- Indoor air quality, www.lungenliga.ch
- The indoor air quality (IDA value) is described in EN 13779.

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The right airflow improves the quality of the room air

Complaints about room air – such as "it's muggy", "it's too dry" or "there's a draught" – are signs that the airflow is not adjusted correctly and must be checked.

Action
Adapt the airflow for the ventilation system to match the actual requirements in the rooms.

Requirement
It must be possible to control the airflow fan with a frequency converter, a step switch or an EC (electronically commutated) motor.

If the airflow is halved, the energy consumed by the ventilation decreases by 80 percent

What to do
1. Record the initial situation
- Determine the airflow setting (supply and exhaust air). These values should be recorded in the commissioning record for the ventilation system. If the data is missing, a ventilation specialist can determine the volume flows.
- Note the current supply and exhaust airflows in the logbook (plant journal).

2. Measure the air quality
Use a data logger to determine the air quality in the room for a period of about 2 weeks (CO_2 concentration and air humidity).

3. Compare the measurement results with the default values
- Compare the measured values with the default values (see page 2) for CO_2 content and relative air humidity and adapt the airflows if necessary (see page 2).
- Coordinate the supply and exhaust airflows.

4. Note, observe and correct
- Enter the newly adjusted airflows and setting values (frequency and speed) in the logbook.

- Observe the users (are there any complaints?) and correct the settings if necessary. In case of doubt, measure the CO_2 values and the humidity again.

Costs – effort
- Your own labour (measurements, settings, updating the logbook): approx. one working day
- Air quality measurement (CO_2, air humidity): CHF 200 per measuring point

Please note!
- Depending on the room usage, peak CO_2 values may occur briefly with no need to increase the airflow permanently (e.g. in meeting rooms).
- In terms of energy efficiency, it is worth checking all rooms even if there are no complaints. It could be that too much air is being blown in without anyone noticing.
- Pay attention to additional requirements for the rooms (such as overpressure or underpressure).
- For plants with a recirculating air system, the minimum proportion of outside air may be reduced to save energy.
- On ventilation systems with old motors (belt drive), the speed can be changed by changing the size of the drive pulley.

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Additional explanations

Setting the volume flow

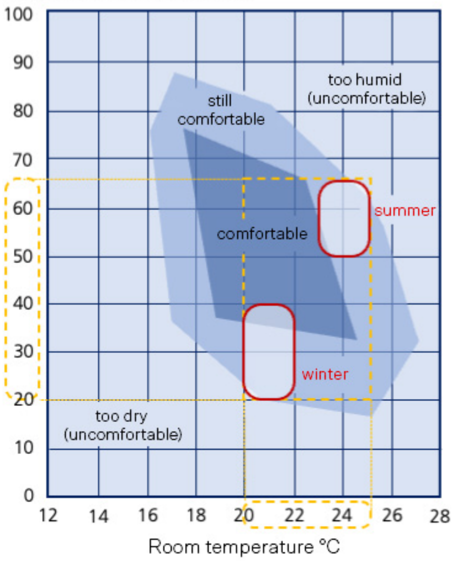
The volume flow (m³/h) is the airflow that is fed to the room. Depending on the ventilation system, either fresh air only or fresh air with a percentage of recirculated air is blown in. The volume flow can be changed as follows:

- Change the levels on the relevant fans (e.g. levels 1 and 2)
- Adjust the speed of fans with a frequency converter (e.g. continuous control based on limit values such as CO_2 and temperature)
- Adjust the speed on fans with EC (electronically commutated) motors (using the integrated motor electronics)
- Cycle the system (switch on/off) over the operating times for an average/moderate volume flow
- Define seasonal operating times or levels

The supply and exhaust airflows must be coordinated with each other.

Temperature and relative air humidity

When assessing comfort, the relative room air humidity is an important factor as well as the temperature. To ensure that the ventilation system operates economically, both values must be adapted to outside climate conditions (see the illustration).



