

## StealthGen Grid Tied Micro Wind Turbine System

Please read this manual in conjunction with the specific product instruction manuals supplied covering the D400 Wind Turbine, the Mastervolt Grid Tie Inverter, and the Schams MPPT Controller.

### Introduction:

Small wind turbines are one of a range of technologies that offer a practical way to generate electricity for the home or business.

The StealthGen D400 wind turbine from Eclectic Energy Ltd. is very compact and visually unobtrusive, virtually silent in operation, yet is highly efficient and productive when installed at a site with a good wind resource.

The wind turbine outputs variable voltage DC, and this is conditioned to produce grid synchronised AC by a solid state inverter. This AC power is fed directly into the building's ring main.

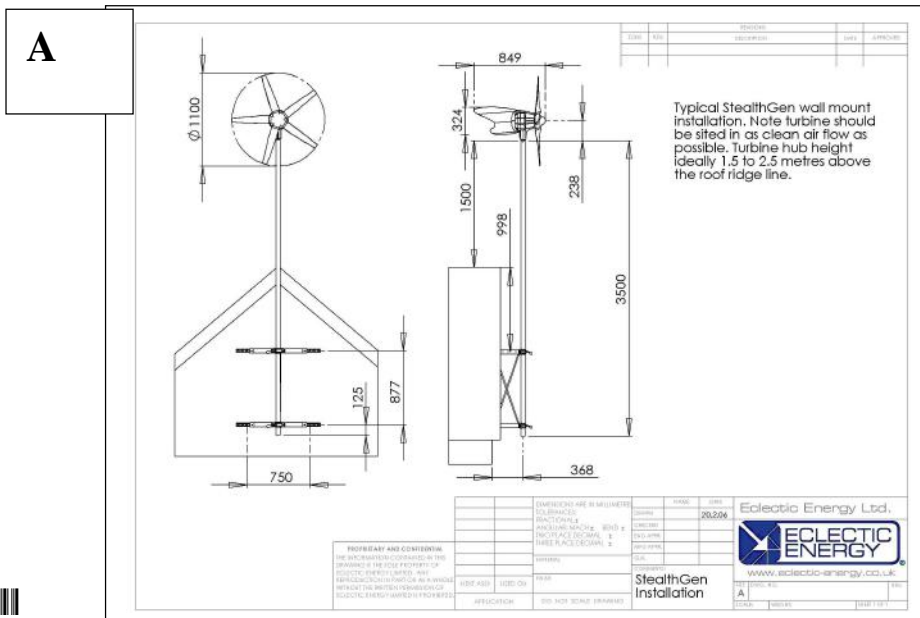
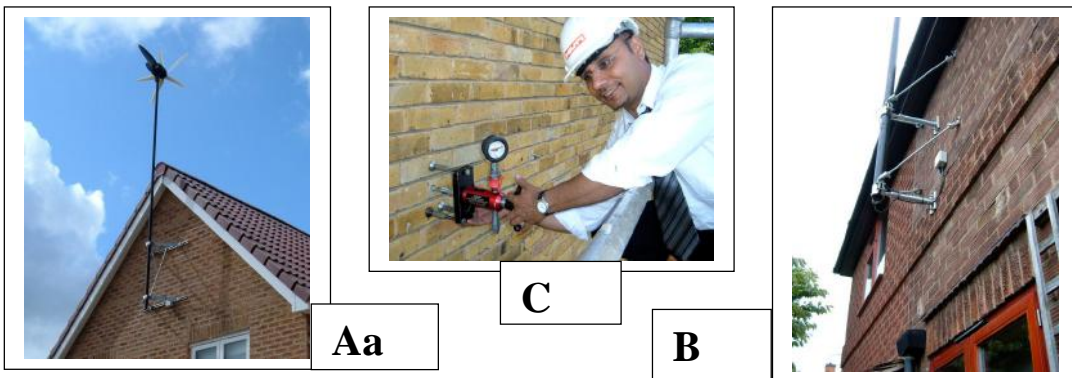
### Building Mounting:

Eclectic StealthGen turbines can be successfully mounted off structural walls (typically the gable wall) using the specially designed bracketry illustrated. Drawing A (and photograph Aa) shows a typical standard duty installation, secured by 4 x M10 masonry anchors, and provides for a maximum free tower length of 2.5 metres. Refer to 'Standard Bracket Installation' section.

