



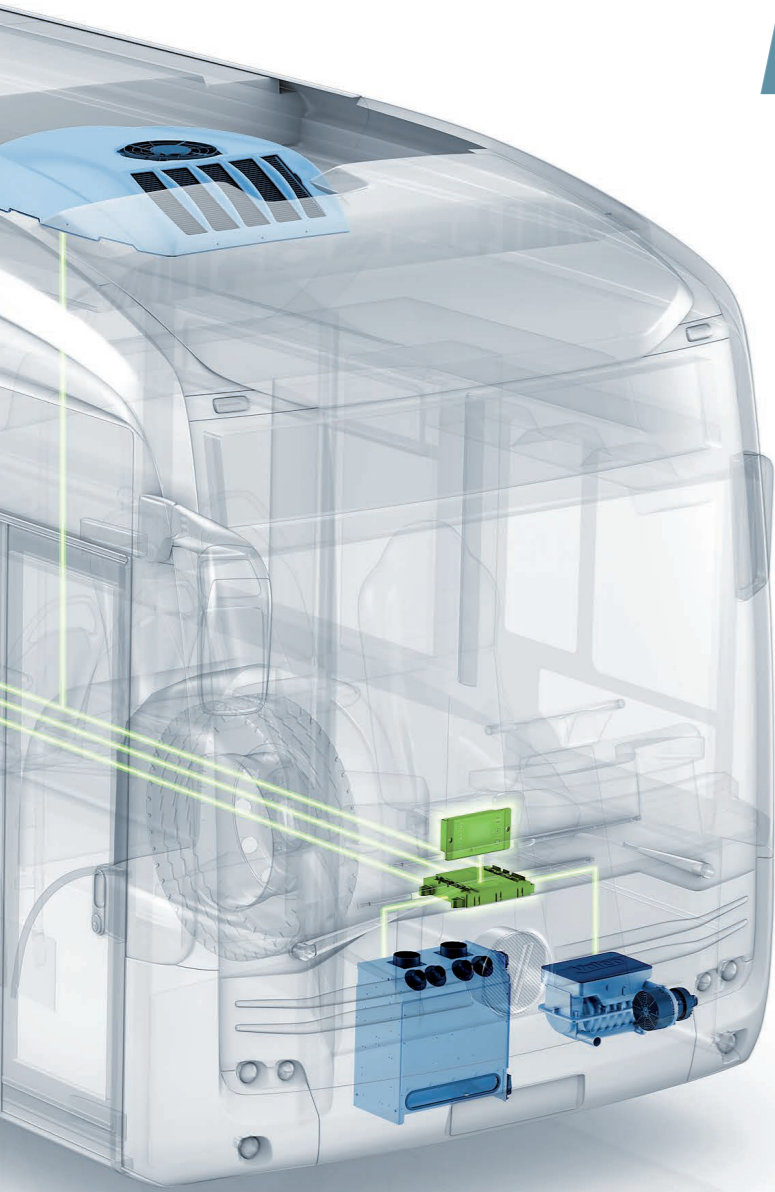
# BEST *e*BUS CLIMATE – SYSTEMIZE THE FUTURE



Cooling,  
heating,  
ventilation,  
we manage it all.

[BEST-BUS-CLIMATE.COM](http://BEST-BUS-CLIMATE.COM)

# STATE-OF-THE-ART BUSES SHOULD HAVE THE SMARTEST HVAC SOLUTIONS



*Major challenges are posed for the development of cutting-edge drives, e.g. electric or hydrogen-based, in particular by public transport with its special route profiles and operating times on the one hand, and the demands of the general public on the other. This directly concerns the energy supply for air conditioning in these vehicles and thermal supply to new aggregates, e.g. large battery packs that must be cooled.*

## DID YOU KNOW...?

that heating and air conditioning systems are among the most complex energy consumers in a bus? In particular, they make the heaviest demands on drives in E-buses. But at the same time they offer the greatest opportunities for energy saving.







# A SYSTEM IS MORE THAN THE SUM OF ITS INDIVIDUAL PARTS

**Holistic and intelligent thermal management of the entire system has never been more important in the operation of electrobuses. We call this holistic approach of clean and efficient air conditioning of hybrid and electrobuses „Entelligence“.**

A wide range of air conditioning components are interlinked and controlled by means of newly developed control software. Depending on the ambient conditions (mainly temperature), battery charging status and geographical position, the control system always selects the Valeo component with the maximum efficiency. Behind this lies an intelligent air conditioning strategy for buses. The energy requirements for the respective air conditioning task are estimated in advance and the components are selected by way of an optimization process.

