FUTURE OPTIONS FOR INDEPENDENT POWER SUPPLY TO REMOTE AREA FARMS

LINDA BEGG

KELLOGGS 2005

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IS YOUR POWER STILL GOING

TO BE COMING ALONG THE

LINES NEXT YEAR

EXECUTIVE SUMMARY

- From 2013 power users with mains grid connections supplied by a lines company may be responsible for repairs, maintenance and or replacement of same.
- New supplies costs are in the order of $15,000.00 plus per kilometre.
- This will impact on many farms in remote areas.
- There are alternative Stand Alone systems that sre now well proven.
- Costs of stand alone systems suitable for a farm situation are from $25,000.00.
- Several generation possibilities exist, depending on site. Wind, solar, hydro, motorised, and others.
- Most solutions will incorporate more than one means of generation.
- Where mains power is to be used opportunities exist to save money by judicious use of motorised generators in situations where power is required sporadically.
- Solar water heating is a viable option in all situations to save power usage.

INTRODUCTION

The research for this paper was done in Otago but there is every reason to expect that it would apply equally to any region in New Zealand.

It is intended as a guide to any farmer contemplating a stand alone power system. Individual farm circumstances make it unlikely that all the answers could be provided.

I have a background and interest in stand alone power systems for the past 15 years, since we purchased our initial block of land. Although situated less than four kilometres from the city centre it was not connected to the grid.

Since then we have lived with a windmill and battery system, and diesel generator back up, recently supplemented with solar panels.
We are currently on an 80 ac farmlet and the power system has shifted with us.

When it came to my attention that the Govt had passed legislation stating that the power companies would not be required to guarantee supply to uneconomic areas, it provided the incentive to write this paper.

THE LAW

Currently the Electricity lines companies are required by law to maintain existing connections until March 2013. After this date the expiry of Section 62 of the Electricity Act 1992, will remove the obligation of lines companies to continue to operate in isolated rural areas. Despite the fact that Federated Farmers have made two lengthy submissions over recent years, promises of review, and the current Govt requesting reports, it appears to be a long way down the list for consideration.

Discussions with Delta the maintenance company wholly owned by Aurora Energy, who cover a significant area of rural Otago indicated that they have no planned strategies to cope with the change in legislation, and in fact indicated to me that they would not be developing any in the foreseeable future. It appears that they are going to rely on a change of Govt and or the experience of the Kyoto protocol as it unfolds to solve the problem.

If nothing changes officially I seems that the most likely outcome will be that the power companies will just try to carry on as before with existing customers responsible for all repairs, and new connections entirely at the consumers expense.

HISTORY

Various forms of alternative energy have been around for over a century. These depend on sources available and the local climate.

Most of the Australian remote sheep stations have relied in the past on alternatives to the grid system, and many still do so.

In many instances they were poorly designed systems that were fed directly from batteries, and required DC appliances which were often not reliable and usually expensive. This would have been a major reason why alternatives did not become more popular, remaining the second choice of electricity users.

Things changed approximately 20 years ago when DC to AC solid state inverters, in useful sizes, became commercially available. This meant that normal household appliances could be utilised, and that standard wiring as in all other housing was suitable. This had the added advantage of no further wiring costs to connect to the grid at a later date if required.

The other big advance in recent years has been the availability of Solar panels, at reasonable cost. These greatly extended the possibilities of both sites and systems.

MAINS DISTRIBUTION

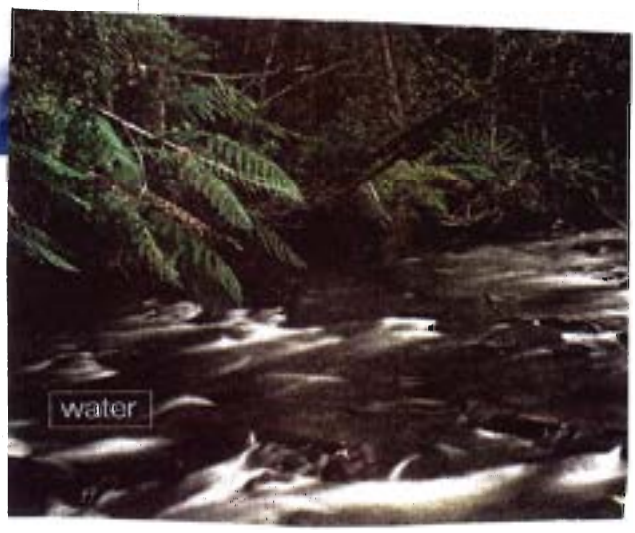
In order to compare the alternative, a rough cost of connecting to the mains grid system needs to be taken into account. Interviewing the supply companies it appears that all are within a similar costing formula.

