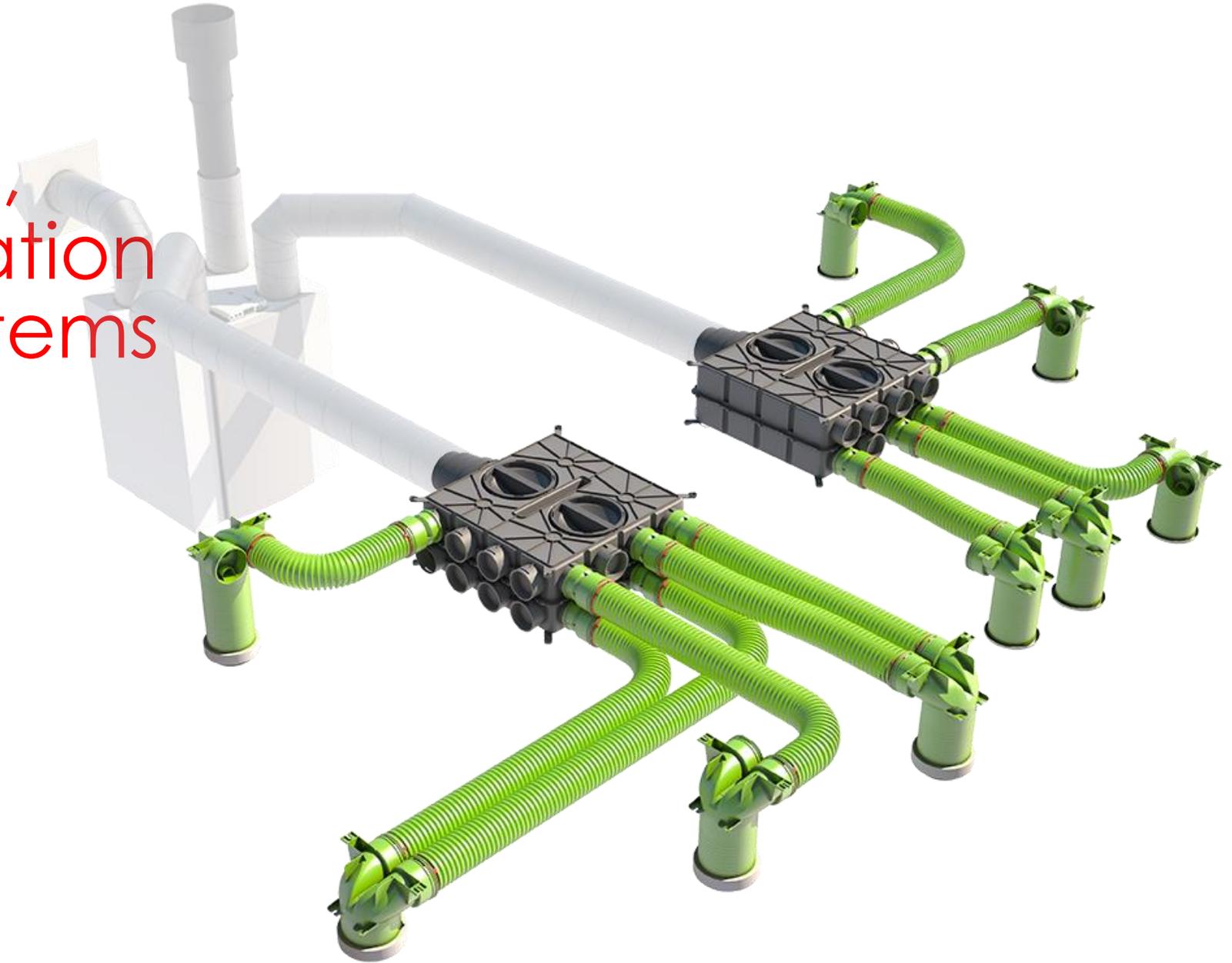


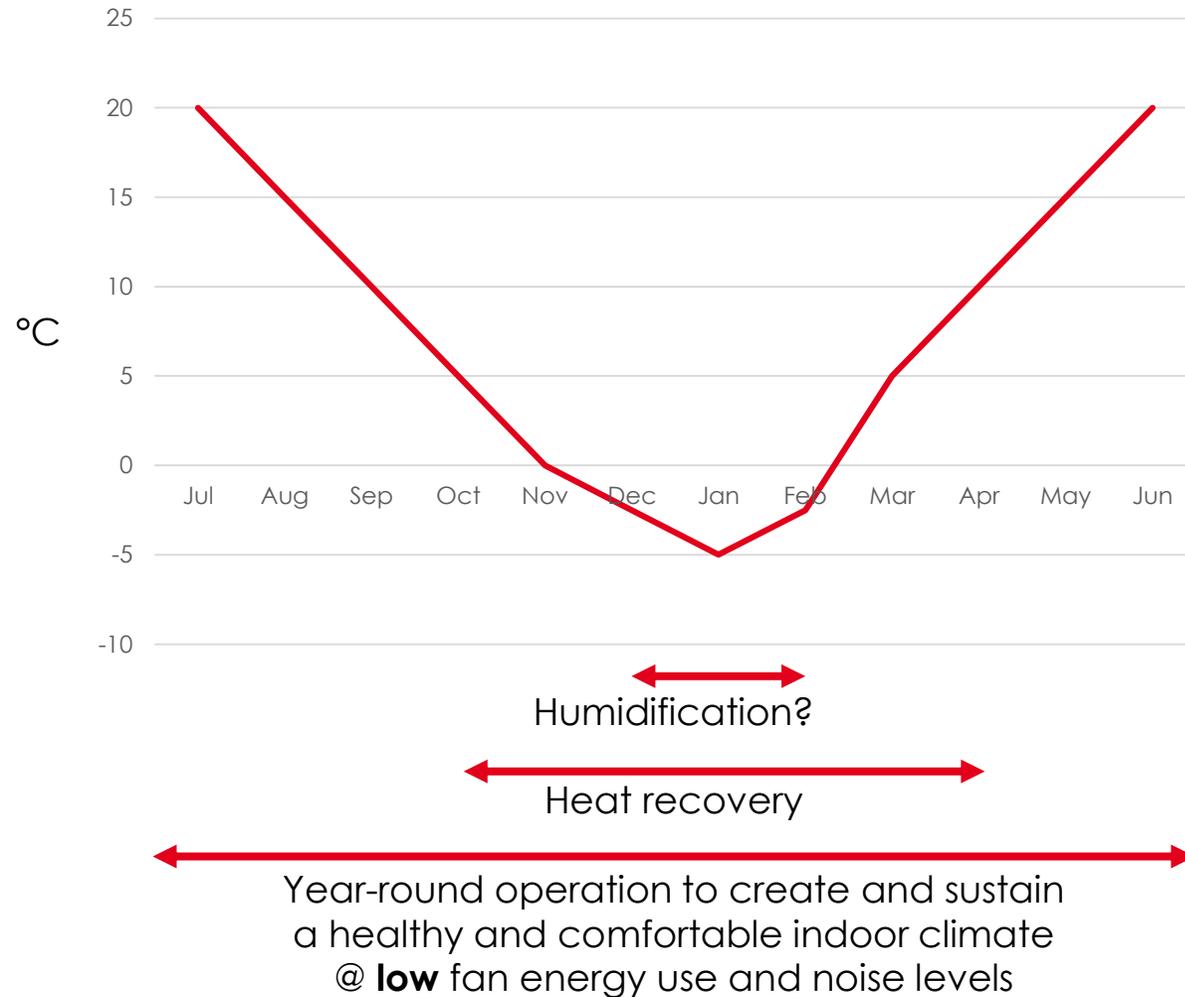
High-
performance,
plastic ventilation
ductwork systems
for residential
buildings



THE IMPORTANCE OF PURPOSE-PROVIDED VENTILATION

- Ventilation systems, including their ductwork, are an **integral part of the building fabric** and should be treated as such however cheap they may be compared to the total cost of the building
- Certainly as building fabrics are becoming progressively air-tighter