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How to unplug from the grid

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Using solar power for ironing while camping (Image: Hollandse Hoogte/Eyevine)

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"I HAVEN'T paid an electricity bill since 1970," says Richard Perez with noticeable glee. He can afford to be smug. While most of us fretted over soaring utility bills this year, he barely noticed. Nor is he particularly concerned about forecast price hikes of 30 to 50 per cent in 2009.

Perez, a renewable-energy researcher at the University at Albany, State University of New York, lives "off-grid" - unconnected to the power grid and the water, gas and sewerage supplies that most of us rely on. He generates his own electricity, sources his own water and manages his own waste disposal - and prefers it that way. "There are times when the grid blacks out," he says. "I like the security of having my own electricity company."

Perez is not alone. Once the preserve of mavericks, hippies and survivalists, there are now approximately 200,000 off-grid households in the US, a figure that Perez says has been increasing by a third every year for the past decade. In addition, nearly 30,000 grid-connected US households supplement their supply with renewables, according to the non-profit Interstate Renewable Energy Council. In the UK there are around 40,000 off-grid homes: the number has also risen in recent years due to escalating house prices and now to more expensive home loans, both of which have driven buyers far from conventional utility networks in search of properties they can afford.

For people who live off-grid, self-sufficiency means guilt-free energy consumption and

peace of mind. "It feels brilliant to use clean, free energy that's not from fossil fuels," says Suzanne Galant, a writer who lives off-grid in rural Wales. "And if something goes wrong, we can fix it ourselves." Now even urbanites are seeing the appeal of generating some if not all of their own power needs. So is energy freedom an eco pipe-dream or the ultimate good life?

Whether you live in town or the middle of nowhere, the first consideration for any wannabe off-gridders is to calculate how much energy it takes to run your home and whether it is feasible to replace this with alternative sources of power where you live.

The good news is that the energy you require is likely to be a fraction of what you presently use, says Tony Brown, head engineer at the UK's Centre for Alternative Technology near Machynlleth in Powys. The average UK household uses around 4500 [kilowatt-hours](#) (kWh) of electricity annually, plus some 18,000 kWh of gas for cooking, hot water and domestic heating. In the US the figure varies considerably from region to region. For example, households in New York City use around 4700 kWh a year, whereas those in Dallas use 16,100 kWh: there are a lot of air conditioners in Texas. In chillier regions where people use gas for heating and cooking, on the other hand, they can burn up an extra [28,000 kWh or so](#) per household.

It would be a struggle to generate this much energy from renewables alone, so an important first step is to dramatically reduce wasted energy. This may be less fun than installing shiny new energy-generating gadgets, but it is almost as effective in cutting your reliance on fossil fuels and the grid.

The biggest energy savings will come from properly insulating your home to minimise heat loss. That done, you'll need to work out what is eating up the rest of the power you consume. The easiest way to do this is to buy an energy monitor that can provide a live display of your total energy consumption or that of individual appliances (see "What's guzzling the juice?"). This will help you focus on reducing consumption to the bare minimum, not just by switching to low-energy light bulbs and energy-efficient white goods, but also by turning unused appliances right off rather than leaving them in standby mode. With a bit of effort and investment, you should be able to get by on a few hundred kilowatt-hours of electricity a year.

Now you are ready to start replacing this with home-grown energy. Some 80 per cent of off-gridders rely on the sun to do this, with good reason: it blasts our planet with enough free energy every hour to power the world for a year and you don't need to live in the middle of nowhere to get it. The simplest way to tap into this is to use a solar collector for your domestic heating or hot water. In the summer, solar thermal devices installed on a south-facing roof or wall (north-facing in the southern hemisphere) could provide all your hot-water needs. Even in winter, solar collectors can make a worthwhile dent in heating bills, even if the water needs top-up heating from the grid or from a stove that runs on logs, wood pellets or other biomass.

For electricity generation, photovoltaic (PV) solar panels are also a good option. They

convert the sun's rays into direct-current electricity with up to 20 per cent efficiency, and most are guaranteed to retain at least 80 per cent of their original efficiency after 25 years. A 2-square-metre panel rated to give 1 kW per square metre in peak conditions could provide up to 1500 kWh per year in the UK. In more southerly and reliably sunny latitudes - somewhere like Texas, say - it would probably provide 2000 kWh per year.

With enough solar panels it is possible to cover all your electricity needs with PV, year round; the downside is that it requires a significant investment up front. Installing 8 square metres of PV panels, enough to sustain a family of four in the UK, plus storage batteries and accessories such as inverters to convert DC into alternating current, can cost tens of thousands of pounds and will take up more space than is available to most urban households. Until the cost comes down substantially, switching to a grid supplier that gets its energy from renewables may be a more realistic alternative - although it will not free you from the risk of supply interruptions.

Outside towns and cities, though, there are more options. If you have access to a nearby river or stream with a reliable flow, hydro is an excellent, cheap source of power, and flow rate is usually greater in winter when you need more power. Galant's home, a five-bedroom house in the second-wettest part of Europe, is powered by a fast-flowing mountain stream that drives a turbine, plus solar water heating and PV panels. All this reliably supplies her with around 5500 kWh per year. "If you came to my house, you wouldn't know it was off-grid," she says. "It's always lovely and warm and there's always plenty of hot water."