Accordingly, the most efficient component for the respective application can be selected from the available air conditioning components (e.g. fossil or electrically powered heater, heat pump) according to the current heating requirements, existing restrictions (driving in an emission-free zone) or electric resources still available (charging status of the traction battery, SOC). If necessary, a number of heat sources can be employed simultaneously in boost mode. Communication with Valeo Entelligence takes place via body interface components:

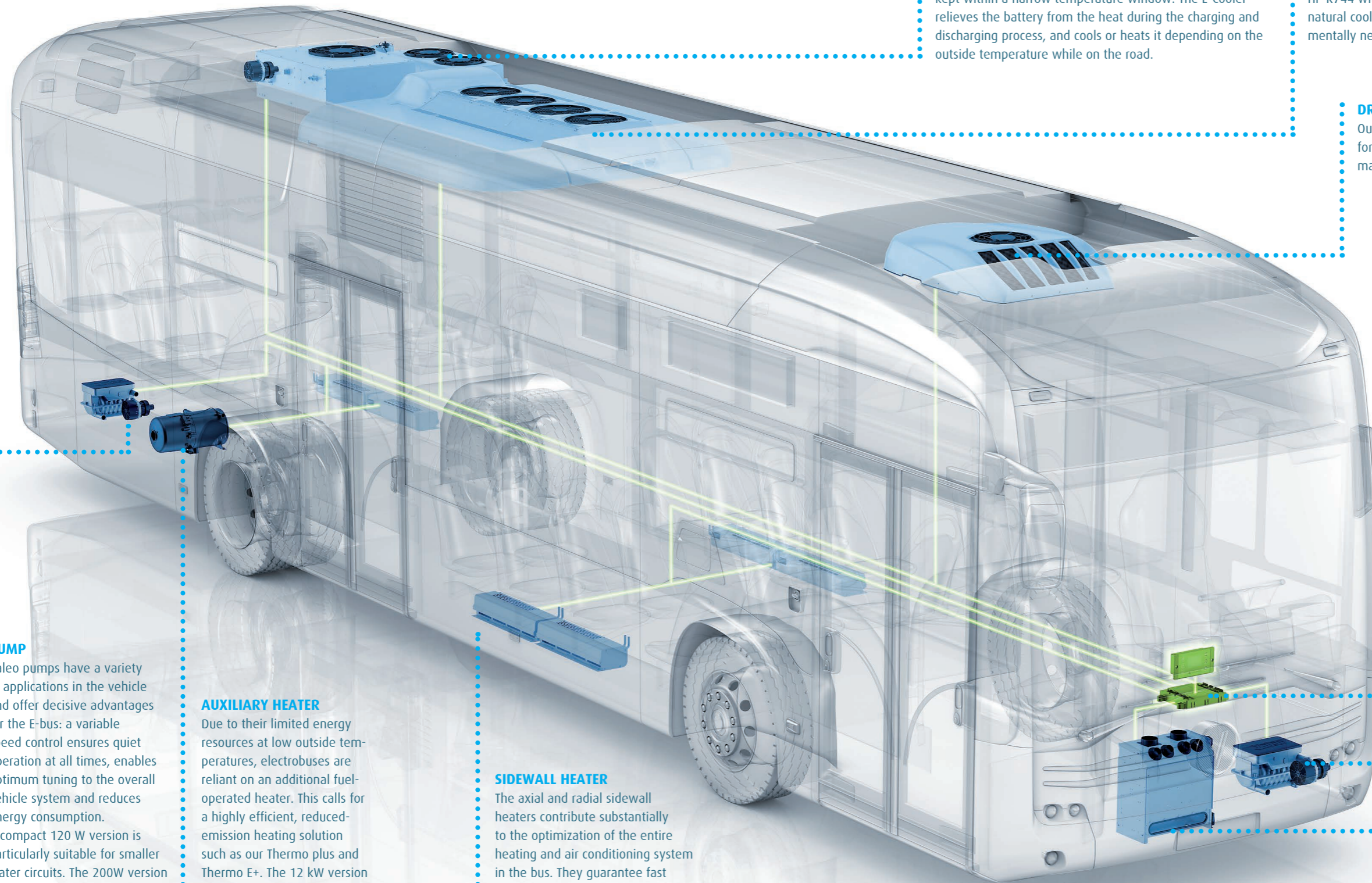
 <p><b>ENTEILLIGENCE</b> Innovative air conditioning components and newly developed control software that always intelligently selects the components with the highest level of efficiency.</p>	 <p><b>COOLING</b> To those who know anything about cooling – as we do – it’s not just a matter of generating cold temperatures, but creating a feeling of well-being and safety for driver and passengers as well.</p>
 <p><b>HEATING</b> Our roots lie in the production of bus heating systems, and it shows. We have been developing, testing and producing our Thermo series for over 60 years.</p>	 <p><b>VENTILATION</b> A good climate requires fresh air. As market leader for roof hatches we are well aware of the significance of hatches in the “bus climate system”.</p>

