OFF GRID GUIDE

A definitive guide to powering your home or business off grid

ENERGY SOLUTIONS

INTRODUCTION

Energy Solutions are the UK's leading supplier of off grid power systems supplying high quality systems to residential and commercial customers across the UK and internationally for whom connection to the grid is not a viable option.

Our range of Off Grid Solutions includes EasyGrid – a plug and play solution for homes and businesses looking for a straightforward, affordable way to generate their own power; FrameMount – an off grid system for situations with larger power requirements that need sophisticated control and monitoring; and Containerised systems – robust, semi bespoke systems ideal for isolated projects.

See our Case Studies for examples of how our systems are being used by customers in various locations.

Our systems offer reliable, efficient, sophisticated power to businesses and home owners and give owners periods of silent power. The option to link into a range of renewable energy is a key part of the systems alongside our personalised controls and programming.

Our customers use off grid power solutions for many reasons including:

- Location makes a grid connection too expensive or not possible.
- A need for uninterrupted power - protection from power cuts and the ability to power independently in all conditions.
- Reduction in energy bills and the ability to maximise the use of renewable energies.
- Eco friendly - using green alternatives alongside traditional options.
- Adaptable and expandable power to accommodate changing uses.

CONTENTS:

LIVING OFF GRID – RESIDENTIAL

Living off grid is a lifestyle choice for some, but an economical necessity for many. Even in advanced western economies the grid does not reach everywhere – and getting it extended to reach your dream property can be a surprisingly expensive proposition.

So how can you live a grid connected lifestyle without the grid? Many property owners have done this by installing diesel generators to supply their needs. These either run 24/7 or are turned off overnight. These overnight periods can either be without power, or small loads such as central heating boilers and fridges can be run from a battery supplied inverter.

These systems work well, but there is a cost. Diesel is a variable cost. Long generator running hours also mean frequent servicing and replacement.

Any off grid system will require careful selection. The power supplies are finite – unlike the grid! When considering the capacity of the system you will need to be realistic about your power consumption – including peak power. Under sizing the system will result in power outages and / or extended generator running time. The up front costs of a larger system need to be balanced against the ongoing fuel costs.

The Off Grid systems from Energy Solutions are designed to optimise generator usage – cutting fuel consumption and wear and tear. We can also integrate renewable energy into the system to further drive down your fuel costs (and actually earn you money from the Electricity Company who can't supply you!)

We achieve these savings by using state of the art inverter charger units that regulate the loads applied to the generator to keep it loaded but not overloaded.

Of course the first priority is to be as efficient as possible in your use of energy. Modern 'A' rated appliances, low energy lighting and good insulation will all reduce your demands. The figures and illustrations within this document are all based on 15 KwH of energy usage a day (the average UK domestic usage according to Energy Trends 2007 is 4800 Kwh – 13.15 Kwh per day). Modern homes, built to code 4 of the sustainable homes, can use less than half of this amount.

WORKING OFF GRID – BUSINESS

Energy Solutions are specialists in electrical power system for businesses where there is either no grid or intermittent grid power.

We have a proven track record in providing products and support to blue chip customers across a wide range of industries. Since its inception in 1998 Energy Solutions has developed and installed a range of innovative power management products used in the Industrial, Marine, Solar PV and EV market sectors and has supported products across the globe for many leading OEM's.

Our range of Off Grid power solutions are currently being supplied to industrial and residential sites, providing electricity to areas that otherwise would have no economic access to power.

Our solutions can incorporate the very latest Lithium Ion battery technology and our proprietary power management system E-Plex. These systems when coupled with renewable energy sources provide an off grid power source that has unrivalled efficiency both in terms of fuel usage and generator management.

The rising cost of fossil fuels and the increased demand for power in today's modern society have been key factors in the development of our solutions that can be used both in developed countries and emerging markets. The main development of our systems has centred on the supply for rural businesses and properties where connection to the main grid has been unreliable or uneconomic.

We have built upon this experience to develop products for humanitarian relief, remote telecom masts and numerous commercial applications.

All of our systems have the ability to provide remote monitoring which can also provide alerts such as low fuel. The fail-safe backup is being able to run the generator in the event of a failure of the systems. Connections are also provided for external generators to be connected during service times.

WORKING OFF GRID – SPECIFIC APPLICATIONS

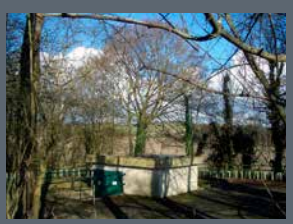
Telecom:

Mobile phone telecom masts in developed countries and emerging markets do not always have ready access to the grid or the grid maybe unstable. Our systems can supply all the power required to provide reliable power at low cost. Competition within the telecom market is fierce which has led to lower revenue. Providers must look to reduce their operating costs to remain competitive. Reducing operating costs in this area will also help to address the environmental policies that many large companies currently have in place. Our systems are designed to provide the power directly at 48V DC for telecom equipment alongside traditional 220/110v for ancillary uses. The use of our energy management software, E-Plex, maximises the efficiency of the whole system monitoring battery capacity, state of charge, battery current, solar and wind generation. Through its advanced logic it will automatically calculate when and if to run the generator, either to boost the power during peak demands, or to top up the charge in the batteries.

Humanitarian relief / disaster relief:

Energy Solutions' Off Grid power solutions can be rapidly deployed to provide the power for non-governmental organizations and victims after a natural disaster. Running large generators 24/7 can be inefficient. Using our solutions generator running time can be significantly reduced down to a few hours a day. The E-Plex control system uses logic to maximise generator efficiency by charging a Lithium Ion battery which can provide the power at lower demand times saving fuel and operating costs. This also allows for completely silent power for significant periods of the day. It is estimated that it costs in the region of 7 litres of fuel to deliver just 1 litre to a troubled site. Usually fuel is at a premium so the hidden financial savings can be significant. Savings in time and money spent on fuel deliveries can be allocated to the main mission. Adding renewable technologies to the system can also reduce fossil fuel dependency.

Commercial:



Many remote sites, particularly for utility companies, do not have ready access to the grid. Our systems can supply all the power required to provide reliable power at low cost. Companies must look to reduce their operating costs to remain competitive. Reduction of operating costs in this area will also help to address the environmental policies that many large companies currently have in place. Our systems are designed to provide the power directly at 24V or 48V DC for control equipment alongside traditional 220/110v for ancillary uses. The use of our energy management software, E-Plex, maximises the efficiency of the whole system monitoring battery capacity, state of charge, battery current, solar and wind generation. Through its advanced logic it will automatically calculate when and if to run the generator, either to boost the power during peak demands, or to top up the charge in the batteries.

SIZING YOUR OFF GRID SYSTEM – RESIDENTIAL

Electric Power Consumption at Home

This list of household appliances will help you access the power you may be using and what size off grid system you need to consider purchasing.

