# FORCED VENTILATION WITH DUPLEX RECOVERY UNITS

Barbora Paříková

CARA ACADEMY

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The lecture is a conversation between an architect and a specialist in ventilation with heat recovery, focused on the importance of quality air exchange in modern buildings. The discussion covers technical, health, and environmental aspects that are key to designing energy-efficient and climate-resilient buildings.

## .SUMMARY

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### Motivation

- Modern buildings are airtight (insulation, quality windows), so natural leaks disappear.
- $CO_2$, VOCs (formaldehyde, benzene, toluene, limonene), moisture, and dust accumulate indoors.
- Elevated $CO_2$ concentrations cause fatigue, drowsiness, headaches, and reduced concentration.
- Pollutants are generated even in the absence of occupants (off-gassing from materials), so ventilation is necessary then as well.
- Goal: a healthy and pleasant environment, higher occupant comfort.

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### Principle of operation

- Heat recovery = reclaiming energy from exhaust air.
- Warm and cold air pass across a membrane; they don't mix, they only transfer energy.
- Heating savings up to 34%; it does not replace the heating system.
- Works in summer too—"coolth" recovery reduces cooling costs.
- Control is crucial: $CO_2$ sensors or boost buttons improve efficiency and prevent unnecessary drying of the building.

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## Application in practice

- Placement options: wall-mounted units, ceiling-mounted units (slim, suitable even for retrofits), units behind a Geberit frame.
- Technical rooms must be sized for multiple technologies (boiler, water heater, heat pump, PV, water tank, heat recovery).
- Important: do not place indoor units in uninsulated spaces—risk of frequent electric post-heating activation and higher bills.
- In design, combining architecture and technology is essential—the right environment for the unit saves energy.
- Boost buttons: short-term performance increase during cooking or toilet use.

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## Adaptation to climate change

- Heat recovery is part of a package of measures (architecture + technology).
- Enables controlled ventilation without opening windows, beneficial in wind, heat, or when outdoor air quality is poor.
- Guarantees a set indoor environmental quality ($CO_2$, VOCs, humidity) without user intervention.
- With the right efficiency it can save up to 80% of the energy that would otherwise be lost with traditional window ventilation.
- In the future, broader use of apps is expected for individualized settings and control of heat recovery according to needs.

## .TRANSCRIPTION OF THE RECORDING

### 00:00:00

Hi Miro, today I came to talk with you about forced ventilation using recovery units. Thanks for having me.

### MOTIVATION

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NaTo start, just a brief outline of what we'll talk about. There should definitely be some motivation for installing ventilation (air-handling) in buildings. Ventilation as an energy saver. Is it possible? Not? Does it work? Implementing heat recovery in residential buildings—also an important topic. What does the future look like? And of course, quality control according to each of our needs. So let's continue. What should motivate the installation of ventilation? I'd first look at the types of buildings we're building today. We insulate, we use quality windows, and we seal the house from the outside. Because we no longer have direct airing or the micro-ventilation that used to happen through leaks, pollutants accumulate indoors. Those pollutants are carbon dioxide, VOCs, humidity, and of course dust.

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I'd pause here before we go on. What are VOCs?

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VOCs are volatile compounds released from materials. We'll certainly get to that on another slide. Carbon dioxide—definitely a hot topic in indoor environments—but it's a normal part of air. What's normal is a concentration around four hundred ppm in the air. We breathe that, we live with it, that's normal for humans. You'll find it in nature and in our surroundings. What can scare people is the concentration we exhale with each breath: up to forty thousand ppm. We all fill the air with that wherever we gather—at home with family, sitting in a doctor's waiting room, or shopping in a mall. We all exhale those forty thousand ppm; it won't be that concentration in the environment at that moment because it dilutes, and the overall concentration then begins to rise. What's actually harmful to health is five thousand ppm.

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At that point we should take action, and the standard changes that we notice—what bothers us and where we can feel it already at fifteen hundred ppm—are fatigue, drowsiness, lack of focus, etc. That already bothers us. From experience I can say that in a class of thirty children, the air reaches those fifteen hundred ppm within about ten minutes—quite fast. Currently across Europe, regulations are starting to lower the permissible concentration of $CO_2$, with a requirement to have at most twelve hundred ppm indoors. In the Czech Republic this is set by Decree 146/2024, and the Eurovent association is also dealing with this intensively.

