GF Piping Systems

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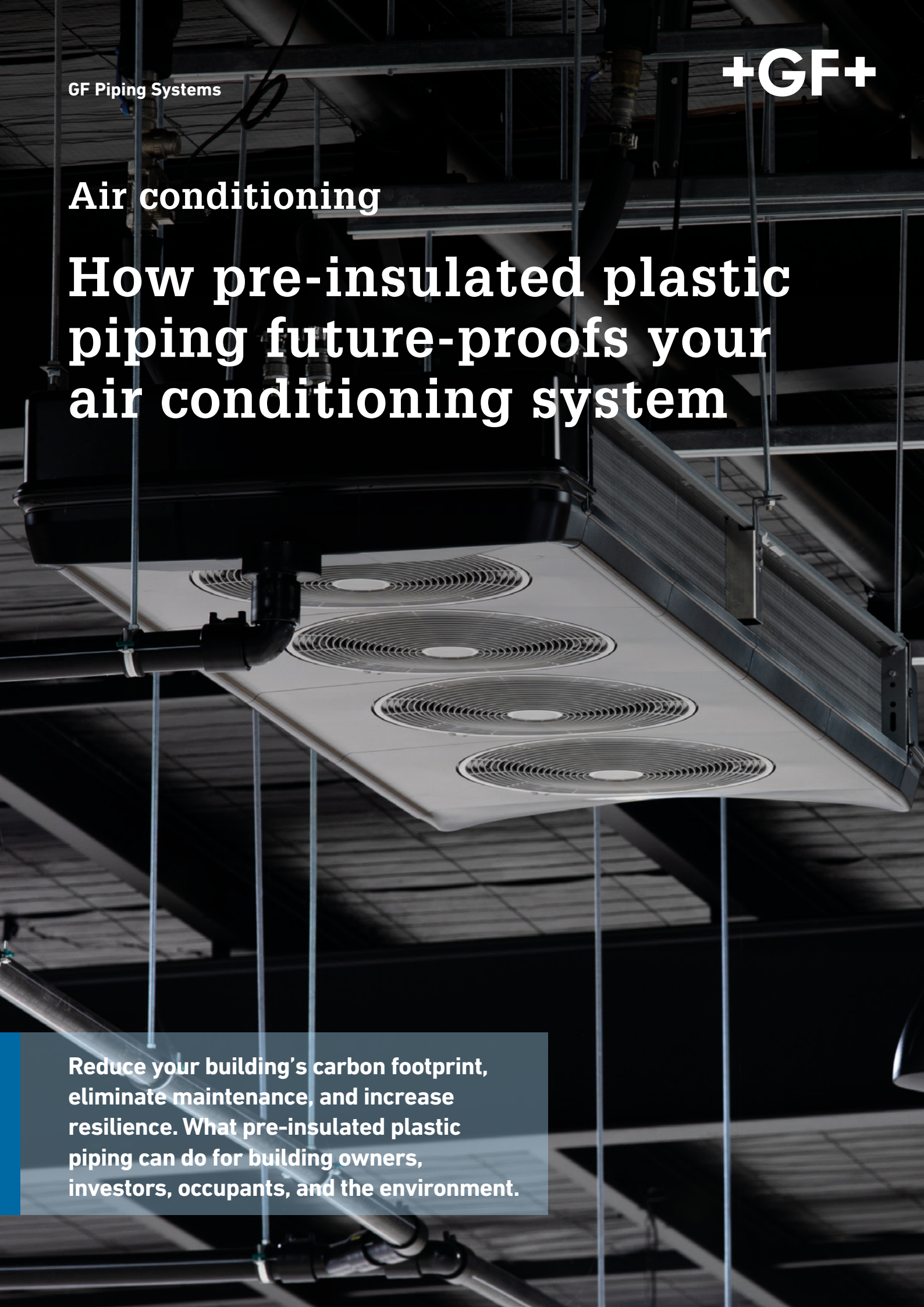
Air conditioning

How pre-insulated plastic piping future-proofs your air conditioning system



Reduce your building's carbon footprint, eliminate maintenance, and increase resilience. What pre-insulated plastic piping can do for building owners, investors, occupants, and the environment.