Appliance	Power	On-time	Energy/day	minimum summertime base load for a two person household
High efficiency refrigerator	20W	24h	480Wh	480Wh
High efficiency freezer (with DC permanent magnet compressor motor)	20W	24h	480Wh	480Wh
Average refrigerator	50w	24h	1200Wh	
Average freezer	60W	24h	1440WH	
Plug-in chargers and standby loads	30W	24h	720Wh	720Wh
Modem	10W	24H	240Wh	240Wh
Ventilation	30W	24h	720Wh	720Wh
Electric space heater	2000W	12h	24,000Wh	
Hot Water heater (boiler)	3000W	2h	6000Wh	
Central heating (on) and water heater (on)	130W	8h	1040Wh (wintertime, gas fired)	
Central heating (off) and water heater (on)	130W	2h	260 Wh	260Wh
High efficiency lighting	200W total	6h (winter)	1200Wh	240Wh
		3h (summer)	600Wh	
One 100W traditional Incandescent lamp	100W	6H (winter)	600Wh	600Wh
		3h (summer)	300Wh	
Radio	30w	3h	90Wh	90 Wh
LCD TV	50W	3h	150Wh	150Wh
Large Plasma Screen TV	300W	6h	1800Wh	
Personal Computer	100W	3h	300Wh	300Wh
Laptop	30W	3h	90Wh	90Wh
Range hood	150W-300W	1h	150Wh	150Wh
Total summertime baseload, energy conscious two person household.				4520Wh =4.5kWh

This table will help you to access your power requirments for an average residential dwelling in the UK.

SIZING YOUR OFF GRID SYSTEM – BUSINESS

Electric Power Consumption - Small Business

This list of appliances will help you access the power you may be using and what size off grid system you need to consider purchasing.

Appliance	Power	On-time	Energy/day	minimum summertime base load for a small business – 5 employees
Computer x 2	100W	3h	300Wh	300Wh
Laptop x 1	30W	3h	90Wh	90Wh
Coffee Machine	200W	8h	1600Wh	1600Wh
Credit Card Terminal	10W	8h	80Wh	80Wh
Photocopier	75W	8h	600Wh	600Wh
Plug-in chargers and standby loads	30W	24h	720Wh	720Wh
Router	10W	24H	240Wh	240Wh
High efficiency refrigerator (with DC permanent magnet compressor motor)	20W	24h	480Wh	480Wh
Ventilation	30W	24h	720Wh	720Wh
Hot Water heater (boiler)	3000W	2h	6000Wh	
Central heating (on) and water heater (on)	130W	8h	1040Wh (wintertime, gas fired)	
Central heating (off) and water heater (on)	130W	2h	260 Wh	260Wh
High efficiency lighting	200W total	6h (winter)	1200Wh	240Wh
		3h (summer)	600Wh	
Radio	30w	3h	90Wh	90 Wh
LCD TV	50W	3h	150Wh	150Wh
Total summertime baseload, energy conscious small business.				5570Wh =5.6kWh

WHY HAVE A GENERATOR?

Some off-grid systems do not feature a generator. If the demands are very low or you have a reliable renewable source you can engineer a system without using a generator. These systems can be built up using components that we supply.

However there are a number of reasons why a generator is required:

- Large seasonal variations in renewable energy
- Seasonal changes in energy needs (often you need more power when there is no sun!)
- High peak loads where a generator is required
- A need for having a reliable power source – frozen food, business interruption, heating

Our standard systems are all designed to work with a generator, if wanted. The purpose of the technology in the system is to use the generator only if needed. This minimises fuel consumption whilst ensuring reliable power.

Why is generator loading so important?

The chart below shows the power consumed from a generator that runs 17 hours a day. You can clearly see the amount of time where the loads are very low. This low loading results in very poor fuel efficiency.

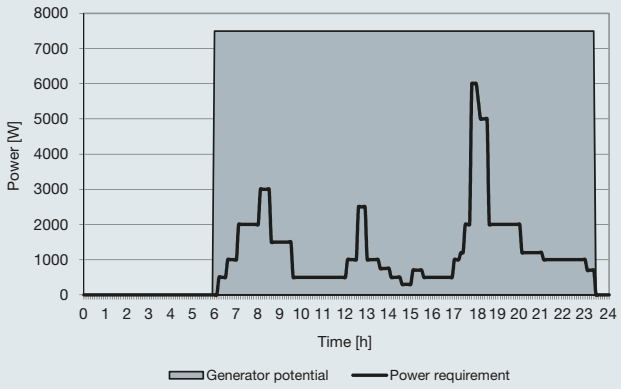
All generators use fuel to just run – even if they are not delivering any power. This means that their actual efficiency is very poor at low loads. We can see this in the table below which shows typical efficiency levels and fuel consumption figures for a 10 Kw generator. These figures are summerised from extensive tests performed by Victron Energy in Holland.

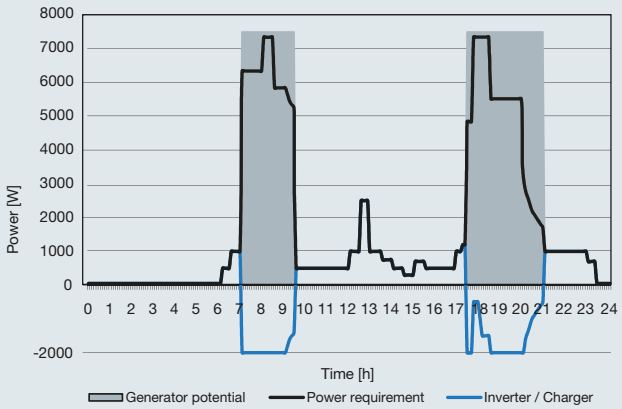
Load applied	Efficiency	Specific fuel consumption (grams per KwH generated	Actual fuel consumption in Litres per hour
0	0%	Infinite	1.06 L/h
0.5 Kw	4%	2200g / KwH	1.22 L/h
1 Kw	8%	1200g / KwH	1.32 L/h
2 Kw	13%	680g / KwH	1.53 L/h
4 Kw	22%	400g / KwH	1.91 L/h
6 Kw	25%	350g / KwH	2.50 L/h
8 Kw	27%	310g / KwH	3.00 L/h
10 Kw	27%	300g / KwH	3.73 L/h

The overall efficiency is based on diesel fuel containing 10.8 KwH of energy in every litre. In the table above, at 1 Kw, the fuel used in an hour contains 13.2 KwH of energy – however the generator has only produced 1 KwH of electrical output – 7%!

If we take a house with a daily average 15 KwH energy consumption we can estimate fuel usage depending on the power system configuration:

By using a battery system to store the energy you can run the generator at high loads, to get the best possible efficiency, and then use the stored power from the batteries at other times.





