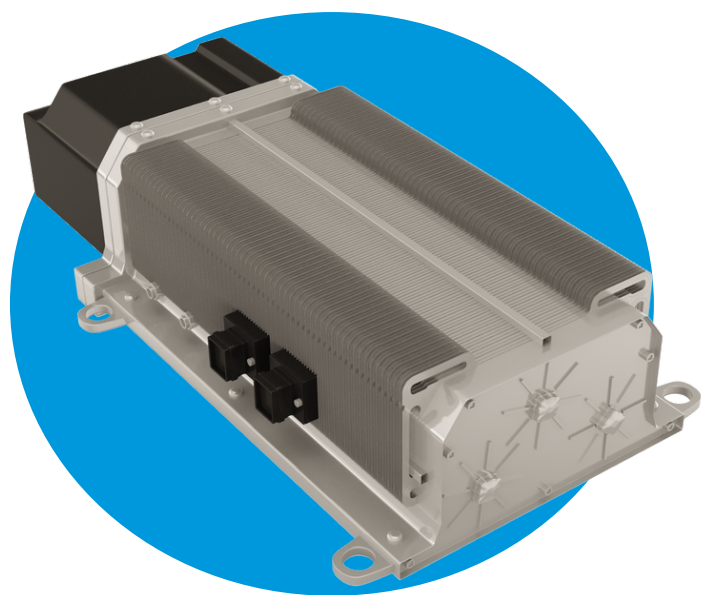


| Hydrogen, an emerging sector for tomorrow

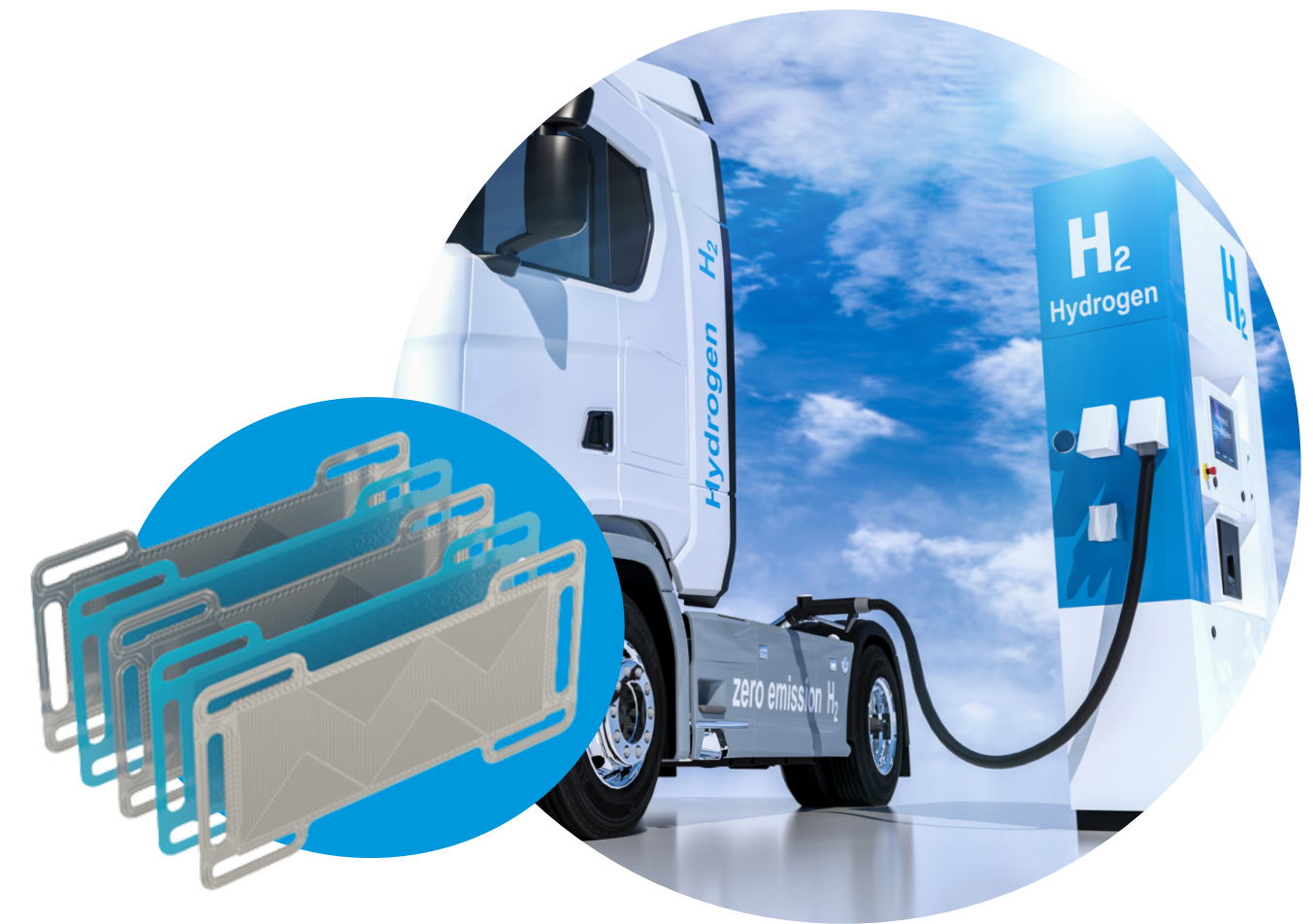
HEF applies its expertise in surface materials engineering to the hydrogen value chain.

