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EV Electric
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Range extended
H2/electric
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Solar PV Roof on the Cheetah Factory



In 2013 we invested in Solar PV for our seafront factory roof. The 25kw of energy from our solar PV is fed straight into our 240v supply with excess going to grid. This means that during the day, when we use most of our power for welding, controlling temperature and humidity and electrical tools, the Solar PV is fully utilised.


We use LED lighting wherever possible and our factory is built to the latest environmental specification with high quality insulation. Unfortunately 25 kw is not enough power to supply the Hydrogen Refueler for a realistic tank filling time.

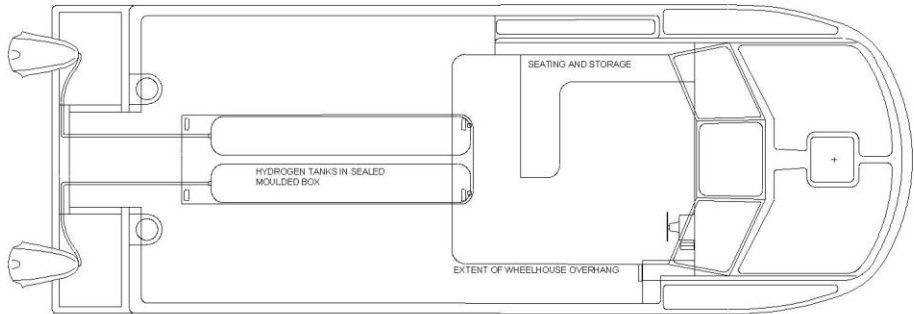
We have however used this learning to design a suitable shore based power generation scheme which can then truly supply our new EV propulsion system with sustainable green energy.

With a 12m EV Cheetah and a shore based green charging infrastructure it is possible to have a unique zero emission marine base which would act as a carbon free technology show case whilst also providing a working zero emissions patrol/survey vessel.

2014 Initial concept for a HICE, Hydrogen internal combustion engine, powered Cheetah

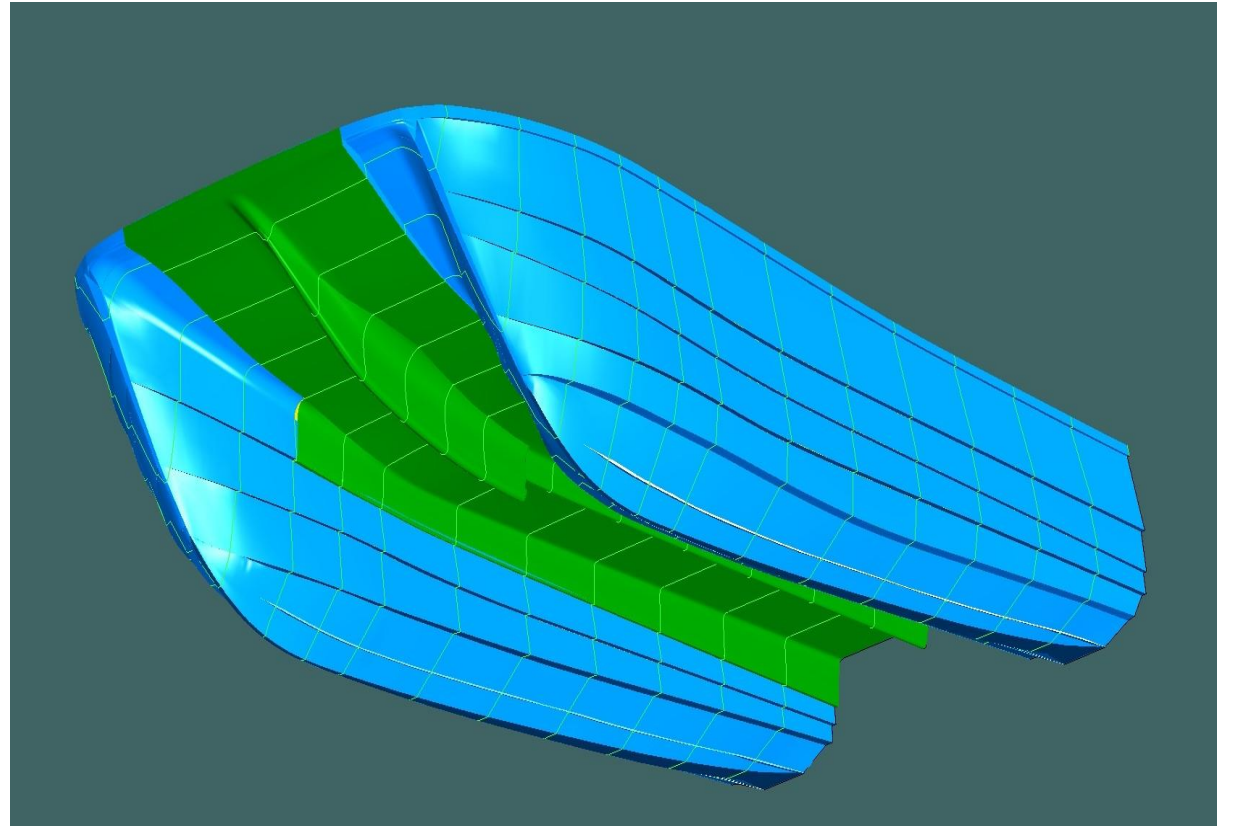
Cheetah Hydrogen vessel, design, build and testing.
Initial concept GA using above deck tanks with high rise H2 vent system