How to determine the default values

The theoretically required volume flow can be calculated on the basis of the number of occupants, the usage or the room type. The following table provides guidance values for the calculation:

Room type	Outside air volume flow (m³/h/person)	Targeted CO_2 concentration (ppm)	Requirements for room air (category)
Office	36	800–1000	IDA 2 – medium
Open-plan office	36	800–1000	IDA 2 – medium
Meeting room	36	800–1000	IDA 2 – medium
Retail shop	30	800–1000	IDA 2 – medium
Restaurant	36	800–1000	IDA 2 – medium
Warehouse hall	36	1000–1400	IDA 3 – moderate
WC	—	1000–1400	IDA 3 – moderate
Changing room/ showers	—	1000–1400	IDA 3 – moderate
Classroom	25	800–1000	IDA 2 – medium

Implementation

- If the measured CO_2 values are above the default values, the airflow must be increased (to improve the air quality).
- If the measured CO_2 values are below the default values, the airflow can be reduced (to save energy).

Example of calculation: default values for outside air supply

- Office with 10 people:
  10 pers. x 36 m³/h person = 360 m³/h
- Set the CO_2 control to constant regulation at 1000 ppm.
- For CO_2 controllers with a hysteresis: switch the ventilation on at 1000 ppm and switch it off at 800 ppm.
- With dynamic CO_2 controllers that can map a setpoint ramp, set the frequency converter so that the airflow increases continuously from 800 ppm, and 100 percent of the airflow is delivered at 1200 ppm.

Dry air in winter

Before you set up an energy-intensive air humidifier, check whether the airflow for the room can be reduced.

Additional information

- "Room usage data for energy and building technology", SIA fact sheet 2024, www.sia.ch
- Indoor air quality (IDA value), see standard EN 13779

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Reduce the airflow in large spaces that are not in use

In many restaurants, auditoriums and multi-purpose halls, the ventilation setting is too intensive outside of usage times. Also, excessive airflows are often encountered in rooms where smoking has taken place in the past.

Action

Adjust the ventilation airflows to the effective requirements.

Requirement

It must be possible to control the airflow fan with a frequency converter, a step switch or an EC (electronically commutated) motor.

If the airflow is halved, the energy consumed by the ventilation decreases by 80 percent

What to do

1. Record the initial situation

- Determine the airflow setting (supply and exhaust air). These values should be recorded in the commissioning record for the ventilation system. If the data is missing, a ventilation specialist can determine the volume flows.
- Note the current supply and exhaust airflows in the logbook (plant journal).

2. Analyse the demand and measure the air quality

(See page 2 for procedure and details)

3. Adapt airflows

- Compare the measured values with the default values (see page 2) and adapt the airflow if necessary.
- In case of major variances in occupancy, adapt the airflows to the specific occupancy situation.

4. Note, observe and correct

- Enter the newly adjusted airflows and setting values (frequency and speed) in the logbook.
- Observe the users (are there any complaints?) and correct the set values if necessary.

Costs – effort

- Your own labour (measurements, settings, updating the logbook): approx. 4 hours
- Air quality measurement (CO_2, air humidity): CHF 200 per measuring point

Please note!

- If additional requirements are defined for the rooms (overpressure/underpressure), they must be taken into account.
- The supply and exhaust airflows must be coordinated with each other.

Additional explanations

Analyse the demand

Ascertain whether the ventilation system – as originally planned – is still needed today, or whether it can be shut down completely (especially outside of usage times). If you are not sure about this, proceed as follows:

- Switch the ventilation system off completely.
- Using a time switch, turn the system on only at times when it is definitely required.
- Monitor the air quality with a CO_2 meter (note that the increase in CO_2 is delayed).
- Monitor the indoor air temperature in rooms with high, fluctuating occupancy (e.g. multi-purpose halls).
- Adapt the times on the time switch.

Setting the volume flow

The volume flow (m^3/h) is the airflow that is fed to the room. Depending on the ventilation system, either fresh air only or fresh air with a percentage of recirculated air is blown in. The volume flow can be changed as follows:

- Change the levels on the relevant fans (e.g. levels 1 and 2)
- Adjust the speed of fans with a frequency converter (e.g. continuous control based on limit values such as CO_2 and temperature)
- Adjust the speed on fans with EC (electronically commutated) motors (using the integrated motor electronics)
- Have the fan's transmission ratio adjusted by a ventilation specialist (change the pulley)
- Cycle the system (switch on/off) over the operating times for an average/moderate volume flow
- Reduce the required volume flow with intermittent operation so that the airflow per person is only 30 m^3/h
- Define seasonal operating times or levels

Consider replacing the motor

For large ventilation systems that operate for more than 4000 hours per year, it is often worth replacing an inefficient motor that is 15 to 20 years old with a new and efficient model.

