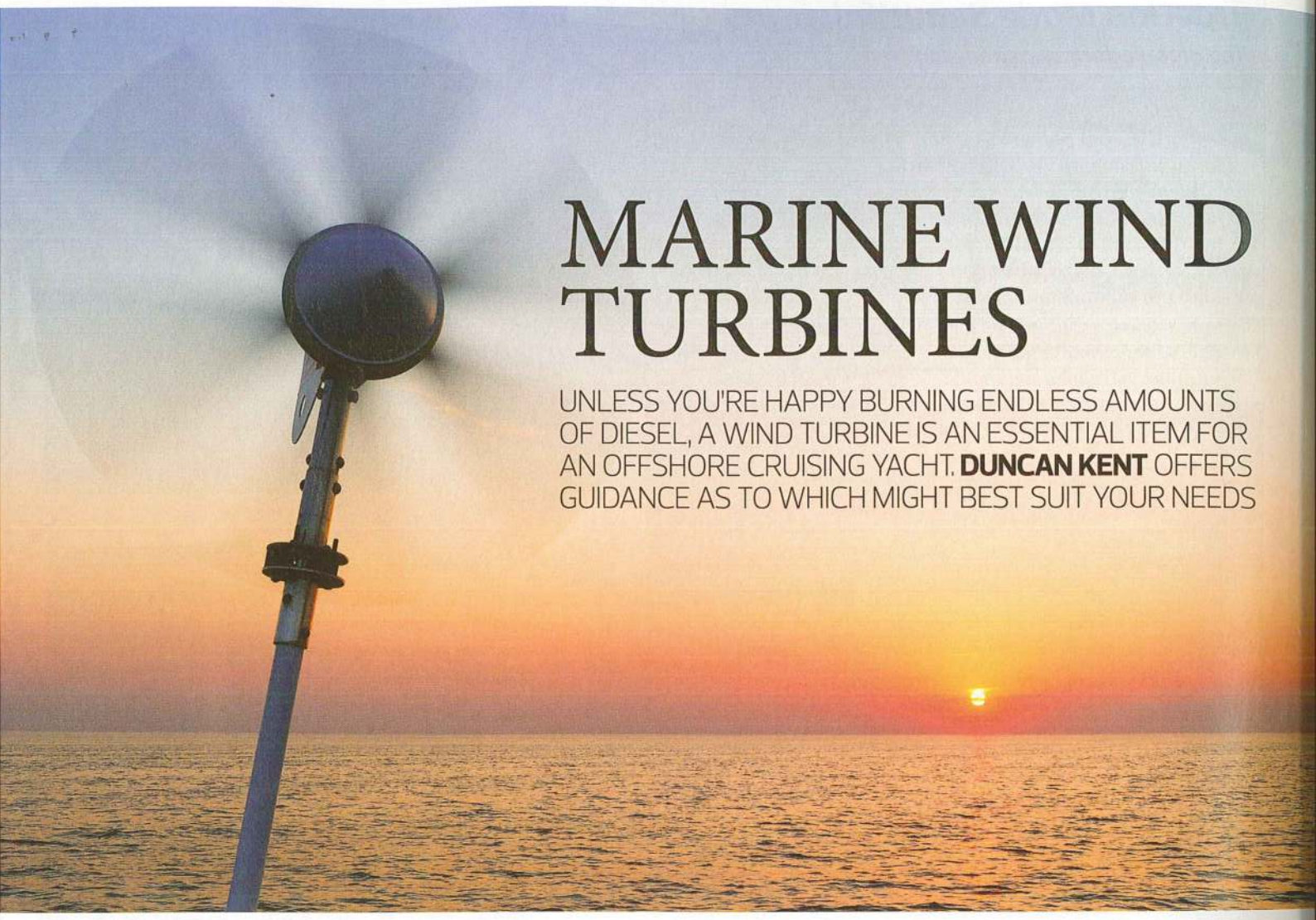


MARINE WIND TURBINES

UNLESS YOU'RE HAPPY BURNING ENDLESS AMOUNTS OF DIESEL, A WIND TURBINE IS AN ESSENTIAL ITEM FOR AN OFFSHORE CRUISING YACHT. **DUNCAN KENT** OFFERS GUIDANCE AS TO WHICH MIGHT BEST SUIT YOUR NEEDS

