ELIXAIR® Earth-Air Heat Exchanger

Technical brochure for non-residential buildings

An infinite source of energy savings

Table of Contents

Introduction to the ELIXAIR® Earth-Air Heat Exchanger

Why Use It?

The primary objective of the ELIXAIR® Earth-Air Heat Exchanger is to significantly reduce a building's heating and cooling needs-achieving 20 to 30% heating savings in cold periods and covering 80 to 100% of cooling needs in warm periods. This system harnesses an unlimited, free, and renewable energy source: geothermal energy.

- Cost-Effective System
- Built to Last
- Year-Round Thermal Comfort
- Made from Recycled and Recyclable Cast iron

How Does It Work?

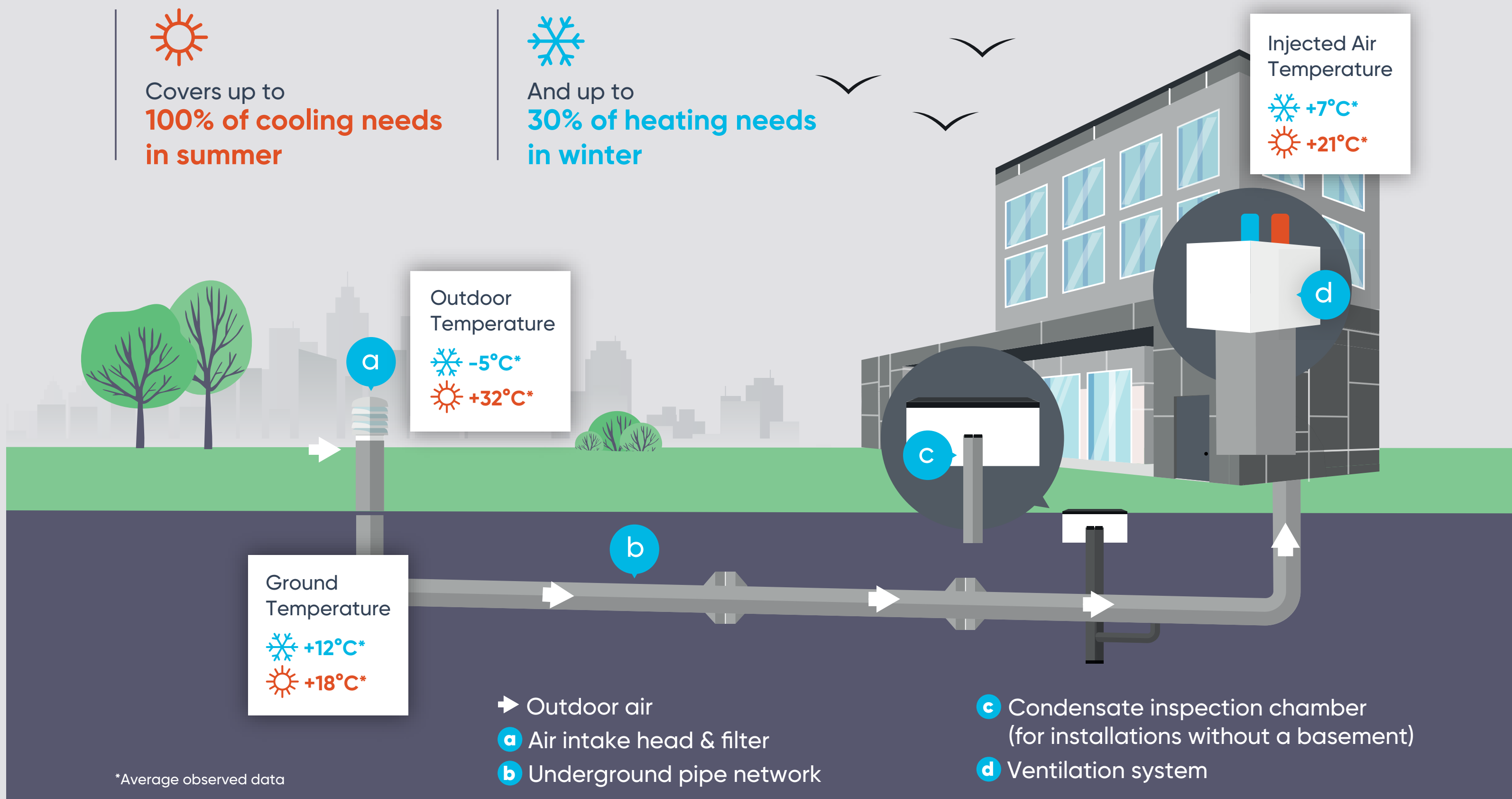
Sized according to the required fresh air flow rate and the target performance, the ELIXAIR® Earth-Air Heat Exchanger consists of an underground network of pipes that functions as an air-to-ground heat exchanger.

Designed for fresh air renewal, it must be buried at a minimum average depth of 2 meters. The ELIXAIR® solution harnesses the thermal inertia of the surrounding soil, allowing the system to act as a natural temperature regulator. The temperature difference between the outside air and the subsoil enables free and natural preheating during cold periods and cooling during warm periods.

When integrated with an air handling unit (AHU), the Earth-Air Heat Exchanger helps distribute filtered, tempered, and comfortable air throughout the building. The filtered air is delivered at a consistent temperature, without sudden fluctuations, drafts, or discomfort from airflows.

Year-round efficiency

The reversibility of the ELIXAIR® Earth-Air Heat Exchanger allows for year-round operation with the help of a bypass system, ensuring comfort for occupants as well as providing protection for goods and equipment.



*Average observed data

Integration with Ventilation Systems

An Earth-Air Heat Exchanger is systematically connected to a ventilation unit, with the choice of the AHU being dependent upon the overall thermal objective of the project.

Several types of ventilation systems belong to the AHU (Air Handling Unit) family.

AHU (AIR HANDLING UNIT)