Where a greater free tower length is required, i.e. up to 4.5 metres, the heavy duty bracket system (see photograph B) should be used. These brackets are secured with 8 x M12 masonry anchors, and can accommodate towers up to 75mm diameter.

The masonry anchors used should be of the pumped resin grout type, and fixings should be subject to a proof load test prior to the bracket installation (photograph 'C'). This testing demonstrates that fixings and masonry are sufficiently strong to absorb the loading produced by the turbine.

Note, any StealthGen mounting tower should be designed to provide a safe working load of 70 kg in a lateral direction at the hub height of the turbine.



Wiring Instructions (Refer to schematic in conjunction with these notes.)

- 1) DC cabling from turbine to control interface/unit. The StealthGen/D400 turbine typically outputs in the range of 0 – 140 volts DC. The maximum DC current is 8 amps. For cable runs up to about 45 metres, 16 SWG (2.5 square mm conductor section) is adequate. For longer runs, 13 SWG (4.5 square mm conductor cross-section) is preferable. Where cable is run externally or is susceptible to mechanical damage, armoured cable should be used.
- 2) Eclectic's standard duty wall mount brackets are supplied with an IP 67 junction box. It is recommended that the cable run from the turbine down the tower tube be terminated at the junction box associated with the brackets. This allows for rapid and easy disconnection where it is necessary to lower the turbine tower.
- 3) To avoid the weight of the cable in the tower tube hanging on the connections at the turbine, it is recommended that strain relief is provided to take the weight of the cable within the tower. If this is not possible, ensure the connections at the turbine are mechanically robust.
- 4) It is recommended and most practical to terminate armoured cable in a junction box adjacent to the control interface/unit.
- 5) The DC feed from the turbine passes through a cable gland in the control/ interface unit , and is connected via the terminal block on the internal board.
- 6) The output from the control/ interface unit is via the factory-fitted, double insulated leads, and 4mm multi-contact plugs. These are plugged into the inverter. Note, it is not possible to connect these plugs with incorrect polarity. However ensure correct polarity from the control/ interface unit to the plugs.
- 7) The AC output cable from the inverter is made into the 'break' (non-ring main) side of the lockable AC isolation switch.
- 8) The ring main side of the lockable AC switch is connected to the buildings consumer unit or fuse box.
- 9) The connection into the ring main at the consumer unit should be made via a type D 16 amp MCB. Note: faster acting MCBs may be problematic and trip out frequently in association with grid tie inverters. Type D breakers only should be used.
- 10) Where AC meters are fitted, they should be wired between the lockable isolation switch and the type D MCB at the consumer unit. Note: due to a combination of rapidly fluctuating power levels and harmonics in the output current, many typical OffGem type cumulative kW hour meters with low sample rates fail to read accurately when used with grid tied, micro wind systems. Refer to Eclectic for information on recommended power meters.
- 11) The Windmaster 500 grid tie inverter is supplied, factory set to the grid parameters required by grid authorities in the country where the unit is to be installed. If there is any doubt regarding configuration, contact Eclectic Energy Ltd. prior to installation.  
Note: all inverters carry a label stating the country for which Eclectic has configured the unit prior to despatch.
- 12) As well as adjustable output settings to comply with different national grid requirements, the Windmaster 500 can also be programmed for input characteristics. It is particularly important to match the inverter with the turbine, and the pre-programmed input power curve ensures maximum efficiency for the StealthGen Micro Wind System. We strongly advise against altering the Eclectic programmed settings.

Turbine Site and Installation:

There is a cubic relationship between wind speed and the amount of energy it contains. For example, there is 70% more energy available in a breeze of 12 mph than 10 mph. For this reason, it is very important to site turbines carefully, in the fastest -moving air possible. Obstructions such as trees and other buildings in close proximity to the turbine will slow the wind down and also introduce turbulence. These factors will dramatically reduce the yield from the turbine.

Where possible, the turbine should be placed on the elevation of a building that faces the prevailing wind direction, with the hub height at 1.5 to 2 metres above the roof line. It is always advisable to assess your site carefully prior to installation to ensure the available wind resource is adequate. Wind speed data is available on line (see [www.est.co.uk](http://www.est.co.uk)) or wind

speeds can be physically measured and assessed over time, using an anemometer and data logger.

