Science seeks solace in the sun

THE WORLD TOMORROW

By GREG HARTUNG

PETER Carden and his team of solar scientists at the Australian National University are tight-lipped about their research into a new concept for the commercial use of solar energy.

It has been the central issue in the debate on solar power and the solution to the problem could create a dramatic new dimension in energy utilisation. However, the ANU scientists are refusing to make predictions until their studies are conclusive. This could be in 10 weeks or 10 years.

What is known about their research is that it involves the collection and transmission of solar heat, a method of storing energy, the use of paraboloidal mirrors for collection and the cheap mass production of such mirrors. These types of experiments put Australia in the big league in solar research.

Peter Carden, a senior fellow in the research school and a former understudy to the distinguished nuclear physicist and present Governor of South Australia, Sir Mark Oliphant, will not be drawn into disclosing his experiments and he is equally guarded about his own lifestyle.

"I suppose I had a very boring life. If I'm sufficiently dull you won't write anything about me," he said. "But I hope I'm the same as everybody else."

The fact is that Mr Carden is distinctly different from other people and is certainly not a patch on the copy-book image of an eccentric scientist. He's certainly not forgetful and is a long way from abandoning his duties as a husband and father but he concedes that in his younger days science and study was a pre-occupation. Now he generally leaves his work in the laboratory although he admits to mulling a few problems over in his mind before he goes to sleep.

He says the problems are enormous. While it is one of the oldest forms of energy, serious research in the field is comparatively recent and it is attracting scientists from all fields. Peter Carden is an electrical engineer by profession and became involved in solar research as late as 1972 after a varying career at the Weapons Research Laboratory at Salisbury, near Woomera, in South Australia to the mines of Mt Isa in Queensland.

Deeply conscious of the importance of the ANU research he says the world should cherish and protect energy as one of its most exclusive possessions.

Advantages

"The western world has been living too high and it is not right while the rest of the world can't keep up," he said. "It is to be hoped that we will be able to preserve things. And energy is the most important of these."

For without energy, people would not be able to build their own homes as Peter Carden did 15 years ago in the now fashionable Canberra suburb of Yarralumla which sprawls around Lake Burley Griffin. Even then he was conscious of the advantages of the sun. He designed his house so the rooms are able to soak up the mild Canberra winter sun and keep it out during the summer months when it rides higher in the sky.

He hasn't bothered to install a solar heating unit, it doesn't really interest him. Bad economics, he says, but he is taken with the idea "just to wave the flag."

Mr Carden's whole lifestyle is as basic as his philosophy toward man's most basic energy source. "People are going back to more natural lifestyles; not just hippies but most people who find they don't require large fast cars or expensive consumer goods." Somehow the three small sedans parked outside seem a little incongruous. He is quick to add they belong to his family. He rarely uses a car, preferring to ride the five kilometres each day to work by bicycle.

"My four kids are a little more modern in outlook. They tend to be more artistic and get to the basis of things," he said. "There is a potter's wheel in the garage although I'm not a good potter." He is 46 and a grandfather and as far as the do-it-yourself generation goes, Peter Carden seems before his time, although he freely confides that in his younger married days the shortage of cash was his main motivating factor as an amateur carpenter.

As a young engineering graduate from Queensland University, he was tempted to the Weapons Research Laboratory in South Australia, where he worked on equipment to measure distances by radio, by the promise of a good income.

In 1955 he went to Mt Isa where he specialised in electronics but a year later jumped at the chance of working with Sir Mark Oliphant in the physics school at ANU. Sir Mark was one of the original pure scientists and was working on a device called a proton synchrotron to accelerate atomic particles.

Knowledge

Peter Carden was a junior in Sir Mark's team but was later to make an important name for himself for his research into magnetic fields. He led the team which developed and built, over four years, an experimental device to produce intense magnetic fields.

The experiments were successful and today the magnet is still the most powerful of its type in the world and is used in solid state physics experiments. It is widely tipped that Peter Carden will receive his doctorate later this year for that work in the early 1960s.

"All of these fields give one knowledge which helps in solar research. You can't expect anyone to go into solar research with a ready-made background because it is such a new area," he said. It is this field which is inspiring his best work and engendering that old-fashioned ideal of doing something purposeful.

