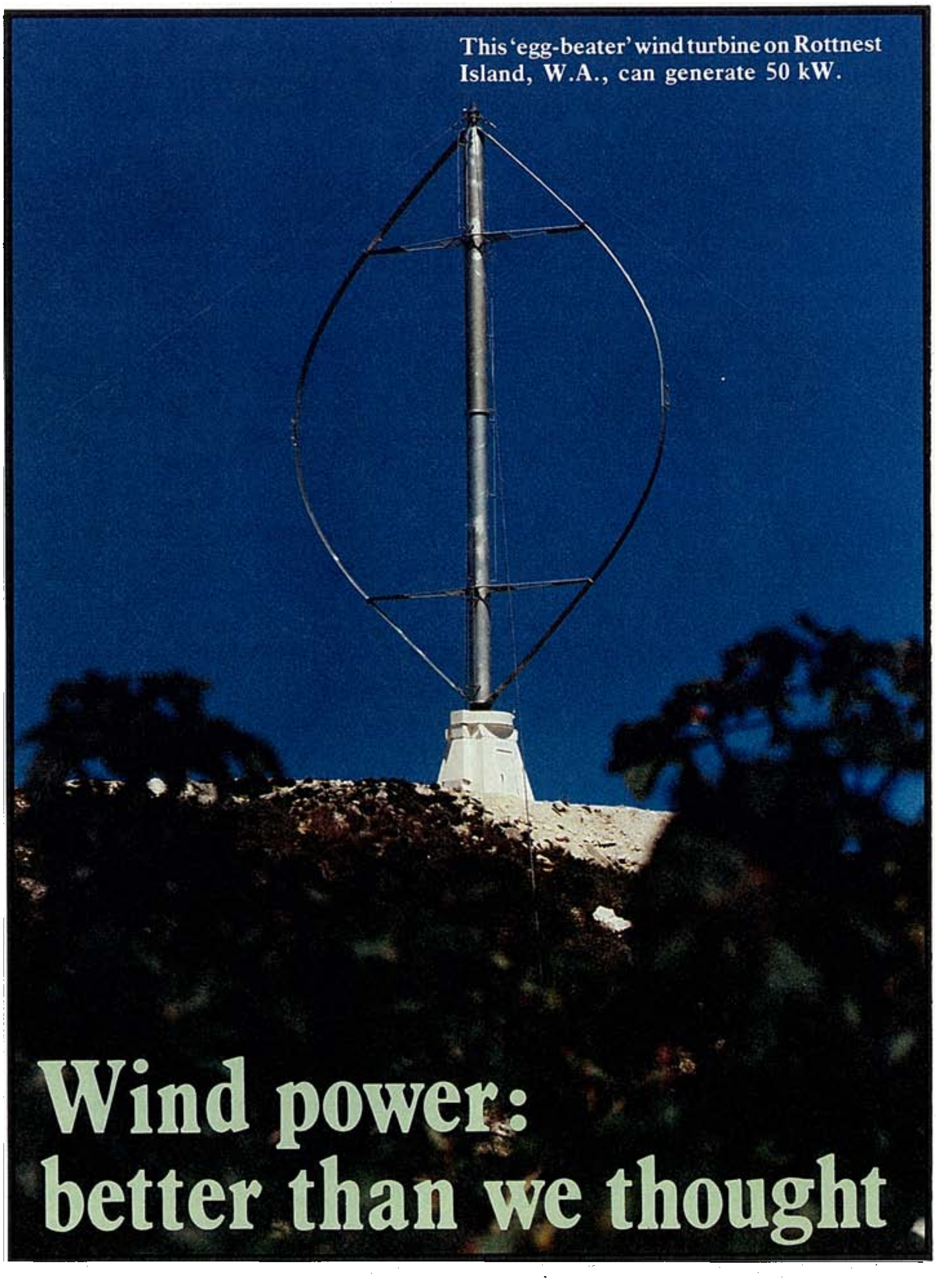


This 'egg-beater' wind turbine on Rottnest Island, W.A., can generate 50 kW.

Wind power: better than we thought

The concept of an array of wind generators feeding renewable pollution-free power into our electricity grids is attractive to those concerned with conservation. But even its most ardent proponents acknowledge an obvious drawback: a wind generator in periods without wind is pretty useless.

Wind is not a completely reliable or 'firm' source of power. For this reason it was thought that introducing some wind turbines into a grid saved fuel, but did not diminish the amount of conventional power-generating capacity that was needed. After all, what are we to do on calm days?

Only in conjunction with some system of energy storage was wind power thought to offer enough dependability to be of use to a grid. Without it, wind power seemed to be as useful as an unpunctual newsreader to a television station.

