



**REHAU**  
QUALITY ENERGY  
EFFICIENCY

## REHAU ECOAIR™ GROUND-AIR HEAT EXCHANGE SYSTEM

THE ENERGY-EFFICIENT FRESH AIR SOLUTION



## IMPROVED VENTILATION, LOWER ENERGY COSTS

### IT'S A BREATH OF FRESH AIR!

With today's tight building envelopes, it is often necessary to bring in outdoor air to ensure good indoor air quality. A gentle breeze wafting through an open window first comes to mind. It's the symbol of health and comfort, until you realize that fresh air brings with it heat, cold and humidity, which detract from a building's efficiency and introduce allergens into the living environment.

The REHAU ECOAIR ground-air heat exchange system supplies fresh air without these drawbacks. The system takes advantage of the more moderate and relatively constant ground temperatures to precondition incoming fresh air, reducing heating and cooling costs. It also filters the air and can lower the relative humidity.

So, build your energy-efficient, airtight building, and take a breath of fresh air – renewable, preconditioned fresh air from REHAU ECOAIR.

# GROUND-AIR HEAT EXCHANGE

## CAPITALIZING ON THE EARTH'S ENERGY

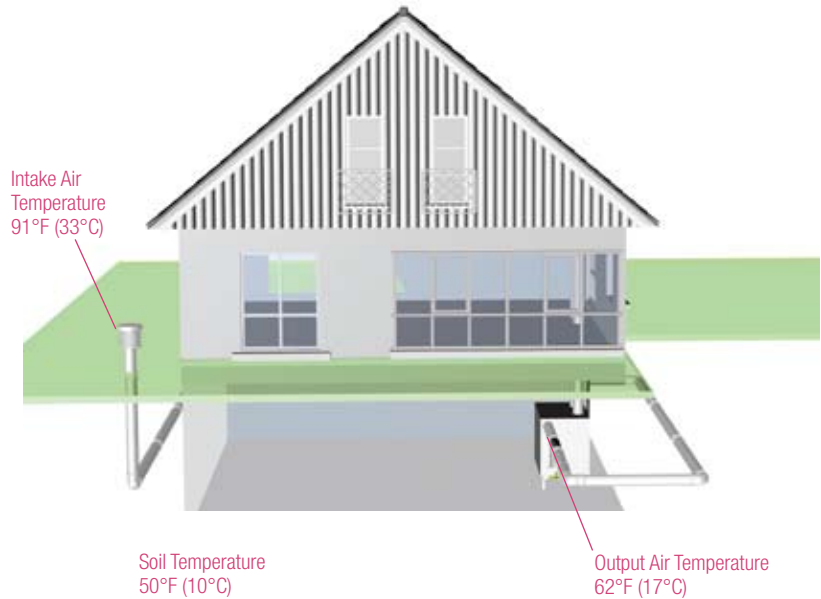
Controlled ventilation is becoming a necessity in modern, airtight buildings to ensure good indoor air quality. By taking advantage of the earth's energy, a ground-air heat exchange system enhances the efficiency of a building's fresh air ventilation system.

### Geothermal Energy Reduces Heating and Cooling Costs

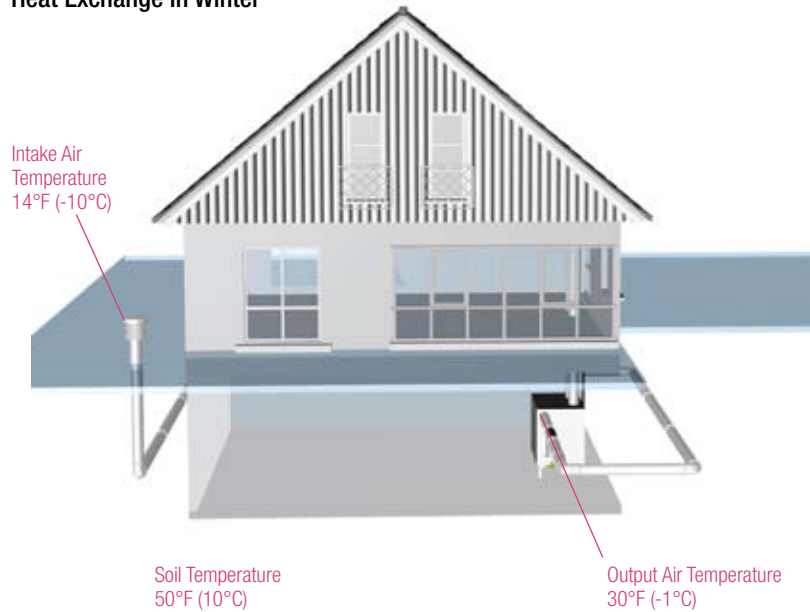
At 5 to 7 ft (1.5 to 2 m) below the earth's surface, ground temperatures remain relatively constant throughout the year. As incoming air passes through the underground pipes, it is pre-warmed with ground heat in winter and pre-cooled with cooler ground temperatures in summer. For example, in mid-latitude where ground temperatures range from 45°F-54°F (7°C-12°C), it is possible to reduce the intake air temperature by up to 29°F (16°C) in summer and to raise the intake air temperature by up to 16°F (9°C) in winter.