"When you get older you wonder what the hell you are doing: you wonder what contribution you are making. Life's really silly sometimes — you keep earning money and spending it. There must be more to it."

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Looking for new energy sources

THE ANZAAS conference in Hobart sounds a warning which this country cannot afford to ignore. Future shock is not now very far away: in just nine years' time Australia will be facing an energy problem. On the estimates of Esso Australia's exploration division we will inevitably need to import up to 300,000 barrels of oil a day by 1985. That amounts at today's prices to an added import bill of over $1000 million a year. It requires little calculation to visualise the strains this will impose on an economy which has not managed to cope satisfactorily with its problems even while it has enjoyed the temporary fortune of near self-sufficiency in oil.

On geological evidence there is slender chance of us ever increasing our oil production and the probability is for rapid decline after 1980. Further, the ANZAAS delegates were told there is now no chance at all of exploration filling the 1985 gap between supply and demand. The time lag between discovery and production rules out any such possibility.

Very plainly, we need to intensify research into alternative energy sources as rapidly as possible to soften the oil crunch of the 1980s, or possibly to avert it altogether.

Australia has considerable material to work on. Our uranium will probably only be important as an export commodity because of technological changes anticipated in nuclear engineering before the date at the turn of the century when we are likely to require nuclear power. But we possess solar energy in abundance. Solar work has been poorly funded up to now, but even so techniques have been worked out at the ANU, suggesting the potential of generating electricity on a commercial scale, and at Sydney University, pointing the way to the likely production of solar boilers to produce industrial grades of steam power.

Of course, it is not electricity that Australia is going to be short of in the next 25 years. We have ample coal supplies available to generate the electricity we will need for the next few centuries. But if solar power can be used to generate ample cheap electricity this in turn can be used to create cheap hydrogen, opening the way at last to the so-called "hydrogen economy" in which the compressible, inflammable gas can be used to power internal combustion engines. Alternatively, public transport at least is capable of being adapted to direct electric power.

The scope is considerable and the future need not be at all black — if we can get serious research energetically under way as soon as possible. As a result of such an effort we may easily discover the added benefit of creating an exportable alternative energy technology. This would give us the technological export capability we have always needed, but lacked, in order to gain a more equal footing with the industrialised giants of the advanced world.

The various voices calling in Hobart for a boost to our research programs — the commercial experts from Esso, the academic scientists, and the interested politicians — are unquestionably correct. But Senator Jessop's suggestion for financing it is not so close to the right track.

The senator, recognising that the economy is hardly in the best shape to afford massive central government research spending, wants to raise $15 million a year by a levy on oil, gas, coal and other mined fuels.

The idea has some passing merit, in that it amounts in effect to a tax on the use of our finite reserves of fossil fuels in the attempt to discover their replacements. But the idea of levying one particular type of industry to finance something that needs to be done by the community is inequitable and has some dangerous implications. The inflation-ridden Australian economy is in no position to afford yet another impost on the cost of fuel, which would inevitably be fed straight through to general price levels, and so take us still higher up the inflation spiral.

Also Senator Jessop wants to see the funds collected by the levy distributed by a Commonwealth research council which would have overriding authority in the field of alternative energy. This is simply revived Connorism under another name. No one in the field wants to see another monolithic bureaucratic institution set up to dictate Australia's energy policy. Everyone remembers all too clearly what happened to alternative energy research last time, when Mr [illegible] wasn't any: Mr Connor and the bureaucrats did not believe in it at the time.

A far simpler idea, which would not limit research to public service approved channels and would have the added advantage of concentrating effort in practical directions, would be to offer existing firms and corporations in the energy field attractive tax concessions proportionate to the alternative energy research they undertook.

The energy companies have as much need to get into alternative energy today as the community has to find that technology. Companies such as BHP and Esso have not only the resources but much of the research facility needed. The tax concessions could act as a sort of oil producers' depletion allowance keyed to the discovery of the new technology our society needs to acquire. By bending the energies and the resources of some of Australia's most successful corporations to the effort, we might speedily find the answers on which Australia's future in large part depends.

