



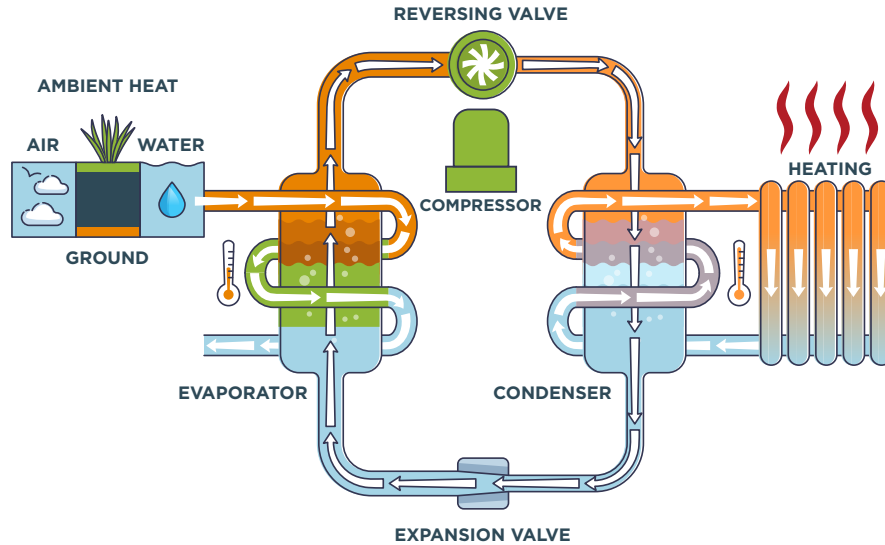
# HEAT PUMP INNOVATIONS: SUSTAINABLE COMPONENTS FOR ENHANCED PERFORMANCE

In the realm of sustainable heating and cooling, heat pumps represent a groundbreaking solution, offering exceptional energy efficiency by harnessing natural heat sources. With advancements in technology, modern heat pumps achieve remarkable energy savings while minimizing electricity consumption. Multiple trends are driving the global adoption of heat pumps, creating a significant business opportunity for heating equipment and component manufacturers to collaborate to improve device performance and sustainability. TE Connectivity (TE) offers a broad portfolio of connector and relay solutions made with eco-friendly materials that are space-saving and have ingress protection rated sealing capabilities.

According to Mordor Intelligence<sup>1</sup>, the global heating market reached nearly \$87 billion in 2023, with heat pump sales accounting for almost 78% of the total market share. With sales projected to reach \$137 billion by 2027, those firms that can innovate fast to meet emerging requirements stand to reap the lion's share of the spoils.

## THE HEAT PUMP REVOLUTION

Amidst the evolving landscape of energy-efficient solutions, heat pumps are emerging as a cornerstone technology. Unlike traditional furnaces or boilers reliant on fuel combustion, heat pumps operate by transferring heat from one location to another. Whether extracting warmth from the ambient air for heating or expelling heat to cool indoor spaces, these innovative systems offer impressive efficiency. Remarkably, they harness thermal energy even in freezing temperatures, making them versatile and reliable year-round. Moreover, their dual functionality can eliminate the need for separate heating and cooling systems, streamlining comfort management for homeowners and businesses alike. In a world increasingly prioritizing sustainability and cost-effectiveness, the surging popularity of heat pumps comes as no surprise.



A heat pump's coefficient of performance (COP) indicates how much heat it can move for each unit of electricity it consumes. Modern heat pumps can achieve COPs of 3 or higher, meaning they can provide 3-5 times more heat energy than the electricity they use. This translates to significant energy savings compared to traditional electric resistance heaters or furnaces.

Other factors that contribute to minimizing energy consumption in heat pump systems include inverter technology and variable-speed fans. Inverter technology continuously adjusts compression speed to match HVAC needs, allowing heat pump systems to precisely adjust their output according to heating or cooling demands. This avoids the energy-intensive "on/off" cycling typical of traditional systems, thus reducing peak energy demand and potentially lowering electricity bills depending on a utility's pricing structure. Additionally, variable-speed fans adjust airflow according to demand, saving energy compared to single-speed fans.

While heat pumps are generally more efficient, their effectiveness depends on factors such as climate, structure size, and insulation levels. Furthermore, incorporating sustainable components into heat pump design can contribute to the overall sustainability picture, supporting broader goals of protecting our planet.



### HEAT PUMP BENEFITS



Energy  
Efficient



Environmentally  
Friendly



Cost  
Savings



Convenience

## ENVIRONMENTAL IMPACT OF HEAT PUMPS

Heat pumps can play a crucial role in mitigating greenhouse gas emissions. Unlike furnaces and boilers, which rely on burning fossil fuels and emit greenhouse gases like carbon dioxide, heat pumps operate without direct emissions at the point of use. However, the indirect environmental impact of heat pumps hinges on the source of electricity. If electricity is generated from renewable sources such as solar or wind, the environmental footprint is significantly reduced compared to electricity sourced from fossil fuels, albeit still lower than combustion heating methods.