Abstract

Air conditioning's growing global footprint

Global demand for heating, ventilation, and air-conditioning (HVAC) solutions is on the rise, driven by population growth, rising income in developing economies, heightened expectations in terms of comfort, and increasing demand from service and industrial applications. Already today, buildings account for roughly 40 percent of total CO_2 emissions. Of those, 40 percent stem from HVAC applications, with cooling accounting for a growing piece of the pie.

By 2050, two-thirds of the world's households will use air conditioning (AC), according to the International Energy Agency (IEA). Space cooling will be the fastest-growing use of electricity in buildings, going up from around 2000 TWh in 2016 to over 6 000 TWh in 2050. This growth will be paralleled by a rise of the share of cooling in the overall power sector CO_2 emissions from 8 to 15 percent.[1]

With the growing demand for cooling, meeting global greenhouse gas emissions targets to limit climate change will require adopting more efficient cooling applications.

Fortunately, there is vast upside potential. Only a fraction of cooling solutions in use today are highly power-efficient. Upgrading these could considerably increase energy efficiency, reducing building-associated CO_2 emissions. New environmental regulations and sustainable construction certification schemes are already in place to incentivize the adoption of state-of-the-art solutions in new buildings. However, the long service life of already deployed solutions and the high cost of upgrading them will slow down their uptake in the existing building stock.

To address the building sector's sustainability challenges and tap into its vast greenhouse gas reduction potential, efficiency gains need to be exploited wherever they are available. As outlined in this white paper, that begins with a piping system with high-performance insulation.

But benefits of adopting state-of-the-art piping solutions go far beyond reducing greenhouse gas emissions. Building owners, tenants, investors, businesses, and occupants all stand to gain from various factors the World Green Building Council has identified as contributing to the value of sustainable buildings.[2]

- Reduced operating costs
- Improved risk mitigation
- Higher asset values
- Protection of their investment
- Access to financial tools
- Reputational advantages
- Improved productivity and wellbeing

This white paper explores how pre-insulated plastic piping can help future-proof air conditioning systems. After providing an overview of cooling solutions and common piping systems, it highlights the sustainability benefits of pre-insulated plastic piping over more conventional metal-based solutions. Finally, it explores the overall capacity of plastic piping solutions to future-proof AC applications, revealed in a comprehensive comparative lifecycle analysis of a real-world deployment.

[1] https://www.iea.org/reports/the-future-of-cooling
[2] https://worldgbc.org/beyond-the-business-case/