Considering the feasibility of the solar-power alternative

ENERGY DEBATE

By P. O. CARDEN*

THE nuclear debate in your columns is becoming so caught up in detail that I fear we are losing track of the salient issues.

We are primarily questioning (a) whether the world **should** turn to nuclear power and (b) whether it **will** (despite Sir Ernest Titterton's figures and projections the facts are that nuclear power, relatively speaking, is not at present widespread so the latter question is valid).

Both of these questions spring from the fact that Australia possesses some 20 per cent of the world's reserves of uranium. Hence what we decide to do with it will substantially influence the plans of other nations.

The first question arises because there is contention about the dangers to mankind both now and in the long term if we turn to nuclear power.

Mercenary

By addressing ourselves to this question we are taking part in a world debate the outcome of which will be influenced by what consumer countries think and also very much by what supply countries like us think. But whether consumer or supplier, it is apparent that the dangers from nuclear power, if they are real, will affect us all.

The second question interests the more mercenary among us, for if the world debate turns against uranium then the value of our uranium reserves will diminish considerably and so too will the value of any capital works that we have embarked upon beforehand such as mine development and refinery plant etc.

Growth

One very important fact must always be kept in mind. We must distinguish between the present generation of nuclear reactors and the next generation of "fast" breeder reactors. As Sir Ernest himself has said ('Facing the Atomic Future'), "Breeder reactors . . . will be essential if atomic power is to take its place in the world as one of the major power sources".

In fact, without breeding, uranium will probably take us only another 15 to 20 years beyond the lifetime of the world's coal reserves, assuming world economic growth will continue as it has so far this century. (Is there one national government which does not espouse growth as a primary goal? The potential for further growth among the underdeveloped nations is immense).

Almost the entire set of safety records pertaining to nuclear [illegible]

dollars and 20 years of work, the breeder reactor does not work".

Assuming, however, that breeders will work it is apparent that the present generation of reactors will then be but the tip of the iceberg. Thus the statement of Mr Hart regarding the low concentration of plutonium in shipped consignments to and from reactors is quite irrelevant in the long run.

Security

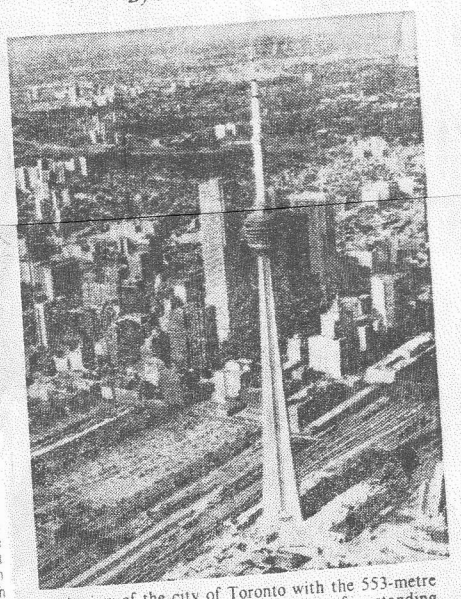
The operation of breeders will in fact involve high concentrations of plutonium which will have to be transported in quantities which are large in terms of energy content and money value — possibly as much as 15 million kilograms of plutonium per year by 2070 (see 'Mankind at the Turning Point' — M. Mesarovic and E. Pestel).

The extreme concentration of energy, toxicity and money value in these substances of trade would obviously require security measures beyond our present experience. (Incidentally the same projection coupled with the Rassmussen Committee's report on the probability of a meltdown would indicate one meltdown every 9 months somewhere in the world).

In spite of the assurances of Sir Ernest, many other gentlemen equally learned and of high repute have misgivings. For example Hannes Alfven, 1970 Nobel prizewinner for physics, has said, "in my opinion, the dangers associated with fission energy have not received necessary attention. . . . If a reactor goes out of control, the consequences may be terrible. Even if extreme safety precautions are taken, the large quantities of radioactive material in them constitute a permanent danger.

"For example, in periods of political or social unrest, sabotage against reactors may cause catastrophes. Furthermore, in a full-scale fission program, the radioactive waste will soon become so enormous that a total poisoning of our planet is possible".

Alfven went on to say that under such conditions, safety margins that might be quite acceptable in other fields were inadequate.