Moreover, heat pumps can seamlessly integrate with renewable energy sources like solar panels, resulting in heating and cooling systems that are virtually carbon neutral when powered by renewables. Beyond reducing greenhouse gas emissions, heat pumps offer additional environmental benefits such as minimal indoor air pollution—unlike systems relying on combustion—and lower noise levels compared to gas-powered alternatives.



Heat pumps will play a crucial role in the future as they can adjust their operation based on the availability of electricity or other household electricity usage. The electrification of vehicles will require expanding power distribution systems, which will benefit heat pumps by enhancing the efficiency of future electric consumption. In the future, heat pumps equipped with smart controls will integrate with solar panels and electric vehicle chargers to ensure more efficient energy usage.

*Source: Markets & Markets Mordor Intelligence*

Solar-powered HVAC systems are gaining momentum, driven by the increasing demand for sustainable solutions and technological advancements. As the world becomes more aware of the need for renewable energy, we can expect the following trends and developments:



**Improved Efficiency:** Ongoing research and development efforts are focused on enhancing the efficiency of solar panels and energy storage systems. This will lead to more efficient solar-powered HVAC systems that can generate more energy while occupying less space.



**Smart Integration:** Integrating solar-powered HVAC systems with smart home technologies will enable more effective control and management. Users will have the ability to remotely monitor and adjust HVAC settings, further optimizing energy consumption.



**Energy Storage Solutions:** Advancements in energy storage technology, such as better batteries and advanced thermal storage systems, will address the issue of intermittent solar power generation. This will enable solar-powered HVAC systems to operate even during non-sunny periods.

## SHIFT TO RELIABLE AND SUSTAINABLE COMPONENTS

There is a global shift towards the use of more reliable and sustainable components for heat pumps, driven by several factors. For one thing, the increased demand for heat pumps prompts manufacturers to invest in research and development for better components. Heat pumps, particularly in high-vibration environments, necessitate the utilization of reliable components to ensure optimal performance and prevent mismatching issues. Also, governments around the world are implementing stricter regulations on emissions and energy efficiency, thus incentivizing manufacturers to develop cleaner and more efficient heat pumps. Manufacturers are also focusing on using sustainable materials and processes in their production. This includes using recycled materials, reducing waste, and minimizing the environmental impact of manufacturing.

### GLOBAL HVAC MARKET INSIGHTS

IEA reported that **North America currently holds the highest number of heat pumps installed** for heating buildings. In 2022, heat pumps surpassed gas furnace sales in the United States, following a period of nearly equal growth.

Europe announced the installation of **60 million more heat pumps by 2030**, in line with the EU targets, which would reduce the EU's gas demand in buildings by 40% by 2030 compared to 2022 and reduce its energy import bill by EUR 60 billion.

The **Global HVAC market** is shifting towards environmentally friendly refrigerants with a low rate of global warming potential (GWP) and energy-efficient technologies.

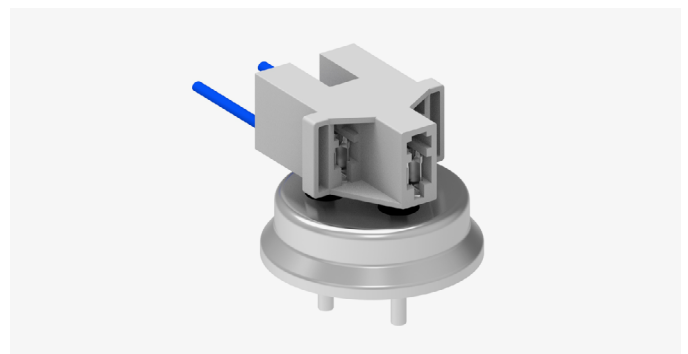
*Source: Markets & Markets Mordor Intelligence*

Research is ongoing to develop new, more reliable, and efficient components for heat pumps. The innovations include developing quieter and more efficient compressors that operate at higher temperatures and broader power ranges. Another innovation is utilizing lighter, stronger, and more corrosion-resistant materials for different components. Magnetic-bearing compressors eliminate the need for oil lubrication, reducing maintenance and refrigerant leaks. Variable-speed inverter technology allows for precise compressor speed control, optimizing efficiency and reducing energy consumption.