By narrowing the gap between outdoor temperatures and comfortable indoor temperatures, a ground-air heat exchange system significantly reduces the amount of additional energy required to heat or cool the building. The system requires only a small amount of electrical power to operate an air intake fan and provides significant energy cost savings, especially when used in conjunction with heat or energy recovery ventilators (HRV or ERV). It can also allow downsizing of heating and cooling equipment particularly in larger buildings, and may replace the need for an air conditioning unit in residential buildings in some climates.

### Heat Exchange In Summer



### Heat Exchange In Winter



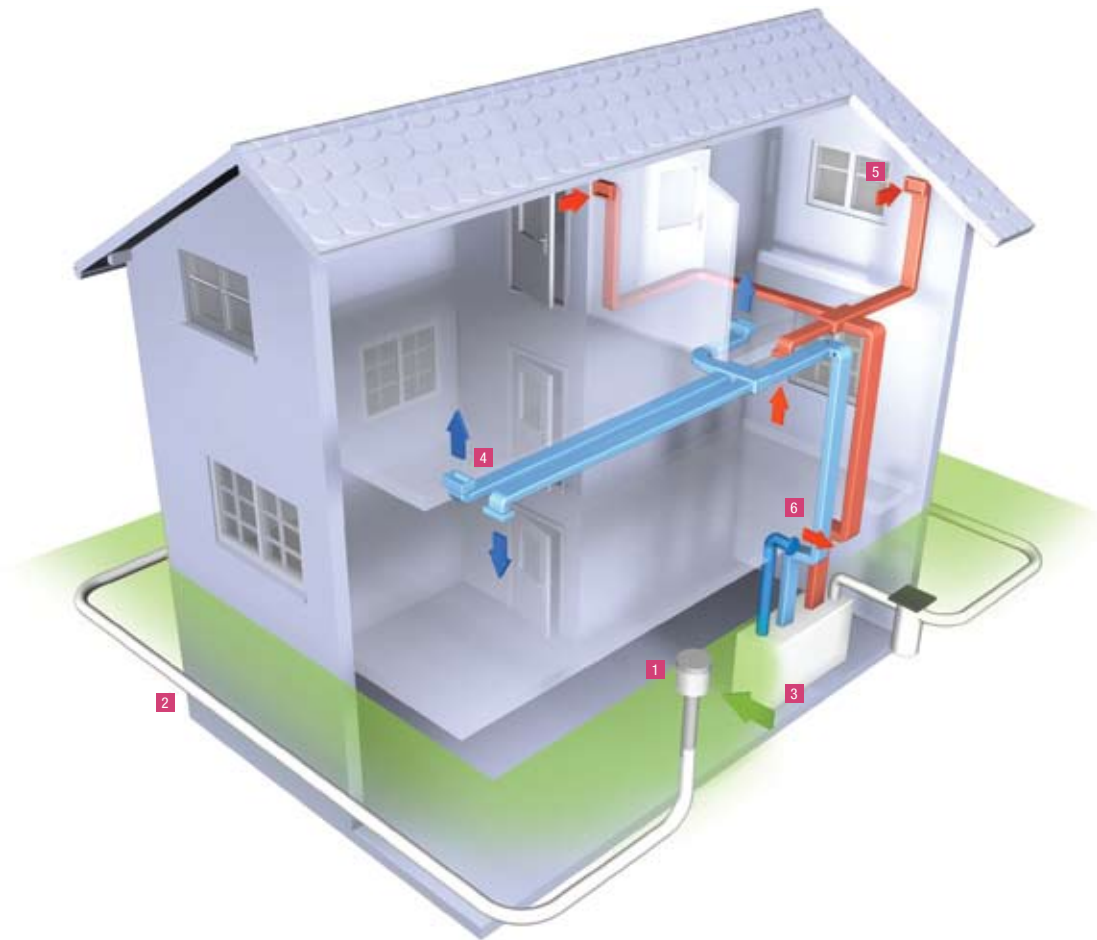
*These examples demonstrate how heat exchange occurs in summer and winter.*

# CONTROLLED VENTILATION

## OPTIMIZING AIR QUALITY AND EFFICIENCY

In addition to directly reducing the energy required to heat or cool incoming fresh air, REHAU ECOAIR contributes to overall ventilation system optimization. Preconditioning the intake air can eliminate the need for an HRV defrost cycle in the winter and it

can lower humidity in the summer, further reducing energy consumption. Lower humidity has the added benefit of improving comfort.