GENERATOR OPTIONS

We are happy to work with any generator. If you are choosing a generator we suggest you consider the following or speak to us about our range:

- **Generator running speed** – Generators are built to run at either 3,000 Rpm or 1,500 Rpm. The slow speed sets will be much more durable as ½ the engine speed means the unit 'travels ' half the distance every hour it runs. The forces in the engine are also reduced exponentially meaning that it travels half the distance every hour but should also be able to do a much longer distance. A good expectation is for a 1,500 Rpm machine to last 4 times the hours of a 3,000 Rpm machine.
- **Duty cycle** – generators can be built for occasional 'stand by' use where they are expected to only operate a small number of hours a year or for 'prime power' where they are expected to be operating long hours – even 24/7. Stand by machines are not designed for the duty expected in an off grid application.
- **Autostart** – An Autostart system is required for the automated off grid systems. An autostart system can take a signal from our system and then correctly take the generator through the pre-heat and crank cycle to start the generator.
- **Fuel efficiency** – Look carefully at the fuel consumption figures at full and half load for the machine you are looking at. Fuel saved can justify spending that bit more on the generator.
- **Heat recovery** – If your property can utilise any waste heat from the generator then you need to make sure you can capture that energy. This will be a combination of jacket water and exhaust gas heat recovery.
- **Simplicity** – Remember that this machine is an essential part of your power system. A simple, reliable machine that can be easily maintained and repaired is important.
- **Fuel system** – Spend money on good filtration and fuel conditioning. Most diesel generator problems are fuel related. Money spent on fuel filtration will be paid back many times!

What we offer

We offer JCB generators. We can offer these with heat recovery and, of course, auto start.

Features

- Four cycle, 3 or 4 cylinder liquid cooled, naturally aspirated, overhead valve, industrial duty diesel.
- Indirect injection with glow plugs for fast cold weather starts.
- Based on heavy-duty tractor engine blocks customised for optimal prime power production.
- With proper maintenance they have logged over 25,000 hours.
- Low torque operating at 1500 at 50Hz, they exhibit less wear and tear than the competitors' light weight intermittent duty 3000 rpm gensets.
- To ensure ease of maintenance all key service points are on a common side. Low oil pressure and high coolant temperature shutdowns protect your investment.
- Liquid cooled with radiator and pusher cooling fan. Steel radiator shroud and fan guard protects the radiator and operator.
- Four centre-boned mounts isolate vibration.
- Large, replaceable air filter protects engine in dusty environments.

FUEL CONSUMPTION TEST

We carried out a test that simulated the variable loads experienced in many off-grid applications.

The aim of the tests were to look at running costs, not capital costs, to see how much of a fuel saving our systems offer over running a generator 24 / 7

The hardware
We used one of our containerised 8Kw off grid systems with integral fuel tank and 6Kw generator. Then we added a precision fuel monitor from Flo-Scan in Seattle and our iPad interface. We also added a Victron Global Remote Monitoring system so that data on battery capacity and inverter activity could be logged.

The test
We ran the loads from the system and calculated the litres of fuel per KWh of energy used. The energy consumption varied, but bringing the results back to these figures gives a very good indication of relative efficiencies.

The variables
We wanted to test the benefits of adding a very simple energy storage system for overnight 'silent running' and fuller 'automated' control of the generator.

Solar power was also tested. Energy captured from the solar panels means fewer generator running hours and less fuel burnt.

Different battery technologies were also tested. We selected conventional flooded lead acid (Rolls traction batteries) and Lithium Ion (our own 700 Ah 24 volt bank – 18 KwH).

Test 1: Run the generator 24/7 and see how much energy was consumed and how much diesel was burnt. We ran the test for 34 hours and the results were:

	Amount	Value
Fuel burnt	62.5 litres	
Energy consumed	67.1 KwH	
Litres per KwH consumed	0.93	£0.708
Solar Income	0	£0
Overall cost per KwH	0	£0.708

It showed there is a decent amount of saving to go after. Add the replacement costs of the generator and the costs only go up!

Test 2: Run the generator all day (charging a battery and running the loads) and then run the loads from the battery overnight.

This test was performed with Lithium Ion batteries which we anticipated to be more efficient than lead acid (we tested this later). We ran this test for 5 days and the results were:

	Amount	Value
Fuel burnt	42.6 litres	
Energy consumed	62.9 KwH	
Litres per KwH consumed	0.68	£0.515
Solar Income	0	£0
Overall cost per KwH	0	£0.515

Test 3: The third test was based on running the loads from the inverter and only running the generator when it was needed to recharge the batteries. This meant that the generator was loaded heavily when it did run which kept it's fuel efficiency high and the running hours low. We ran the test for 10 days and the results were:

	Amount	Value
Fuel burnt	123.1 litres	
Energy consumed	309.4 KwH	
Litres per KwH consumed	0.49	£0.372
Solar Income	0	£0
Overall cost per KwH	0	£0.372

The test was repeated with a set of brand new Rolls traction batteries and found that this increased the fuel consumption by over 12%. Bearing in mind that lead acid batteries have a steady decrease in performance we would estimate that Lithium would save 15%-20% fuel costs over the course of their life.

FUEL CONSUMPTION TEST

Test 4: Solar power was added to the same set up as in the third test. This meant that the generator only now runs when the solar fails to keep up with the loads and battery charging duties. We used a 3.6 Kw peak solar system. Again the generator was loaded heavily when it did run which kept it's fuel efficiency high and the running hours as low as possible. We ran the test for 18 days and the results are:

	Amount	Value
Fuel burnt	132.6 litres	
Energy consumed	473.4 KwH	
Litres per KwH consumed	0.28	£0.213
Solar Income	278.7 KwH (£58.53)	£0.124
Overall cost per KwH	0	£0.09

Test 5: More solar power was added to the same set up as the fourth test. It was increased from 3.6 Kw peak to 5.6 Kw peak.

Again the generator was loaded heavily when it did run which kept it's fuel efficiency high and the running hours as low as possible.

	Amount	Value
Fuel burnt	6.1 litres	
Energy consumed	58.1 KwH	
Litres per KwH consumed	0.10	£0.080
Solar Income	55.7 KwH (£11.70)	£0.122
Overall cost per KwH	0	-£0.12

Conclusions: The tests show that with the correct mixture of renewable energy it is possible to engineer a system that can produce electricity at a much lower price than from a generator on it's own.

It is possible to cut fuel costs by almost 90%.

The results will vary upon the time of year but these figures give a guide to the costs across the year. Recovering waste heat from the generator will improve energy efficiency further still.

Figures based on test in 2013

BATTERY SELECTION

We offer two types of battery technology with our systems. Understanding the way that different batteries work will help you to choose the best option for you.

Deep cycle batteries

Our default offering is a battery bank formed from deep cycle lead acid batteries. These types of batteries are used in forklift trucks, electric vehicles and other high power, high discharge applications. They are conventional lead acid gel, but are designed to cope with deep discharge levels and repeated cycling. Their life expectancy is 2 - 3,200 cycles giving 5 – 10 years.

Lead acid batteries have two characteristics that are important to this application. The first is that the deeper the battery is discharged on a daily basis the fewer cycles you will get. The best price / performance balance is reached by sizing the batteries so that you do not take them below 50% full.

The next characteristic to consider is the rate that the battery will accept a charge. Lead acid batteries can be charged quickly (approx 15% of their capacity) to 80% charged. After this point the rate that they can be charged at gradually drops. This means that getting a battery fully charged takes us into the area of really poor generator efficiency! We cope with this by stopping the automated charge on most days at 80%. This means that we are only using the battery between 50% and 80% in the main. This optimises battery life and generator efficiency – but also means that we are only using 30% of the stated capacity of the battery.