## SUSTAINABLE MATERIALS TO LIMIT CARBON FOOTPRINT

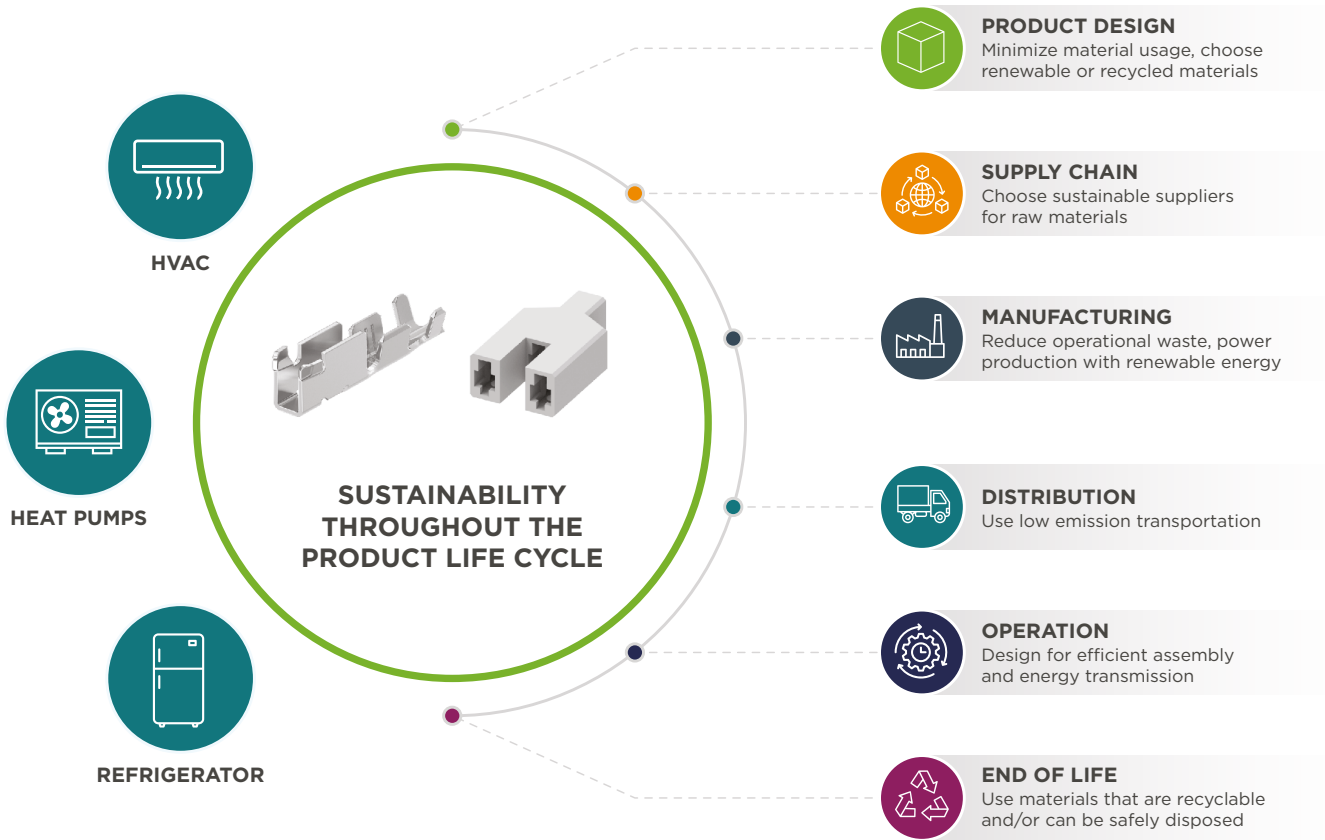
At TE Connectivity, we recognize the significance of integrating sustainable components into heat pump systems. By embracing our space-saving and reliable component solutions, you can unlock a realm of unparalleled comfort, sustainability, and performance. Our commitment to sustainability is evident in our designs, where we prioritize the use of recycled or renewable alternatives with lower carbon footprints over virgin materials. Furthermore, we continuously strive for efficiency improvements during manufacturing processes and develop connectors that use flame retardant materials, ergonomic design and insulation protection. With TE Connectivity, you can trust that your heat pump system not only delivers exceptional performance but also contributes to a greener, more sustainable future.

One example of our sustainable solutions is our cluster block products, specifically designed for compressor applications such as air conditioners, heat pumps, and refrigerators. These cluster blocks feature a low-cost, fully insulated electrical quick-connect system that mates with hermetic compressor header pins. They are engineered for high-impact resistance, providing durability against shock and abuse, and can provide long-lasting performance even in the presence of oils and refrigerants. By enhancing the reliability of compressors and reducing energy consumption, our products contribute to minimizing carbon footprint while promoting sustainability in heat pump systems.