And yet, we now find this is not so. Dr Mark Diesendorf of the CSIRO Division of Mathematics and Statistics and Dr Brian Martin from the Department of Applied Mathematics, Faculty of Science, Australian National University, have devised a mathematical model of wind-fed electricity grids and backed it up by a computer simulation. One of the interesting discoveries they have made is the following surprising result. Provided wind generators contribute only a small fraction (less than 10%) of a grid's total electrical energy output, they can meet demands on the grid with as much reliability as conventional steam generating plant that has the same average power output.

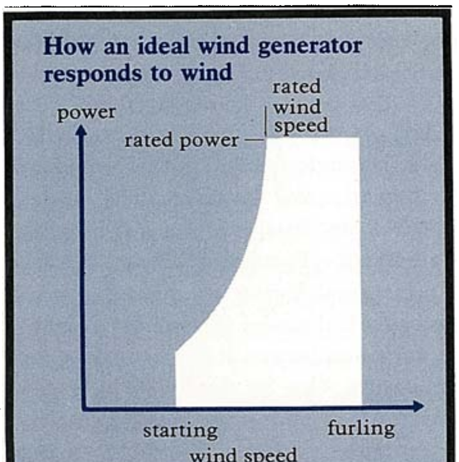
An explanation

Malfunctions and breakdowns mean that conventional plant also is not a totally reliable power source. It suffers a 'forced outage rate' of typically 5 to 15%. This means that this proportion of the plant's life is spent out of commission due to breakdowns.

As part of the system design, back-up generators are always ready to step in and take over from the ailing plant. Now this 'reserve capacity' would, of course, also be available to fill in for a becalmed wind generator. Furthermore, while mechanical breakdowns in thermal power stations require several days or even weeks to repair, lulls in the wind are usually much shorter than this.

Actually, the system is somewhat more complicated, since there is a whole set of related probabilities: of calms, breakdowns in one or several generators, unexpected electricity demands, and so on. Therefore, the methods of probability theory and statistics need to be applied to the problem. We shall look in more detail at what really happens, but this will not change the main conclusions.

However, for the moment let us examine the implications. The main one is that the study has removed a frequent objection to use of wind power. It makes wind look like a fairly reasonable power source for areas where suitable fossil fuels are in short supply and wind is abundant, such as Western Australia. As we pointed out in *Ecos* 19, the southern coastline of that State is ideal for locating wind generators. (Other areas near the 'roaring forties', like the coasts of South Australia and Tasmania, are also prime sites.)



Between start-up and reaching the rated wind speed, power output increases as the cube of the wind speed.

In Western Australia in 1978, imported oil made up about 20% of the fuel used to generate electricity. With oil now priced at about $160 a tonne, this means that electricity from it costs nearly 4 cents a kWh, comparable with current estimates of costs of large-scale wind power.

The State Energy Commission of Western Australia has erected a vertical-axis ('egg-beater') wind generator with a rated capacity of 50 kW on Rottnest Island, a holiday resort near Perth. During 1981, a second 22-kW machine, with blades on a horizontal axis, will supplement the first. The machines will save fuel (perhaps 10%) used in the diesel generators supplying the island's small grid. They could almost meet its overnight winter power demands.

Dr Diesendorf suggests that the possibilities for wind power in Western Australia are far from limited to Rottnest Island. The section of the coast from Albany to Cape Naturaliste is both windy and, in parts, close to the existing grid. Along its 350-km length could ultimately be placed 700 large wind generators, each rated at 2 MW and spaced half a kilometre apart. That would realize an average power of 280 MW, roughly half the State's current average requirement.

Of course, the wind power potential of the whole State could in principle be considerably larger. And in isolated towns and communities, especially those near the coast, wind generators could save fuel now used in diesel generator sets.

A few large wind generators are likely to be more economical than many small machines because the wind can provide about twice as much power at a hub height of 50 metres — characteristic of large units — as is available at the 10-metre height of small units (because there is less ground-induced drag hindering air movement at the higher level).

Wind power may also be suitable for special uses where only intermittent supplies of energy are required — for example, pumping of town water supplies or desalination of sea water.

In context

Extracting energy from the wind is, in effect, another way of harnessing solar energy. Surprisingly, perhaps, deriving power from the wind is, at suitably windy sites, a more efficient way of capturing solar energy than those using direct absorption of sunlight.

The power available in the wind increases with the area swept out by the blades (or the square of their diameter). A

Extracting energy from the wind is, in effect, another way of harnessing solar energy.

real wind generator, though, will not start work until the wind reaches a start-up speed — say 4 metres per second.