Thanks to background in PVD technology, HEF develops unique, resistant carbon coatings for metallic bipolar plates, one of the main components of Proton Exchange Membrane Fuel Cells (PEMFC).

PEMFC fuel cells convert chemical energy into electrical energy. They consist of a membrane-electrode assembly where hydrogen reacts with oxygen to generate an electrical circuit used to propel vehicles.



Bipolar plates are an essential component of fuel cells. Their role is to provide structural support, distribute flows and guarantee electrical conductivity. To make systems lighter and more compact, metal bipolar plates are preferred to their graphite counterparts.



DID YOU KNOW?

Hydrogen currently accounts for 1.2% of energy consumption. By 2030, it should reach 13%. Aware of this challenge, HEF has positioned itself as a leader and offers you innovative coatings.

| HEF your innovative partner for hydrogen coatings

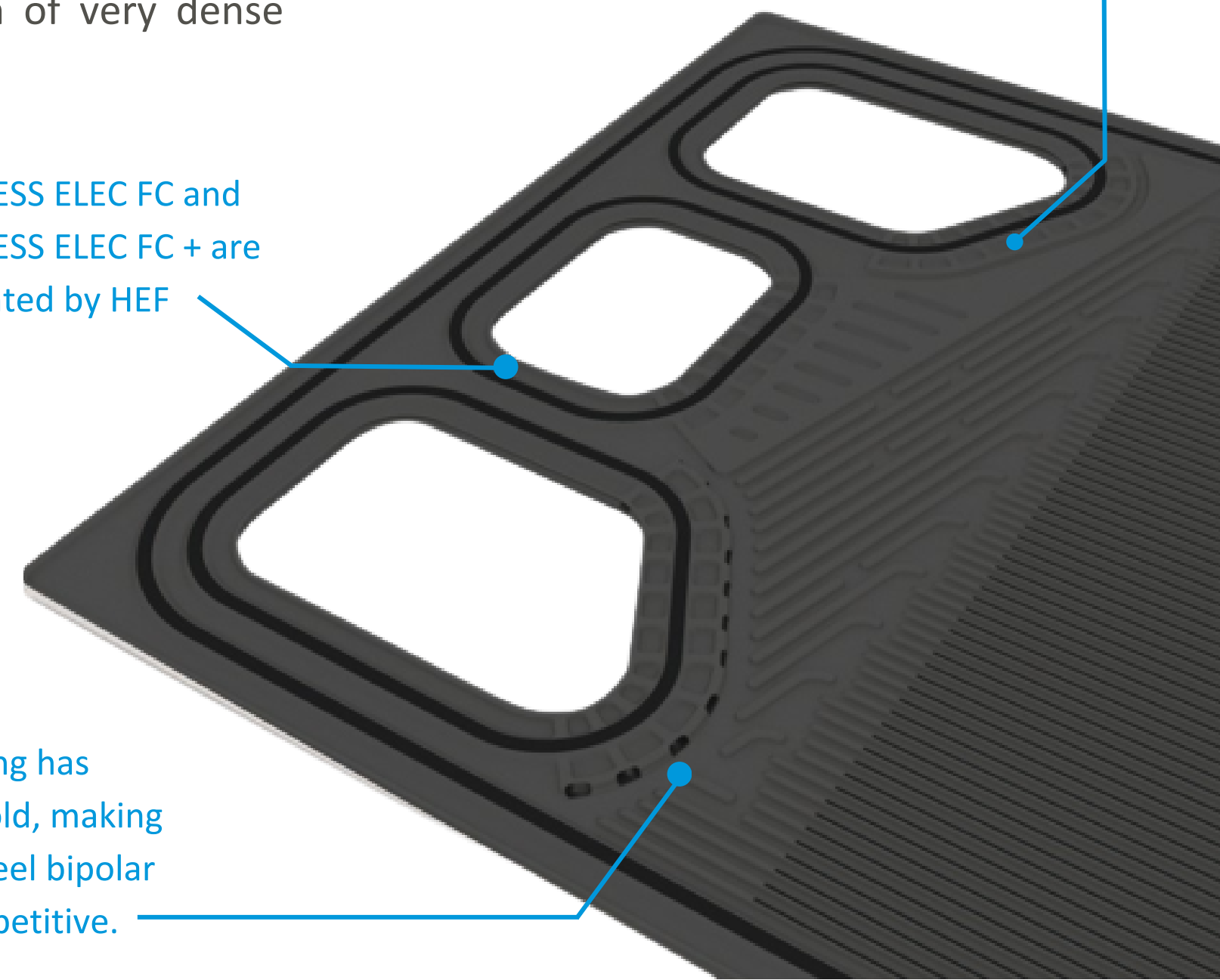
The application of a protective coating on the surface of the plates is therefore essential, protecting parts against corrosion while guaranteeing optimum electrical conductivity over operating times of several thousand hours. PVD treatment is the way of the future, as it enables the production of very dense coatings with low contamination levels.