Micro wind systems that are building mounted need to be securely and professionally attached to the building in the interests of safety. Also in the UK, generating systems that are grid tied are covered by an electrical technical connection protocol called G83. For these reasons, StealthGen micro wind systems should only be installed and maintained by specialist contractors who hold G83 accreditation and are registered under the Micro Wind Certification Installers Scheme.

#### Standard Duty Wall Mount Bracket Installation:

Eclectic has developed a mount bracket system that enables a typical turbine to be installed by two people, using appropriate access equipment that need not extend beyond the height of the upper mounting bracket.

In addition to the supplied bracketry, a length of galvanised steel scaffolding tube is required to act as the turbine mounting tower. Standard scaffold tube is 48.6 mm O/D, 41.6 mm I/D. The tube should be 3 – 3.6 metres long. The maximum free length of tube above the upper bracket clamp should not exceed 2.5 metres.

#### Procedure for mounting using standard duty wall brackets:

The mounting comprises two unistrut sections that are fixed horizontally to the wall (usually a gable) using an appropriate anchoring system. The upper unistrut section would normally be positioned around 800 - 900 mm below the ridge line with the second unistrut section 875 mm below the first. Note – recommended fixing centres are 675mm horizontally and 875 mm vertically. (Refer to mounting schematic drawing)

A stand-off bracket is then bolted to the unistrut. The stand-off bracket carries tube clamps that can be opened to accept the turbine tower tube, and then locked shut. The tube clamps are isolated both mechanically and electrically from the rest of the mount bracketry by neoprene anti-vibration mounts.

Finally, two vertical braces are fitted, running from the unistrut to the tube clamp mount plates, triangulating the brackets in order to stiffen the structure when loaded vertically.

The structural integrity of the turbine installation is dependent on the anchors used. Generally, an injection resin system is recommended, HILTI HY50 or similar, together with M10 stud anchor rods.

We strongly recommend that each anchor be subjected to a pull-out test to 4kN prior to installation of the brackets. This ensures a safety margin of 3 against maximum expected service loads.

- a) Assemble the turbine to its tower at ground level. Refer to the D400 / StealthGen manual for details of turbine assembly. If the rotor nose cone is left unfitted, the turbine will sit flat on the ground on its rotor hub.
- b) Thread a cable through the tower tube and arrange for a cable tie or similar to prevent the weight of the cable hanging off the turbine's output leads when installed.
- c) Temporarily connect the turbine output cables at the base of the tower together. This will act as an electric brake and prevent the turbine from spinning during installation.
- d) Check that the black acetal tower liner fits the inside of the tower tube. The weld line on the inside of the tower tube may need to be removed with a file to achieve this.
- e) Make the electrical connections between turbine output and tower cable using terminal block or crimp connectors. Bind with insulation tape.
- f) Assemble the turbine to the tower, ensuring that the grub screws locking the tower liner to the yaw shaft are tight. Secure with 2 x self-tapping screws, passing through the tower wall and into the tower liner.
- g) Fit the turbine nose cone.

- h) Lift the turbine and tower up to the wall brackets. A rope passing around the upper bracket can be used as a fail safe to make this process more controllable. Install the tower into the bracket clamps and secure loosely.
- i) Next, raise the turbine and tower vertically to its chosen operating height and lock the tower clamps firmly. NB – Hub height is normally about 1.5 – 2 metres above the ridge line.
- j) Finally, assemble the IP55 junction box to the Unistrut, and the turbine is now ready to be connected to the controller/interface and inverter input cable.