The power then increases as the cube of the wind speed until the generator's rated power is reached (determined by the robustness of the electrical equipment); this may be at some 10–15 m per second and, if maximum annual energy output is required, is usually designed to be close to twice the average wind speed. (The latter rule of thumb has been justified theoretically by Dr Diesendorf and Mr Glenn Fulford).

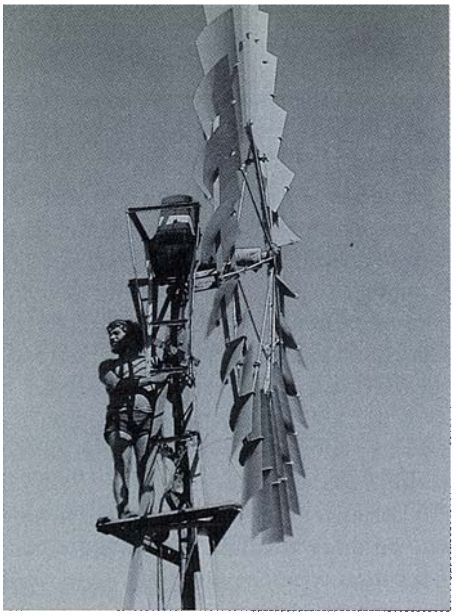
From that speed onwards, the power output is constant until a 'furling' speed is reached, at which the blades must be brought to a halt so as to prevent damage. Depending on the blade's mechanical strength, this may be at a wind speed of 20 to 40 m per second. (Remember that, at their tips, the blades of a wind generator rotate with a speed several times that of the wind.)

These separate phases of operation are shown in the graph.

The blades of a wind generator typically extract 25–40% of the power passing through their sweep. In reasonably windy regions the electrical power extracted from each square metre of swept-out area is many times that available from photovoltaic cells, solar-concentrating towers, and flat-plate thermal-electric devices (per unit of their collection area).

In line with this, the materials and energy investments needed for constructing a wind generator are relatively small. In the case of a 2-MW generator, the

In Denmark, windmills were used for grinding grain.



A traditional Australian windmill — for pumping water.

energy put into its construction is paid back (in terms of kilowatt-hours) in about a year's operation. Moreover, a set of large machines could be constructed in 1–2 years, compared with 6 years required to build a coal-fired station or 10 for a nuclear power station.

Wind generators have a relatively small effect on the environment. There are no pollutants from their operation, not even waste heat. Only the mining and production of the construction materials could lead to a degree of pollution. Visually, of course, a wind generator can be likened to a high-voltage transmission tower, and there would need to be constraints on erecting such obelisks in scenic areas.

The generators take up little area; sheep can be grazed and crops planted right up to their footings. Compare this with hydro-electric power, which calls for the flooding of river valleys, often the most productive land.

An ill wind?

There must be some drawbacks to wind power — and there are. Interference with television reception may occur within 200–1000 metres of a megawatt machine. Reflection of signals from the blades can give ghosting and jittering effects just like those produced when a light aircraft flies overhead. However, large wind generators are unlikely to be sited in built-up areas and the effect is much less when fibreglass, not metal, is used for the blades.

Unavoidably, wind generators create some noise when spinning, but normally this is barely audible above the sound of the wind itself at a distance of 0·5 km.

Concern is sometimes expressed that withdrawing energy from the winds may change local or even global climate, if done on a big enough scale. Our present knowledge of climatology is insufficient to calculate how much can be safely extracted.

What we do know is that wind generators could extract only a very small proportion of the wind's energy in the foreseeable future. If concern is warranted over this, high-rise buildings would seem to provide more cause for worry. Even if all the world's current electrical energy consumption were supplied by the wind, this would use up only half of 1% of the power in the earth's surface winds.

Progress around the world in harnessing wind power is reported on page 26.

Setting sail

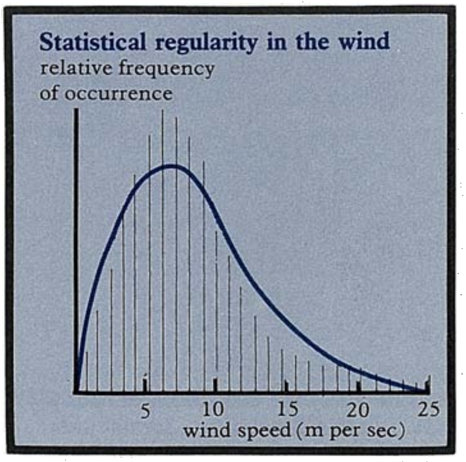
Utilization of wind power in Australia is at present minute and, with few exceptions, we haven't even troubled to 'prospect' for good windy sites.

