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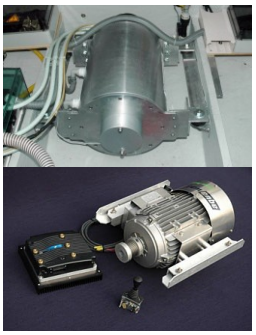
advanced electric boat propulsion

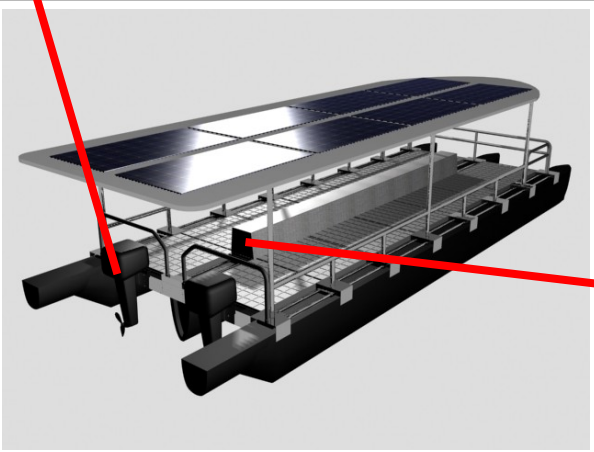
Electric Boat Quick Checklist

1) Type of engine (incl. controller)

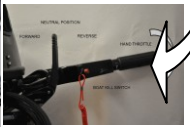
❑ 13 kw ❑ 22 kw Outboard Motor
❑ 10 kw Air Cooled Inboard Motor
❑ 15 kw Air Cooled Inboard Motor
❑ 30 kw Water Cooled Inb. Motor
❑ 2 HP Outboard Trolling Motor
Number of engines: ❑ 1 ❑ 2

REF: (calculator)
http://www.all4solar.com.au/ALL4SOLAR_CALCULATOR.htm





❑ Remote ❑ Tiller
Throttle & gear shift needed (per engine)
Installation of display/switches to console



2) Cables

❑ 6mm2 double 50A	_____	m
❑ 32.5 mm2 10kw red	_____	m
❑ 32.5 mm2 10kw black	_____	m
❑ 50/65 mm2 13kw red	_____	m
❑ 50/65 mm2 13kw black	_____	m

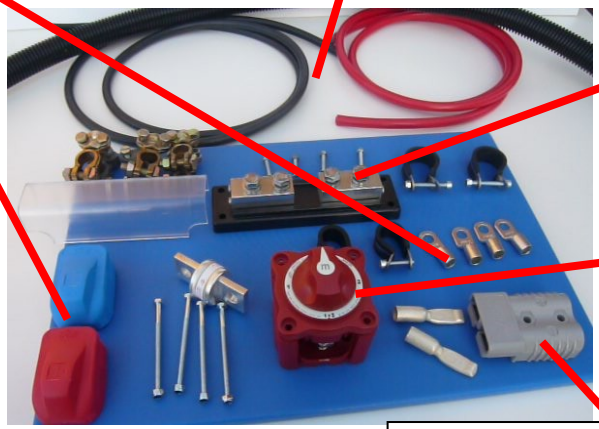
REF: operator's manual

6) Lugs

❑ 8 mm2/8 mm
❑ 8 mm2/8 mm
❑ 50 mm2/10 mm
❑ other

11) Propeller

❑  ❑



3) Fuse

❑ 60-100A 1.2kw
❑ 350-400A 12kw

4) Switch

❑ 50 A on/off
❑ 300 A on/off
❑ 300 A on/on/off
Qty ❑ 1 ❑ 2

7) Battery T

❑ Lead Acid standard
❑ Lead Acid quick rel.
❑ Lead Acid 6-8mm
❑ Lithium see lugs

8) Installation

❑ Switch board
❑ SS bolts _____
❑ SS cable clamps __
❑ Solder

5)Plug

❑ 50 A (50V) _____
❑ 300 A (50V) _____
❑ other

9) Battery

❑ Lead acid 33kg/kw h
❑ LIFEPO4 10 kg/kw h
❑ LIPO 7 kg/kw h
❑ 1 battery block
❑ 2 battery blocks

