

GROUP GEAR TEST The UK's most trusted kit tests

# Watts in the wind

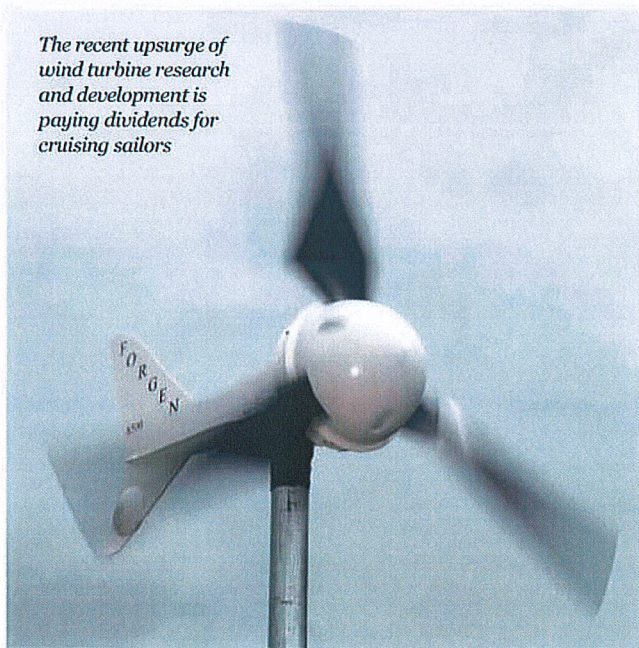


Emrhys Barrell tests  
16 wind turbines ranging  
from £318 to £1,880

*Power generation is a major issue for yachts that spend a long time at anchor. One of the best solutions is a wind turbine*



*The recent upsurge of wind turbine research and development is paying dividends for cruising sailors*



**K**eeping your electronics and appliances working is no problem when you're connected to a marina's shore power but if you're cruising to remote locations, or you keep your boat on a swinging mooring, fitting a wind turbine will help to keep your batteries topped and your mod-cons working – and once you've bought one, it's free electricity.

Most turbine alternators cut in at about 8-9 knots – below this point, even if they are turning, they are not generating power. In theory the average annual wind speed on the coast of the UK is around 9 knots, or Force 3 but, as our tests showed, as soon as the wind picks up above this speed, the output rises rapidly. In practice, as our test shows, you can expect to generate up to 50-90 amp-hours (Ah) per day from an average 0.9-1.2m (3-4ft) diameter yacht turbine. This is

a significant amount of power.

Small marine wind turbines have been on the market for over 25 years, and cruising yachtsmen have been using them to generate power as they travel round the world. But with wind energy set to provide at least 25% of UK national needs by 2030, there has been a recent upsurge in research and development of land-based turbines – not least because of the Government's 'Feed-in Tariff' scheme, where excess electricity produced by your private turbine can be fed back into the National Grid, earning you up to 34p tax-free for every kilowatt-hour (kWh) you don't use.

The marine market is now less significant to turbine makers, but innovations have trickled down to marine units so we decided the time was right to take a look at all the equipment on the market, and see if it has a value for yachtsmen.

PHOTOS: OXOGEN

## Turbine considerations for sailors

### Is there enough wind?

The actual variation of wind speed throughout the year in the UK is a surprisingly hard figure to establish, so we have taken data from a variety of sources and come up with our own estimates of likely wind speeds throughout the year at 5m above the surface, the typical height of a yacht's turbine. This reveals that around 40% of the time the wind is actually below 8 knots, which is close to the useful power threshold. A further 35% of the time it is between 8-14 knots, and 20% of time between 14-20 knots, which are the speeds that deliver meaningful outputs. Wind speeds above 34 knots, or Force 8, will only occur for some 1-2% of the year.

### Turbine noise

The speed at which the blades turn governs the size of the alternator and the amount of noise the unit produces. A small alternator turning fast generates the same amount of power as a large unit turning slowly. It is also lighter and cheaper to make, as it has less copper in its windings and lighter magnets,

but it will be noisier. The tip speed of a 1.2m (4ft) diameter blade turning at 1,400rpm, will be 200mph and it is this tip speed that makes the noise. In extreme conditions the tips of some turbines could approach the speed of sound.

Noise was difficult for us to evaluate because of the ambient wind noise, but above 20 knots or so, some of the faster-spinning units could be heard whirring more than the others.