**Key Weights:**

- StealthGen Turbine – 17 kg
  - Wall-mounting bracketry - 9.5 kg
  - 4m x 48mm tower tube - 6.5 kg  
(aluminium)
- TOTAL SYSTEM WEIGHT – 33 kg
- Rotor wind loading at rated output – 13.5 kg (11m/s)
  - Max. rec. un-stayed tower length at 49mm diameter – 2.5 metres

How the system works:

The StealthGen Grid-Tied System comprises three major elements, configured as per the installation schematic and as described below:-

- 1 x 48 volt S/G or D400 Wind Turbine – MCS accreditation pending.
- 1 x Turbine Controller/ Interface unit – featuring:-

- MPPT Circuit
- Voltage Limiter
- Dump Circuit
- Dump Load
- Brake Switch
- LED status Lights

- 1 x WindMaster 500 grid tie inverter. Producing synchronised grid compatible Ac from the variable voltage DC input. Features:-

- G83 Compliance
- Max 500w Ac output
- Programmable Parameters and Data Collection

Moving air has both mass and velocity. Wind generators are designed to extract a percentage of this kinetic energy from the moving air and convert it to electricity.

The StealthGen/D400 utilises a five air blade to capture energy from the wind, and the rotary motion from the air rotor drives a three phase alternator producing variable voltage alternating current. The AC is rectified to DC within the alternator body and exits via slip rings and brushes. These allow the turbine to rotate on its axis to face the wind without twisting the output cable.

The DC electricity from the turbine then flows to the turbine control/ interface unit. This unit contains power conditioning electronics which holds the turbine voltage within a safe maximum value following an interruption in grid supply.

The MPPT circuitry (maximum power point tracking) incorporated in the controller/ interface maximises the energy capture from the wind and increases the power delivered by the turbine. The MPPT continually adjusts the electrical load seen by the turbine's alternator which allows the air blades to operate at their optimum aerodynamic efficiency for more of the time. A DC/DC converter within the controller/interface unit then re-adjusts the turbines input

power to produce the optimal balance of output voltage and current to match the inverter input requirements.

In addition, the control unit features a brake switch that allows the turbine to be stopped and started. These modes are marked 'run' and 'braked' on the units casing.

The output from the turbine control/interface unit then passes to the Mastervolt inverter. The inverter takes the variable voltage DC supplied at its input and produces 240 volt AC synchronised to the grid at its output.

As the AC produced is grid synchronised, it can be fed directly into the ring main, where it is used in preference to electricity entering the home from the grid via the domestic meter.

Usually, the power being generated will only be sufficient to offset a proportion of the draw on the grid. However, if more power is produced than is being used, the surplus will naturally flow back into the grid. In these conditions power is being exported.

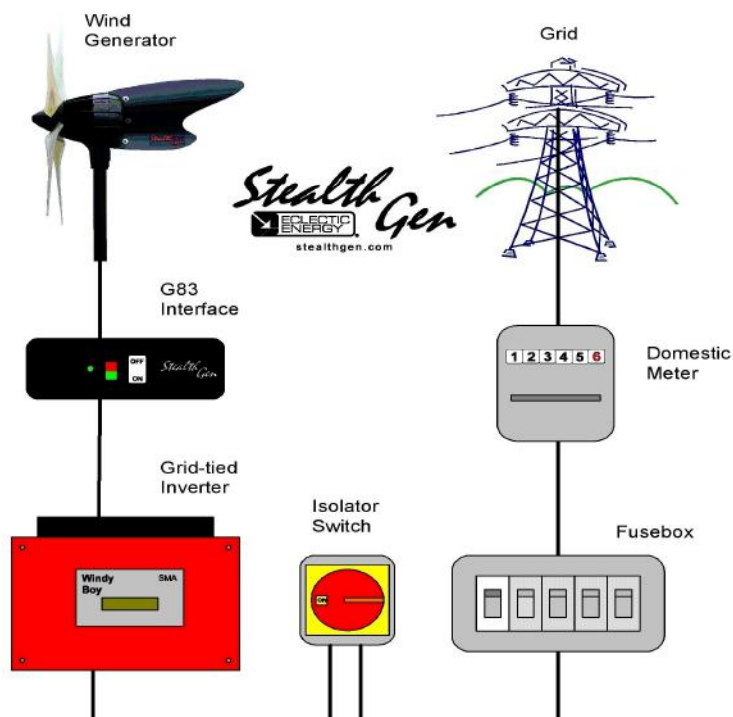
Two other items are required for the system to comply with G83, the technical standard governing secondary generating equipment.

There must be a lockable AC isolator switch in the output line from the inverter. Although all G83 compliant inverters are designed to shut down in the event of mains failure, the lockable switch allows the utility to definitively isolate the system when working on the adjoining grid.

