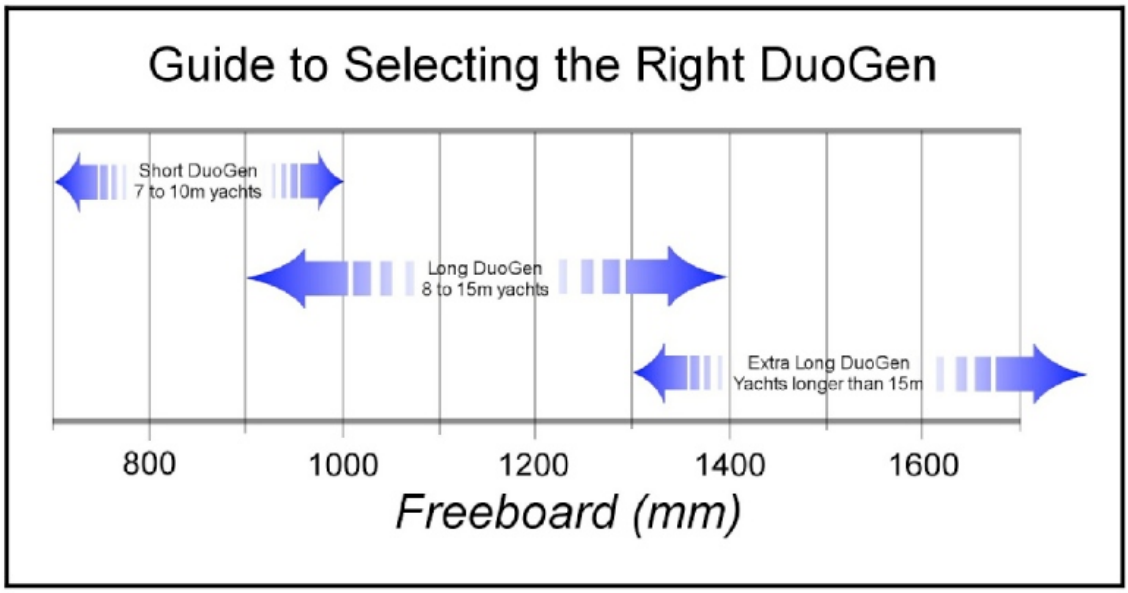
The DuoGen is designed to be easily retro-fitted to yachts and multihulls. This represents a substantial challenge because yachts vary widely in size, performance and form.

To accommodate the differences in size, the DuoGen is available in three different tower lengths, short, long and extra- long. The appropriate tower length depends on the yacht's transom height. This ensures that the angle of the water mode keeps the water impeller immersed, despite heel angle and wave action. It also ensures that when the DuoGen is changed to wind mode, there is sufficient clearance under the air blades for crew safety.

For each tower length we recommend a maximum and minimum mount height above the static water line. We also recommend that where possible, installations are kept within 800 – 900 mm of the yacht's centre line. This keeps the running depth of the water impeller within the optimum range, regardless of tack.

Note that the majority of DuoGens are installed alongside self-steering systems. The two technologies complement each other, and assuming they are installed 600 – 700 mm apart, will not interfere with each other's operation.

The table below offers a guide as to which variant is best suited to different yacht sizes. Note that there is considerable overlap and this reflects different hull designs in terms of length over all and freeboard.