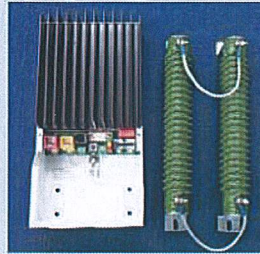
### Power control

In high winds, a variety of systems are employed to prevent damage to the turbine, its mounting, and the batteries. Some feather the blades, either automatically or electronically, limiting speed and loading. Other units with dump load regulators – resistors that dissipate excess power as heat – also have kill-switches, which short out the windings, and stop the blades

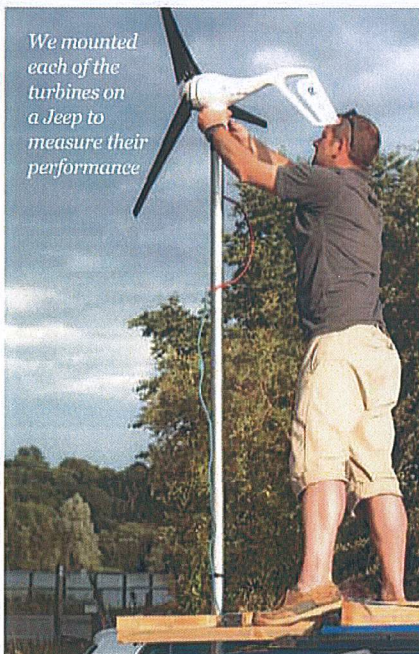
turning. Electronic regulators, either integral or external, restrict the maximum voltage produced to approximately 14.4v, the figure above which lead acid batteries start to gas.

Some of the smallest turbines have no limiters, as their output is so low that a reasonably sized battery bank can absorb the power produced. Or they may have two output settings, one for times when you are on board, and so taking power from the batteries, and one for times when you are away for long periods, when the state of charge could rise too high.

All of the horizontal axis models have holes in the tail fins, which allow you to take a rope through them, and lash them at 90° to the wind in extreme conditions, spilling the wind completely. Make sure you keep clear of the spinning blades as these are often razor sharp, and can cause serious injury at high speeds.



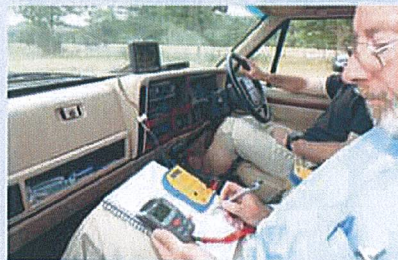
A regulator and dump load – essential if a large turbine is left to charge for long periods



We mounted each of the turbines on a Jeep to measure their performance

## The test

We mounted each unit on a Jeep driven at up to 35 knots into the wind. With some units we were able to test at up to 45 knots, and we also added makers' data above 35 knots. The units were mounted 2m above the roof to reduce turbulence, and the wind speed was measured using a Tacktick remote anemometer mounted at the same height.



We used a Tacktick anemometer to gauge wind speed and a multimeter for amps and volts



The turbines were mounted 2m above the roof to reduce turbulence as we drove upwind

We measured the turbines' output at a range of wind speeds, into two identical batteries, one half charged, and the other fully charged to check the voltage regulation.

We invited all the manufacturers to attend our test, to ensure we had assembled their units correctly, and to ensure there were no anomalies in our measurements.

MAIN PHOTO: GRAHAM SNOOK ©Zephyrus. ALL OTHER PHOTOS: WILLIAM PRYNE

# Products tested

Prices include VAT, but exclude voltage regulators in some cases, and were correct when we went to press

PHOTOS: WILLIAM PAYNE

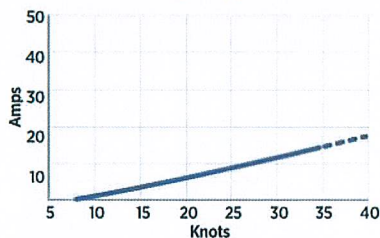


## Aero4gen £722

The long-established Aero4gen is a substantial unit with an aluminium alternator casing and cooling fins. The blades are fixed in a mounting disc in two halves. You set the angle of the blades as you assemble them, lining up two marks, which was fiddly in practice but we eventually got it right. The mounting is a 25.4mm (1in) clamp socket. There is no mechanical furling mechanism. Its performance of 48Ah was mid-range.



During assembly, setting the angle of the blades was a rather fiddly procedure



Output at 30 knots was 11A, and rose steadily afterwards, giving 48Ah per day

### SPECIFICATIONS

WEIGHT	9kg (20 lb)
DIAMETER	0.87m (2ft 9in)
CONTACT	Cleghorn Waring
TEL	01462 480380
WEB	www.cleghorn.co.uk

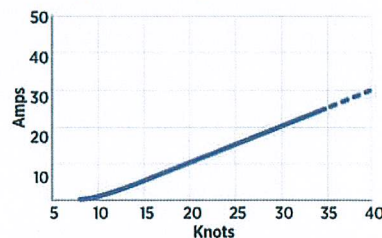


## Aero6gen £1,090

Like the Aero4Gen, this model was formerly made by LVM, but it's now made by ITT and an Aquagen water-powered version is also sold. It's a larger and heavier unit with 1.22m (4ft) diameter blades, but uses the same construction and assembly principles as the smaller Aero4Gen. Its performance of 84Ah reflects this, and is up towards the top of our test. The mounting is a 38mm (1½in) clamp and it is also made in 12v or 24v versions.



