FRIENDS OF THE EARTH'S chain reaction

•WIND POWER FOR AUSTRALIA

•Antarctica
•Desert Creep
•China–Environmentalist's Dream?
•Build a wind generator

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EDITORIAL

The Federal Liberal Government is well and truly back in power for the next three years. It is instructive (and very depressing) to look back over the Government's record of the last two years on the environment. In virtually every area apart from Fraser Island we find that the original promises made to the electorate in 1975 fail to match up with the actual performance of the 'catch-all' ministry of "Environment, Housing and Community Development". A detailed survey of this record by FOE, Canberra is reported on page 6.

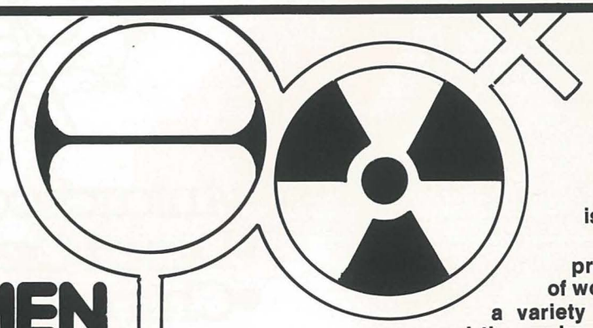
What then does the future hold? About the only definite promise on the environment made by Mr Fraser has been that an inquiry will be held into whaling. This promise, if carried out, should allow both a major public forum in which to press the case for a final end to whaling and *the adoption of a more careful treatment of the oceans generally.* More broadly, however, an inquiry into whaling would mark some sort of return to the process started under Labor in 1974 of allowing public input on matters of environmental concern. Not only should we be presenting our case on whaling at such an inquiry but also pressing for the right of everyone to have a say in determining priorities in a resource-scarce world.

There are many issues arising in the next three years which Friends of the Earth have not been greatly involved in so far, but which increasingly will force themselves to the forefront of the environmental battlefield. For instance, the conference on Antarctica likely to be held in Australia early in 1978 will be vital to the future of that continent. Clearly any benefit to be derived from this frozen wilderness should be shared equally between all countries and not gained by a few countries who have bogus 'historical claims' on the continent. (Australia currently 'claims' rights to nearly 50% of Antarctica'. The greatest benefit we can gain would be scientific information and an understanding of the delicate balance of life on our planet.

The continuing struggle to prevent the government and the multinational owners of the uranium in Australia proceeding with its export as quickly as possible, with minimum precautions, will naturally take a great deal of FOE's effort. The fact that the motion by the ACTU calling for a referendum has been universally ignored can only mean that the involvement of unions will increase over the next few months, the possibility of union bans on the export of uranium, particularly by rail and shipping unions, is now very real. It is therefore imperative that efforts to spread information through the unions, particularly at the grass-roots level, be redoubled.

Overall the basic issues will remain those of energy; how we use it and where we get it from. Recently Friends of the Earth have had two Penguin paperbacks released on energy. The first being the long-awaited FOE Australia book, *Ground for Concern,* detailing the case against the mining and export of Australia's uranium) reviewed on page 41). The second is the latest work by Amory Lovins, FOE Britain's brilliant energy analyst, *Soft Energy Paths.* The important task is to ensure that the circulation of these books and the many others produced by FOE is as wide as possible, particularly amongst schools and other educational institutions.

The current edition of *Chain Reaction* is devoted to a detailed study of a very neglected alternative-energy source, the wind. In a stimulating discussion paper (page 24). John Andrews spells out a possible scenario in which wind-generated electricity, used in conjunction with hydroelectricity, supplies virtually all of Australia's electricity requirements by the year 2000. The key conclusion is that it is impractical to develop wind power as a totally decentralised technology if the existing concentration of people and production in our cities is maintained — even if we reduced our electricity use to half its present level.



WOMEN and the environment

The next issue of Chain Reaction (Vol. 3 No. 4) will be produced by a collective of women and will look at a variety of issues concerning women and the environment.

Contributions, ideas and assistance are invited from any interested women.

Contact Linnell, Barbara or Karina, 51 Nicholson Street, Carlton. Phone (03) 347 6788.

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Chain Reaction is the quarterly magazine of Friends of the Earth Australia, publishing feature articles and news on national and international environmental issues.

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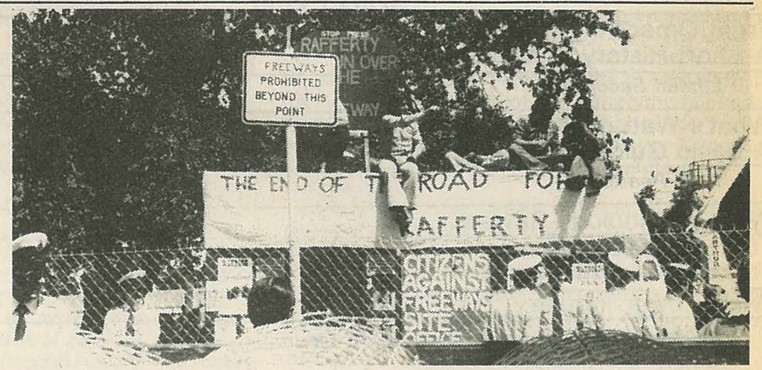
This issue was produced by: John Andrews, Michael Russo, Alan Parker, Mark, David and Rosie Carter, Karina Veal, Andrew Herington, Barbara Hutton, Richard Graves, John Hallam, Stan Rosenthal, Brian Appleford, Ted Andrew, Ian Pausacker, Linnel Secombe, Alan Pears, Mick Waters, Rod Andrews and others. Thanks also to John M. Fraser and Rupert Hamer for giving us something to write about.

EARTH NEWS

THE NO GO ROAD SHOW



The direct action taken by residents of the inner suburbs of Melbourne over the last few months to oppose the F19 Eastern Freeway have once again thrown into the public spotlight the arguments over freeways and public transport.

The bitter arguments over the F19 have stretched out over the last eight years since Melbourne's notorious and now defunct 1969 Transport "Plan".

The Government has consistently refused to face up to the issue despite the widespread opposition of resident groups and inner-city councils.

Most overseas cities have already abandoned planned freeway systems and in Australia only a few freeway projects are continuing, except in Victoria where three freeways are under construction and a further 13 are planned.

This state of affairs is partly due to federal cutbacks (motivated by the desire by National Country Party minister for Transport, Peter Nixon, to divert money to country roads) and commendable actions such as the NSW ALP State Government's cancellation of virtually the whole Sydney radial freeway network ($491 million worth). In Victoria the only cancellations made by the bumbling Transport Minister, Joe Rafferty, have been 'ad hoc' decisions axing politically unpopular sections of freeway — such as the recent halving of the proposed F2 Hume Freeway.

The frustrations of residents opposed to the Government-planned opening of the F19 finally boiled over after the Government refused to discuss the issue for nearly twelve months. The Fitzroy and Collingwood councils who strongly support the anti-freeway cause brought the issue to a head by narrowing the intended approach road to the freeway to one lane each way.

The Government reacted furiously by taking the road out of the council's control and calling in 400 police to protect workers erecting traffic lights. The ensuring guerrilla war raged for six weeks with residents taking a heavy toll on the government and the police making 58 arrests and causing several very serious injuries to demonstrators.

After workers and police were forced to a standstill in mid-November the Government finally agreed to discuss the basic issues. However, the report that the councils and residents prepared — calling for restricted use of the freeway, no use of the contentious Alexandra Parade and a vastly improved public transport service using fully separated lanes of the freeway — was never read by the government.

Even before the talks finished 500 police descended on the barricade erected to protect Alexandra Parade and started a new round of arrests and violence. It is clear the Government had no intention of listening to the residents.

By mid December the Hamer government had succeeded in using the police to ram the freeway through and open the first section of the F19. Residents meanwhile have decided to adopt new tactics of rolling disruption to ensure the freeway never works smoothly and to prevent any further freeway construction work starting.

The Government's answer to Melbourne's transport crisis has been higher fares, cutbacks in public transport services, and increased reliance on private cars and the development of a freeway network.

Despite the Hamer government's claims that it is only pushing ahead with the F19 because it is completed, the facts tell a different story.

There have been significant cutbacks forced upon the government because of the growing strength of the anti-freeway movement throughout Melbourne, notably the F2 freeway.

However, freeways remain a central aspect of this government's transport policy. The recent statements by the Minister for Transport, Mr Rafferty, on the Malvern Freeway, and the recent Country Roads Board statements on Alexandra Pde and a connection of the F19 and the Tullamarine Freeway reflect this policy.

This Government has not yet learnt the lessons of the F19 freeway: That you cannot expect a community to consent silently to a freeway (or any other project) which vitally affects their living standards, their health and environment, and about which they were never consulted. The Hamer Government has shown gross contempt for the rights of the Fitzroy-Collingwood community throughout the whole F19 affair.

CIVIL LIBERTIES AND U

Friends of the Earth held a seminar on uranium and civil liberties in November in Melbourne. Jim Roulston of the AMWSU placed the Atomic Energy Act within the context of other measures introduced or proposed: the Industrial Relations Bureau, the Commonwealth Employees Bill, the Hamer Government's Vital Projects Act, the collection of dossiers on anti-uranium activists and the Queensland Government's restrictions on free speech.

The Atomic Energy Act gives the responsible minister power to intervene in the free operations of the Act's ability to sweep aside Aboriginal rights. After he had drawn attention to the commitment and activism of Australian trade unions — unique among the world's labor movements — other speakers emphasised the need for wide community support for the unions.

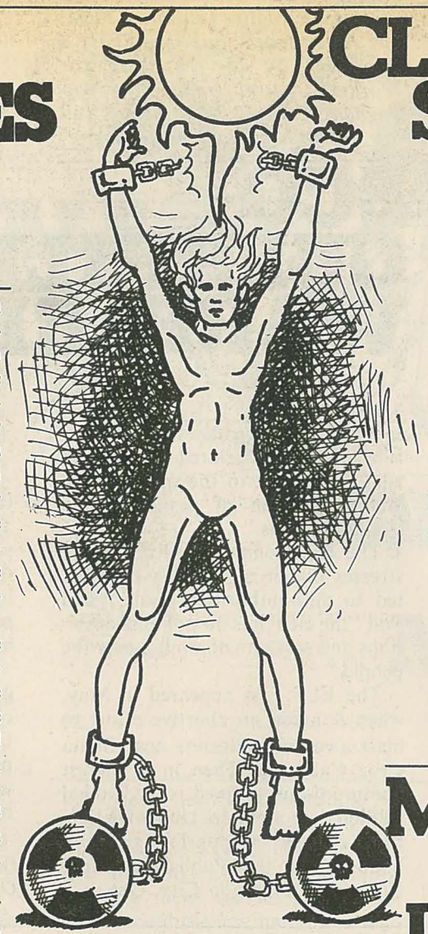
John Basten of the University of NSW Law Faculty, described this Act as "ferocious". It placed severe restrictions on the flow of information; it reversed the normal procedure of common law by placing the burden of proof on the accused; conviction could be made on the known character of the accused; there was no resort by law to compensation; many trivial matters were covered by heavy penalties.

Joe Camilleri said that nuclear proponents throughout the world are seeking the centralisation of power, and they will risk the most extreme measures to secure control of such a position.

Jim Roulston answered the one wavering questioner with: *"We will not win by keeping the struggle away from the community"*, and Joe Camilleri maintained that an appropriate campaign of militant non-violence would prevent the government intervening with the violent powers they presently have. He warned that success elsewhere has only followed months of preparation. Jim Roulston said that we must first study the role of government, in particular the manner in which a mere four or five bureaucrats have been able to accumulate huge power.

The Fraser government has engaged in a repressive denial of civil liberties. It has done this by rejecting the Ranger Inquiry's recommendation for a full public debate and by its refusal to open its doors to community involvement in decision-making processes. The Atomic Energy Act and concomitant legislation are the means by which the government can police this repression. Confronted with a securely-based resistance, it will find all its violent powers about as useful as Vance Dickie's elephants.

Richard Graves.



CLAMSHELL SUPPORTS US

The Clamshell Alliance, organisers of the non-violent occupation of the Seabrook reactor site in the USA, have applauded the activities of the Australian anti-nuclear movement.

A resolution of the Clamshell Congress, 7 November 1977, held in Putney, Vermont, read as follows:

"The Clamshell Alliance applauds the selfless decision of so many Australian Labor unions, joining with environmentalists, to oppose the mining of Australian uranium. We acknowledge your historic contribution toward the use of safe energy sources on an international level. You keep Australian uranium in the ground, and we will stop the nuclear plants here."

MAJORITY AGAINST URANIUM

It's hard to find any comfort in the recent federal election results, but we believe one feature gives some ground for optimism.

While of course uranium was not the only election issue, it is interesting that the combined first preference vote for the parties with strong anti-uranium policies (the ALP and Australian Democrats) was 49.5%, 0.2% *greater* than that for the pro-uranium parties (LP, NCP and DLP).

No doubt the Fraser Government will now claim a strong renewed mandate for uranium mining, but it's a curious political system that allows the executive once elected to proceed with a particular policy which is probably opposed by the majority of Australians.

LATEST FROM LUCAS

Several of the products outlined in the alternative corporate plan put to management by Lucas Aerospace workers in the UK are now under development. The plan is part of Lucas workers' fight for the right to work on socially-useful projects instead of defence contracts (see previous three *CRs*).

A vehicle capable of running on a road or railway is soon to be tested on British Rail's high-speed (190 kph) track. Working with the North East London Polytechnic, Lucas workers helped develop this prototype road-rail vehicle which already has successfully been tested at lower speeds on a disused railway line. The vehicle could be very suitable for rural areas and the third world.

A second product proposed in the original alternative corporate plan is currently being developed in conjunction with Queen Mary College, London.

Undercurrents 25, Nov. 1977.

Note: The introductory section of the "Lucas Alternative Corporate Plan" has now been published as a pamphlet by the Institute for Workers Control, Gamble St, Nottingham, Price £0.30 in the UK (allow generous amount for postage).

ECO-GUERRILLA WARFARE

A new American West-coast guerrilla group has declared "war on all who . . . persist in the manufacture and application of pesticides and similar poisons."

The Environmental Life Force stresses that it is "strongly committed to anti-authoritian goals," and that "the ELF has no political ambitions and seeks no dominion over the people."

The ELF first appeared in May, when it made an abortive effort to blast away crop dusters near Santa Cruz, California. Then, in an August communique (signed the Rachel Carson Ecommando Unit of ELF), they claimed responsibility for a bombing at the Publishers Paper Company in Oregon City, Ore.

The bombing was in response to the company's aerial spraying of Tordon, a chemical defoliant, onto people protesting the use of a dangerous herbicide on land owned by the firm. Twelve demonstrators, part of a group occupying the land, have become sick since the spraying.

In the communique, the eco-guerrilla ELF demanded that the company hire five physicians (acceptable to those sprayed) to treat the protesters and that these doctors "be willing to testify in court with regards to their findings."

The ELF writes that it will continue its armed actions.

Open Road, fall 1977.

WATER

Can you imagine life without water? People can only live 48 hours without a drink and it is vital to many of the things we do. However, a recent study carried out in Melbourne's suburbs shows that the average *domestic* use of water is running at 153 litres per head per day (that's a 44-gallon drum full, or enough to quite comfortably drown in).

The breakdown for domestic use is as follows.

	Litres per head per day	%
Toilet flushing	37	24
Shower	34	22
Clothes washing	33	22
Bath	20	13
Dish washing	17	11
Drinking etc	8	5
Car washing	4	3
TOTAL	153	100

Components of Domestic Water Consumption

As the city grows, so does the demand for water. But it's not in proportion to population. Our industrialised, high-standard-of-living society uses far more water per capita than early cities did. In 1891, the figure for Melbourne was 230 litres per person per year (this is an all-inclusive figure) and in 1975, it was 390 litres per head per year. Domestic consumption is 40% of total consumption.

by Rod Andrews.

(This information came from a report of the Australian Water Resources Council entitled "Efficiency in Industrial, Municipal and Domestic Water Use", by D. P. Heeps. The areas studied were Kew, Studfield, Heathmont and Caulfield in Melbourne. Additional information was obtained from the Melbourne Metropolitan Board of Works).

DUST SETTLES AT WINDSCALE

The Windscale Inquiry on oxide fuel reprocessing in the UK is now over and Justice Parker has retired to consider his report — no mean task considering the vast pile of evidence that has collected up in the Civic Centre at Whitehaven. But the dust won't be allowed to settle for long: BBC TV, who were denied access for film during the hearings are using the transcripts to re-enact some of the more celebrated exchanges that occurred, using actors.

No doubt amongst these will be the session when Walt Patterson from Friends of the Earth (UK) was interrogated about his political affiliations and asked "what cards he carried". He replied at length, by going through his wallet, itemizing his Library Card, Bank Card, jazz club card and so on.

The Socialist Environment and Resources Association (SERA) was subject to similar treatment when it presented its evidence in October.

SERA pointed out that the £600m investment would create only 1000 jobs, and that only about 500 of these would involve local people on a permanent basis. Dave Elliott drew attention to a number of studies which suggested that a larger number of jobs could be created in a wider range of skills and locations if alternative energy-generating and conserving technologies were developed, while Judy Bartlett outlined some specific alternatives suited to the Cumbria area.

SERA also pointed out that, while they were unable to support further nuclear developments, they fully supported and accepted the right of workers in the existing nuclear plants to organise industrially and engage in conventional trade-union activity in order to protect and improve their terms and conditions of employment.

However, SERA argued, it appeared that the nature of the industry — in particular the national security aspects — could put severe restrictions on the workers' ability to organise effectively.

The British Trades Union Congress, in its own submission to the Inquiry, had pointed out that "restriction on trade union rights of disclosure of information and the accompanying security and secrecy arrangements already exist for those trade unionists in United Kingdom Atomic Energy Authority and British Nuclear Fuels Ltd sites".

from David Elliot in the UK.

(G)RUMBLES FROM MALVILLE

A sharp debate is beginning to emerge in Europe over the appropriate tactics to adopt at the massive demonstrations now being regularly held at nuclear-reactor sites throughout Europe.

The mass media have repeatedly charged that the violence erupting at such demonstrations as Whyl, Brockdorf and Malville has been caused by "anarchists and communists" with insinuations that in the case of West Germany it is all somehow tied in with the Baader-Meinhoff group.

This has led to sharp disagreements on the appropriate tactics to adopt for site occupations. These disagreements seem to have put a wedge between different groups of protesters. More seriously, critics of the established leaders of the anti-nuclear movement claim that the much-vaunted decentralisation and democracy is a grass-roots phenomenon that does not run very deep. When tens of thousands of people are attracted to the big protests, the critics claim, democracy within the movement breaks down entirely.

Peace News, a British Pacifist/Anarchist Journal, had the following report on the demonstration at Creys Malville.

"At Malville, France, where 60,000 people gathered on July 31 for one of the largest non-violent demonstrations in the history of Europe, the heavily-armed riot police began lobbing tear gas and explosive fragmentary grenades into crowds of peaceably milling people at a distance of 600 yards, wounding scores of people and killing one demonstrator.

"When the police started to attack, the organizers' primitive communications system broke down nearly immediately. Militants tried to defend themselves with sticks and stones, but the great mass of people were simply immobilized on a hillside overlooking the scene as if it were a war movie.

"A French anarchist who was on the scene blames the fiasco almost entirely on the organisers: "They said it was to be non-violent occupation but they didn't say how we were supposed to do it."

"Biggest pest since Rabbit!"

In many of the election campaigns of the early 1970's the problems of the environment have been a very definite political issue. It is an interesting reflection that in the election just finished environmental issues have been largely ignored. Even uranium has failed to establish itself as a major issue in terms of the amount of time politicians have devoted to it. Of the parties the Australian Democrats have said the most about the environment and made the most innovative and definite proposals. The ALP have broadly promised to make good the ground lost since the Department of the Environment was scrapped in 1975. The Liberals have made bland general statements.

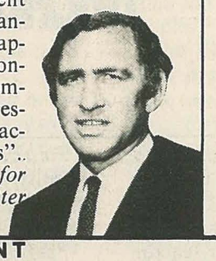
In this context it is worthwhile to look back at the promises made by Mr Fraser's government in 1975 and how these promises have been forgotten. Someone has said that the last two years has seen the worst attack on the Australian environment since the introduction of the rabbit. Certainly there have been no great advances apart from the preservation of Fraser Island.

The information set out below was prepared in a detailed study by FOE Canberra.

Fraser Government's Performance

(1) GRANTS TO CONSERVATION ORGANISATIONS

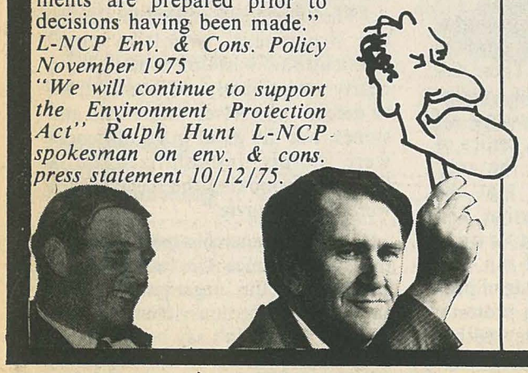
PROMISE
"A Liberal and National Country Party Government would seek to increase substantially financial support to approved non-government conservation organisations to compensate for inflationary pressures and to cover increased activity by these organisations"..
Andrew Peacock, Minister for Environment 26/11/75 (letter to Dr G. Mosley ACF)



PERFORMANCE
* The appropriation for grants to conservation organisations in the 1977-78 Budget is $300 000 compared with $450 000 in Labor's 1975-76 Budget. This represents a real decrease of 50.3%.
* The Technical Assistance Scheme, which provided grants to enable local conservation groups obtain expert advice to back up their cases, was scrapped soon after the 1975 election.
* The "dollar for dollar" provisions have meant voluntary conservation groups have to spend half their time just fund raising.
* FOE's annual grant of $10 000 has been *cancelled* by the Fraser government. FOE was the only group to lose its funds entirely.

(2) ENVIRONMENT PROTECTION (IMPACT OF PROPOSALS) ACT

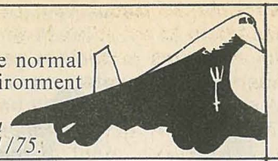
PROMISES
". . . We will:- Ensure, in development projects which are likely to have a significant and or damaging effect on the environment and involving the Commonwealth, that Environmental Impact Statements are prepared prior to decisions having been made."
L-NCP Env. & Cons. Policy November 1975
"We will continue to support the Environment Protection Act" Ralph Hunt L-NCP spokesman on env. & cons. press statement 10/12/75.



PERFORMANCE
* Under the coalition government the Environmental Protection Act has become a lame duck and toothless piece of legislation. Not one public environmental inquiry has been commissioned under the coalition government (Ranger and Fraser Is. were set up by Labor).
* The 1977-78 Budget saw a massive 87.3% reduction over the 1976-77 Budget in the appropriation for Environmental Impact Statements — costs associated with public hearings (see table below).
* When the government has required the production of Environmental Impact Statements by proponents the draft EIS's have been largely inaccessible to interested members of the public.
* The Federal Government has entered into an agreement with the Western Australian Government entitled "Agreement on Guidelines for Co-operation in Environmental Analysis of Proposals". Agreements have since been or are being negotiated with other states. Clearly the Federal Government intends to abrogate its environmental responsibilities in relation to export and financing powers by allowing assessment of proposals to be carried out under inferior state procedures such as WA 's ERMP procedure. In this situation state rivalries will override environmental concerns as developers play the states off against each other.

Specific Examples of Application of EPA:

*** Concorde**



PROMISE
"We would follow the normal procedures of the Environment Protection Act"
Andrew Peacock, in a Letter to ACF, 26/11/75.

PERFORMANCE
* The coalition Government announced a decision to allow Concorde Flights into Australia before the proponent had produced a final EIS. This was clearly a breach of the EPA.

