

the passenger boat

*the hydra*





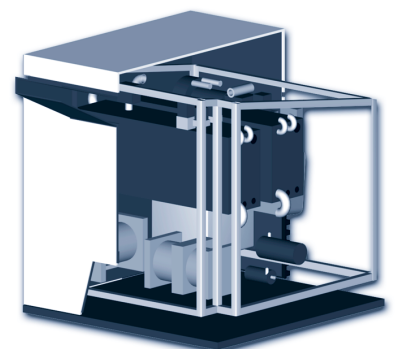
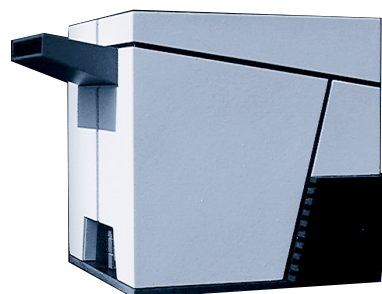
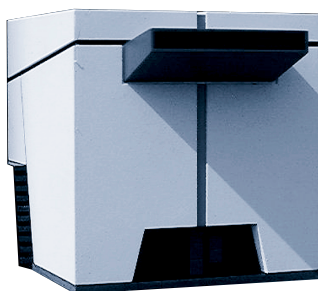
## fuel cells

### *Fuel cells*

The advantage of fuel cells in comparison to conventional propulsion technologies is apart from the fact that there are no moving parts especially that absolutely no harmful emissions are produced and that with a comparable efficiency. The only emission of a fuel cell propulsion is pure water.

Another advantage of fuel cell systems is their much higher efficiency and range compared to present solar and battery propulsion systems. And the saving of room or weight in comparison to these technologies is not included in this analysis yet.

Fuel cells will effect a real increase in the quality of life because they produce neither emissions nor odours and they have a wide range of application.

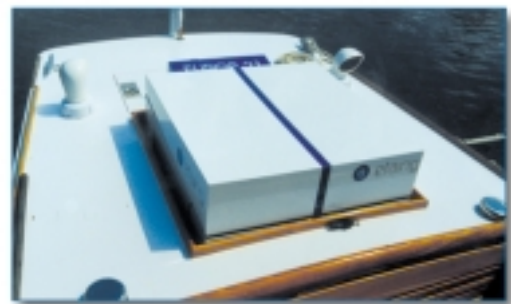




## die hydra

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The "Hydra" is the first passenger boat of its kind. She is gliding nearly silently and elegantly through the water. She can cruise on waters that are not open for normal motor boats because of her revolutionary fuel cell propulsion and special design. No matter whether nature reserve, storage dam or idyllic canals, Hydra is an ideal excursion boat for tourist purposes. She is silent, produces no emissions and is unusually exclusive. This fuel cell boat offers useful ecological as well as economical application opportunities for the operator.



Ecologically friendly and economical Hydra can open up new water-ways that could be used up to now just by a few privileged.



## technical data

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Length:	12 m (39 ft 4 ins)
Breadth:	3 m (10 ft)
Draught:	0,45 m (1 ft 6 ins)
Weight without fuel cell:	1,8 t
Displacement completely equipped and with passengers:	4,3 t
Power of OECOSACHS electric motor:	8 kW
Maximum speed:	9 km/h (5,6 mp/h); (measured: 15 km/h)
Cruising speed:	5 km/h (3,1 mp/h)
Capacity:	22 passengers, 1 skipper

## steering gear

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BECKER-steering gear with hydraulic wheel steering.

The BECKER-rudder is a patented rudder blade mechanics. An attached blade is deflected twice as much as the main rudder blade. That makes possible to direct the propeller wash very effectively sideways. The very small rudder that Hydra is equipped with because of the very low draught results in a turning circle that is only one and a half of the length of the boat: 20 m (65 ft 7 ins).





## motor / propulsion

### *motor / propulsion*

The permanent magnet DC OECOSACHS motor is a highly efficient electric motor with a high torque even at a low number of revolutions. Its output is 8 kW at an operating voltage of 48V and about 3000 revolutions/min. An electronic control with an acceleration-rate control makes possible to directly switch from "fully forward" to "fully reverse". The power transmission to the propeller shaft is done by a belt gear with a transmission ratio of 3:1.

A 3-blade bronze propeller of 350 mm diameter propels the boat. This big propeller in proportion to the total power of the motor is made possible by the torque characteristics of the electric motor and allows handling characteristics of the boat comparable to that of a 15 PS internal combustion engine.

To seal the rotating shaft at the shaft tube a maintenance- and grease-free and therefore environmentally friendly PROFIL SEAL rotary seal is used.



## design

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The CAD-drawing of the boat has been done by Dipl.-Ing. (Naval Architect) Peter Gottwald from Steinkirchen in accordance with specifications by etaing and the shipyard ECOBOOT. As a basis for this served the rules of Germanischer Lloyd for wooden boats concerning strength and safety.

## boat building

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The boat is designed in plywood hard chine construction. This design is efficient and combines the ecological aspect (wood, little glue) with tough, light structure. This is the ideal design for the planned shallow waters and low bridges.