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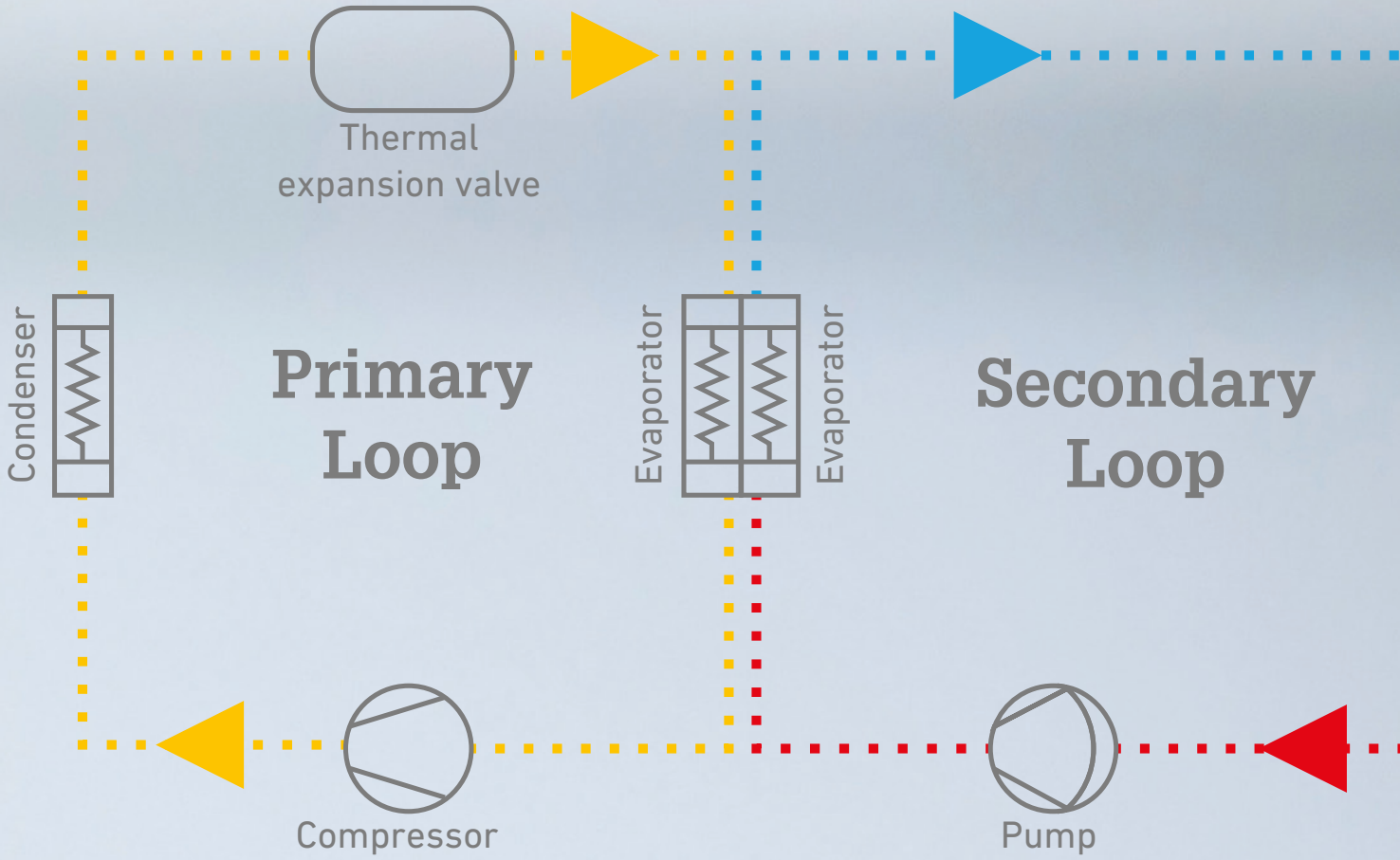
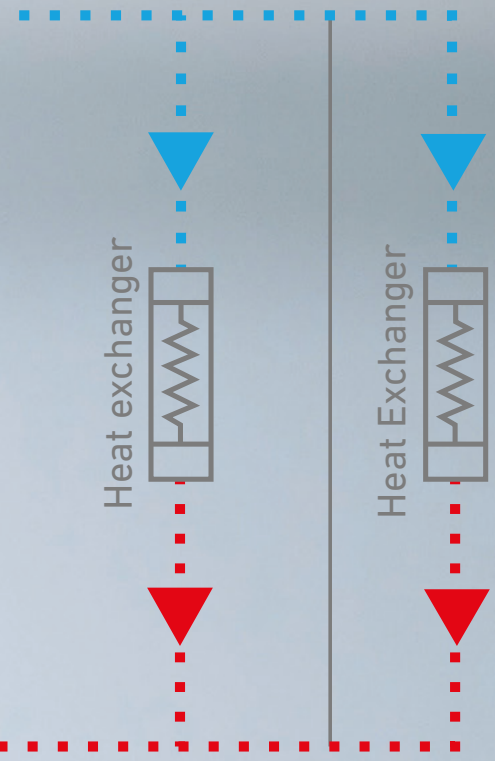


Cooling cycle

Piping systems and their role in air conditioning

The cooling cycle in a nutshell

The cooling component of any air conditioning (AC) system generally comprises two cooling loops. The primary cooling loop lowers the temperature of a refrigerant - often an HFC gas. The refrigerant absorbs heat from a typically larger secondary cooling loop, which distributes a usually water-based (non-HFC) coolant to air conditioning units deployed throughout the building.