 CHEETAH MARINE CATAMARANS			<u>PRIVATE AND CONFIDENTIAL</u>	This drawing is issued by CHEETAH MARINE LLP for the purpose of record only and on the express terms that it is to be treated as private and confidential and is not to be copied or communicated to another person. © copyright 1995	VENTNOR ISLE OF WIGHT ENGLAND PHONE: 44 1983 852398
2	03.10.13	HICE CHEETAH			
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9.95m HICE Cheetah Catamaran
Plan View

A crucial part is the light weight, low drag, hull design. These are our Cheetah 9.95m x 3.6m hull and 10.2m x 3.7m hull. I designed the 9.95m x 3.6m hull in 1995 and with only a few small changes to date this hull has, and is still, very successful for commercial fishermen who need to use very low power outboard engines due to licence restrictions.



Final converting of the engine and making the tank frame in Cheetah's Seafront factory at the Ventnor, Isle of Wight.



The completed Cheetah 9.95m fully tested, with all glitches ironed out, returns from round the “Isle Of Wight” trip.

55 N miles, 6.59kg of hydrogen used which equates to 50% of the fuel capacity.

A vessel range of 100 nautical miles.



Hydrogen HICE Conclusions

- The tanks needed to be removable for refuelling from the ITM refueler at Cheetah's Seafront factory.
- Inbuilt tanks are possible if access for maintenance and good vertical venting is achieved.
- Twin ECU's are required to run dual fuel, both petrol and H2 for back up and redundancy. Engine conversion developed by Revolve.
- With course propellers running low RPM on H2 the fuel consumption was up to 15% lower than running on petrol. Twin tanks 2.8m long and 450mm diameter gave us a 100NM range.
- It has been challenging to overcome the conversion reliability however with the correct twin ECU set up and injector design the use of direct injection hydrogen is viable.
- Converted, mass produced four stroke petrol engines keep the propulsion price realistic however it is still expensive.
- When combined with a light and strong, fuel efficient Cheetah catamaran the overall design lends itself to a commercially viable, zero emission's work boat.
- The next step is the availability of hydrogen and the hydrogen infrastructure. Wind turbines producing excess sustainable electricity can be used to make and store hydrogen. This fuel can then be used in hydrogen powered vessels. This is one of the next steps forward for a zero emission's marine environment.
- This project demanded a high level of responsibility because of the difficulties and dangers associated with hydrogen and particularly hydrogen at pressure.