A view of the city of Toronto with the 553-metre CN Tower, the world's tallest free-standing structure, in the foreground. "... The roof area of Toronto's buildings occupies a substantial fraction of Toronto's area and offers a convenient locality for domestic and industrial solar-water heaters".



A simple solar collector for heating domestic water on the roof of a house in Israel.

Storage

Even for the present first generation of nuclear power stations the complete fuel cycle has not yet been attained in the US, ie, the partially spent fuel rods which need reprocessing before the remainder of the uranium in them can be used are now simply stored in water because it is not economical to proceed with the expensive process of separating the plutonium and highly radioactive wastes from the unused uranium.

Hence as far as the US is concerned the discussion of the economics and safety (which go hand in hand), even of the first generation of reactors, cannot be completed because the full cycle is not yet operating. In countries where reprocessing does occur, the plant is run by government agencies so the economic data tends to be obscure.

Non-viable

The first of the questions posed in my opening paragraph assumes there is an alternative to nuclear power and this is generally stated as solar power with continual exploitation of coal until solar is sufficiently developed.

Both Sir Ernest and Mr Hart dismiss solar power as a viable proposition: Sir Ernest says it cannot possibly supply his projection of world energy needs and Mr Hart draws attention to the "large" land areas required, eg, an area one-third the size of Toronto to supply Toronto.

Mr Hart says the problems are the dispersion of solar energy and the consequent cost of gathering and concentrating it. These are indeed the problems, but it would be quite erroneous to assume them to be insoluble. On the contrary the limited research done so far indicates that the problem is more manageable than was first thought.

Arable area

As to the areas required, what is basically wrong with employing a land area of one-third of Toronto (ie, 100 sq miles according to Mr Hart) to supply Toronto with energy?

The arable area required to supply Toronto with food is at least 5,000 square miles. We take for granted the farming of such areas but rarely consider it in the light of collecting and gathering solar energy for our own personal energy needs.

It only requires a change of concepts and a little imagination to grasp the idea of farming for our other energy needs, ie, "working" areas of land covered with solar collectors, as an alternative to strip mining and drilling.

Adequate

The land areas needed for energy and food need not compete. Canada, to be sure, is not well endowed with sunny arid areas but the world as a whole is, the total arid area being at least equal to the arable land area.

This is more than adequate since the requirements per person are for food .33 hectare (Europe) and for solar energy .02 hectare (based on the coal-equivalent consumption of developed nations and an annual average useful solar radiation of 40 thermal MW per square kilometre).

The transport of energy from sunny countries to ones like Canada might be by solar-derived synthetic fuels — possibly hydrogen.

One must not forget, either, that the roof area of Toronto's buildings occupies a substantial fraction of Toronto's area and offers a convenient locality for domestic and industrial solar-water heaters.

Dispersed

The large-scale utilisation of solar energy would bring several advantages: almost pollution-free, perpetual, a small energy recovery time (the time a power station takes to generate sufficient energy to build a second power station) therefore enabling rapid proliferation without interference with other uses of energy.

Solar power suits underdeveloped countries because of its "low" technology and because these nations usually have dispersed populations which require numerous small power stations rather than just a few large ones.

In this context it is to be noted that nuclear reactors must be large to be economical, so much so that nations such as Chile, Greece or Israel would need only three or so to supply the whole country but would have to develop a prohibitively expensive distribution network to carry the energy to the dispersed customers.

Australia is indeed richly endowed with uranium but in comparison its resources of solar energy are enormous. Perhaps we should at least postpone our decision to help the world turn nuclear until sufficient research has been done on the solar alternative. And perhaps we should participate much more in that research.

Recommendation 13 of the much-publicised and quoted Fox Report states, "steps should be taken immediately to institute full and energetic programs of research and development into (a) liquid fuels to replace petroleum and (b) energy sources other than fossil fuels and nuclear fission".

In my view, this recommendation should have come first.

*Dr Carden is a Senior Fellow in the Department of Engineering Physics at the ANU and head of the energy conversion group working on utilisation of solar energy.

