EECA
Energy Efficiency and Conservation Authority
Te Tari Tiaki Pūngao

RENEWABLE ENERGY

Fact Sheet 2
Stand-alone Power Systems

For New Zealanders concerned about rising electricity prices, interested in more sustainable and self-sufficient modes of living, or facing big costs in connecting a remote property to their local lines network, an option well worth considering is a stand-alone power system.

Stand-alone power systems can generate electricity with renewable forms of energy – solar, wind or hydro. They are generally backed up by a diesel or petrol-driven generator and often supported with other energy efficient technologies.

They're proven – for example, there are 1,000 or so homes on Great Barrier Island using them. They save connection costs, provide independence and can be highly attractive financially. That's because often they cost only marginally more than connecting to the local network, and there is no monthly power bill from an electricity retailer.

An alternative to expensive connections

Connecting a property to the local lines network can be expensive, particularly in rural locations. The actual cost will depend on factors like the distance to the nearest connection point, whether the connection goes underground or overhead, the terrain, and physical obstacles such as trees or streams. But typically, it can cost between $18,000 to $24,000 per kilometre.

Against this sort of investment, stand-alone solutions are widely used for homes, communications stations, farms or lodges in remote areas.

A stand-alone system provides autonomy from the local network. So if there is a power failure, a household or business with a stand-alone system will still have electricity.

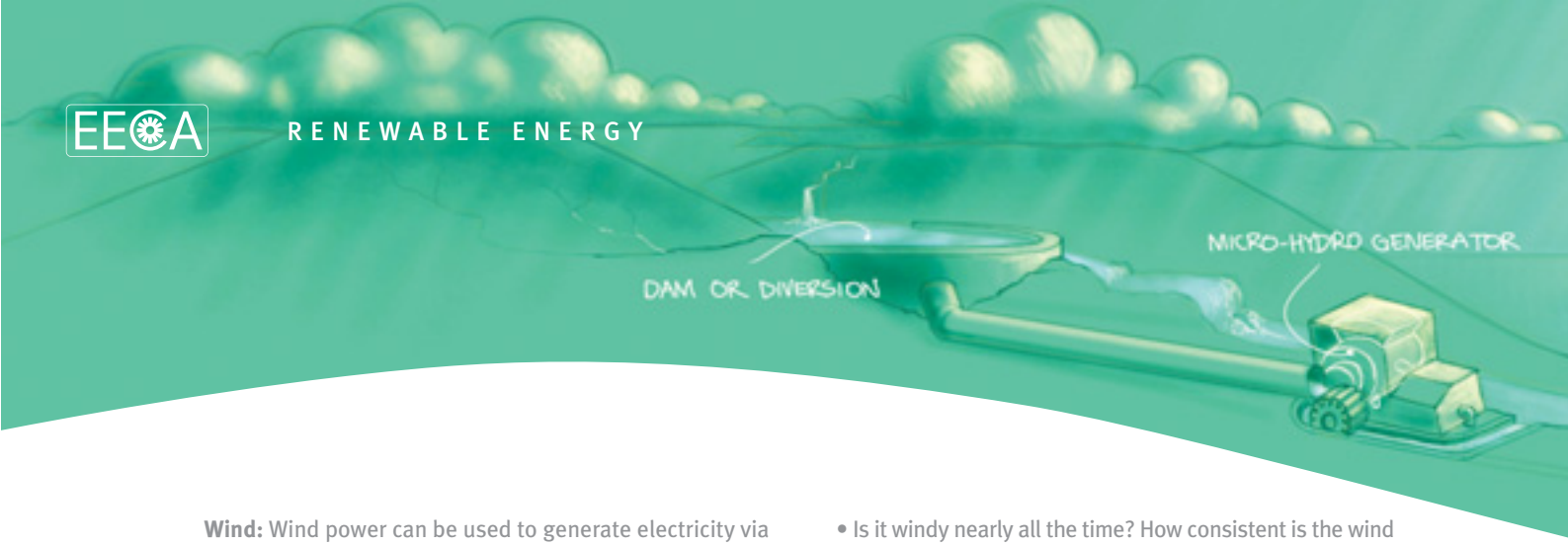
Some systems can be connected to the local network. This is not technically a stand-alone system but it uses the same generating technology. Network connection is therefore described briefly in this fact sheet.

Options and components

Stand-alone systems use a variety of energy sources and come in various configurations.

Solar electric: Solar electric panels, also known as photovoltaic or PV panels, use the sun's energy to generate electricity directly.