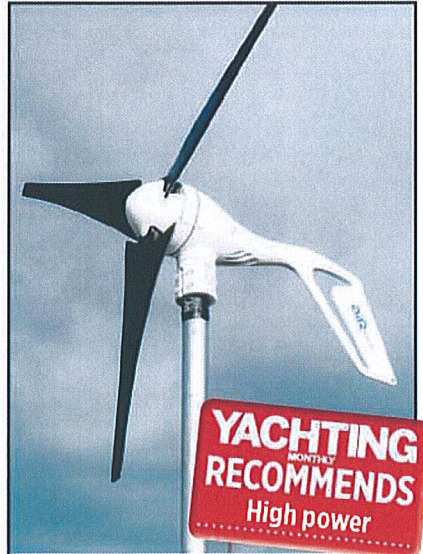
The blade fixing and angle setting was the same as for the Aero4gen



Output at 30 knots was 20A, and again rose steadily above this, giving 84Ah

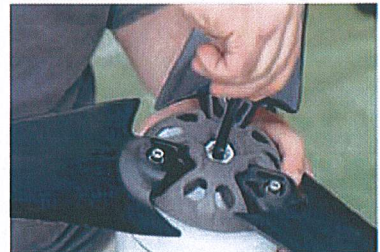
### SPECIFICATIONS

WEIGHT	13kg (29 lb)
DIAMETER	1.22m (4ft)
CONTACT	Cleghorn Waring
TEL	01462 480380
WEB	www.cleghorn.co.uk

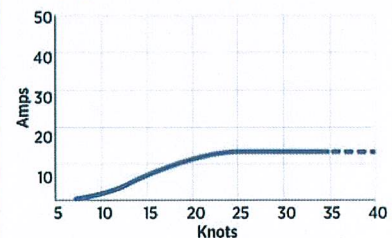


## Air Breeze £795

This model, from Southwest Windpower, USA, supercedes the AirX but spins slower so it's quieter than its predecessor. Sales of over 100,000 are claimed for both models, in 12v, 24v and 48v versions. The unit has a one-piece cast aluminium fin and casing. The built-in speed and output regulators cut in above 25 knots. It weighs about half as much as its nearest rivals. Mounting is a 50mm (2in) clamp socket. Performance is high, at 89Ah.



Assembly of the Air Breeze was straightforward and simple



Output levelled off at 14A, but high figures at low wind speeds gave 89Ah overall

### SPECIFICATIONS

WEIGHT	6kg (13 lb)
DIAMETER	1.17m (3ft 10in)
CONTACT	Air Breeze
TEL	+01 928 779 9463
WEB	www.airbreeze.com

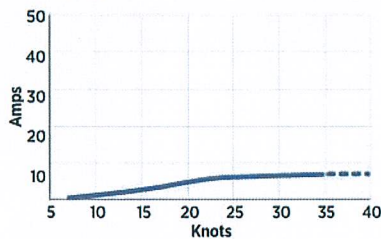


### Ampair 100 £813

Another long-established player in the market, but now under new ownership, Ampair makes sturdy units with an aluminium casing and fin, in 12v, 24v and 48v versions. The 100 has six black blades of approximately 0.9m (3ft) diameter, fixed in a clamping ring. RPM is controlled electronically above 30 knots but an output regulator costs an extra £120. Mounting is a 38mm (1½in) spigot. Performance was mid-range at 34.5Ah.



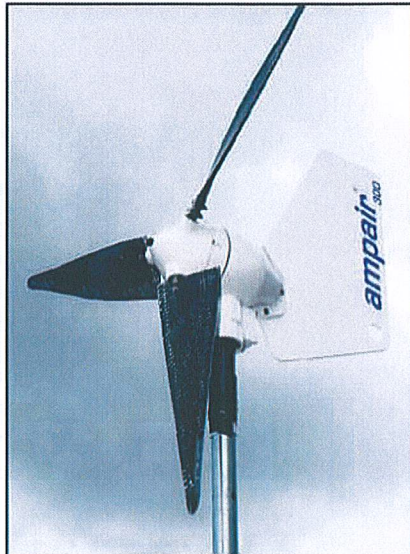
The blades were fixed at a pre-set angle in a clamping disc