Single-Flow Supply Ventilation	Dual-Flow Ventilation
✓	✓

Technical Certification and Standards

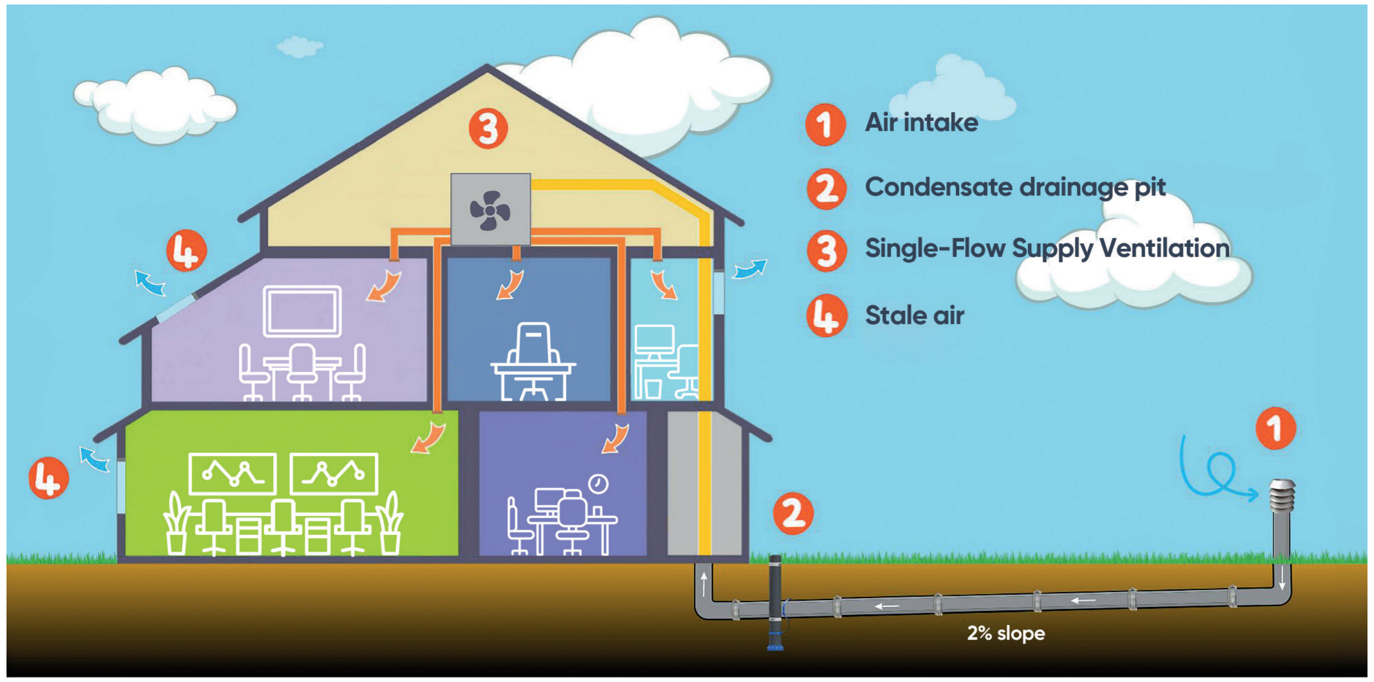
The ELIXAIR® system is certified by the CSTB under Technical Approval AT 14.5/23-2310. This certification provides a regulatory framework covering thermal, technical, and hygienic aspects. This regulatory framework also ensures that the installation is covered by a 10-year liability guarantee.

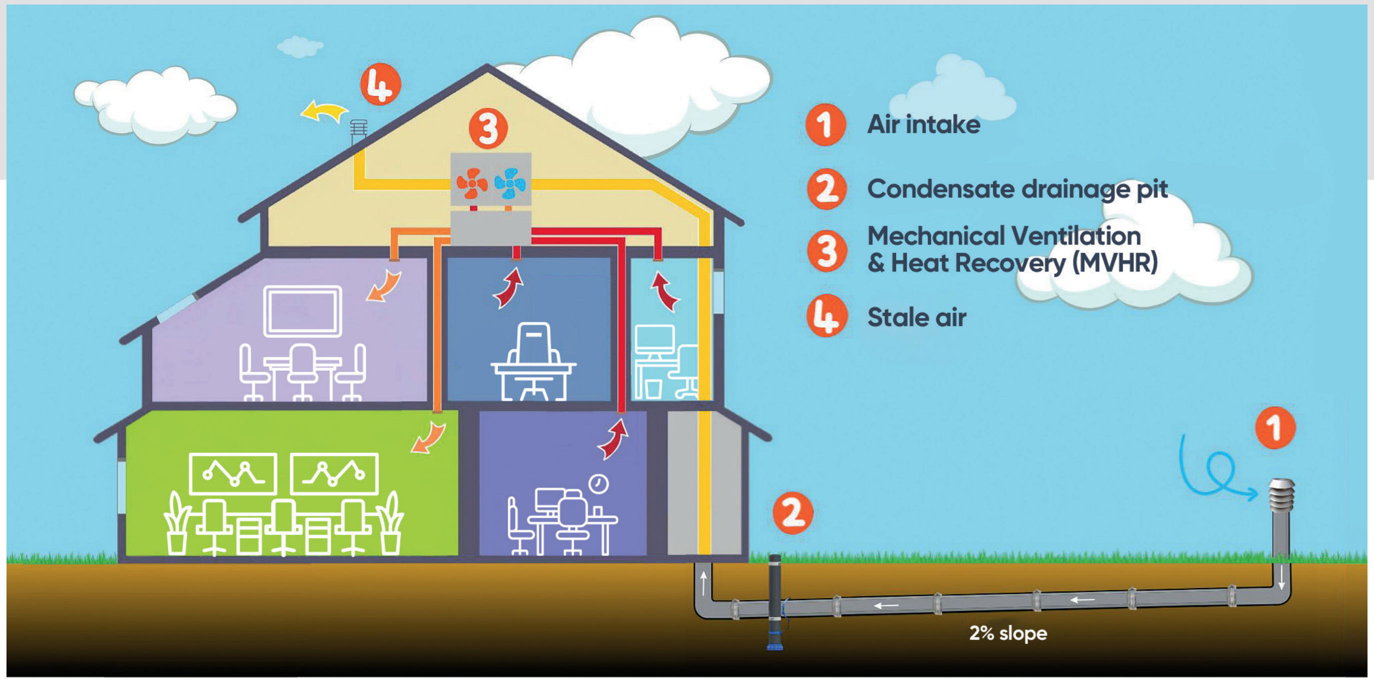
Single-Flow Supply Ventilation

Principle: Fresh air is supplied to the building's rooms via the Earth-Air Heat Exchanger, creating a slight overpressure. Stale air is then extracted naturally through window vents or other openings. Door undercutting is recommended. A complementary mechanical ventilation system (MVS) may also be advised. This simple approach is best suited for mild winter climates. It can also be used in colder regions, but primarily for the preservation of goods or equipment (e.g., frost protection for a storage area). To optimize comfort throughout the year, the supply unit should be equipped with a variable airflow control.

Advantages of Integrating an ELIXAIR® Earth-Air Heat Exchanger with an Air Handling Unit (AHU)

→ Easy installation and low maintenance
→ Ideal for regions with mild winters
→ Variable airflow control for personalized comfort
→ Low energy consumption





Mechanical Ventilation & Heat Recovery

Principle: The Mechanical Ventilation & Heat Recovery (MVHR) operates year-round. It consists of an extraction and supply system equipped with a heat exchanger. The Earth-Air Heat Exchanger (EAHX) seamlessly connects to the system's fresh air intake. In cold periods, stale (warm) air is extracted from the building and transfers its heat to the incoming (cold) air through the heat exchanger. In warm periods, the heat exchanger is bypassed or deactivated, and a higher airflow rate is often distributed by the AHU. In this case, the Earth-Air Heat Exchanger helps cool ventilated areas. Optimizing airflow to meet the building's needs is key to system performance. **Since heat exchangers have varying efficiency levels, it is recommended to pair an EAHX with a low-efficiency heat exchanger to avoid oversizing the system.**

Bypassing the Heat Exchanger in a MVHR

The heat exchanger in a MVHR system is highly useful in winter for recovering heat from extracted air. However, it can be counterproductive in summer, as it may unintentionally warm the building by transferring heat from the outside air. To prevent this, the heat exchanger should be bypassed in warm periods to fully benefit from the cooling effect of the ELIXAIR® Earth-Air Heat Exchanger.