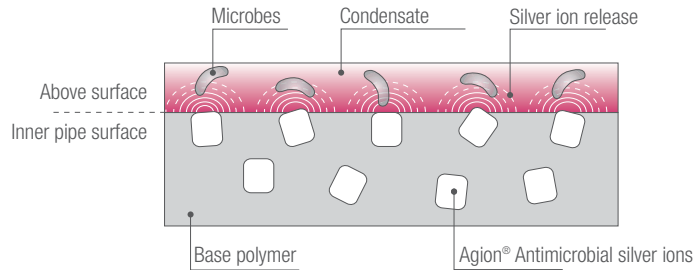
### Geothermal Energy Preconditions Fresh Air

- 1 Air inlet tower with integrated air filter draws in fresh air
- 2 REHAU ECOAIR pipes temper fresh air with geothermal energy
- 3 Fan propels air into ducts after passing through optional heat recovery ventilator
- 4 Registers distribute fresh air to rooms
- 5 Return vents remove stale air from rooms
- 6 Exhaust fans expel air from the building after passing through optional heat recovery ventilator

# A SILVER LINING

## INHIBITING MICROBIAL GROWTH

During the cooling season, condensation can occur in the ground-air heat exchange pipes in regions with high humidity. This moist environment can be conducive to microbial growth. To grow, microbes require moisture and a food source. The first defense against microbial growth is removing the moisture through proper condensation management. Effectively removing particles from the incoming air – the food source – is the next most important safeguard. The complete REHAU ECOAIR system provides for both condensate drainage and inlet-air filtration. In addition, the unique design of REHAU ECOAIR pipes provides yet another layer of protection against microbial growth.



*Embedded silver particles create an antimicrobial inner pipe surface that inhibits microbial growth. Silver ions are released when moisture is present, just when antimicrobial protection is most needed.*

### Antimicrobial-Protected Inner Pipe Surface

Smooth-walled PVC pipes do not harbor particles. To further inhibit microbial growth, Agion Antimicrobial silver ions are embedded in the inner, exposed layer of REHAU ECOAIR pipes. The antimicrobial property of this silver-enabled lining was tested and verified by SGS Institut Fresenius in Taunusstein, Germany to ASTM Standard E2180. The silver material is also registered by Agion Technologies with the EPA for use as an antimicrobial in HVAC applications.



Agion® is a registered trademark of Agion Technologies

# REHAU ECOAIR

## PROVIDING EFFICIENT VENTILATION TO RESIDENTIAL AND COMMERCIAL PROJECTS

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### **BioHaus Environmental Living Center in Bemidji, Minnesota**

The BioHaus Environmental Living Center at Concordia Language Villages in Bemidji, Minnesota is the first-ever certified German Passivhaus in North America. Opened in June 2007, this innovative living and learning center uses 85 percent less energy than comparable U.S. structures.<sup>1</sup> The BioHaus laid claim to being the nation's tightest building when it passed the stringent Passivhaus airtightness test – a notable achievement in light of the structure's location in an extreme climate zone.

The REHAU ground-air heat exchange system is essential to a building as airtight as the BioHaus. The system not only supplies fresh air ventilation, but also significantly reduces energy consumption for space heating and eliminated the need to install a central air conditioner.

On a sub-zero winter day, air taken into the system at 20°F below zero (-29°C), after traveling through a grid with a total of 328 ft (100 m) of 8 in. (200 mm) underground pipes, entered the building at 25°F (-4°C). Heat gain increases further as the outdoor temperature drops and decreases as the temperature differential between the ground and the outdoor air diminishes.

In the summer, the ground-air heat exchanger turns into an “air-conditioner,” providing fresh, cool air throughout the day by cooling 85°F (29°C) outside air down to a comfortable 67°F (19°C).