*** Woodchips**

PROMISE
"In the exploitation of forests for timber and woodchips for export purposes, the Liberal and National Country Parties will seek to ensure that public inquiries are conducted before export licences are granted."
L-NCP Env.' & Cons. Policy Nov. 1975.

PERFORMANCE
* Renewed permits for export of woodchips by Harris-Daishowa at Eden, NSW, were issued in July this year without the holding of a public inquiry into the proposal. In fact while the company had over a year to prepare the draft EIS, a completely inadequate period of four weeks was provided for the public to comment on the draft.

(3) NATIONAL PARKS

PROMISE
"We will support the Australian National Parks & Wildlife Service"
L-NCP Env. & Cons. Policy — November, 1975.

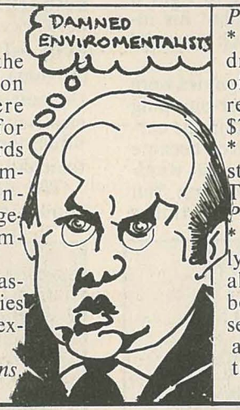
PERFORMANCE
* In a major statement on 12 August 1976, EH & CD Minister, Kevin Newman, announced that "the Commonwealth Government has *re-defined* the role of the Australian National Parks and Wildlife Service". The Fraser Government's redefinition means ANP & WS is a totally emasculated hypothetical national park owner/manager without one single park.

PROMISE
"We will proclaim further appropriate areas as National Parks . . . in the Territories". L-NCP Env. & Cons. Policy, November, 1975.

PERFORMANCE
* Not one national park has been proclaimed in the Territories since the coalition has been in office. Kakadu (NT) and Gudgenby (ACT) National Parks are still in limbo.

(4) POLLUTION

PROMISE
"We will
— Assist in expediting the definition of pollution standards and where necessary criteria for measurement standards and, in areas of Commonwealth responsibility, make arrangements for their implementation.
Co-operate with and assist transport authorities in efforts to control exhaust emissions."
L-NCP Env. & Cons. Policy, Nov. 1975.



PERFORMANCE
* The National Air Quality Monitoring Program has been drastically curtailed since the Coalition Government came into office. The 1977-78 Budget appropriation is a 79.7% decrease in real terms over Labor's 1975-76 appropriation. ($275 000 versus $75 000).
* Using the catchcry of "energy savings" as an excuse, the next stage of emission control regulations have been put off 12 months. Transport minister Nixon argued for a two year delay.
PERFORMANCE.
* The National Sewerage Program has been abolished completely by the Fraser Government. In 1975/76 the Labor Budget allocated $114.9 million for the NSP. The 76/77 Fraser budget began the wind-down with an allocation of $50 million. Raw sewerage continues to be discharged into river systems and the sea all over Australia (e.g. 96% of Townsville's sewerage is untreated).

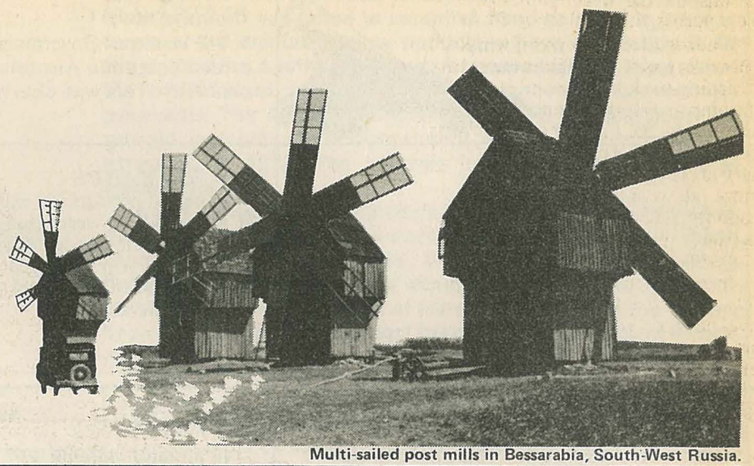
(5) DEPARTMENT OF ENVIRONMENT, HOUSING AND COMMUNITY DEVELOPMENT.

PROMISE
"Matters relating to the protection of the environment, the conservation of the national estate and national resources . . . should be the responsibility of an *upgraded* department".
— R. J. Hunt.
Press release, 10 Dec. 1975.

PERFORMANCE
* Labor's allocation to the equivalent of the Department of EH & CD's administrative expenses in 75/76 was $8.8 million. Under the coalition's 77/78 Budget this was slashed to $2.3 million.
In 1977/78, while the overall public service staff ceilings were cut by 1%, the Department of EH & CD was cut by 6% (from 766 to 710). Staff threatened industrial action over working conditions.
* The annual appropriations for EH & CD have been severely cut: 1975/76 — $77.3m; 1977/78 — $41.5m

From Omar's Slave To Grandpa's Knob

A SHORT HISTORY OF WINDMILLS



Multi-sailed post mills in Bessarabia, South-West Russia.

Long ago, a Persian slave in Medina complained to the Caliph Omar because he was being taxed two pieces of silver a day. But it was considered he was well able to pay the tax as he was a "carpenter and expert in construction of windmills".

It is hard to establish when windmills were first used, though it seems probable that in China and Persia they were in use about 2000 BC. They were certainly a well-established craft in Persia by the 7th Century AD when Omar's slave made his complaint.

There is dispute over the introduction of windmills to Europe. Some sources suggest they were introduced by returning crusaders in the early 10th century AD, others that they were invented independently in the north. The windmills that appeared in Europe undoubtedly had a radically different design to that of Persian mills: European windmills had sails spinning about a horizontal shaft, whereas Persian mills had blades fixed to a vertical shaft.

Windmills arrived in England around the end of the 10th century AD. Their low construction costs allowed them to be sited not for maximum average wind speed, but conveniently close to the corn to be ground or water to be pumped.

Windmills were introduced into North America when the country was first settled by Europeans and were mainly used to pump water for livestock. The multi-bladed fan-type mill was the most widely used, although early settlers did build large European style mills on the east coast.

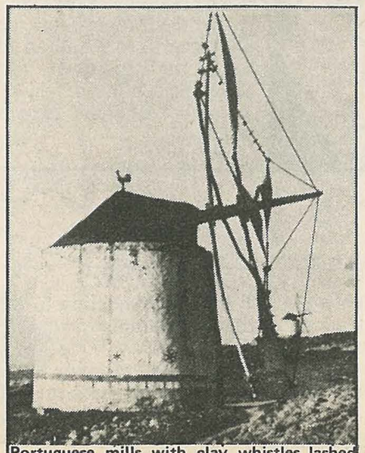
There are no records of scientific investigation into windmill performance until 1759 when John Smeaton carried out experiments and presented a paper "On the Construction and Effects of Windmill Sails" to the Royal Society in London.

The first person to show that the wind could generate electricity was Moses Farmer. In the 1860s he drove magnets with three small fans, generating enough power to light a small incandescent bulb, but his invention didn't really catch on until the turn of the century.

By this time many companies were producing all sorts of water-pumping windmills in the USA and in the early part of this century it even became a status symbol to have a wind-electric generator for your farm. But the grid lines from the power utilities were spreading fast across the countryside, bringing cheap and convenient electricity — no messy storage batteries, just plug in and pay your bills. U.S. windmill manufacturers couldn't compete and their sales declined rapidly.

Much the same happened in Australia. In 1930, 55% of electrical generating capacity was privately owned. Thereafter state electricity authorities extended their grid networks to rural areas, and with the help of government subsidies provided electricity as cheaply as in the cities. The actual cost of electricity to rural consumers was often three or more times that to their city counterparts.

The old Dunlite and Quirk's wind generators became scarcer and



Portuguese mills with clay whistles lashed to the rigging between the sails.

Thatched windmill dating from 1740 on the Kinderdijk, Rotterdam.

scarcer, and now they are only used in a few very remote places, for example to provide power to booster stations on the telecommunications route across the Nullarbor Plains.

In Europe too a working windmill is now very rare, though there is talk of turning back to the wind for water pumping in Holland once more, as safe fuel for electrical pumps becomes harder to find. Where flour used to be ground in mills close to where it was grown, it is now produced in highly centralised industries.

Several attempts to use wind to produce electricity on a large scale and to feed it into transmission lines have been carried out and were to some extent successful. At Yalta before World War I the Russians built a windmill with two 30-metre blades to drive a 100 kilowatt (kW) induction generator. It worked together with a 20 000 kW steam plant and fed current into transmission lines. In 1942 a 200 kW wind-electric generating plant was built at Gedser, Denmark, to feed current into the grid.

The most powerful of the early wind generators was built on Grandpa's Knob in Vermont, USA. It was 33 metres tall (more than three times the height of a typical telegraph pole) with two 21-metre long blades, and was meant to generate 1250 kW (1.25 Megawatts) in a 13.5 metres/sec (30 mph) wind. Ironically the project received some financial assistance at the time from the General Electric company, which is now heavily committed to nuclear power.

The generator ran intermittently in experimental exercises from October 1941 to March 1945, when one of its blades snapped from the structure in a high wind and flew off by itself down the mountain-side. The wind plant never ran again and was dismantled after the war. The nuclear genie was now well and truly out of its bottle and beginning to beguile scientists and companies alike. The initial excitement of wind power was forgotten — for a while.

As John Reynolds concludes in *Windmills and Watermills:*

"By modern standards the traditional windmill (was) feeble and inefficient. But their use of natural power placed them in a class apart from the heat engine, and ethically they remain the most satisfactory machines devised by man . . . It is to be hoped that the future will see the increasing use of this admirable source of power."

Linnell Secomb

1.25 Megawatt Smith-Putnam windmill, built at Grandpa's Knob, Vermont, in 1941. Note the scale of the human figures at the base of the tower.

What's Watt Of Wind

A BASIC GUIDE TO WIND ENERGY

How many times must a man look
up before he can see the sky,
How many ears must one man have
before he can hear people cry,
How many deaths will it take till he
knows that too many people
have died,
The answer, my friend, is blowing in
the wind,
The answer is blowing in the wind.

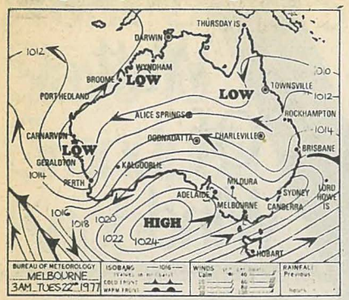
Bob Dylan, could almost have been writing about today's energy crisis when he penned this verse of "Blowing in the Wind" in the early sixties. Today people are beginning to look past the misery caused by tinkering with nuclear energy, towards reducing energy consumption and rediscovering the natural energy sources that we find around us if we just look up at the sky and feel the winds.

The wind patterns that occur are a result of three factors:

- the varying intensity of solar radiation over the earth's surface which warms air, making it rise, so that cooler air moves in under it;
- the rotation of the earth, which creates the characteristic large-scale circular patterns; and
- and the more localized effects of the shapes of land masses which interfere with the simpler large-scale patterns.

It's possible to use daily weather maps to determine overall wind patterns. Broadly speaking, the isobars (the lines on weather maps)

indicate the paths of the winds, although they can diverge from the



direction of the isobars through angles of up to 30°: light winds diverge through larger angles than do strong winds. In the southern hemisphere, the direction of travel of winds is such that a 'low' is always to their immediate right. So winds blow clockwise around 'lows' and anti-clockwise around 'highs'.

The strength of wind can be judged from the distances between isobars: when they are close together, strong winds normally occur; conversely, when they are far apart, winds are light. The example in the accompanying diagram should give some idea of how this method works.

Local effects, however, can play an important modifying role. For example, wind will tend to blow along a valley rather than diagonally across it, and sea breezes can dominate the conditions at coastal sites. It is therefore important to find out from local people about typical wind patterns and, if possible, to make long-term wind measurements at prospective sites (see *CR*, Vol. 2 No. 2, 1976, for how to do this).

Winds absorb about 0.2% of the energy from the sun that reaches the earth, amounting to about 3.2×10^{15} kWh each year. In practice it should be possible to extract up to 0.8×10^{12} kWh from the wind each year. This compares with a global energy consumption of about 60×10^{12} kWh each year. The energy absorbed by winds drives ocean waves and currents, or is eventually lost as heat through friction with the earth's surface.

Apart from indicating that wind is a potentially significant source of energy, the above figures are not of great value. The amount of energy that can be practicably extracted from the wind depends more on the efficiency and siting of wind machines, as well as the methods of cost analysis that determine whether or not they will be built.

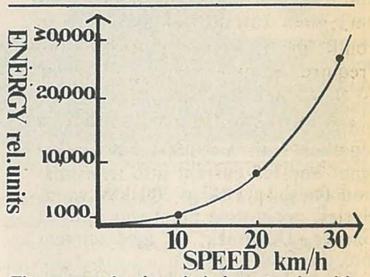
A wide variety of energy forms can be produced directly from wind energy: it can generate electricity or heat; drive machinery or transport vehicles. This flexibility combined with widespread availability is found in few other renewable energy sources. Importantly, wind free from turbulence caused by obstacles such as hills, trees and buildings is a much higher-grade energy source than direct solar energy, so it can be converted to other high-grade forms of energy such as electricity and mechanical motion with relatively high efficiency.

The wind's energy is of a form called energy of motion, or kinetic energy. Energy can be extracted from the wind by absorbing some of this energy of motion, thereby reducing its speed. The more efficient a wind machine, the more of the energy of motion of the wind that strikes it is removed, and hence the slower the wind moves after it comes out of the wind machine.

A theorist named Betz has shown mathematically that no windmill can be more than about 60% efficient: that is, no more than about 60% of the energy of the wind that is striking a windmill can be utilised. In practice, no wind machines seem to have greater than 40% efficiency.

At a given place, wind speed increases with height. The air moving near the ground is interfered with and slowed by vegetation, buildings and contact with the ground itself. At greater heights, the moving air does not experience these slowing effects and therefore moves much faster. All wind machines should, if possible, be mounted high enough to avoid most of this so-called 'boundary layer' effect.

The amount of energy that can be extracted from the wind is heavily dependent on its speed. From the graph, you can see that wind moving at 10 metres/sec (22 mph) has eight times as much energy as does wind moving at 5 m/s, while 15 m/s wind has 27 times as much energy! Hence wind machinery must be built to withstand the enormous energy of storm winds, or designed so it can be protected. It also follows that it is important to choose sites very carefully so that the highest-speed winds in the area can be utilised.

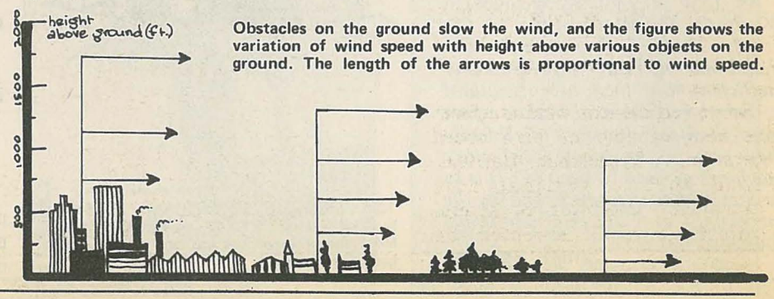


The energy in the wind rises steeply with increasing windspeed (energy is proportional to wind speed cubed).

Low Speed Machines

For activities like grinding grain or pumping water, low-speed wind machines designed to work best in moderate winds are quite suitable. Across Europe, one can find many large windmills designed for these tasks. These include the Dutch and Mediterranean types that utilise canvas sails on wooden frames. In Australia, there are thousands of multi-bladed fan-type windmills used mainly for pumping water.

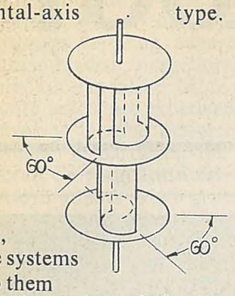
The windmills mentioned so far are horizontal-axis machines: that is, the axle or shaft on which the blades are mounted lies parallel to the ground. The Savonius rotor, a very useful low-speed machine that can even be constructed from an old oil drum, is a vertical-axis machine: that



Obstacles on the ground slow the wind, and the figure shows the variation of wind speed with height above various objects on the ground. The length of the arrows is proportional to wind speed.

is, its central shaft points vertically upwards.

Vertical-axis machines are generally less efficient than the horizontal-axis type. The latter,



though, require systems to keep them pointed into the wind — small machines simply have a wind vane built in but large machines may require complex control systems. Vertical-axis machines don't need to be pointed into the wind, as they can make use of wind from any direction — this is especially useful at sites where the wind is turbulent, like cities.

High-Speed Machines

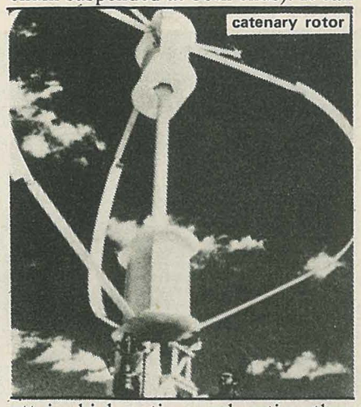
The kinds of wind machine described so far have tip-speed ratios of less than 2: that is, the speed of their blade tips is less than twice the speed of the wind. To drive electricity generators at the fairly high speeds required for efficiency, higher-speed wind machines are needed.

All the machines that operate at tip-speed ratios significantly higher than 2 are 'low-solidity' machines. When viewed from the direction of the wind, only a small part of the area their blades sweep is actually filled by their blades. This contrasts with the low-speed fan windmill, a 'high-solidity' machine whose swept area is almost completely filled by its blades.

The most common type of high-speed horizontal-axis wind machine makes use of a 2, 3 or 4-bladed propellor. Although this is the most efficient of all present wind machines it performs best in relatively high wind speeds greater than 5 m/s (12 mph), and cannot make use of light winds.

Some vertical-axis wind machines are also capable of high speed operation. A Frenchman, Darrieus, found that a vertical axis "panemone" consisting of several vertical aerofoils mounted on rotating framework could spin at high speed and quite efficiently extract energy from the wind. In 1931 he patented this type of wind machine.

Recent research has resulted in the development of the catenary rotor. This aesthetically pleasing vertical-axis machine consists of two or more aerofoils bent in the shape of a catenary (the shape taken up by a chain suspended at both ends). It can



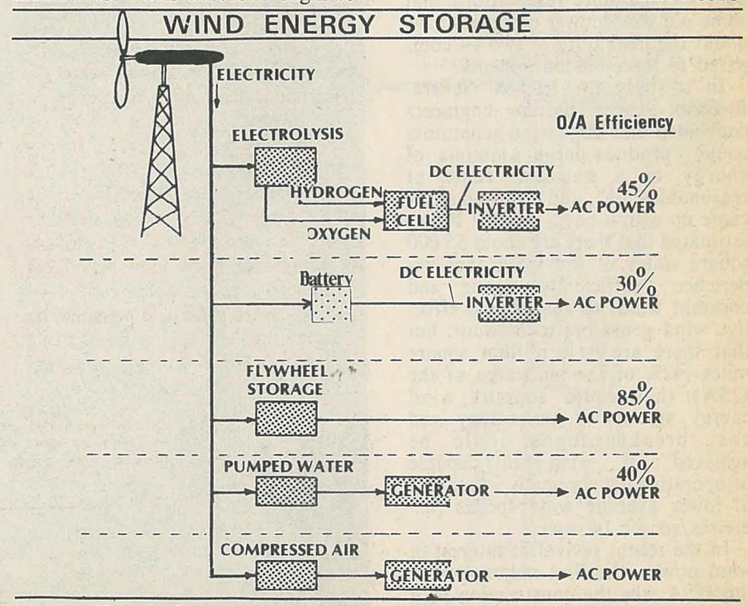
attain higher tip-speed ratios than the Darrieus rotor, and its design is such that light-weight units can be built.

Both the Darrieus and the catenary rotor have one major drawback. They cannot start themselves. Their aerofoils begin to generate lift only when they are moving at about one and a half times wind speed, so they require an external system to bring them up to this speed. Some rotors are 'run-up' to this speed by electric motors, others by auxiliary Savonius rotors.

If wind energy is to be used on a large-scale basis, energy storage-systems will be needed. To date, lead-acid batteries have been used with small wind generators but their capacity and longevity are limited "Pumped storage" in which wind energy is used to pump water to a higher-level reservoir from which it can run downhill through a water turbine has also been used. This, of course, necessitates construction of a dam. Other possibilities include the production and storage of heat energy or, on a large scale, the manufacture of combustible gases such as hydrogen by electrolysis using the electricity generated: this gas could then be liquefied or compressed and stored in tanks or even in underground geological formations.

Who knows, when Bass Strait oil supplies are finished, we might have banks of wind generators converting the energy of the "Roaring Forties;" winds into gas which would be stored in the oil basin until needed.

Alan Pears



Means of storing wind energy, with estimates of the overall energy efficiency of each process.

WIND TECHNOLOGY REVIEW

A world round-up of latest developments in wind-power technology

PROTOTYPE WIND MACHINES

Wind generators with power ratings 8 kilowatt to several megawatts. Plus some exotic wind developments.

Propeller-type Wind Generators

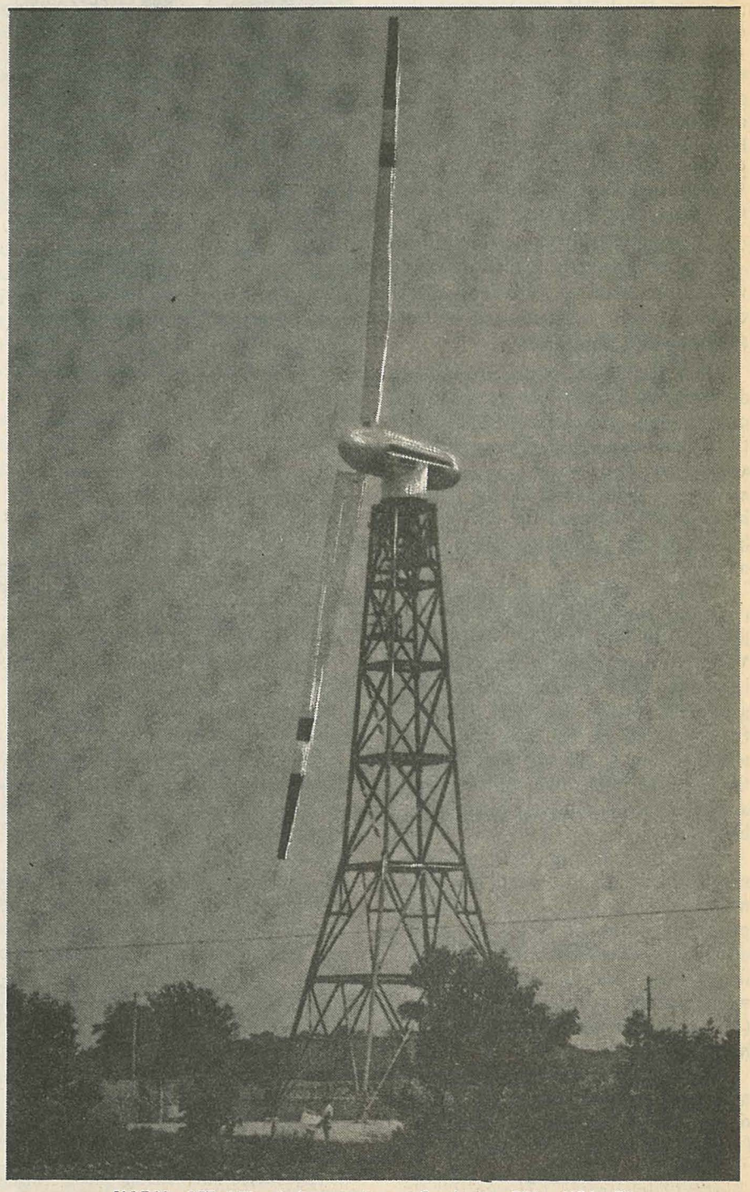
Megawatt Machines

Imagine a romantic Dutch windmill, and blow up your image to about 10 times its actual size. You arrive at the size of the latest range of wind-electric generators being designed around the world, which produce a megawatt (MW) or more of electrical power.