Delivering lossless transportation of the cooling medium – and more

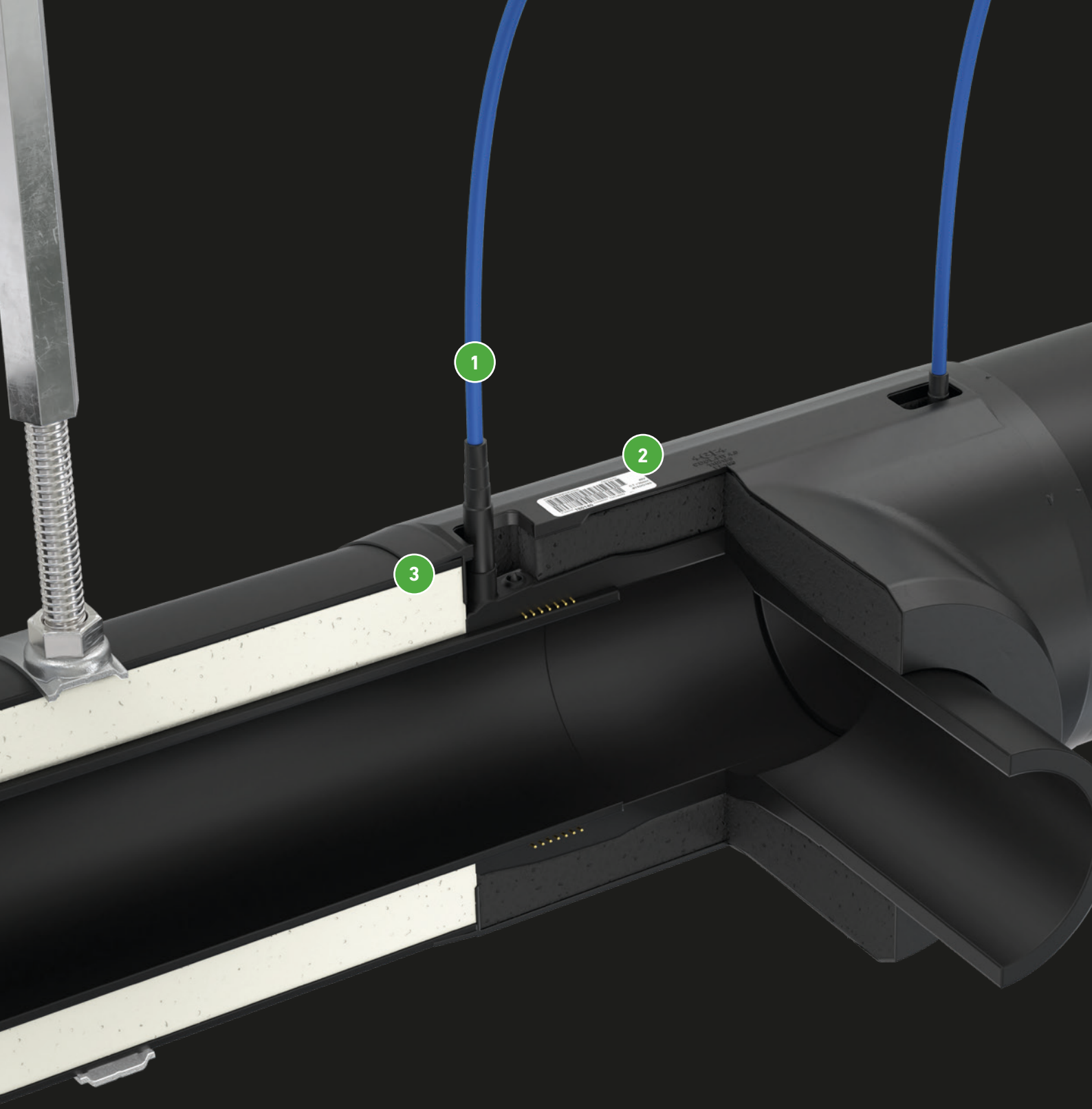
Pipes are a critical component of any cooling system. Centralized cooling systems used in medium to large buildings convey the refrigerant from the chiller to the heat exchanger in the primary cooling loop. In the secondary cooling loop, they deliver the water-based coolant from the heat exchanger to the building's air conditioning units, often using hundreds of meters of piping.