because air infiltration can no longer **create and sustain a healthy IAQ in the occupied rooms**
- Which means that **purpose-provided** ventilation is now needed
- Purpose-provided ventilation comes in various forms, but often means **continuous, central and mechanical, which in turn means ventilation ductwork systems**

THE IMPORTANCE OF CENTRAL MECHANICAL VENTILATION WITH ENERGY RECOVERY IN COLD(ER) CLIMATES

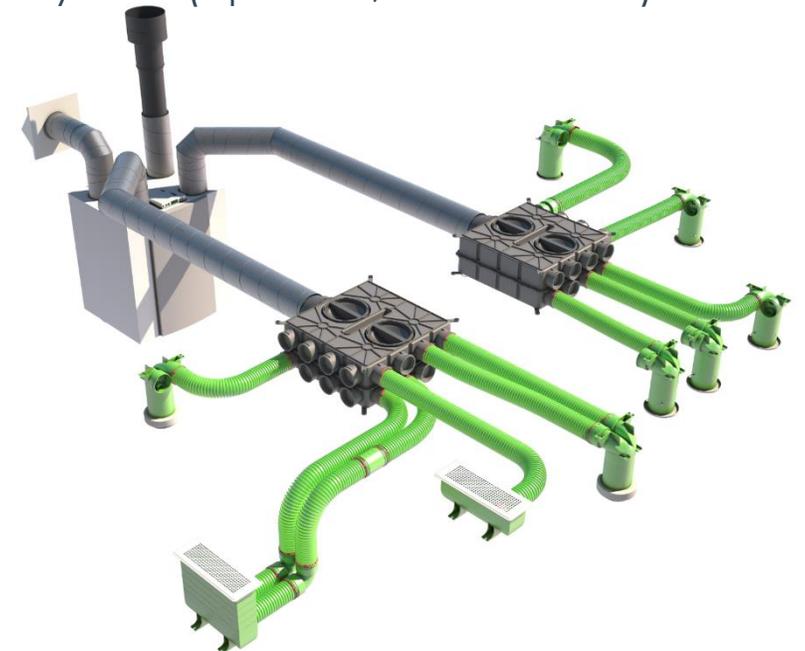


WHAT IS VENTILATION DUCTWORK?