<sup>1</sup>Source: <http://waldseebiohaus.typepad.com>

*The following REHAU systems contribute to the outstanding energy performance of the BioHaus: REHAU ECOAIR ground-air heat exchange, REHAU SOLECT™ solar-thermal hot water, RAUGEO™ ground loop heat exchange as the energy source for REHAU radiant heating and REHAU high-performance vinyl tilt-turn windows.*



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### TESCO Supermarket in Zdzeszowice, Poland

By taking advantage of sun, wind and ground-source energy, the TESCO supermarket built in Zdzeszowice, Poland in March 2007 uses significantly less energy than conventional supermarkets. A REHAU ground-air heat exchange system contributes to the heating and cooling requirements of the 35,000 sq ft (3,250 sq m) building. Pipes were placed under the building where ground temperatures are more moderate, boosting system efficiency.

The system comprises 2,300 ft (700 m) of 8 in. (200 mm) underground pipe installed in a grid connected to 20 in. (500 mm) header pipes that run 164 ft (50 m). In conjunction with a central ventilation and heat recovery system, the ground-air heat exchanger provides fresh air at a volume of 1,600

cubic feet per minute (2,700 cubic meters per hour) with significant energy savings.

In the winter, the system provides an annual heating output of 70 million BTU (20,500 kWh), fulfilling nearly half of the 158 million BTU (46,320 kWh) requirement and providing an annual savings of €2,000. The system also provides an annual cooling output of 3,043 tons (10,700 kWh), adding €1,000 to the savings compared with a conventional air-conditioning unit.

Air humidity and temperature were monitored for the first year of operation, confirming the high performance of the REHAU ground-air heat exchange system. For example, on April 4, 2007, with an outdoor temperature of 28°F (-2°C), output air temperatures were confirmed at 55°F (13°C).