Do Not Confuse This with the Earth-Air Heat Exchanger Bypass

We also recommend a bypass for the Earth-Air Heat Exchanger. This is a manual or electronic **valve that selects the most beneficial fresh air temperature based on the time of year or even between day and night.**

In cold and hot seasons, the Earth-Air Heat Exchanger operates almost continuously. During mid-season, it may be more efficient to use outdoor air directly rather than the EAHX. The bypass settings depend on building characteristics (thermal inertia, internal and external heat gains, occupancy, etc.) and occupant comfort preferences. Most importantly, the EAHX bypass serves as a safety feature, allowing the ventilation system to continue operating and supplying fresh air in case of a fault or maintenance intervention.

Advantages of Integrating an ELIXAIR® Earth-Air Heat Exchanger with a Dual-Flow Ventilation System

→ In winter, the EAHX reduces the required size of the ventilation heat exchanger, optimizing system efficiency.
→ Frost protection via the EAHX eliminates the need for an anti-freeze heating coil, reducing energy consumption.
→ In warm periods, the cooling effect of the EAHX is gentle and evenly distributed throughout the building.
→ Dual-flow ventilation systems typically feature variable airflow control, allowing for optimal comfort management.

4 Key Project References

FRANCE

Bruges

Building type: Frida Kahlo School Group
Ventilation type: Supply ventilation
Total airflow: 15,500 m³h

Margaux

Building type: Cantenac Brown Wine Cellar
Ventilation type: Dual-flow
Total airflow: 4,400 m³h

Tours

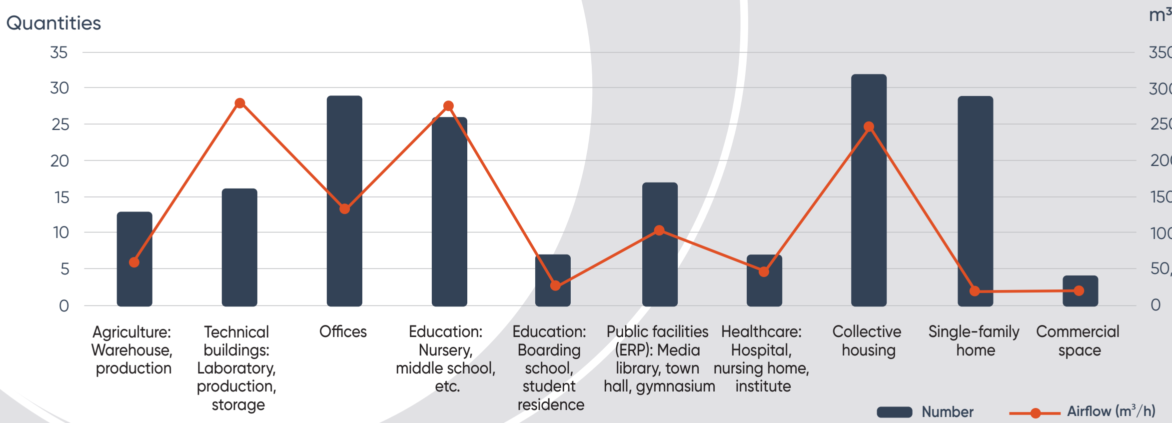
Building type: High-voltage electrical relay station
Ventilation type: Supply ventilation
Total airflow: 2,800 m³h

SPAIN

Extremadura

Building type: School Group
Ventilation type: Dual-flow
Total airflow: 29,000 m³h

Global Distribution of ELIXAIR® Installations by Building Type



MOROCCO

Tangier

Building type: School & Leisure Center
Ventilation type: Supply ventilation
Total airflow: 3,600 m³h

CHINA

Xion'an

Building type: Multi-purpose Exhibition Hall
Ventilation type: Dual-flow
Total airflow: 12,000 m³h

A Versatile Solution for Every Building

The ELIXAIR® Earth-Air Heat Exchanger, a natural passive solution, is suitable for a wide range of building types. It provides passive comfort not only for people but also for equipment and stored goods. ELIXAIR® is used in offices, schools, and other public buildings, as well as in agricultural and industrial production and storage facilities, and even in technical areas such as server rooms. While the core benefits remain energy savings and thermal comfort, the specific needs and return on investment vary depending on the project type.

Environmental and Thermal Challenges

Unlike active solutions that require energy input, the ELIXAIR® Earth-Air Heat Exchanger operates without any external energy supply and consumes no natural resources. The energy savings achieved through simple geothermal heat exchange do not deplete any raw materials. This system enables maximum energy savings by eliminating unnecessary consumption, making it fully aligned with building decarbonization and energy efficiency goals. It also contributes to energy independence. Furthermore, in many cases, integrating an Earth-Air Heat Exchanger facilitates certification for environmental labels such as LEED, Net Zero, BDM, Passivhaus and others.

Thermal Benefits

Thermal Conductivity and Cast iron Thickness

Ductile or grey cast iron is the metallic material with the highest thermal conductivity on the market, rated at 36 to 46 W/mK.

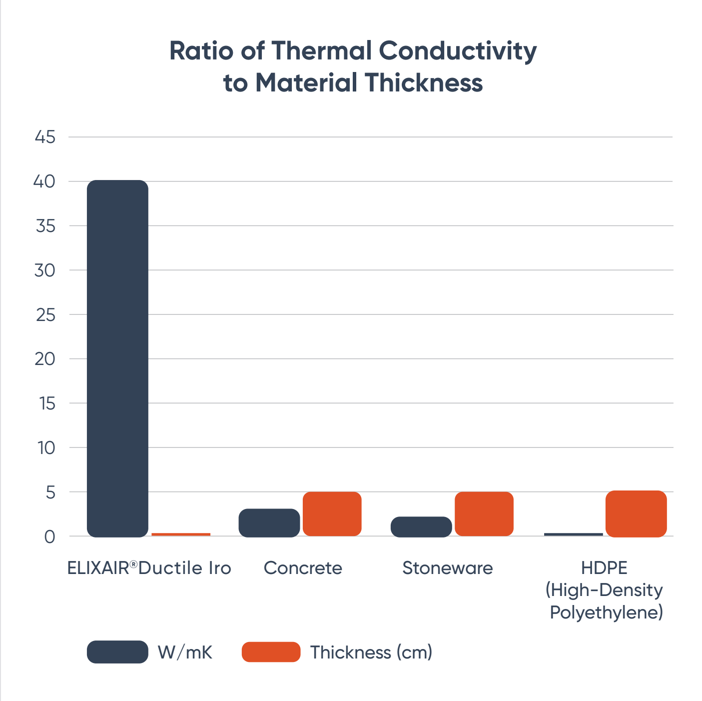
For comparison:
- Polymers: 0.2 to 0.4 W/mK
- Stoneware: 1.3 W/mK
- Concrete: 1.5 to 2 W/mK

In addition to its high mechanical strength, cast iron benefits from a **low thickness, ranging between 3.4 and 4.8 mm**, while other materials typically range from 1 cm to several centimeters (average observed data).