The main advantage of solar panels is that they are virtually maintenance free, and fairly unobtrusive. However they are more expensive than other stand-alone options, and they require a substantial bank of batteries to store the power.



Wind: Wind power can be used to generate electricity via a small wind turbine. The turbine will generate electricity as long as there is a reasonable wind speed (a minimum annual mean wind speed of over 4 metres per second is required); no power is generated when there is little or no wind or when the wind is too strong.

Micro-hydro: Micro-hydroelectric schemes (i.e. generating less than 100 kW of power), operate on the same principle as large hydroelectric plants. Micro-hydro schemes can be installed where there is a suitable stream on the property. The big advantage of a micro-hydro scheme is that, unlike solar or wind systems, it can operate continuously – depending on stream size and/or reservoir size.

For more information on solar electric panels, wind power and micro-hydro visit www.eeca.govt.nz.

Batteries: Because solar panels and wind turbines do not generate power continuously, the output must be stored using batteries. At present, banks of 12V to 48V lead-acid batteries are commonly used. Sealed batteries cost more and require less maintenance, but a well-maintained lead-acid battery will usually last longer than a sealed battery.

Batteries should be sized to maintain at least 50% charge and, for optimum life, deep cycle batteries should be used. The batteries will typically need replacing in four to ten years, depending on quality, sizing and how they are used.

Inverter/charger: Solar panels, most small wind turbines and micro-hydro systems generate direct current (DC) electric power. Since most household appliances run on alternating current (AC), an inverter is usually required. The inverter converts power stored in the batteries to 230V AC.

Gen-set: It is necessary in most situations to install a diesel or petrol-driven generator as a back-up to the renewable energy source. The less productive or reliable the renewable energy source, e.g. a stream with highly variable flow, a location sheltered from wind in one particular direction, or from the sun at certain times of year, the larger the generator required. Diesel generators are most common. However, generators using bio-diesel made from plant oils are currently in use in several European countries and are likely to become available in New Zealand in the near future.

Designing a system

To design a system for your home, you will need to talk to an expert who can help you calculate your energy needs and the energy resources of your site accurately.

To get a rough idea of what is possible, consider these issues:

- Is there a water course nearby that might suit a micro-hydro scheme? Does it ever dry up?
- Is it windy nearly all the time? How consistent is the wind speed? Does the wind pattern change much with the season?
- Does the sun rise late or do you lose it early because the site is in a valley? Are there trees or poles that will cast shadow?

For detailed information on the different types of renewable energy resource, and a database of designers and equipment suppliers for stand-alone systems, visit www.eeca.govt.nz.

Designing and installing a stand-alone system should be carried out by skilled personnel to ensure a safe, and energy efficient, outcome. To avoid damage or risk of fire, appropriate New Zealand standards need to be observed, such as those relating to the installation of batteries, and wiring regulations must also be followed.

Which to choose

Solar electric panels are one of the most popular choices for many people. However, it is worthwhile considering a hybrid system with two or more electricity generating units. For example, a combination of solar and wind power, often found on yachts, is also a popular option to solar alone.

Hydro-powered systems have a number of advantages and can be readily complemented with wind or solar.

Because they generate power continuously, hydro systems require smaller and less expensive batteries. Even in a hybrid system, if there is a hydroelectric component, the batteries usually last longer.

However, a successful micro-hydro system is critically dependent on having a suitable stream nearby. It needn't necessarily be a big stream – even one you can jump over may be suitable – but generally you need a drop (i.e. a 'head') of at least 10 metres between the inlet pipe and the turbine.