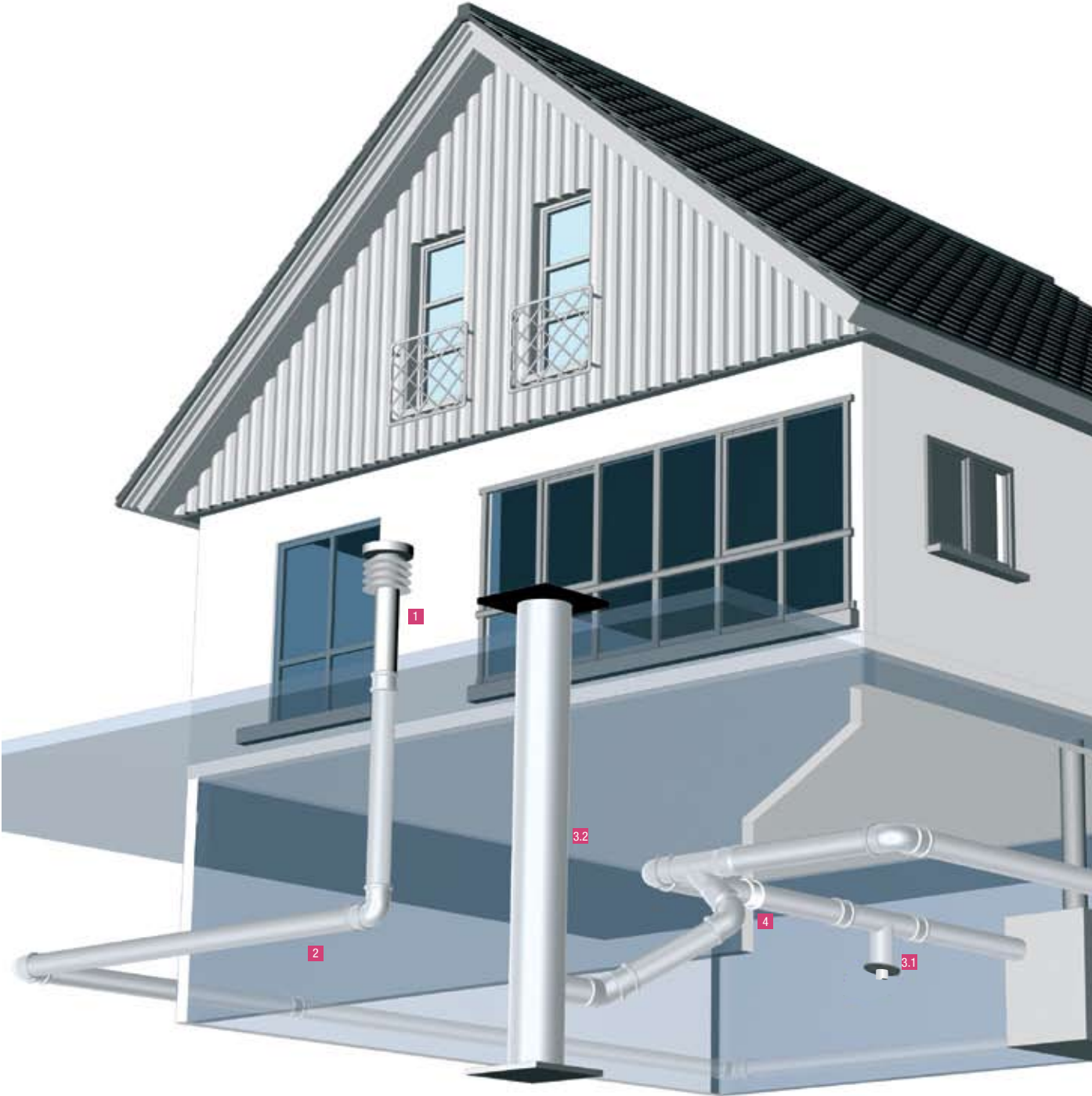


*REHAU ground-air heat exchange pipe in grid layout provides sufficient air flow volume for the supermarket's fresh air requirement.*



# SYSTEM COMPONENTS

SUPPLYING AN ENGINEERED SOLUTION







**1** Air Inlet Tower

Incoming fresh air enters through the louvered hood of the stainless steel tower where it is filtered to remove dust and pollen.



**2** REHAU ECOAIR Pipes

Solid-walled PVC pipes and fittings can be configured in various patterns to achieve the required ground-to-air heat exchange. A unique silver-enabled lining inhibits microbial growth.



Two options for condensation management protect pipe hygiene:

**3.1** Integrated Condensate Drain Adapter

This integrated drain adapter discharges condensate into the building's existing drainage system and prevents odors from entering the ventilation supply air.



**3.2** Condensate Collection Shaft

This stand-alone drainage solution uses an exterior shaft and pump to expel water into a water reclamation or storm drainage system or directly into the ground.



**4** Wall Penetration Sleeve

This PVC sleeve adds flexibility that reduces potential stresses to the pipe and the building structure due to natural movements.

# SYSTEM DESCRIPTION

## ADDRESSING DESIGN FLEXIBILITY, FILTRATION AND CONDENSATION



REHAU ECOAIR System Components

### REHAU ECOAIR Pipe

REHAU ECOAIR pipes have been engineered to meet the requirements of a ground-air heat exchange system. They inhibit ground-water intrusion, provide good thermal conductivity with the ground and have sufficient strength to resist sagging or crushing when buried under normal circumstances.

#### – Solid-Walled PVC Pipe

PVC pipe is a good heat conductor, providing efficient heat transfer from ground to air. Pipes have minimum stiffness of 46 psi (320 kPa) in accordance with ASTM D3034 and CSA 182.2, allowing them to be buried under load.

#### – Antimicrobial-Protected Inner Layer

REHAU ECOAIR pipes feature a unique antimicrobial-protected inner layer developed by REHAU for ground-air heat exchange systems. The antimicrobial properties are achieved by incorporating silver ions into the inner layer of the pipe.

#### – High Longitudinal Rigidity

The high longitudinal rigidity of REHAU ECOAIR pipe promotes effective condensate drainage. Pipes with inadequate longitudinal rigidity are not recommended for ground-air heat exchange systems because they may sag and allow puddles to form at low points.

#### – Resistant to Radon

Radon is a natural colorless, odorless radioactive inert gas encountered in rock and soil. It diffuses through the ground, dissolves in water and escapes into the atmosphere at the ground surface. REHAU ECOAIR pipes are equipped with locked-in gaskets that resist penetration by liquids and gases such as radon. The pipe joint design is tested to ASTM D3212 “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.”

#### – Wide Range of Fittings

A wide range of fittings provides flexibility in designing the ground-air heat exchange system. Elbows, wyes and couplings are available to allow for the installation of grid, serpentine and ring pipe configurations.

### Wall Penetration Sleeves

A wall penetration sleeve must be incorporated into the exterior wall so that the pipes may enter the building correctly with a sealed joint. The REHAU system includes sleeves designed for use above the water table. In situations where the installation is below the water table, more robust wall penetration seals are required to prevent leakage into the building.



### Condensation Management

Condensation can occur in the pipe system, particularly in summer when humid air in the pipes is cooled. To inhibit the growth of bacteria, mold and mildew which can lead to unpleasant odors and adverse health effects, condensate must be effectively discharged. The REHAU ECOAIR system offers two condensation management options:

- Integrated

In buildings with basements, condensate is discharged through the building's drain. This is achieved via a condensate branch located at the lowest point in the ground-air heat exchange pipe system. A ball siphon is positioned between the condensate discharge and the drain, to help prevent the entry of unpleasant odors from the drain into the REHAU ECOAIR system.