These two properties—high thermal conductivity and reduced thickness—play a key role in performance, as cast iron does not create thermal resistance with the surrounding soil. Instead, it enhances heat exchange efficiency.

For reference:
- Dry soil: ~0.7 W/mK
- Water-saturated soil: >2 W/mK

These characteristics significantly reduce the required pipeline length compared to other materials, minimizing project footprint and overall cost. For example, with a DN300 cast iron network, an air velocity of 5 m/s can be achieved, equating to 1,400 m³/h. In contrast, a synthetic material DN300 would be limited to 3 m/s, or approximately 720 m³/h.

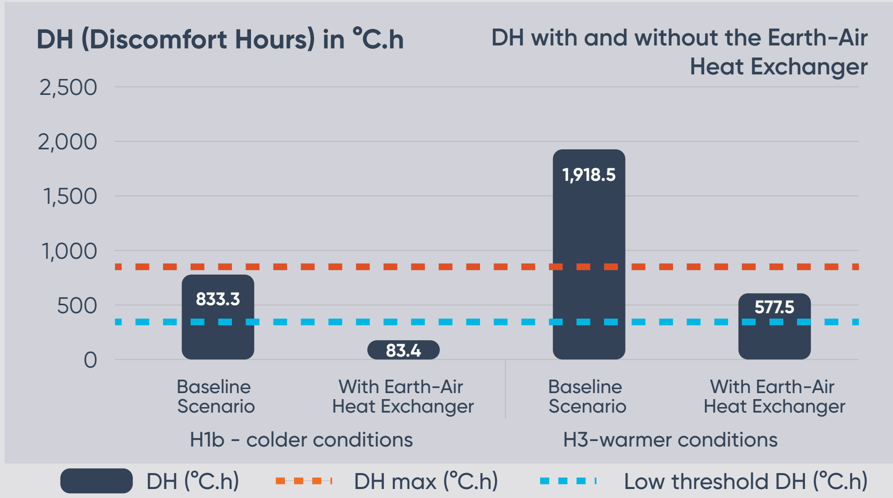


Regulatory Simulations in France: RE2020

The French thermal regulation RE2020 recognizes and promotes the use of geothermal energy and Earth-Air Heat Exchangers (EAHXs). A comprehensive report on the integration of EAHX in RE2020, prepared by TRIBU Energie, is available on our website.

Below is an excerpt from a case study on a 4,384 m² school building located in two different climate zones:
- Strasbourg (H1b climate zone)
- Marseille (H3 climate zone)

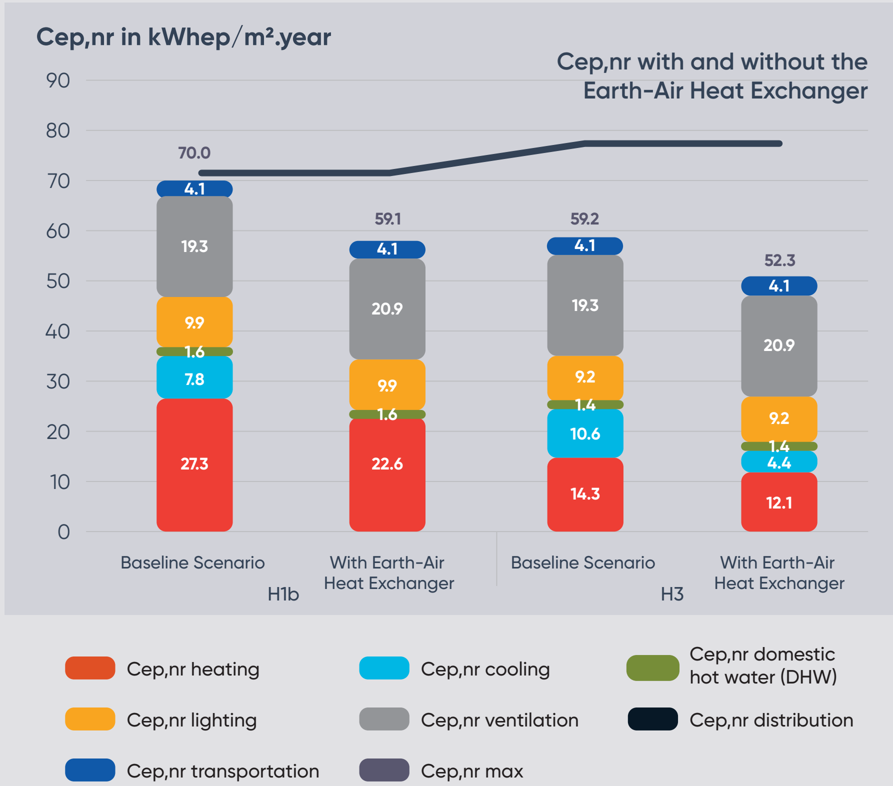
DH (Discomfort Hours), an indicator of summer thermal comfort



DH	H1b	H3
With/Without EAHX	-90 %	-70 %

The significant decrease in summer discomfort hours (DH) eliminates the need for cooling in H1b and ensures compliance with the maximum regulatory threshold of 950 DH in H3.

Cep,nr – Non-Renewable Energy Consumption



	H1b	H3
Cep,nr	-15.6 %	-11.7 %
Cep,nr heating	-17.3 %	-15.4 %
Cep,nr cooling	-100 %	-58.5 %
Cep,nr ventilation	+7.8 %	+7.8 %

Heating and cooling energy consumption drops significantly, while ventilation energy consumption increases slightly due to system pressure losses. However, the overall energy balance remains highly positive, with substantial net gains.

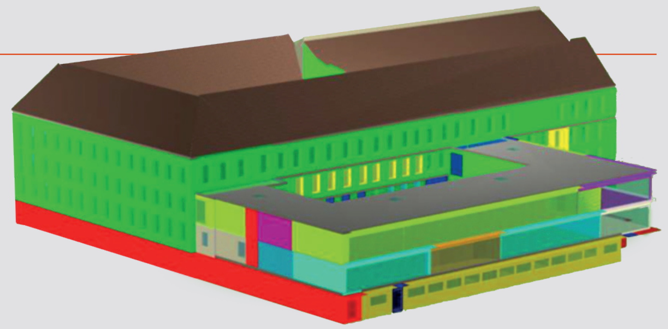
Dynamic Thermal Simulations

In engineering, Dynamic Thermal Simulation (DTS) refers to the calculation of a system's thermal evolution over time, using a numerical model that approximates real-world conditions.

Integrating an EAHX into a DTS model allows for a clearer assessment of its effectiveness and benefits for a given building.