Designed to continuously maintain a set ambient temperature, the AC system makes up for any thermal losses incurred as the coolant flows through the pipes by lowering its set point temperature. Because this negatively affects the cooling system's power efficiency and carbon footprint, piping systems typically feature an insulation layer that minimizes thermal losses from the cooling medium.

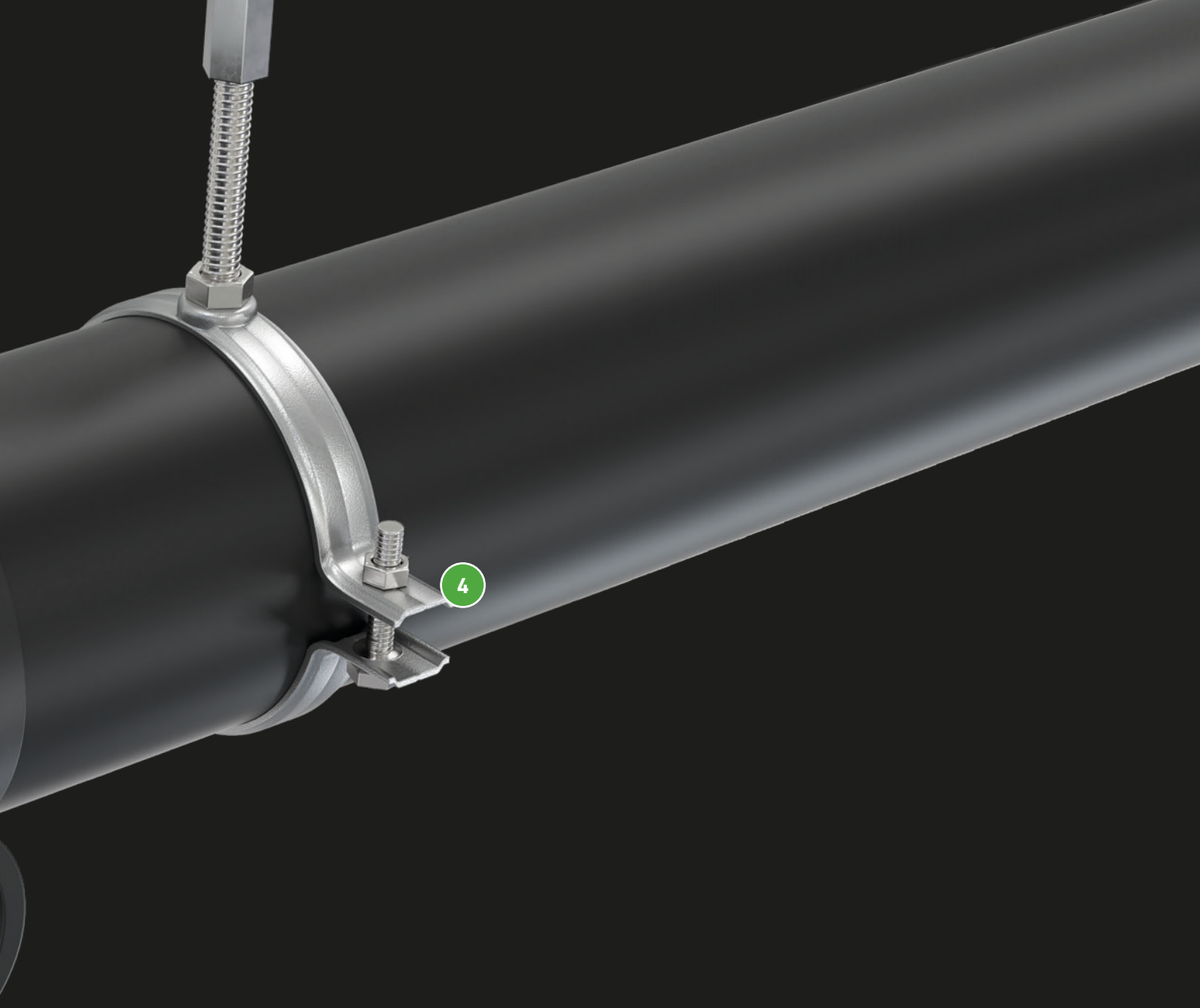
Thermal insulation is, however, only one functionality that piping systems need to deliver. As part of the building's integrated infrastructure, they also need to be easy to install correctly, offer minimal maintenance throughout their long lifetime, and be simple to dispose of. Just as importantly, they need to be cost effective across all phases of their lifecycle. If poorly installed on day one, pipes can go on to perform below expectations for decades, needlessly wasting energy. Easy-to-set-up piping solutions and well-trained fitters help avoid this issue and reduce the need for costly maintenance by preventing destructive processes such as corrosion, molding, and incrustation from occurring in the first place.