From Direct injection HICE system to electric outboards, battery's and hydrogen fuel cells

For Cheetah, a natural progression into electric outboards, using battery power with the possibility of adding a fuel cell was the obvious way forward.

Battery power with shore side charging doesn't require the availability of hydrogen.

Solar PV can be added to the roof for additional charging

If hydrogen is available then the addition of the fuel cell will increase the range of the vessel.

Welcome on board Treharne Automotive Engineering, TAE.

The Cheetah 12M E - Electric



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The 12M Cheetah is a cost-effective vessel with the EV200 electric outboard package and a first with a plug and play battery system.

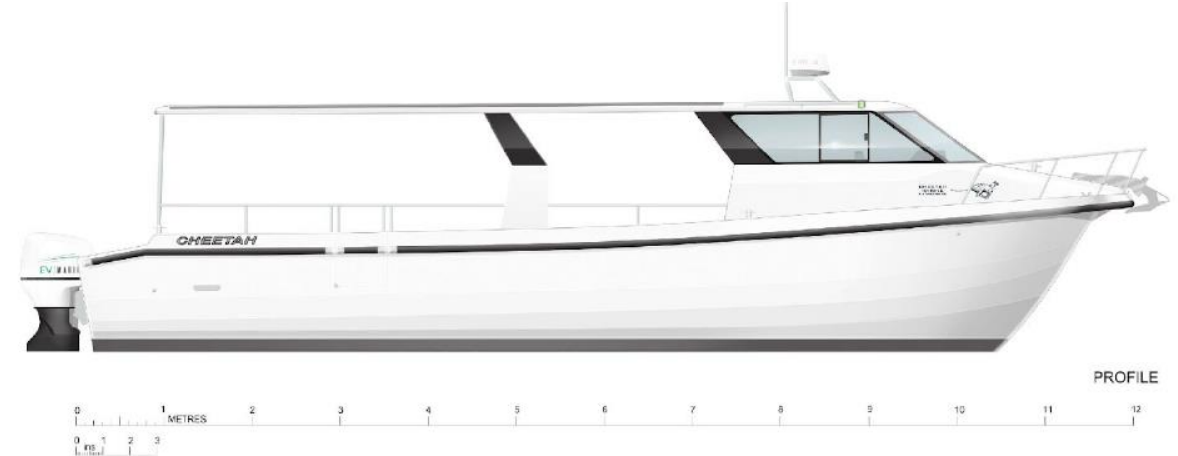
The EV200 has a simplified Motor system specifically designed to operate in vertical application and harsh environments.

Known advantages of our electric outboards are light weight, low noise, constant high torque from 1rpm and motors speeds in excess of 6,000 rpm, which combined, result in exceptional maneuverability experience far exceeding a conventional outboard engine.