The current quote is $15,000.00 plus per kilometre, naturally depending on the site geology, and degree of difficulty of access. This does not include the cost of any upgrade to existing equipment. Typically a transformer is required at a further cost of $5,00.00. Existing connections will eventually need renewed at comparable costs.

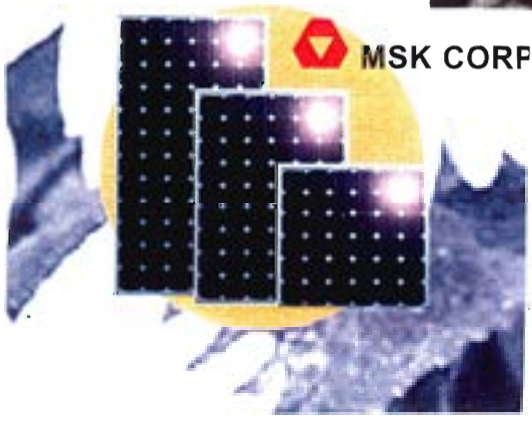
This does not include the ongoing repairs and maintenance which if using company lines would need to be undertaken by them, at the consumers cost. I have no doubt that costings will be rising with fuel price increases.

STAND ALONE SYSTEMS

WINDMILL



HYDRO



SOLAR

BATTERY STORAGE

STAND ALONE SYSTEMS

WIND

Wind farms are now tried technology with large wind farms supplying significant amounts of power to the existing grid, and from personal experience I can say that single household units have been operating successfully for at least 15 years. The proven types are horizontal axis turbines although there are vertical axis turbines on the market they are less efficient.

Obviously not suited to every site as they require an area exposed to the prevailing wind. They work best when the wind is constant rather than gusty and can be mounted within a 100 metres of the battery system, if low voltage. High voltage systems will allow installation up to 500 metres away, although they are more expensive to install.

Our experience has been that 3 blade mills are inherently superior to 2 blade types due to the fact that they are in better balance and are smaller diameter for the same output. This tends to put less strain on bearings.

We do not have personal experience of high voltage windmills because they were not available when we installed our low voltage system.

A household only, can run efficiently on a wind turbine from 1kw, but units up to 5kw are available depending on the size of the family and or how much compromise one is prepared

to make mainly in the areas of heavy draw appliances such as refrigeration.

All wind turbines require a battery bank to store the power, and this is the largest ongoing cost of a wind system. They also require a tower or a pole to mount the unit and cabling to bring the power to the batteries. An inverter to convert the power from DC to AC so it can be used on conventional house wiring, and a switch board with indicator to show the state of the battery storage. The indicator can be mounted inside the house which is far more convenient but requires a specific wire taken from the batteries to the house.

Most household systems I have seen have also had a diesel generator backup. These can be made automatic, to start when batteries are low or the load on the household wiring exceeds the inverter capacity.

Maintenance on wind generating heads is mainly confined to the bearings which are generally low cost, readily available and fully sealed. Our personal experience is that they need replaced annually. At the same time it is wise to check blades mountings and towers.

There are now totally integrated systems on the market complete with generator back up and battery bank, on wheels, automatic start up. Plug in and forget around $30,000.00 suitable for a full household.

If you wish to choose your own combinations of supply and purchase them separately then it can be done for around $25,000.00

HYDRO

A small hydro system naturally needs a stream as a source of driving power. The amount of energy is a product of the head or fall multiplied by the flow.

A variety of heads and flows can be utilised by the selection of appropriate turbine types. Heads from 1m to 100m can be used and a wide variety of flows with the proviso as stated above that small flows will only give small amounts of energy.