State-of-the-art

The advantages that state-of-the-art piping systems offer go beyond operational effiency gains.
Choosing the right piping system can considerably cut capital and operational expenses, increase the value of assets, attract green investments, help access sustainable building subsidies, and solidify a business's reputation. At the same time, reliable performance can mitigate risks caused by adverse events and improve occupants' health, well-being, and productivity.



1 Welding wires and electrofusion unit
2 Welding indicator and tracking code
3 Pipes and fitting with sealing lip
4 Fixation



Anatomy

Secondary cooling piping system

In general, AC piping solutions are expected to deliver a variety of functionalities:

- Ease of high-quality installation
- Lossless transportation of the cooling medium
- Minimization of thermal losses
- Condensation protection to prevent corrosion of metal piping and molding of the insulation
- Seamless integration of valves, actuators, sensors, and meters needed to implement the HVAC solution

To fulfill these requirements
Piping solutions typically comprise multiple layers offering complementary functions:

- The inner pipe, referred to as the medium pipe, transports the coolant
- An insulation layer, which prevents heat loss from the medium pipe
- A moisture barrier, which prevents water vapor from penetrating the insulation and causing the formation of mold or corrosion
- An outer jacket, which protects the insulation from damage

Piping solutions

Comparing piping solutions used today

Today's medium pipes are commonly made of steel, copper or, increasingly, plastic. Steel pipes, still the most prevalent today, have considerable drawbacks compared to plastic ones. These include their higher weight, energy-intensive production, and susceptibility to corrosion.

Piping system materials

Steel pipes

- Have a higher weight
- Require energy-intensive production
- Are more susceptible to corrosion

Today's medium pipes are commonly made of steel, copper or, increasingly, plastic. Steel pipes, still the most prevalent today, have considerable drawbacks compared to plastic ones. These include their higher weight, energy-intensive production, and susceptibility to corrosion.

Polyethylene pipes

- Are light-weight
- Require less energy in production
- Are not susceptible to corrosion

Polyethylene pipes, on the other hand, are light-weight and require less energy in production. Additionally, their smoother surface delays or eliminates the onset of incrustation within the medium pipe.

Insulation materials for AC piping systems

Flexible elastomeric foam

The most common insulation materials for AC piping today are flexible elastomeric foam, polyurethane-based foams (PUR or PIR), and cellular glass, which each have their own set of advantages and disadvantages.

Polyurethane-based foams (PUR or PIR)

Soft-foam insulation, for example, is easy to cut on-site during installation, while cellular glass and hard polyurethane-based foams need to be milled in a specialized factory and shipped to the site. Both soft-foam insulation and cellular glass are easily damaged during installation.

Open-cell insulation materials require an additional moisture barrier to prevent water vapor from penetrating the insulation, potentially triggering mold formation or corrosion. Therefore, closed-cell insulation materials such as flexible elastomeric foams, PU-based foams, and cellular glass, are used predominantly and help to avoid incursion of moisture altogether, eliminating the need for an additional moisture barrier.

Cellular glass

How pre-insulated plastic piping raises expectations on all fronts

Pre-insulated plastic piping offers multiple advantages over other piping systems that contribute to future-proofing AC solutions.