Finally, the connection into the ring main should be made at the consumer unit via a Type D 16 amp miniature contact breaker.

All boxes and switches should be clearly labelled as 'Dual Supply'.

## Grid-tied Wind Turbine Installation Schematic



### System Operating Instructions:

1. Ensure the dedicated MCB, located within the consumer unit or fuse box, is in the ON position.

2. Ensure Lockable AC Isolator switch is in the ON position.
3. Ensure turbine brake switch, located on the control box, is in the RUN position.
4. Assuming there is sufficient wind i.e. approximately 3m/s (6.5mph) plus, the system should start to output as indicated by orange flashing lights on the inverter.
5. In the event of a mains failure or other anomaly (i.e. extreme voltage fluctuation) the inverter is designed to shut down immediately. Where this occurs the controller/interface connects the turbine to a dump load. This dump load prevents over voltage in the system and also ensures that the air rotor does not over speed. Power produced by the turbine during a mains outage passes through the dump load and is lost as heat.
6. Note that in many countries there is mandatory time delay or 'grid monitoring period' before a system can re connect to the grid following a grid outage. In the UK this is 180 seconds or 3 minutes after mains power is restored. The StealthGen system will automatically reconnect following the mandatory grid monitoring period. The inverter will flash red to during this monitoring period, indicating that and re-connection is imminent.

#### System Indicator Lights

The system controller/ interface features three LED lights.

Green - indicates voltage input from wind turbine

Red- not active in this application

Yellow – indicates dump circuit active, Refer to 'Schams' manual for further information.

The Grid Tie Inverter features LED lights on its front housing.

Orange flash – indicates normal operation. The faster the flash the more power is passing to the grid.

Red flash – Indicates the inverter is in grid monitoring mode following an grid outage.

Red flash – can also indicate insufficient input voltage due to low wind.

Sequenced Red flash – can indicate fault modes. Refer to Mastervolt inverter instructions for more details.

No lights – indicates that the inverter is in standby mode and suggests that either there is no wind or the turbine is braked.

#### System performance:

1) Unlike many other grid tied micro generation systems, StealthGen power electronics are wholly powered by DC power from the wind turbine. Other systems power the electronics from the mains and this means a continual, albeit low, draw from the grid even during periods of low or zero wind. StealthGen draws nothing from the grid in these conditions.

2) Airborne noise – the StealthGen wind turbine should be virtually inaudible in normal operation. Typical sound emission levels are between 30 – 40 db. If there is a distinct whistling or shrieking noise from the air blades, this could indicate that the turbine is over speeding due to a fault in the system (i.e. an open circuit condition caused by a poor connection). Erratic yaw behaviour, where the turbine keeps turning away from the wind, is also symptomatic of a possible open circuit fault.

3) Vibration and mechanically transmitted noise – in normal operation, there should be very little noise or vibration evident inside the building. If noise and vibration are continually present, this may indicate a turbine fault such as a loose or worn air hub, a damaged air blade or failing bearings.

Occasional vibration, associated with very high or gusty wind, is probably due to resonance in the turbine tower. This can be addressed by adding stays to the tower to prevent its flexing, or by reducing the height of the turbine (i.e. shortening the tower) or by using a stiffer tower tube.

4) Power Output – the output from a micro wind system varies continually due to fluctuations in wind speed and direction. For this reason, many conventional cumulative kW hour meters fail to record system output accurately, and typically substantially under read.

Power meters with a high sample rate are required for accurate metering. Refer to Eclectic Energy Limited for further information.

5) Multiple systems – two or more StealthGen turbines can be successfully installed where more power is required. Turbines should be mounted at least 2.75 metres apart where the turbines are perpendicular to the prevailing wind direction. This spacing should be increased to 4 metres plus where the turbines are in line with the prevailing wind, and also the mount height raised if possible.

Avoid mounting in the centre of flat-roofed buildings. Always aim to mount at a point nearest to the direction of the prevailing wind.