Maximum output was 6.5A, levelling off, giving 34.5Ah overall

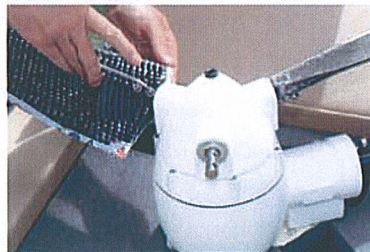
#### SPECIFICATIONS

WEIGHT	13kg (29 lb)
DIAMETER	0.93m (3ft)
CONTACT	Ampair
TEL	01258 837266
WEB	www.ampair.com

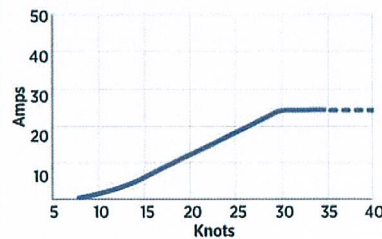


### Ampair 300 £1,440

This larger, 1.2m (4ft) diameter unit has three black blades that 'powerfurl', adjusting their pitch centrifugally as the wind speed increases. This limits the power output and RPM, with the mechanism integral in the hub. An external regulator and dumpload, costing an extra £470, safely disperse excess output. 12v, 24v and 48v versions are available. Mounting is a 38mm (1½in) spigot. Performance was in the top of our group, at 86Ah.



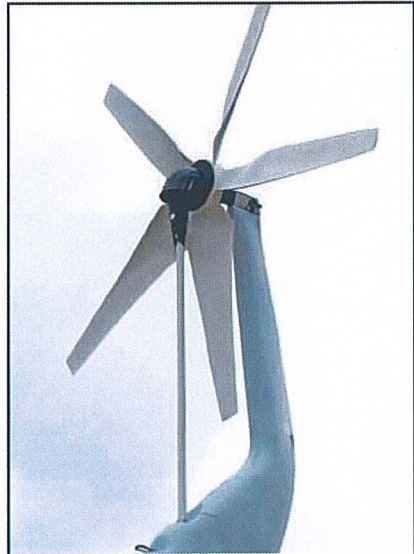
The blades feather at high wind speeds using a centrifugal system



Maximum outputs at 30 knots was 25A, levelling off, giving 86Ah

#### SPECIFICATIONS

WEIGHT	11kg (24 lb)
DIAMETER	1.2m (4ft)
CONTACT	Ampair
TEL	01258 837266
WEB	www.ampair.com

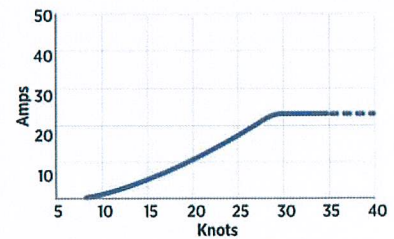


### Duogen £2,240

The Duogen is a combined wind and water generator, using a five-blade turbine or a three-blade propeller respectively to drive its substantial, low-speed alternator. It converts easily between wind and water modes. The turbine automatically swings away from the wind at high speeds, reducing the power generated and structural loading, or it can be locked in one position for maximum output. The 1.1m (3ft 7in) diameter blades produced 78Ah.



The alternator is driven by an air turbine, or water impeller



Output at 30 knots was 23A, levelling off, giving 78Ah

#### SPECIFICATIONS

WEIGHT	20kg (44 lb)
DIAMETER	1.1m (3ft 7in)
CONTACT	Duogen
TEL	01623 835400
WEB	www.duogen.com

# Products tested

PHOTOS: WILLIAM PAYNE



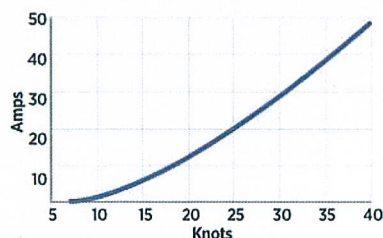
## Duogen D400 £1,120

The D400 is the pure wind turbine version of the Duogen, made by the same company. It has the same dimensions, with five blades at a diameter of 1.1m (3ft 7in), and it's available in 12v and 24v models.

The tail fin is curved to stiffen it, but it has been found that this also limits fluttering and resonant vibration. The mounting is a 50mm (2in) socket. Power output was the highest of the 12v units in our test, at 95Ah.