50%

faster installation[3] and easy jointing using electrofusion

In addition to shortening installation times, electrofusion jointing increases the safety, quality, and performance of the air conditioning system.

60%

more lightweight than steel

Light-weight plastic piping allows for flawless, single-person installs and lighter building structures, reducing construction costs and the CO_2 footprint.

30%

higher energy efficiency

High-grade, highly robust pre-insulation in the factory prevents heat bridge formation around clamps and reduces losses due to imperfect mounting, torn moisture barriers, and wet insulation.

Zero

corrosion and incrustation

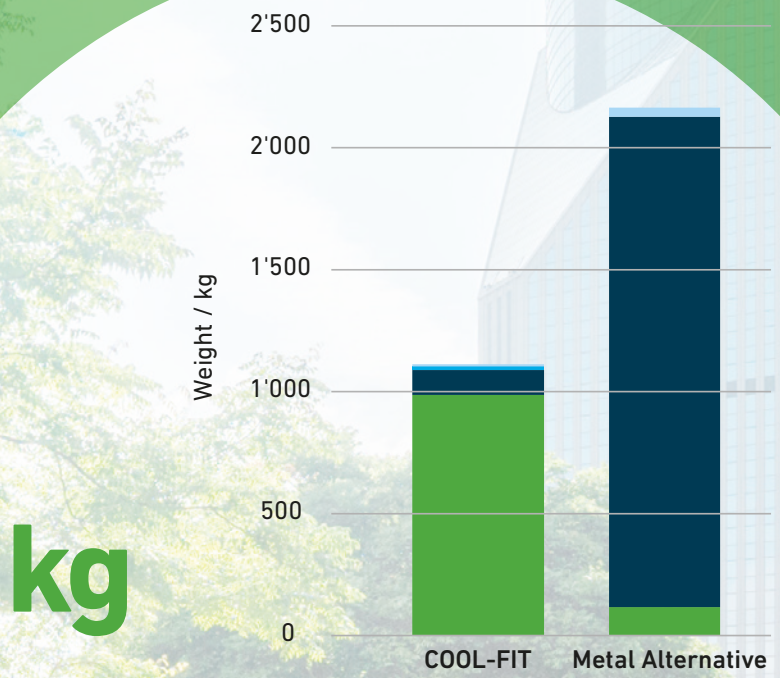
Non-corrosive materials and extremely smooth surfaces reduce corrosion, leaks, and mold, offering maintenance-free operation over the system's foreseen 25-year lifecycle.

[3] On average


TOYOTA

Comparing pre-insulated plastic and post-insulated steel in an office air conditioning system

A comprehensive life-cycle analysis (LCA) based on a construction project in Germany compared the environmental impacts of pre-insulated plastic AC piping and post-insulated steel. The analysis revealed unprecedented quantitative insights into the benefits of plastic-based piping over steel-based piping across multiple dimensions.



kg

	COOL-FIT	Metal Alternative
Non-ferrous materials	9 kg	38 kg
Fiber-reinforced polyamide	14 kg	0 kg
Ferrous materials	102 kg	2'010 kg
HDPE, GF-HE, and other plastics	987 Kg	117 Kg
Total	**1'112 kg**	**2'165 kg**

The LCA, carried out in partnershp with Swiss Climate AG, a Swiss consultancy in the areas of CO_2 management, sustainability, CO_2 offsetting, and energy, assessed the environmental impact of both solution variants in the context of a real-world office building. Focusing on the secondary cooling loop, the analysis compared a black steel-based AC piping solution detailed in an initial quote with the pre-insulated plastic piping solution that was, ultimately, deployed in the building using a proprietary solution.[4]

The LCA assessed the core environmental impacts of all the element used in the 380-meter-long piping system – pipes, fittings, ball valves, butterfly valves, clamps, and the pump – from cradle to grave.

[4] The pre-insulated plastic piping solution used in the secondary cooling cycle analyzed in the LCA was implemented using the COOL-FIT 2.0 piping system by GF.