- Ductwork is a system or network of ducts, i.e. not just 'plastic pipes', but in fact everything needed to distribute air except the ventilation unit itself
- High-performance ductwork will help ventilation units perform just as well as their manufacturers claim they will
- The installed **performance gap** (if the ventilation unit uses more fan energy and makes more noise than claimed by the manufacturer) is often the result of poor quality and/or poorly designed and installed ductwork

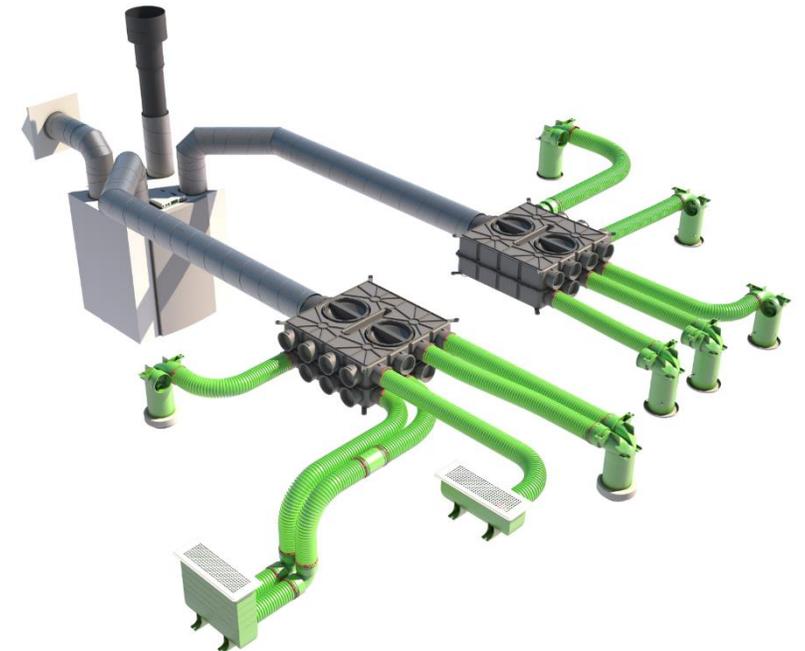
VENTILATION (DUCTWORK) SYSTEM COMPONENTS: You're only as strong as your weakest link

1. Roof and/or wall terminals, which penetrate the building fabric
2. Air-tight seals in warm loft spaces to keep the building fabric air-tight
3. Often insulated mass flow ductwork (DN \geq 125mm) between the terminals and the ventilation unit
4. Ventilation unit
5. Sound attenuators between the ventilation unit and the air distribution system (optional, but advised)
6. Air distribution system
7. Supply and/or extract valves



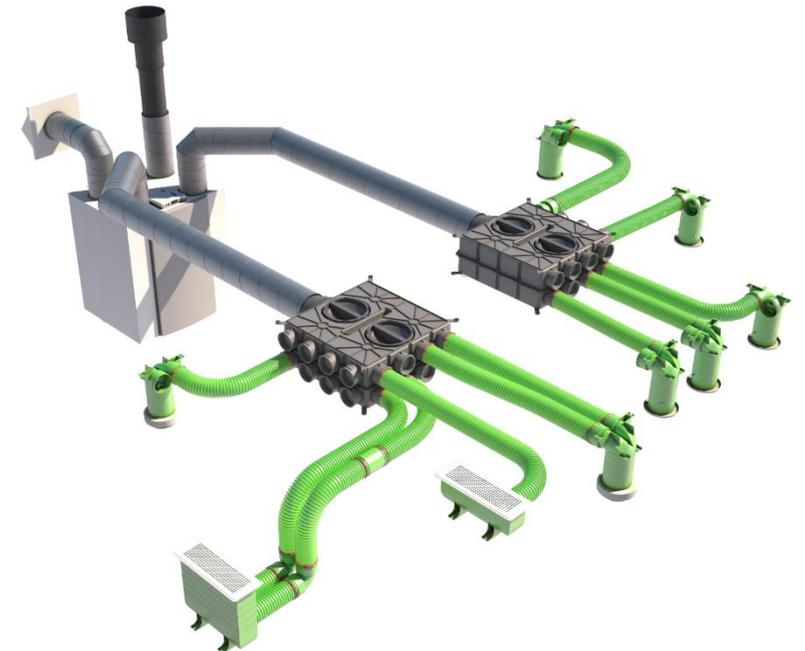
CHARACTERISTICS OF HIGH-PERFORMANCE VENTILATION DUCTWORK SYSTEMS

- Low air velocity
 - To minimise sound production
- Low system pressure loss
 - To minimise energy use and sound production
- Air-tight
 - To minimise energy use and sound production
- Insulated (if necessary)
 - To minimise the risk of condensation
- Minimal transfer of sound/noise between rooms
- Easy, quick, safe and clean installation
- Commissioned correctly
- Healthy and safe
- Easy to clean



INTRODUCING UBBINK'S VENTILATION DUCTWORK SYSTEM

- Roof terminals: Ventus and Ventub
- Air-tight seals
- Insulated mass flow ductwork: Aerfoam
- Air distribution system: Air Excellent
- Extract and supply valves: Haelix