It is worth noting that although some of the energy provided by small hydro systems may seem trivial it is on a 24 hr - 7 day basis and so contributes a very useful consistent supply. The slow trickle charge effect is also beneficial to battery life.

A resource consent to use a stream will be necessary but should be granted because you are not removing any water from the stream only using it on the way past.

New Zealand is leading the way in developing small hydro and wind plants using the smart drive unit from Fisher and

Paykel washing machines. The advantages are that they are low cost and utilise particularly good engineering.

Again the main maintenance component will be the bearings but other checks will need to be done on the rotors and housing, given that they are near water most of their lives. Some units depending on your choice may be vulnerable when flooding of the stream occurs.

SOLAR

Solar panels are manufactured in modules and can be added to without stress as required. They can also be used as part of an integrated system as we do. Our wind turbine is supplemented with solar panels, and there is no reason why a Hydro system could not be supplemented in the same way. There are two types of panels. Power producing and Hot water producing.

Power producing are simply installed mainly on roofs but not always. This often depends on whether there is a north facing surface that can be utilised. It is quite feasible to have a frame built as a stand alone panel holder, but they need to be installed out of an easily damaged zone. The correct angle to the sun is going to make your panels even more efficient, but they still work well when angles are close enough.

Hot water producing panels will be the ones most kiwis will know. They do not produce power as such but are a very good source of hot water. Given that much of a household power account is for heating water they can make a very significant contribution to costs. The later model panels are evacuated tube type which do not require water to be drained during the winter freeze.

The cleanest system available.With no moving parts they are low maintenance. Most places in New Zealand have enough sun light hours to work either type of solar panels efficiently. Your particular site may demand more or less panels to serve your needs, and you would be wise to keep a generator back up. Solar costs are fairly standard at $1,000.00 per 100watts.

STEAM

There are available small steam driven generators some of which have been installed in Aust these could possibly be an option for farms with a good supply of firewood or those few with their own coal pit. Costs are around the $20,000.00. The expertise at this stage does not seem to be in New Zealand

COMBUSTION ENGINES

Some generators and in particular the smaller sizes which are often of Japanese manufacture tend to be optimistically rated as to power output. The larger diesels are generally rated to British standard or the equivalent, which is a true continuious rating including an allowance for short periods of overload.

SMALL PETROL

There are a large number of alternatives. From 1kw to 10kw. These operate at 3000 rpm and tend to have a relatively short life and are only really suitable for intermittent use. They do however have their place when power is required at a remote site and can be used as back up to the main installation if usage is not great. Costs from $1 to $6 thous

SMALL DIESEL

These are a little more robust and can be purchased from 2kw up to 8kw also operating at 3000rpm so really only useful for intermittent use. The costs are slightly more expensive than petrol to purchase with lower running costs and the applications are similar.

LARGER DIESEL

Here we are talking of units which run at 1500rpm and are generally continuously rated and could therefore be used in applications where power is required on a 24 -7 basis. These

tend to be bigger heavier non portable units. These start from 2kw and go as big as required right up to container size. There is a hire unit that now days goes round all the night racing venues and powers the lights. Hard to comment on costs because of the variations of needs, but roughly $2,000.00 per kw. There are suppliers in most cities throughout NZ