Anyone who has an exposed windy hillside can exploit wind power. Tony Marmont, an off-grid pioneer from Loughborough, in the English Midlands, gets 40,000 to 50,000 kWh per year from his two 25 kW turbines. People with a lot of land can benefit from a ground source heat pump, which works in the same way as a refrigerator, using electricity to transfer heat from a cool space (the ground, in this case) to a warm one (the house). A typical installation, with 500 metres of underground piping, will stabilise the temperature of a well-insulated home, keeping further heating or cooling requirements to a minimum. If, like Marmont, you have a lake to store the pipes, so much the better: it saves the trouble of digging up the lawn.

Being completely off-grid, however, does mean you need to store excess energy for when the sun doesn't shine and the wind doesn't blow. Most off-gridders use bulky, expensive lead-acid batteries for this purpose. These can store electricity only for a couple of days and their performance degrades over time, but for now they are the best available option. A few pioneers, like Marmont, use excess electricity to produce hydrogen by electrolysis of water; the gas is then stored in tanks and used to power fuel cells when needed. This allows electricity generated in summer to be used in winter, but it is prohibitively expensive for most: a system like Marmont's will set you back around £1 million. What's more, the hydrogen tanks take up a lot of space.

For most of us, the energy-storage issue is a major stumbling block to going completely off-grid. And it's one reason why, for most people, it's not yet worth pulling the plug. Cost is likely to be another show-stopper - though not for those who live in really remote locations. "If you live more than a quarter of a mile from the grid, then installing your own systems

works out considerably cheaper than connecting to the grid," says Otto van Geet of the US National Renewable Energy Laboratory in Golden, Colorado. Perez, for example, was told it would cost him \$280,000 to be connected, which made the decision to install \$25,000-worth of PV panels an easy one. Both of these barriers are coming down, albeit slowly. Engineers are working on reducing the size and cost of renewable-energy installations, while fuel-cell and battery manufacturers are trying to increase power output and storage life. The cost of generating and storing your own energy will fall as the commercial and domestic generation market grows and as new technologies emerge: thin-film PV panels, for instance, are cheaper to make than existing PV cells, which use crystalline silicon. For many, the transition is becoming easier and less costly as newly built houses are increasingly offered for sale with some of the infrastructure for renewables, such as inverters for PV panels, already installed.

In the meantime, one way to beat the problem of how to store surplus power and make good on your investment is to stay connected to the grid - or connect if you are already off-grid - and sell what you don't use to a utility company. It may not be the energy freedom you had in mind, but it does mean that the grid effectively becomes your battery - there when you need more electricity, and able to take your excess power. The return you will receive for this varies widely, but Germany has already shown that such a system can work. There, homeowners selling back renewably generated power are guaranteed to get four times the market rate charged to consumers for electricity. As a result, Germany has a thriving market in domestically generated energy, with 200 times the solar electricity output of the UK. The UK is planning to bring in a similar "feed-in tariff" system in 2009, although it is not yet clear what sort of price power-generating homeowners can expect. In the US, California and New Jersey are leading the way with feed-in tariffs in the range of 8 to 31 cents per kWh, depending on the contract and the time of day when the power was generated. Most other states have a long way to go.

There is no doubt that being off-grid has its problems and it is not always the cheapest way to get your energy. Even so, pioneers like Galant, Marmont and Perez have proved that it can be done, and without giving up a 21st-century lifestyle.

"I've got five computers, two laser scanners, two fridge-freezers, a microwave, a convection oven, vacuum cleaners - you name it," says Perez. "There's an external beam antenna on the roof for the cellphone and a bidirectional satellite for internet connection. I've got 70 kWh stored in batteries that could last me five days. I have too much electricity." Too much electricity and no more bills. That's got to be worth aiming for.

If money is no object

Tony Marmont founder of Beacon Energy, living near Loughborough, UK. Set-up: Heat pump in lake; Two 25 kW wind turbines; Two water turbines; 9 kW PV array that tracks the sun; Hydrogen storage; Rainwater storage. Total cost: £2 million (£1 million for the hydrogen storage system alone). Generates: Around 50,000 kWh per year, with 30,000 kWh consumed; the remaining power is used for electrolysis to produce hydrogen, storing 700 kWh per year.

No fortune required

Mick Bestwick forestry expert, living in rural Aberdeenshire in the UK. Set-up: Galvanised steel waterwheel; Grid connection as back-up for when the river freezes; Wood-burning stove. Total cost: £18,500, of which £6000 went towards renovating an existing waterwheel as a generator and connecting it to the house. The rest paid for connection to the grid. Generates: 4000 kWh per year.

The bare necessities

The average person in the UK uses 150 litres of water per day. To go off-grid, that figure will have to come down to around 80 litres. You can work towards this by fitting a dual flush to your toilet, putting a brick in the cistern, fitting aerating taps - which use infused air to give the feel of normal flow while using less water - and buying the most water-efficient washing machine you can afford. Reuse water from the shower and washing machine to water the garden and flush the toilet, and throw away your hosepipe. It's usually quite legal to dig a borehole to obtain water for domestic use, but you should have the ground surveyed to check for potential contaminants. If you have a stream on your land, tap it; otherwise collecting rainwater is the best option. Water from any of these sources will of course need treatment if it is to be used for drinking. A UV filter is the tidiest method, but will cost a few hundred pounds; systems using chlorine and ozone are cheaper. Going off-grid the sustainable way requires more of a commitment when it comes to sewage. A well-designed composting toilet is not at all smelly and generates a handy supply of nutrients for the garden. This type of toilet often needs a drop, however, and it's good to be able to rotate between different compost piles, so space is an advantage. If you live in a town or city, however, stay on-grid and leave sewage to the experts.

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