The final characteristic that we need to be aware of is the 'charge efficiency' of a lead acid battery. We know that we can store energy in a battery. However the bad news is that you don't get back all the energy you put in. In fact the efficiency is around 90% for a lead acid battery. This means that 10% of all energy generated from a diesel genset or solar system, if put into a battery bank, is lost as heat. Remember, however, that this charging efficiency is much less of a problem than running the generator lightly loaded!

Lithium Ion batteries

Our upgrade option for batteries is Lithium Ion. These batteries carry a significant up front cost. They are available in different formulas, but are used in electric cars, smart phones and power tools. Their life expectancy is 2 - 4,000 cycles giving 5 – 10 years.

Lithium Ion batteries differ in their characteristics from lead acid. They suffer less with reduced life through deep discharge (in fact charge 'quality' is the most important issue with battery life). This means that we can use all the stated battery capacity.

The next difference is the rate that the battery will accept a charge. Lithium Ion batteries can be charged very quickly (approx 100% of their capacity) all the way to 100% charged. This means that getting a battery fully charged presents no problems with generator efficiency. This means that we can now use 100% of the stated capacity of the battery.

The 'charge efficiency' of a Lithium Ion battery is also dramatically improved – it is 98%. This means that almost all the precious energy generated from a diesel genset or solar system can be used.

The cumulative effect of these differences in characteristics is a dramatic difference in the battery sizing for the different technologies.

If we take a 1,000 Ah lead acid battery as a reference we can calculate the following:

- To optimise battery life and generator loading we operate the battery between 50 and 80% - effectively we use only 300 Ah of capacity.
- Of this 300 Ah of capacity 25% is lost through the charge discharge process. We can either view this as lost energy in or a further reduction in battery capacity to 225Ah.

This means that a 360 Ah Lithium Ion battery offers significantly more useable power than a 1,000 Ah 2 volt battery bank in this type of application.

SAVING EVEN MORE WITH RENEWABLES

So far we have just looked at optimising generator usage. However we can save yet more precious fuel by integrating renewable energy into the system.

Solar panels generate DC power that can, via a solar regulator, charge a battery. However we can replace a solar regulator with a solar inverter that will convert this DC power to 230 v AC. This power can then be fed, via a power meter, to our system where we can use it to run household equipment or charge the batteries.

A 4 Kw solar system will generate approximately 4,484 KwH per year. This could save you 1,500 litres of fuel if you could use all the solar energy generated. In reality there will be periods in the summer where the system generates more than you use so assume that you will only realise 65% of the fuel saving.

Of course you will find the generator running more hours in the winter when the days are short and the sun low in the sky. However there will be days in the summer when the generator will not need to run at all. We have a system in use in a 3 bedroom remote house and a 4 Kw solar system where the client has recorded weeks in the summer with less than 2 hours generator run time.

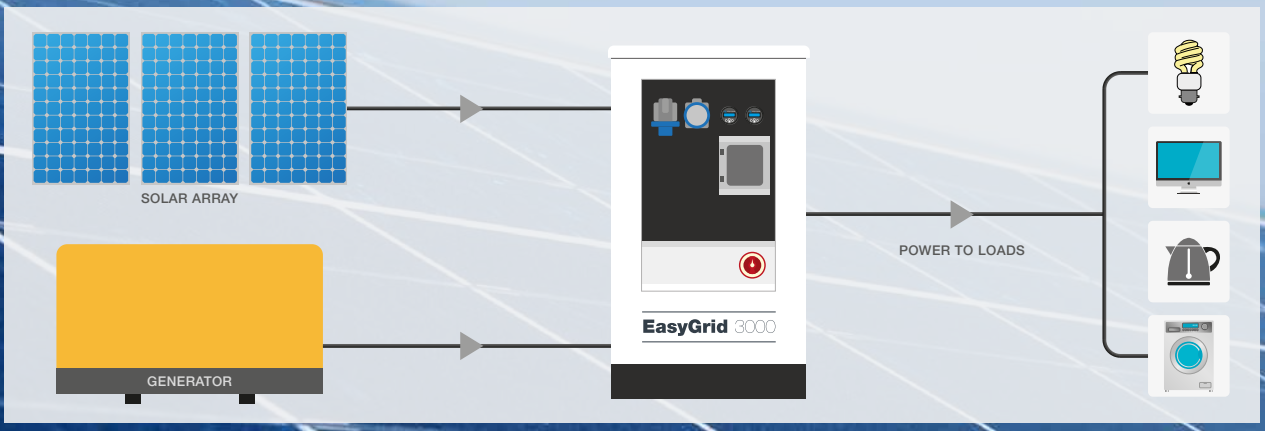
EASYGRID

EasyGrid 2000, EasyGrid 3000, EasyGrid 5000, EasyGrid 10,000

Our EasyGrid range brings off grid power solutions to homes and businesses without a mains grid connection, at a reasonable cost. Rather than having to source separate components and have a bespoke system designed, our EasyGrid series offers a pre-configured, self-contained unit built from durable, high quality components; fully tested and ready to install. The enclosure is made from powder coated steel and is fully lockable; allowing it to be installed either outside or within an outbuilding, depending on requirements. Suitable for installation worldwide the EasyGrid range addresses off grid power needs for both UK and International customers and can be installed by a competent local electrician.

How does it work?

The unit connects to your solar array and also has a connection for a generator. Energy from the solar array is used to charge the batteries, where energy will be stored until needed. The array then tops up the batteries as the power is used. If a generator is connected and the batteries are depleted and no solar power is available, the system will send a start signal to the generator to provide power.



What can you run with a EasyGrid?

It is always difficult to define exactly what you can run from an off grid system – average demands can be easy to manage but peak loads can be more challenging to assess. The EasyGrid units are designed to run (without a generator) the following loads:

EasyGrid 2000 - Residential Example: Holiday home / caravan with gas cooking & energy efficient appliances.

EasyGrid 3000 - Residential Example: 2 bedroom home with gas cooking and energy efficient appliances.