### Performance and Power Output

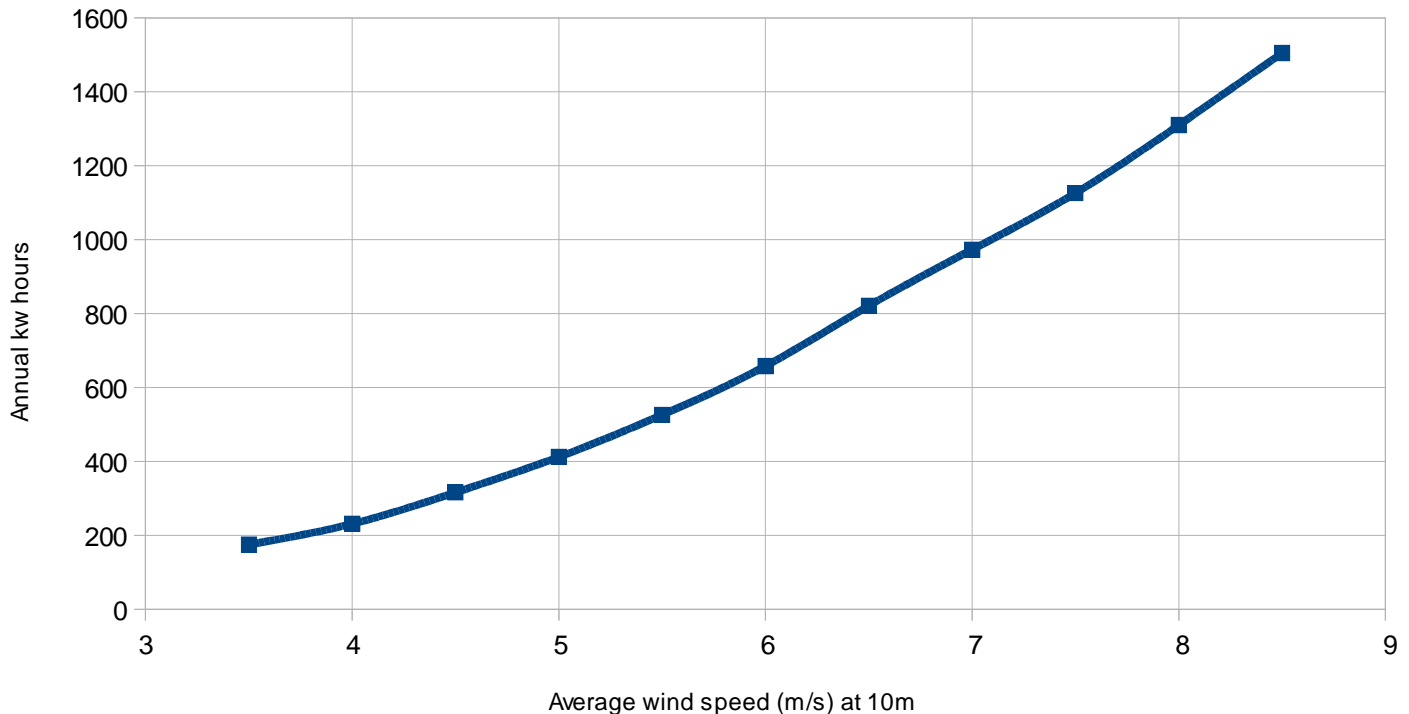
Refer to D400 manual for the wind turbine power curve. Estimated annual power yields are represented below.

The StealthGen / D400 wind turbine is very robustly engineered and will operate safely in all typical wind speeds. It is generally preferable to allow the turbine to operate normally even in very high winds.

The brake switch on the control/ interface unit may prove ineffective in wind speeds above 18m/s (40mph), and should therefore not be used in these conditions as damage to the turbine can result. Also the brake switch should not be treated as a parking brake for the same reason.

Refer to the D400 Manual for further information on the brake switch and high wind speed strategies.

Estimated Annual generation (AEP) for D400/ StealthGen



### Routine Maintenance



The Eclectic StealthGen system is carefully designed and robustly engineered for a long, trouble-free service life. The major system components do not require regular maintenance. However, we do recommend an annual visual inspection to ensure that the air blades are free from cracks or chips, and that all fasteners are tight. Also, check that the air blades run true and that the turbine yaws freely to face the wind.

Should you notice any undue wobble in the rotor or yaw axis, or if you hear any undue noise or vibration, stop the turbine using the brake switch on the control box, and call a service agent.

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