Power available from the wind goes up in proportion to the cube of the wind speed.

Of some use are standard meteorological measurements of daily 'wind run' — the distance the wind appears to cover in a day — and the standard estimates at 9 a.m. and 3 p.m. of wind speed. However, for deciding on where to locate a wind generator, measurements are somewhat lacking. Power available from the wind goes up in proportion to the cube of the wind speed, so wind gusts can supply much more power than their contribution to the average wind speed would suggest. Furthermore, small increases in average wind speed, resulting from small changes in site location, can lead to large increases in average power.

For these and other reasons, a special 2-year survey of the wind-power potential of north-western Tasmania is being carried out by scientists from three CSIRO Divisions and the Department of Science and Technology. Those directly involved are Dr Jetse Kalma and Mr Haralds Alksnis, from the Division of Land Use Research, Dr Mark Diesendorf and Mr John Carlin, from the Division of Mathematics and Statistics, Mr Jim O'Toole from the Division of Atmospheric Physics, and Mr Kim Briggs from the Cape Grim Atmospheric Baseline Monitoring Station. The work is supported in part by a grant from the Tasmanian Energy Research Committee.

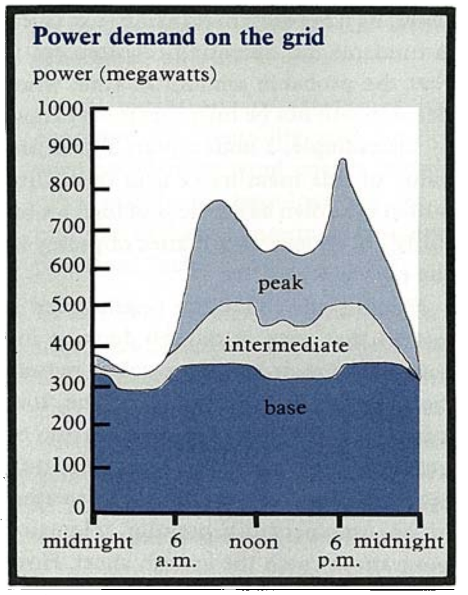
Although fitful, the wind shows a clear statistical regularity. Observations plotted here for Port Lincoln, S.A., lie close to a Rayleigh distribution (coloured curve).



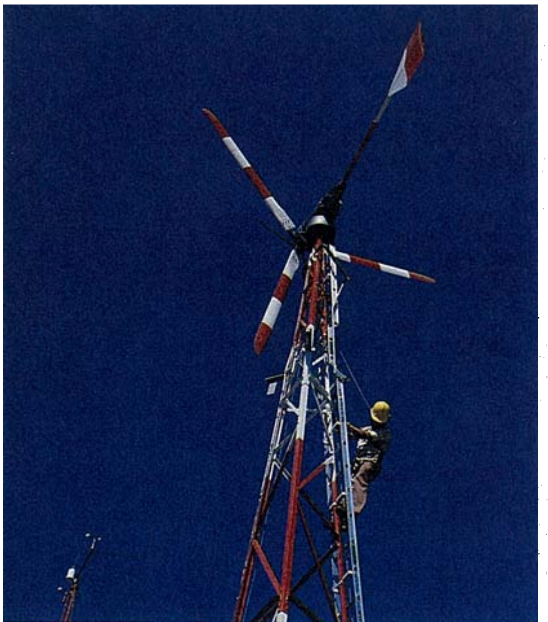
The region is known to be windy, but detailed measurements will allow the particular statistical regularities and fluctuations of the wind there to be determined and the magnitude of the wind energy resource to be more accurately assessed.

The investigators believe the north-west — between Cape Grim and Temma — to be a particularly suitable region of Tasmania. It has large areas of cleared pastoral land, on which wind generators could be easily accommodated. Although the south-west is probably as windy, it is prime wilderness, largely inaccessible.

Preliminary calculations by Dr Diesendorf suggest that to provide the same average power (170 MW) from wind as from new hydro-electric works proposed by the Tasmanian Hydro-Electric Commission for the Gordon River would



Power demand varies considerably throughout the day. Shown here is a typical winter's day curve for the 1978 Western Australian grid. A combination of base, intermediate, and peak-load plant meets the demand.



How suitable for outback farmhouses? This Elektro 5-kW unit installed at Fishermens Bend, a Melbourne suburb, by the CSIRO Division of Mechanical Engineering may provide the answer.

require 250 machines each rated at 2 MW. (Average power of a wind generator is usually 30–40% of its rated power.)

This brings us back to where we began — how is it possible for wind generators to displace convertional plant, even in the absence of storage?