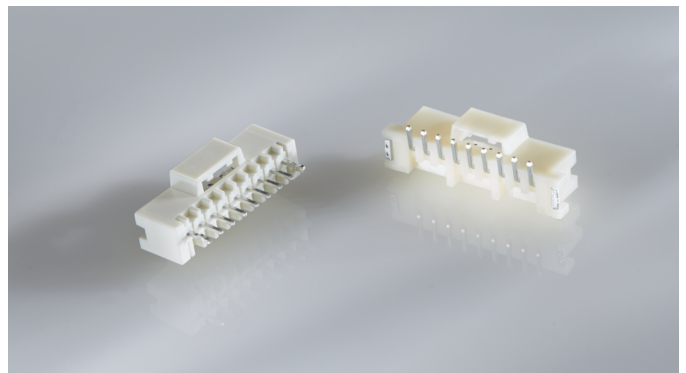


[HERMETIC CLUSTER BLOCKS](#)

Reducing connector temperatures during operation minimizes wasted energy and enhances appliance efficiency, especially for compressors. Our sustainable cluster block achieves this through innovative design features, including an additional contact beam that optimizes energy transmission and reduces temperature rise. The cluster block also incorporates a lead-in alignment feature for safer and more productive assembly processes. Crafted from renewable, plant-based material, it meets rigorous International Electrical Code (IEC) standards, with 50% castor bean oil composition, making it halogen-free and significantly reducing its environmental impact. This material reduces the cluster block's carbon footprint by over 45% throughout its life cycle, while eliminating potential health hazards associated with traditional materials.



At TE Connectivity, we prioritize miniaturization in our product designs to reduce material content and offer lighter-weight solutions. Our compact 2.0mm Signal GRACE INERTIA connectors are a testament to this commitment, featuring innovative designs that enhance manufacturing efficiency by preventing assembly errors and supporting automated production processes. With surface mount technology (SMT) headers providing a lower mating height than conventional through-hole headers, these connectors are both reliable and robust, making them useful for even the harshest and smallest applications in the home appliances industry.



[2.0MM SIGNAL GRACE INERTIA CONNECTORS](#)

TE Connectivity also offers highly reliable, efficient electromechanical relay solutions to the heat pump market, including a wide range of variations. Our power PCB relays are used in thermostats, electric boilers, general pumps, heat pumps, fan control and more within HVAC systems. Inrush capabilities and long life with high switching cycles combined with a high temperature range make TE's power PCB relays a strong choice for HVAC applications.



By January 2025, refrigerants using legacy Hydro Fluoro Carbon(HFC) gases will no longer be allowed due to environmental regulations. By that point, all new residential HVAC units must operate with more eco-friendly gases (known as A2Ls) in their systems.

Here at TE Connectivity (TE), we are a big supporter of HVAC manufacturers to help meet the industry standards by providing components that receive the certifications! Check the components that have received UL 60335-2-40 A2L certification.

## EMBRACING SUSTAINABLE HVAC INNOVATION

Using sustainable components in the manufacturing of heat pumps not only enhances their overall efficiency but also contributes to minimizing their environmental impact. While connectors may appear as small details in the grand scheme of the global transition to sustainable technologies, it's essential to recognize that even marginal improvements in sustainability can significantly contribute to the overall solution.

As HVAC manufacturers continue to innovate and optimize heat pump technology over the coming decades, incorporating new low global warming potential (GWP) refrigerants and leveraging advancements in artificial intelligence, TE stands ready to support these developments. Our commitment to providing rugged, sustainable components enables HVAC manufacturers to seize new opportunities, helping enable that their products deliver the desired performance and efficiency gains while aligning with evolving environmental standards and regulations.

**HARNESS THE HEAT, PUMP UP THE SAVINGS**

Heat Pump Water Heater

Air-Sourced Heat Pump

Heat Pump Clothing Dryer

<sup>1</sup> HVAC Equipment Market Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029), Mordor Intelligence, research report, page 16, <https://www.mordorintelligence.com/industry-reports/hvac-equipment-market>

### te.com

TE Connectivity, TE connectivity (logo), TE and GRACE INERTIA, are trademarks owned or licensed by the TE Connectivity Ltd. family of companies. All other logos, products and/or company names referred to herein might be trademarks of their respective owners.

The information given herein, including drawings, illustrations and schematics which are intended for illustration purposes only, is believed to be reliable. However, TE Connectivity makes no warranties as to its accuracy or completeness and disclaims any liability in connection with its use. TE Connectivity's obligations shall only be as set forth in TE Connectivity's Standard Terms and Conditions of Sale for this product and in no case will TE Connectivity be liable for any incidental, indirect or consequential damages arising out of the sale, resale, use or misuse of the product. Users of TE Connectivity products should make their own evaluation to determine the suitability of each such product for the specific application. TE reserves the right to make any adjustments to the information contained herein at any time without notice.

©2024 TE Connectivity. All Rights Reserved.

Published 03-24