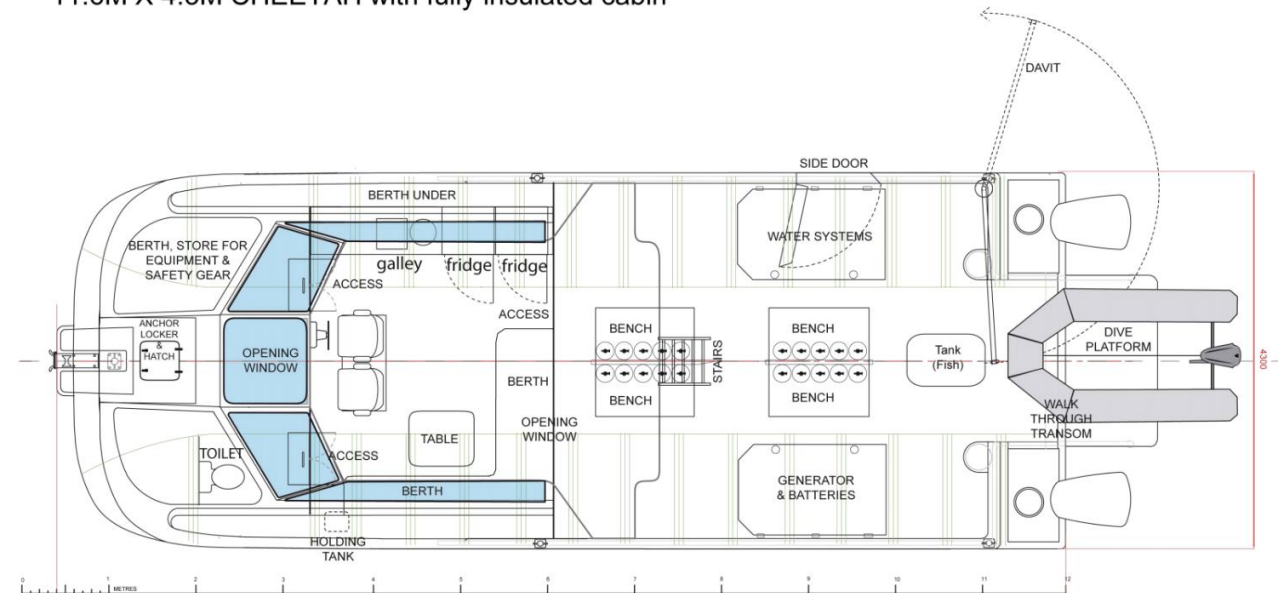
The EV200 together with the Cheetah 12M and its low coefficient of drag will be the best Electric Vessel available in its size range for custom work boat applications.



EV200 Electric Drive
2 x 148kW / 198 bhp



11.6M X 4.3M CHEETAH with fully insulated cabin



The Cheetah 12M E – PV System



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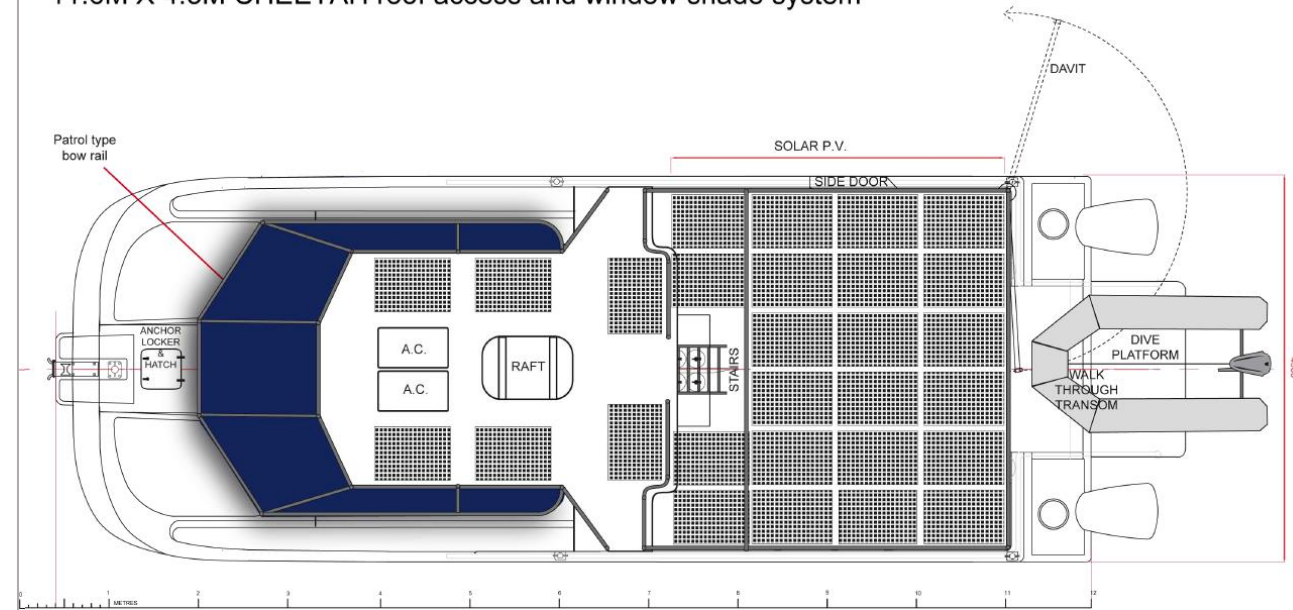
The 12M Cheetah design allows the vessel to carry up to 30 M2 of PV panels capable of up to 7Kw of electric power. This will assist with:

- Charging the Main Batteries
- Supporting House Load
- Supporting the 12V System

The Cheetah design lends itself to a large area of PV panels

The PV system layout does not compromise any of the available deck space of the vessel.

11.6M X 4.3M CHEETAH roof access and window shade system



The Cheetah 12M H – Shore Proposal



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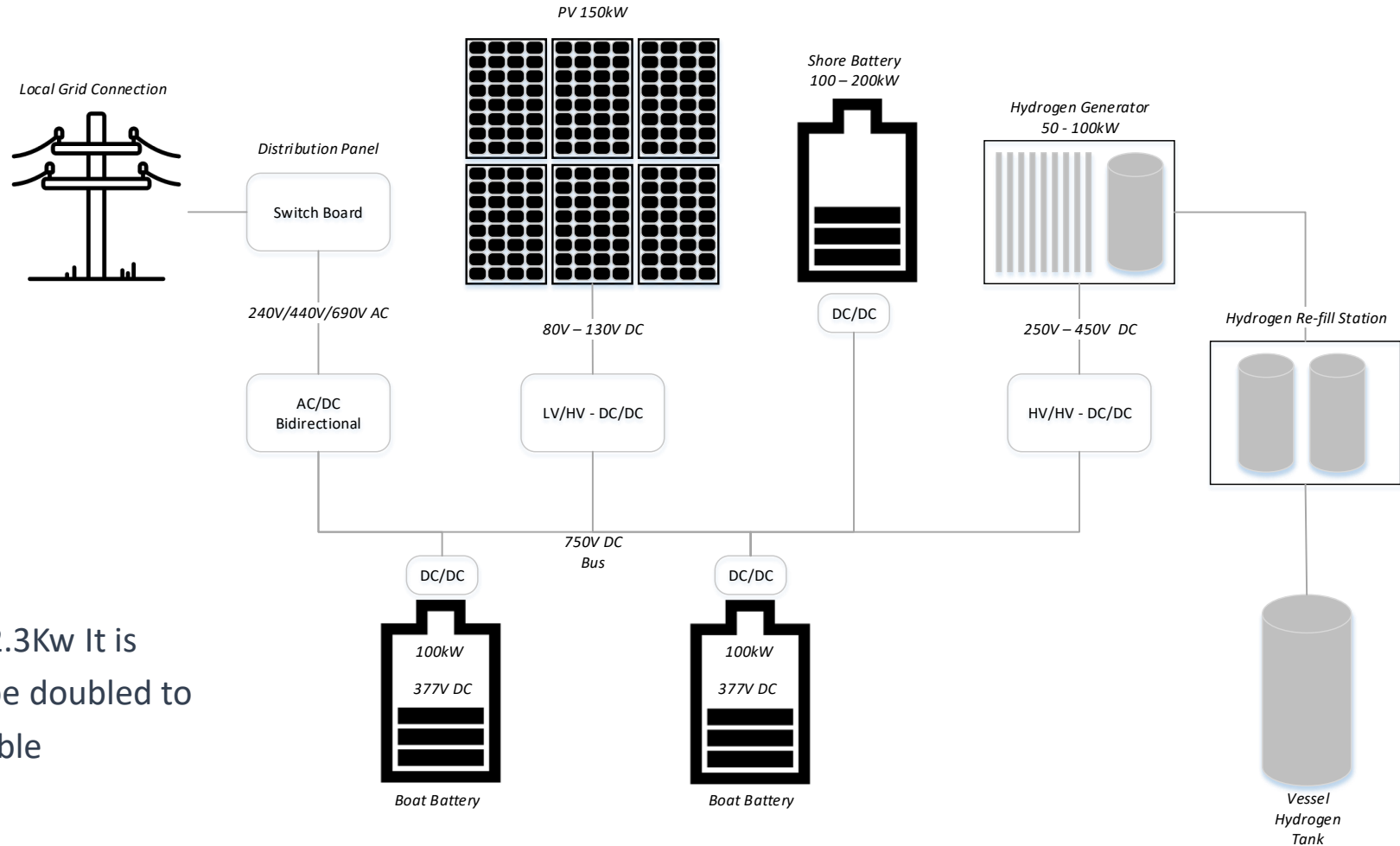
This shore power proposal is for a facility capable of charging at 50-100kWh for a Vessel with two Lithium Ion batteries.