Dr Diesendorf and Dr Martin chose the Western Australian and South Australian grids for their mathematical analysis. As we shall see, Western Australia looks like being the first State to make use in its grid of the power in its wind.

Running out of steam . . .

An electricity grid consists of a set of power stations linked together, and to users, by a network of transmission lines. A fundamental operating requirement is that the probable amount of time when demand will not be fully met is very small — for example, 1 hour a year. The actual value of this measure of grid reliability, which is known as the 'loss of load probability', is chosen as a matter of policy by the electricity utility.

Meeting the reliability requirement is not all that easy. Although demand follows a more-or-less repeatable pattern from day to day (as shown in the 'load curve' for the Western Australian grid on page 23) and season to season, it only requires an unforeseen change in weather or an unexpectedly popular television program to catch the system short. However, most of the random (unpredictable) demands can be met by fast-response reserve plant.

Unfortunately, unlike Tasmania, neither Western Australia nor South Australia has any hydro-electric storages of any significance. Such a source is very useful for storing power in a form that can be recovered almost instantaneously (in a few seconds). Instead, their grids must rely heavily on 'peak-load' generators with fairly fast start-up times (some minutes) and on plant that is kept 'free-wheeling' in case its power is needed quickly. In South Australia, generators fuelled by natural gas are used, while the Western Australian authority uses oil. As well as unexpected demand, the extra power may be needed to replace that lost by the breakdown ('outage') of some other conventional generator.

Basically, then, the grid is supported by a tier of generators. 'Base-load' generators meet the bottom part of the demand curve. These have a high capital cost but a low running cost. In Western Australia they are fuelled with local coal and require at least 6 hours to be started up from cold. Apart from scheduled maintenance, the State Energy Commission tries to operate them continuously.

'Intermediate-load' plant can be started and regulated more quickly. It is usually former base-load plant, older and smaller, and hence less efficient and more expensive to run.

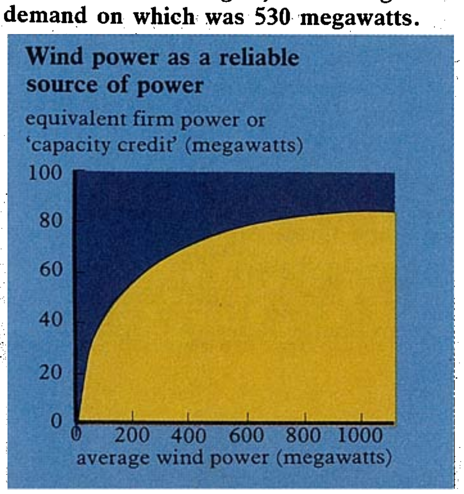
Filling in the top of the load curve is the 'peak-load' plant. Running costs are high because the units are generally less efficient and (in Western Australia) oil-fired.

The grid voltage is therefore supported by a large number of generators all characterized by their own rated power, fuel, start-up times, range of regulation, and so on. A complex operating strategy allows for scheduled and unscheduled outages and unforeseen demand.

. . . and out of puff

At first sight, adding an unreliable power source — wind power — may appear to complicate the operation of an electricity grid and pose entirely new operational problems.

The fraction of average wind power output equivalent to a completely reliable power source can be calculated. It is highest (approaching 100%) when the wind power contribution to the grid is small. Shown here are Dr Diesendorf's calculations for the 1978 Western Australian grid, the average demand on which was 530 megawatts.



However, wind speed data from around the world show that, although the wind varies considerably over the span of a day or a year, the hour-to-hour and year-to-year variations are relatively small. Indeed, the wind shows clear statistical regularities. Its speed generally follows a Rayleigh distribution (see the graph on page 23) with a well-defined average behaviour and variation from it.

It follows that outages, although they will be more frequent with wind power plant than with conventional plant, will have shorter average duration.

Beyond this point, if we wish to know more about how a real grid can cope with the vagaries of wind power, we need a mathematical model or simulation by computer. Dr Diesendorf and Dr Martin have devised both. The computer method simulates the Western Australian grid each half-hour and the South Australian grid each hour from the start to the end of 1978. It takes wind-speed and electricity-demand data and examines how a combination of existing power stations and hypothetical (but typical) wind generators would go about meeting demand.

Although the wind varies considerably over the span of a day or a year, the hour-to-hour and year-to-year variations are relatively small.

Hourly wind-speed data for Fremantle, W.A., in 1971 or Waitpinga, S.A., in 1955 have been used. For simplicity, it was assumed that in each State all wind generators experienced the same wind speed at any time. This assumption underestimates the wind's usefulness, with regard to both fuel saving and power reliability, for in reality some wind generators may still be operating when others are becalmed.