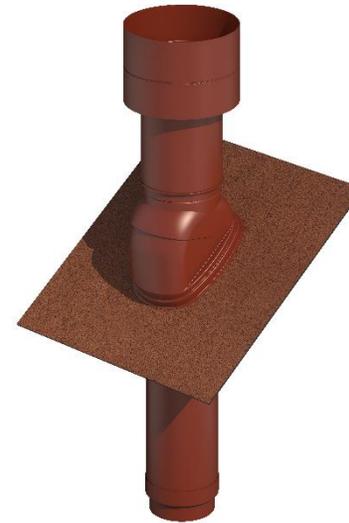


UBBINK ROOF TERMINALS: VENTUS & VENTUB

- Ubbink offers a wide range of both uninsulated and insulated roof terminals in various diameters (125, 160 and 200mm) and colours (black, red and terracotta) for both pitched and flat roofs with waterproofing for most roof coverings



Ventus



Ventub



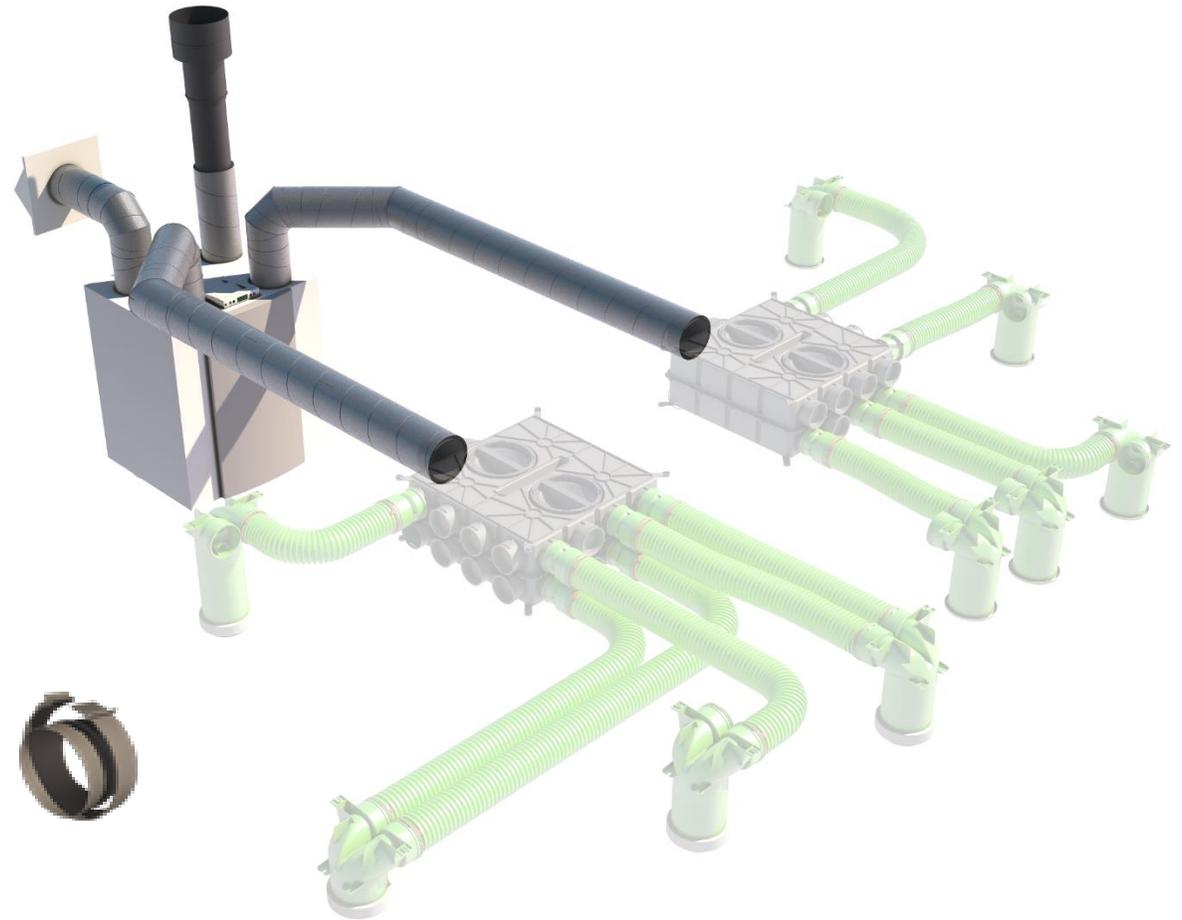
UBBINK AIRTIGHT SEALS

- Ubbink offers a wide range of both screw-fix and self-seal airtight seals to keep the building fabric air-tight



UBBINK AERFOAM

- 125, 150, 160, 180 and 200mm
- Material: EPE
- Thickness: 16mm
- Thermal conductivity (EN 12667): 0.041 W/m.K
- Airtightness (EN12237): Class D ≤ 200 Pa
- Reaction to fire (EN13501): class E
- EPD certified