The US Department of Energy, which developed out of the Energy Research and Development Administration (ERDA), has commissioned several studies regarding the application of wind power in the US, and is pressing on with the development of giant two-bladed wind generators despite reservations that some old wind-power designers have about the instability of two — compared to three-bladed systems.

In a study for ERDA General Electric Space Division engineers concluded that large wind generators could "produce large amounts of energy at a national scale at reasonable cost", and a second study came up with a basic design.[1] It was estimated that there are about 55 000 square miles of the USA that experience "sufficiently strong and constant winds to enable cost effective wind genrators to be built, but that there are "1½ million square miles (42% of the land area of the USA) that could support wind energy systems if technology and cost breakthroughs could be achieved"; i.e. wind plants capable of operating economically in regions of lower average wind speeds (6.3 metres/sec or 14 mph.

In the recent revival of interest in wind power, the first major step in the USA was the construction of a 100 kilowatt (kW) wind generator at Sandusky, Ohio, with a 38-metre diameter two-bladed propellor (see illustration. However, vibration problems and the interference of the tower with the air stream have now caused the this NASA-designed plant to be temporarily shut down [2].



NASA's 125 kW wind generator at Sandusky, Ohio, USA. The diameter of the propellor is 38 metres.

The latest news is that the two-bladed design is being adhered to since three-bladed propellors are considered too expensive. More companies with aerospace experience are to be involved in wind research and development. In particular the Boeing Aircraft Company is to develop a 100-metre diameter wind generator (a jumbo jet wing span is only about 60 metres) producing 2.5 MW at the relatively low average wind speed of 6.3 metres/sec. (14 mph). (The ill-fated 1.25 MW wind generator built at Grandpa's Knob, Vermont, USA at the end of World War II — which ended up by throwing off one of its blades — was designed to operate in a 11 m/s average wind speed).

The Boeing 'Jumbomill' is due for competion in 1979[3]. Power from this generator will be fed into the grid to gain interfacing experience. The cost for this one-off machine is US $10 million, though costs are expected to fall when the units are batch produced in lots of at least 100. The windmill blades will be made by Kaman Aerospace Corporation, who manufacture helicopter blades; they will be constructed of fibreglass and weigh 17 tons each.

Large electrical generating companies are playing an important part in field-testing of four large wind generators for the US Department of Energy. The largest machine proposed has a 60-metre diameter prop and will be situated on a 1100 metre high mountain in North Carolina where there are strong steady winds (9 m/s average). It should develop 2 MW of power in a 11 m/s wind. Three smaller machines with 38-metre tip diameters (modified versions of NASA's mill at Sandusky) are scheduled to be field tested in Clayton, New Mexico; Block Island and Rhode Island.

But ERDA, Boeing, General Electric *et al.* have been completely upstaged by an 'amateur' group of resourceful Danes, who have already built a low-cost working windmill several times the size of the largest yet built in the USA, the 100 kW NASA machine.

The idea for the Danish windmill came from teachers at progressive schools at a windswept coastal town called Tvind (appropriately!). About 40 people participated in creating the Tvind mill. They came from all over Denmark, from all walks of life, and ranged in age from 17-45. They had to learn construction methods — welding, mixing concrete, reading blueprints etc. Sympathetic scientists and engineers offered their skills for nominal fees or for the pleasure in helping out.

The windmill has been considered part of the area's power grid from the start. When the wind off the nearby North Sea is blowing briskly, as it usually does, the mill will produce an average of 500 kW, far more than the schools can use. The surplus will be sold to the local utility. When the wind doesn't turn the blades, power is bought from the utility. The Tvind schools should be self-sufficient in a few years, but, says one of the mill's creators, Jens Gjerding, "more important than self-sufficiency is a non-nuclear future".

Intermediate-Size Machines

The best application for intermediate-sized prop-type wind machines (25-100 kW) is on the farm, where they could be used to dry crops, pump irrigation water, operate dairies, heat buildings, aerate ponds and electrolyse (decompose) water to produce hydrogen for fertilizer.

They could also provide electrical power to small industries, or direct mechanical power (possibly with flywheel storage) to industries such as sawmilling and printing, provided good wind sites could be found sufficiently close to where the power is to be used.

Small Wind Generators

The following is a review of some of the small (<25 kW) wind-electric generators currently available commercially, together with a few wind-system accessories. Many of these products are made in the USA or Europe and we do not know the details of importing them.

Machines definitely available in Australia:

Dunlite, rated at 2 kW in a 11 m/s (25 mph) wind. Current cost of this 4 metre diameter, 3-bladed machine, $3000 plus 50 ft. tower at $900. With 5.4 m/s (12 mph) average wind speed, produces 160-250 kWh per month. Contact: Davey-Dunlite, 28 Osmond St., Hindmarsh, S.A. 5007 Ph: 08 - 46 3832. Or: Self-Reliance Distributors, 24 John St., Bayswater, Vic., 3153. Ph: 03 729 1087.

Quirk's, rated at 200 Watts in 10 m/s wind (23 mph). Current cost of this 2-metre diameter machine, $700 complete with 3-metre high stub tower. Called the Wincharger, it's made in the USA and imported by Quirk's, 33 Fairweather St., Bellevue Hill, NSW 2023. Ph: 02 36 6630. Also available through Self-Reliance Distributors as above.

Other Units Available Overseas

Elektro, rated at 5.3 kW in 11 m/s (25 mph) wind. 3-bladed prop, 5-metre diameter. Power production from this US $6500 machine is 400-600 kWh per month in 5.4 m/s average wind (12 mph). Elektro has other units available. Contact: Elektro, St., Gallerstrause 27, Winterthur, Switzerland.

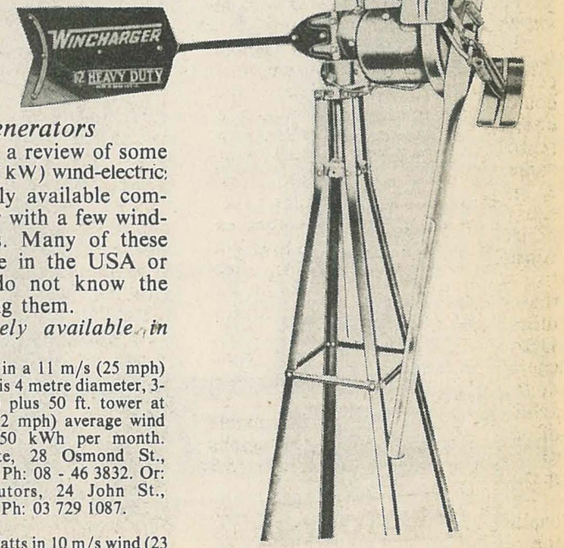
Grumman Aerospace Corp. has developed an 8-metre diameter machine rated at 15 kW in a 12 m/s (26 mph) wind. Contact: Grumman Energy Systems, 4175 Veterans Memorial Highway, Ronkonkoma, NY 11779, USA.

Kedco Model 1200, rated at 1.2 kW in 9 m/s wind (21 mph). System partially disassembled sells for about US $1700. Contact: Kedco, 9016 Aviation Blvd., Inglewood, CA 90301, USA.

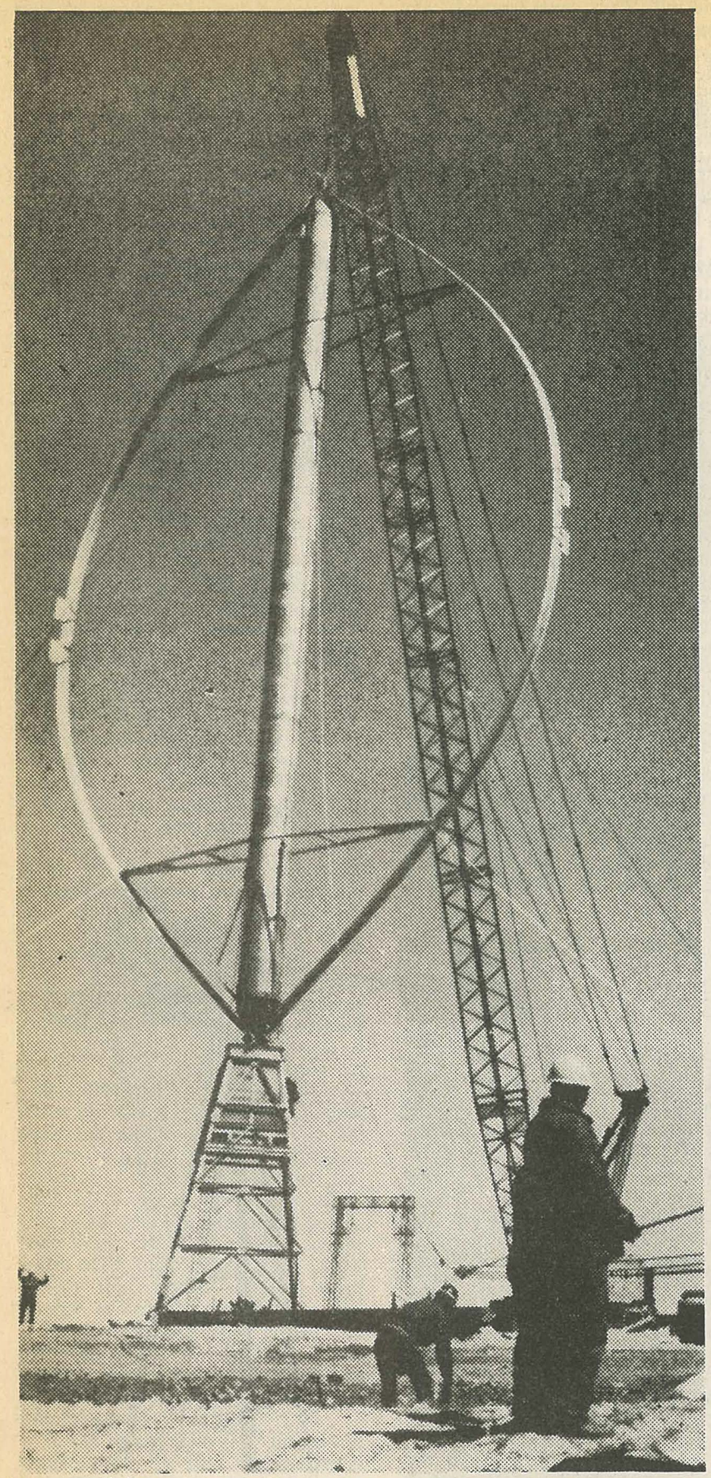
Aerowatt 4100FP7, largest diam., most expensive machine now available. 9-metre diam. prop, gives 4.1 kW in 7 m/s (16 mph) wind. Cost US$22,000. Effect of low rated wind speed is high average output, 1000 kWh per month in 5.4 m/s average wind (12 mph). Other models available. Contact: Aerowatt S.A., 37 Rue Chanzy, &5-Paris 11e, France.

American Wind Turbine, 5-metre diam. model, rated at 3.2 kW in 7 m/s wind. System cost incl. tower, US$3200. Other models available. Contact: American Wind Turbine, 1016 East Airport Rd., Stillwater, Oklahama 74074, USA.

Windworks, for designs of sail windmills for water pumping, octahedron towers (low-cost, light), and d.c. to a.c. inverters for use with wind-electric systems. Contact: Windworks, Box 329, Route 3, Mukwonago, Wisconsin, 53149 USA.



Quirk's 2-metre diameter 200-watt wind generator.



50 METRE DIAMETER EGG-BEATER WIND GENERATOR ON MAGDALENE ISLAND, CANADA.

In Australia CSIRO'S lone wind researcher, Dr. Julian van Leersum of the division of mechanical engineering, Highett, Vic., is developing a computer program to assess the economic viability of wind-electric generators in various applications. But further research and development of small wind-electric generators is an area the Australian Government could immediately get into. There is room for technical improvement in the machines currently available in Australia, and for the introduction of new low-cost models.

2-20 kW wind electric generators are ideally suited for farms and rural co-operatives, and could play an important role in reducing electricity demand from central power stations in rural areas (where distribution losses are greatest), and in obviating the need for further grid extensions into newly settled areas.

The availability of low-cost kit built machines of this type could be very helpful to groups or individuals with the time to build and install them.

Vertical-Axis Wind Turbines

Egg-Beater Wind Generators

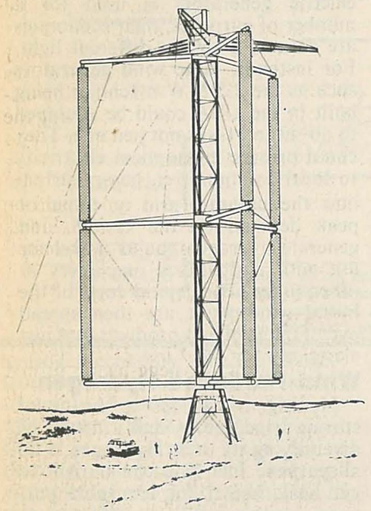
Think of a giant egg-beater turned upside down and there you have in essence a Darrieus, or egg-beater, wind generator, a new development in wind technology which is exciting considerable interest around the world (see illustration, and page 11 for how it works). The curved blades are usually made of aluminium and have an aerofoil cross-section (like an aircraft wing).

The Research Council of Canada and other research groups are testing egg-beater wind generators in various parts of the world. Some are also to be built in South Australia (see p. 30). Canada still retains leadership in developing this type of wind generator and a large 50 metre diameter unit (five times the height of a typical telegraph pole) has been erected at Hydro Quebec Institute of Research's test facility on Magdalene Island in the Gulf of St. Lawrence[5]. It operates at wind speeds between 3.6 and 29 m/s (8-65 mph) and can withstand gales of up to 45 m/s. The plant is designed to generate 200 kW, enough to light 600 homes.

The principal advantage of this type of machine is that it may prove cheaper to build and maintain because the generating equipment can be attached to the drive shaft at ground level, reducing tower construction costs. Unlike conventional prop systems, no system is needed to turn the blades into the wind, nor is a pitch-control device needed to feather the blades in strong winds because the rotor automatically stalls at high wind speeds.

The disadvantage is that the rotor extracts somewhat less energy from the wind than two or three-bladed props.

At the Sandia Laboratories' test site in the USA another egg-beater has been built that is designed to produce 60 kW in a 13 m/s (28 mph) wind and 30 kW in a 10 m/s (22 mph) wind[6]. How the second generation of this type of machine will be applied is probably in those areas of higher average wind speed, which being in remoter regions will also favour the automatic stalling feature and low maintenance cost.



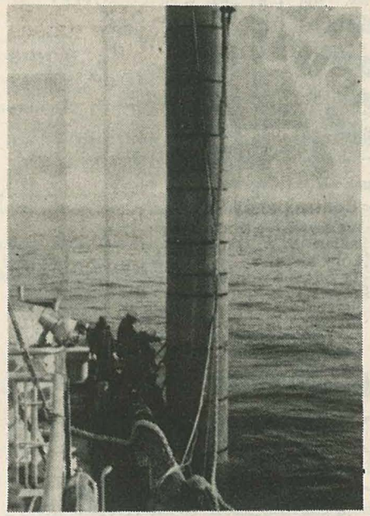
A giromill.

Giromills

ERDA has awarded a contract of US$156 000 to McDonnell-Douglas Corporation to evaluate a new windmill concept, the so-called 'giromill'[7]. This is a vertical axis wind mill with vertical aerofoil blades. As with the egg-beater machines, the hope at ERDA is that something like the giromill concept would be more cost-effective for electrical generation than a conventional prop-design because it may be cheaper to build. McDonnell-Douglas engineers estimate that a typical giromill with three blades each 40 metres long could generate enough electricity to power 40 modern US houses.

Researchers at Reading University, UK, have come up with a novel variation on the giromill concept[8]. In their machine, the blades are vertical when stationary but tilt outwards as their speed of rotation increases (see diagram). It is therefore self-regulating, since when the wind speed gets too high the blades are almost horizontal and stop generating any more torque. A 3-metre prototype has been produced and the designers claim 1 MW versions of the machine could be made.

Vertical axis windmills are particularly convenient for coupling to a churn (like a washing machine agitator) in an insulated water container and producing hot water directly. Professors Weeks and Price at Cornell University, USA, are developing a working model of such a system to be tested for a year at Cornell's research farm at Dryden, NY. It is designed to produce about 120 gallons of hot water at a wind speed of 4.5 m/s (10 mph) ranging up to almost 1000 gallons/day at 9 m/s. The 110-gallon figure is sufficient to meet the hot-water requirements for cleaning and sanitising milk-handling equipment for a 60-head dairy farm, amounting to about 25% of the farm's electrical consumption[9].



A 5 kW wave generator made by the Mitsui Engineering and Shipbuilding Co. in Japan.

Exotica

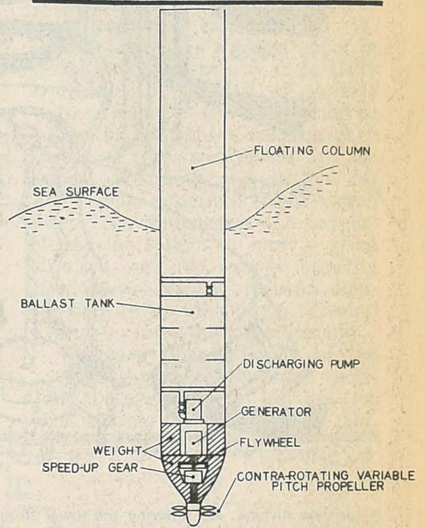
Hybrid Machines

An Israel Professor, Anthony Peranio, has developed a wave-powered electric generator which might also be used as a mount for a wind generator[10].

This idea could probably best be applied to the 0.5-1 MW wave-power plants that the Japanese will be marketing in a few years.

Japanese wave energy research started in 1973 and tests with progressively larger models have been underway since 1975. In 1978 Mitsui Engineering and Shipbuilding Co. will be testing out the model shown in the photograph [11] which is fitted with a propellor and generator giving an output of between 3 and 5 kW. The first production prototype will be a 200 kW unit with a 5-metre diameter floating column. Used on its own or as a hybrid wave/wind machine, this is the kind of engineering work that could stop the Newcastle shipbuilding industry dying!

Off-shore siting of combined wind-wave generators would circumvent the visual pollution of arrays of windmills along coastlines, but would raise problems such as hazards to marine life and shipping.

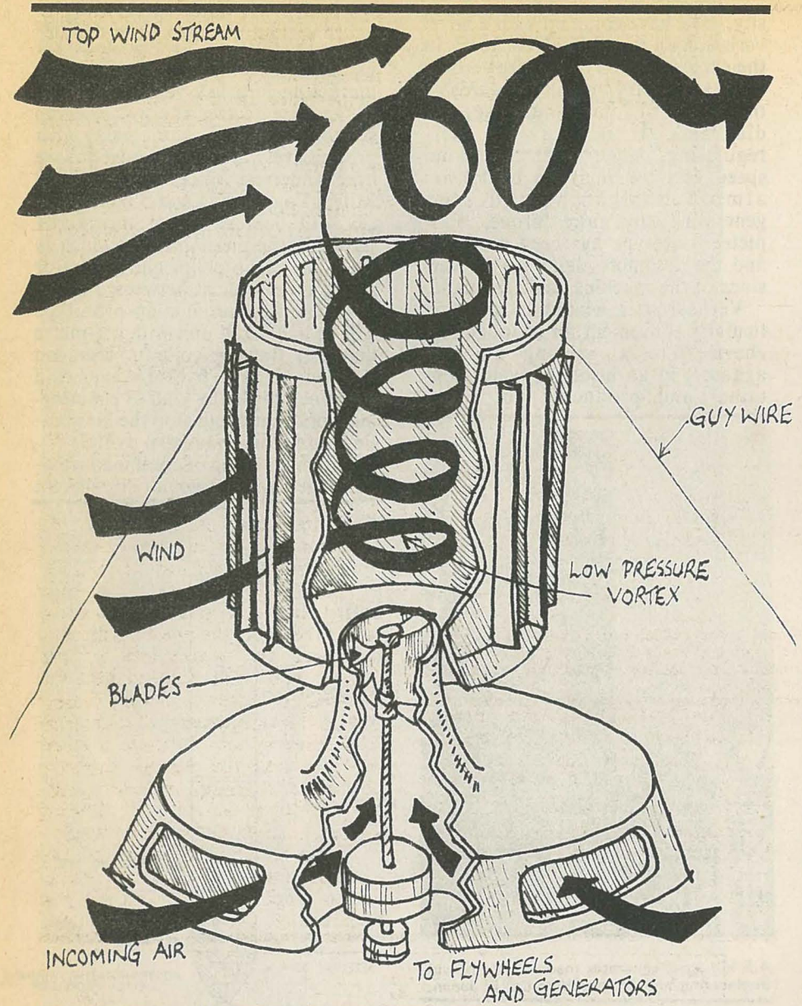


Schematic of the wave generator opposite. Could this serve as a mount for an off-shore wind generator?

Tornado Turbines

Here's the biggest and boldest wind generator yet — a new kind of skyscraper structure called a tornado turbine, possible 600 metres high and 200 metres wide (but is this alternative techology, you may well ask?).

As the illustration shows [12], these towers are designed to capture the wind and turn it into human-made tornadoes from which energy to produce electricity could be derived. It's an intriguing scheme that aims to get a maximum of power from small rotating blades, thus effectively lifting the size barrier on windmills.



A tornado turbine. Air entering the tower through vents in one side sets up a vortex with a low pressure centre. Air is therefore sucked up through the turbine.

So far only a model system a metre or so high has been made by its inventor, Dr. James Yen of Grumman Aerospace Corp., USA[13], but the US ERDA has granted a US$198 000 contract to Grumman so that a bigger proof-of-concept model can be built.

Theoretically the tornado turbine has a much higher efficiency than conventional wind generators. The vortex creates a considerably greater pressure difference across the propellor than is ever possible with a simple flow-through system, and the effective area of energy collection is the frontal area of the whole tower, i.e. many times greater than the area of the turbine alone.

Dynaships

Will the tall ships sail again, transporting cargo around the world quietly, cleanly and driven solely by the winds?

Today attempts are being made to apply the most modern technology to the design of wind-driven cargo ships[14]. At the University of Hamburg's Shiffbau Institute the theoretical basis has been established for a new generation of sailing ships. Known as 'dynaships', they would utilise modern navigational aids, receive hourly weather information and satellite photographs, and be completely automated and require a smaller crew than the average freighter. They could, according to workers at the Institute, eventually replace the majority of fuel-driven ships at sea.

Whether such a highly automated ship appeals or not, there seems little doubt that modern knowledge of the aerodynamics of sails, hull design and meteorology could allow a new line of wind clippers to cover most ocean routes almost as quickly as current freighters.

WIND ENERGY SYSTEMS

Wind-electric generators whose power is used for multiple purposes

When the output from wind-electric generators is used for a number of purposes, their economics are seen in a totally different light. For instance, large wind generators such as the 2.5 MW machines being built in the USA could be equipped to do several tasks not just one. They could provide economical electricity to local communities, pump current into the national grid at times of peak demand on the system, and generate hygrogen gas as a fuel for use with agricultural machinery at other times. The capital costs of the initial wind plant are then spread over a range of end-products, not just electricity for local use.