Highly fluctuating occupancy

If there are major fluctuations in occupancy, the airflow must be adapted to the effective demand insofar as possible.

- If the room is unused throughout the day (works holidays, semester breaks, rest days, etc.), switch the ventilation off entirely and "flush" it for 30 minutes once a day.
- For "medium" occupancy, operate the ventilation system at level I (or airflow of 50 percent) instead of level II (100 percent).
- For "high" occupancy, let the ventilation system run at a higher level (level 2 or airflow of 100 percent).

How to determine the default values

The theoretically required volume flow can be calculated on the basis of the number of occupants, the usage or the room type. The following table provides guidance values for the calculation:

Room type	Outside air volume flow (m^3/h/person)	Targeted CO_2 concentration (ppm)	Requirements for room air (category)
Open-plan office	36	800–1000	IDA 2 – medium
Meeting room	36	800–1000	IDA 2 – medium
Retail shop	30	800–1000	IDA 2 – medium
Restaurant	36	800–1000	IDA 2 – medium
Warehouse hall	36	1000–1400	IDA 3 – moderate
Classroom	25	800–1000	IDA 2 – medium

Example of calculation: default values for outside air supply

- Restaurant with 100 persons
  100 persons x 36 m^3/h person = 3600 m^3/h
- Set the CO_2 control to constant regulation at 1000 ppm.
- For CO_2 controllers with a hysteresis: switch the ventilation on at 1000 ppm and switch it off at 800 ppm.
- With dynamic CO_2 controllers that can map a setpoint ramp, set the frequency converter so that the airflow increases continuously from 800 ppm, and 100 percent of the airflow is delivered at 1200 ppm.

Additional information

- "Room usage data for energy and building technology", SIA fact sheet 2024 (charge payable)
- The IDA (indoor air) values are described in standard EN 13779.

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Fine-tune the heat recovery unit to achieve top performance

If the heat recovery unit (HRU) is not working properly, you won't see or feel anything because the supply air is reheated by the heating coil even without an HRU. Nevertheless, valuable room heat is lost.

Action

Check and optimise the efficiency of the heat recovery unit to reduce energy consumption.

Requirement

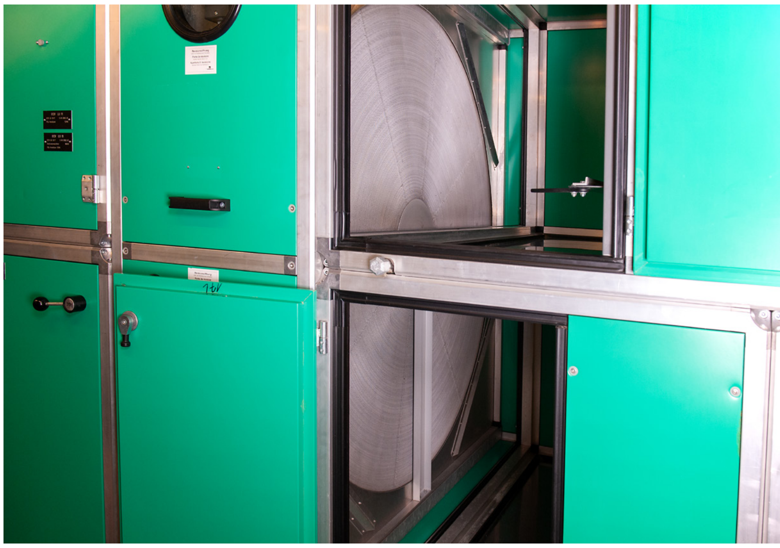
You have a supply and exhaust air system with a heat recovery unit (HRU).

An HRU that functions correctly will save energy costs of up to CHF 3800 per year[1]

What to do

It is best to check the heat recovery unit (HRU) on a day when there is no solar radiation, with an outside temperature of between 5 °C and 10 °C. The ventilation system must be operating for this purpose.