Today's cruisers carry so much electrical equipment that wind turbines, solar PV arrays and hydro-generators are becoming more and more common. The marine wind turbine has been around for several decades now and has gradually been refined to give a much higher degree of efficiency. Better alternators, CAD-designed blades, life-sealed bearings and smart charge controllers make the latest devices more reliable, quieter and safer.

HORIZONTAL OR VERTICAL AXIS?

The majority of marine wind turbines are horizontal axis devices, either upwind or downwind driven. These are powerful and as such need speed and/or charge output limiters or they can burn out the batteries and self-destruct in storm-force winds. Vertical axis turbines are more suited to trickle charging – usually connected to one or two batteries up to 200Ah capacity. The blade design means they are unidirectional and thus have no need for a bulky tail fin to point them into the wind. They are also considerably quieter than most horizontal turbines and much easier to mount and install.

BLADE DESIGN

Modern turbines usually sport a one-piece, cast aluminium body and, commonly, three aerodynamically designed plastic/composite blades. One of the first of these models, the original Air-X, worked exceptionally well, particularly in high winds. However, it was so noisy that neighbouring boats frequently complained, leaving the owner the option of turning it off or moving well away from other boats. Since then CAD-inspired blade design has significantly helped to reduce ambient noise levels, although none could be termed silent.

ABOVE
An effective wind generator can provide a vital boost to your battery

RECTIFICATION

Modern wind turbine alternators produce alternating current (AC) initially, but the majority convert this to direct current (DC) via a rectifier within their own housing, leaving a simple positive and negative wire to be connected to the battery bank or regulator.

'CAD-inspired blade design has significantly helped to reduce ambient noise levels'

Some have three AC wires exiting the generator and have to be connected either to a dedicated charge controller to convert this into DC. Although the end result is the

same, less voltage drop is suffered over a long cable run from turbine to batteries using AC wiring.

REGULATION

Once your battery bank is fully charged, additional energy from the turbine needs to be dissipated or the turbine stopped. Low power vertical-axis models don't usually produce enough to warrant fitting a regulator, but the more powerful models all need some form of charge limiter to prevent overcharging.

The simplest form of regulation is to switch it off when no further charge is needed. If you electrically disconnect the turbine, however, it can either damage the alternator diodes or carry on spinning at an even higher speed, so most are electrically 'braked' by shorting out their output wires and a high-current switch is usually provided for this action.

If you leave a turbine running unattended, you'll need an automatic regulator and there are two systems commonly available. The first lets the turbine continue to spin and produce power, diverting any that isn't needed into 'dump' resistors to burn off the excess as heat. While effective, it is pretty rudimentary and you have to be careful where you mount the bulky resistors, which can get quite hot. Alternatively, some use this unwanted charge to pre-heat the hot water tank via an immersed element.

Other turbines incorporate 'pitch control', comprising feathering blades that either flatten out or turn edge into the wind to regulate turning speed at high wind speeds.

CHARGE CONTROLLERS

A variety of automatic charge controllers are available, some more sophisticated than others, and you don't necessarily need to use one from the same manufacturer unless it specifically states that you must. A basic model has a voltage-sensitive on/off switch that will trigger at a pre-set threshold battery voltage. The more useful controllers have a built-in display for monitoring turbine output and battery condition and some can also accept and distribute charge from other sources, such as solar or hydro generation.