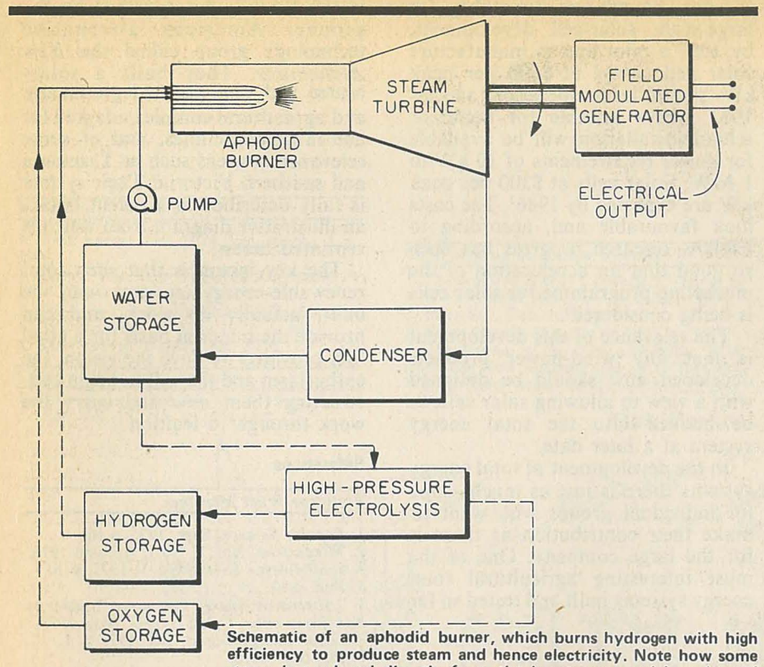
Wind-Produced Hydrogen

Hydrogen provides a means of storing wind energy and a means of diversifying its uses. Hydrogen is an all-purpose fuel: you can burn it to get heat, use it for transport purposes, and recombine it with oxygen in a fuel cell to generate electricity. Alternatively electricity can be generated by a turbine powered by steam produced directly by burning hydrogen in an aphodid burner (see illustration)[1].

Hydrogen can be stored as a gas under pressure (e.g. in the LPG gas cylinders used widely today); or if compressed and cooled, stored as a liquid; or stored in compact solid form in metal hydrides, compounds with a high proportion of hydrogen atoms.

Hydrogen gas, along with oxygen gas, can be obtained from wind-generated electricity by passing the current produced through salty water. A process called electrolysis takes place, decomposing the water (H_2O) into its components, hydrogen and oxygen. Electricity from sunlight falling on solar cells can also be used to electrolyse water in this manner.

The universal applications of hydrogen have led certain researchers, most notably Professor J. O'M. Bockris of Flinders University of SA, to propose the so-called



Schematic of an aphodid burner, which burns hydrogen with high efficiency to produce steam and hence electricity. Note how some steam is produced directly from the input gases and how 'waste' heat coming out from the turbine is recycled.

hydrogen economy, where hydrogen from solar and wind sources is used to supply all energy needs[2]. This certainly seems technically possible but there is an urgent need for a thorough analysis of the likely environmental and political impacts of this sweeping new technology.

Wind-Powered Transport

In the short-term the most important use of hydrogen is likely to be as a substitute for oil products used in transport. The world's first 'wind-powered car' was exhibited in May 1977 at Palm Springs, California[3]. It was equipped to run on hydrogen and in a paper at the conference following the exhibition, it described how the hydrogen could have been obtained from wind power via water electrolysis.

The city of Riverside in California is experimenting with hydrogen-powered buses to demonstrate the effectiveness of this non-polluting fuel. The buses can travel 180 km a day on 11 kg of hydrogen. A small wind-hydrogen system producing 500 kg a day could power 50 buses[4].

Storage of hydrogen remains the principal limitation to its use as a transportable fuel. As a gas it is bulky; there are weight and cost problems at present with liquid or solid storage, and safety risks. If technical problems are overcome, storage in solid form in metal hydrides, the hydrogen being released by gentle heating, is likely to prove the safest and least-bulky method.

Fertilzer from the Wind?

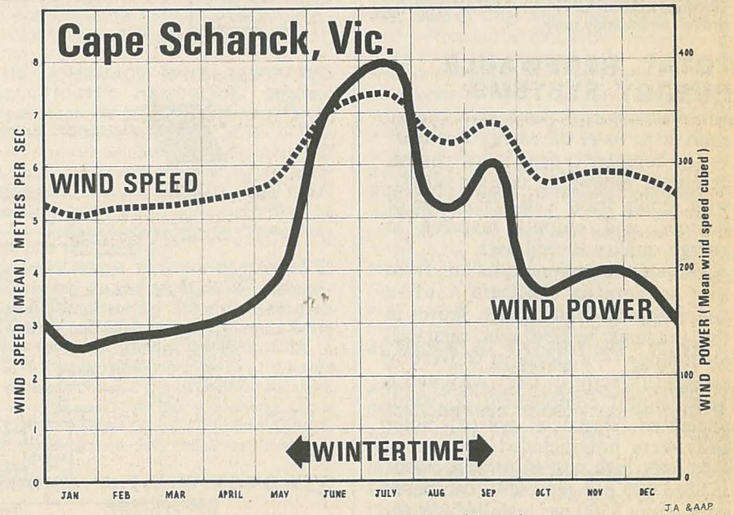
Engineers at the US company, Lockheed, have proposed the use of wind-generated electricity in the production of nitrogen fertilizers[5]. The electricity is used to produce hydrogen from water by electrolysis and to extract nitrogen from the air. These two gases would then be reacted under high pressure and temperature in the presence of a catalyst to produce anhydrous ammonia, or by further processing, ammonium nitrate — valuable nitrogenous fertilizers. It was estimated that "a wind power plant with a 125 ft diameter rotor could produce about 55 tons of ammonia per year, enough to fertilise 1100 acres growing one crop or 400 acres growing two crops".

COUPLED WIND-SOLAR SYSTEMS

Complementary use of wind and solar power

"When the sun hides, the winds blow", an old saying might go, and this observation has a great deal of importance to the combined use of solar and wind energy. As J. W. Andrews noted in a recent paper in *Solar Energy*[1] "one way to partially overcome the problem of variable output (from sun and wind) could be to use the strengths of each source to overcome the weaknesses of the other". His study showed that for US weather patterns both the overall size of the components of a coupled wind-solar system to meet a given demand, and the storage capacity needed, are greatly reduced compared with an all-solar or all-wind system to meet the same demand.

We have done a study of the average annual wind-velocity variation at Cape Schanck, Victoria (see illustration), and this confirms that,

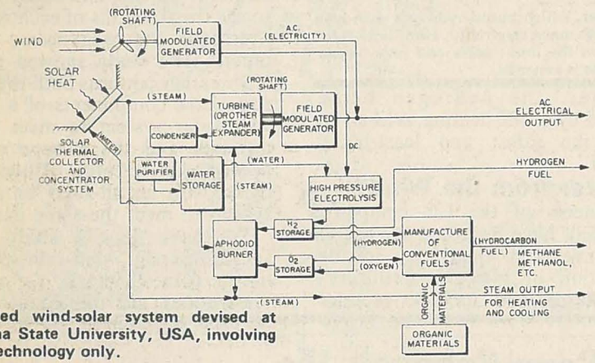


The annual variation of average wind speed at Cape Schanck, Victoria, and the corresponding variation of wind energy. The strong peaking of wind energy in winter is particularly useful since it matches the annual pattern of electricity demand.

at least in this part of Australia, the energy in the winds peaks strongly in winter when demand for energy is also at a maximum, but solar energy is in the doldrums. This matching of wind energy to, for example, electricity demand would reduce the overall storage capacity needed, and allow wind-generated electricity to meet more easily peak winter demand for lighting, and possibly some electrical boosting to solar and water and space heating systems. (In south-eastern Australia, peak summer demand for electricity is 30% lower than peak winter demand).

A coupled wind-solar system for the UK is described in detail on p. X8).

Oklahama State University have worked out a solar-wind energy system relying only on proven technology. This system, shown in the schematic diagram below, can be used to visualise the basic components of similar systems applied to a large farm, rural co-operative, a region, or a whole country[2].



A coupled wind-solar system devised at Oklahoma State University, USA, involving proven technology only.

TOTAL RENEWABLE ENERGY SYSTEMS

Diverse range of renewable energy sources to meet all energy demand

The long-term goal is, of course, complete renewable energy supply, with inputs from a diverse range of sources, and outputs matched in energy quality to end-uses.

One of the major omissions from the schematic diagram of a coupled wind-solar system shown in the previous section was solar-cell technology — a means of converting sunlight directly to electricity and a very helpful complement to wind-generated electrical power. Solar cells were not included because of their very high cost at present, about US$13 000 per peak kW[1] compared with about $500 per installed kW for coal-fired power stations.

But according to a US National Science Foundation timetable for large-scale solar-cell development, by 1981 a pilot line to manufacture solar cell arrays at $500 per peak kW should be in operation, and by 1982 arrays suitable for home or school installation will be available for power requirements of 10 kW to 1 MW. Solar cells at $300 per peak kW are expected by 1986[2]. The costs look favourable and, according to ERDA, research progress has been so good that an acceleration of the marketing programme for solar cells is being considered[3].

The relevance of this development is that any wind-power products developed now should be designed with a view to allowing solar cells to be hooked into the total energy system at a later date.

In the development of total energy systems there is just as much scope for individual groups who want to make their contribution as there is for the large company. One of the most interesting agricultural total energy systems built and tested so far is the "Ark", put together by the pioneer American alternative technology group called the *New Alchemists*. They built a solar-heated and wind-powered greenhouse and agricultural complex adapted for use in colder climes, and of some relevance in areas such as Tasmania and southern Victoria. Their system is fully described in a recent book[4], an illustrative diagram from which is reprinted below.

The key lesson is that such total renewable-energy systems can be built, actually do work, and can provide the material basis for a good life, provided we have the vision, the enthusiasm and the will to begin constructing them *now* and carry the work through to fruition.

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11. Ibid, Nov. 1977.
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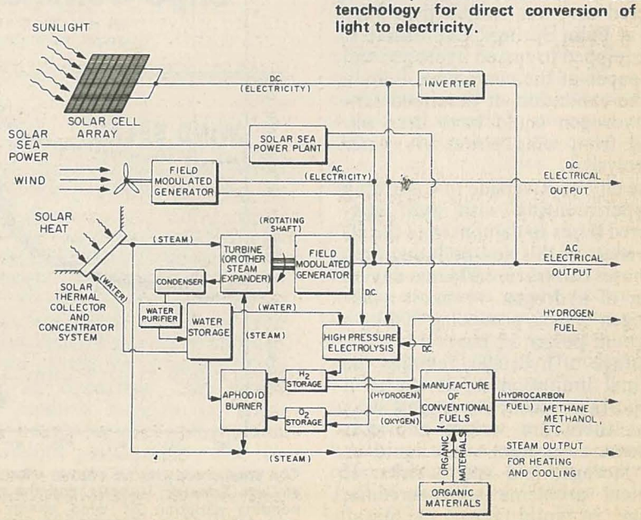
A total renewable energy system for the future involving inputs from solar, wind, wave and biofuel sources. The key addition to the previous schematic is solar-cell tenchology for direct conversion of sunlight to electricity.



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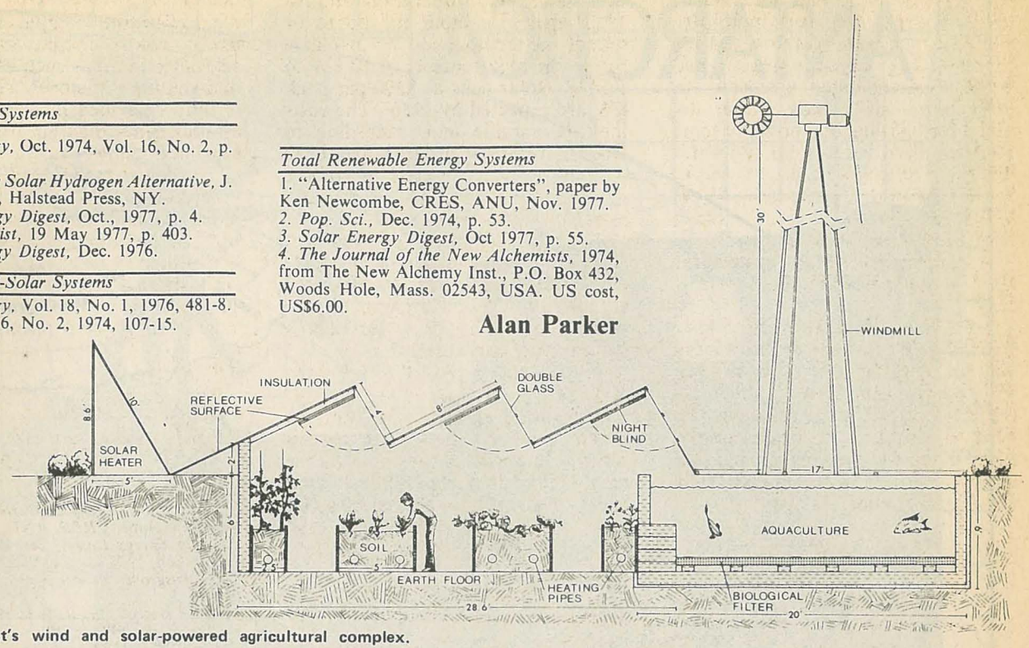
Alan Parker



New Alchemist's wind and solar-powered agricultural complex.

WIND POWER — A SHORT BIBLIOGRAPHY

BOOKS SPECIFICALLY ON WIND POWER

ELECTRIC POWER FROM THE WIND. Henry Clews. Solar Wind $2.

Good general introduction to wind power. Technical knowledge is simplified, so even the beginner should have no trouble.

POWER FROM THE WIND. Palmer Cosslett Putnam, Van Nostrand Reinhold, 1974. 224 pp. (H) $9.95. A classic on wind power. Scholarly tone, more for the advanced experimenter than for the casual reader. Reports on the 1940's Grandpa's Knob wind studies. A lot has changed since then, but book is still helpful.

WIND AND WINDSPINNERS. M. A. Hackleman and D. W. House. Peace Press (Bulk orders); Earthmind (single copies), 1974. 115 pp. (S) $7.50; $9.50 airmail. Strictly on the Savonius, but it's written in an engaging style that leaves no breeze unchurned along the way. You can learn to calculate efficiency without being an Einstein.

WIND ENERGY BIBLIOGRAPHY. Windworks, 1974. $3. Available from Windworks, Box 329, Route 3, Route 3, Mukwonago, Wisconsin 53149, USA.

WINDMILLS AND WATERMILLS. John Reynolds, 1970. 195 pages. Praeger Publishing Co. Available from Whole Earth Bookshop, 81 Bourke St, Melbourne 3000. A superbly illustrated history of wind and waterpower. The Author's own cutaway isometric drawings of windmills add greatly to an understanding of the evolution of early windmills.

WIND ENERGY SYSTEMS WORKSHOP. June 11-13, 1973. Washington DC. Copies available from the National Technical Information service, Springfield, Virginia, 22151, USA.

THE HOMEMADE WIND GENERATED ELECTRICITY HANDBOOK. Michael Hackleman, $9.50. An Earthmind/Peace Press Publication 1975. One of the problems with home-made wind generators is that they are far more complex than other do-it-yourself alternative technology projects and one needs to know a lot about electricity. The value of this book is it tells you the problems and how to solve them.

ENERGY FROM THE WIND. Barbara L. Burke and Robert N. Meroney, Publications, Engineering Energy Research Centre, Foothills Campus, Colorado State University. Ft. Collins, C080523, USA. There were 800 new references to wind power published between 1973 and 1977 so for those who really want to get into wind energy, this is a book that shows the way. This book consists of a basic report, $10, and a supplementary report of $15.

BOOKS WITH WINDPOWER SECTIONS

NATURAL ENERGY IN YOUR HOME. Des Theodore, $1.95. Ure-Smith of Sydney. As a general introduction to the use of alternative energy sources, including wind energy, this book is by far the best buy.

ENERGY FOR SURVIVAL — THE ALTERNATIVE TO EXTINCTION. Wilson Clark, $6.95 paper back. Anchor Press/Doubleday, Garden City, New York, 1974. This book — forceful, detailed, lucid, definitive — is the result of a profound authoritative examination of energy policy and potential by an astute observer. The 54 pages devoted to wind energy provides a compact presentation of the possibilities, many of which have or are being realised in the four years since publication.

ENERGY, ENVIRONMENT AND BUILDING. Phillip Steadman. Cambridge University Press, 1975. A well-written and easily understood book that originated as a report to the Academy of Natural Sciences, Philadelphia. Covers the whole area of energy conservation in buildings and contains a 26-page section on windpower including a bibliography. $8.95, Rodale Press, 1974.

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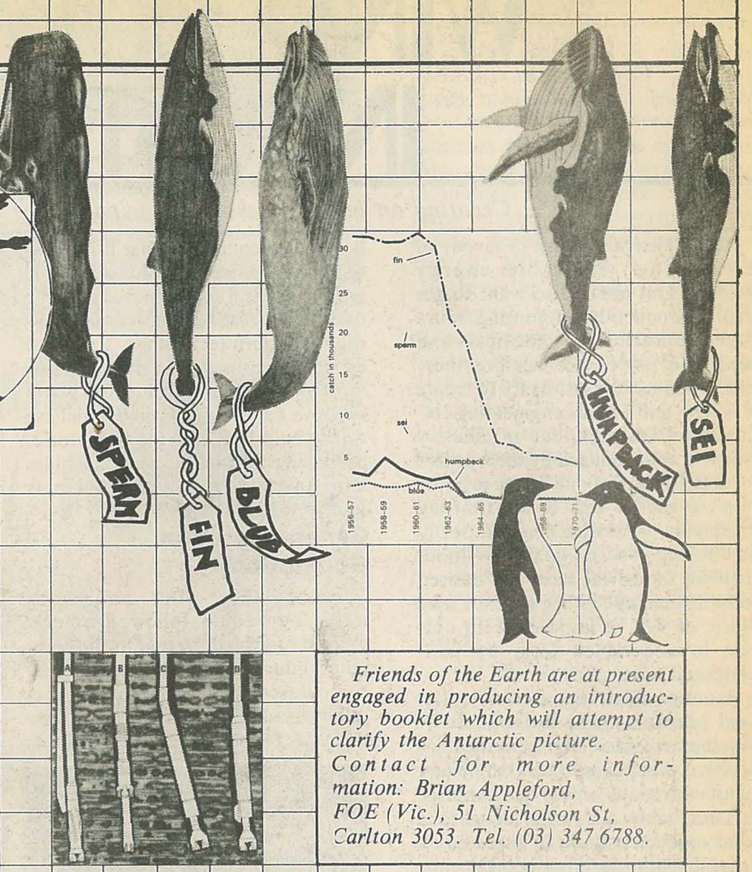
SOLAR ENERGY DIGEST. Monthly $38 year, available from P.O. Box 17776, San Diego, California, 92117, USA.

SUN WORLD: INTERNATIONAL SOLAR ENERGY SOCIETY. Quarterly, $12 year, Pergamon Press.

WINDUSTRIES. Quarterly, $10 year, available from Great Plains Windustries Inc., P.O. Box 126, Lawrence, KS66044, USA.

ANTARCTICA



Friends of the Earth are at present engaged in producing an introductory booklet which will attempt to clarify the Antarctic picture.
Contact for more information: Brian Appleford, FOE (Vic.), 51 Nicholson St, Carlton 3053. Tel. (03) 347 6788.

What is Antarctica?
Antarctica is freezing temperatures and howling gales, glaciers, icebergs and penguins.
Antarctica is seals, snow, frozen seas, whales and desolation.
And more.
Antarctica is sky and clear air and relative purity. Antarctica is a wild and beautiful wilderness.
Antarctica is about to be raped.
Within the snow and ice are rocks. Within the rocks, minerals. Upon the snow and ice are birds and animals. Within the sea is protein. Beneath the seas, oil. On the sea floor, more minerals. All can and will be exploited greedily unless rationalism and sensibility and international co-operation predominate — and that's a big, big order.

Take krill. Or think about it.
Krill is a small crustacean. Massive gangs of it graze merrily on phytoplankton in the southern oceans around Antarctica. They are, in turn, chomped up by baleen whales, fish, seals and seabirds.
Such a short and fragile food chain.
Krill is rich in protein and the seas are rich in krill, so we say: "Oh how great. This will feed some of the world's starving people."
BUT! Could it be that we are wrong? Could it be krill isn't destined for the third world, but that Russia and Japan and other industrial countries have the exclusive potential to develop the means of harvesting and processing krill? Could it be that krill will end up as stock food in these countries?
Of course — and it's happening.

Further. How much can be taken without badly depleting stocks or seriously disrupting the Antarctic ecosystem?
Don't know. No-one knows.
The biomass (total body weight of the total population), ecology, distribution, biology and population dynamics of krill are not known or understood. They are still being investigated and it is not known when we will have the answers. (Perhaps we will have that information when it doesn't matter any more. What is the biomass of Russian pork or Japanese chickens?)
Think about it.
Think about oil drilling — and icebergs and spills and the absorption of aromatic crude-oil fractions in sub-zero temperatures and the uselessness of detergents and booms in Antarctica.

Or — think about the proposals for the storing of radio-active wastes on the continent.
Think about Australia claiming it owns half the Antarctic continent while Russia and America say we don't.
There are lots of things to think about.
Antarctica must be protected from greed, from destruction from neo-colonialism.
Antarctica is part of the world. Not part of Australia or Argentina or Chile. If Antarctica can be used, without it being harmed, for the benefit of humanity, then it must be used for the benefit of all humanity and not be the exclusive preserve of a few countries powerful enough to exploit it.
Antarctica must be protected before it is necessary to have to save it.
Antarctica is alone in the world.

Brian Appleford.

WIND POWER INDUSTRY

Creating an industrial base for wind power in Australia

Most Australians are in favour of developing renewable energy sources, and many also want to see their introduction promoting more decentralisation of political and economic power. To achieve these ends I believe it is necessary to create a solar and wind engineering industry in Australia, but an industry which is self-managed by the workers involved in it, and one whose production is geared not to maximising profits but to meeting democratically determined social goals. Without such an industrial base the desired technical change either will not take place, or will be imposed from outside in a perveted form by multinational companies.

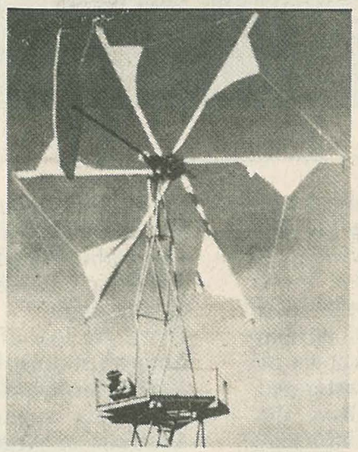
Among alternative technologies, wind machines made by some do-it-development of a highly skilled industry if it is going to be used on any significant scale, unless one confuses the unreliable and often dangerous wind machines made by some do-it-yourself enthusiasts as being examples of alternative technology. The latter form of built-in-obsolescence should not be the hallmark of alternative technology products, of that we can be quite sure.

Anyone familiar with the fine works of craftspeople over the centuries will know that quality springs from pride in using the tools available in the best way possible, and this applies as much to the potter's wheel as the tape-controlled jigborer. Contrary to the opinion of many people unfamiliar with the realities of the engineering world, craftwork is alive and well in many parts of manufacturing industry today, in particular where the industry is involved with small-batch production. Whereas some of the inferior products of the new generation of craft workers would make medieval craftsmen turn over in their graves.

The present craft revival is certainly to be welcomed because it is an attempt to rediscover old skills and regain control over at least some means of production, but let's not write off **all** modern technology. From my experience as a design draftsperson, most manufacturing industry is not like the car industry, and I believe work could be satisfying in factories producing the kind of wind machines and integrated energy systems described in this *CR*.

Generation upon Generation

Technically, wind and solar technology could follow a similar pattern of growth to that of the computer industry. For instance, the first computers were bulky, extremely expensive and applied in very few places. These were called first-generation machines. Second-generation computers were smaller and more widely applicable, but there were still only ten thousand of them in the world and most were used for accounting purposes or purely scientific work. Now the computer industry has produced computers that are integrated into all kinds of industries and all manner or production processes and anyone can buy one for a few hundred dollars that would have cost millions a few years ago.