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To talk about volatile compounds—the so-called VOCs—these are substances all around us: notably formaldehyde, benzene, toluene, limonene. Where can you encounter them? We all live somewhere, go to work, are surrounded by furniture, or we renovate, buy new things, buy a new car—lots of plastics. All those volatiles I mentioned are released from those items. Limonene is a typical additive in plastics so they don't smell bad but "smell pleasant" to the customer. That's why we smell what we smell in cars. What you smell when you buy an appliance—that's limonene. Just so you know how to recognize a volatile; the air becomes saturated with these substances as they evaporate. So not only $CO_2$, but also those volatiles are released and fill the air we breathe.

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They bother us without our realizing it. That's why we need to ventilate—because we don't want to be "poisoned" by those substances. We want a quality environment. We don't want headaches. We don't want to be sleepy at work; we want to perform. At home we want comfort; we want to feel good. That's the reason and motivation to ventilate. $CO_2$ is produced by people through breathing, whereas volatile compounds are produced continuously through off-gassing. Therefore we need to ventilate even when people are not present. We don't have to ventilate at full power all the time; we can ventilate cyclically; we can pre-ventilate the space when we know we'll be back home; we can set up pre-ventilation. It all comes down to configuring the ventilation in the building. We should plan for this and ventilate even when we're away to prevent—

## PRINCIPLE OF FUNCTION

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—the presence of volatile compounds. Ideal indoor humidity is forty to fifty-five percent. The source is water vapor produced by people—cooking, bathing, any household activity. Due to intensive ventilation in winter, indoor humidity drops. That's why it's good to ventilate according to the needs of the specific environment/household. I'd like you to know that in addition to $CO_2$ and volatile compounds, air around us also contains viruses, bacteria, various fungi, pollen, molds, smoke, soot, etc. What you see on the slide are concentrations typical in our environment. These factors also affect the indoor environment we want at home. Ventilation as an energy saver. Imagine a single-family house: the yellow part of the graph shows the building's heat losses. Ventilation can reduce heating costs by thirty-four percent. Energy recovery—heat recovery. Air streams pass through a heat-recovery exchanger and transfer energy across membranes. The air streams don't mix; they only meet.

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Coolth recovery: in summer we can help the building by recovering "coolth." If we intake hot summer air above thirty degrees, thanks to the air streams meeting (without mixing) with the exhaust air from the occupied space, we can lower the supply air temperature into the building. This helps reduce cooling costs. I want to emphasize that ventilation with heat recovery doesn't cover the building's heat losses and doesn't replace the heating system. How are units applied in residential buildings? Today there are several options. Units can be hung on a wall—as you see on the slide—or installed in ceiling voids. Ceiling-mounted recovery units are now made very thin,

## APPLICATIONS

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so the required void isn't large—they can be only twenty centimeters high. If you don't have space in apartment-building cavities, you can install them under the ceiling in your technical room. Or, more recently, it's possible to place units behind a Geberit frame to save space. This is suitable for retrofits as well.

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I'd like to show you how a technical room can be configured in a family house. I'll take a quick step back in time—what the requirements used to be and what they are today. In the past a water heater and a boiler were enough; that was all the technology, and a very small technical room—or none—sufficed. Today houses are full of technologies: we will ventilate, we will cool, we'll have heat pumps, photovoltaics, we need a water tank. We must keep this in mind when designing houses. The technical room must be adequate. To help visualize dimensions, I've inserted a picture so you can see how to design the technical room.

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I'd add that one should approach the technical room by first clarifying which technology will be used, roughly how it—

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Mm-hmm.

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—can be arranged, what spatial demands each technology has—and then design the technical room accordingly, so it's not unnecessarily—

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—large. Yes. A slide for a little laugh. I want to show cases of how ventilation is applied in ways that aren't good—or where it's not suitable. On the slide you can see a recovery unit installed in an attic, but if you look closely, you'll find the space is uninsulated. What does that cause? The regular user won't notice a difference because the unit will work, it will heat properly, etc., but since the space is cold, it has to post-heat more than if the space were insulated. So when choosing the technical room location, pay attention to the environment where you place it. It's about the energy that the investor will continue paying for.