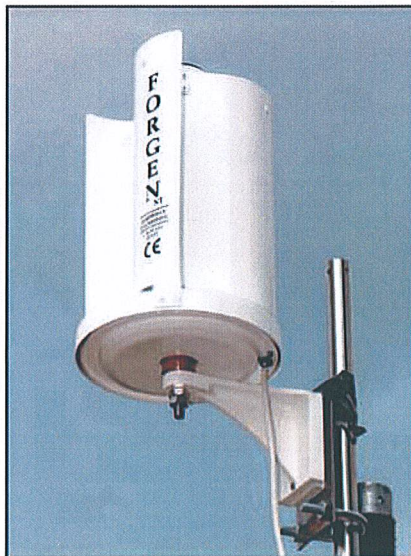
The blades clip together, allowing quick assembly and disassembly



Output at 30 knots was 28A, rising steadily after, giving 95Ah

### SPECIFICATIONS

WEIGHT	15kg (33 lb)
DIAMETER	1.1m (3ft 7in)
CONTACT	Duogen
TEL	01623 835400
WEB	www.duogen.com

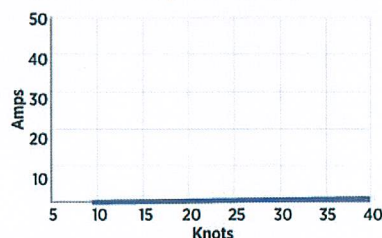


## Forgen 500 £446

Forgen's vertical axis turbines are safer, with no sharp whirling blades, and less affected by high winds. The 500 is seen as a trickle-charger, able to maintain battery condition but not sustain high loads. Hundreds of these are used to power scientific instruments in remote sites, such as Antarctica. Mounting is a 50mm (2in) socket. 12v or 24v, it does not need a regulator, and in our test it produced an equivalent of 4.75Ah per day.



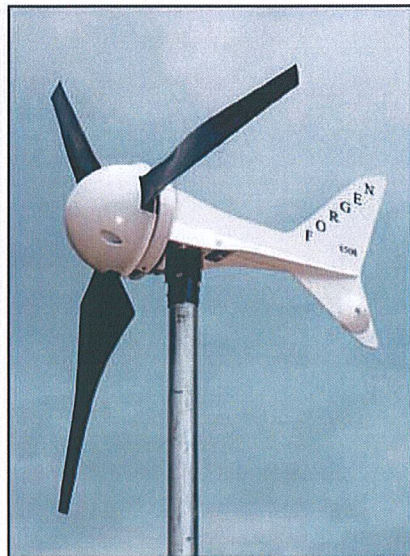
The unit comes ready assembled. A larger 1000 unit is shortly to be launched



Output is low, but OK for trickle charging

### SPECIFICATIONS

WEIGHT	3kg (7 lb)
DIAMETER	0.2m (8in)
CONTACT	Goodridge Environmental
TEL	01452 527457
WEB	www.goodridge-engineering.co.uk

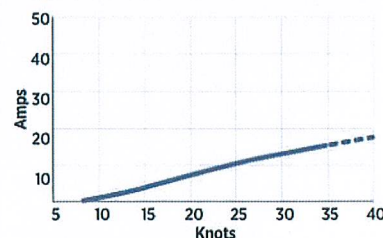


## Forgen 8500 £763

The 8500 is another new model from Forgen, this time a more conventional horizontal axis unit. It is very lightweight, at 7kg (15 lb), with its three blades just over 1m (3ft) in diameter, and it comes with a simple 50mm (2in) socket for mounting on a standard scaffold pole. It's available in 12v or 24v outputs and in our test it produced an output of 50Ah, making it a good compromise between the trickle-chargers and the largest units.



The Forgen 8500's three blades were very easy to assemble



Average output was 50Ah

### SPECIFICATIONS

WEIGHT	7kg (15 lb)
DIAMETER	1m (3ft 3in)
CONTACT	Goodridge Environmental
TEL	01452 527457
WEB	www.goodridge-engineering.co.uk

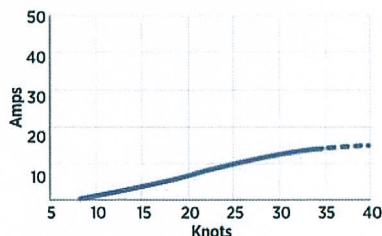


### LE 300 £658

Leading Edge, or LE, Technology is a new name to the marine market, having hitherto concentrated on land-based wind turbines. The LE 300 is a three-blade horizontal axis unit, very similar in appearance to the Forgen 8500, and it's available in 12v and 24v versions with a 50mm (2in) socket mounting. In our test it also delivered a similar output to the Forgen 8500 at 48.5Ah, but it's sold at a significantly lower price.