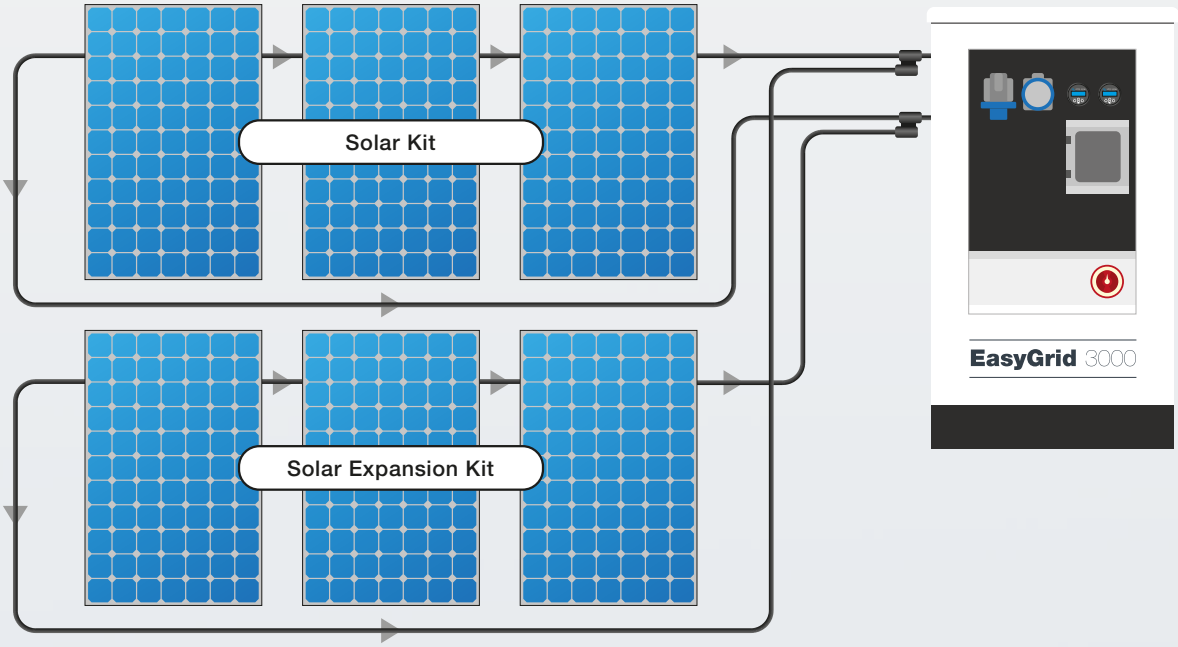
EasyGrid 5000 - Residential Example: 3 bedroom home with gas cooking and energy efficient appliances.

EasyGrid 10000 - Residential Example: 5 bedroom home with electric cooking & efficient appliances.

See EasyGrid online

Connecting a Solar Array to EasyGrid

Sizing your solar array correctly is vital in getting the most effective renewable energy into your EasyGrid unit. On the datasheets you will find full details on the options available to you and how you can connect solar panels to optimise your power for peak loads.



Connecting a Generator

If you are looking at connecting a generator to one of the EasyGrid range we would recommend sizing of a 3kVA – 45 kVA (dependent of EasyGrid unit) which will allow you to run additional loads. We are able to supply a generator with your EasyGrid if required. Please ask for prices and we can include this with your quotation.

Connecting to an Unreliable Grid

For our international customers we are able to add an additional connection point for connecting the EasyGrid 5000 and 1000 units to an unreliable local grid connection. This allows users to make use of grid power when it is available and then to automatically switch to the EasyGrid supply during power cuts. This additional option is viable if you are installing the unit in an area with frequent daily power outages and you require continuous power. Please ask us and we can include this option with your quotation.

FRAMEMOUNT

The Frame Mount Off Grid system supplies a complete Off Grid system in a simple to install unit. With the batteries, controls and monitoring all in one place, the system arrives with you ready built and preconfigured to your requirements.

The purpose of the Frame Mount system is to give you continuous power with the minimum running of the generator whilst maintaining the batteries, storing sufficient energy for a silent night time quiet period. If alternative energy (i.e. solar or a wind turbine) is fitted, the system optimises this energy and allows enough room in the batteries to store the excess for later use and to further reduce the run time of the generator.

Frame Mount Off Grid System

8kW - 30kW Single and Three Phase options

A typical frame mounted system has the following specification:

- Inverter charger with a continuous output meeting the system capacities above.
- Input isolator to accept supply from stand alone generator set
- Lithium Ion battery pack or Lead acid deep cycle battery bank. (Lithium system offers superior energy performance due to low battery losses and also optimises fuel consumption and generator running hours as it can be charged fast to 100%)
- Solar ready
- DC and AC distribution boards
- Sophisticated E-Plex control system to maximise renewable use (if fitted), minimise fuel consumption and minimise generator running hours. All designed to keep cost per Kwh of energy used as low as possible.
- Frame package affords quick simple installation within existing building or structure.

E–Plex Control System
To be able to accomplish the above, you need an advanced control system that can monitor many parameters including the charge state, solar generation and the load on the inverter. This information is constantly processed within the control system to see if any action is required.

Overload Protection
To prevent the inverter from being overloaded in high demand periods, the system monitors the size of the load and its duration and calculates if a generator start and assist is required.

Silent Period
This is a user-defined period, such as night time, which restricts the generator from running. However, if the batteries become discharged below a safe level, then the generator will automatically start up, and run until they are at a safe level.

End of Day Top-Up
At the end of the day, a top-up charge is used to ensure that by the start of the silent period, the batteries contain enough charge to run the loads until the end of the silent period, without having to start the generator. The duration of this charge is determined by using the capacity of the charger, and the required change in SOC.

Battery Monitor Synchronisation
In order to maintain the accuracy of the battery monitor measurements, the system will track the time between full charges. If the battery has not been fully charged for more than a week, the generator will run until a full charge is achieved. This will be combined with the end of day top up charge to minimize the amount of additional generator running time.

See Frame Mount Off Grid system online

CONTAINERISED

Our containerised hybrid power system is an ideal solution for those needing deployable power, emergency power, back up power or sites with no grid connection.

The system uses E-Plex Control technology, options for links to renewable power sources, highly efficient generator power and energy storage in lithium ion or Gel/AGM batteries.

This stand alone hybrid system is being installed in situations from national parks to coastal power - with each system being semi-custom designed to suit each application. A perfect option for more challenging environments our containerised off grid systems offer a highly effective way to get power to the right places.

Containerised Off Grid System

8kW - 30kW Single and Three Phase options

A typical containerised system has the following specification:

- Inverter charger with a continuous output meeting the system capacities above.
- Diesel, water cooled, 1500 RPM (or 1800 RPM for 60 Hz applications) generator (single or three phase as appropriate) in sound enclosure with autostart control system.
- Steel, bunded, diesel 'floor' tank with mechanical and system fuel gauges.
- Recessed connection box for outgoing power, auxiliary connections and external controls and indications.
- Lithium Ion battery pack or Lead acid deep cycle battery bank. (Lithium system offers superior energy performance due to low battery losses and also optimises fuel consumption and generator running hours as it can be charged fast to 100%)
- Solar ready
- DC and AC distribution boards
- DC lighting inside container

E–Plex Control System
To be able to accomplish the above, you need an advanced control system that can monitor many parameters including the charge state, solar generation and the load on the inverter. This information is constantly processed within the control system to see if any action is required.

Overload Protection
To prevent the inverter from being overloaded in high demand periods, the system monitors the size of the load and its duration and calculates if a generator start and assist is required.

Silent Period
This is a user-defined period, such as night time, which restricts the generator from running. However, if the batteries become discharged below a safe level, then the generator will automatically start up, and run to they are at a safe level.

End of Day Top-Up
At the end of the day, a top-up charge is used to ensure that by the start of the silent period, the batteries contain enough charge to run the loads until the end of the silent period, without having to start the generator. The duration of this charge is determined by using the capacity of the charger, and the required change in SOC.

Battery Monitor Synchronisation
In order to maintain the accuracy of the battery monitor measurements, the system will track the time between full charges. If the battery has not been fully charged for more than a week, the generator will run until a full charge is achieved. This will be combined with the end of day top up charge to minimize the amount of additional generator running time.