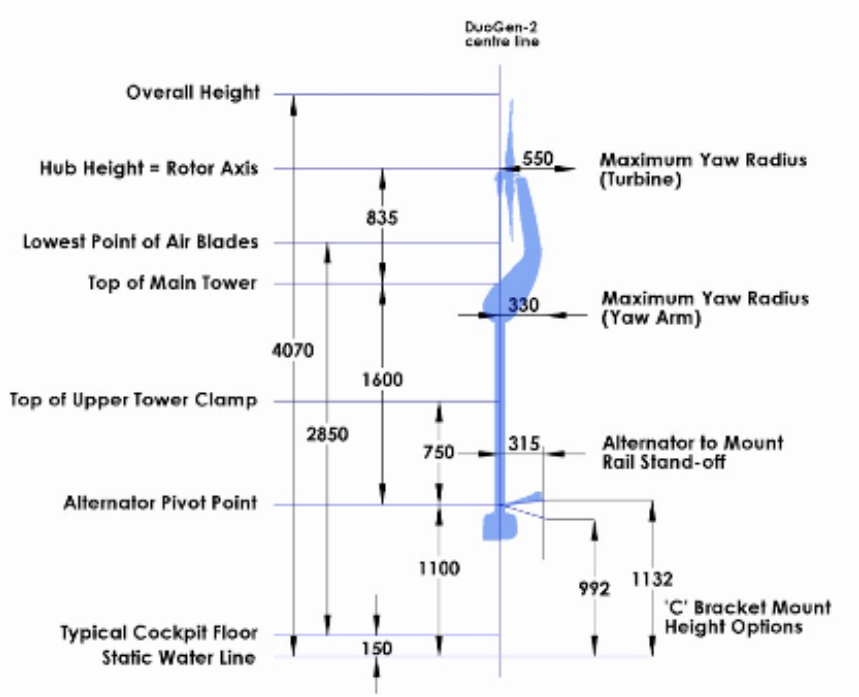


Other factors can also affect tower length choice. For example, where a 38 foot yacht is fitted with a stern arch, the extra-long DuoGen may be preferred to the long because it provides greater clearance above the arch for the air rotor. Equally, a 55 foot yacht that only wished to use the DuoGen in water mode could fit the short tower machine, and simply mount it lower on the transom.

The DuoGen is supplied complete with standard mount hardware. This bracketry is designed to accommodate most yacht transoms, and offers a simple and flexible approach to mounting. The bracketry has a range of adjustment and is usually sufficient to achieve an excellent and robust installation.

Long Tower Length DuoGen

Suitable for yachts with transom freeboard of 1m to 1.4m.
The schematic below gives mounting dimensions in millimetres for a typical installation.
See variables table for mount options.



Variables	Typical (inch)	Minimum (inch)	Maximum (inch)
Alternator pivot point from static water line.	1100mm (43)	950mm (37)	1200mm (47)
Alternator pivot point to the top of upper tower clamp	750mm (30)	650mm (26)	950mm (37)
Note that by reversing the alternator yoke the bottom of the 'C' bracket falls either 32mm (2¼) above or 108mm (4¼ inch) below the chosen alternator pivot point.			

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Where additional bracketry is required, as is the case with canoe stern yachts and some multihulls, Eclectic Energy can offer advice and bespoke parts.

One of the DuoGen's key benefits is that most of the system's weight, i.e. the alternator, is at coaming level. This remains the case in both water and wind mode. Consequently, when operating in wind mode, the mounting only has wind loadings to resolve, not the mass of an alternator.

Installing a conventional wind generator involves a dedicated mount tower and substantial braces fore and aft and athwartships. The cost and weight of this structure is avoided with the DuoGen.

The DuoGen is supplied with full installation instructions. However, it is not always easy to visualise how and where the DuoGen could be mounted, and what clearances will exist when it is operating or being changed from one mode to the other. For this reason we encourage anyone considering a DuoGen installation to contact us and provide a photograph of their yacht's stern. We then discuss installation options and implications. This is particularly important where a yacht has no push pit rails or has davits or backstays that are secured at the base of the transom.

The mount bracketry incorporates the upper and lower attachment points for the DuoGen. Once the brackets are in place, the DuoGen is installed and secured with a single M10 pivot pin at the alternator, and its tower secured with the upper releasable clamp. This makes it very simple and straightforward to remove the DuoGen for a weekend's racing.

The electrical output cable is usually taken into the yacht via a cable gland and hard wired within the stern locker / lazarette area. Deck plugs and sockets are not recommended due to the potential shock hazard should they become disconnected.

Repairs and Maintenance

The DuoGen is designed to require minimal maintenance, but a little attention will pay dividends in terms of appearance and performance.

Periodic washing with fresh water will remove accumulated salt deposits and keep the yaw bearings and the telescopic drive shaft sliding smoothly. An occasional application of a domestic silicone-based polish on the tower tube and drive shaft is also recommended.

The alternator requires no maintenance as it is hermetically sealed, and the bearings are protected by a twin lip radial shaft seal.

The water mode is robust and efficient, and maintenance free as the impeller transmission device is lubricated by a combination of synthetic oil within the matrix of the bearing material and water. When dry following immersion in sea water, the unit may feel a little

stiff. This is due to dry salt deposits and the unit should free up immediately it is returned to the water.

However, the DuoGen's water impeller rotates about 5 million times for every thousand miles sailed, and like all mechanical devices, is prone to wear. We recommend that the transmission elements are replaced every 8,000 to 10,000 nautical miles, (or 40 to 50 million revolutions!), in order to maintain optimum performance. This is a straightforward procedure that can be undertaken by the owner.

The DuoGen's air mode transmission device incorporates a heavy duty gear set and thrust bearings, all running behind grease seals. The gear faces benefit from the occasional light application of a good quality weather resistant grease, as supplied.