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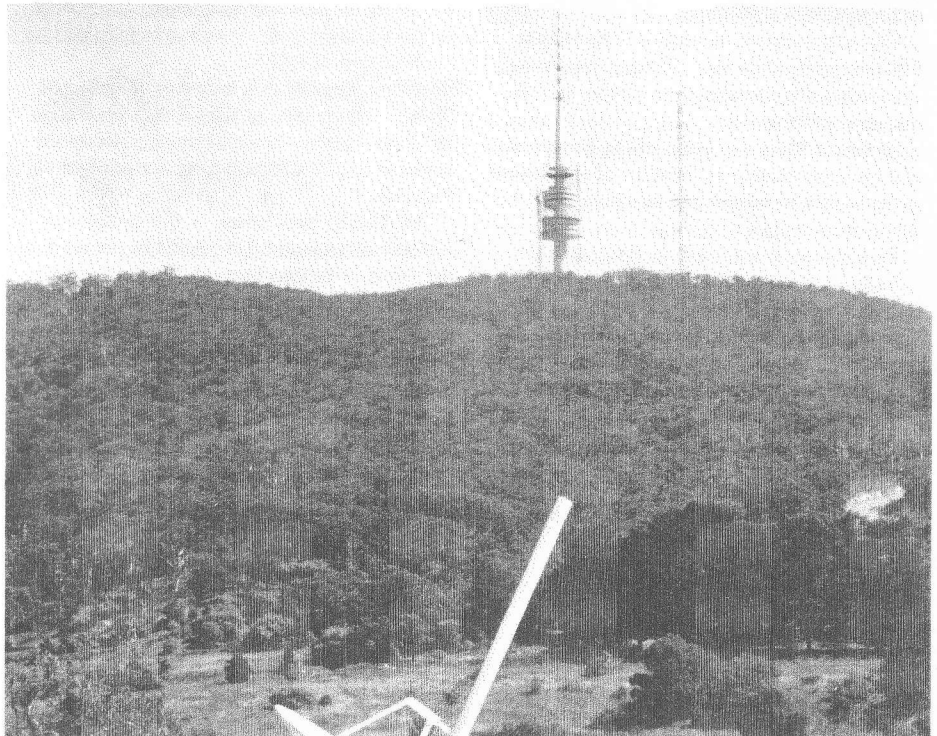
Commercial solar energy: experiments indicate prototype plant will work

Experiments over two years by a research group in ANU's Department of Engineering Physics have indicated that a prototype plant for the generation of solar energy on a commercial scale can be made to work.

The Energy Conversion Group within the Department in the University's Research School of Physical Sciences has told the Senate Standing Committee on National Resources that the solar energy research work 'is now progressing from the stage where confidence in the proposed system has been established and the major unknown factors have been resolved'.

The submission to the Senate Standing Committee was presented by Professor Stephen Kaneff, Head of the Department of Engineering Physics, and Dr Peter Carden, leader of the Energy Conversion Group, in collaboration with other members of the Group.

The Group's system is based on the extraction of heat from the sun using a heat-absorbing chemical reaction – the decomposition of ammonia into nitrogen and hydrogen. The nitrogen and hydrogen produced are transmitted to a central recovery plant where they can be resynthesised to release energy in the form of heat or can be stored or 'canned' for future energy generation, especially when there



experiments to explore the practicability and feasibility of the system and to provide information on which to base economic assessments. Even though resources in the Department were meagre, the importance of the newly-generated ideas was recognised by Professor Kaneff and an increasing effort was mounted, using funds and other resources which flexibility within the Department allowed. Dr Carden and his Energy Conversion Group (Dr Owen Williams, Dr Winston Revie, Mr Robert Whelan, Mr Peter Cantor, Mr Kazys Erick and PhD scholar, Mr Brian Edwards) have been working on key experiments since early 1975.

However, because of a policy determination within the Research School of Physical Sciences, the Group may be forced to close down its work in the near future for it is assured of funds only to the end of this year.

'We are now approaching a serious situation regarding continuation of this project', says Dr Carden. 'Because of the economic situation, physicists in the Research School of Physical Sciences have to reduce their spending. New research projects are vulnerable, especially those which depart from the traditional branches of physics and seek to answer questions related to

Energy Conversion Group, in collaboration with other members of the Group.

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It could also be possible to export Australia's sunshine by transporting surplus ammonia to overseas countries with climates less suitable for solar energy production.