- Read the temperatures on the air duct thermometers. The heating coil and the cooling coil must not be operating when you do this because they influence the temperatures.
- Calculate the quota of recovered waste heat (see page 2)
- Optimise heat recovery (see page 2)
- Check the heat recovery unit regularly



Costs – effort

Your own labour: approx. 4 hours

Please note!

- The supply and exhaust airflows must be coordinated with each other.
- Check the accuracy of the thermometers. Even small deviations (such as 1 °C) can severely falsify the measurement. In case of doubt, rent or purchase an accurate digital thermometer and use it to record the temperatures.

1 Applies to a medium-sized ventilation system that operates for 10 hours, 5 days a week and delivers 5000 cubic metres of air per hour.

Additional explanations

Air temperatures

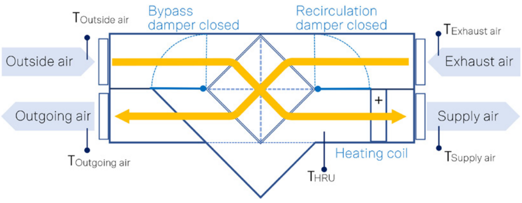
The various air temperatures can be read directly from the thermometers in the air ducts. So that you can determine the efficiency of the HRU:

- If bypass dampers (which bypass the heat exchanger) are present, they must be fully closed;
- If recirculation dampers are present, they must also be closed (with this type of bypass, a certain proportion of the exhaust air is fed directly back into the room).

Otherwise, not all of the air will be fed through the heat recovery unit and it will be impossible to determine its efficiency correctly.

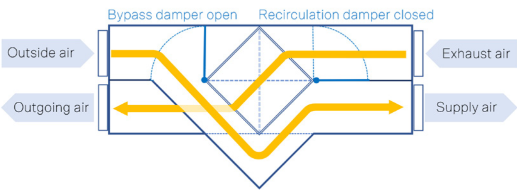
A: Bypass and recirculation dampers closed

HRU operation with closed bypass and recirculation damper.



B: Bypass damper open and recirculation dampers closed

If the bypass damper is open, the heat recovery unit is bypassed (this is ideal in summer, for example, when the exhaust air temperature is higher than the outside temperature).



C: Bypass damper closed and recirculation dampers open

If the recirculation damper is open, part or all of the exhaust air is fed back directly into the supply air (in winter, for example, in order to maintain the air humidity). In this case, the HRU's capacity is not fully utilised (no illustration).

Calculate the recovered waste heat

You can calculate the efficiency of the HRU on the basis of the various air temperatures. Percentages of waste heat recovered by a good HRU with a:

- Cross-flow heat exchanger: 65 percent
- Composite circulation system: 60 percent
- Rotary heat exchanger: 75 percent

$T_{\text{Outside air}} = 3\,°C$; $T_{\text{HRU}} = 16\,°C$; $T_{\text{Exhaust air}} = 21\,°C$

Efficiency $= (T_{\text{HRU}} - T_{\text{Outside air}}) / (T_{\text{Exhaust air}} - T_{\text{Outside air}})$
$= (16\,°C - 3\,°C) / (21\,°C - 3\,°C)$
$= 13\,°C / 18\,°C$
= 0,72 resp. 72 percent

Instead of T_{HRU}, you can also measure the temperature of the supply air (TSupply air). But in this case, you must make sure that neither the heating coil nor the air cooler are operating.

Optimise heat recovery

You can take these actions to optimise heat recovery:

- On the monobloc ventilation control or the building management system, set the HRU so that 100 percent of the exhaust air is routed via the heat exchanger.
- Make sure that the exhaust air is not routed past the HRU through the bypass. Check whether the bypass dampers are working and that they close tightly.
- Check whether the recirculation dampers are closing tightly.
- Check whether the icing protection is functioning correctly. Rule of thumb: a plate heat exchanger starts to ice up when the plate temperature falls below 0 °C.
- Check whether the heat exchanger is soiled and have it cleaned or clean it yourself if necessary. In this case, follow the manufacturer's instructions.
- If you do not find the cause of the fault, have the system inspected by a specialist.

Additional information

See the manufacturer's maintenance instructions.