The facility also provides the capability to generate and store renewable hydrogen via a hydrolyser for an electric vessel fitted with a hydrogen fuel cell.

For 150kW Energy at 320W per panel.
Each Panel is 1m x 1.7m

476 Panels are needed for a total energy of 152.3Kw It is recommended that the measurements below be doubled to allow for access and maintenance, where possible

17 Rows of 28 Panels = (28.9m x 28m)



The Cheetah 12M H – Hydrogen



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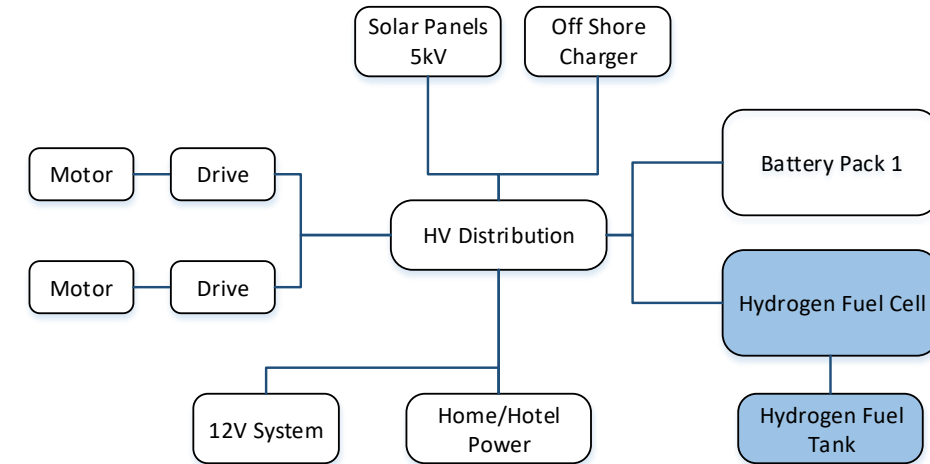
The Cheetah 12M E which is a stable full electric platform is needed before the hydrogen plug and play system is installed. This will allow a smooth integration by optimizing the hydrogen hardware and software based on the full electric vessel characteristics and performance.

The Hydrogen Fuel cell can propel the vessel without the need of the battery incase of an emergency, also it will maintain the support to the 12V system and house power.

The weight increase of the hardware is minimal as a new innovative container technology is used which reduces the existing weight of the containers by 40%.

Each fuel cell is self contained in its cooling and pressure management hardware making for a compact unit that is easy to install and maintain as a new installation or retrospectively.

All the Hydrogen system data will be available on the main console and also available for monitoring off-board if needed.



Key Hydrogen Pack Features:

- **2 years / 6000 hours warranty**
- **Build in Safety including smoke detection, hydrogen leak detection, insulation monitoring and many more**
- **Build in control system (Stand alone)**

Thank you

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