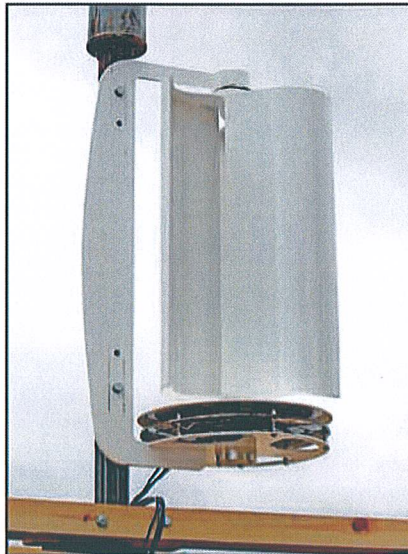
Assembly of this three-blade unit was straightforward



Output at 35 knots was 16A, rising steadily, giving 48.5Ah

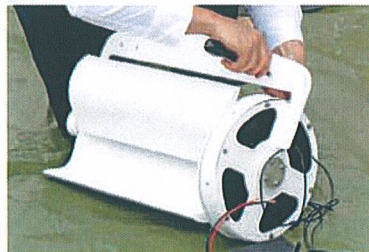
#### SPECIFICATIONS

WEIGHT	4.5kg (15 lb)
DIAMETER	1m (3ft 3in)
CONTACT	LE Technology
TEL	0845 652 0396
WEB	www.leturbines.com

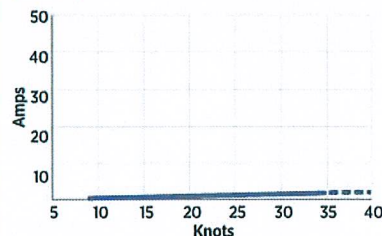


### LE V50 £940

This is a vertical axis unit, again from the newcomer to the marine market, Leading Edge. It shares the virtues of the other vertical axis machines – namely safety, as it has no sharp, spinning blades, and the ability to spill wind from its blades in stronger conditions. Our test confirmed its trickle-charging status as the LE V50 produced an output of 7.25Ah, slightly more than the Forgen 500, but it costs £460 more.



Output at 35 knots was 1A, rising steadily, giving 7Ah



Output at 35 knots was 1A, rising steadily, giving 7Ah

#### SPECIFICATIONS

WEIGHT	12kg (27 lb)
DIAMETER	0.3m (1ft)
CONTACT	LE Technology
TEL	0845 652 0396
WEB	www.leturbines.com

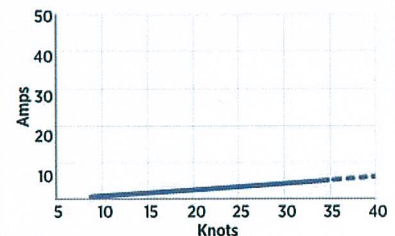


### Rutland 504 £318

Rutland units have a reputation for simplicity and reliability. The 504 has a 0.6m (2ft) diameter, six-blade rotor, with a ring round its circumference, giving it extra strength, but also reducing the risk of injury from spinning blades. The casing is plastic and weight is a minimal 3.5kg. Output was correspondingly at the low end, at 16Ah, making this suitable as a trickle charger. Mounting is a 30mm (1.25in) spigot.



The 504 was quick and easy to assemble, with a one-piece rotor



Output at 35 knots was 2.5A, rising steadily, giving 16Ah

#### SPECIFICATIONS

WEIGHT	3.5kg (8 lb)
DIAMETER	0.51m (1ft 8in)
CONTACT	Marlec
TEL	01536 201588
WEB	www.marlec.co.uk

# Products tested

PHOTOS: WILLIAM PAYNE

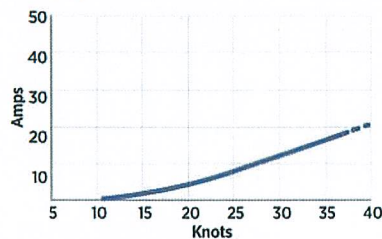


## Rutland 913 £516

One of the longest-established names in the game, Rutland's 913 is a more substantial unit than the 504 with a 0.9m (3ft) six-bladed rotor, and a weight of 11kg (24 lb), which is still comparatively light thanks to its plastic casing. Like the smaller 504, it is easily assembled using basic tools. Mounting is a 42mm (1.6in) spigot. Output at 48Ah puts this in the middle of the mid-range units but the relatively low price makes it a popular choice.