Cable Sizing

When installing DuoGen or D400, the minimum requirement is that the rating of the cable chosen should be equal to the maximum current (amperes) that the machines can generate. Note that power (watts) = volt x amps so the maximum current generated by a 24 volt D400 will be half that produced by a 12 V D400. A 48 volt turbine at full output will produce one quarter of the current of a 12 volt machine. However the actual power delivered remains the same in each case.

Wire size is important because when current flows through a resistance (which is measured in ohms) voltage is lost. This is referred to as voltage drop. The greater the current and the higher the resistance in the circuit the larger the magnitude of the voltage drop. All cables have a certain level of electrical resistance, but using a larger cross sectional area of cable results in a lower resistance for a given cable length. Minimising resistance in the circuit improves efficiency by reducing voltage drop. However for practical reasons when installing turbines cable selection is usually a trade-off. The greatest electrical losses only occur when the turbine is producing the highest output, and this only occurs in high winds which are relatively infrequent. As long as the cable selected is rated to safely carry the peak current, it is not generally considered practical or economic to fit very heavy cable which provides for the lowest possible loss in these rarely encountered conditions. Therefore most cable sizing recommendations are designed to deliver on acceptable overall transmission efficiency of around 95%. Where the recommended cable sizes are used, electrical losses will be minimal in the operating conditions which prevail for most of the time.

Note that poorly made connections and corroded connections can introduce very high resistance into a circuit and are probably the most frequent cause of poor system performance. Tinned cable is recommended as this offers superior corrosion resistance to untinned copper wire, particularly in the marine environment.

All connections should be securely made using terminal block or the joints can be soldered for extra security. Quality crimp connectors closed with a proper crimp tool are another option, but beware of badly crimped joints. Note also that the quality of the insulation affects the rating of cable. PVC insulated cable with a temperature rating of

75°C is typically used. Cable insulated with butyl rubber has a higher temperature rating and can therefore carry higher currents.
On a yacht cable is normally run from the lazaret area at the stern, forward to the batteries. Cable runs should be run to ensure that it is unlikely to be accidentally pulled or strained. Also avoid placing it where heavy or sharp objects may be dropped onto the cable which could damage the insulation. As with all power cables it is preferable to route turbine output cables separately and away from aerial and sat nav cables. If this is not practicable, as a minimum avoid bundling power cables tightly together with signal cables.
When considering which cable size to use make an assessment of the total length of the cable run in metres. Remember to include the height of any mounting tower or tube. Then multiply this by two, which gives the total circuit length i.e. positive to load and back to negative. Use this figure to select a minimum wire size from the tables below

Cable Selection Table
This table reflects the minimum wire cross-sectional areas which should be used. Lengths quoted are total circuit, i.e. positive battery terminal to the turbine + return to negative battery terminal.

D400						
Voltage	0-20 m	20-40 m	40-60 m	60-80 m	80-100 m	100-120 m
12	10 mm²	16 mm²	25 mm²	35 mm²	50 mm²	--
24	4 mm²	6 mm²	10 mm²	16 mm²	25 mm²	35 mm²
48	2.5 mm²	2.5 mm²	4 mm²	4 mm²	6 mm²	6 mm²

DuoGen						
Voltage	0-20 m	20-40 m	40-60 m	60-80 m	80-100 m	100-120 m
12	6 mm²	10 mm²	16 mm²	25 mm²	35 mm²	50 mm²
24	4 mm²	4 mm²	6 mm²	10 mm²	16 mm²	25 mm²

The following table shows voltage drop in millivolts per ampere of current, per metre for some popular cable sizes. Note there are 1,000 millivolts to one volt DC.

Conductor Cross-sectional Area in mm^2	Voltage Drop per ampere per metre in millivolts
2.5	18
4	12
6	7.6
10	4.5
16	2.7
25	1.7

You can use this table to assess the relative efficiency of different cable options. To work through a typical example assuming a 12 V D400 wind generator mounted at the stern of a typical cruising yacht. Cable run turbine to batteries, 9 metres. Total circuit length i.e. positive to load negative to generator, is 18 metres. Maximum probable charging current is 50 amps (approx. 650 watts). Assuming 10 mm≤ cable, and maximum turbine output, the volt drop would be 4.5 x 50 x 18 = 4050 millivolt or 4.05 VDC, equivalent to about 33% of the total power being generated. However at more typical turbine outputs of say 5

amps, the loss through the same cabling would be only 0.4 VDC or 3.3% of power generated.
Referring to wire sizing table you will see that 10 mm≤ is actually the minimum recommended for the D400 and this length of cable run. If we calculate the same example using 16 mm≤ cable, the volt drop figures becomes 2.4 VDC and 0.24 VDC respectively. This example illustrates that in typical operating conditions electrical losses with both wire sizes are acceptable. However, the system would achieve higher overall transmission efficiencies with the 16 mm≤ cable.