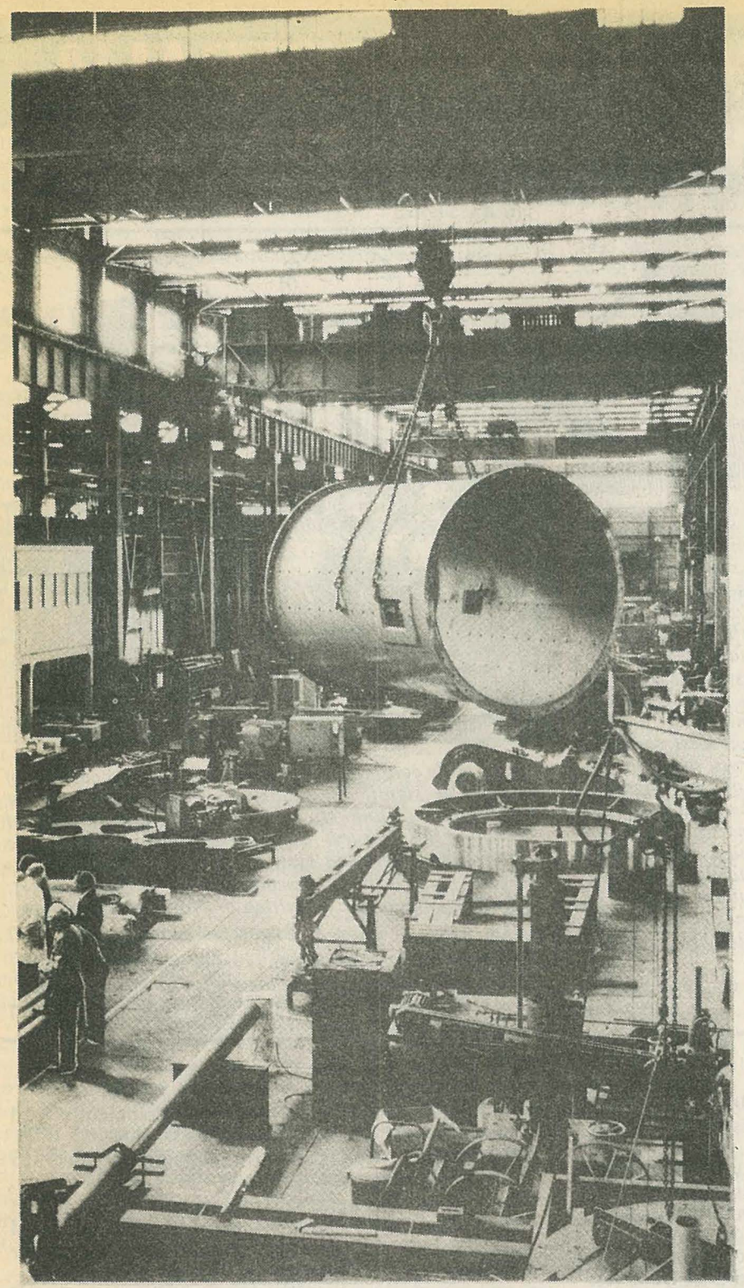


A sail windmill for water pumping designed by the US alternative technology group, Windworks.

In computer jargon, current wind-power machines under development are only first-generation technology: their most important feature is that they will lead to the development of more efficient and more widely applicable second-generation machines and so on. We must consider the future potential of solar and wind power. Some products are still at the design prototype stage such as the very large 60-100 metre diameter wind generators, while others such as solar-electric cells are at the take-off stage with economies of scale about to be realised similar to those recently achieved with transistors. What is important about the 2.5 Megawatt wind generators being designed and built now is not their immediate performance figures as single-purpose wind generators, but how these performance figures and production-cost estimates affect the economics of total energy systems that could be built in the future.

Making Windmills in Australia

Very large wind generators are being developed in the USA, Canada, Denmark, West Germany, the United Kingdom and the Soviet Union, and there are smaller projects of considerable importance elsewhere, particularly in Israel and Japan. This is the start of a world-wide research and development effort that, when coupled to the more intensive and widespread research into solar energy, will lead to the formation of another major world industry, the solar engineering industry. The rapid development of this new international industry is absolutely vital and Australia should be playing her part in contributing towards its technical development. We should ensure that the great employment opportunities available are realised in Australia, in Australian owned and controlled industries. As a first step I think we should intensify the campaign for increased Government funding for wind-energy (along with solar) research and development in Australia — in universities, CSIRO, certain industries, and in an Australian Renewable-energy Commission (ARC, a revamped version of the Australian Atomic Energy Commission!). To increase funding for wind research would not be difficult given its present level of less than fifty thousand dollars per year.



Another possibility — which importantly embodies the political muscle required to force change — is that unions in key industries with the necessary plant and skills might consider production of wind-power technology in alternative corporate plans advanced to management in Lucas Aerospace-style initiatives (see *CR* 2(4), (1), 1977). Faced with the threat of unemployment Lucas Aerospace workers in the UK proposed a whole new product range for the company, including in fact wind-electric generators, as a substitute for the company's existing production, mainly aircraft components. Assuming, of course, interest within the Australian union movement in such action, industries such as aircraft production (largely government-owned) and shipbuilding — neither of which are healthy economically — might prove suitable for diversification into wind technology.

And we mustn't forget smaller enterprises. Design and construction of small wind machines could very appropriately be conducted in small co-operatively-run companies. Government financial assistance to such co-operatives would be essential to get them started, but they could serve as very useful providers of local work and job-training. We already have a working example of a scheme of this type in the USA. One of the original US alternative technology groups, Windworks, has just received a contract worth nearly US$400 000 from the US Government to develop an advanced 8 kW wind generator for farms, rural homes and other applications[1].

In the previous article (p.12), essentially an ideas section, wind machines are described for domestic, industrial and agricultural purposes, but above all in the hope of stimulating action to get similar wind technology being designed and manufactured in Australia.

Reference

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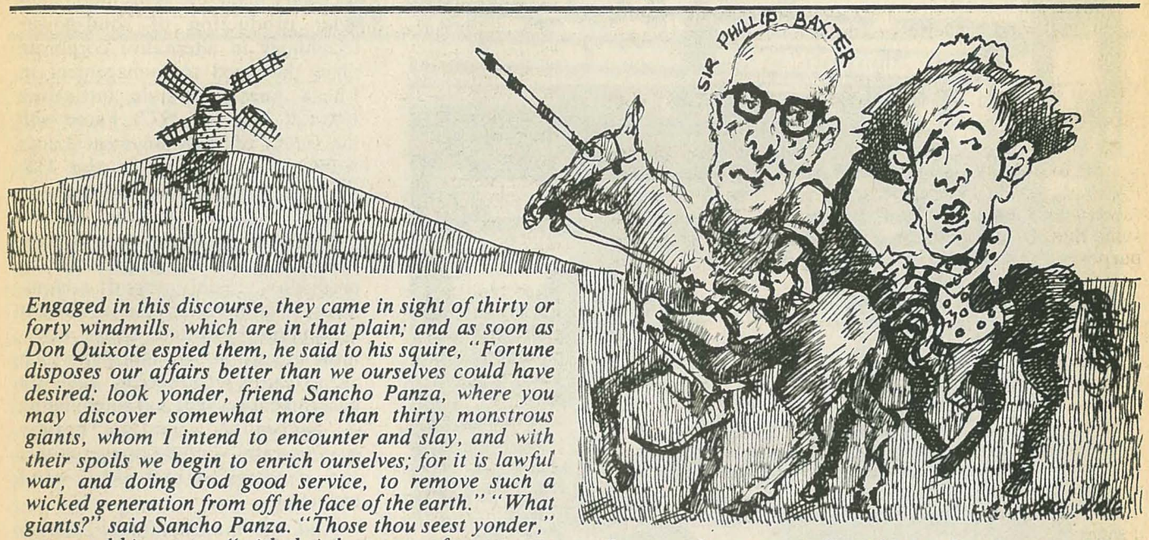
Alan Parker

WIND POWER FOR AUSTRALIA

1 How Many Mills?



Engaged in this discourse, they came in sight of thirty or forty windmills, which are in that plain; and as soon as Don Quixote espied them, he said to his squire, "Fortune disposes our affairs better than we ourselves could have desired: look yonder, friend Sancho Panza, where you may discover somewhat more than thirty monstrous giants, whom I intend to encounter and slay, and with their spoils we begin to enrich ourselves; for it is lawful war, and doing God good service, to remove such a wicked generation from off the face of the earth." "What giants?" said Sancho Panza. "Those thou seest yonder," answered his master, "with their long arms; for some are wont to have them almost the length of two leagues," "Look, sir," answered Sancho, "those which appear yonder are not giants, but windmills, and what seems to be arms are the sails, which, whirled about by the wind, make the millstone go." "It is very evident," answered Don Quixote, "that thou art not versed in the business of adventures. They are giants; and if thou art afraid, get thee aside and pray, whilst I engage with them in fierce and unequal combat."

The Adventures of Don Quixote
Cervantes

Large scale commercially viable wind systems capable of making a significant contribution to electric power generation are unlikely to be available before the last decade of this century. . . . the development of large scale windpower generation systems does not appear at this stage to merit a special research and development effort.
Senate Standing Committee of National Resources.
Report on Solar Energy, 1977

Wind power and other fringe types of energy are unlikely to play a significant part in the Victorian energy scene."
Vic. Government Green Paper on Energy, March 1977

Struggling uphill against these icy blasts, there is no doubt that it will be a long tough battle to convince State and Federal Governments that energy from the winds could make a major contribution to Australia's energy needs well before the year 2000. The dismissal of wind power as a "fringe-type of energy" belies a ubiquitous official attitude: that wind power is uneconomic, impractical, suited only for the wild schemes of well-meaning, but essentially misdirected, technological Don Quixotes.

But who are the real Don Quixotes in this debate? Those who advocate escalating use of fossil fuels, and inevitably nuclear power for Australia, to meet continued growth in energy consumption? Or the growing body of responsible scientists and citizens in Australia and overseas who see wind power as having an important contribution to make in supplying energy to a sustainable economy characterised by a constant level of energy consumption?

Official Australian pessimism for wind power contrasts starkly with overseas enthusiasm. For example:

- NASA estimate that it is technologically and economically feasible to build 350,000 1.5 MW (megawatt) wind plants to supply half the US electricity demand by 1985[1].
- A Danish wind expert, Bent Sorensen, has proposed that wind power coupled with solar collectors could provide all of Denmark's energy needs by the year 2050[2].
- The Swedish Government has decided to invest $A4.5 million over the next three years in analysing wind-energy potential. 95% of this will go into grid-attached systems using hydropower as a pumped-storage facility[3].
- Martin Ryle, writing in May of this year in the highly respected international scientific journal, *Nature*, estimates that wind electricity could substitute for energy now obtained from North Sea oil and gas in the UK as those reserves are depleted, at about half the cost of meeting this supply shortfall from a rapidly expanding nuclear-power programme as presently proposed[4].

This article will investigate the possibility of meeting **all** of Australia's electricity needs by the year 2000 from wind power **plus existing hydroelectricity** alone, or with an additional contribution from solar cells. A particular aim of the analysis to estimate the number and size of wind generators that would be required and consider where they might be sited. Any usage of wind energy for purposes other than electricity generation would require additional wind converters to those mentioned in this article.

Wind Power for an Urbanised Conserver Society

As a reference case, let us consider a wind power system to provide electricity in Australia with settlement patterns (i.e. the vast majority living in urban areas) and total population maintained as at present. But we will assume that, by using electricity sparingly and only for the purposes for which this high-grade form of energy is necessarily required, total annual electricity consumption could be reduced to half its present level [5].

Urban Windmills?

There is, I think, a lingering belief in some people in the alternative technology movement that, with reduced demand, city people could get their electricity from small, friendly, locally built, controlled and sited wind generators, one per house, one per block, or even one per sky scraper. However desirable this may be politically, there are unfortunately cogent technical factors militating against this form of deployment of wind devices.

In most large cities in Australia (see p.31 for wind speeds), each house would need at least a 7 metre diameter wind generator to get anywhere near the half present demand target proposed [6]. If almost every house had such a machine (not to mention factories and commercial buildings), the turbulence created by one prop would interfere with the next and so on; there would be safety risks with whirling blades on top of 20 metre high towers; trees and tall buildings would shield many propellors; and the visual impact of so many wind generators so close together would be considerable.

Why not then use large 'community' wind generators, say a 2MW model with 60 metre or greater diameter propellors, each supplying all or part of a suburb? The problem is again the number required to meet half today's electricity demand. In Sydney or Melbourne, several thousand of these large wind plants would be required in each city, each one about the size of a jumbo jet turned on edge. There would be safety problems, enormous visual impact, and the wind plants would operate at low efficiency because buildings and trees lower the average wind speeds in urban areas.

There is a very good reason why the alternative technology books which project the ideal of a wind generator per house or 'autonomous' terrace implicity assume we're all living in an essentially *rural* situation.

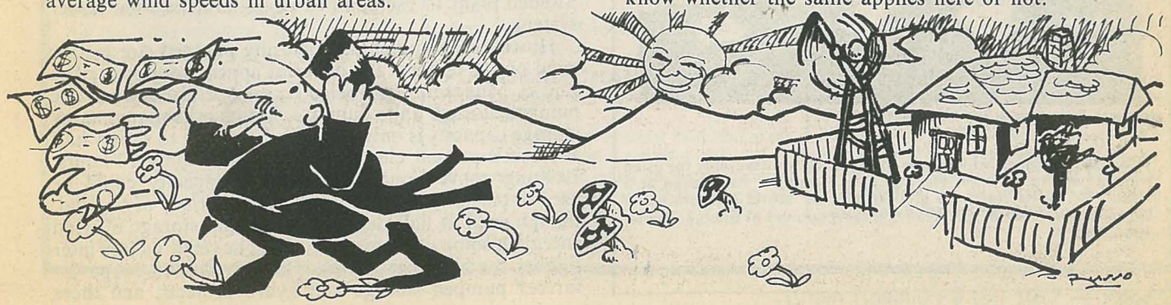
Remote Siting

Although siting large wind generators remote from the main centres of population they supply incurs energy losses in distributing the electricity generated, another factor will usually more than compensate for these losses [7]. This factor is the much higher mean wind speeds that exist in favorable sites — coastal, off-shore, or inland mountain ridges — compared with urban areas, and hence the considerably higher energy density in the winds at these locations. The energy in wind is proportional to the cube of its velocity, so a wind generator at a good site, say on the S.A. coast bordering the Great Australian Bight, where the mean annual wind speed is 9 metres per sec. (20 mph), would generate approximately eight times more energy per year than it would in say urban Adelaide with a 4.5 metre per sec (m/s hereafter) average wind speed.

One of Australia's foremost wind-energy pioneers, L. F. Mullett, wrote in a paper on wind potential in S.A. published in 1957: "a hill 200 ft high in open country is a potential site for a commercial wind power installation; but flat country sites should not be selected more than a few miles from the ocean coastline . . . a good wind site will not be found near vegetation stronger than coarse grass" [8]. But by 'good site' Mullett meant an annual mean wind speed of 8.5 m/s (19 mph) or greater, which are indeed limited usually to near the cost. Present research in the U.S.A. is aimed at designing windmills for economical operation at sites with mean wind speeds of 6.3 m/s (14 mph), which greatly expands their possible areas of application [9]. In particular it opens up inland areas of Australia for wind-energy collection. The maps following show the general distribution of wind energy resources in Australia and their seasonal variation.

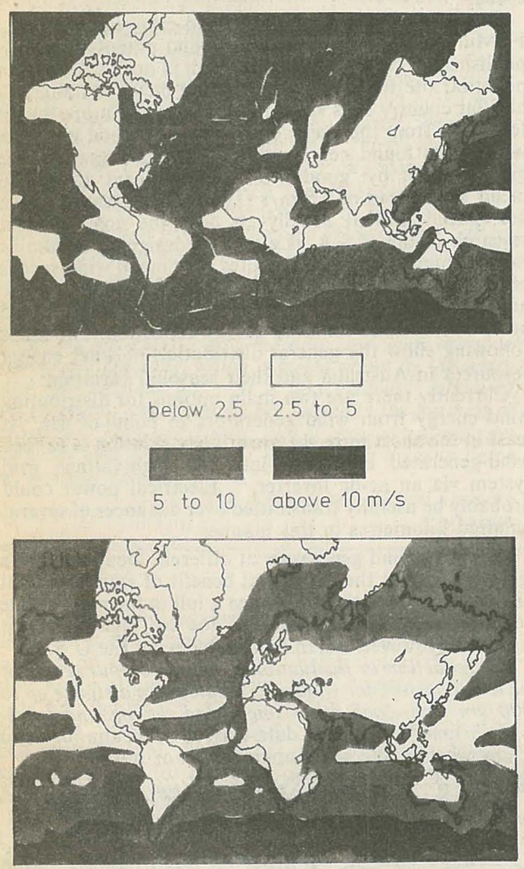
Currently there are two main options for distributing wind energy from wind generators to point of use. At least in the short term the most likely solution is to feed wind-generated electricity into the high-voltage grid system via an ac-dc inverter [10]. Electrical power could probably be usefully transmitted over distances of several hundred kilometres in this manner [11].

Coupling wind generators at different locations into a grid system has the additional benefit of smoothing out the net input into the grid, since a lull in the wind at one location may be compensated for by high winds at another. However, Sorensen concludes for the U.S.A. [12]: *"The reduction in fluctuation of power output seems to be less than 10% for windmills located at a distance up to 300 km from each other since wind regions change slowly"*. Insufficient wind data exist in Australia for us to know whether the same applies here or not.



How Many Mills?

The second possibility for distributing wind energy is to use the electricity generated to electrolyse (decompose) water (sea water if near the coast, brackish water if inland) and produce hydrogen, which could then be piped or otherwise transported to the point of use. Hydrogen can be reconverted cleanly to electricity by burning (e.g. in an aphodid burner, see p.17) or by combining with oxygen in fuel cells [13]. Its use as a storage medium for wind energy is discussed later. Professor J. O'M. Bockris of the Institute of Solar and Electrochemical Energy Conversion at Flinders University of S.A. argues that wind-produced hydrogen could be "transferred economically to sites of high energy use up to 6000 km distant from a wind belt" [14].



This map, indicating which areas of the world are favorable for using wind power to generate electricity, is based on data taken at a height of 10 meters above ground. Source: World Meteorological Organisation, Proc. of UN Conf. on New Sources of Energy, Rome, 1961, Vol. 7.

Choice of Wind Generator

There seems to be a consensus among authorities that basic strength-of-material limitations place an upper bound of 5 MW for a single wind generator, while the largest at present being designed is Boeing's 2.5 MW wind-electric plant with blades 90 metres in diameter. In the calculations which follow I shall assume 2 MW wind plants are used, which means a blade diameter of 60 m in sites with 8 m/s average wind speed, and 80 m for 6.3 m/s sites.

At such sites it appears quite practical to design wind generators with a 30% load factor[15]; i.e., the actual electricity produced over a year is 30% of the quantity that would be generated if the machine operated at peak load all the time. The load factor thus takes into account the variability of the wind. Assuming then a 30% load factor, we can calculate that the total electricity generated by a 2 MW wind plant is approximately 5.25 GWh per year (1 GWh = 1 Gigawatt hour = 10^6 units of electricity) — about enough to supply a town of population 2000, at half today's electricity demand.

Storage

In the early period of a wind - power programme, when a small number of wind generators at various locations would be coupled into existing grid systems, no additional storage of wind energy would be needed, since fluctuations in supply from wind plants could be accommodated by varying the output from the rest of the generators feeding into the grid (fossil fuel and hydro stations in Australia). In this mode, wind plants would serve as fossil-fuel savers. However, the maximum contribution of wind power to total electricity supply would be limited to 10%, otherwise the grid system would become too unstable [16].

If wind power is going to provide a major portion of electricity supply, clearly storage is necessary. The principal methods proposed are hydrogen, pumped-water storage, flywheels and lead-acid batteries (see p.11). Only the first two being the most promising at present, will be considered here.

In pumped-water storage, whenever electricity from wind plant fed into the grid leads to an excess of supply over demand, the surplus electricity is used to pump water from the low to the high dam of a hydroelectric scheme. When the wind drops, water in the upper dam can be run back to the lower dam through turbines to produce electricity and hence supplement supply. Neglecting transmission losses, electricity can be stored in this way and be reconverted back to electricity with an overall efficiency of about 70% [17]. Pumped storage has been in use for many years in several countries to store the surplus night-time output of conventional base-load power stations; some schemes cleverly have a single machine which doubles up as pump and turbine [18]. Sweden plans to use pumped storage for its wind power system [19].

However, the potential for using pumped storage for wind power in Australia does not appear very great. The Snowy Mountains hydroelectric scheme already has one pumped storage unit, Tumut 3, but its maximum energy storage capacity is only 10 GWh [20], enough to satisfy half Victoria's present electricity demand for only 10 hours. Existing conventional hydroelectric capacity could be used to partially meet demand during periods of no wind, though even at half demand substantial storage of wind energy in some other manner would be required (see later figures for hydro capacity). There is limited scope for further pumped storage and hydro projects, and there would be strong environmental objections to using these potential sites. Suitable mountainous areas are also located many hundreds of kilometres from population centres and wind belts, so transmission losses would be high.

The conversion of wind electricity to hydrogen via water electrolysis and back to electricity in fuel cells looks more promising than pumped storage for the Australian situation. Bockris, one of the strongest Australian advocates of the so-called hydrogen economy (see p.16), holds that the efficiency of converting electrical energy to the chemical energy of hydrogen could be improved to 85%, while fuel cells with hydrogen input could generate electricity with an efficiency of 65% (the best so far achieved is 50%)[21].

In the absence of precise data on matching between wind speeds and electricity demand I will assume *all* the electricity generated from wind plants is stored as hydrogen and then reconverted back to electricity before use. This will give an overestimate of the number of wind plants required.

On assuming Bockris's optimistic conversion efficiencies, the 5.25 GWh/year of electricity produced by one 2MW plant would give 5.25 x 0.85 x 0.65 = 2.9 GWh/year at the point of use.

How Many Mills

Before calculating the number of wind generators needed to meet our target year-2000 demand, we must consider the renewable energy supply available in existing hydroelectric schemes, especially from the Snow Mountains and Tasmania.

Since Tasmania already supplies very nearly 100% of her total electricity demand from hydro plants, we need only deal with the mainland situation. Currently the total mainland electricity production is approximately 73 500 GWh/year [22], so our goal is to supply half that, i.e., 36 750 GWh/year.

The contribution from existing mainland hydro schemes (mainly the Snowy) is 7350 GWh/year [23]; hence if we assume it would be possible to use this hydroelectricity in an optimum complementary manner to wind-generated electricity [24], the remaining demand to be met from wind power is 29 400 GWh/year.

With 2.9 GWh/year produced by one 2 MW wind generator, the total needed to supply half our present electricity demand for all mainland Australia is 29 400/2.9 = 10,000 wind plants. This figure compares with the 10,000 windmills dotted around Britain at the turn of the eighteenth century and the 100,000 that were still operating in Denmark in the early 1900s. But the latter were about ten times small than 2 MW machines.

Apart from Mullett's wind analysis for S.A., reliable data suitable for pinpointing sites for these 10,000 wind plants are unavailable. It is therefore impossible to say at this stage definitely whether enough locations could be found. But with wind generators capable of operating in a 6.3 m/s mean wind speed. (allowing inland sites to be used), and a very windy coastline stretching thousands of kilometres from Geraldton in W.A. round to Kingston, south of Adelaide, it would seem probable that there would not be a shortage of physically suitable sites. Wind plants with 60 m diameter propellers can be placed as close as 600 m without interfering with each other through air turbulence [25]. Whether an array (2 or 3 deep) of such plants along a particular coastline, or off-shore, is acceptable environmentally is a question that would no doubt stimulate heated debate.

NASA's contention[1] that 350,000 1.5 MW machines could be built in the U.S. by 1985 suggests that, given the political will and sufficient financial encouragement, there would be no technological reason why Australian industry could not produce 10,000 2 MW units by the year 2000. The job-creating potential of this new industry would be considerable [26]. The most technically similar existing Australian industry is aircraft production.