Dr Carden says final proof of the concept would come with the building of a 10 million watts solar ammonia 'stand alone' system at a remote township, probably a mining town.

'Our theoretical and experimental investigations so far lead us to believe that a successful prototype system can be built in the manner indicated but until this is realised in actual practice, there is no absolute assurance of success', the Group has told the Senate Standing Committee.

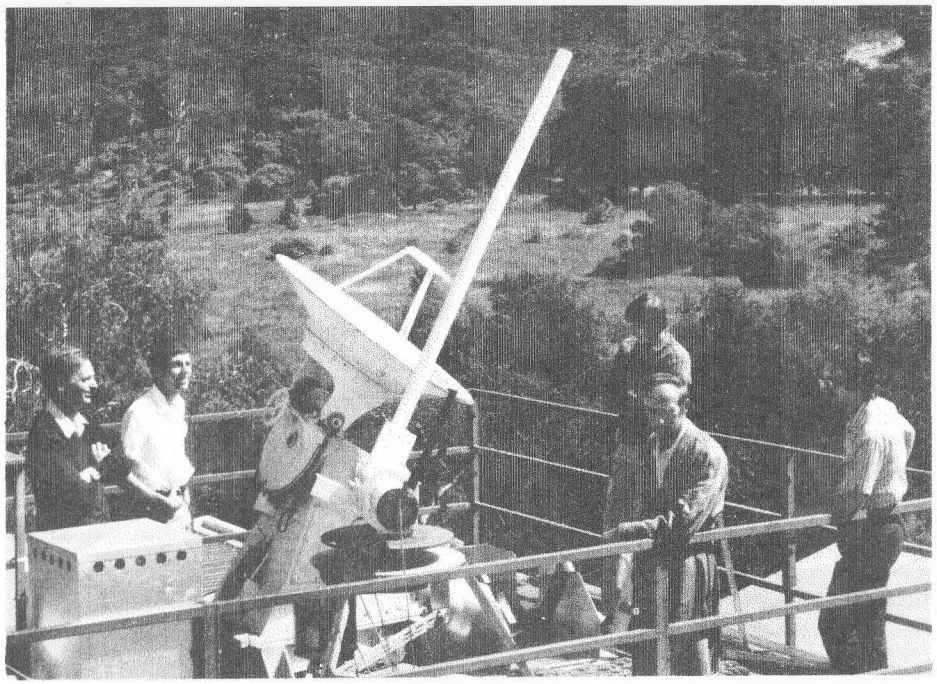
The collection mirrors would be pressed out of cheap sheet steel, like car bodies are pressed, and covered by reflective film.

Instead of expensive tanks to store the nitrogen-hydrogen mixture, the Group proposes using natural and underground reservoirs. There is a great variety of such reservoirs associated with sedimentary basins underlying three quarters of the continent and if disused oil or gas wells or existing water bores are used, access to the reservoirs is already available.

The use of high pressure in the system allows the pipes carrying the fluids to be small in diameter. Indeed, high pressures also reduce the size and cost of other components. The pipes connecting each mirror, Dr Carden says, may be reduced to about a quarter of an inch in diameter. This enables them to be laid as long, continuous lengths of tubing reeled directly off a spool instead of the costly alternative of aligning and joining numerous shorter and more rigid lengths. Additionally, the smaller tubes are more flexible and are therefore able to conform more easily to natural terrain contours. They also enable a simple flexible connection to be made to the moveable collectors.

With help and encouragement from Professor Kaneff, Dr Carden began the project a little over four years ago with the specific objectives of devising and assessing systems for the mass utilisation of solar energy. Within the first year, the concept of an array of controllable paraboloidal mirrors to collect the solar energy had been established. Later, the concept of gathering and transporting this energy thermochemically emerged.

During this period of early conception and development, Dr Carden was able to produce sufficiently convincing evidence, mainly theoretical, to warrant the initiation of



Doug Jervis, ANU Reporter

During a break in experiments, members of the Energy Conversion Group relax around their solar energy experimental equipment in a rooftop 'laboratory'. From left, Dr Peter Carden, Head of the Group; Dr Owen Williams; Mr Brian Edwards; Mr Kazys Erick, and Dr Winston Revie.