EXAMPLE 1

Cultural Center in Cambrai, Northern France

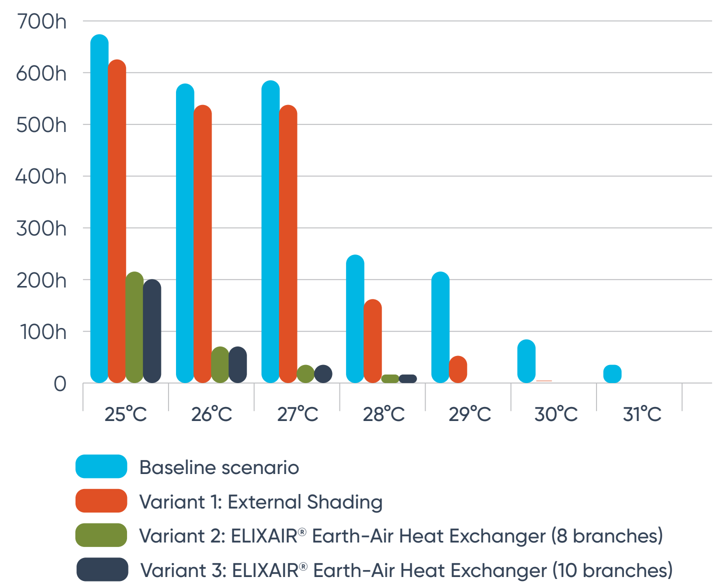


Extract from a DTS conducted by BERIM, a French engineering firm specializing in building systems, urban technologies, environmental preservation, and sustainable development. The study was performed using Pleiades+Comfie software, version 3.3.3.0.

The following air renewal rates were considered:

- 25 m³/h for office spaces
- 18 m³/h for other areas

Area	Baseline		VARIANT 1 external shading		VARIANT 2 ELIXAIR® Earth-Air Heat Exchanger	
	Max Indoor Temperature	Discomfort Hour (Indoor Temp. > 28°C)	Max Indoor Temperature	Discomfort Hour (Indoor Temp. > 28°C)	Max Indoor Temperature	Discomfort Hour (Indoor Temp. > 28°C)
Ground Floor Offices	31.4°C	245h	30.8°C	170h	27.8°C	0h
CIAP Offices	30.8°C	242h	30.2°C	181h	27°C	0h
Scenic Area	33°C	460h	32.3°C	370h	28.7°C	6h
Science Lab	33.4°C	510h	32.9°C	386h	29.3°C	25h

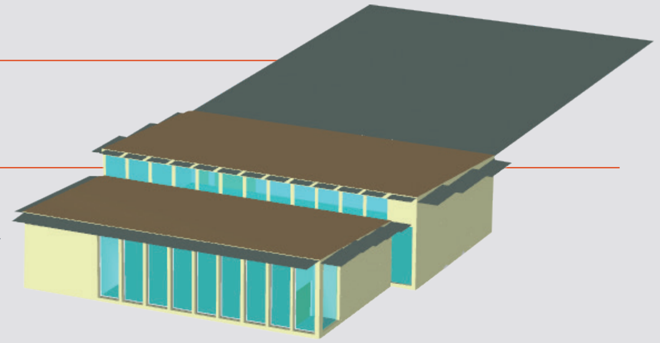


Conclusion: The integration of an 8-branch ELIXAIR® Earth-Air Heat Exchanger in this DTS clearly demonstrates the system's efficiency compared to:

- **The baseline scenario**
- **The installation of external shading**
- **The implementation of a 10-branch Earth-Air Heat Exchanger**

The results highlight that the ELIXAIR® system significantly enhances the building's thermal performance, outperforming other solutions such as external shading or the standard baseline. This study underscores the importance and tangible benefits of the ELIXAIR® Earth-Air Heat Exchanger in terms of thermal regulation and energy efficiency for buildings.

EXAMPLE 2



500 m² Commercial Space in Bénesse-Maremne (France)

Extract from a DTS conducted by INSPYR, a French engineering consultancy firm specializing in thermal performance analysis, using PLEIADE+COMFIE software, version 5.22.1.1.

Target indoor temperature: 19°C in winter / 27°C in summer

Discomfort Rate Formula: Discomfort Rate = Number of Discomfort Hours / Number of Occupied Hours

Building Energy Needs – Baseline Scenario

Area	HEATING		AIR CONDITIONING		Hours > Discomfort temperature (h)
	Energy Demand	Power	Energy Demand	Power	
Exhibition Area	887 kWh/year or 4 kWh/m²/year	7.3 kW	9,628 kWh/year or 48 kWh/m²/year	12.2 kW	1,683h
Self-Service Area	232 kWh/year or 1 kWh/m²/year	11.2 kW	16,091 kWh/year or 54 kWh/m²/year	17.4 kW	2,217h

Building Comfort – AME05 = Variant with ELIXAIR® Earth-Air Heat Exchanger

Area	Minimum Temperature [°C]	Maximum Temperature [°C]	Number of Discomfort Hours [h/year]	Discomfort Rate [%]	Discomfort Rate – Baseline Simulation
Exhibition Area	11°C	33°C	1,098h	31.99%	49.04%
Self-Service Area	11°C	33°C	951h	27.71%	64.60%

Overview

Area	Discomfort Hours Without EAHX [h/year]	Discomfort Rate Without EAHX	Discomfort Hours With EAHX [h/year]	Reduction in Discomfort Hours
Exhibition Area	1,683h	49.04%	1,098h	-35%
Self-Service Area	2,217h	64.60%	951h	-57%

Cooling Demand Savings vs. Air-to-Air Heat Pump (COP 3)

Building Energy Needs – AME05 = Variant with ELIXAIR® Earth-Air Heat Exchanger

	AME05 Exhibition Space	BASELINE Exhibition Space	AME05 Self-service Space	BASELINE Self-service Space
Cooling Energy Demand	7,169 kWh/year or 36 kWh/m²/year	9,628 kWh/year or 48 kWh/m²/year	8,914 kWh/year or 30 kWh/m²/year	16,091 kWh/year or 54 kWh/m²/year
Cooling Power	11.6 kW	12.2 kW	17.4 kW	18.5 kW

CASE STUDY: RETURN ON INVESTMENT

ASSUMPTIONS

- Electricity price: €0.289/kWh*
- Annual electricity cost increase: 10%
- Cost of the Earth-Air Heat Exchanger: €43,000

ACCORDING TO THE DTS OF THE COMMERCIAL SPACE

Cooling Demand
→ Without Earth-Air Heat Exchanger (Exhibition Area + Self-Service Area): 25,719 kWh/year
→ With Earth-Air Heat Exchanger: 16,083 kWh/year
→ Cooling energy savings: 25,719 – 16,083 = 9,636 kWh/year

Heating Demand
→ Using the same calculation method as for cooling:
Heating energy savings = 782 kWh/year

Total Energy Savings
= Cooling + heating energy savings
= 9,636 + 782
= 10,418 kWh/year

kWh/year Saved	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
10418	3,021.22€	3,323.34€	3,655.68€	4,021.24€	4,423.37€	4,865.71€	5,352.28€	5,887.50€	6,476.25€	7,123.88€
+10%/year	302.12€	332.33€	365.57€	402.12€	442.34€	486.57€	535.23€	588.75€	647.63€	712.39€
ROI	-	-	-	-	-	-	-	-	41,026.59€	48,150.47€

Conclusion: In this example, the Earth-Air Heat Exchanger will achieve full payback between the ninth and tenth year.