Solar Electric Supplement to Wind

While wind power offers one of the highest efficiency ways of getting electricity from a renewable source of energy, other ways exist of converting sunlight to electricity, the use of which could reduce the total wind capacity needed.

Solar cells in particular offer an attractive

How Many Mills?

decentralised means of supplementing electricity generated from remote wind plants, and their cost is falling rapidly (see p.18). A rough calculation for Melbourne shows that 10 square metres of solar cells on a house roof could collect over a year 30% of today's average annual *household* electricity consumption [27]. The latter includes electricity for an all-electric water heater, and if solar collectors were used for water heating, 10 m² of solar cells could provide 50% of the household's yearly demand.

Factory roofs obviously provide much greater areas than houses for solar cells. Outputs from these could supplement wind electric inputs to industry. Yet even with extensive installation of solar cells, wind power would still probably supply the greatest proportion in meeting the half-current-demand target set.

Economics

Mullett concluded in 1957 from his wind study of S.A. for the Electricity Trust of South Australia that economic quantities of wind for large-scale exploitation existed on high country in the southern regions of Australia, provided wind generators could be built for the costs he assumed [28]. None were ever built in Australia. Here and overseas interest in wind power wained as news spread around the world of stupendous oil discoveries in the Persian Gulf.

Almost two decades later, Donald Atkinson of Flinders University, a latter-day colleague of Mullett (who is now retired), used the old wind pioneer's data and some of his ideas in a proposal to the Ranger Inquiry for large-scale wind generation in South Australia [29]. Suggesting the use of large lead-acid batteries for storage, Atkinson arried at the rough estimate of $250-400 per installed kW [30] of wind capacity, including storage. Such a figure would make wind power economic today in Australia compared to coal-fired power stations, the present cost of which is about $400-500 per installed kW.

Bockris has done a detailed costing of a complete wind-based hydrogen scheme, involving 5 MW wind generators floating off-shore and undersea storage of hydrogen. His figure is $450-900 (1975 prices) per kW, which includes the cost of water electrolysis, storage, distribution of hydrogen over distance of 1000 miles from point of production and its reconversion by fuel cells to electricity. He estimates the cost/kWh of electricity at point of use would be 0.79 cents, lower even than off-peak electricity rates today (1.31 cents/kWh in Victoria).

Sorensen has done a detailed comparison of the economics of wind power with other sources such as nuclear[31]. His figures, perhaps some of the most reliable so far, are $US 400 /installed kW and 1.3 cents/kWh for 1 MW wind units without storage, and $US600/installed kW and 1.7 cents/kWh for the same units with storage (1975 prices). He quotes $US720/installed kW and 1.4 cents/kWh for light water nuclear reactors. Sorensen's conclusion is that wind power is likely to be economic today when coupled to a grid system and used as fossil-fuel or nuclear-fuel savers (i.e. when no separate storage is needed).

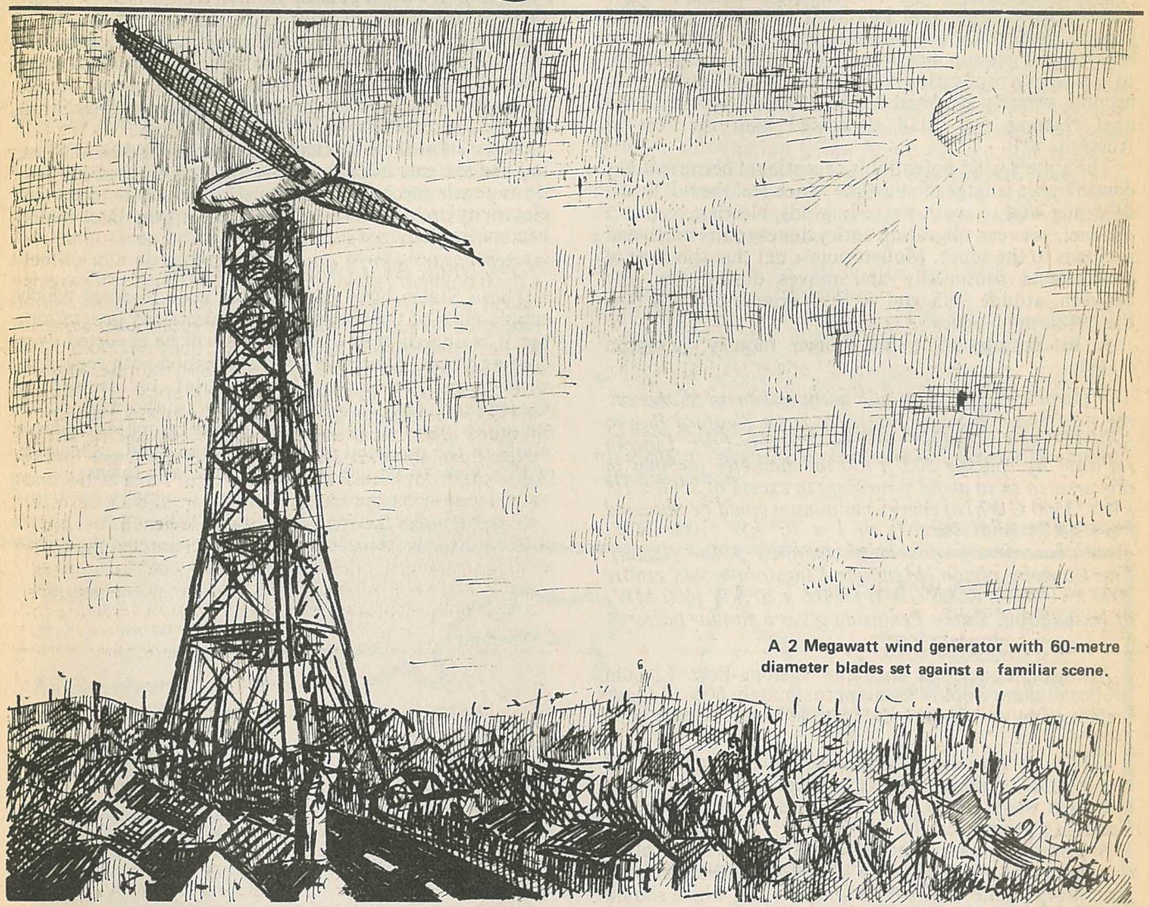
In considering the economics of wind power it is essential to keep in mind the particular energy priorities of the country or area under examination. For example, Martin Ryle has shown very convincingly in *Nature* [32] that over the next 10-15 years wind-generated electricity offers a far more economical and practical means of replacing energy now obtained from oil and natural gas in the U.K., than does nuclear power. Comparing wind and nuclear power on the basis of provision in both cases of 150-hour storage facilities for low-grade heat at the point of use to reduce peak loadings, Ryle estimates the costs as $US 500/installed kW for 1 MW wind generators, and $US 1250/installed kW for nuclear power stations when costs of fuel reprocessing and waste-storage are included.

Notes

1. From "Alternative Energy Converters", paper by Ken Newcombe, CRES, ANU, Nov. 1977.
2. *Science,* 1975, Vol. 189, 255-60
3. The Swedish Wind Energy Program, March 1977, Mimeo. From Karlbergsvagen 77,6 tr Stockholm.
4. *Nature,* 12 May 1977, Vol. 267, 111-7
5. For number of wind generators needed to meet today's electricity demand, simply double number arrived at later.
6. In this case taken as half present *household* electricity demand, which in Victoria is about 2450 kWh per year.
7. Overall distribution and transmission losses in Victorian system amount to about 10% of total electricity generated.
8. *The Journal, Institution of Engineers, Australia,* March 1957, 69-73.
9. See page 12 , "Wind Technology Review" article in this *CR.*
10. An ac-dc inverter converts direct current from an alternator or battery into alternating current as in the mains supply.
11. Power is at present transferred over 400 km by high-voltage (330 kV) grid line from the Snowy Mountains to Melbourne during times of peak demand.
12. Sorensen, B., "Wind Energy", *Bulletin of the Atomic Scientists,* Sept. 1976, 38-45.
13. See, e.g., J. O'M. Bockris, *Energy: The Solar Hydrogen Alternative,* Halstead Press, New York.
14. *Search,* July 1975, Vol. 6, No. 7, 280-4.
15. Mullett in ref. 8 used a load factor of 33% in his economic analyses.
16. See ref. 12, p.42.
17. From A.C.H. Frost, "Pumped Storage", Institution of Engineers Australia, Conference on Energy Resources for Electric Power Generation, Sydney 1974.
18. See 'Reversible Units' section of ref. 17.
19. See ref. 3.
20. Private Communication, Mr. Boreham, SEC Vic. Production Coordination Dept.
21. See ref. 14, p. 281.
22. Total Australian electricity production taken as 79 500 GWh/year (estimated from *End-Use Analysis of Primary Fuels Forecast 1971-2 to 1984-5,* Dept. of Minerals and Energy, Aug. 1974). Tasmanian electricity production taken as 6000 GWh/year.
23. Assumed to be 10% of total mainland electricity production, from G. Newstead, "Hydro Power", presented at Conf. noted in ref. 17.
24. Currently mainland hydro schemes are principally used to meet peak demand, i.e. produce high outputs for short periods of time. If used to meet supply shortfall with a wind system, hydro would need to supply some base-load electricity, i.e. lower output for longer periods. The turbines now installed would operate at lower efficiency in the latter case, so would probably need to be replaced if used in a large-scale wind-hydro system.
25. See ref. 12, p.39.
26. See "A Solar Solution to Unemployment," *Chain Reaction,* 1977, Vol. 3, No. 2, p. 10.
27. Assumes: average annual household electricity consumption of 4972 kWh (SEC Vic. Annual Report 1974-5, p.30); 1520kWh/year solar energy input to 1 square metre of solar cell (CSIRO Solar Energy Studies Unit, Sub. to Senate Solar Energy Inquiry, 1976, Appendix V., p.2); 10% efficiency of conversion to electricity.
28. See ref. 8, p. 73.
29. Ranger Uranium Inquiry Transcript, Monday 23 Feb. 1976, Adelaide, 5878-5914.
30. Ref. 29, p. 5884.
31. See ref. 12.
32. See ref. 4.

WIND POWER FOR AUSTRALIA

2 Siting Windmills



A 2 Megawatt wind generator with 60-metre diameter blades set against a familiar scene.

In Australia we are mainly concerned with comparing the cost of wind power with that of fossil-fuelled power stations, in particular coal. From part 1 of this article it is clear that wind plants connected to the grid are already likely to be economically viable as fuel savers. However, all such calculations assume no inherent value to a fossil-fuel in the ground; e.g. the cost of coal to the SEC in Victoria is the cost of digging it up. This in effect treats fossil fuels as inexhaustible, and distorts the comparison with renewable energy sources such as wind power.

Lovins [1] has suggested the use of long-run marginal-cost pricing of fossil-fuels as a way round this problem, and as a way of taking into account the value of non-renewable fuels to future generations. In this scheme, energy is priced *now* according to what extra prices supplies will cost *in the long run.* A thorough investigation of this pricing scheme is needed in Australia, since if adopted it would certainly mean oil and natural gas would be priced much higher, making wind power *including storage* economical when substituted for these fuels to generate electricity.

The price of coal would rise too, and if we fixed this price now according to what electricity will cost in the long run, in the limit we arrive by definition at the cost of wind-generated electricity, since coal supplies will eventually run out and we will have to use wind power. Importantly the money raised by taxes on non-renewable fuels to set them at their 'long-run cost' could be used to finance research and development into wind power and other renewable energy sources, and to provide financial incentives for their use. The relative economics of renewable and non-renewable sources of energy supply could thereby be radically transformed in favour of the former.

Wind power is also economic today in Australia when used to obviate the need to extend the grid in many rural areas. Currently the cost of grid extensions to the consumer benefiting is greatly subsidised. If the consumer is

willing, this subsidy could be given instead as a grant towards installation of a wind-electric generator with suitable storage facilities.

State-by-State Review of Wind Resources

South Australia

SA is one of the best suited of all the states for large-scale utilisation of wind power. It also has one of the greatet needs for wind-generated electricity since at present natural gas supplies around 50% of the energy input to electricity production [2]. Supplies of gas are likely to become severely depleted in the 1990s or before. SA's coal reserves are small compared with the rest of Australia's.

The state's wind potential is exceptional because it has considerable lengths of coastline which feel the full thrust of strong west to south-westerly winds, blowing, as if in a channel, between migrating anticyclones to the north and cyclones to the south. Mullett points out that this lane of wind exists continually and moves during the year between latitude 30°S and 40°S. Mariners call this lane the "Roaring Forties" [3].

In his submission to the Ranger Inquiry, Atkinson stated:

"An example can be given of a fairly well sampled area on the west coast of South Australia from Sleaford Bay to Streaky Bay bounded by the Penong-Port Lincoln railway. By spacing 200 ft (60 m) diameter turbines in this area so as to avoid screening, in excess of 3500 x 10^6 kWh (3500 GWh) of energy per annum could be obtained from an installed capacity of 1 x 10^6 kW (1000 MW, about the capacity of a large coal-fired power station). The Coorong region (Meningie-Kingston) would realise 2000 x 10^6 kWh (2000 GWh) for 0.6 x 10^6 kW (600 MW) of installation. Yorke Peninsula gives a similar pattern" [4].

Atkinson concluded that the Penong-Port Lincoln proposal alone would "save approximately 60% of fossil fuels used by the Electricity Trust of South Australia in 1974"[4].

Electricity from these coastal wind plants could be fed into a grid, or perhaps more conveniently converted to hydrogen which could then substitute for natural gas in electricity generation.

A private company, the Aerodyne Corporation, plans to build a test group of six 75 kW Darrieus wind electric generators on the Yorke Peninsula in 1978, which should provide direct evidence of local cost factors and the feasibility of large-scale wind power for S.A. [5].

Western Australia

With much of its long ocean coastline in the path of the roaring forties (Geraldton to Eucla), W.A. also has considerable wind power potential. Since the state is in the unhappy position of using fuel oil for about a third of the energy input to electricity production, it will soon need a replacement source of supply. Wind power could well be the best candidate. Wind generators on the Bunbury to Albany coastline would be close enough to Perth to allow high-voltage grid-line transmission.

Victoria

At half today's level of electricity consumption and provided coal was not used in quantity for conversion to oil, Victoria's brown coal reserves would last 100 years or longer. There are a lot of 'ifs' there, and since coal is not the most benign substance either to mine or to burn, there is no room for complacency.

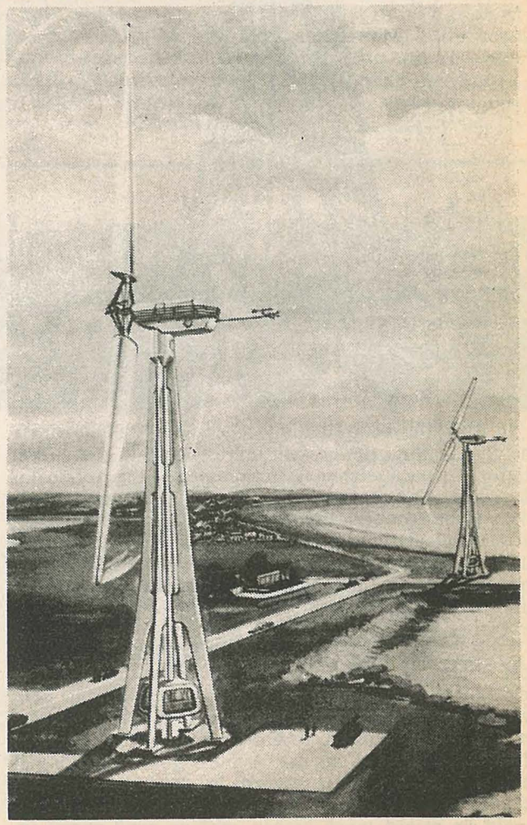
It is recommended that the Federal Government begin immediately a feasibility study for a prototype 2 MW wind generator for coastal or off-shore siting, and later initiate investigation of a similar machine for lower wind speed, i.e. inland, operation. The State Electricity Commission of Victoria should participate in this study.

Musgrove has proposed in the *New Scientist*[6] that depleted off-shore oil wells and natural-gas fields in the North Sea could be used to store hydrogen produced by sea-borne wind generators. The same pipes used to bring the oil and gas ashore could then be used for the hydrogen. It would be interesting to study the Bass Strait oil and gas deposits with this aim in mind.

In the short term in Victoria an aim should be to phase in wind systems as old coal-fired and oil-fired power stations reach the end of their useful life, and to supply electricity to rural areas distant from grid lines which become settled.

NSW (incl. ACT) and Queensland

These States have considerable coal reserves which supply most of the energy used for electricity generation, but it is uncertain how much coal will be exported over coming years. Hence the general position with regard to wind-power development is similar to Victoria's. Queensland and N.S.W. electricity authorities could therefore usefully collaborate in the proposed federal study of the potential of a 2 MW wind plant, especially with a view to its use in isolated outback towns.



N.T.

Being within the tropics and encountering the occasional cyclonic wind which would probably take any wind generator away with it, conversion of sunlight to electricity may prove the more suitable course for the N.T.

The low population might reduce the land areas required by centralised schemes such as solar-power towers (25 hectares of mirrors to supply 10,000 people at today's level of electricity usage) to acceptable levels. Solar cells could certainly be used for electricity generation and would operate at high load factor during the year.

Wind Power and Decentralisation

The concentrated energy available in fossil fuels has facilitated the congregation of people into our large sprawling cities, and the associated concentration of capital and control. As our material standard of living has risen, these urban areas have become regions of incredibly intense energy conversion. If we attempt then to meet anywhere near today's urban energy demand from a diffuse energy source such as the wind, we must necessarily collect energy from a large number of units and then 'pipe' it back to the cities The assumption of maintenance of present urban settlement patterns in Australia (one of the most urbanised countries in the world) thus leads to a mode of deploying wind power involving arrays of large wind generators along suitable coastal areas and some high inland mountain ridges, generally remote from centres of population. While each 2 MW wind plant is tiny in energy terms compared to a modern 1000 MW power station, each plant must be coupled, via hydrogen or a grid, to a large centrally coordinated distribution system. Such a wind power system, *by itself*, would not promote, nor conversely prevent, greater decentralisation of political and economic control.

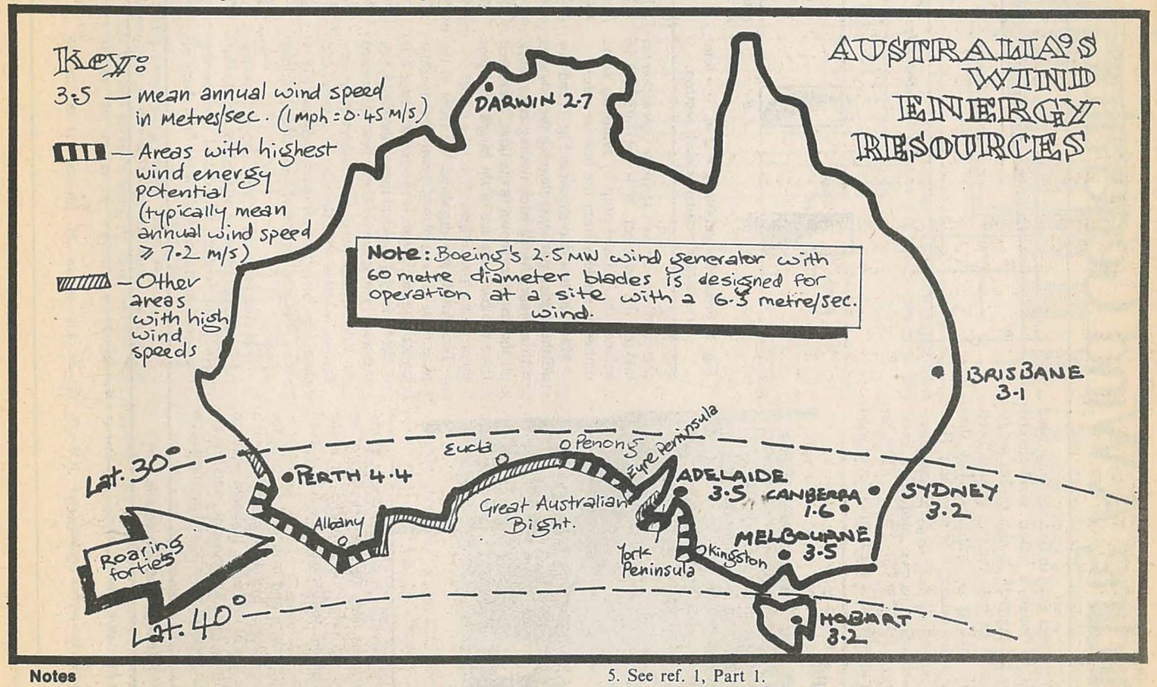
But given a widespread desire to use a soft renewable-energy sources such as the wind, the problems of meeting even half present electricity demand in large urban areas could be used as an additional argument in favour of decentralising our population distribution. To the extent that people were willing to settle in country towns and rural areas, wind power could indeed provide the technical means of their achieving greater political and economic autonomy. If windmills mainly supplied local demand, distribution losses would also be minimised.

To keep our options for the future open, there is I believe a need now to begin full-scale research and development of the following broad types of wind generators in Australia:

- a 1-2 MW wind plant for use with a grid or hydrogen-based system;
- intermediate-sized plants, — 100 kW for industrial, agricultural, and possiby for supplying electricity to large cooperatives;
- 1-25 kW plants for use at isolated houses, farms and small rural cooperatives and communes.

There is also an urgent need for a full survey of the wind-power resources in Australia, as a basis for future decision-making.

JOHN ANDREWS



Notes

1. Amory B. Lovins, *Energy Strategy: The Road not Taken?*, FOE Australia, 1977, p. 14.
2. "Sectoral Use of Energy in Australia", J. D. Kalma, CSIRO Division of Land Use Research, Canberra, April 1976.
3. See ref. 8, Part 1.
4. See ref. 29, Part 1.
5. See ref. 1, Part 1.
6. *New Scientist*, 9 Dec. 1976, 596-7.

The foregoing article is essentially a working paper: comments to the author (via FOE Melbourne) are welcome. Thanks to Ken Newcombe for sending his recent paper, which provided many useful facts and references.

Building A Wind Generator

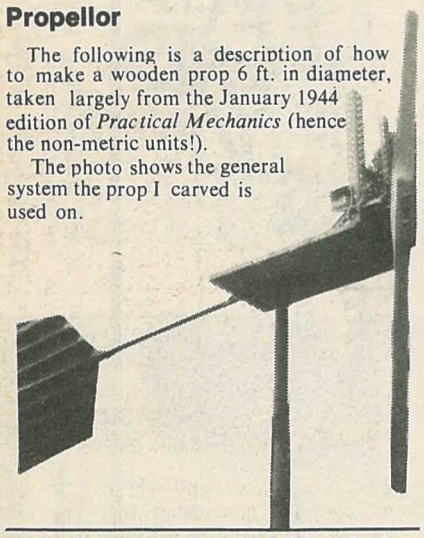
Page One

One of the best ways to find out about wind power is to make a small wind-electric generator for yourself. It also makes an excellent school project. The two most difficult steps are making a propellor, and then matching it to a generator or alternator. Here I'll deal only with these two tasks; many alternative technology books adequately cover other aspects (see CR Vol. 2 No. 2, 1976, for determining whether a site is suitable for wind power).

Propellor

The following is a description of how to make a wooden prop 6 ft. in diameter, taken largely from the January 1944 edition of *Practical Mechanics* (hence the non-metric units!).

The photo shows the general system the prop I carved is used on.



The first essential is a sound board of uniform thickness with the grain running along the length, 6ft.x4in.x¾in. Douglas fir is the best timber but well-seasoned ash is a good substitute.