ALAMY

HIGH-POWER HORIZONTAL AXIS

1. AIR BREEZE 200

Although the latest generation Air Breeze, made by Primus Windpower, provides an increased charge output, it is also quieter and should apparently outlast its predecessors. Its low start-up speed (4.2kn) means that, on average, it should be able to produce more energy than some higher-rated turbines over long periods of low-to-moderate wind speeds. Though it only has a maximum output of 200W, its output has been optimised to provide a more constant charge in typical northern European and Mediterranean wind conditions.

The new Air Breeze weighs less than 6kg and has an integral electronic charge controller and over-speed regulator, rendering bulky dump resistors unnecessary and making installation considerably quicker and easier.

- **turbine £1,169; controller included**
- **primuswindpower.com**

2. LEADING EDGE LE-300/LE-450

UK company, Leading Edge supplies wind turbines for both marine and terrestrial installation. The LE-300 and LE-450 are available in 12V, 24V and 48V versions and are remarkably light, making them ideal for sailing yachts.

Output is DC via two wires and a run/stop switch is supplied that brakes the turbine by shorting the output. The units can also be supplied with charge controllers, which is a dump load style regulator that allows you to leave the turbine on 24/7 without the batteries overcharging. The three-bladed LE-300 is very light (6kg) and one of the quietest of the three-bladed models. However, its output is poor for a horizontal-axis turbine, although it starts spinning in the gentlest breeze. The five-bladed LE-450 is more powerful (105W at 15-knots), while remaining quiet and stable.

- **LE-300 £649; LE-450 £899; controller £190**
- **leadingedgepower.com**

3. RUTLAND 1200

The latest in the Rutland wind turbine line up, the 1200 is Marlec's answer to the third generation three-blade, permanent magnet turbine models. More powerful than the 914i, it features 'Tri-namic' blade design, which is said to provide a low start-up speed, very quiet running and more power towards the top end of the wind scale.

With a claimed peak production of 483W (that's 35.5A at 12V) in 29 knots of wind, the 1200 can also supply a very useful 40W of power in just 10 knots of wind – a more realistic average in UK waters. The 1200's charge controller has dual outputs for two separate battery banks and can accept up to a 20A solar PV supply. It reduces the turbine speed automatically after winds reach 30 knots, regulating the charge without using dump resistors. It also has an integral start/stop switch and can support a remote display, which connects to the controller via a simple Ethernet cable.

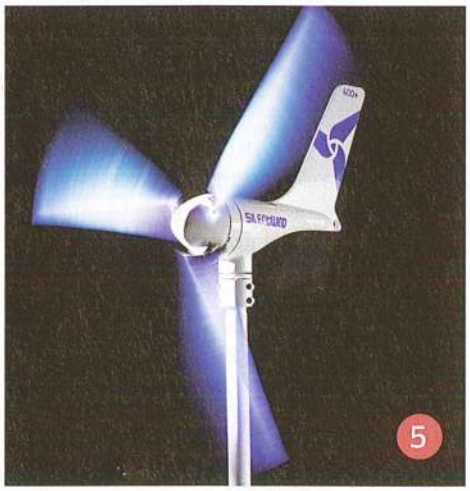
- **turbine £1,195; controller included**
- **marlec.co.uk**

4. SUPERWIND 350

The blades on this German-built device are very steeply pitched towards the hub, resulting in an early start-up in lighter airs and they also incorporate tiny fins along their length, said to quieten them at high speed. The blades have a kinetic rotor pitch control system designed to feather them in very high winds, not unlike the large terrestrial wind turbines. With a charge controller in the circuit, the turbine can therefore be left spinning in all weathers without worry.

Output is two-wire 12V or 24V DC, so it could, in theory, be directly connected to a battery bank. It can also be used with a simple short-circuit stop switch, which will slow it down enough to be tied off. The Superwind 350 can also be supplied with a 40A SCR Marine charge controller, which has two independent, diode-isolated outputs for start and service battery banks, and dissipates unwanted energy via two large, wire-wound dump resistors. Nominal power is 350W at 25 knots.