- Stand Alone

This solution drains condensate through an external condensate collection shaft for buildings without basements or where external drainage is preferred. Water is discharged from the ground-air heat exchange pipe to the condensate shaft and is then pumped out using a standard submersible pump. The shaft is fitted with an airtight cover at ground level designed to prevent unfiltered air from getting into the ventilation system.

### Filtration

The air inlet tower is a sleek, modern design made of rust-resistant stainless steel. Standing 6 ft (2 m) above ground, the tower is ideally sized for proper air intake and convenient access. It's tall enough to clear low-lying obstacles such as vegetation and typical snow banks, yet it's still easy to reach during filter changes. Standard and fine particulate filters are available from REHAU.

# DESIGN AND INSTALLATION

## PUTTING IT ALL TOGETHER

This is a brief overview of technical considerations. Refer to REHAU ECOAIR Design Guide and Installation Guide for details.

Ground-air heat exchange systems integrate into a building's balanced fresh air ventilation and drainage systems. The main considerations for system design are air-flow volume and energy transfer requirements, building heating/cooling loads, physical constraints such as property size and pipe diameter as well as the viable pipe layout options.

### System Sizing

When determining the diameter and length of the pipe, the following variables apply:

- volume of the building
- required air change rate
- property size
- pipe layout (grid, ring, serpentine)
- pipe depth
- soil and climatic conditions
- ground water level

With nominal 8 in. (200 mm) pipes and 15 in. (375 mm) header pipes, a maximum volume flow rate of 1,400 cfm (2,400 m<sup>3</sup>/h) can be achieved. Higher flow rates will negatively affect air pressure levels and reduce heat transfer performance. Higher air-flow volumes can be achieved with standard system

components by combining several pipe zones to reach the total required output, while the largest projects may require customized header solutions.

### Single-Family Residences and Small Buildings

Tightly built structures designed to meet ASHRAE 62.2 guidelines for fresh air changes or to achieve ratings such as LEED gain energy efficiency by integrating a REHAU ECOAIR ground-air heat exchange system. In temperate climates, the system may even replace a central air conditioner. The required pipe length can often be designed to fit into existing trenches, resulting in a lower installed cost.

### Large Buildings

REHAU ECOAIR is also suitable for use in large buildings such as schools, sports facilities, open-plan offices and warehouses. The ground-air heat exchange system can be designed as a whole-building solution or can be zoned to boost the efficiency of individual air handling units. During the planning phase, the geothermal and mechanical system engineers should work closely together to ensure optimal integration of the ground-air heat exchanger with all the building's mechanical systems.

### Sample System Requirements for Single-Family Residences

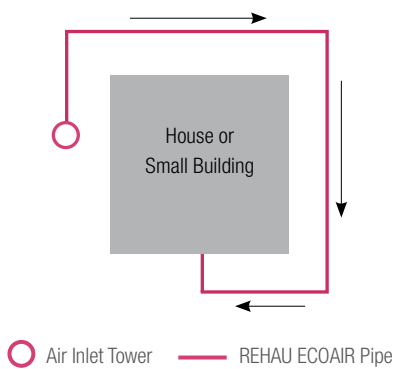
Assumptions	Example 1	Example 2
Floor Area	1,100 ft <sup>2</sup> -1,600 ft <sup>2</sup> (100-150 m <sup>2</sup> )	1,600 ft <sup>2</sup> -2,150 ft <sup>2</sup> (150-200 m <sup>2</sup> )
Building Volume	10,600 ft <sup>3</sup> (300 m <sup>3</sup> )	14,000 ft <sup>3</sup> (400 m <sup>3</sup> )
Air Change Rate	0.5 per hr	0.5 per hr
Region	Washington, D.C.	Washington, D.C.
Ground Type	Clay, damp	Clay, damp
Results of System Simulation		
Volume of Flow	10,600 ft <sup>3</sup> x 0.5/h x 1/60 = 88 cfm (300 m <sup>3</sup> x 0.5/h = 150 m <sup>3</sup> /h)	14,000 ft <sup>3</sup> x 0.5/h x 1/60 = 117 cfm (400 m <sup>3</sup> x 0.5/h = 200 m <sup>3</sup> /h)
Pipe Requirement	100 ft (30 m) of 8 in. (200 mm) diameter pipe	115 ft (35 m) of 8 in. (200) mm diameter pipe
Energy Saved	4.4 million BTU (1,300 kWh/year)	5.8 million BTU (1,700 kWh)
Δ Hottest Day	100°F (38°C) to 81°F (27°C)	100°F (38°C) to 81°F (27°C)
Δ Coldest Day	11°F (-12°C) to 37°F (3°C)	11°F (-12°C) to 37°F (3°C)

## Pipe Layout

Pipes can be laid in grid, serpentine or ring patterns, in the open or under the building, depending on the system requirements and available space.