How it works . . .

The solar radiant energy is collected by a series (perhaps 10,000) paraboloidal mirrors each about four metres in diameter. The solar energy is reflected to the focal points of the mirrors where it is absorbed. It is in the focal absorbers (metal tubes containing a catalyst) that the ammonia, being run under high pressure through small tubes from the ammonia store to the mirrors, is decomposed by the solar energy into a mixture of nitrogen and hydrogen. This mixture is then directed through the tubes either to the synthesiser and steam generator or to the nitrogen-hydrogen store, or both. In the synthesiser, the nitrogen and hydrogen are resynthesised, producing heat to make steam in the steam generator. The steam is then passed through a turboelectric generator to produce electricity. The reactants in the process (nitrogen and hydrogen) are recirculated through the system and never used up. Any electric power not provided to consumers can be used to produce saleable ammonia, nitrogen, hydrogen, oxygen and rare gases byproducts.

down its work in the near future for it is assured of funds only to the end of this year.

'We are now approaching a serious situation regarding continuation of this project', says Dr Carden. 'Because of the economic situation, physicists in the Research School of Physical Sciences have to reduce their spending. New research projects are vulnerable, especially those which depart from the traditional branches of physics and seek to answer questions related to social needs rather than to the nature of the Universe.

'Consequently, it is generally felt that if our work is to continue it should be completely paid for from "external sources", most probably by an additional grant from the Government. On the other hand, the Government, although sympathetic towards solar energy research, will want to know first why at least some support should not properly come from the University. Certainly our work is compatible with the University's charter as set down in the Australian National University Act and it would also seem valid from the taxpayers' point of view since there is some concern in the community about the relevance of science to the aspirations of those who pay for it', Dr Carden says.

In its submission to the Senate Standing Committee, the Group said it needed $1.4 million (at May 1976 prices) over the next five years to complete its research program – if the ANU continued to provide the staff, materials and equipment it did last year. If the University could no longer support the project, $2 million would be needed over the ensuing five years.

Considerable assistance from industry in providing materials and manufacturing services would also be needed, Dr Carden says, but he expects such assistance would be forthcoming.

The small prototype plant which the Group says can now be made to work, would be built for final experimentation in the five-year period. This would be a 'closed loop' system which took solar energy from the computer-controlled paraboloidal mirrors tracking the sun, transferred the energy through the ammonia process and gave an output of heat or electricity. Notional output power would be several kilowatts.

The Energy Conversion Group has concentrated on the economy of the solar ammonia system. 'It has been – and continues to be – of paramount importance that solutions to problems in the design of the system meet very stringent cost constraints so that the whole

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Power from the sun

Continued from page one

solar energy system will be economically viable compared with alternative energy sources like fossil and nuclear fuels', Dr Carden says.

Cost calculations by the researchers show that electricity produced by the solar ammonia system could, even now in some Australian localities, be competitive with electricity produced from present fuels such as oil and would become more competitive as the prices of conventional fuels rose.

Additionally, the ANU solar system can be used to simultaneously produce ammonia as well as electricity. 'The advantage of dual production is that the proceeds from the sale of surplus ammonia can be used to reduce the electric power costs, an arrangement which will be economically viable before the advent of commercial solar systems devoted entirely to ammonia production', Dr Carden says.

Ammonia is the starting point for the manufacture of nitrogenous fertiliser, so scarce and costly in Asia, and several Asian scientists and officials have expressed interest in the ANU solar ammonia project.

There is also the possibility of using the solar energy collected by the ANU method to produce hydrogen from water, hydrogen itself being a valuable fuel. Oxygen, too, could be produced as a saleable by-product.

Commenting on the work so far and the problems remaining to be solved, Dr Carden said the Group used to be worried about the dissociation process (in which the ammonia is decomposed into nitrogen and hydrogen in the focal absorbers). 'Some people thought there would be trouble with recombination in the heat exchanger and with the catalyst. We have demonstrated now that these problems do not occur and in fact, it is fairly certain that one can make practical dissociators and heat exchangers at acceptable cost', he said. (The heat exchanger exchanges the heat from the nitrogen-hydrogen mixture leaving the focus to the incoming cold ammonia. This saves the solar energy which would be required to heat the ammonia if it were sent to the mirror focus cold.)