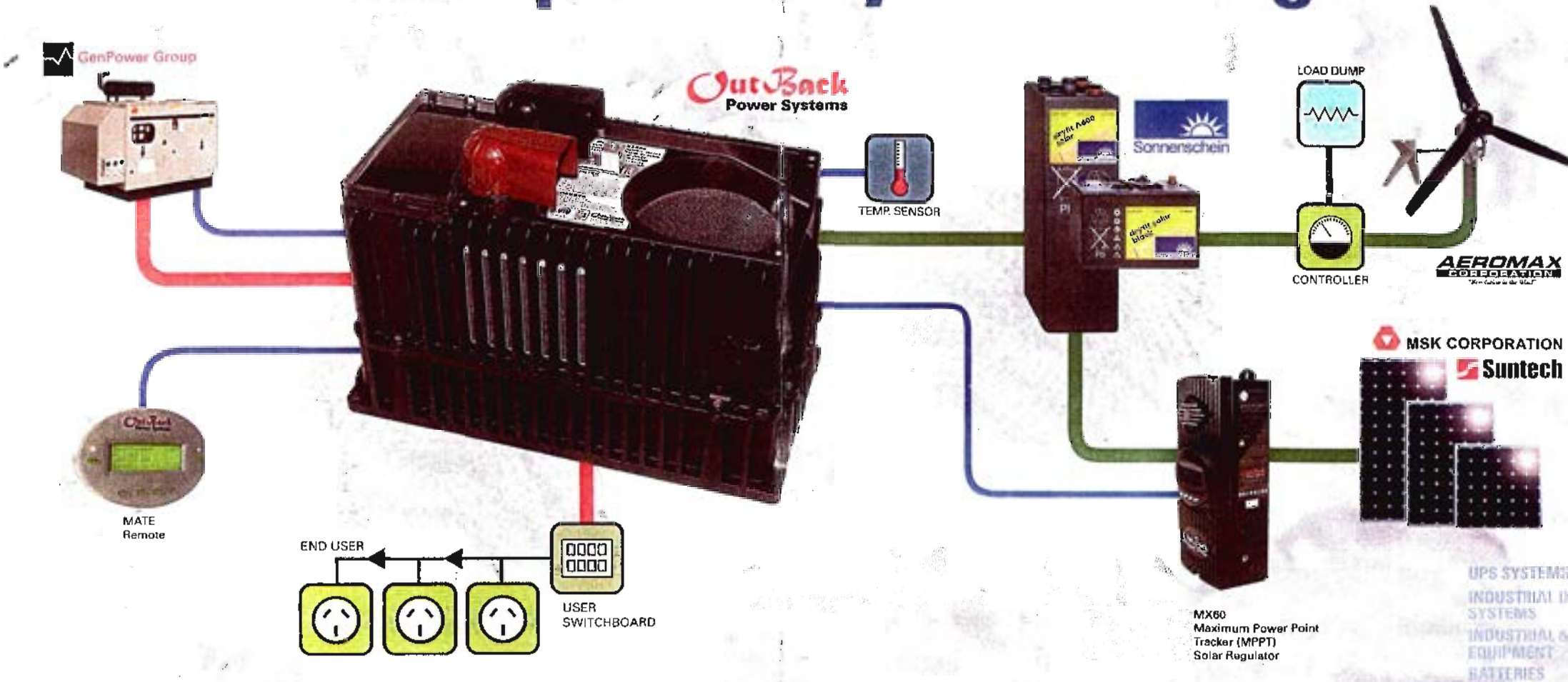
TRACTOR MOUNTED

There is now readily available a range of tractor mounted single and 3 phase alternators. While these would have limitations for permanent installation they could have a number of uses where relatively large amounts of power are needed sporadically ie shearing or welding.
These units are aprox $1,000.00 per kw starting at 3kw. They have a big advantage of reducing the number of motors to be maintained on the farm.

OTHER

Some experimentation is going on with natural gas and bio gas powered plants, but they are not as yet commercially available. Depending on who is doing the developing, it is not always wise to be the first to try new technology

Total remote power system integration



Batteries, Inverters, Chargers, Solar Panels, Controllers, Wind Turbines & Generators

UPS SYSTEMS
INDUSTRIAL
SYSTEMS
INDUSTRIAL &
EQUIPMENT
BATTERIES
BATTERY
CHARGERS
INVERTERS
EMERGENCY &
EXIT LIGHTING
RENEWABLE
ENERGY
INSTALLATION
& SERVICE

STORAGE

There have been some attempts made on storage of energy by pumping water and using that stored water as an energy source but these really are unproved at this stage and tend to have high frictional losses. For practical purposes the only alternative is battery storage.

WET CELL BATTERIES

These are the commonly known battery similar to automotive batteries, but configured internally to provide longer life and deep draw capacity. It is important to emphasise that auto batteries although cheaper are quite unsuitable for this storage type of application.

There is a huge range of sizes at 2 to 6 volts per unit. These can be built up to provide the designed capacity required. Batteries are the down side of stand alone power plants. They require careful attention and have a relatively short life span 7 to 12 years. The cost of suitable deep draw batteries for a domestic situation start around $200 per unit.