- **turbine £1,645; controller £462**
- **mactramarine.co.uk**



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5. SILENTWIND 400+

As fitted to all boats in the Volvo Ocean Race and featuring 'Silent Power Blades' – hand laminated carbon blades, successfully tested at hurricane speeds – the latest Silentwind 400+ has improved wind tracking and earlier start-up than its predecessor, the 400. Featuring aerodynamics combined with a three-phase Neodymium-Iron-Boron permanent magnet generator, the 400+ is said to have a start up speed of only 4.3 knots and a peak output of 420W at 30 per cent less rotation speed than other 400W generators. 12V, 24V and 48V models are available. The Silentwind has a 3-wire AC output, which connects directly to the matching hybrid multi-stage charge controller that enables trickle charging and the connection of up to 20A of solar PV power. An adjustable boost function increases performance and optimizes the power yield, while the LCD displays all the important charge information. When the batteries are fully charged the turbine automatically stops or switches to trickle charge mode with a significant reduction in rotation speed. It can also be stopped (braked) manually with the built in switch on the controller.

- **turbine £1,298; controller £423**
- **primuswindpower.com**

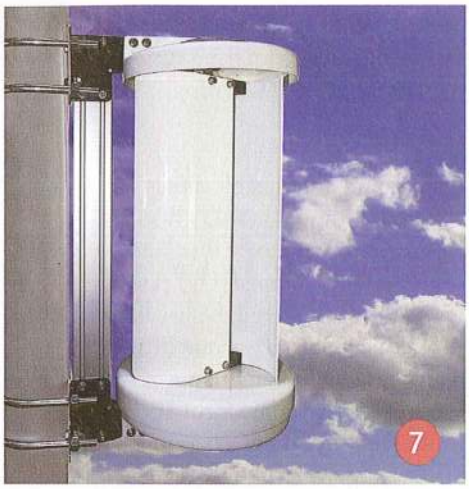
LOW-POWER HORIZONTAL AXIS

6. RUTLAND 504

The Rutland 504 is a small and lightweight (just 3.5kg) mini-horizontal turbine from UK off-grid power specialist, Marlec. The earlier model (503) has proven to be extremely popular over the years, in both the small leisure craft market and in commercial applications such as remote street lighting and signage, buoy lights, ATON power etc., and the 504 should prove equally so.

Like its predecessor it is very compact and its blades are 'encapsulated' – ie. they have a protective ring around them to prevent limbs and clothing getting caught up in the blades. Its output is better than that of the vertical-axis turbines, but nowhere near the more powerful generators listed above. It is, however, notably quieter. Typical output in around 15 knots of wind is 12W (1A @ 12V), doubling to 24W/2A at 20 knots. It also has a lower start-up speed than the vertical turbines and, although it takes around 10 knots of wind to provide any useful charge, its low-friction alternator compensates for the gusts by 'smoothing out' its output.

The 504 does require a charge controller if it is to be left unattended.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- **turbine £368; controller £80**
- **marlec.co.uk**

VERTICAL AXIS OPTION

7. LEADING EDGE

The LE-V50 and V150 vertical axis turbines are compact, lightweight and virtually silent. The V50 measures 270mm dia x 456mm high and is intended for trickle-charging batteries or for running low-power devices. Available in 12V, 24V or 48V versions, it has a nominal output of 12W, but a peak of 70W. In typical UK waters this results in an average charge of 0.5-1.0A @ 12Vdc in a fresh breeze. The bigger V150 model has a peak output of 200W, but a more typical rating of 24W in wind speeds of 15 knots – double that of the V50. Originally designed to provide power for industrial data monitoring equipment in the most remote locations where there is no other power source, these often supplement solar PV arrays in an off-grid situation.

- **turbines £700 (V50) £900 (V150); controller £200**
- **leadingedgepower.com**