	Certess ELEC FC	Certess ELEC FC+
Corrosion, cathode (1,0V vs NHE at 80°C) 24H	<1 $\mu\text{A}/\text{cm}^2$	<1 $\mu\text{A}/\text{cm}^2$
Interface Contact Resistance after treatment	<5 $\text{m}\Omega.\text{cm}^2$	<5 $\text{m}\Omega.\text{cm}^2$
Interface Contact Resistance after 24h (1,0V vs NHE at 80°C)	<10 $\text{m}\Omega.\text{cm}^2$	<10 $\text{m}\Omega.\text{cm}^2$
Durability in extreme conditions (1.6V vs NHE at 80°C) 24H	$\approx 2\text{h}$	$\approx 20\text{h}$

CERTESS ELEC FC and CERTESS ELEC FC + are patented by HEF

HEF's coating has replaced gold, making stainless steel bipolar plates competitive.

Optionnal surface texturation with femto-second laser

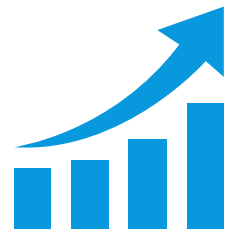


| Innovation for hydrogen technologies



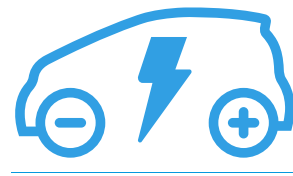
Our teams have developed a high-performance automated in-line coating machine, the "HPLV", based on our robust coating process. It is able to carry out the surface treatment of bipolar plates in large quantities (up to several million parts per year).

A first pilot plant is currently being set up in France, close to the company's head office, to meet our customers' growing needs for hydrogen equipment coatings. Large-scale deployment is planned before 2025.



Performance

Coatings developed by HEF guarantee electrical conductivity, corrosion resistance and durability of parts in their environment



Environment

HEF reduces the ecological footprint of systems by reducing and substituting the use of precious metals



Economically competitive

In-house-developed hydrogen coating machine combines high productivity and economic competitiveness



Customized solution

For the past 5 years, HEF has mobilized its research and development to offer unique, tailor-made solutions to its partners