(The effect of the dispersal of wind generators is being studied by Mr John Haslett and Mr John Carlin, of the CSIRO Division of Mathematics and Statistics. They have found that, roughly, dispersal over a few hundred kilometres increases the reliability of wind power by about 25%.)

Power stations were taken to have a start-up time of 6 hours for base plant, 1 hour for intermediate plant, and zero for peak units.

One of the vital figures is the forced outage rate — the proportion of the time that malfunctions force generating plant out of service. Because much of the plant in the Western Australian grid is relatively new, only estimates are possible, but the State Energy Commission informed Dr Diesendorf that 8% would be a reasonable figure. The time that a unit is out of service was taken to vary (exponentially) around an average of 2 days.

Operating strategies

The computer program simulates the actions of the master grid operator in turning on or shutting down particular power stations in response to demand or because of breakdowns. This person's job is to minimize the operating costs while keeping the probability of 'loss of load' within bounds. In the presence of wind generators with fluctuating output, how would the operator make decisions? Basically, the computer program used the following operating strategy to optimize the fuel saving due to the wind.

Each half-hour, it made a forecast of wind power and power demand over the next half-hour as well as the next 24 hours. The wind power for the next half-hour was assumed to be the same as that in the last half-hour, and the demand in the next half-hour was taken to be the demand immediately before plus the change in demand experienced 24 hours earlier. The difference between the half-hour forecasts for demand and available power decided whether intermediate-load plant should be turned on or off. Similarly, the difference for the 24-hour forecast determined whether base-load plant should be started up or shut down.

And of course, peak-load stations were started up to cover any shortfalls in the actual supply, or to cover for plant breakdowns (outages were set to occur randomly). If there was too much discrepancy and the peak-load stations could not cope, a 'loss of load' was registered. A real operator could be expected to take a better account of wind and load variations than the computer program, by considering weather forecasts, known industrial patterns of electricity demand, and so on.

An impression of a 'wind farm'. The construction of three of these 'Mod 2' machines — each rated at 2·5 MW and with blades 91 m in diameter — has begun in Washington State, U.S.A.

The computer program was run many times with different amounts of available wind power, wind-generator characteristics, forced outage rate, and loss of load probability, and with slightly different operating strategies.

The research pair also developed mathematical equations to approximate the grid system's dynamic behaviour, which did not need the large amounts of computer time the simulation process requires. This 'numerical probabilistic model' enabled them to determine the reliable power (or 'capacity credit') of wind power and its sensitivity to changes in the characteristics of the grid or the wind generator. A wealth of data was produced, but only the main results are given here. The outcome depends of course on the particular operating strategy used for the grid, but in general the following can be said to hold true.

This calculation is based on the 1978 Western Australian grid and an operating strategy to save peak power.

How wind power in a grid can save fuel

rated wind power capacity (megawatts)	percentage of annual energy demand met by				wind energy lost (percentage of demand)
	base plant	intermediate plant	peak plant	wind	
0	61	18	21	0	0
500	55	14	14	17	3
1000	48	12	13	27	12
1500	44	11	12	33	26
2000	40	10	11	39	41

- ▶ The capacity credit of wind power depends very much on the proportion of wind-operated plant to conventional plant. When only a small percentage of the grid's average power comes from the wind, the capacity credit is roughly equal to the average wind power. But when the proportion is about 20%, wind plant has a capacity credit of about 40% of the average power supplied by the wind. More specifically, installing 100 MW of average wind power in the Western Australian grid is equal to installing completely reliable power plant with a rating of 40 MW, or base-load power plant rated at a minimum of 44 MW with a forced outage rate of 8%.
- ▶ Wastage of wind power also increases quickly above the 20% level. At that level, the proportion of wind power generated, but surplus to requirements, is about 20% of the wind generators' output.
- ▶ Small variations in strategies for operating the electricity grid can determine whether wind energy substitutes mainly for base-load fuel or a mixture of base-, intermediate-, and peak-load fuels.
- ▶ In the 1978 Western Australian electricity grid, the economic value of the capacity credit of wind power, taking into account the greater reliability resulting from dispersal of wind generators, is by no means negligible. It amounts to about one-quarter of wind power's value as a fuel-saver.

Taking these results and looking at typical prices for generating plant, both conventional and wind-powered, the two investigators made some basic economic calculations. For the Western Australian grid as it was in 1978, they found that a

30% increase in the price of oil and coal would make some wind power a profitable investment. However, since peak oil-burning plant is at the moment being converted to coal-burning intermediate-load plant, the fuel-saving worth of wind power is not quite so great, nor does its use look quite so imminent.