the central unit is an intelligent substation. In summary, Valeo Entelligence stands for innovative HVAC solutions that contribute to ensuring that existing energy resources are put to the best use,

thereby significantly extending the range of electrobuses – according to the motto **“The system is more than the sum of its individual parts”.**

# THE COMFORT SYSTEM OF AN ELECTROBUS: HARDLY VISIBLE, BUT FEELS GOOD

The graphic shows the well networked, highly complex system and interplay of the elements, ensuring that people are comfortable and the technology always functions optimally.



## BATTERY COOLING

Batteries are the core element of electric drives. To ensure that their energy is put to optimum use, they must be kept within a narrow temperature window. The E-Cooler relieves the battery from the heat during the charging and discharging process, and cools or heats it depending on the outside temperature while on the road.

## AIR CONDITIONING SYSTEM

We have supplemented our range of electric rooftop air conditioning systems with the emission-free REVO®-E HP R744 with heat pump function. It operates with natural coolant R744 (CO<sub>2</sub>) and is completely environmentally neutral.

## DRIVER A/C

Our electric air conditioning system Citysphere 5 for the driver's section is simple to install, maintenance-friendly and easy to operate.

## CONTROL SOFTWARE SU020

Intelligence and thermal management are crucially important to us in the control of all components for optimum bus climate. Intelligent software is a fundamental requirement for the efficient management of component hardware. In climate control of the future, a large number of components are included and the operating status of the vehicle is read out and evaluated. For us, this demanding type of thermal management is the central task of modern bus air conditioning, today and in the future.

## CONTROL SYSTEM

Intelligent networking of HVAC components in the bus ensures the best possible use of energy resources and optimum range.

## ELECTRIC HEATER

With a heat output of 12 kW, in addition to the Thermo AC/DC and Thermo H+ hybrid heaters, the Thermo HV high-voltage heater has been added to the portfolio of electric heaters.

## FRONTBOX

The frontbox works in conjunction with an air conditioning system in cooling mode and circulates up to 1,100 m<sup>3</sup> of air per hour in and around the driver's section.

## PUMP

Valeo pumps have a variety of applications in the vehicle and offer decisive advantages for the E-bus: a variable speed control ensures quiet operation at all times, enables optimum tuning to the overall vehicle system and reduces energy consumption. A compact 120 W version is particularly suitable for smaller water circuits. The 200W version is suitable for medium to large water circuits.

## AUXILIARY HEATER

Due to their limited energy resources at low outside temperatures, electrobuses are reliant on an additional fuel-operated heater. This calls for a highly efficient, reduced-emission heating solution such as our Thermo plus and Thermo E+. The 12 kW version delivers optimum performance at temperatures as low as -40 °C.

## SIDEWALL HEATER

The axial and radial sidewall heaters contribute substantially to the optimization of the entire heating and air conditioning system in the bus. They guarantee fast heating up of the interior with ideal temperature distribution.



# USE OF ALTERNATIVE FUELS IN VALEO BUS HEATING SYSTEMS

Valeo's conventional fuel-operated Thermo heating systems can run on alternative fuels such as HVO (hydrogenated vegetable oils) and GtL (gas-to-liquids). Using alternative fuels reduces soot and CO emissions by as much as 50 per cent, making these heating systems even more environmentally friendly.

Alternative fuels mean lower greenhouse gas emissions thanks to their inherent properties (HVO comes from vegetable oil, for example, and GtL is a synthetic diesel fuel made from biogas, among other things). They are easy to use, odourless and guarantee clean and efficient combustion. The CO<sub>2</sub> mitigation potential of HVO and GtL compared to conventional fossil fuels is particularly noteworthy, as these alternative fuels are 100 per cent renewable and sustainable.

## Clean combustion in the heating system

The use of alternative fuels in bus heating systems produces a brighter flame in the burner, making flame detection more difficult and sometimes disrupting the combustion. Valeo uses an additional component and optimised software to ensure that flame detection is not affected and combustion remains stable. The Thermo, Thermo E, Thermo E+, Thermo S and Thermo plus heating systems are suitable for use with alternative fuels as long as the required fuel hoses and filter are retrofitted.