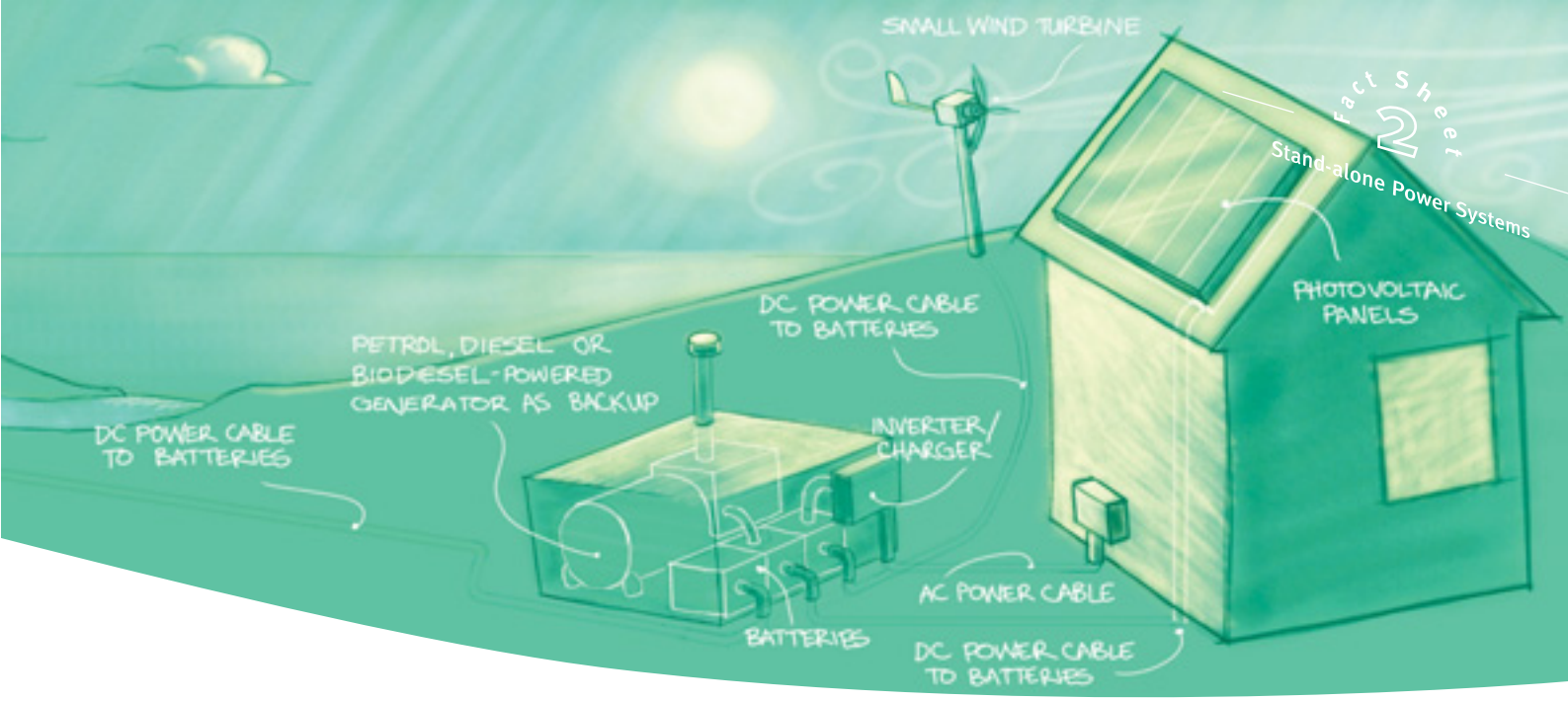
Network-connected systems

On a property that already has a mains power connection, additional equipment can be used to link a stand-alone system to the local lines network.

This sort of connection allows electricity to be drawn from the lines network if there is a shortfall, or electricity to be supplied to the network if the stand-alone system is generating excess power. Effectively, the network acts as the back-up system, instead of a gen-set and batteries.

As a small-scale generator, you may be paid for electricity exported to the network. As a consumer you pay for electricity imported from the network.

No changes in the household wiring are necessary, but the system must meet the technical requirements of the local lines network company. You will also need an agreement with your



retailer if you are to sell electricity. The requirements vary between network companies and electricity retailers. Your retailer will be able to advise you of their requirements and which network company you need to contact.

Local authority requirements

Local and regional councils will have different rules regarding the installation of a stand-alone power system. For example, local council height restrictions may apply to a wind turbine tower, or consent from a regional council may be required to dam or divert a stream. You should talk to your local and regional council about whether you will require a resource consent and/or building consent for the system you are planning.

Energy efficiency and other options

The cost of a stand-alone system is largely determined by the peak load – the maximum amount of electricity likely to be demanded at any one time.

There are various energy efficiency strategies you can adopt to reduce peak load and the cost of your system:

- Make sure you don't run a number of energy intensive appliances (such as electric heaters, ovens, clothes dryers and electric hot water cylinders) at the same time.
- Invest in energy efficient appliances. Look for a high number of stars on the energy rating label on whiteware. Energy efficient compact fluorescent lights use around 20% of the electricity of an ordinary light bulb.

You need to consider the wider options when you're designing your system.

For instance, it might be more economical to design a home with passive solar heating, install both a gas cooker and solar water heater and use solid fuel heating than to install a stand-alone system with the capacity to provide electricity for these same functions.