In isolated towns . . . wind power is already likely to be worth while for saving fuel.

Nevertheless, in isolated towns situated on the windy south coast of Western Australia — such as Esperance, Hopetoun, and Bremer Bay — and on islands such as King and Flinders in Bass Strait, where the cost of generating electricity is about 10 cents per kWh, wind power is already likely to be worth while for saving fuel used by diesel generating sets.

Storing wind

Up to now we have totally ignored the role of storage. But on a windy coastline it may be possible to use excess wind power to pump sea water to the top of a cliff, later to be released through hydro-electric generators to meet peak demand. Level-

Wind power around the world — a progress report

Wind power isn't new, as the Dutch will politely remind you, but novel ways of harnessing it are being invented. And, not wishing to rest on its laurels, Holland is building a 300-kW horizontal-axis wind generator.

New materials are being employed for generator blades: the list now includes carbon-fibre-reinforced plastic, fibreglass and plastic, and aluminium, as well as the older steel or wood. New configurations of blades have been invented (or older ones rediscovered — like the vertical-axis arrangement).

Various methods — mechanical, hydraulic, and electrical — have been developed for converting a variable-frequency input to a fixed-frequency output.

Megawatt-rated wind generators are now operating in Denmark and the United States and are under construction in Sweden, the United States, and West Germany. The world's largest operating wind generator is the 'Mod 1' machine at Boone, North Carolina, run by the United States Department of Energy and NASA. Its twin blades, 61 m in diameter, give a rated power of 2 MW in a wind of 11 m per sec. The construction of three 'Mod 2' machines — each rated at 2·5 MW, with a blade diameter of 91 m — has commenced in Washington State. And a 4-MW machine, the WTS 4, is planned for Wyoming.

In the San Gorgonio Pass — near Palm Springs, California — Southern California Edison is constructing a wind generator with three blades that will span 50·3 m and generate a rated 3 MW at a wind speed of 18 m per sec.

The United States Congress has just passed a bill to provide US$1000 million for wind power over the next 8 years. Part of this sum will be allocated to the development of small wind generators, while the main portion will be used to bring large (megawatt-rated) wind generators to mass production at a price that the government believes will be competitive with conventional power plant by 1988. The Americans envisage that at least 800 MW of wind power capacity will be installed in the United States by 1988.

In Denmark, the community-financed-and-built 'Tvindmill' (three blades, 54-m diameter) is going well. Its large thermal storage has not yet been built and so its power output is currently limited to 925 kW — the capacity of its inverter (425 kW) plus the heating coils (500 kW) of the hot-water space-heating system. Its full rated power is 2 MW.

The Danish government has built two three-blade machines rated at 600 kW each, which are now operating at Nibe. Sweden is erecting two machines of 3 MW apiece, while Holland is building the aforementioned 300-kW unit. Canada has a 200-kW vertical-axis machine operating. Several types of wind generators rated at less than 50 kW are being manufactured and are selling widely in rural Denmark.

This English wind turbine rotates about a vertical axis.

The United Kingdom has announced that it will initially build a machine rated at 1 MW or more; like Sweden, it is also investigating the possibilities of putting up arrays of wind generators off-shore. West Germany is designing a 100-m- and a 52-m-diameter machine.

Machines rated at 100–200 kW are now available commercially in North America, and are being purchased by electricity utilities, towns, and smaller communities.

Here in Australia, efforts have been much more modest. Apart from the Rottnest Island installation already noted, wind power is keeping a fairly low profile. Dunlite are now manufacturing in Australia a new 5-kW version of their well-known 2-kW unit and will soon be selling it world wide.

Dr Pratish Bandopadhayay of the CSIRO Division of Mechanical Engineering is collecting data on the operation of a 5-kW Elektro machine installed at Fishermens Bend, Vic., which is feeding a typical outback farmhouse system — batteries, inverter, and back-up generator (and simulated load). His aim is to determine the cheapest configuration of equipment.

Modest research projects are also progressing on various types of small vertical-axis wind turbines at Flinders University, Sydney University, the South Australian Institute of Technology, and Murdoch University, while scientists from the University of New South Wales are conducting a wind-energy survey of Lord Howe Island.

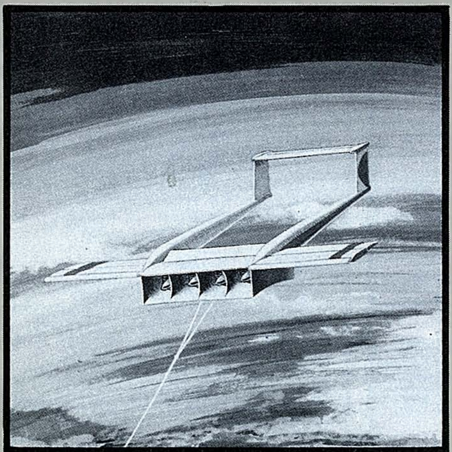
An Australasian Wind Energy Association (P.O. Box 1965, Canberra City, A.C.T. 2601) has recently been formed so that those with interest in wind power can keep in touch with one another.

