



BENEFITS OF SOLSTICE® TECHNOLOGY IN HEAT NETWORK APPLICATIONS

Solstice® ze Refrigerant (R-1234ze)
Solstice® zd Refrigerant (R-1233zd)



DELIVERING DECARBONIZED HEATING AT SCALE



SUSTAINABLE BUILDINGS

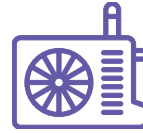
Buildings are responsible for 40% of global energy consumption and 33% of greenhouse gas emissions.

Moving towards renewable energy and eliminating fossil fuels in buildings will be key to our efforts to reduce emissions, lower energy costs, and tackle climate change.



DECARBONIZING EXISTING NETWORKS

The decarbonization of existing fossil fuel-powered heat networks is crucial to achieving Europe's net-zero emissions goal. By transitioning to low-carbon heat sources and embracing new technologies like Solstice® ze (R-1234ze) and Solstice® zd (R-1233zd) refrigerants, heat networks can become more energy-efficient and sustainable. The use of Solstice® refrigerants can enhance the efficiency of heat pumps applied in existing heat networks, reducing energy consumption and lowering costs for end-users.



NEW HEAT NETWORKS

Due to its exceptional energy efficiency and sustainability, Solstice® ze (R-1234ze) is the perfect choice for greenfield district heating projects that incorporate advanced technologies to optimize energy use. Its unique thermodynamic properties enhance system performance, resulting in energy savings and lower operating costs. Solstice® ze is also well-suited for use in lower-temperature heat pumps, enabling efficient utilization of renewable energy sources and significant reduction of carbon emissions.



SOLSTICE® DECARBONIZED HEATING AT SCALE

Solstice® ze (R-1234ze) and Solstice® zd (R-1233zd) refrigerant offers a safe, energy-efficient alternative to traditional refrigerants like propane R290, ammonia R717, and carbon dioxide (R744), striking a perfect balance between safety, sustainability, efficiency, and cost-effectiveness. With the new F-Gas regulations in Europe, Solstice® ze (R-1234ze) and Solstice® zd (R-1233zd) is a sustainable solution for district heating networks, ensuring compliance while reducing environmental impact.



FLEXIBLE PERFORMANCE

Simpler HFO heat pump design reduces capital costs, boosts efficiency, and subsequently reduces financial expenses and CO₂ emissions related to power usage. The wide operating range of Solstice ze refrigerant supports high-performance heat pumps for medium heat applications (55°C to 70°C) and high-temperature networks up to 100°C.

Meanwhile, fourth generation Solstice® zd (R-1233zd) refrigerant excels in high-temperature heat pump applications exceeding 100°C.



SUSTAINABILITY

Both Solstice® ze (R-1234ZE) and Solstice® zd (R-1233zd) have an ultra-low GWP of <1 and stand out as the green alternatives when compared to HFC refrigerants.

Solstice® ze and zd have zero ozone depletion potential (ODP). Solstice® ze has an atmospheric life of 18 days (about 2 and a half weeks) compared to more than 10 years of R-134a and R-410A, resulting in lower environmental impact and better compliance with environmental regulations.