See Containerised Off Grid system online

FRAMEMOUNT & CONTAINERISED CONTROL

Standard control and monitoring panel.

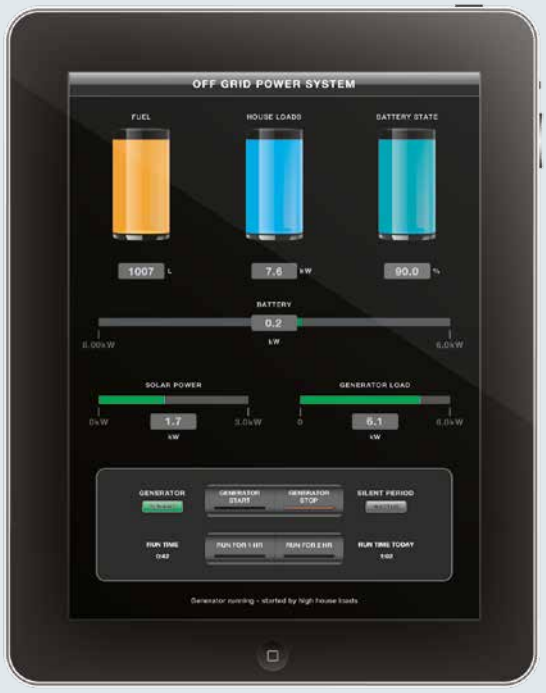
The E-Plex touch screen allows full control and monitoring of the system. You can set your silent period, manually start and stop the generator and monitor the battery status.

Optional wired remote control and monitoring panel.

The status of the system can be viewed from a remote control panel; this is usually positioned within the house and allows you to monitor the system status and carry out a remote start and timed run of the generator.

Optional iPad remote control and monitoring

Control and monitor your off grid system via your iPad. With our new iPad interface you have a wireless link to view your fuel tank levels, state of batteries, solar power input, generator run times and current timed run as well as a host of other features. This allows you to keep track of all the elements of your system in one place.



The iPad display will show you the following:

- House loads
- Battery state of charge
- Battery load charging/discharging
- Solar power input
- Generator load in KW
- Generator running
- Silent period active or inactive
- Generator run time today and current timed run.
- Text description stating why the generator is running.

CASE STUDIES >

Commercial Off Grid Solution in Somerset

Solution

- 9x Quattro 48/10000/140
- 6080Ah Batteries at 48V
- 57Kwp Solar Panel array
- 9x Solar Inverters
- BMV600 Battery Monitor
- Custom steel fabricated rack

Energy Solutions were called in to set up a commercial off grid development in Somerset. The client had already decided that solar was the best option for the site but needed a specialist team to design and install a comprehensive off grid power system that would be able to store the power generated and offer sophisticated control and monitoring.

The remote site was installed with a 57kwp solar array which was ample to supply power to the business at all times, including nights and times with no sun. The off grid system was designed to store the excess power for these periods.

Working closely with the client's existing solar supplier, Energy Solutions, designed a large off grid system that consisted of specialist solar batteries and inverter / chargers.

Although the site was remote and the installation required quickly, Energy Solutions rose to the challenge and the entire design, manufacture and installation was completed in just two weeks.

Off Grid House and stable complex

Solution

- 1x 24/5000/120 ES Off Grid Kit
- 1104 Ah batteries at 24V
- 1x 11KVA Generator

Due to the cost and difficulties in connecting to the National Grid, we were approached by a customer to design and commission an off grid system in a large rural dwelling and stable complex. The system had to be completely automated, providing 24 hour continuous power.

The customer initially considered installing a large generator, and running it continually. However, it soon became apparent that this option would be costly, noisy and inefficient.

Instead, the customer opted for a standard Energy Solutions's 5kw off-grid kit, who's features fitted his requirements. Subsequently, Energy Solution supplied the kit, configured with the customer's specified configuration and generator run-times. This was then installed by a local electrician.

The system now provides the customer with a comprehensive management of the generator running times , including pre-defined runs , a weekly synchronisation charge, a silent period (ie. Night-time), automatic generator running if batteries discharge becomes low or if there is an unusual high load demand. Within the house is situated a control panel, which provides the customer with information regarding the status of the system, and allows him to remotely start/ stop the generator.

The system has significantly reduced the running hours of the generator, but still provides 24 hour power. It is expected that the ES Offgrid system costs will be recovered within 3-4 years due to the savings in diesel and servicing costs.

Off Grid System for Oxfordshire Barn

Solution

- 3x MultiPlus 48/3000/35
- 820Ah Batteries at 48V
- 5.85Kwp Solar Panel array
- Solar Inverter
- ES DC Link Box
- BMV600 Battery Monitor

For some businesses the best option for new operations are remote locations. This proved to be the case for a client based in Oxfordshire that wanted to start breeding game birds on their farmland.

A barn was purpose built for the new operation but being in the middle of field connecting to the grid was not an option. Off grid power was seen to be the most efficient way to supply the heat and light required for the breeding and housing of the birds throughout the year.

Space was of a premium within the barn so the off grid system needed to be kept external to the building. Solar panels were installed by a local supplier and Energy Solutions designed a complete storage, monitoring and control system housed within a dedicated container.

Remote Home in Lincolnshire

Solution

- 5kw Victron Inverter / Charger
- 7kw Northern Lights Generator
- 1100Ah Rolls Batteries
- ES Remote Panel

The client owns a detached property in a rural part of Lincolnshire. He had always relied on an off-grid system to provide the power for his home. However, his existing system proved expensive, noisy and unreliable, and frequently required him running a generator for 16 hours per day.

After learning about Energy Solutions range of Off-Grid systems, which focused on reducing generator run times, the customer contacted us. We undertook a site survey to establish his power needs, peak loads and consumption, present and future. It was decided to install a 5kW off grid kit, a 7kw Northern Lights generator and 1100Ah Rolls batteries. This was perfect for both his current needs and future requirements, whilst allowing for solar panels to be added at a later date as the client's budget allows.

To make the system convenient, and easy-to-operate, the remote control panel was located in the kitchen area. The client could therefore monitor the system at all times, and if needed, carry out a remote generator start-up from inside the house.

The off-grid system was installed in a small outbuilding. Installation took one day to complete, and it was operational immediately.

The biggest savings for the customer is the reduction in generator running times, and fuel costs. It is estimated that his fuel costs have been reduced by £5k per year, as the new system generator will be running for only 3 hours per day, resulting also in a quieter home environment.

Silent power for remote home in Kent

Solution

- 5kw Victron Inverter / Charger
- 2kwp Solar (PV)
- 2kw Victron Solar Inverter
- 1100Ah Rolls Batteries
- ES Remote Panel
- Customer's Generator

We were approached to supply an off grid system for a weekend retreat home in a remote location in Kent, in Spring 2012. At the time the owner was solely using a generator to provide power, but this was proving to be a noisy and uneconomic option. The main requirement of the new off grid solution was to have near silent running with only minimal use of the generator.