Find the centre and drill a ¼ in. hole for testing the balance by hanging the prop on a nail in the side of the bench. It should return to the horizontal from any position, and it is essential that this test be done and any deviation

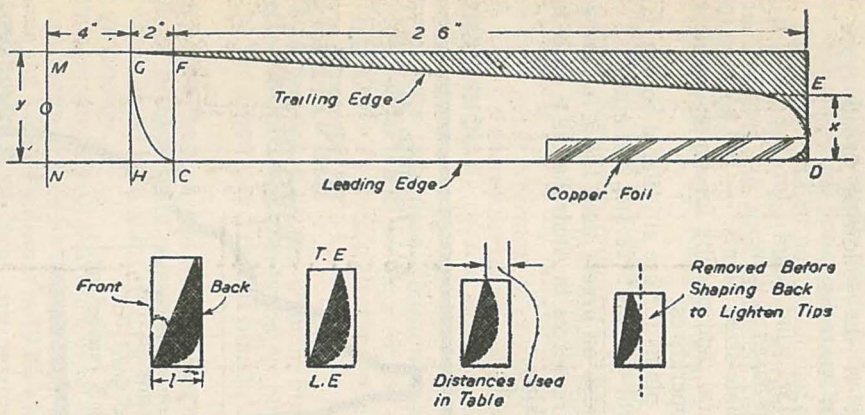


Fig. 1. Propellor details. x = 3 in., y = 4 in., l = ¾ in. The curve of the leading edge remains the same at each section.

corrected *after each separate operation* in making the propellor. It is not sufficient to balance the finished prop by removing some timber at random from the heavier side.

Mark the board as shown in Fig. 1, and saw off the shaded portions, cleaning the saw cuts with a plane. Along each trailing edge mark off the distances shown in the table, measured from the back surface of the board, and join them with a pencil line.

To form the driving slope, the front of the prop must now be planed down so that a flat smooth surface connects the original edge CD of the board to the pencil line all the way along the blade. The space GFC can best be scooped out with a spokeshave. The flatness of the new surface is tested with the edge of a ruler, and should be fairly true all the way along. Fig. 1 shows the cross-section of the blade at various points.

This completes the driving slopes. Now the back surfaces must be shaped for the lowest possible air friction. The dotted lines on the cross-section diagrams show the final shape of the back surface, which is planed to a smooth curve with a 'blunt' leading edge and decreasing rapidly away to a point along the trailing edge, the maximum thickness of timber being about one-third of the width of the blade from the leading edge at all points.

To reduce the weight of the outside portions of the prop, and to maintain the correct proportions between thickness and width, some timber has to be removed from the back before shaping to the streamline section described.

Lay the propellor with back uppermost *and put two or three blocks of timber underneath the front face to act as supports, since the driving slopes will not lie flat on the bench.* Plane the board, keeping a flat surface, until it changes from its original thickness at the centre to about half its thickness at the end of each blade. The streamline curve illustrated by dotted lines in Fig. 1 can now be worked on to the back of the blades.

Cut the tips of the blades to the shape indicated and the prop is ready to be sandpapered. This should be continued, from coarse paper to fine, until the whole propellor has a glass-like surface. Particular attention should be given to the blade tips, where the speed is greatest. The leading edge should be protected for the last 12 inches of its length by light copper or aluminium foil. The foil is bent to fit the shape of the blades perfectly, extending back about ¾ inch on the blade, and fixed by about six small wire staples, passed through tiny holes drilled in the foil and timber, and clenched on alternate sides. This protection is almost a necessity, otherwise the timber comes to pieces along the leading edge after several months working. Give the prop at least two coats of outside varnish, leaving a week to dry between each coat. Enlarge the central hole to fit. Attach a ¼ inch thick metal plate with similar central hole to the centre of the prop with two ¼ inch bolts positioned about 2 inch either side of the centre. Cut a key slot to accommodate the key on the alternator axle. Remove the pulley wheel from alternator and bolt propellor onto axle with nut and spring washer.

Rewinding the Alternator

Unfortunately 12 volt car alternators and generators operate over an rpm (revolutions per minute) range unsuitable for direct coupling to the prop described (and most others). I used a Bosch 12 volt 35 amp (420 watt) alternator obtained from a car wrecker, so let's look at how to modify this type.

The Bosch alternator is designed to start charging a battery when it gets to 960 rpm, and its maximum rotational speed is about 5000 rpm. This contrasts with the propellor described which rotates at about 300 rpm in a 5.4 metres/sec. (12 mph) wind, speeding up to 900 rpm in an 11 m/s (25 mph) wind.

If then we want our wind generator to begin charging in a 5.4 m/s (12 mph) wind, we have to change the alternator's characteristics so

Table 1. Propellor carving details.

A. Distance from centre of board (inches)	2	3	4	4.5	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
B. Distance from back surface on trailing edge (inches)	0.75	.75	.75	.25	0.10	.06	.06	.06	.10	.20	0.24	.26	.28	.30	.31	.32	.34	.36	.39	.40	0.41	.41	.41	.42	.42	.44	.50	.55	.57	.58	0.59	.60	.60	.61	.62	.62

that it generates 12 volts at around 300 rpm.

The way to do this is to rewind the stator coils, the fixed coils surrounding the rotating central field windings (see Fig.2) with about three times as many turns of smaller diameter wire. The alternator will then generate about three times the voltage as before at a given rpm. But less current will flow and the maximum power output is lowered (which we want anyway since we could only expect a maximum of 200 watts from a 6 ft. prop).

The easiest path is to pay for an alternator repair firm to do the rewinding. I contacted Electrowind Sales and Bearings Pty. Ltd., 146 Argus St., Cheltenham (ph 550 1033) in Melbourne and they said it would cost about $10.

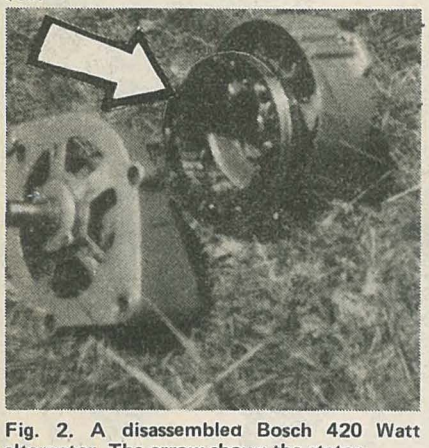


Fig. 2. A disassembled Bosch 420 Watt alternator. The arrow shows the stator.

This firm kindly let me watch their chief coil rewinder, Tonie Hancock, as he rewound my alternator. A painstaking do-it-yourselfer could do the job, but it's not easy. Here are the basics of the method used.

First note carefully where the stator leads are soldered onto the rest of the alternator, then remove the whole stator and strip its present windings.

Wind three series of six coils, each series as shown in Fig. 3, using the former shown in Fig. 4. Wind 36 turns of 0.63-0.67 mm diameter enamelled copper wire on each coil. *All* coils must be wound in the same sense (all clockwise or anticlockwise. it doesn't matter).

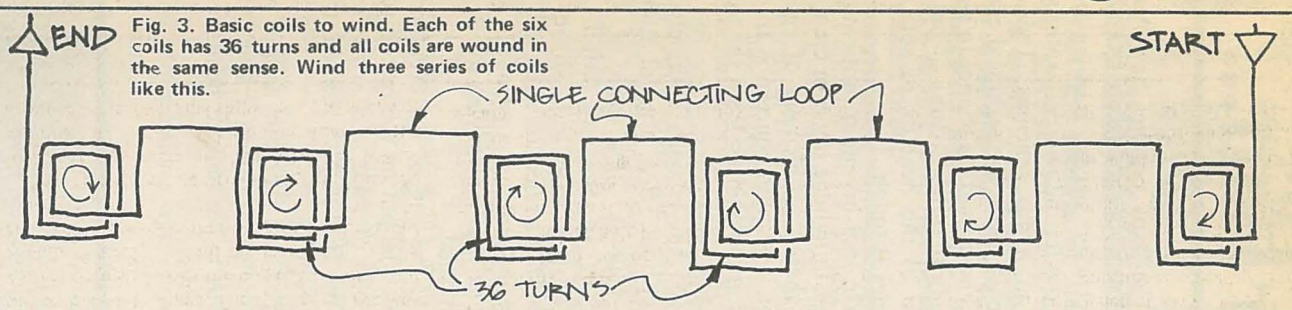


Fig. 3. Basic coils to wind. Each of the six coils has 36 turns and all coils are wound in the same sense. Wind three series of coils like this.

The line of coils in Fig. 3 can be obtained by carefully folding out one turn of each coil as it is taken off the former. Sellotape the coils to hold them together temporarily.

The coils are then manipulated into the slots on the stator assembly as shown in Fig. 5. Tap in wooden wedges to hold the coils in place in each slot. The 'out' leads of the coils are insulated and all soldered together. Make sure no wires protrude into the tunnel, and flatten and neaten up the coils by pressing them with a flat piece of wood.

Test for continuity and shorts, coat with a baking varnish such as Shellac, and bake the whole assembly.

The 'in' leads can now be soldered to the appropriate tags on the alternator assembly (connecting to the diodes) and the alternator reassembled. It's then a good idea to get an auto-electrical firm to test the alternator. Find out at what rpm it will start to charge a 12 volt battery, and its maximum power output.

Mine started to charge at around 400 rpm, but disappointingly only gave a maximum power output of 70 watts. Connected to the propellor it began to charge at wind speeds a little over 12 mph. It's not going to generate much power, but at least IT WORKS!

John Andrews

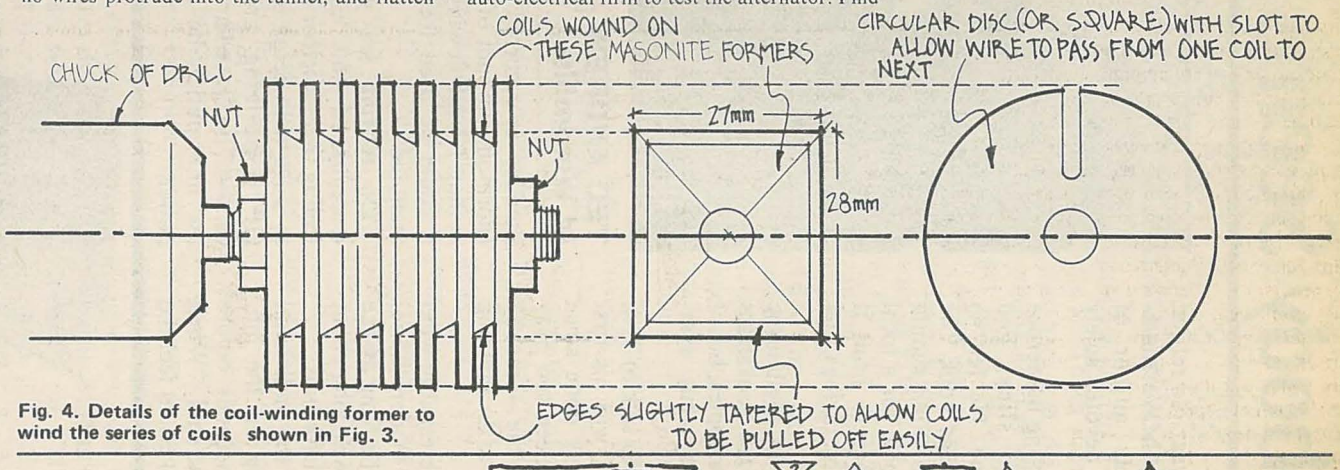


Fig. 4. Details of the coil-winding former to wind the series of coils shown in Fig. 3.

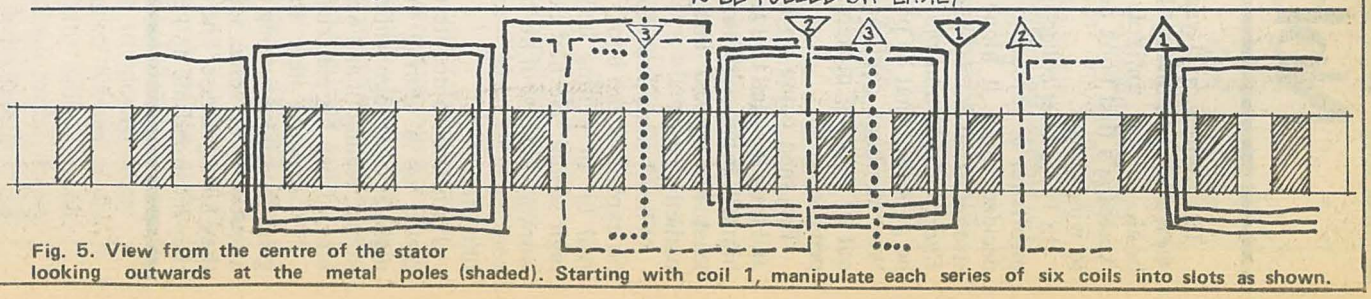


Fig. 5. View from the centre of the stator looking outwards at the metal poles (shaded). Starting with coil 1, manipulate each series of six coils into slots as shown.

Nobody Seems To Hear Him...

Ted Andrew, a 71-year-old retired shearer's cook living in Warrnambool, is the unlikely author of Australia's first book devoted solely to wind power.

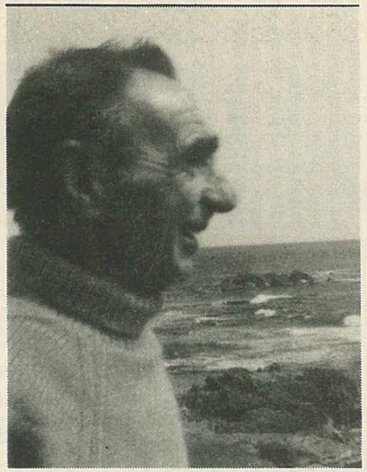
In 1975, after collecting numerous publisher's rejection slips, Ted decided to go it alone. He felt so strongly that his 50-page book *The Energy Crisis and the Wind* should be published that he paid for a local Warrnambool publisher to print it out of his own meagre savings and pension.

Ted then came up to Melbourne and took it round to a few bookshops himself. It has sold few copies, but at least has passed into some sympathetic hands.

When I went down to talk to Ted, he explained the book was his first real bit of writing he's done since high school. He had been too busy working the rest of his life — mostly cooking in Victoria — to do anything like that.

He first became interested in wind power on a stormy Warrnambool night 25 years ago while lying awake in bed, feeling ill and worrying about how to pay his electricity bills.

"You could hear the individual gales coming, roaring up the hill, about two or three seconds before they hit my house," he said. "When they hit broadside on I could feel the



TED ANDREW — Dreaming of Windmills

shudder. It occurred to me what an enormous amount of energy there is in that. It's all blowing to waste when it could be used for the benefit of mankind".

On retiring six years ago Ted remembered this experience, and feeling that "nuclear energy as a way to solve the energy crisis is like my GP prescribing arsenic to cure cancer", he "raced around" to get all the information he could on wind power.

The book outlines how Australia and other countries could meet their electricity needs from giant sail windmills and pumped-water storage as in hydro schemes. Ted admits himself there are technical errors — he's never had the chance to build the windmill of his dreams — but his vision of the benefits of soft energy shines through.

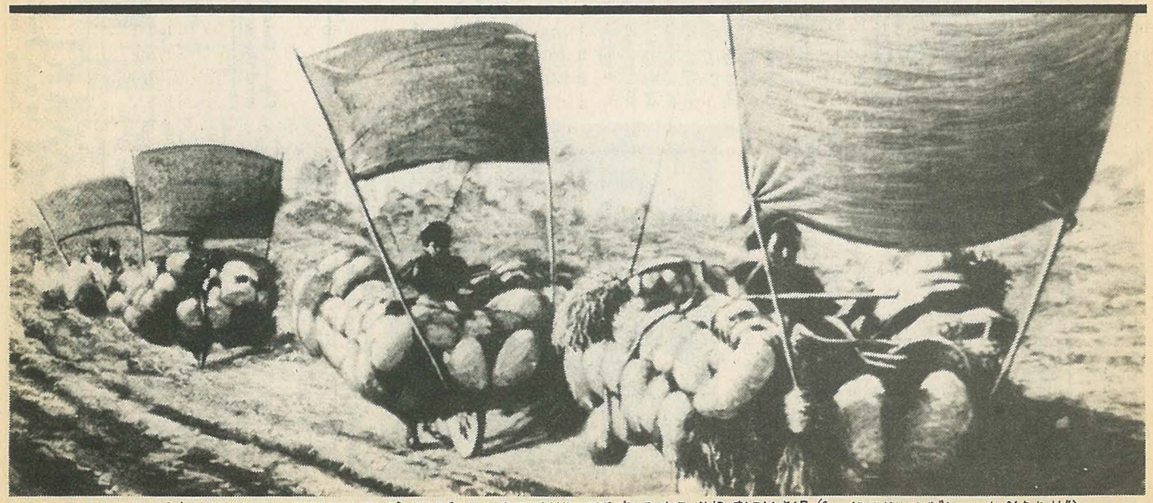
He said his main motivation was "not to indulge my own creativeness — there's an element of egoism in that. My main concern is to protect my grandchildren from the threat of nuclear energy".

Ted has recently completed a second book, *Ben*, a novel attempting to explain "the risks of nuclear energy to the lay mind". He's already collected some more publisher's rejection slips, and is considering sinking most of his remaining savings into paying for *Ben* to be published.

At the end of the evening of my visit, Ted put on the record player a version of Paul McCartney's "Fool on the Hill", which seemed strangely appropriate.

Ted's no fool, and neither was the Beatle's lone dreamer. But "Nobody seems to see him, or hear the words he says".

JA



• EARLY CHINESE ROYAL AIRFORCE SAILBORNE BOMBERS, ABOUT TO TAKE OFF TO BOMB THE JAPANESE (from SPIKE MILLIGAN'S "Transports Of Delight")

DESERTIFICATION

DAVID CARTER reports on the insidious spread of deserts around the world . . . and it's happening in Australia too. One estimate suggests almost 40% of the world's arable land has been lost to 'desert creep'.

It wasn't until the 1967-72 drought which struck at countries along the southern fringe of the Sahara — the Sahel — that interest grew in the spread of desert. During those years, between 100 000 and 250 000 people died, largely due to disease brought on by malnutrition or to starvation. As they retreated back to better pasturage, their herds stripped the vegetation and valuable breeding stock was lost.

Initially, the drought was thought to be part of a long-term climatic change which had been going in cycles for some time. Because the Sahel is a fairly complicated area, prone to violent fluctuations and without adequate long-term weather records, it was difficult to reach definite conclusions. However, as the drought progressed, scientists began to wonder if it was a sign that the boundaries of the Sahara were moving southward.

This progressive extension of desert conditions into once fertile regions is known as desertification, or 'desert creep'. It is a complex process which is still not fully understood, but its major cause is known to be the influence of humans on the environment, and it is now affecting many of the semi-arid areas of the world.

Overgrazing, the denudation of forests for firewood, industrialisations, construction, excessive ploughing due to mechanisation, land-tenure systems, population growth and the settling of nomads, have all played a part in the inter-reaction between desertification and development. Although to most people, 'desertification' is a relatively new term, it is not a new phenomenon. Scientists have been aware of its existence for some time.

There has been a theory around for over a century that the Rajasthan Desert in India was human-made. Tiger and deer used to roam the area several thousand years before Christ. British Archaeologists of the Empire, who investigated the ruins of the Harappan culture that existed in the Punjab along the Indus and other rivers of the area around 2500 BC, suggested that the desert resulted from the degradation of the local forests. The trees were cut by the Harappan people to fire the bricks for their cities and ovens. It was suggested the denudation of the land raised the water table in the area, thereby bringing salt to the surface and salinizing the soil.

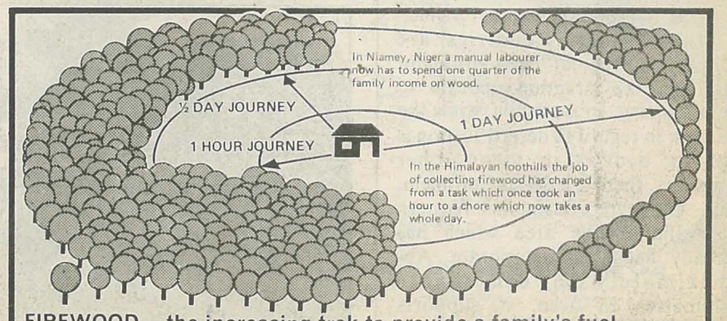
In the late sixties, Reid Bryson, an eminent climatologist in the United States, came up with a theory to further reinforce this opinion. He suggested that, if you remove vegetation and bare the surface of the ground, you increase the amount of reflected radiation from both the ground and off dust in the atmosphere caused by erosion.

Consequently, less radiation is absorbed by the land. This leads to a cooling of the air surface above the ground and increases the rate of subsidence of air masses coming into the desert area, which is exactly the opposite conditions to those needed to produce rainfall. To produce rainfall, you need both water vapour in the atmosphere and rising air. With subsidising air it is almost impossible to get significant rainfall.

More recent investigations by the Indians of the vegetation changes occurring in the area and of the climate at the time have suggested that the climate was deteriorating naturally. This adds further evidence to the claim that either the Harappan's caused the climate change, or their activities magnified an already deteriorating situation. Humans' reactions to a naturally occurring climatic change can often have just as significant an effect as those changes.

In September of this year in Nairobi, the United Nations called a World Conference on desertification which was attended by 1500 delegates from 110 nations. In preparing for the conference, the UN Environment Programme was asked to "assess all available data on desertification". There was so little known on the subject that the team preparing the information had virtually to create a new science of 'desertology'.

As a result, the size and importance of the problem is beginning to be known. In North Africa alone, every year at least 100 000 hectares of land are lost to 'desert creep'. Professor Mohamed Kassas of the University of Cairo estimates that the area of human-made desert, world-wide, is now over 900 000



FIREWOOD — the increasing trek to provide a family's fuel

square kilometres, which means almost 40% of the world's arable land has been lost to desert. Desert areas now cover 30% of the world's land surface and contain 628 million people.

It is therefore not surprising to hear that the 1977 State of the World Environment Report predicts a halving of the area of cultivated land per person by the year 2000, owing to the dual effects of population pressure and the loss of arable land.

One controversial issue which arose at the Nairobi Conference was the building of the proposed Jonglei Canal in Sudan. The Sudanese claim it will reduce destructive annual flooding, provide water for agriculture and help to improve the standard of living of the local people, most of whom are at present living below subsistence level.

The Jonglei's opponents claim it could have harmful effcts on the local ecosystem, particularly the Sudd swamps, by changing evaporation rates and thereby affecting rainfall regimes, not only in Sudan, but also in neighbouring countries. A decrease in seepage from the swamp could also lower water tables in areas far removed from the Sudd, thereby leading to desertification in lands now relying on underground water resources from the area. The confusion over the Jonglei Canal highlights the problem of large-scale construction and water-diversion projects and their effects on desertification. Often the only way of finding out what the effect will be is to go ahead and build, but then the damage done might be irreversible.

Most western countries are relatively free of the problem, although the situation appears to be worsening. In Australia, while the outlook in regard to desertification is not as bad as in many other countries, there is a definite problem. The Gascoyne Basin in Western Australia is one area which has already begun to deteriorate. Approximately 165 000 square kilometres in area, if supports 290 000 sheep and 17 000 cattle. After more than six decades of heavy grazing, only a third of the land is still fit for use. Droughts are becoming increasingly more common and nourishing perennial native plants are giving way to inedible shrubs.

Dr R. Wasson of the Department of Geography, Monash University, has carried out studies of the Australian range lands, mainly in western New South Wales and northern South Australia. When asked about desertification in Australia, he was careful firstly to place Australia in a world context:

"The Australian desert is not verv dry in comparison with, say, the Sahara desert," he said. "Australia is wetter, generally speaking. We have vegetation of some sort or other over most of our arid areas and we are environmentally more stable. In the Sahara, there are vast areas of sand or bare rock, incapable of supporting life of any sort. There is no danger that great areas of Australia will end up like the Sahara."