Assembling the 913 was simple and straightforward



Output at 35 knots was 17A, rising steadily, giving 48Ah

### SPECIFICATIONS

WEIGHT	11kg (24 lb)
DIAMETER	0.91m (3ft 1in)
CONTACT	Marlec
TEL	01536 201588
WEB	www.marlec.co.uk

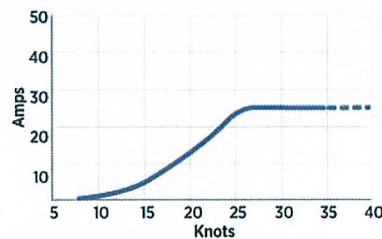


## Superwind £1,260

Germany's Superwind is a comparative newcomer. The aluminium casing is strong and the mounting is a 42mm (1.6in) spigot. In 12v or 24v models, it has twin outputs for charging two separate batteries. Output in our test was 73Ah, at the lower end of the 1.2m (4ft) models. Our first test only recorded a maximum 16A at 25 knots, but Superwind sent us a new unit which gave 25A, levelling off after that.



Assembly was straightforward, using a single Allen key



Output rose quickly from about 10 knots, levelling off at 25 knots, giving 73Ah

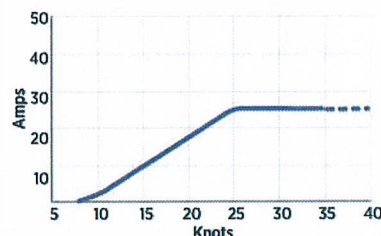
### SPECIFICATIONS

WEIGHT	11kg (24 lb)
DIAMETER	1.2m (4ft)
CONTACT	Mactra Marine
TEL	01934 517288
WEB	www.mactrashop.co.uk

## Powerful turbines for big boats with 24v systems

### Ampair 600 £1,880

Available in 24v, 48v or 230v only, with three 1.7m (5ft) blades. External weights on the blades alter their pitch by centrifugal force. Mounting is a 50mm (2in) socket. Output was 122Ah at 24v, almost three times the best of the rest. The regulator is an extra £520.



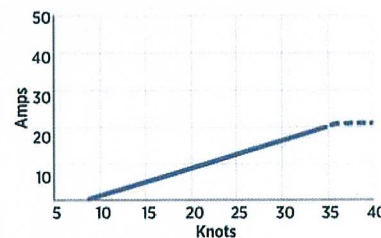
Output at 25 knots was 25A, at 24V

### SPECIFICATIONS

WEIGHT	17kg (38 lb)
DIAMETER	1.7m (5ft 7in)
CONTACT	Ampair
TEL	01258 837266
WEB	www.ampair.com

### LE 600 £1,170

Unlike all the others, this is a 'downwind' unit - its blades rotate behind the alternator rather than ahead of it, and there's no fin. It seemed directionally less stable than the upwind units, perhaps because of the lack of a nose cone. On test it delivered an output of 58Ah at 24v.



Output at 35 knots was 25A, leveling off

### SPECIFICATIONS

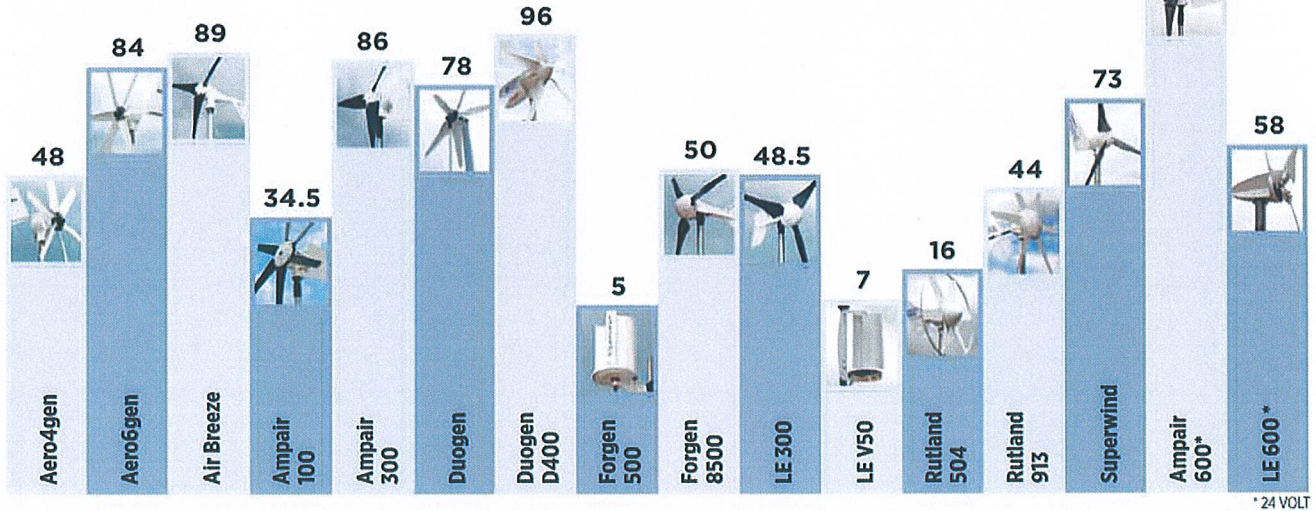
WEIGHT	14kg (31 lb)
DIAMETER	1.54m (5ft)
CONTACT	LE Technology
TEL	0845 652 0396
WEB	www.leturbines.com