For more information on solar water heating visit www.solarsmarter.org.nz.

For more information on energy efficient homes visit www.eeca.govt.nz.

Sizing the system

First you need to establish how much electricity the household uses, and what the peak demand is.

As a rule of thumb, an average household will use just over 20 kWh per day but an energy efficient home could use as little as 5 kWh per day.

In a network-connected home, you can easily estimate average electricity usage by recording the electricity meter reading each day and then calculating the average.

Alternatively, you could calculate usage in the following way:

1. List all electrical appliances and lights.
2. Note the power that each item will use. This is usually written on the appliance and measured in Watts (W).
3. Note for approximately how long each appliance and light will be used.
4. Multiply the power rating in Watts for each appliance and light by the hours it will be used each day.

Power rating (W) x hours per day = Watt hours per day (Wh/day)

5. Add the Watt hours per day used by all appliances and lights for an estimate of your daily electricity usage.

To get kWh, you simply divide the total Wh by 1,000. For example, a 2,000 W heater running for one hour uses 2 kWh of electricity.

Peak demand can be estimated in the following way:

1. List all electrical appliances and lights.
2. Add up the power rating of all appliances and lights that may be used simultaneously. The combined power rating indicates your peak demand.

The economics

The cost of a stand-alone power system has to be weighed up against the cost of finance and the relative cost of other power supply options, such as connecting to the local lines network.

Often the cost of connecting to the lines network is the same as, or only slightly less than, a stand-alone system. However,

once the savings from having no monthly power bills are taken into account, the payback period for a stand-alone system becomes even more attractive. Depending on the individual circumstances, the payback period can range from less than a year up to around 30 years.

Case study: Nelson family home

A family of three living in a three-bedroom home in the rural Nelson region needed poles and lines extended 900m to connect their home to the local lines network. The local lines network company quoted them $17,000 for the task. In addition to this cost, there would be ongoing monthly power bills.

After investigating various options, the family opted to combine a stand-alone system with gas for cooking and water heating, and a log burner for space heating.

The system was sized with the capacity to also supply a two-bedroom flat that would be used in the summer months. It provides more than adequate power, and allows for expansion in the future.

There was no cost for a petrol generator used in the system as it was already owned by the household. It was incorporated into the new system using an inverter/charger. When there is insufficient sun, the inverter/charger allows the generator to meet demand while simultaneously charging the batteries. This means the household has electricity all the time without having to run the generator continuously.

The total cost of the system, installed in 2003, was $26,100. That included:

Solar electric panels; 8x75 W	$7,800
Batteries (24V); 1395 amp hour total	$5,200
Inverter/charger (4kVA)	$10,800
Installation	$2,300
Total	$26,100

The costs

The cost of installing and maintaining a stand-alone system can vary depending mostly on the combination of components installed and the energy output required.

A middle-of-the-range system, with either solar electric panels or a wind turbine as the primary energy source, typically costs between $15,000 and $25,000. The setup costs of a micro-hydro system usually range from $12,000 to $15,000. Of these costs, 20 to 25% will go on the batteries.

The other major item is the inverter, which can cost from $3,000 to over $10,000, depending on the size and quality. Alternatively, to avoid the need for an inverter, you could install DC-powered appliances, but these are generally more expensive and the choice is limited.

A diesel or petrol-fuelled generator will cost between $4,000 and $12,000 installed. The size of the generator you need will depend on the electricity required to meet demand and on the scale of the renewable energy options available at the site.

A system with solar electric panels or a wind turbine, micro-hydro generator, batteries, inverter, and a diesel or petrol generator could cost up to $60,000.

Maintenance costs can be significant, particularly for batteries and those systems with moving parts such as a gen-set and wind and hydro turbines. Often, skilled and trained people are required to install and help maintain these.

It is unlikely that the cost of stand-alone systems will reduce significantly in the near future unless there are technological breakthroughs. For example, ongoing developments in microelectronics are lowering the cost of solar electric panels.

This fact sheet was produced by the Energy Efficiency and Conservation Authority (EECA). EECA is a Crown entity implementing the National Energy Efficiency and Conservation Strategy through improving energy choices.

For more information about EECA and the renewable energy target visit **www.eeca.govt.nz.**

Other useful websites are:
www.photovoltaics.org.nz
www.windenergy.org.nz
www.hydropower.org
www.solarsmarter.org.nz

For information on the Government's climate change programme visit **www.climatechange.govt.nz.**

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