Our solution was to supply a standard Energy Solutions 5Kw off grid kit with the addition of 2Kwp of solar. The generator will only run if there is a shortage in energy produced from the solar.

The roof mounted solar panels were designed to have a minimal visual impact on the home. Positioned within the roof gully to be as unobtrusive yet efficient as possible they were installed and commissioned by our own MCS registered team, allowing the customer to claim an income from the Government's generation tariff for the power created.

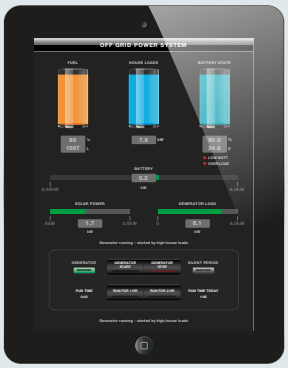
The system has been running throughout the summer with all energy being provided silently by the solar, any excess energy is stored in the batteries for use later. During the winter when there is less sun the batteries will be charged during the week ready for weekend use.

Scottish Highlands Home installs Off Grid System and Maximises Renewables Efficiency

I choose the Energy Solutions system due to it's user functionality, versatility and ability to link in with renewables.

Jamie Robinson

Jamie Robinson has lived in an off grid situation all his life. He chose the Energy Solutions' Frame Mount Off Grid system over other solutions available due to its user functionality, versatility and ability to link in with renewables.



Some of Energy Solutions Off Grid systems have a semi-bespoke design to ensure they match customer's exact requirements, Jamie's was one such example. The kit consists of a 5KW Victron Quattro inverter, linked to an SDMO 5KW auto start generator with a Rolls battery bank of 1100AH at 48V. The off grid kit starts the generator when required. The kit is linked with grid tied renewables: solar & wind.

Overall the kit provides an artificial grid and the renewable power is used in the property first with any leftover being diverted back to the batteries. The generator running times are set to maximise renewable options. For example it will not run the generator and achieve a full charge to the batteries first thing in the morning so as to maximise the potential solar yield.

The inverter also has a "power assist" function and it will use the generator as backup thus giving 10KW of available power. Waste heat from the jacket water of the generator exhaust are used to heat domestic hot water and also the poly tunnel in winter.

As an experienced engineer Jamie was able to install and commission the system himself and is more than happy to demonstrate and talk through the system to anyone in Western Scotland who is interested in an off grid solution.

"My business is working with alternative energy, after looking at other options I have found the Energy Solutions' Off Grid approach to work the most effectively. So much so that as well as installing it for my own home, I recommend and install them for my own customers in Western Scotland." If you would like to contact Jamie to discuss the Off Grid system you can reach him via his website: www.alternativeengineeing.co.uk

Off Grid Power System For New Bike Park

Solution

E-Plex controlled off-grid system incorporating:
- 3 phase
- 30kW system
- 3 x 10kW Victron Quattros
- 170kWh Lead Acid Batteries
- Auto Changeover System

Due to the cost and difficulties in connecting to the National Grid, we were approached by a customer to design and commission an off grid system in a large rural dwelling and stable complex. The system had to be completely automated, providing 24 hour continuous power.

The customer initially considered installing a large generator, and running it continually. However, it soon became apparent that this option would be costly, noisy and inefficient.

Instead, the customer opted for a standard Energy Solutions's 5kw off-grid kit, who's features fitted his requirements. Subsequently, Energy Solution supplied the kit, configured with the customer's specified configuration and generator run-times. This was then installed by a local electrician.

The system now provides the customer with a comprehensive management of the generator running times , including pre-defined runs , a weekly synchronisation charge, a silent period (ie. Night-time), automatic generator running if batteries discharge becomes low or if there is an unusual high load demand. Within the house is situated a control panel, which provides the customer with information regarding the status of the system, and allows him to remotely start/ stop the generator.

The system has significantly reduced the running hours of the generator, but still provides 24 hour power. It is expected that the ES Offgrid system costs will be recovered within 3-4 years due to the savings in diesel and servicing costs.

Off Grid System, Camas Salach, Scotland

Energy Solutions supplies Alternative Engineering Solutions in Highlands, Scotland with the off grid systems and generators for their clients across the region.

Camas Salach is a remote property on the shores of Loch Sunart owned by a family trust. It consists of 2 small holiday cottages (similar in size to static caravans) and is accessed either by sea or via a very long, heavily potholed track. The owners use the property for holidays for their family and friends - so occupancy can be fairly high in the summer, with long breaks over the winter.

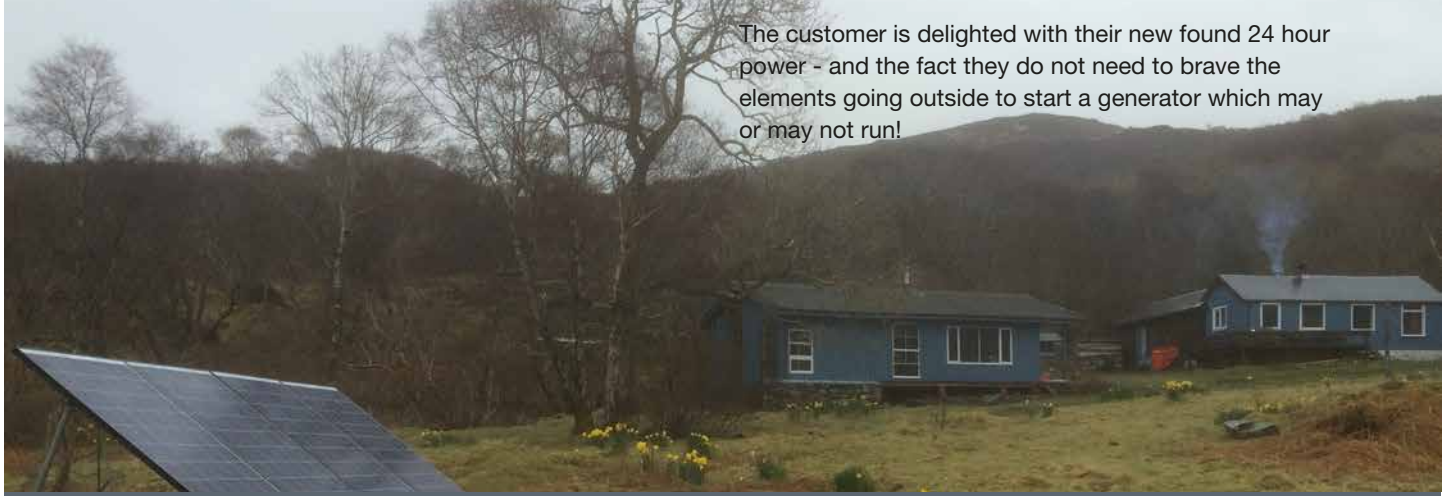
With no prospect of a grid connection either now or in the future, all cooking, refrigeration and most of the heating has been done on gas and unfortunately the owners have had a series of very unreliable hand start generators. The Trust was also poorly advised in the past as to the potential of wind power and had spent a significant amount of money on infrastructure that has proved to be unreliable.