**00:13:57**
 So in this case, with an uninsulated attic, the ventilation—or heat-recovery—unit contains an electric post-heater—

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 Yes.

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 —which will switch on regularly. The person will still get the airflow they requested—

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 Yes.

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 —and the temperature they require—only they won't know until the electricity bill arrives that it was heating electrically the whole time.

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 Exactly.

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 And there's one more point: these are ventilation units intended for interiors—

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 Yes.

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 —that is, for insulated spaces. If someone wants to install one in an uninsulated attic, they should choose a unit intended for outdoor use, because there are units designed for the exterior as well.

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 Yes. After installing a ventilation unit, it's good to focus on control. It's not ideal to keep the recovery unit running constantly; it should be controlled. The ideal control uses $CO_2$ sensors or boost buttons. The intensity and control will help reduce pollutant concentrations while maintaining a pleasant climate and humidity.

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 And the intensity should be optimal because it saves energy when we don't over-ventilate—

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 Right.

**00:15:29**
 —and when we over-ventilate, two things happen: high energy consumption and drying out of the building.

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Yes, exactly.

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Please explain what boost buttons are.

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Boost buttons are used to quickly increase the ventilation rate. For example, when you're cooking and need more intensive extraction, or in the toilet. Typically, boost buttons are installed in toilets or near cooktops/hoods. They can be part of a switch. It's what you know from classic bathrooms—when you turn on the light and the fan starts. The recovery unit can work the same way; the extract is increased for that specific space.

## ADAPTATION TO CLIMATE CHANGE

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With some timing—

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Yes, with a set interval and run-on time—just like traditional fans. Adaptation to climate change. First, it's a set of measures that must go together. Architecturally: shading (external and internal), thermal mass for coolth storage, greenery in and around the building, cooperation with landscape designers. And then the technology part, which is very important and which we're discussing—ventilation with heat recovery belongs here. The key takeaway from this slide is that this is a set of measures—

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Yes, that—

**00:17:16**
—Architecture and technology.

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—Technology. In other words, heat recovery itself isn't a single "salvation" technology—it's part of a larger whole.

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Exactly. The future of ventilation in residential buildings. Based on energy security, we must minimize energy needs—that's essential. We all want that. If we don't have enough electricity or any energy, we want something that helps reduce demand. Heat recovery is part of that, because with high recovery efficiency it saves eighty percent of the energy—

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—Eighty percent of the energy we'd otherwise lose by opening a window and then having to reheat.

**00:18:20**
Right. Yes, it's a heating saving. Another point I'd like to mention is quality and controlling that indoor air quality through a single intake. If I can control it at one intake—that is, the unit's intake—I can monitor indoor quality. I have sensors monitoring pollutant concentrations. I have filtration there. I deal with one intake into the building—not ten open windows. For me, it's—

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—That wouldn't even be manageable, because with one intake I can control airflow rate and I can install a filter there. But if I open ten windows, I can't put filters on ten windows, so the indoor air will be only as good as the outdoor air nearby; if that degrades, indoor quality degrades too.

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Yes, that's right. With climate change the outdoor environment is changing; we're facing strong winds that didn't used to be as common. So when I ventilate with a recovery unit, I can keep windows closed—sealing the building as protection against strong winds or other unpleasant weather we're starting to face—yet I still ventilate and have quality air. And as we said several times, I can control the indoor environment. I can manage it; I can set ventilation according to whether guests have arrived. Today, recovery units have their own apps and allow the client to adjust settings to what they're doing. I have visitors—I increase the rate. Conversely, when I'm away, I can reduce the rate or set just cyclic airing. That's the advantage of ventilation technology,

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which I couldn't influence without installing it.

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I'd add that if the goal of climate adaptation is to ensure or improve quality of life and environment despite climate change, then the logic is this: this technology lets you set, say, 1200 ppm, yes? Set thresholds for volatiles so everything switches automatically—so the person, without any intervention, knows that indoor air quality is guaranteed as expected. In this case, we're talking about indoor air quality as the person wants it.

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Yes, exactly. You understood me correctly. Thank you.

**00:21:38**
You explained it well.