Prometheus 5

COMBINED HEAT AND POWER SYSTEM

An alternative solution
FOR POWER AND HEAT GENERATION

Highly Innovative | Enviromentally Friendly | Energy Efficient | Cost Effective

- Novel processes dealing with hydrogen and fuel cells.
- Reduced greenhouse gases emissions. Capability to operate with biogas.
- High electrical efficiency. Excellent performance on partial loads.
- Low operational and maintenance costs. Small payback periods.
- Multifuel fed system operating with NG, LPG or Biogas

Powered by Helbio

THE PRODUCT

Prometheus 5 is a combined heat & power CHP System. It has a capacity of 5 kW electric power, while in the combined heat and power (CHP) mode, it can also produce up to 7 kW thermal energy in the form of hot water. The system is multi-fuel fed, i.e. it can operate with either Natural Gas, Propane/LPG or Biogas, converting it to electrical power through an intermediate production of hydrogen using a Proton Exchange Membrane Fuel Cell (PEM-FC).

The unit is equipped with a power management system, delivering electrical energy in the form required (DC or AC, grid connected or stand alone), depending on application. It has the ability to operate in the range of 40-100% of its nominal capacity. Its electrical efficiency is greater than 35% (based on LHV), while total efficiency exceeds 85%.

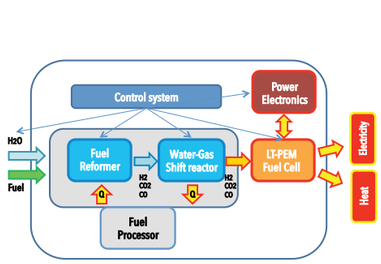
The integrated system consists of the following sub-units:

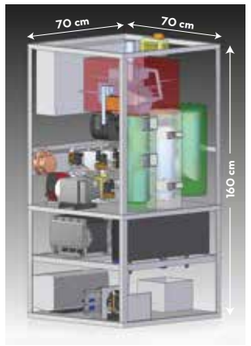
. Fuel processor/hydrogen production unit, where hydrogen production takes place via the reformation of the feeding fuel

. Low temperature PEM fuel cell stack, where power production takes place using the produced hydrogen from the fuel processor

. Batteries and electronic power management systems, where the excess produced power is managed

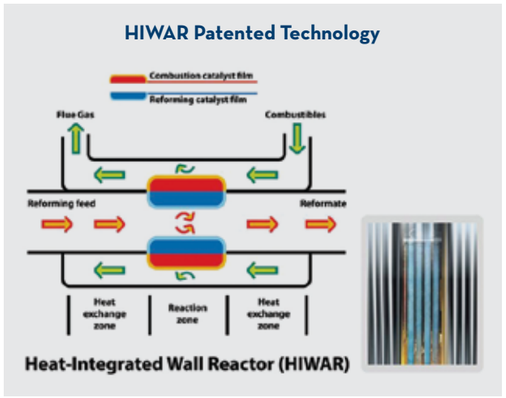
. Control system, capable to control the unit and to achieve proper, smooth and safe operation of the Prometheus-5 product





TECHNOLOGY

Helbio's technology is based on proprietary and patented reactor – catalyst configurations for reformation processes. The reactor configurations utilize the concept of the Heat-Integrated Wall-Reactor which offers very rapid heat exchange characteristics.
Prometheus 5 uses PEM-FCs coupled with a fuel processor based on a reforming step in advance.



The system comprises a reforming step and a power generation step.

Firstly the reformer stage:
It produces hydrogen and carbon monoxide.
The following reactions take place in the reforming step:

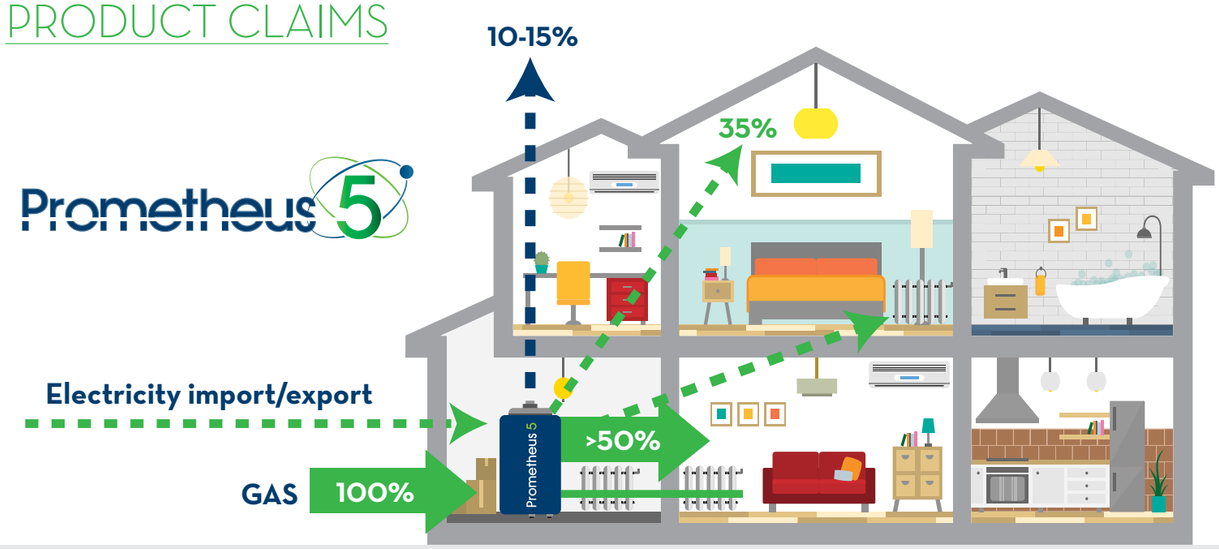
Steam Reforming:
$CnHm + H_2O = nCO + (n+m/2)H_2$