GEL CELL BATTERIES

These operate chemically the same as wet cell batteries but require far less upkeep. They are however significantly more expensive aprox twice the price, and not as readilly available. They do however have their applications where batteries are difficult to access for maintenance

NICAD BATTERIES

These are starting to be used in stand alone power systems they have similar costs to Gel cell but are not so well proven and can give difficulties unless charging regimes are very carefully designed.

NEW TECHNOLOGY

There is research taking place on a number of designs, some of which have been incorporated into small rechargeable devices or used in very specific circumstances ie space stations. These are some way off becoming a realistic option, but an eye should be kept on this technology.

GENERAL COMMENT

The size of the battery bank is dependent on how many days you may be without input from which ever renewable sources you are using. Like other things in life this becomes a compromise. More storage means that any fuel burning back up will be needed less often but involves a higher investment in batteries and worse still a higher cost of replacement. They can also create a disposal problem. Nicad have a particular problem in that they contain Cadmium.

There is an equation of Battery costs vs Fuel burnt. This can be worked out theoretically or as in our case done experimentally by establishing the cost of living on a generator per day and from that deciding on the storage required, to minimise generator running.

INVERTERS

Inverters convert DC power power ex the battery to AC 230volts which is required to run normal appliances. Most modern inverters are sine wave and have a facility to switch to a standby mode until a preselected amount of load is detected when any household appliance is switched on. The reason for this is that inverters have a significant standing power usage to operate regardless of load.

There is a huge range now available. The best of them are USA or Australian manufactured and the aprox price is $1500.00 per kw. A typical farm house installation would require 3kw

APPLIANCE SELECTION

As a general statement stand alone power plants are not an option for any application that requires heat unless for very short periods in relatively small amounts eg toaster ,electric jug. In general the main heating will need to be by fuelled appliances.

LIGHTING

The best choices is fluorescent this can be by way of tubes or the more convenient miniature fluorescent lamps which fit a normal light fitting. Either of these should be the choice anywhere light is required for extended periods and with the reduced purchase prices now applying, and considering the very long life, they are a good option in all places.

REFRIGERATION

This is a considerable continuous draw on power in any house. For stand alone systems it is worth considering the relative power usage of different models and even looking at the ultra efficient units now available from specialist shops. They do cost more initially but are 5 star rated compared with the Fisher & Paykel range that are between 2.5 and 4 star

FREEZERS

These do not tend to be as critical as fridges due to their design. Chest type units and the relative low opening frequency keep them more economic. However it is still worthwhile opting for the more efficient units where a choice is available.

COMPUTERS

While these do not draw large wattages it is worthwhile using liquid crystal screens and or portables as both option reduce power by aprox 30% of standard desk top computers.

COOKING

Ovens are one of the big draw items, so it is always going to be more practical and efficient to cook with gas.

For most other small appliances such as mixers, microwaves, any normal type will be OK to use with the size of system likely to be installed in a farm situation.

Coal or wood ranges ar another option. The larger of these can also work as a central heating unit, through radiators or underfloor systems.