REF:"what battery"

Battery _____ kwh

10)Charger

❑ Solar _____ m2 (0.16 kw/m2)
❑ Battery charger 240 V
❑ Generator ❑ DC ❑ AC (240 V)
❑ Inverter DC to 240 V AC

REF: operator's manual

Some technical facts

Static thrust and torque

"The measured thrust produced by a propeller when movement is prevented"
1 Newton = weight power of 102 grams (standard force of gravity) = thrust
1000 lb ft (pound / feet) = 1356 Nm (Newton meter) = torque
1 Newton meter = power to lift 102 gram on an 1 meter moment arm

Power

Electric motors are moved by electric power. For boats we need to use a DC (direct current) power supply, as the electricity needs to be stored in batteries which can only provide DC power. As AC motors have some advantages, the motor controller can have an AC output to the motor (see AC / DC motors) which acts like an inverter (converting DC to AC power).

Watt = voltage X ampere or amps
1 kilo watt = 1000 watts
1 kw h = 1 kilo watt output per hour (f.e. battery capacity)

AC / DC motors

DC = direct current / positive and negative / electricity always flows in one direction (battery)
AC = alternating current / the electricity changes direction by alternating at a certain wave frequency (like the 240 V power supply to a household)

DC motors are equipped with permanent magnets on a stator and electric magnets on a rotor (rotating) which are switched on and of in a sequence related to the rotation of the stator. The brushed DC motors (the cheapest option) have brushes to the rotor switching the electric coils (magnets) on and off to create a force with the permanent magnets. The controllers for these motors just need to limit the power input to change the power output of the motor. The brushless DC motors do have the electric coils in the stator and the permanent magnets fixed on the rotor which makes the construction simpler and more efficient. But the motor controller is more complex and needs to switch the electric power according to the information of the position of the rotor by sensors. The AC induction motor has electric coils on the stator and a rotor driven by the magnetic field (induction). The rotation is related to the alternation of the current. There are a lot of subtypes, synchronous, two or three phase or induction. But the following points are important: A DC motor is a cheaper option, but changes the torque with the rotation speed, where an AC motor can create a more stable torque over a wide range of rotation speed. The AC motor is maintenance free as the shaft bearings are the only moving parts. This makes this motor ideal for engines over 5 kw.

Efficiency

Efficiency is defined by the percentage of energy output compared to the energy input. An electric drive system has several components, so the overall efficiency is important to look at.

Batteries – efficiency input (charge) and output - Lead acid = 90% - Lithium = 99%
DC brushed motor including controller = 60 – 85 % - only efficient at specific rotation speeds
DC brushless motor including controller = 65 – 95% - only efficient at specific rotation speeds
AC motor including controller = 85-90% - efficient over a wide range of rotation speeds

The AC motor or for smaller applications the synchronous brushless motor in combination with a lithium battery are the most efficient systems for boat propulsion.

Setup examples

Specifications
5-6 meter boat / 600-1000 kg / 8 – 15 knots
Average power use 50% while in operation (6 knots 2 kw only)

Setup
1 x 13 kw electric outboard engine
300 A switch and fuse / 20 m cable
Remote kit (Throttle & Steering)
4 x 5 kw lithium iron phosphate battery pack
16 A grid charger
200 w solar charger

Performance
Weight of motor, installation material and battery 275 kg
Max. speed 15 knots
Operation 2.5 hours (without recharging)

Specifications
13.9 meter cat /12 tons / 6 – 9 knots

Setup
2 x 10 kw electric air cooled inboard engines
2 x 20 kw h lead acid
10 kw solar panel

Performance
Weight of motors, installation material and battery 1850 kg
Max. speed 9 knots / average 5-6 knots
Operation over 12 hours non stop