"However, there is on-going deterioration in vegetation. People are still using land as if it is a never-ending resource. If you define desertification as simply a decrease in productivity of the arid zone, then desertification is going on in Australia, but it is not going on in the spectacular way you expect, with dunes roaring across the countryside."

Dr Wasson cited the example of the Murray River — "the best known and understood river system in Australia" — as an example of human interference causing unexpected problems. Salinisation caused by irrigation has left large areas of unusable land along the Murray. And salinisation is still a problem today, with experts holding contrary opinions on how the problem can be solved.

Also there are areas around western NSW where the saltbush vegetation has deteriorated to inedible woody shrub, while there is a deterioration of the hummock grasslands of the tropics.

Wasson sees the cause as twofold: "In Australia, you can see problems not only in the way pastoralists use the land, but also in the Governments reaction to them. In my view, Australian graziers are very good at animal husbandry. They understand animals but know virtually nothing about the vegetation. There is a very poor understanding of the tolerance and role of native pastures in soil stability and the reduction of erosion. The pastoralist seems to be the sort of person he was earlier in the century, someone with a very short sighted view — an exploiter.

A laborer in Niamey, Niger, must now spend one quarter his income on fuel. But the caravans that bring this previous resource into the towns are contributing to the creation of desert-like conditions in a wide band along the desert's edge.

"In NSW the Western Lands Commission is the statutory body which looks after the Western Division. It has as one of its policies that at the end of a lease period (approximately 45 years) — and most of the land is under lease — the person who has been running a station will not, as matter of policy, be able to release that land. So, if a person is a demonstrably good pastoralist, if he looks after the vegetation, it doesn't help him one bit. He might as well flog the land for all it is worth and leave the mess for the next guy. To my mind it is an absurd policy, and unless that policy is changed we will see continuing degradation and desertification."

It has been noted in other areas of the world that domesticated animals can have a destructive influence on the land, often assisting the breakdown of areas into desert by overgrazing. The situation is the same in Australia. According to Dr Wasson: "The number of introduced animals in Australia has helped desertification. Goats certainly have. Cattle and sheep have also had a bad influence. Rabbits have had the most dramatic effect — catastrophic. They've also had an effect on small marsupials, along with the fox. The Bilbi in particular has been knocked on the head by both, because the rabbit kicked it out of its burrow and the fox ate it."

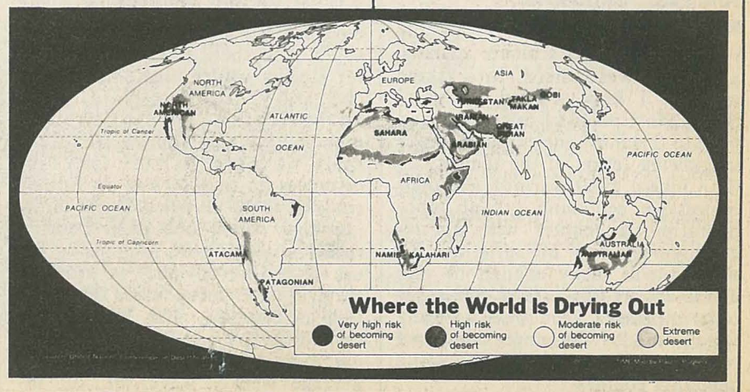
Dr Wasson noted that there was little awareness of the problems in Australia, because: "Australians tend to live on the coast and know little about the drier interior areas. There is very little public awareness of what is going on and, from a conservationist's point of view, that is a fundamental flaw in any efforts one might make to change things in the interior, because most of the changes which have come about in Government policy are largely produced by public pressure.

"We need to have a very good look at our range lands and the policies affecting the range lands. The time is auspicious for serious public and government discussion."

Some preliminary work on understanding desertification has already been done in Australia. In NSW the Soil Conservation Authority has been trying to assess the role of soil erosion in pasture degeneration and to evolve a technique for measuring it. Also the CSIRO has been investigating changes in the soils in the range lands and has been carrying out comparisons between domestic stock and native animals.

Some solutions Dr Wasson suggested to reduce the risk of desertification and to preserve our semi-arid lands include: a return to older methods of open grazing, where droving cattle and sheep from dry areas to land where better feed is available would help ensure overgrazing does not occur; a more aware government land-lease policy, which places the responsibility of land maintenance and upkeep on the pastoralist, with inspectors to keep stringent checks; and greater effort spent on the education of pastoralists in understanding the needs of their land.

Perhaps the most interesting idea comes as a result of the present depressed economic conditions. Dr Wasson has suggested that, as more and more of the outlying pastoralists are driven off their land by the declining cattle market and the increasing transportation and petrol costs, the more marginal areas should be made into a national park, thus ensuring their upkeep and allowing close control to be kept on the state of the land.



CHINA

AN ENVIRONMENTALIST'S DREAM?

IAN PAUSACKER has returned from a recent visit to China with many of his dreams about the country shattered. 'People in our group just wouldn't believe the locks on all the bicycles there existed', he writes. He poses the question: Is the environment movement a capitalist society's luxury? Here he gives a frank account of his experiences in China. Ian is the author of Is Recycling the Solution?, **and runs a small vegetable and fruit farm at Monbulk near Melbourne.**

Ever since the Chinese started allowing westerners into their country, I have wanted to travel there. Most people I knew who had been to this most ancient land, spoke in glowing terms of the tenacity of the Chinese, their warmth, and their impressive economic growth since liberation: a country with no unemployment and no inflation. So when I was lucky enough to visit China earlier this year, I was eager to be impressed, keen to see a society which sounded like utopia compared to our alienated exploitative capitalist country.

Well, what is China really like? Much has already been written about China's political and social structure, and the progress made since liberation. In this article then, I'll concentrate mainly on my reaction to various aspects of China today relevant to the environment movement. I shouldn't dare to offer any opinion at all after only three weeks there, but everyone else does, and fair enough too, after having the zealous Chinese drag you out of bed at 6.30am each morning to take you to a never-ending stream of schools, factories, communes, museums and hospitals. We travelled over 4000 km by bus (mostly), train (the smoothest I've ever been on) and plane (Boeing 707 complete with hostess, but no prepackaged biscuits!). So you arrive back in Australia exhausted and spend the following months trying to work out what it was all about.

As one who is trying small-scale farming at an individual level, my first impression was of the countryside. Travelling into China, I kept waiting for the intensively-cultivated terraced land swarming with people to end and the grazing country to start. It didn't. The only animals we saw were pigs, raised inside. I also kept waiting for the forest areas, until I realised that virtually all the trees had been felled over the centuries for fuel. China's present tree-planting program covers only a very small proportion of the land, and is concentrated mainly around cities like Peking. It suddenly hits you — 80% of China's 800 million people are involved in agriculture.

We visited two rural communes (average population, 30,000 people, about the size of Ballarat), and it was interesting to see the importance placed on self-sufficiency. We saw enormous hot-houses, heated with gas or coal, for raising tomatoes, even though tomatoes were growing outdoors a few hundred kilometres south; and there were large cellars for storing winter vegetables out of the snow. In Australia, with agricultural specialisation, monoculture and sophisticated transport, we choose to move food over distances up to 3000 km. In further contrast to my experience with farming here where one must become rather obsessed with minimising the use of one's own labor in order to survive, on Chinese farms the situation is reversed. The products of technology are very expensive (e.g. a hammer costs nearly 30% of the average weekly wage); if, for instance, the soil in one part of the farm is too acidic, you must mix it with soil from another part using baskets on poles over your shoulder, rather than buy ground limestone and spread it with a tractor.

The workforce on the communes is subdivided into production teams of about 100 people, and each commune has its own clinics, hospitals, middle schools and primary schools. We were surprised to find that not only did the two-roomed house we visited (for eight people) not have a private plot for growing vegetables (many houses do), but that the family had to pay the same price for the vegetables they grew during the day as the people in the city paid. No wholesale price and no 'lerks and perks'! One odd aspect about the houses, which was universal throughout China, was that no-one collected water from their roofs. Why this was not done, when in many cases the alternative was water from a shallow well, we didn't manage to ascertain.

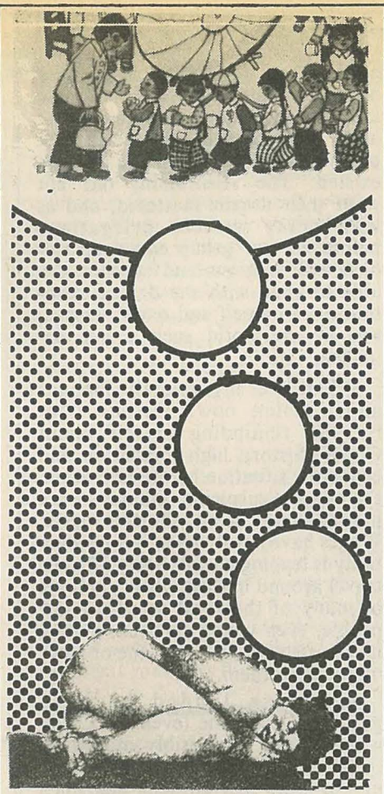
I was rather shocked, coming from a country where at least we are starting to question our use of sprays and chemical fertilizers, to find the Chinese fanatically pursuing the use of these in striving for their ultimate goal: higher yields per unit area. Everywhere we were enthusiastically told about yield increases. It sounded so much like America in the 1950s and '60s. Human and animal manure is, however, still efficiently utilised.

The Chinese are also very keen on using more tractors and harvesters. As Chairman Mao said, "the fundamental way out for agriculture lies in mechanisation". However, we saw much farming still being done by hand or with the aid of animals. Some machines, despite their scarcity, were being used inefficiently since traditional farming methods were still more popular. I kept hoping the Chinese would learn from the West and avoid the inefficiency and alienation that an industrialised agriculture dependent on oil will inevitably lead to, but on questioning them, it seems clear they plan to mechanise as quickly as possible. They seemed to have no concept of resources being finite. Interpreters had much difficulty even translating the word 'finite'. To the Chinese we spoke to, finding more oil or metals "only depends on people's hard work and determination".

In the cities I was struck first, of course, by the staggering number of bicycles, but equally by the racket of blasting horns from the numerous buses and cars for officials. They drive dangerously, otherwise they wouldn't get anywhere: Chinese people on the street move slowly. It was blissful to see no advertising (apart from the posters everywhere condemning the gang of four), but horrifying to see the housing and sanitation, which through Australian eyes was of low standard.

I spent some time wandering through the Chinese appartment stores (not the tourist-orientated 'friendship stores'), and speaking to a fellow Australian who had been to China in 1972 revealed ominous signs of the seeds of consumerism. The shops now had display windows, and people were crowding around glass cabinets containing TV sets. The overall feeling among the people in the shops was one of excitement — even if they couldn't afford the goods, they wanted to look at them. What will China be like in another five years?

In the two northern industrial cities we visited, air pollution was appalling (not that Newcastle or the Latrobe Valley are anything to be proud of). At a steel mill, my questions on air pollution were met with an embarrassed response (obviously other western delegations had asked the same thing) that they now have two workers studying the problem. At a coal-washing plant not only was the noise level deafening, but the washings went out the back into an old river course which was swarming with hundreds of people for a kilometre or more downstream, collecting the washings and hauling them home in hand carts to dry out and use as fuel. The engineer in me freaked at machines with no safety guards, deep vats in a porcelain factory with no protective fence, and gaps in the floor through which one could easily fall. It sunk home that China's priorities, with a high population, low income and low level of technology, are totally different to ours.



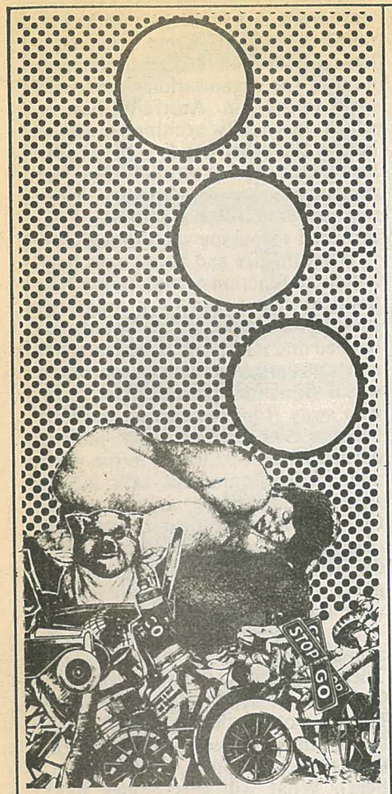
One of the main questions I wanted to find an answer to was: What is it like to live in China? Underneath the barrage of figures, I found what through my western eyes was a rather dull and drab life. Unless you are one of the chosen few who go on to higher education, you start work in a factory or on a commune at about 16. There, you clearly have more say in the day-to-day running of the organisation than a factory worker in Australia has — which was really exciting to see — but on the other hand, you have far less right to question what the organisation, or your country, is doing overall. No stimulation is provided to pursue such thoughts.

What theatre and books exist have a definite function of maintaining the political status quo — a magazine such as *Chain Reaction* would be banned and its editors re-educated — and powerful carefully-controlled social pressures exist against those who sway from the current political beliefs. You work in your job six days per week, 52 weeks in the year, and for entertainment talk in the streets, maybe see an occasional film, and if you are a bit rebellious, play cards (competitive games are discouraged — we went to a soccer game and the only people cheering were the westerners!)

For your work you get paid an average wage of 15 yuan a week. There is still a wide gap in wages in China: 8 yuan for the lowest-paid factory worker through to 26 yuan for the most skilled jobs (equivalent to a range of $5000 - $16,000 p.a. here). What will this money buy? The housing situation is completely different as in China there is no concept of land values, and no capitalists exploiting the housing market. Housing costs are therefore less. To try to compare the purchasing power of Chinese wages to ours, in the following table I have translated the costs of some items in China into Australian dollars, assuming the same proportion of average weekly earnings in Australia are needed to buy them as in China.

ITEM	EQUIV. AUST. COST
rent (for two rooms)	$20
bicycle	$1900
cardigan	$280
singlet	$30
small transistor radio	$200
television (10 inch)	$1800
tennis racket	$160
hammer	$40
beans	$6 p.lb.
cabbages	$9 each
chicken	$8-50 p.lb.
pork	$8 per lb.
rice	$2 p.lb.

Thus, for example, on an average weekly wage of 15 yuan in China you have to work



for 30% of the week to pay for a hammer, and 30% of the average Australian's take-home pay is about $40.

It is not hard to see from these figures that we live in relative luxury — the Chinese spend 60-70% of their wage on basic food alone, i.e., rice and vegetables and maybe a little pork for flavoring.

An interesting aspect of the trip was to watch the reaction of the various members of our group of 40 or so 'working Australians'. Most people seemed to be going to China to have their view of China as an idyllic place confirmed, and the more it became obvious China had as many faults as any other country, the more people would react against any criticism of China. So there were no safety rails because the Chinese are "so much more sensible than we are", and people just would not believe the locks on all the bicycles existed. The Australians did not want their dream shattered, and as with many western delegations before us, our group ended up riddled with tensions and conflict, unable to cope with the drastic reappraisal of oneself and one's perspective of the world such a trip demands.

What are my overall feelings about China now? Despite continually reminding myself about China's history, high population, and economic situation before liberation, the nagging suspicion remains — are the Chinese being short-changed? Wages have hardly risen, yet productivity is leaping ahead. Party officials travel around in sleek black cars, yet in many of the rural areas we saw people, even young children, pulling handcarts with up to a tonne or more of rocks in them.

When we landed back in Australia, everyone (even the China worshippers) was visibly moved by the cleanliness of everything, the luxury of trees and gardens and open space, the high standard of housing and — dare I even say it — of food and transport. It makes you realise how relative all our activities are. Protesting about the widening of a road, the polluting of a river, or the felling of a native tree is a luxury you can't afford if your population is going hungry.

What **is** our goal in the environment movement? What sort of a society do we want to build? One even muses whether it is only because of our high level of industrialisation — with its consequent high consumption of resources and impact on the environment — that we are able to afford the luxury of spending our

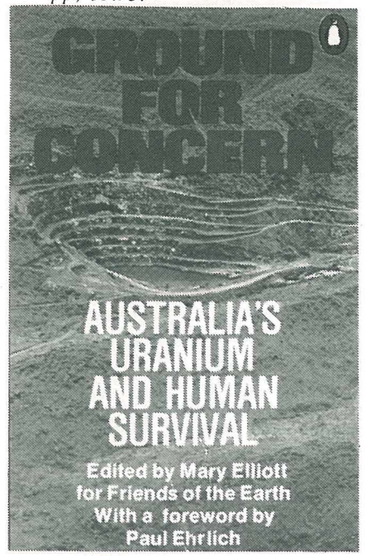
time and energy trying to scale it down again. And if things were scaled down to a level of industrialisation similar to that in China, we'd all be out treading in manure pits, with no time left to campaign for all the changes still needed.

Is then the environment movement a capitalist society's luxury? What we need is a broader perspective on our activities, looking at them not just in terms of our society as it is, but also in terms of the sort of society we want to build, rather than just fighting day-to-day issues and hoping that an ideal society will emerge from the ashes.

BOOK REVIEW

GROUND FOR CONCERN Australia's Uranium and Human survival

By FOE Australia, Penguin, 1977, 235 pp, $3.95.



At last Friends of the Earth's long-awaited Penguin paperback on the case against uranium mining is completed and released. Prepared under the capable editorship of Mary Elliot from Sydney the book consists of eight chapters covering the major problems created by mining and exporting uranium from Australia. The authors include many of the principal witnesses against uranium mining who appeared at the Ranger Environmental Inquiry.

In conventional terms the 'expertise' of the authors varies considerably. Rob Robotham, who wrote the sections explaining the workings of nuclear reactors and their relative hazards, formerly worked for the Australian Atomic Energy Commission and is currently the Radiation Protection Officer at Melbourne University. Greg Woods who wrote the chapter on nuclear terrorism in conjunction with Mary Elliot, is a senior lecturer in law at Sydney University.

Other contributors have less formal qualifications but present their cases with conviction and well-researched material. Wieslaw Lichasz and Stephen Myers have gained their understanding of the problems through their long involvement with the Ranger Inquiry, and through their personal experience and discussions with Aboriginals in the Northern Territory. Jeff Nicholls and Michael Bell bring to bear a long experience of investigating the possibilities of alternative energy strategies for society in an illuminating chapter on a nuclear-free world.

Overall the book presents, for perhaps the first time, the full picture on uranium mining and the world's energy crisis from an Australian viewpoint. Unlike many of the 'quicky' books on uranium mining recently published in Australia (almost all in favour of mining) *Ground for Concern* is comprehensive and well researched. Most importantly it considers the problems in their widest context looking both at the long-term energy questions and the full moral implications of providing uranium to an overseas industry which has demonstrated its inability to control wastes safely or to provide the necessary "failsafe" security to prevent the diversion of nuclear material for non-peaceful purposes.

In my recent visit to Australia, I was dismayed to discover that most of the arguments presented by some of the leading proponents of nuclear power there bore no relationship whatsoever to the facts, but consisted mainly of outright lies mixed with a smear campaign impugning the motives and competence of people who oppose them. The anti-nuclear movement can and should avoid such tactics. The facts of the issue speak for themselves, and people who substitute falsehood and venom for rational discourse do not help their case.

Foreword to *Ground for Concern* — Paul Ehrlich.

The publication of the book by Penguin indicated a belated acceptance by a major publisher that there is a huge outlet for material completely opposed to the mining of uranium. It is worthwhile reflecting that despite the overwhelming victory to the Liberals in the recent election 49.5% of Australians voted for parties completely opposed to the immediate export of uranium. Penguin are to be congratulated for having the foresight to help provide information to this body of concerned people and for helping spread the information to other people who do not get the full facts from the half truths and distortions presented in the mass media. That *Ground for Concern* is just the first in a series of similar publications is evidenced by the simultaneous publication by Penguin of the latest work by FOE Britain's energy consultant, Amory Lovins' *Soft Energy Paths*.

There is a certain uneveness in style throughout the book which is the inevitable result of having such a wide range of authors. Each chapter does manage to cover its alloted area although there do seem to be signs of strain resulting from there being just too much to cover in too little time. The question of Aboriginal rights whilst dealt with briefly in the second chapter perhaps deserved a more detailed examination. However, the use made of the Ranger transcripts to get across the concerns of Aboriginals in the Alligator Rivers area is quite striking.

Ground for Concern is the best book currently available to explain the uranium mining issue from an Australian viewpoint. It covers more of the underlying issues, in a briefer fashion, than either Walter Patterson's *Nuclear Power* or Ralph Nader's *Menace of Nuclear Energy* (Although Walter Pattersons book remains the best book explaining the hazards of nuclear power and the problems of nuclear waste).

With the re-election of the Fraser Government the fight to prevent uranium mining is heading for a climax. Hard-hitting information is crucial if those presently supporting uranium development are going to change their minds. We must do all we can to get them to read *Ground for Concern*.

Andrew Herington.

RESOURCES

prices are the suggested donations

key

N — Nuclear. E — Environment.
A — Alternatives. G — General.
Ab — Aboriginal. ( ) — States available.

Papers/Broadsheets

N Uranium and the Third World (VIC)
N Uranium — Future in the Balance (QLD)
Ab Black Liberation (QLD)
G Plaque (squatters n/p) (QLD)
G Freeway Fighter (VIC, QLD)
G International Whaling Com. ECO no 1234 (VIC, QLD)
N Energy Issues 16 pages (10c) (QLD)

Books

N Ground for Concern (VIC, NSW) ($3.95)
N Mururoa Mon Amour (VIC)
A Soft Energy Paths (VIC)
N Overkill (VIC)
N Nuclear Prospects (VIC)
N Nuclear power — Walt Patterson (NSW, VIC, ACT, QLD) ($2.95)
N Red light for yellow cake. The case against uranium mining (Falk, Barrett, Hayes) (NSW, VIC, SA, WA, ACT, QLD) ($1.00)

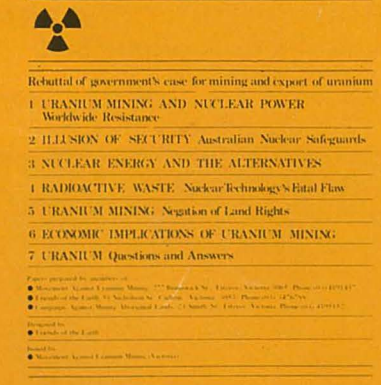
Badges

N Uranium? No Thanks (VIC, NSW, WA, ACT, QLD) (20 cents)
N Stop Uranium Mining (NSW, VIC, ACT, QLD) (20 cents)
G Friends of the Earth (VIC, NSW) (20 cents)

Stickers

G The Earth Needs Friends (VIC, NSW) (20 cents)
N Stop Uranium Mining (English, Greek, Italian) (VIC, NSW, SA, WA, ACT, QLD) (20 cents)
E Let Whales live (VIC — 20 cents; WA — 30 cents)
E Whaling is murder (VIC — 20 cents. WA — 30 cents)

URANIUM: CITIZENS' RESPONSE


Rebuttal of government's case for mining and export of uranium

1 URANIUM MINING AND NUCLEAR POWER Worldwide Resistance

2 ILLUSION OF SECURITY Australian Nuclear Safeguards

3 NUCLEAR ENERGY AND THE ALTERNATIVES

4 RADIOACTIVE WASTE Nuclear Technology's Fatal Flaw

5 URANIUM MINING Negation of Land Rights

6 ECONOMIC IMPLICATIONS OF URANIUM MINING

7 URANIUM Questions and Answers

AN Solar Not Nuclear (VIC) (20 cents)
Uranium. No thanks (VIC)

Paper

N Uranium: Citizen's Response (VIC)

Leaflets (free)

N The Decision Is Ours (QLD)
N Backyard Atomic Bombs

Booklets

G Go back, You are going the Wrong Way (40c) (QLD)
A Getting on the right track (ACT, VIC, QLD) ($1.00)
N The politics of nuclear power (ACT, QLD) VIC) (40 cents)

*please make generous allowance for postage.

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