Water Gas Shift (HT and LT WGS):
$CO + H_2O = CO2 + H_2$

Methanation:
$CO + 3H_2 = CH4 + H_2O$

Secondly the power generation stage:
A low temperature Proton Exchange Membrane (PEM) fuel cell is used.

PRODUCT CLAIMS



> **Electrical efficiency is greater than 35% (more than twice the efficiency of common diesel generators)**

> **Operating cost (Fuel) is more than 2 times lower than that of a conventional diesel generator**

> **Maintenance cost is expected to be reduced to less than 50% compared to the maintenance cost of conventional power generators due to simplicity of construction**

> **Multifuel system, operating with Natural Gas, Propane/LPG or Biogas.**

> **Dramatically reduced emissions Prometheus 5 emits 170 times lower amounts of NOx and HC, 27 times lower amounts of CO and zero amounts of Sox)**

> **Very low noise and vibration levels**

> **Improved safety (no flames)**

> **Excellent performance at partial loads**

> **Capable to operate with raw biogas**

COMPARE WITH OTHER SYSTEMS

Currently, gensents serve the market of decentralized power production, however they present significantly lower efficiency compared to Prometheus 5 and possess a high environmental impact, because of large emissions of atmospheric pollutants and GHG.

CHART 1
Comparison between Prometheus 5 and a 5kW diesel generator

	Electrical Efficiency (%)	Fuel Cost* (€/kWh)	CO2 equivalent (kg CO2 produced/kWh)	NOx (g/kWh)	HC (g/kWh)	COx-(g/kWh)	PM (g/kWh)	SOx (g/kWh)
Prometheus 5	35	0.26	0.76	0.004	0.04	0.3	N/A	0.004
Conventional Diesel Generator	16	0.58	2.57	7.5		8.0	0.4	0.17

* based on Greek market prices (10/2016). Propane as a feeding fuel for Prometheus 5

Helbio
Hydrogen & Energy Systems

HELBIO is a high-tech company founded in 2001, based in Patras, Greece and is specialized in development, manufacturing and marketing of Hydrogen & Energy Production Systems.
The company possesses key expertise in:

- **Catalysis:** proprietary and patented reactor-catalyst configurations and efficient integration of hydrogen generation with fuel cells and six registered patents
- **Reaction engineering**
- **Process design**
- **System integration and control**

Unique selling point and expertise:

- Products based on Innovative Technologies, developed In-house
- 6 International & European registered patents, secure Helbio's "freedom to operate" (FTO), enabling a successful Commercialization of existing & new products
- Advanced Hydrogen and Energy Production Technologies
- Compact and efficient reactor configurations (patented HIWAR concept)
- A multi-fuel system, a unique characteristic of Prometheus-5, makes it suitable for operation in various parts of the world.

APPLICATIONS

Telecommunication stations

Telecommunications providers rely on backup power to maintain a constant power supply and to ensure the operability of cell towers. In telecommunication stations, **Prometheus 5** offer many advantages which include reliability, low maintenance costs, reduced frequency of refueling and reduced cost.

On -or off- grid households and other buildings

Main benefits of using **Prometheus 5** include: energy savings due to high electrical and overall efficiency, reduced (or zero, depending on fuel) CO_2 emissions, essentially elimination of emissions of atmospheric pollutants such as NOx, SOx and particulates, and dramatically reduced noise and vibration level.

Sailing yachts and boats

Boats longer than 10m need a supplementary power generator for power and/or heat production when docked or in the occasion of failure of the main engine. **Prometheus 5** offers the same attractive characteristics as in any other mobile application: reliable, economic, quiet, vibration free, and emission free operation.

Trucks

The market for Auxiliary Power Units (APU) for trucks represents an interesting potential opportunity for fuel cell power systems. Replacement of diesel engines with **Prometheus 5** power system will result in significant fuel savings, drastically reduced emission of pollutants and significantly quieter operation.

Small-sized farms with biogas availability

Future and developing markets for **Prometheus 5** include small biogas producers in farms, food industries and food chains. In the biogas field, conventional technologies suffer from unreliable and interrupted operation due to the low heating value of the fuel, issues which are not important in **Prometheus 5.**

Prometheus-5 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 733099

HELBIO S.A. Hydrogen and Energy Production Systems
Patras Science Park, Stadiou Str. Platani, Rio 26504, Greece
Tel.: +30 2610 911538 • Fax: +30 2610 911565
www.prometheus5.com • info@helbio.com