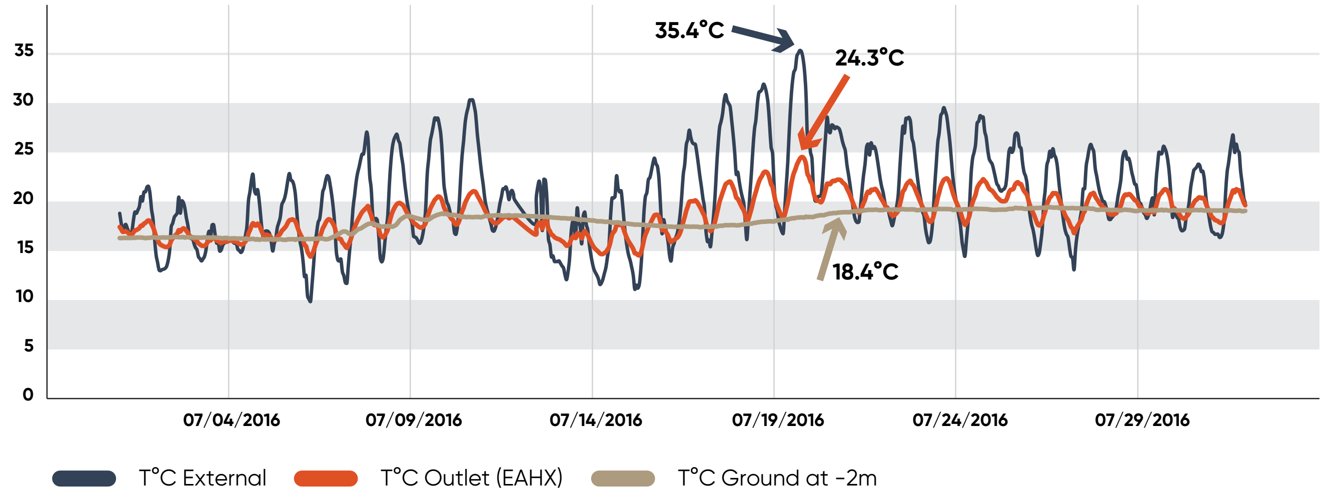
Estimated data

*Average kWh Price in Europe in 2024

Actual Temperature Results (Point P Massy, France)

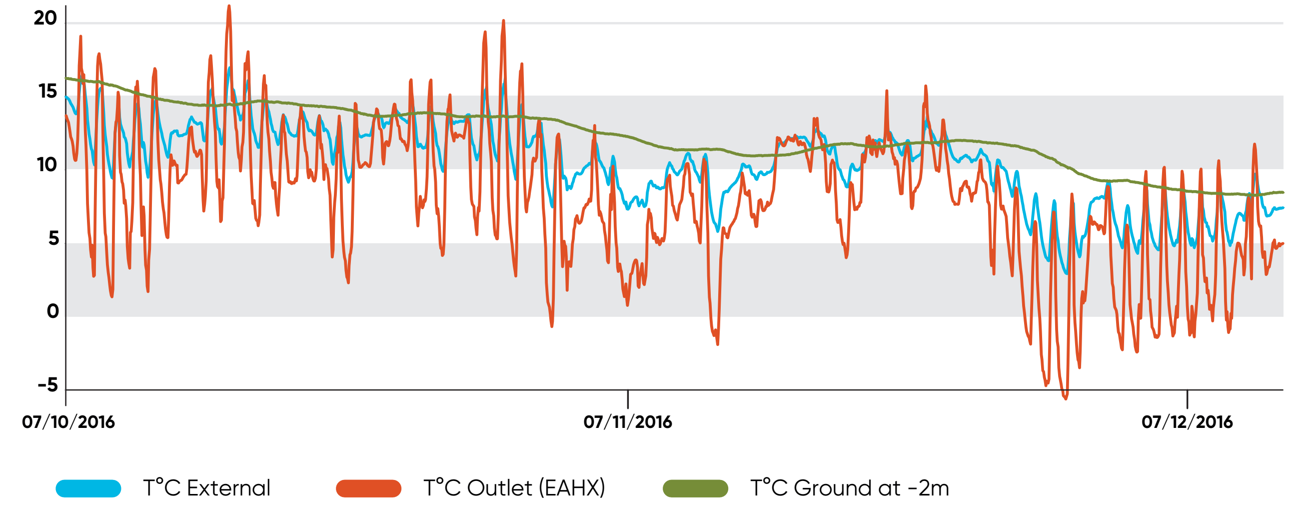
In any type of building, the ELIXAIR® EAHX should be an integral part of the heating and cooling strategy. As an example, we analyzed a monitored retail space (Point P Massy, a construction materials store in France), where temperature data was recorded to assess system performance.

SUMMER



Summer Objectives Achieved:
→ Significantly reduce heat peaks: 12°C lower at the Earth-Air Heat Exchanger outlet
→ Cooling through continuous airflow or over-ventilation, depending on the building's thermal inertia
→ Minimize or eliminate the need for air conditioning

WINTER



Winter Objectives Achieved:
→ Significantly preheat cold air: 10°C higher at the Earth-Air Heat Exchanger outlet
→ Preheat fresh air for the AHU without the need for an anti-freeze heating coil
→ Reduce heating demand

Technical Benefits

A Cast iron System

Cast iron has a proven lifespan of 70 to 100 years, backed by over 150 years of experience in the field.

Mechanical Strength (MPa)

Cast iron is renowned for its exceptional mechanical properties, including: impact resistance (bending and ovalization stress), **high resistance to soil loads (no deformation), withstands rolling loads (can be buried under traffic zones without risk of crushing).**

Thanks to its mechanical characteristics, the ELIXAIR® system is highly robust and long-lasting. Its mechanical properties are validated through rigorous testing. Minimum tensile strength: 420 MPa; minimum elongation at break: 10%, in compliance with section 6.3 of NF EN 598. With these high-performance characteristics, the ELIXAIR® system can withstand construction loads and be installed in a variety of demanding locations, including: under buildings, beneath parking lots, under roadways and highways, and with a depth of cover of up to 6 meters.

Exterior Coatings

The exterior coatings are designed to withstand a wide range of soil conditions, as specified in the calculation note. They comply with NF EN 877:2021 standards and provide superior corrosion protection.
DN 300: ZINALIUM external coating: Zn85Al15 alloy (400 g/m²) with a 70 µm grey epoxy finishing layer (compliant with NF EN 598).
DN 500: External coating with a minimum 200 g/m² zinc layer and a 70 µm grey acrylic finishing layer (compliant with NF EN 598).
For detailed installation guidelines based on soil type, refer to the Technical Approval (Avis Technique).

The ELIXAIR® system has obtained a Technical Approval (Avis Technique) issued by the French CSTB, an independent scientific and technical body that assesses the performance, safety, and compliance of innovative building solutions. This approval serves as a recognized validation for the construction sector, similar to technical assessments and certifications found in other countries.

