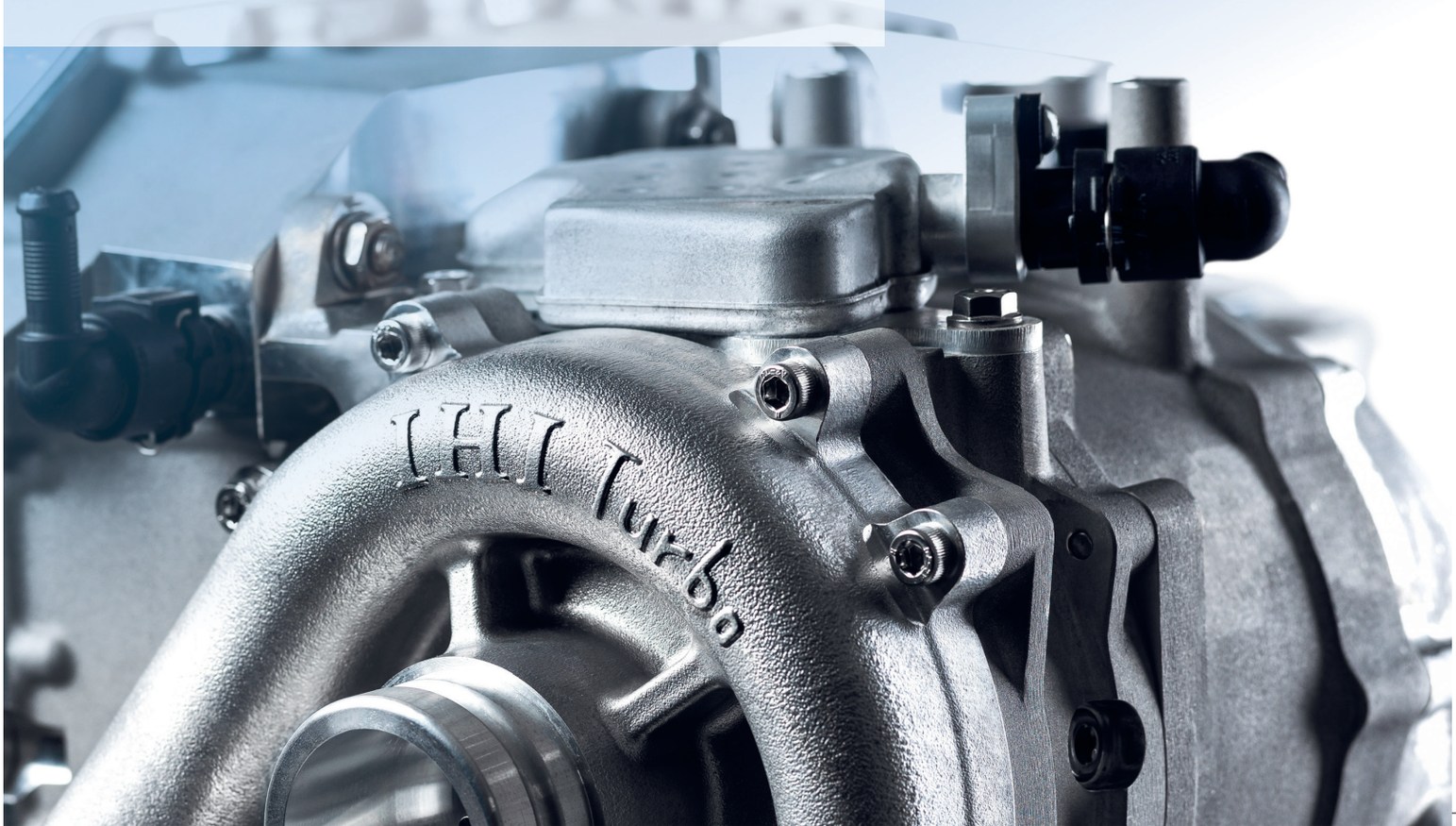
IHI

HIGH PERFORMANCE E-MOBILITY

THE NEW TURBOCHARGER FOR FUEL CELL ELECTRIC VEHICLES



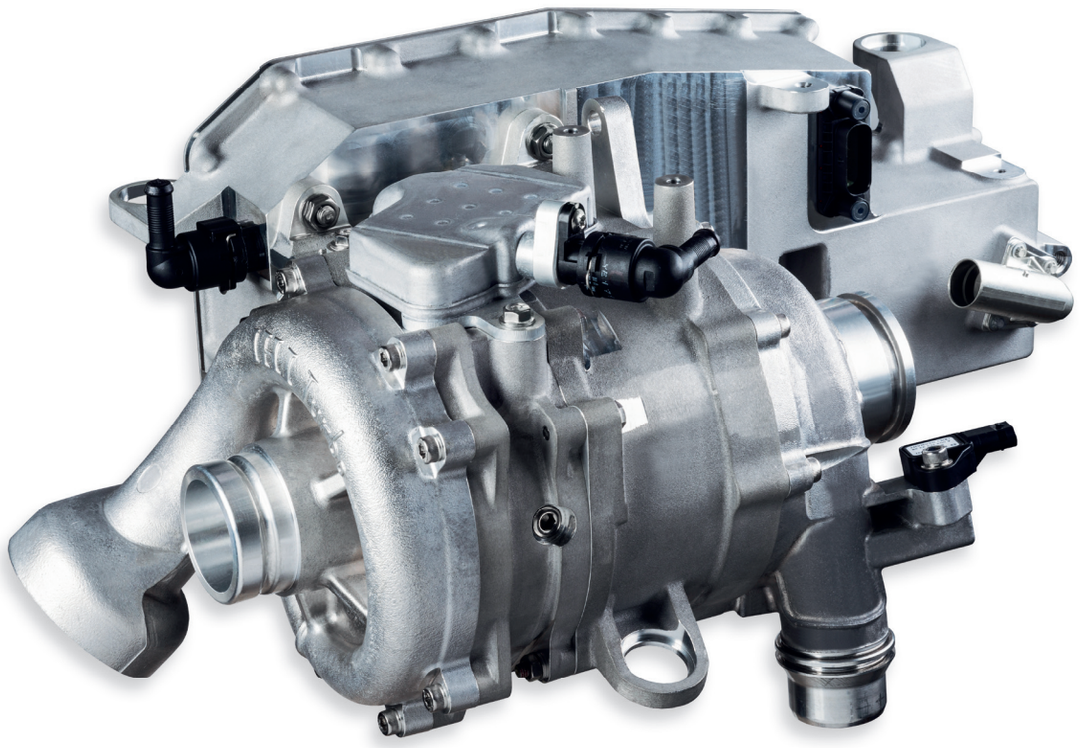
IHI´s contribution to sustainable mobility