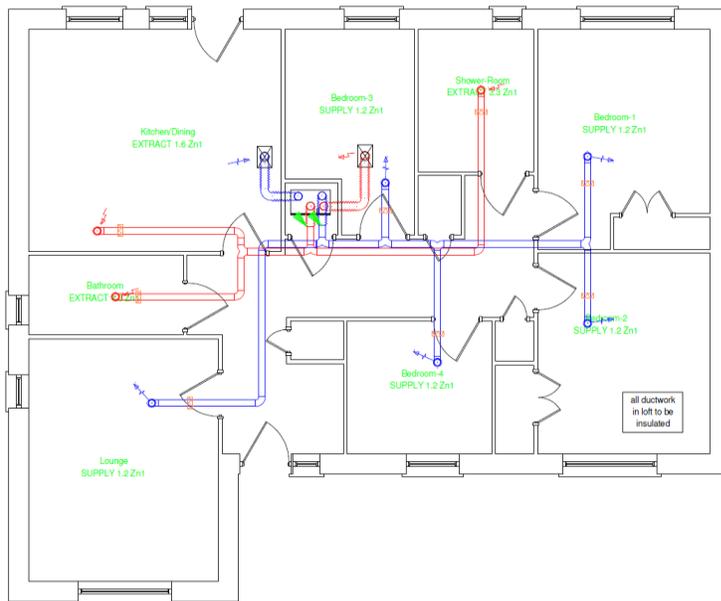


AIR DISTRIBUTIONS SYSTEMS

- There are two common air distribution system designs used with/for central mechanical ventilation units with heat and/or cold recovery (MVHR) in domestic buildings:

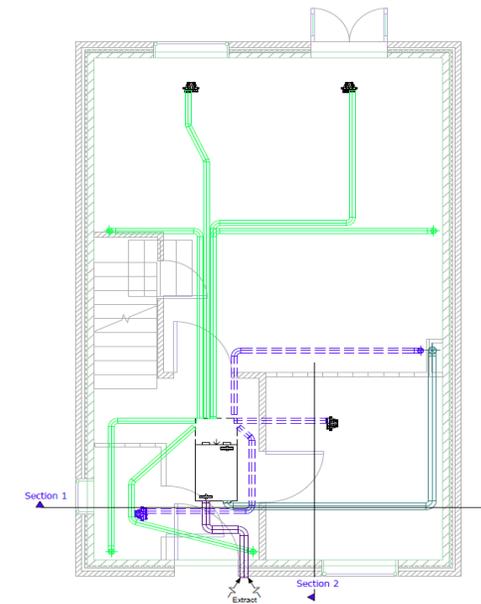
Trunk & branch

Typically with metal or rigid plastic ductwork



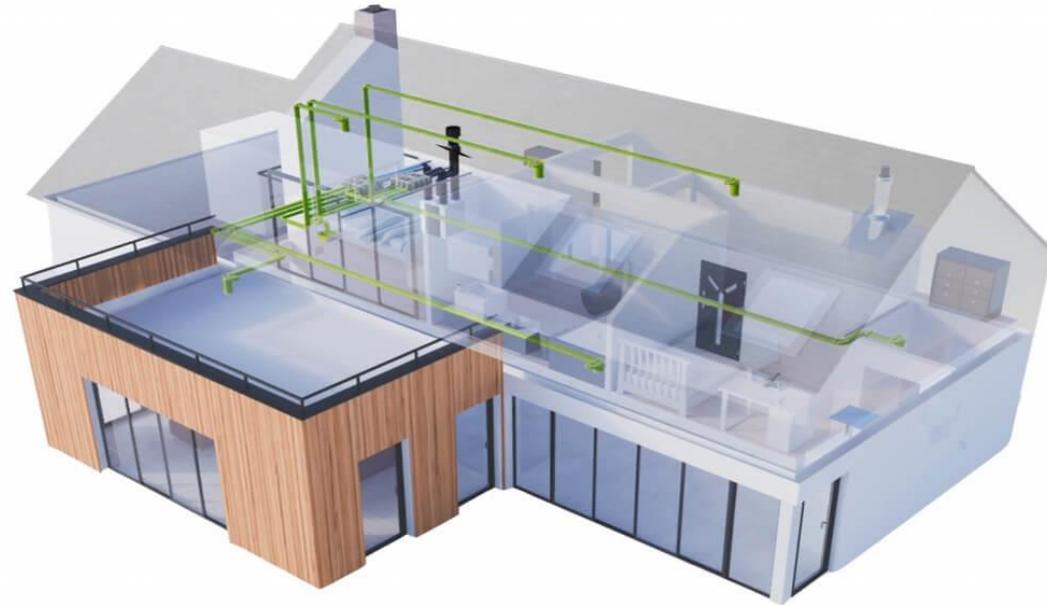
Radial

Typically with distribution boxes and semi-rigid plastic ducts



UBBINK AIR EXCELLENT

- Air Excellent is radial air distribution system with plastic distribution boxes and semi-rigid (bendable, but not flexible) plastic ducts
- <https://www.youtube.com/watch?v=XpUacNV3KiM>



UBBINK AIR EXCELLENT DISTRIBUTION BOXES

- Distribution boxes for all domestic mass flow duct diameters (125, 150, 160 and 180mm) and all Air Excellent duct types
- Videos:
 - 800 series: <https://www.youtube.com/watch?v=lef6D7Ao5A0>
 - 200 series: <https://youtu.be/ZcFaAUCRtI8>



UBBINK AIR EXCELLENT DUCTS

- 6 duct types with airtight mechanical connections and a wide range of accessories for all domestic applications:
- Circular
 - AE23C (63/50mm) = 23 m³/h @ 3 m/s
 - AE34C (75/63mm) = 34 m³/h @ 3 m/s
 - AE48C (90/75mm) = 48 m³/h @ 3 m/s
- Semi-circular
 - AE35SC (100x50mm) = 32 m³/h @ 3 m/s
 - AE45SC (140x50mm) = 47 m³/h @ 3 m/s
 - AE55SC (130x60mm) = 55 m³/h @ 3 m/s