Water and Air Tightness

The ELIXAIR® Earth-Air Heat Exchanger ensures water and air tightness, meeting the requirements set forth in the Technical Dossier* (NF EN 877, NF EN 1610). Additionally, cast iron does not undergo ovalization over time, allowing it to maintain its long-term sealing performance.

In compliance with the L method of NF EN 1610, it is strongly recommended to conduct an air tightness test on the network before final backfilling to verify proper installation.

A properly executed test ensures compliance with best practices, validates the acceptance of the installation, and qualifies it for the installer's liability warranty, covering any defects in workmanship or materials, when applicable.

Sealing and Root Penetration Tests

All assemblies of the ELIXAIR® Earth-Air Heat Exchanger network meet, at a minimum, the following requirements as per the testing method defined in NF EN 545 and NF EN 598:

- **Air tightness under a 0.9 bar depression (negative internal air pressure)**
- **Water tightness under 2 bar internal pressure**
- **Water tightness under 2 bar external pressure.**

Root Penetration Test

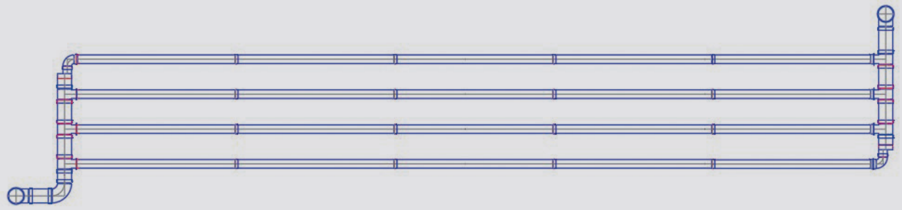
Tests show that the seals used in the ELIXAIR® range prevent root penetration (test according to EN 17970:2024).

*The Technical Dossier is a detailed technical file that provides essential documentation to demonstrate compliance with building standards and regulations. It includes design specifications, performance data, and installation guidelines that must be followed to ensure the system meets the required safety and performance criteria.

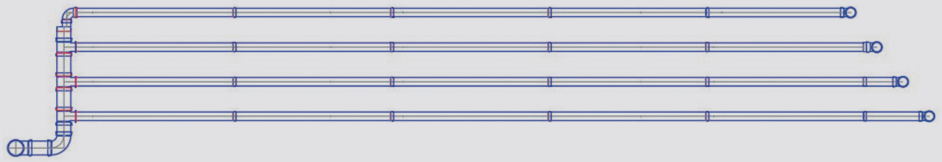
Generic Design (Tickelmann Loop)

TWO EXAMPLES OF CONNECTIONS WITH 4*DN300 (REFER TO TECHNICAL APPROVAL)

The Tickelmann loop principle involves equalizing the pressure losses between the different branches of a hydraulic or air distribution network (heating, air conditioning, solar network, etc.) by ensuring each branch has the same length, the same number of bends, and the same equipment. This way, each branch of the network experiences the same pressure drop.



The Earth-Air Heat Exchanger must follow the Tickelmann loop, meaning the air intake is diametrically opposite to the air outlet. This configuration ensures that the airflow is balanced within the ducts of the heat exchanger.



In certain cases, we can integrate multiple air intakes. This reduces costs and significantly minimizes the pressure drop associated with the Earth-Air Heat Exchanger. However, branch balancing is required: we must shorten the branches furthest from the intake (maintaining the same principle, as all branches work equivalently).

Application Areas for the ELIXAIR® Earth-Air Heat Exchanger

The ELIXAIR® Earth-Air Heat Exchanger system is designed to be installed:

- Under gardens and green spaces
- Under any type of vegetation
- Under vehicle parking areas
- Under roadways and pavements
- Under buildings

Indoor Air Quality Preservation

The tests for selecting the indoor coating were conducted by the MEDIECO Institute.

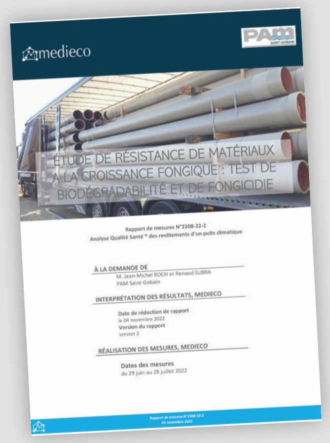
The following two points concern the indoor coating.

VOC emissions (Product Hygiene)

The Earth-Air Heat Exchanger carries fresh air, so it is essential to have a suitable coating to protect indoor air quality, occupant health, and the longevity of the raw cast iron.

The internal protection of our pipes is a healthy and adhesive epoxy resin that prevents air from coming into contact with the metal. Tests have confirmed that it does not release solvents or VOCs after drying. **In conclusion, the internal coating is chemically inert.**

Air intake is equipped with **a coarse filter ISO 60%** (previously known as G4), designed to trap particles from the outside air that could negatively affect the comfort of the building (such as pollen, dust, etc.).



Fungal and Bacterial Testing (ISO 16000)

Fungal and bacterial resistance test performed according to ASTM D3273 and NF EN ISO 846 standards, adapted to the specific conditions of earth-air heat exchangers.

Tested strains:

- Aureobasidium pullulans IHEM N°22776 (Ap)
- Aspergillus fumigatus IHEM N°1246 (Af)
- Aspergillus glaucus IHEM N°2425 (Ag)
- Fusarium solani IHEM N°2099 (Fs)
- Alternaria alternata IHEM N°18586 (Aa)
- Cladosporium herbarum IHEM N°3260 (Ch)
- Aspergillus niger IHEM N°3766 (An)
- Rhizopus stolonifer IHEM N°0718 (Rs)

Conclusion: The epoxy formulation has demonstrated high resistance to fungal contamination: none of the selected strains proliferated upon contact with this coating. In other words, the coating used does not provide a "food source" for microorganisms to grow.

Filters

Thanks to G4 filters, the air quality at the output of the Earth-Air Heat Exchanger is better than the outside air.

As a result of pre-filtration, the lifetime of the central air filter (which is often more expensive) increases significantly.

It is imperative to check the filter for dirt at least 3 times per year and replace it if necessary.

Regular filter maintenance is essential for the proper functioning of the system.