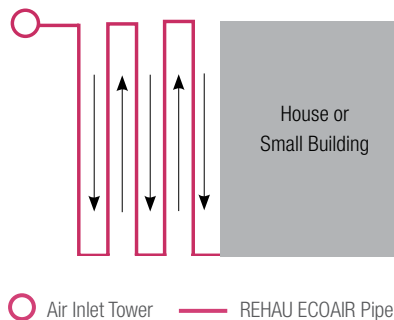
### Ring

A ring layout around the building is recommended for smaller ground-air heat exchange systems, such as single-family residences. This is the simplest and most cost effective layout, because it saves excavation costs by using existing trenches and requires fewer joints.



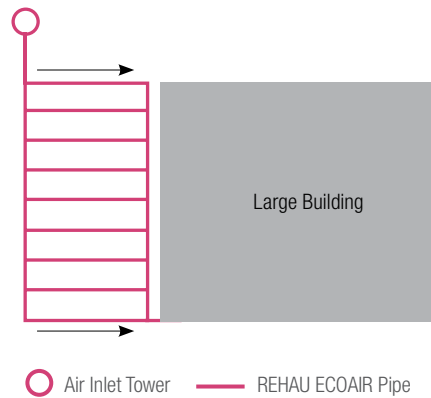
### Serpentine

A serpentine layout is ideal for medium-sized systems that require a longer pipe length to transfer sufficient energy.



### Grid

To achieve the greater volume of flow required for larger buildings, the most common layout is a grid with larger header pipes. Like the classic Tichelmann pipe layout, this pattern creates a self-balancing system: no matter which path the air takes, it always travels the same distance, balancing the pressure losses.



### Pipe Installation

- Lay pipes at a depth of at least 5 ft (1.5 m).
- Lay pipes in clay or soil, not in sand, for best possible heat transfer. Make sure the ground is well compacted around the pipes following industry guidelines for buried PVC pipes.
- Lay pipes at least 3.25 ft (1 m) away from the building and from each other.
- Slope pipes continuously at least 2% toward condensation collection point.
- Install pipes working from building toward air inlet tower with belled end in direction of progress.
- Seat gasketed joints properly to prevent infiltration.

Proper design of REHAU ECOAIR systems requires consideration of many local factors. For best results, hire a local geothermal engineering firm to design your system. REHAU can assist this firm in sizing your system by modeling system performance.

# MAINTENANCE

## PREVIEWING OWNER RESPONSIBILITIES

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Proper maintenance of your REHAU ECOAIR system will keep it operating efficiently for many years.

This is an overview of maintenance requirements. Refer to the REHAU ECOAIR Maintenance Guide for details.

### Owner Maintenance

Owners should change the air filter in the air inlet tower once or twice a year depending on airflow volume and environmental conditions.

To purchase a new air filter, contact your REHAU ECOAIR system installer. To locate the nearest dealer, go to [www.na.rehau.com/dealers](http://www.na.rehau.com/dealers)

### Professional Maintenance

For best performance, owners should arrange for a qualified professional such as a certified practitioner of the National Air Duct Cleaners Association (NADCA) to inspect and, if necessary, clean their REHAU ECOAIR system at least once a year.

### Servicing the Underground Pipes

The smallest diameter of REHAU ECOAIR pipes is 8 in. (200 mm), allowing them to be serviced using standard municipal pipe equipment. Buried REHAU ECOAIR pipes can be accessed for maintenance through air inlet towers, condensation collection chambers, air outlets to buildings and manholes, when installed. They can also be inspected by camera.



REHAU makes no guarantees regarding the quality of air supplied by the REHAU ECOAIR system. Failure to properly design, install and maintain the system substantially increases the risk of microbial growth and resulting illnesses or allergic reactions. Refer to industry standards and manufacturers' recommendations.

# FREQUENTLY ASKED QUESTIONS

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## **Wouldn't it be easier to open a window?**

A properly-designed and installed ground-air ventilation system supplies just the right amount of fresh air to a building in a controlled manner, without the security risk of open windows. The system also filters the air, reduces drafts, provides dehumidification and reduces noise from outside, boosting the comfort of building occupants.

## **What does it cost to operate a ground-air heat exchange system?**

The operating cost of a ground-air heat exchange system is minimal compared with the high electrical demand of conventional air conditioning systems. The small amount of electrical power used by the ground-air system air fan and the costs of replacing the air filter are the main operating costs.