AIR EXCELLENT DUCTS

- 'It's easy to change the fan or PCB in a MVHR unit, but the last thing you ever want to have to do is to change the ducts'
- Made in Germany
- With or without Anti-microbial resistance (TUV/Isega tested and certified)
- Do **not** emit volatiles (TUV tested and certified)
- Do **not** contain hazardous substances (REACH compliant)
- Anti-static (TUV tested and certified)
- Only virgin raw material used, i.e. not recycled, to guarantee consistent high quality and longevity (TUV tested and certified)
- High-density PE outer layer, low-density PE inner layer
- Inner layer tolerance to allow bending without fracturing
- E.g. AE34c; (75/63) weight 308 g/m, ring stiffness 7,85 kN/m² (TUV tested and certified)
- UV-protected packaging; not only around, but also on top of and underneath the ducts



UBBINK AIR EXCELLENT TUV CERTIFICATION

- Highlights:
 - **System** airtightness (EN12237): Class D/ATC2 for AE23c, AE34c, AE48c, AE35sc and AE55sc and class C/ATC3 for AE45sc at the following +/- test pressures: 50, 100, 150, 200, 250, 300, 400, 500, 1,000 and 2,000 Pa;
 - Operating temperature: -20 – +60°C;
 - Reaction to fire (EN13501-1): Class E;
 - Resistance to external pressure: 200mm of concrete;
 - Sagging: supports advised every 2m;
 - Anti-Microbial resistance as tested and certified by ISEGA;
 - Anti-static: $< 10^{12}\Omega$;
 - No emissions of volatiles.
- Ubbink products are also REACH compliant, i.e. they do not contain hazardous substances
<https://echa.europa.eu/regulations/reach/understanding-reach>



AIRTIGHT DUCTWORK SYSTEMS = WIN, WIN, WIN

- Ductwork systems are perfectly airtight on the screen or paper, but not installed
- If a ductwork system leaks, then the fans have to work harder to overcome the leakage and ventilate the rooms at the design/hygienic flow rate
- The higher the flow rate, the higher the pressure loss = more fan energy use and sound production
- High-performance ductwork systems, like Aerfoam and Air Excellent, are airtight so that the fans don't have to work harder than is necessary to ventilate 'right', i.e. in the rooms

AIRTIGHT DUCTWORK SYSTEMS = WIN, WIN, WIN; THE SCIENCE

Impact of ductwork leakage on the fan energy use and sound production of central mechanical ventilation units in houses

Valérie Leprince^{1*}, Marcus Lightfoot², Jelmer de Jong³

*1 PLEIAQ
84 C Av de la Libération
69330 Meyzieu, France*

**Corresponding author: valerie.leprince@pleiaq.net*

*2 Ubbink - Centrotherm
Verhuellweg 9
6984 AA Doesburg, the Netherlands*

*3 Brink Climate Systems
Wethouder Wassebaliestraat 8
7951SN Staphorst, the Netherlands*

DUCTWORK LEAKAGE AND FAN ENERGY USE

- The **fan power** scales with the flowrate multiplied by the pressure at the fan

$$P_{el} = \frac{\Delta P * Q}{\eta * 3600}$$

- The higher the flow rate, the more power is needed
- The higher the pressure drop, the more power is needed

DUCTWORK LEAKAGE AND FAN ENERGY USE

- **Pressure loss** in a ductwork system is the sum of the friction and dynamic losses

$$\Delta p = \left(\frac{1000f}{D_h} + \sum C \right) \left(\frac{\rho V^2}{2} \right)$$

- The pressure loss in a ductwork system is also proportional to the square of the flow rate
- The higher the flow rate (to overcome leakage), the higher the pressure loss
- Therefore, the fan needs to work harder and will use more energy to overcome the leakage and additional pressure loss to maintain the hygienic flowrate at the valves in the habitable and wet rooms

IMPACT OF DUCTWORK LEAKGE ON THE FAN ENERGY USE OF MVHR

	House 1	House 2	House 3
Hygienic flowrate (m ³ /h)	225	225	300
Required pressure at ATD's (Pa)	10	10	10
Ductwork area of each airflow m ²	14.72	9.36	23.6
Pressure drop in ductwork (without leakages) (Pa) for each airflow	100	100	150

Required flowrate of each fan (m ³ /h)			
	House 1	House 2	House 3
3*Class A	286	264	424
1.5*Class A	256	245	362
Class A	245	238	341
Class B	232	229	314
Class C	227	226	305
Class D	226	225	302
No leakage	225	225	300

With leaky ductwork

60-122 m³/h extra with leaky ductwork

With Air Excellent

Required pressure at each fan (Pa)			
	House 1	House 2	House 3
3*Class A	172	148	309
1.5*Class A	139	128	228
Class A	129	122	204
Class B	116	114	174
Class C	112	111	165
Class D	111	110	162
No leakage	110	110	160