Condensate Management

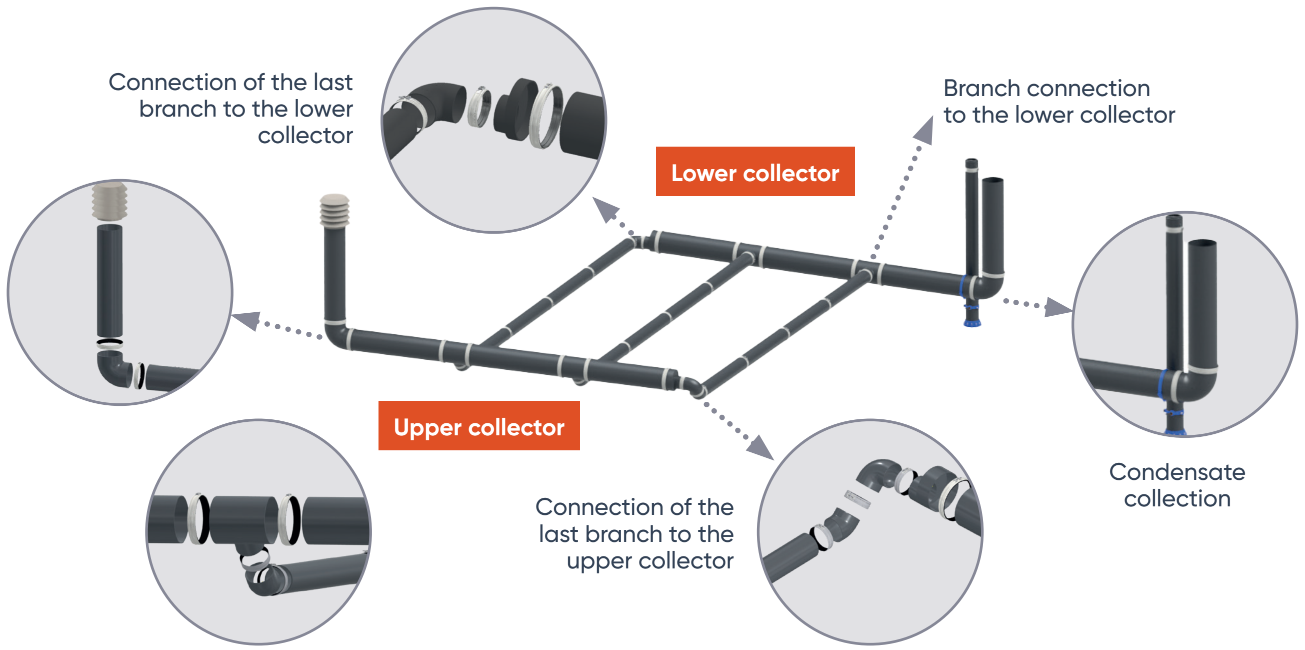
Condensates may form in the network, so a 1.5% slope is essential to ensure that the condensates can be collected at the low point, in a dedicated collection pit equipped with a micro-pump for drainage.

Furthermore, thanks to our sealed collection pit, the condensates are not in contact with the air, which helps prevent any risk of unpleasant odors.

The use of a "lost pit" is to be avoided (i.e., drilling the bottom of the pit to prevent any upward movement of water tables or contamination from pollutants like radon or gas).

If the Earth-Air Heat Exchanger is installed in a basement, the condensates can be drained by gravity using a siphon, eliminating the need for an external collection pit.

Our ELIXAIR® Solutions



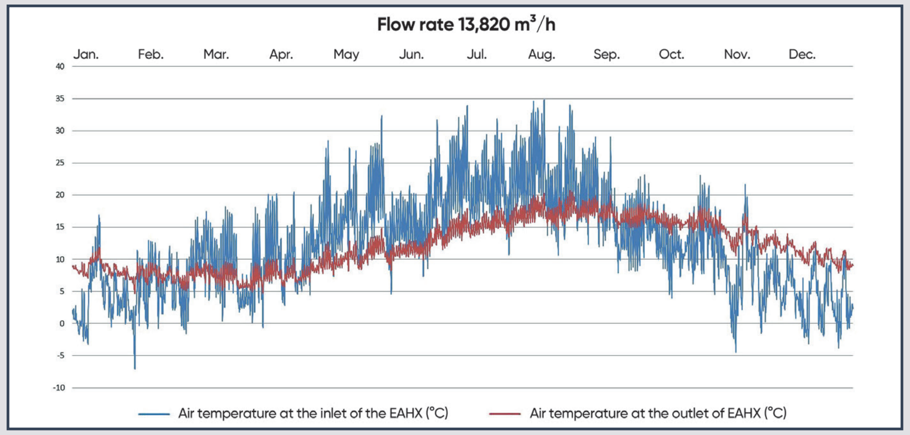
pam building supports you throughout the entire project development process, from design to execution

Here are the services associated with the supply of the ELIXAIR® range:

FEASIBILITY STUDY

Depending on the context and project, we have the experience to assess the potential applicability of our solution to your project.

THERMAL CALCULATION AND PRESSURE DROP NOTE



- → RE2020 Algorithm with the THBCe method
- → COSTC Algorithm with the RAGE method
- → Possible parameters:
  - Flow rate variation
  - Loading of a specific climate zone
  - Operating hours
  - And more...

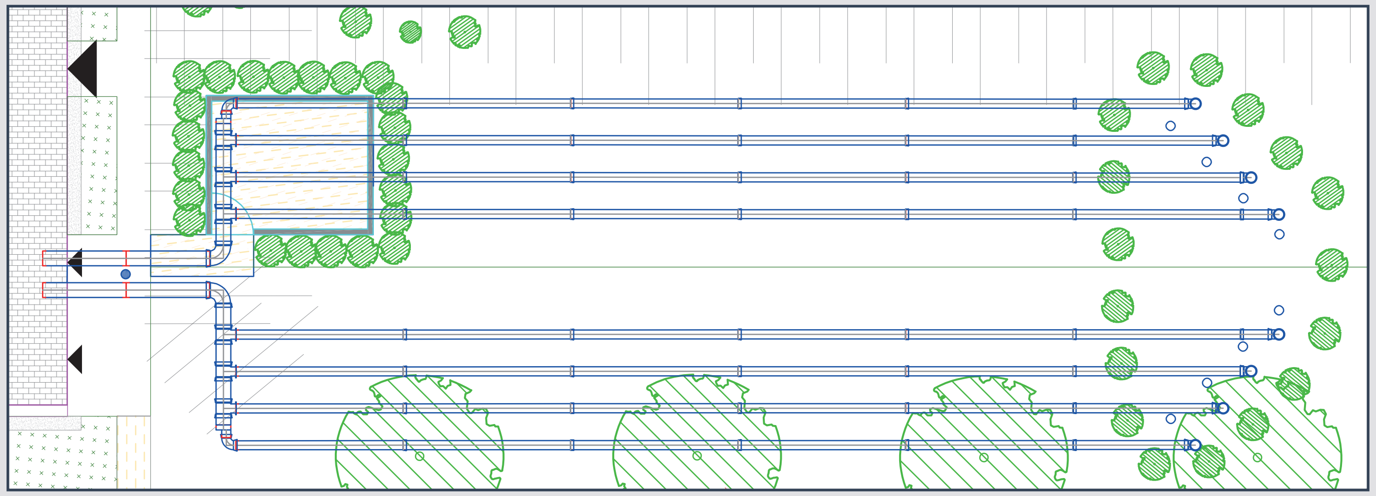
CREATION OF ISOMETRIC PLAN

- → DWG
- → BIM

Any questions?
Contact us by email at:
elixair@saint-gobain.com

TECHNICAL ADVICE

- → Instrumentation of the Earth-Air Heat Exchanger
- → Bypass management
- → Most suitable ventilation system
- → System implementation
- → CCTP, FDES, Technical Approval



SUPPORT FOR INSTALLATION COMPANIES

- → During the tender phase
- → In the pre-execution phase to prepare the installation
- → On-site, during the implementation phase

DURING OPERATION

- → Startup protocol
- → Regulation advice
- → Maintenance guide and advice

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