FARM REQUIREMENTS

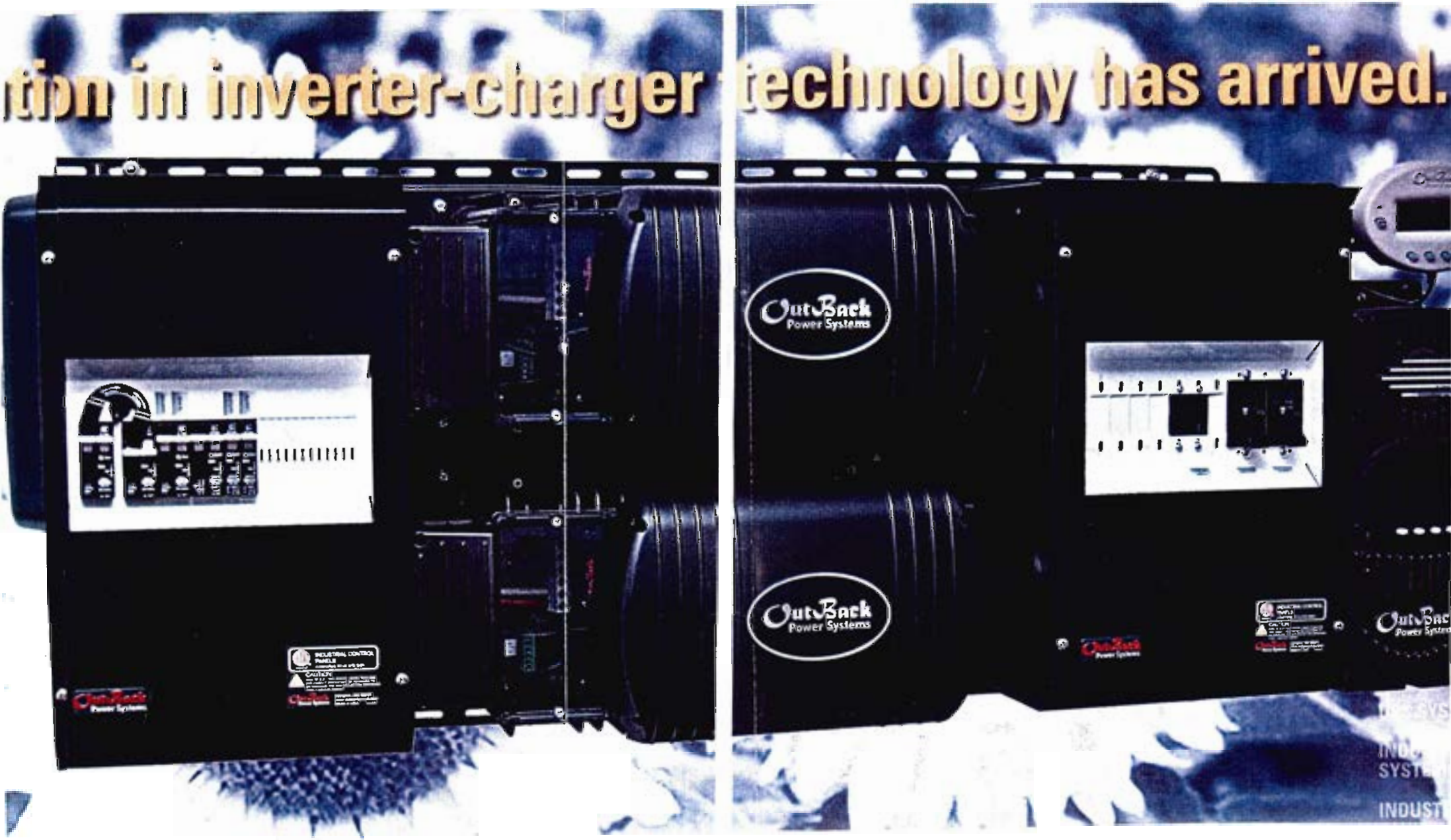
The household has already been discussed so we need to move to The farm specific areas of power usage.

SHEARING

If sheds are are remote from the house then the choice would be for a portable or trailered generator, 1kw per shearing machine, plus an extra 2kw for a press and 2kw for a zip if required. This generator would have many other uses around the property. This could be the same generator that acts as a backup for the house or it may be farm specific. Used for such jobs as scrub cutting, providing power to run digital scales - readers are just two such jobs
It would also be feasible to run your shearing shed from an alternator fitted to the tractor.

PUMPING

The other job that may be necessary on the farm is water pumping. It is feasible to run small household supply pumps from an inverter type system. If however large volumes of water are required as for irrigation then a seperate diesel powered pump would be needed.



A FULLY INTEGRATED

AUTOMATIC SYSTEM

LIMITATIONS

Sustainable stand alone systems can be designed to cope with any power draws but obviously there is a point where the costs could not warrant such a system.

DAIRYING

Stand alone systems would probably be limited to the household on dairy farms. If the house was a stand alone separate system then you may be able to take a single mains feed to a shed and save on connection costs. There would still be considerable savings to be made under this system and would save even more is there is more than one dwelling on the property.

There may have been several small blocks combined to work as one unit, but with some distance or roadways between them which necessitates seperate grid connections. Single line service is well worth a look in these circumstances.

We have a neighbour who purchased another block across the main road and pays a seperate connection fee, which at the moment is just running his electric fencing.