With leaky ductwork

61-145 Pa extra With leaky ductwork

Air Excellent

IMPACT OF DUCTWORK LEAKGE ON THE FAN ENERGY USE OF MVHR

- Fan energy use with class D/ATC2 airtight ductwork systems is 36% to 63% lower than with 3* class A airtight ductwork systems
- And that's a considerable saving over the life cycle of the ventilation (ductwork) system and we should be assessing buildings and their services like this; not just the purchase price of a PE duct/m

Annual energy use of both fans (kWh)				
	House 1	House 2	House 3	
3*Class A	888	703	2359	With leaky ductwork
1.5*Class A	641	565	1488	
Class A	571	523	1255	438-1,481 kWh wasted per year with leaky ductwork
Class B	485	471	984	
Class C	459	454	904	
Class D	450	449	878	With Air Excellent
No leakage	446	446	865	

SOUND PRODUCTION

- The higher the flow rate and pressure loss, the harder the fan has to work and the more sound (power) it will produce

- In the room

$$L_p = L_w + 10 * \log\left(\frac{Q}{4\pi r^2} + \frac{4}{A}\right)$$

- Where

- L_p [dB(A)] = sound pressure in the room
- L_w [dB(A)] = sound power after the distribution box
- $Q = 2$; coefficient depending upon the angle of rotation
- $R = 1.5$; distance to source
- $A = 20\text{m}^2$ for a living room, 8.5 m^2 for a bedroom; reference sound absorption area

IMPACT OF DUCTWORK LEAKGE ON SOUND PRESSURE LEVEL OF MVHR

- The sound pressure level in the habitable rooms is much lower with class D/ATC2 airtight ductwork systems than with 3x class A airtight ductwork systems

Leaky ductwork Air Excellent

	House 1		House 2		House 3	
	3*Class A	Class D	3*Class A	Class D	3*Class A	Class D
Required flowrate (m ³ /h)	286	226	264	225	424	302
Required pressure (Pa)	172	111	148	110	309	162
Sound power to dwelling (dB)	78.7	73.1	75.5	73.1	80.4	78.7
Sound power to dwelling with A correction and silencer dB(A)	43.9	38.5	41	38.5	46.8	43.9
Sound power to each room (- 6dB)	37.9	32.5	35	32.5	40.8	37.9
Sound pressure in bedrooms dB(A)	35.2	29.8	32.3	29.8	38.1	35.2
Sound pressure in living rooms dB(A)	32.2	26.8	29.3	26.8	35.1	32.2

<30 dB(A)	Quiet
30-35 dB(A)	Audible sound
>35 dB(A)	Loud

- Measured according to ISO 5135 for Brink's MVHR unit Renovent Excellent 400 (data provided by the manufacturer)
- Sound attenuator = Brink's ISO AKS 1m, DN160mm (data provided by the manufacturer)

HOW DOES UBBINK AIR EXCELLENT ACHIEVE CLASS D/ATC2 AIRTIGHTNESS?

- By using purposed-designed **mechanical connections** =
 - Easy, quick, safe and clean installation, i.e. **without** 'screw and glue' and/or adhesive tape
 - Reproduceable high quality/airtightness even for inexperienced installers
- The below plastic connection mechanisms are class D/ATC2 (according to EN12237) airtight up to system pressures of +/- 2,000 Pa and can be installed in a few seconds!
- Semi-rigid plastic mechanical connections:
 - <https://youtu.be/FblwGRJ97Zs>



UBBINK HEALIX SUPPLY AND EXTRACT VALVES



COMMISSIONING

- **All** high-performance ventilation/ductwork systems **are** commissioned correctly
- Commissioning can be simplified, speeded-up and not require calibrated instruments and skilled labour by using airflow restrictors in the manifolds, which also means that end-users cannot decommission the system by fiddling with the supply and extract valves
- Such instruments offer the opportunity of off-site commissioning in modular and/or prefabricated buildings and those buildings designed in 3D



UBBINK AIR EXCELLENT COMMISSIONING TOOLS

- Used to calculate how many rings to cut out of the dbox internal air flow restrictors in the distribution box to set the flow rate in each duct run
 - Online: total system pressure drop, but time consuming
 - Offline: pressure drop in Air Excellent system only, but quick

Ubbink Centrotherm group Air Excellent Calculator [Login](#)

Step 1 Step 2 Step 3 Step 4 Step 5 Results

Room definitions for Air Supply and Air Extract

Enter information of all rooms according to the building plan. This has to be name and intended v to get the complete system into balance.