Wind power from the jet streams?

Since the power obtainable from the wind goes up as the cube of the wind speed, the power residing in the jet streams (where speeds up to 100 m per sec. are found) is considerable. A recent study by Dr Clive Fletcher of the Department of Mechanical Engineering at Sydney University indicates that perhaps more than half of Australian jet streams carry 10 kW per sq m, and over certain sites more than 18 kW per sq m.

Dr Fletcher's aim is to see whether that power source can be tapped. The idea is not new, but it remains intriguing and every now and then it surfaces afresh. But is it feasible?

The jet streams are bands of high-speed westerlies blowing at altitudes of about 10 km. A typical speed is 50 m per sec. They are the atmosphere's way of taking solar energy from the tropics to the poles, the earth's spin giving them a westerly bent.



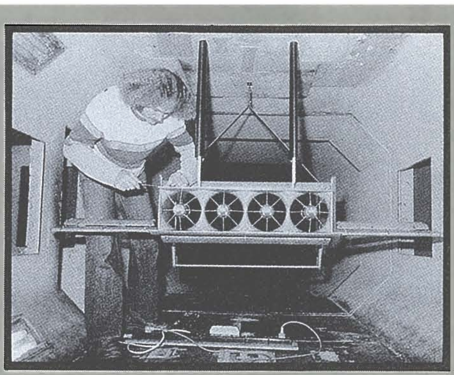
How wind generators on a tethered glider in the jet stream might look.

The basis of Dr Fletcher's feasibility study is a plan that calls for aerodynamic platforms carrying a number of wind generators to be launched into the jet stream, where they would be tethered, just like a kite. The Energy Authority of New South Wales is supporting the cost of elaborating and costing the idea. Because the tethers would need to be about 18 km long, they would have to be extremely strong, yet light. Kevlar, a material used in parachutes, is a possibility.

The tethers would also carry aluminium conductors to bring the generated electricity to the ground.

The jet streams are quite persistent, with their speed falling below the stalling speed of the platform (20 m per sec.) only occasionally. Dr Fletcher finds this would happen perhaps half a day per month in winter and 4 or 5 days per month in summer. When this occurred, electricity could be used to drive the turbines and maintain lift.

If the jet-stream energy flowing at an altitude of 9–13 km were captured over a 1000-km front and converted to electricity at 50% efficiency, as much electricity would be produced in a year as could be got from burning all Australia's known coal reserves.



Wind-tunnel tests of a model glider at Sydney University.

In conjunction with his research assistant Mr John Sapuppo, Dr Fletcher has designed a platform with four generators rated at 25 MW. A model of it is undergoing wind-tunnel tests to determine the optimum configuration.

Dr Fletcher calculates that placing ten such platforms aloft may cost around $300 per kilowatt, comparable to the capital cost of coal-fired power stations. However, operating costs would be higher, principally because of the shorter expected lifetime of the platforms.

The scheme is very speculative at the moment, and there are unanswered questions. However, we are reminded once again that we do not lack energy in our world, only ways to harness it.

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ling the output of wind generators in such a manner greatly increases the capacity credit of wind, making it a reasonably firm source of power.

A few large wind generators are likely to be more economical than many small machines.

Dr Diesendorf estimates that the addition of storage capacity equivalent to 1 day's output of the generators could raise the availability of average wind power from 30% to 70%. A Danish investigator, Professor Bent Soerensen, has found that 10 hours' storage can make a wind energy system as dependable as a nuclear power plant.

But to keep things in perspective, we cannot overlook the fact that storage could also serve to substitute intermediate and base-load power for peak power. Wind and coal can thereby become competitors for the same storage, and in this case the computer simulations become complex. It is a problem Dr Diesendorf and Dr Martin are working on at the moment.

Meanwhile, Dr Diesendorf believes it may already be profitable to install medium-sized wind generators (rated at about 200 kW each) at Esperance and King Island. Furthermore, he suggests that, in the near future, valuable experience would be gained by installing a large wind generator (of 1 MW or so rating) into the Western Australian grid, to prepare for the day when large wind generators are mass-produced and are installed as a matter of plain good business sense.

The calculations Dr Diesendorf and Dr Martin have made convince them that that day is closer than we used to think.

Andrew Bell

More about the topic

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