The IHI Group strengthens environmental, social, and governance (ESG) efforts as a business underpinning. IHI products and services contribute to economic sustainability by resolving social issues that are the subject of Sustainable Development Goals.
IHI contributes to conserving energy and lowering environmental impact by supplying products and services that increase manufacturing efficiency for customers (IHI SUSTAINABILITY REPORT 2018).

Fuel Cell electric vehicles can contribute to reducing greenhouse gas emissions. Hydrogen is a clean and flexible energy carrier. When generated by alternative energy sources, it reduces greenhouse gas emissions. Refueling takes only a few minutes, employing familiar technology. Realized travel distances of Fuel Cell Vehicles are well above 500 km. Local emission is only water; therefore, Fuel Cell vehicles are zero emission vehicles. The tank-to-wheel Fuel Cell system efficiency is in the range of 60 % and therefore higher than for an Internal Combustion Engine. Fuel Cells operate quietly as there is no noise from intermittent combustion processes. There are no mechanical gears needed, as propulsion is done by an electric motor.

Fuel Cells have a broad range of applications. In the transportation sector, these are heavy duty and transit, light and medium duty, auxiliary power for refrigeration trailers and trucks, forklifts, and maritime use. Applications for stationary power, such as backup power for cell tower sites, combined heat and power, data centers are considered, and, also base load power generation as well as portable power supply is possible.

A single fuel cell consists of an electrolyte sandwiched between two electrodes. Bipolar plates on either side of the cell help distribute gases and serve as current collectors. Depending on the application, a fuel cell stack may contain a few to hundreds of individual fuel cells layered together. This „scalability“ makes fuel cells ideal for a wide variety of applications. In a cold combustion, Oxygen reacts at about 100° C with Hydrogen, but direct contact between Air and Hydrogen needs to be avoided, and therefore a Platine plated membrane separates the gases. This membrane is permeable for the Hydrogen protons, but not for the negative loaded electrons. The connected electric motor utilizes the produced current. The power density substantially increases if the system is pressurized. However, contaminants derived from Fuel Cell system component materials, structural materials, lubricants, adhesives, sealants, and hoses have been shown to affect the performance and durability of Fuel Cells. Therefore, the charging system that increases the pressure and therefore the power density of the stacks needs to be oil free.



Gas bearings support the rotor of the IHI Fuel Cell Turbocharger. The IHI Fuel Cell Turbocharger comprises a turbine, a compressor and, on the same shaft, an electric motor. The turbine utilizes the energy from the exhaust to reduce the required electric power for driving the compressor. The turbine can produce up to 30 % of the needed compressor power. Hence, it substantially increases the system efficiency. The turbine is designed to reliably operate with best efficiency in a humid air environment: droplets and vapor can be tolerated. The humid air environment also requires a sealed design, protecting the electric motor and the electronics. The compressor is of a low specific speed type with a vaned diffuser. It is optimized for operating conditions in a Fuel Cell system regarding specified airflow and pressure ratio, which is typically in the range of 3.0. Accordingly, IHI´s charging system enables higher power density Fuel Cells. The gas bearings allow stop-start operation and therefore a complete shutdown of the system, when no energy demand is existing. The coated and shaped foils provide sufficient robustness for multiple events under mixed friction conditions. The gas bearings offer excellent damping behavior under high-speed operation, which is mandatory in vehicular applications. Moreover, the electrified turbocharger system provides direct customer benefit since it is superior in noise behavior compared to supercharger systems that served to pressurize earlier Fuel Cell systems. The electronic inverter is integrated into the turbocharger: IHI offers an installation friendly compact "all in one" unit.

IHI´s oil free turbocharger for Fuel Cell electric vehicle applications is providing latest charging technology to serve emission free propulsion systems. Hence, it helps to achieve indispensable Sustainable Development Goals as requested by modern society.

Specification

Maximum speed	**100,000 rpm**
Maximum pressure ratio	**3.0**
Maximum motor output	**11 kW**
Size W × D × H	**525 × 295 × 250 mm**
DC high voltage	**250 – 450 V**
Control I/F	**CAN**

Sources: "IHI SUSTAINABILITY REPORT 2018", Sept. 2018, taken from www.ihi.co.jp/en/.
"Fuel Cell Fact Sheet", Nov. 2015, taken from Fuel Cell Technologies Office at http:// www.hydrogenandfuelcells.energy.gov.

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