Air Supply

Create room Living room

Create room Master bedroom

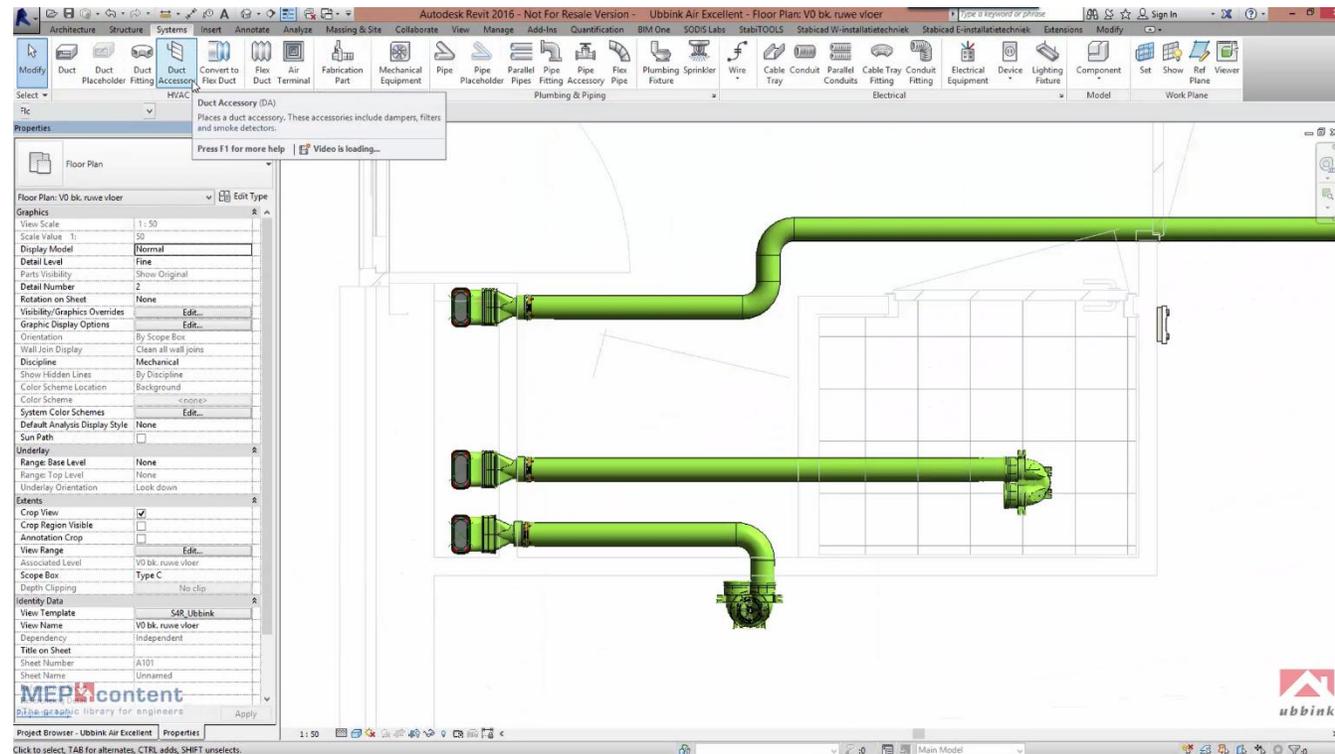
Create room Bedroom 1

Room name	Value [Pa]	Flow rate [m³/h]	Guaranteed pressure loss [Pa]	Ubbink valve	Ubbink valve adaptor	Duct length [m]	No. bends [B]	Vert. bends [B]	Dbox adaptor	Restrictor setting	dp [Pa]	Flow rate check
200 SUPPLY	Living room	1	50	HÆLIX RONDO (setting 0)	2 x AE 34C Valve ADP 90°	12,5	2	2	AE 34C DBOX Adp	5 rings removed	60	●
	Living room	2	30	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	12,5	2	2	AE 34C DBOX Adp	10 rings removed	63	●
	Study	3	30	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	10		1	AE 34C DBOX Adp	5 rings removed	61	●
	Master bedroom	4	40	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	5		1	AE 34C DBOX Adp	no restrictor	63	●
	Bedroom 2	5	25	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	2,5		1	AE 34C DBOX Adp	no rings removed	48	●
	Bedroom 3	6	25	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	2,5		1	AE 34C DBOX Adp	no rings removed	48	●
		7								no restrictor	0	●
		8								no restrictor	0	●
		9								no restrictor	0	●
		10								no restrictor	0	●
200	Kitchen	1	50	HÆLIX RONDO (setting 0)	2 x AE 34C Valve ADP 90°	12,5	2	2	AE 34C DBOX Adp	no restrictor	49	●
	Kitchen	2	25	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	10		2	AE 34C DBOX Adp	4 rings removed	47	●
	WC	3	25	HÆLIX RONDO (setting 0)	AE 34C Valve ADP 90°	7,5		2	AE 34C DBOX Adp	2 rings removed	49	●
	Ensuite	4	50	HÆLIX RONDO (setting 0)	2 x AE 34C Valve ADP 90°	5		1	AE 34C DBOX Adp	3 rings removed	45	●

Restrictor calculation

UBBINK AIR EXCELLENT IS BIM READY

- Ubbink ventilation ductwork can be designed in 3D using Revit/IFC files



EN STANDARD FOR NON-METALLIC VENTILATION DUCTWORK

- **EN 17192** Ventilation for buildings –Ductwork–Non-metallic ductwork–Requirements and test methods
 - Not EN 61386-24:2010, which replaced EN 50086-2-4:1994 –Specification for conduit systems for cable management. Particular requirements. Conduit systems buried underground
- The above EN ventilation ductwork standard is not harmonised (yet) so CE marking is not required/possible (yet)

CONCLUSION

- Airtight (plastic) ventilation ductwork **CAN** contribute to a carbon-neutral continent
- Just imagine ...
 - **WIN** – minimal (primary) energy use for many years
 - **WIN** – minimal sound production/noise hindrance for many years
 - **WIN** – great IEQ for for many years
- Who doesn't want this?



ubpink

Build smart.