SAFETY

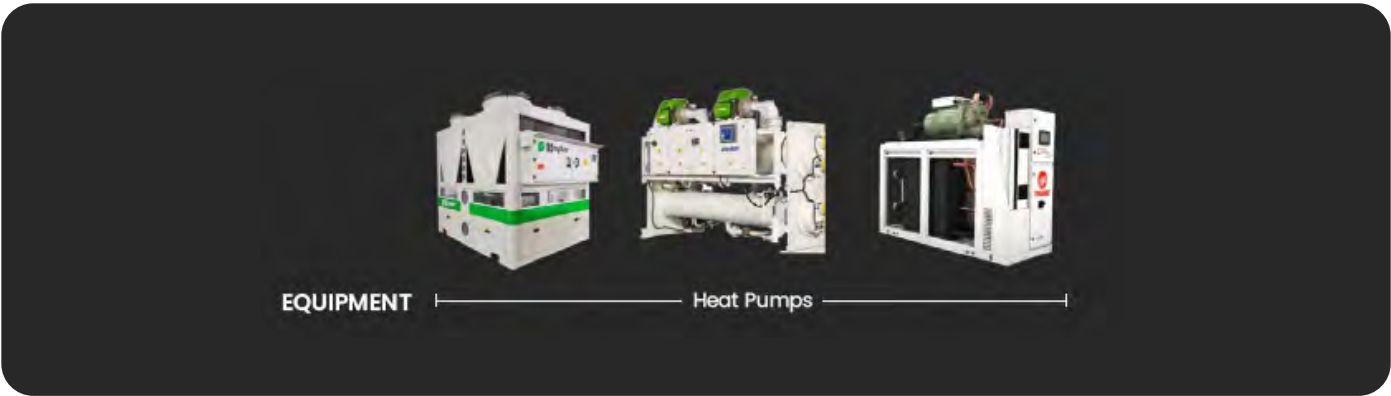
Solstice® ze (R-1234ze) is classified in safety group A2L, which is in the lower segment of the mildly flammable refrigerants and much safer than alternatives like propane, that is classified as a highly flammable refrigerant (A3), or ammonia, that is toxic (B2L). A unique characteristic of R-1234ze is that it is not flammable under 30°C. Therefore, R-1234ze is considered non-flammable for handling transportation and storage and is designated as nonhazardous according to the European directive PED (group 2).

Solstice® zd (R-1233zd) has a ASHRAE rating of A1 making it nontoxic and non-flammable.



MOVING TOWARDS LOW GWP REFRIGERANTS

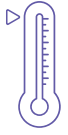
Increasing concerns about climate change have produced environmental regulations aiming to progressively phase down the use of High GWP F-gases, a group of chemicals containing fluorine. Ultra-low GWP F-Gases such as Solstice® ze (R-1234ze), and Solstice® zd (R-1233zd), are HFOs (Hydrofluoroolefins) with a GWP <1, allowing heat pump manufacturers to develop highly efficient and less complex technologies, when compared with alternative refrigerants.



APPLICATION	MARKET SOLUTION	SOLSTICE SOLUTION		COMPRESSOR TYPE
District Heat Network (below 100°C)	Fossil Fuel Combustion	Solstice ze (R-1234ze) GWP < 1 A2L		Screw (<1mw) Centrifugal (>1mw)
Urban Heat Network with specific safety requirements (below 100°C)	Fossil Fuel Combustion	Solstice N15 (R-515B) GWP = 293 A1	Solstice ze (R-1234ze) GWP < 1 A2L	
District Heat Network (above 100°C)	Fossil Fuel Combustion	Solstice zd (R-1233zd) GWP = 1 A1		



APPLICATION



WASTE HEAT, AIRPORT PRECINCT, EUROPE

An airport building in northern Europe replaced the old gas boiler with a 600kW heat pump that reuses heat in flue gas.



+75°C

Supplied temperature—high enough for district heating of the airport

COP 4.0

Improved overall efficiency with the potential to lower the total cost of system ownership

1,000

**MWH
PER YEAR**

Estimated savings with payback period of approximately four years

APPLICATION



SEA WATER HEAT PUMP NORWAY

The first and largest heating plant ever to utilize Solstice® ze (R-1234ze), with two heat pumps simultaneously producing:

- 2.5°C water for district cooling
- Heat recovery at 75°C for district heating



20 MW

Total heat capacity of both heat pumps in winter mode

COP 4.4

Improved overall efficiency with the potential to lower the total cost of system ownership

60–70 MW

Future estimated maximum heating power demand

APPLICATION



DISTRICT HEATING RINGSTED, DENMARK

The utility's old fossil-fuel-powered heat plant was transformed using Solstice® ze (R-1234ze) and Solstice partner compressors.



97%

Carbon-free heat for 7,000 buildings

30%

Capacity increase after just one year

20%

Efficiency increases after just one year

APPLICATION



URBAN HEAT NETWORK LONDON, UK

Replaced legacy gas boilers with modern heat pumps using Solstice N15 (R-515B) to help decarbonize the gas-powered heat networks serving 17,000 council homes.



100°C

Supported heat pump temperature, comfortably meeting 75–80°C requirement due to previous gas boilers

17,000

The network will supply heating to 17,000 of the 55,000 council houses

2030

Carbon neutral goal of 2030 for Southwark council.



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