The wooden hull has been built "overhead", with a new concept from the inside outwards. All fitted parts (bulkheads, sitting benches, frames and longitudinal girders) were prefabricated according to computer drawings and were assembled on the building slip, only afterwards the planking was added - an unusual and fast procedure for wooden boats. After the final varnishing it was possible to turn the hull and interior fittings and deck complete the boat.

The planking is made of 18 mm shipbuilding plywood, deck and fittings are only 12mm thin for reasons of weight. Watertight hollow spaces between the sitting benches and the outside planking make the boat unsinkable.

All varnished solid wood parts are from native larch treated with natural varnish oil. The used wooden parts bottom and stairs had not to be varnished because they are made of naturally weather-resistant robinia.

The white surface has a spraying varnish that is very long-lasting. Under water a durable thin-film antifouling coat has been applied that is essentially made of smooth teflon.

In total it took ECOBOOT 10 weeks to build the boat before it was delivered to etaing GmbH in May 2000 to be equipped with the fuel cell propulsion system.



## preliminary remark

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**etaing GmbH** realized a fuel cell system named "Europ 21" in the 2<sup>nd</sup> quarter 2000 which is being used on a passenger boat as the first propulsion system of its kind in Germany.

The Europ 21 has been developed for mobile applications. Maritime requirements influenced the decision to use an AFC fuel cell. The AFC (alcaline fuel cell) is an electrochemical device that transforms hydrogen and aerial oxygen in a so called cold combustion into electricity and heat, in this process water is produced. It is a low temperature cell that works without pressure. The used electrolyte is potassium hydroxide that is giving the AFC the name.

The Europ 21 has the following advantages: combined use of energy and heat, permanent productivity, modular design, high efficiency, no annoying noise or odour, absolutely no local emissions, the only by-product is pure water.

## technical data

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Fuel cell type:	AFC
Fuel cell producer:	ZeTek
Fuel:	hydrogen
Oxidant:	aerial oxygen
Electrolyte:	30 % potassium hydroxide (KOH)
Max. gas consumption:	air 45 m <sup>3</sup> /h; hydrogen 5 Nm <sup>3</sup> /h
Production of reaction water:	4 l/h
Operating temperature:	70 Centigrade
Stack design:	2 x 8 modules connected in series
Operating voltage:	64 - 88 V
Gross output:	6,9 kW <sub>el</sub>
Net output:	5,5 kW <sub>el</sub>
Efficiency:	electric 60%; system 42%
Measures(l x w x h):	1m x 1m x 1m (3ft x 3ft x 3ft)
Weight:	about 300 kg



# etaing

## transforming processes

### *transforming processes*

The basic reaction that takes place in the AFC is a reverse electrolysis (the production of hydrogen and oxygen from water by introducing an electric current).

In the Europ 21 hydrogen and aerial oxygen react in the fuel cell stack. This is a controlled chemical reaction of hydrogen and aerial oxygen which are separated by an electrolyte, in this case potassium hydroxide. At the anode hydrogen is oxidised using a catalyst and electrons are produced; at the cathode aerial oxygen is reduced using a catalyst and electrons are used. The resulting electric current is used to power the boat (electric motor on Hydra).

The stack as the centrepiece of Europ 21 is a set of fuel cells connected in series and parallel to form a module. Every module produces about 465 W and 8 modules connected in series form a stack. To produce the output of 6,9 kWel,brutto etaing uses 2 stacks





## components

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The Europ 21 consists of the following main components:

- air loop
- hydrogen loop
- potassium hydroxide loop
- programmable logic controller (PLC) and measuring and control technology (MCT)

Furthermore there are two metal hydride storages with a storage capacity of 16 m<sup>3</sup> hydrogen each. In these storages the hydrogen is not compressed in a pressurized chamber, but chemically absorbed in a metal powder (metal hydride). According to a study of TÜV-Rheinland these storages are considerably safer than conventional petrol or diesel tanks. The refuelling of the storages is done very comfortably through a bayonet lock known from natural gas plants and is finished in 15 minutes.

## safety concept

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The potential dangers of hydrogen have been reduced to a minimum with the following measures:

- technical gas-tight design with appropriate material selection
- gas-tight operating chamber with minimal space required
- continuous monitoring of hydrogen leakage in the operating chamber
- technical ventilation in the case of danger
- automatic fire extinguishing system

All safety regulations established by the certification authorities have been exceeded by far by means of the above mentioned measures.



## maintenance and service

### *maintenance and service*

Because the fuel cell system is such a novelty etaing GmbH will provide the maintenance and service for the system free of charge for one year from the date of purchase. This includes all technical parts to eliminate possible system malfunctions. However this does not include service or technical parts to eliminate system malfunctions caused by improper or negligent use.

## provision of hydrogen

### *provision of hydrogen*

As etaing GmbH cooperates closely with leading companies it is possible to offer further assistance in the following areas

- provision of hydrogen and building of refuelling station
- transport and insurance of the fuel cell boat
- registration and licensing for the respective stretch of water

## systemupdates/ -upgrades

### *systemupdate/ -upgrade*

At the customer's request the installed fuel cell system will be replaced at the end of 2000 or beginning of 2001 with a system of the latest generation that is being developed by etaing. This is for statistical reasons and is absolutely free of charge for the customer.