## **How often does the filter need changing?**

The recommended filter change interval is once or twice a year. However, the effectiveness and life of the filter can vary and will depend upon the amount of air borne particles in the area. In areas with very high dirt or particle loading in the air, such as near a construction site, the filter may need to be changed more frequently.

## **Can I use REHAU ECOAIR as an air conditioner?**

The answer to this question depends on the climate in your region and your expectations regarding a comfortable indoor temperature. In some projects, a REHAU ECOAIR ground-air heat exchange system is used in place of an air conditioner, while in many, it minimizes the load on the air conditioning system, reducing cooling costs.

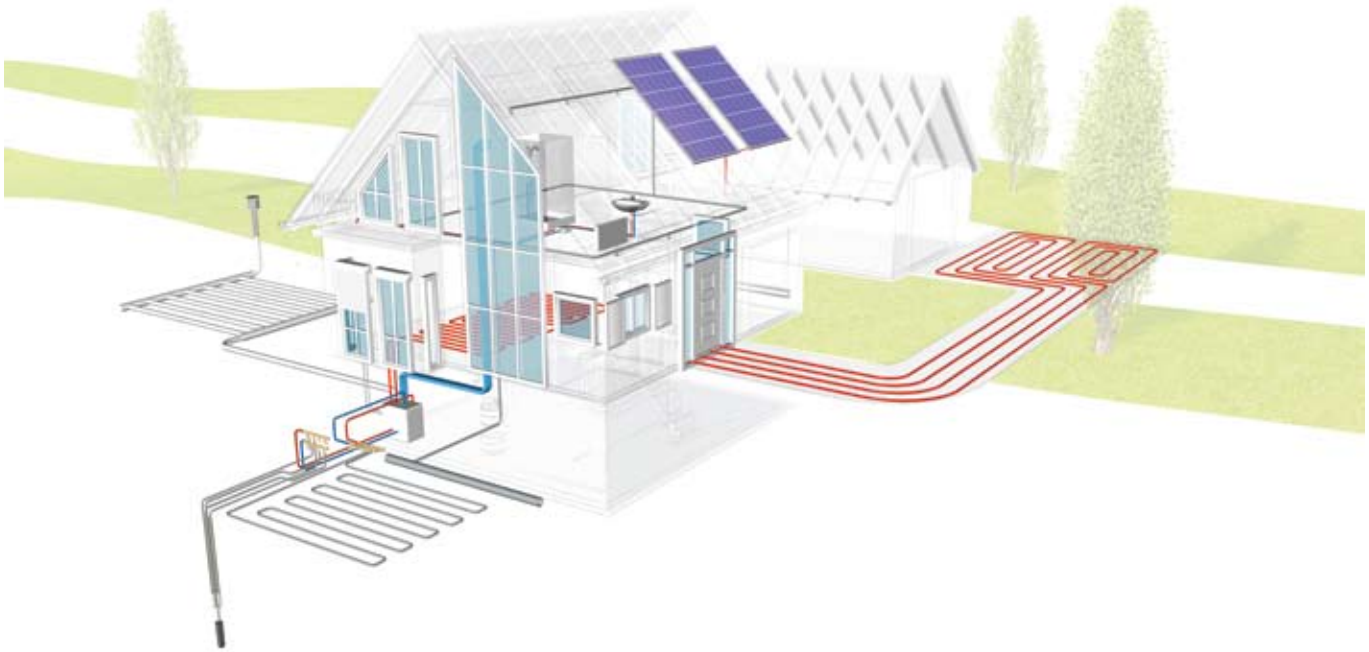
## **Can I use REHAU ECOAIR as a heating system?**

No, REHAU ECOAIR is not a heating system.

Ground temperatures alone cannot achieve a comfortable heating level. When a building requires a fresh air ventilation system, the temperature of the incoming air decreases the efficiency of the heating and cooling systems. By preconditioning the fresh air, REHAU ECOAIR significantly reduces the load on these systems.

## **What type of ventilation system is required for REHAU ECOAIR?**

REHAU ECOAIR can integrate with any ductwork system that moves air through a building, including a central air conditioner or a forced-air heating system. In buildings that do not have ductwork (e.g., hydronic heating with no central air conditioning), you will need to design special ductwork or build in vents for the fresh air, admitted from REHAU ECOAIR, to move through the building.



*REHAU can help you capture more of the earth's energy and realize even greater savings. To heat and cool your building, consider using our RAUGEO™ ground loop heat exchange system combined with our radiant heating system for the ultimate in efficiency and comfort.*

For updates to this publication, visit [na.rehau.com/resourcecenter](http://na.rehau.com/resourcecenter)

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