Dairying has the potential for running bio gas systems, but the technology is as yet unproven in small units.

HOT WATER

A huge saving in water heating costs needed for dairying can be made by using heat exchangers and or solar water heating panels. The solar panels are the same as those for domestic use and the water produced can easily be brought up to required temperatures by the addition of gas or grid connected heating.

Heat Exchangers are a very sensible use of the latent heat contained in milk being used to heat water. They can be used to extract heat from other sources eg. a stream or dam. This technology is now well proven and common in both domestic and industrial applications.

HORTICULTURE

Commercial horticulture is likely to have heating and cooling needs greater than can be provided by the type of systems being discussed here. If the enterprise is one that needs only trickle irrigation such as native plants or fruit trees grown under minimal cover, then that would be quite feasible to run from a stand alone larger household type system.

DISCUSSION

The implications of the new order after 2013 may be that the power companies simply hand over the lines to consumers. The supply companies will be aware that Govt expects them to keep power prices as low as possible. This could have the knock on effect of spending less on maintenance to protect their shareholders. While it may sound good to be given ownership of the lines, the chances are this will not happen until they are in a state of needing major repairs. If these repairs are not done immediately then who is responsible for any accidental injury to the public.

The two main considerations when deciding on a stand alone system are availability of grid mains power and the costs of an alternative system. The mains system is not guaranted after 2013, but even if the grid is still there the costs may become prohibitive.

Most alternative technology is becoming cheaper to install as demand grows, so replacement costs should not get out of control, even considering the costs of fuelling a backup generator, but power accounts from retail power suppliers may well do.

Of course it is a trade off. How expensive does power have to get before you consider another system. Most stand alone

systems are combinations. Typically such as windmill, solar panels, and diesel generator, but can be any make up.

Consideration should be given to paying for your grid connection by farming the wind over your property. Most remote farms are by definition high country and therefore many will have suitable sites to harness enough wind to be producers feeding the grid. Power companies are prepared to enter into lease or purchase and lease back arrangements and these could well work to your advantage. Currently farms are not considered big enough users of power to be able to do pricing deals like manufacturers.

It is surprising how aware you become of power usage when using a stand alone system. However behaviour adaptions are not forced on you they do tend to happen slowly. Turning appliances off at the wall when finished with them, using hot water bottles rather than electric blankets, fitting energy efficient light bulbs, and working with the weather. When it is blowing a howling southerly, it is time to do the big clean, the heavy loads of washing, and vacuuming until the next windy day.

There are currently experiments continuing on growing rape seed oil for use in running diesel motors including tractors, and this has the added benefit of a good value stock food as a by product. These trials were started by Otago Polytechnic during the 1980 oil crisis and proved to be very satisfactory. Invermay Research station also ran their vehicles on Bio gas as a trial during this period.

We did have problems sourcing a windmill 15yrs ago and brought an American made unit but today would definitely buy New Zealand or Australian made if possible. Whatever system suits your needs, be aware that there is a big difference between engineering efficiency and economic efficiency which is well demonstrated in battery banks. Doubling the number of batteries in a stand alone setup will increase battery life but not by much. For a little more convenience of not having to back them up by running a generator quite as often you are doubling the replacement costs.

Some people will find it beneficial to be engaged in setting up the new system because of the greater understanding they will gain. Others will prefer to purchase 'Turn Key' solutions which is a no hassle way of changing over.

Until fairly recently there were no experts in Stand Alone systems, so we had to find tradesmen with an interest themselves, both in alternative power and that liked a challenge. In Dunedin we were lucky that the University has such a close relationship with the community and these tradesmen were out there. Today there are specialists is most big population centres. There is lots of advice out there, but be wary of suppliers selling to you and try hard to get independent advice.

ACKNOWLEDGEMENTS

Delta Utility Services - Dunedin

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Power Solutions - Dunedin

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Rainbow Power - Australia

Fisher & Paykel - Dunedin

Federated Farmers New Zealand

Otago Daily Times - Dunedin

Southern Rural Life News - Invercargill

Earth Garden Magazine - Australia

Alternative Technology Magazine - Australia

Owner Builder Magazine - Australia

Leighton Coutts - Farmer - Otago