# The results

Estimated average daily output (Ah)

To give a realistic indication of the power each unit is likely to generate through the year in a typical UK coastal situation, we multiplied the outputs at different wind speeds to give a comparative daily figure. You won't find this in any of the makers' literature, but we think it provides a rule-of-thumb indication of likely output. Of course this is not the only factor that you will be taking into consideration when deciding what to buy, but it does give you a starting point.

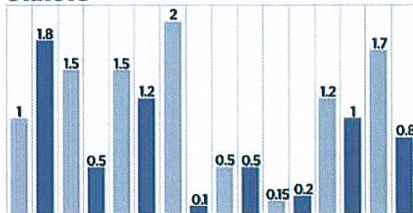
literature, but we think it provides a rule-of-thumb indication of likely output. Of course this is not the only factor that you will be taking into consideration when deciding what to buy, but it does give you a starting point.



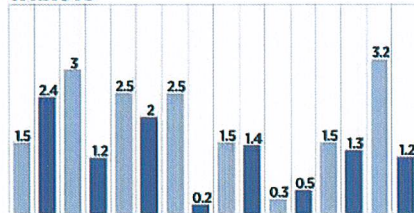
\* 24 VOLT

## Results in detail: power (Ah) generated at a range of different wind speeds

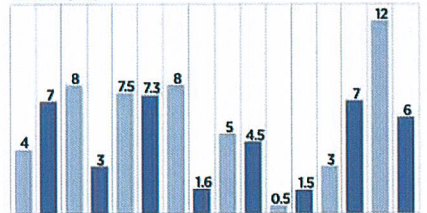
8 KNOTS



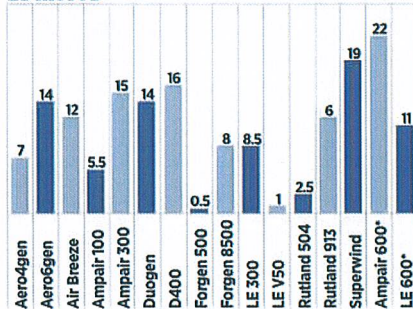
11 KNOTS



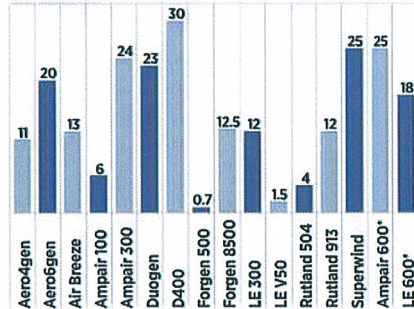
17 KNOTS



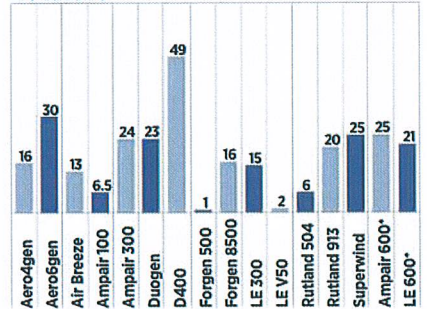
23 KNOTS



30 KNOTS



40 KNOTS



## Conclusion

With such a wide variation of prices and sizes of turbines – and the equally wide range of power requirements on different yachts – there is no overall, all-purpose winner. The vertical axis models are best suited for long-term trickle charging, with low current outputs at 5-10Ah

per day, but simple, reliable construction. The horizontal axis models seem to have blade diameters of approximately 0.5m, 0.9m or 1.2m (2ft, 3ft or 4ft), and outputs of 10-20Ah, 40-50Ah, or 70-95Ah per day. If you are leaving them charging unattended for long periods, you will have to add a regulator to the package for the larger models, with prices between £250 and £450.

**YACHTING MONTHLY RECOMMENDS**  
Low power

In terms of value-for-money, or Ah per £, of the trickle-chargers, the **Rutland 504**, at £318 and 16Ah, comes out top.



**YACHTING MONTHLY RECOMMENDS**  
Mid power

Of the mid-range units, again it is a Rutland unit, this time the **Rutland 913** at £516 and 48Ah, that wins.



**YACHTING MONTHLY RECOMMENDS**  
High power

The **Air Breeze**, at £795 for 89Ah, is the clear winner among the largest output models.