The analysis dissected the lifecycle of the AC piping solutions into the following stages:

Learn more about LCAs

Key findings from the life-cycle analysis

The LCA revealed the following findings in terms of environmental impact:

The lifecycle stages

Unsurprisingly, the highest climate change impact was associated with operational energy required to power the circulating pump over the system's foreseen 25-year lifetime. Other high-ranking lifecycle stages included raw material supply, construction/installation, waste processing, and, in the case of the metal solution, replacement.

The highest discrepancy between the pre-insulated plastic and the post-insulated metal solutions were identified in production and replacement. The metal-based alternative, 5 percent of the black steel and 50 percent of the insulation typically need to be replaced after half of the lifetime, while the pre-insulated plastic piping solution requires no replacement throughout its 25-year lifetime.

The metal-based piping solution had a higher environmental impact across all impact categories and lifecycle stages except waste processing (explained by the fact that 100 percent of the metal can be recycled, whereas 60 percent of the plastic is incinerated). The metal solution's higher impact across the board stems from its significantly higher material needs and the higher environmental cost of processing metal compared to plastic, both in the production and replacement stages. This has knock-on effects in terms of the environmental impact of transportation.

Excluding the operational energy needed by the circulating pumps to drive the refrigerant throughout the system, which both solutions have in common, and energy needed for the chillers to make up for heat lost throughout the system, the

pre-insulated plastic piping solution causes an estimated 51 percent lower climate change impact than the metal-based solution.

Considering production only, the pre-insulated plastic system has a 61 percent lower production-associated carbon footprint than the metal alternative. Considering all lifecycle stages, the pre-insulated plastic system's global warming potential is four percent lower than that of the metal-based solution.

Superior across multiple dimensions

The LCA reveals how the pre-insulated plastic piping solution outperforms the steel-based solution across multiple dimensions. Given the growing prevalence of air conditioning solutions in markets around the world, a four percent reduction in global warming potential significantly reduces the environmental footprint of buildings.

The impact extends beyond greenhouse gas emissions reductions. Due to the vastly lower environmental footprint associated with the production of the pre-insulated plastic solution, it can help a construction project qualify for sustainable building certifications. Easy to assemble and unaffected by corrosion and molding, it eliminates costs and effort associated with maintenance and replacement while also preventing coolant from escaping the system and harming the building's users and the environment.

Embrace the cold with COOL-FIT 2.0

COOL-FIT 2.0, the robust pre-insulated plastic piping solution assessed in the life-cycle analysis presented in this white paper, is designed to make your cooling circuit more efficient.

A cutting-edge technology piping system, our COOL-FIT product portfolio includes pipes, fittings, valves, flexible hoses, and tools, ensuring complete system integrity and a perfect seal. Designed and optimized for fast and easy installation and at least 25 years of operations with zero interruptions and maintenance, it offers a reliable and efficient alternative to post-insulated piping systems.

30%

better thermal conductivity

The system's innovative design minimizes pressure losses and reduces thermal conductivity, improving energy efficiency over metal piping alternatives.

50%

faster installation time

The intuitive 3-in-1 pipe, insulation, and jacket design and electrofusion jointing halves installation time, reducing on-site work and labor costs.

100%

corrosion-free

Fully safeguarded against corrosion and condensation, COOL-FIT 2.0 is ideal for industrial cooling applications.

35%

less environmental impact

COOL-FIT 2.0 minimizes CO_2 emissions and reduces energy loss by 35% on average compared to post-insulated metal piping systems.

The reduced carbon footprint associated with the production and operation of COOL-FIT 2.0 contributes favorably towards qualifying construction projects for relevant green building certifications including DGNB, BREEAM, and LEED. Free of HBCD, halogens, and halogenated blowing agents, chlorinated paraffin, lead, or tin, COOL-FIT 2.0 meets the REACH criteria of the European Chemicals Agency. Moreover, the solution complies with strict quality management (ISO 9001) and health and safety management (OHSAS 18001) standards during production.

To learn more about how COOL-FIT 2.0 can help you future-proof your air conditioning solution and tap into the vast value that sustainable buildings can provide, head over to the COOL-FIT 2.0 product page or reach out to your nearest GF cooling expert.

www.gfps.com/coolfit

Scan to access the COOL-FIT 2.0 EPD

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