Valeo approves the following fuels in accordance with DIN EN 15940:2019-10:

- Shell GTL Fuel (undyed; not Shell GTL Fuel Marine)
- Neste Renewable Diesel® (HVO; previously NEXBTL®)
- All HVO fuels equivalent to Neste Renewable Diesel or directly derived from this fuel but sold under a different brand name and likely to have further additives, namely:
  - C.A.R.E. Diesel® from Tool-Fuel
  - Neste MY from Neste, NL, US, SWE, FIN, Baltics / Swea Energi, SWE / Energifabriken, SWE /

Biofuel Express, SWE / Colabitoil, SWE / Ecobrånslé, SWE / Future-fuels, NL / EG Group, NL / Tamoiil, NL / GP Groot, NL / Goodfuels, NL

Existing heating systems can be retrofitted at any time, thus reducing emissions. The option to use alternative fuels makes Valeo Thermo heating systems an attractive choice for both diesel and electric buses, especially considering that electric buses still rely on additional conventional fuel-operated heating systems in colder outdoor temperatures due to limited energy resources.

# REQUIREMENTS FOR THE REFRIGERANT OF THE FUTURE

The amendment of the F-Gas Regulation and the PFAS restriction proposal will make using refrigerants containing fluorine extremely difficult or virtually impossible in future. Rising global temperatures due to greenhouse gases can only be minimised by using low-GWP refrigerants. Refrigerants of the future should be suitable for both air conditioning systems and heat pump systems, without having a negative impact on the environment.

Refrigerants should have good thermodynamic properties, a high volumetric cooling capacity and good miscibility with refrigerant oils. They should be chemically and thermally stable, non-flammable and above all, not toxic or harmful to the environment. Refrigerants should also be suitable for use at evaporation temperatures as low as -30°C in order to exploit the thermal energy in the ambient air for heating purposes even in cold temperatures. This means that the boiling point of the refrigerant should be lower than -30°C at atmospheric pressure. This minimum threshold (system pressure > 1013.25 mbar) ensures that the system does not take in any ambient air from leakages when the heat pump is in operation. Alternative refrigerants should also have as low a global warming potential (GWP) and ozone depletion potential (ODP) as possible.

## Natural refrigerant as a solution for the future

R744 (CO<sub>2</sub>) and R290 (propane) are natural alternatives to the fluorine-containing refrigerants currently being used with a GWP of 1 and 3, respectively. These refrigerants have excellent thermodynamic properties and are ideal for use in heat pump systems.

They make it possible to take thermal energy from the ambient air at temperatures as low as -20°C and use it for heating purposes. These refrigerants are readily available, and therefore prices remain stable, making them future-proof.

Although R744 is a high-pressure refrigerant and R290 is flamma-

ble, these challenges are easily overcome in modern cooling and air conditioning systems, making these refrigerants suitable for use in the automotive sector within the framework of a comprehensive safety model.

Refrigerant number	Composition	ODP	GWP	Safety class <sup>1</sup>	Fluid group
R134a	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	0	1430	A1	2
R513A	R123a /R1234yf <sup>2</sup>	0	631	A1	2
R1234yf	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	0	4	A2L	1
R407C	R123a /R125/R32	0	1774	A1	2
R744	CO <sub>2</sub>	0	1	A1	2
R290	C <sub>3</sub> H <sub>8</sub>	0	3	A3	1



# THE BEST SYSTEM FOR EVERY BUS TYPE

Tailor-made solutions for modern electrically powered buses

From the fast-growing market for mini-/midibuses to the large articulated or double-decker buses, we offer system-based solutions.



DRIVERLESS BUSES 6-7.5 METRES



MINISPHERE-E



CC205-E



MICRO- AND MINIBUSES 6-7.5 METRES



REVO®-E HP R744 (CO<sub>2</sub>)



REVO®-E PRO



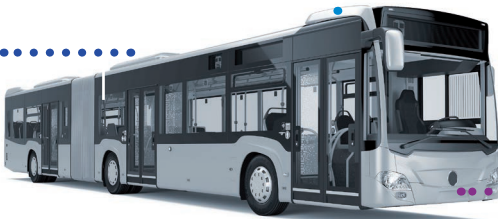
MIDIBUSES 8-9 METRES



THERMO E+ 12 KW



S-PUMP S120 & S200



BUSES > 9 METRES



THERMO HV



HIGH-VOLTAGE PTC AIR HEATER



DOUBLE-DECKER BUSES 12-14 METRES



E-COOLER BATTERY COOLER