Jamie, from Alternative Engineering was called in to have a look at their situation. There is a large burn close by which he advised may be an option to exploit for hydro power at a later date but initially an infrastructure on the site was needed. The convenience of uninterrupted power was a very appealing concept to the clients; but due to the high number of different people passing through the properties, they wanted a reasonably automatic and low maintenance system.

Working closely with the range of power, monitoring and control products from Energy Solutions, Jamie advised that the project didn't warrant a full E-Plex controlled system; rather a simpler, robust configuration built out of the relevant components was put forward; including a new generator and gel batteries - an obvious choice due to their lack of maintenance.

The entire system was built into a cabinet to make installation as easy as possible in this very remote situation. The Victron Multi Plus inverter providing power and automatic generator starting, and the second AC output in the inverter being utilised for water heating to cut down on gas usage. There is also a 1KW solar array via a Victron MPPT DC charge controller to keep up with the small loads and to keep the batteries topped up over the winter.

The customer is delighted with their new found 24 hour power - and the fact they do not need to brave the elements going outside to start a generator which may or may not run!



Dartmoor Cottages Off Grid Systems

These Off Grid systems show how each location has it's own unique needs which our Off Grid team address individually.

Paul Holland, Energy Solutions

Off grid systems provide reliable, flexible solutions for holiday accommodation and home.

A small complex in Dartmoor has now received its' second off grid system from Energy Solutions. The first system delivered was to provide power for two, 3 bedroomed holiday cottages, the second was an off grid power supply for a 3 bedroomed home.

The off grid system for the two cottages, used as holiday lets, needed to be reliable for use with different holiday tenants, as well as secure and flexible enough to make good use of renewable energy. A containerised system was decided upon and the team at Energy Solutions custom built a container so that the fuel section could be accessed independently to the controls and battery system. The solar array was mounted on top of the container to make best use of the space and keeping the entire range of power options in one neat location.

To keep an eye on the entire system whilst not being on site, the owner of the cottages had installed a remote monitoring panel to be able to view the system from home or work providing added peace of mind.

At the 3 bedroomed home, the owner occupier wanted a similarly sized system but this time a frame mount system was the most viable option. Needing power on a constant basis with the normal loads and demands of a family home the system is housed in an outbuilding and monitored directly by the owners.

Solution
E-Plex controlled Off-Grid systems incorporating:

Holiday Cottages
- Double ended custom build container
- 10kW system
- Lead Acid battery bank
- 4kW solar array
- Remote monitoring panel

Home
- Frame mount system
- 10KW system with lead acid battery bank

Float Fish Farm

Solution

E-Plex controlled off-grid system incorporating:

- 4x Quattro 48/5000/70
- 9x Skylla 48/50
- 3000Ah Batteries at 48V
- 40x 220w Solar Panels
- 3x Solar Inverters

Energy Solutions have developed reliable and durable off-grid power and control systems for many industrial situations. Consequently, when they were commissioned to develop a system for a fish farm in Peterborough, they were keen to take on the challenge.

The customer had recently purchased a new site. It did not have any mains power and the cost to install it was prohibitive due to requiring extensive cabling and building a sub-station. The decision to go off grid was made and Energy Solutions started assessing the requirements for the growing 55 acre site.

The bespoke system needed to incorporate generators, inverters, batteries, solar and eventually wind turbines. The Engineering team undertook site visits and assessments to understand the large range of requirements.

Energy Solutions designed the complete control and monitoring system, with power being provided from Victron inverters and chargers and a large battery bank. This is supplemented by generators and a solar array. The important issue for the customer was to be able to control precisely his power needs across the site, including tank pumps, feeding systems, lights and heating. The E-Plex system allows them to do this. The customer is able to control everything from a single touch screen display. The system controls the peak power management and reduces the size of the inverter system and keeps costs down.

As the business expands and develops, the owners have seen the bonus of adding additional power sources to the system. A 9.45 kw ground mounted solar array has recently been added and the next step will be a wind turbine. Both options will be able to add free power to the existing system. The business has linked their solar (and wind when connected) to the governments Generation Tariff, which pays owners an index-linked fee for using alternative energy rather than fossil fuel.*

This system was a complete bespoke design in cooperation with the business owners to ensure that the functionality offered a economical and durable solution. It was also very important that the system was expandable and flexible, allowing for the growth of the business and for new options and incentives to be incorporated as they become available.

* currently 37.8p per kw hour.

Loch Lomond & The Trossachs National Park

The ability to control and monitor our off grid systems remotely make them an ideal choice for businesses that have multiple or remote locations.

Paul Holland, Energy Solutions

Loch Lomond & The Trossachs National Park.

The Off Grid system is powering the Visitor Centre at the Loch so the requirement for all the equipment was for it to be durable, reliable and intelligent.

The E-Plex system uses remote web access so that the system can be monitored and controlled from a central office on a year round basis. The screens allow the owners to monitor all elements of the system including the generator and batteries. The entire E-Plex system was supplied, designed and installed by Energy Solutions, working with the customer to ensure the screens reflected exactly what they needed to monitor on a daily, weekly and annual basis.

System Key Components:

- 48v 8kva Victron Quattro
- 15kva Catapillar Olympian prime power diesel genset
- 1000L capacity bunded fuel tank
- 945Ah 48v battery pack
- 300L calorifier for hot water (heat recovered from the CAT genset)

Off Grid System, Park House, Scotland

Jamie Robinson who runs Alternative Engineering offers a unique and complete service covering the NorthWest of Scotland where he has helped many clients realise their off grid requirements.

Energy Solutions supplies Alternative Engineering Solutions in Highlands, Scotland with the off grid systems and generators for their clients across the region.

Park house is in the West of Scotland, a few miles from Knoydart, and is a small business where the owner lives in an adjoining flat and the 3 Bedroom house is rented out as a holiday let.

The house has never had a grid connection and is unlikely to ever have the possibility of one, so the owner was looking to obtain permanent power with the option of renewables; solar to start with, with a small wind turbine to follow. Renewables allow the owners to reduce diesel consumption – a key factor - as diesel has to bought in by boat to the property making it an expensive and time consuming task.

The new owner of the property got in contact with Jamie via his website and the initial consultation and site visit allowed Alternative Engineering to build a full set of recommendations, specification and a quote. The owner needed the system to offer a good level of automation so that guests would not need to be bothered by an antique, needy generator.

The solution for the house was an Energy Solutions' Frame Mounted System with 5KW inverter and 3KW ground based PV array. Supplied, installed and commission by Jamie within a tight schedule it has been a success all round.

Jamie sums up the project: "The Energy Solutions Off Grid Frame Mount system is fantastic and was perfect for this situation - it gives really good functionality and is a total plug and play solution. Because it contains all the electrical conformity required, even if the house wiring is old, by installing this system it makes it safe at source. The user can easily change their generator starting parameters according to the time of year or renewable options. So whilst being a large value initial outlay, it does save time and money for clients on installation costs."

OFF GRID GUIDE 2015

ENERGY SOLUTIONS

52 – 54 Riverside, Medway City Estate, Rochester, Kent ME2 4DP tel: 01634 290772 email: sales@energy-solutions.co.uk web: www.energy-solutions.co.uk