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Comfortable, energy-saving air humidity at the workplace

Air in workplaces must be neither too dry nor too humid. Correct indoor air humidity settings always pay off, because a great deal of energy is required to humidify the air.

Action
Determine the actual air humidity in the room and select the optimal humidification setting for the supply air on the ventilation system.

Requirement
You have a ventilation system that humidifies the supply air and ensures a pleasant indoor climate.

What to do
Check the relative indoor air humidity on a cool and dry winter day when the outside temperature is below 4 °C. This will enable you to choose the optimum setting values for the supply air. The ventilation system must be in operation when you do this.

- Measure the air humidity in the rooms that you ventilate.
- If the relative air humidity (RH) is significantly above 35%, check the temperature and humidity in the exhaust air duct. If the relative air humidity is also too high here, adjust the humidification values on the ventilation unit so that the rooms are controlled to a relative air humidity of 30%.
- Check the relative air humidity in your rooms on the next day, and also one week after the optimisation. Correct the value on the ventilation unit as necessary.

Costs – effort
- A simple uncalibrated hygrometer costs between CHF 30 and CHF 40. A calibrated hygrometer is available from specialist trade outlets at prices starting from CHF 250.
- You will require about two to four hours of labour, depending on the number of rooms and ventilation units.
- If the air is humidified by an additional 5%, the energy required for humidification will increase by 40% to 80%.

Please note
- In physiological terms, an optimum relative air humidity value in winter is 30% or more. The value may also fall below this level for short periods.
- In cases where active humidification is unavoidable, the value should not exceed 45% RH. Also, please note the SIA recommendations.

Additional explanations

Example: conference centre

To take one example: optimisation of air humidity is particularly effective in a conference centre. If the supply air for the plenary hall is humidified at a constant value of 40% RH, a reduction to 30% RH can reduce the annual energy consumption for humidification by 42'000 kWh. This is because considerable volumes of air are humidified – in this example, the ventilation system conveys 50'000 m^3 of air per hour, and operates for 800 hours each year.

Use humidification for cooling

Consult a ventilation specialist to check whether adiabatic cooling by evaporation is possible and suitable with the existing humidification system. In this case, the supply air can be cooled down by several degrees Celsius with the humidification equipment, instead of using a mechanical cooler. This "evaporative cooling" is particularly suitable in the transition period, when the required cooling effect can be achieved with slightly increased air humidity.

Dry air at very low temperatures

If some ventilated areas are very dry during winter when outside temperatures are below 0 °C, you can manage to improve this by reducing the flow of supply air. Monitor the room air humidity constantly, and reduce the outdoor air flow by up to 50%. It may be necessary to adapt the control (with a second control circuit) for this purpose. Discuss the situation with your ventilation specialist.

Do you have individual rooms with high indoor air humidity requirements?

If there is a need for high indoor air humidity (e.g. 50% RH) in two or three of your rooms, it is not worth increasing the humidification of the whole supply air via the central ventilation unit. Instead, increase the air humidity in these rooms with plants (e.g. papyrus), water features (water walls, fountains, climate fountains, etc.) or with an efficient room air humidifier (evaporator).

Swimming pools and wellness pools/spas

In swimming pools and wellness pools/spas, the air in the facility must be constantly dehumidified during opening hours to provide a pleasant climate. But at night, when there are no guests in the pool or spa, the air humidity there can be increased to save energy.

The air humidity can be raised until condensation water forms on the component with the worst thermal behaviour (glass surfaces, corners, or poorly insulated steel beams). If you discover condensation water on these building components, the air humidity is too high and the set point must be lowered. Experience shows that in buildings where the "worst" building component has a U-value of 1,2 W/m^2K, the air humidity can be increased to as much as 65% at night without condensation forming.

Additional information

- Operational optimisation for energy efficiency – operating buildings more efficiently: reference book, 2021
- Building technology – integral system planning, reference book, 2022
- Energy efficiency in fitness and wellness facilities: the easy way to reduce your energy costs Information sheet 05: Ventilation
- Standard conditions of use for energy and building technology, Fact sheet 2024, SIA, 2015
- Air humidification Fact sheet for specialists in the ventilation industry, architecture and building services, SwissEnergy, 2016

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