'We are coming to the stage where we can turn to other doubtful areas. One of these still remains the mirror collectors; the costs have to because the collector modules are relatively small and it should only be a matter of choosing the right number to match any load from a few kilowatts to hundreds of megawatts. However, there are certain minimum viable limits.

'The central control of the tracking of the collectors requires probably a minimum of 10,000 collectors of about five megawatts (base load). Again, underground storage will probably be available in modules of about 10 megawatts (base load) per well. But apart from these limits the system is flexible in that the collectors may be disposed in any pattern in accord with the local terrain and other land uses and in a manner requiring a minimum of field labour.

'Moreover, the system is capable of dealing with a variety of weather conditions by virtue of its tracking control sub-system which, incidentally, provides excellent around-the-clock performance monitoring of each collector and will, therefore, greatly reduce the cost of maintenance', the submission says.

'The minimum viable sizes quoted above still allow the system to be adapted to the needs of most remote townships. Thus, the system is compatible with an evolutionary process of development because many of these towns are in sunny localities and now experience high energy costs. In many cases, the present energy costs are high enough to raise the cost constraint on the solar system to well over $100 per square metre of collector and this is almost certainly achievable with present technology.

'Evolutionary development should occur smoothly towards large base load stations made possible by cheap underground storage.

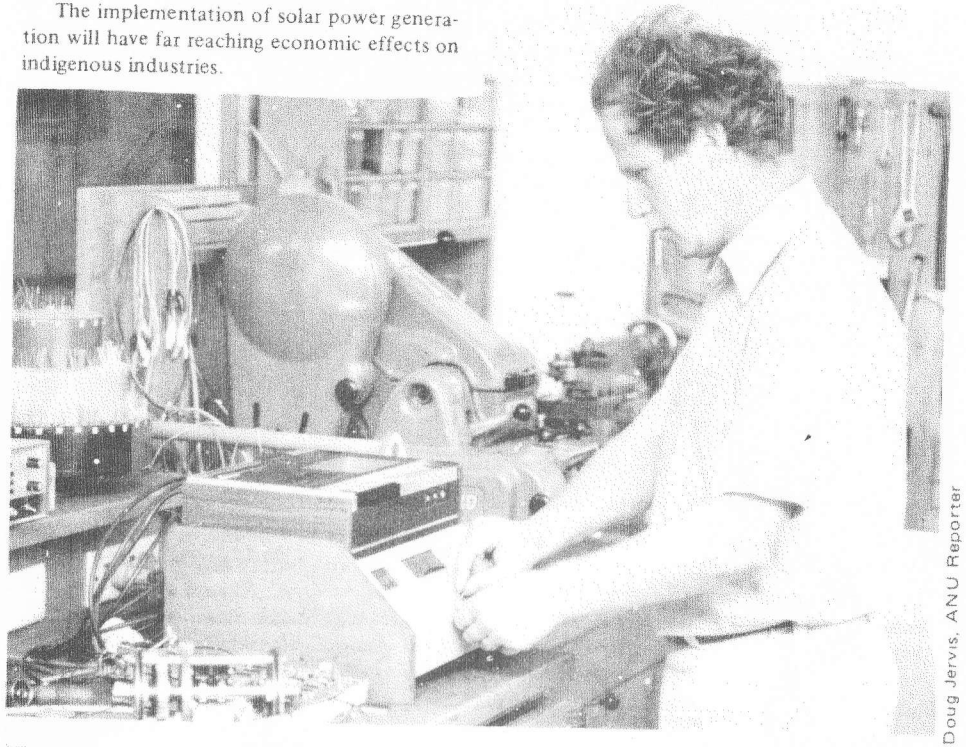
'The prospect for export of solar energy in the form of ammonia is promising. Ammonia is the basis of the nitrogenous fertiliser industry and therefore the prospective demand for it will be immense and perpetual. Ammonia may also turn out to be a useful liquid fuel.

'There are several other economic benefits which should be mentioned. The major industries which would be involved in the implementation of the solar ammonia method of power generation are those concerned with manufacturing steel pipes, tubes and automobile bodies. The potential is immense.

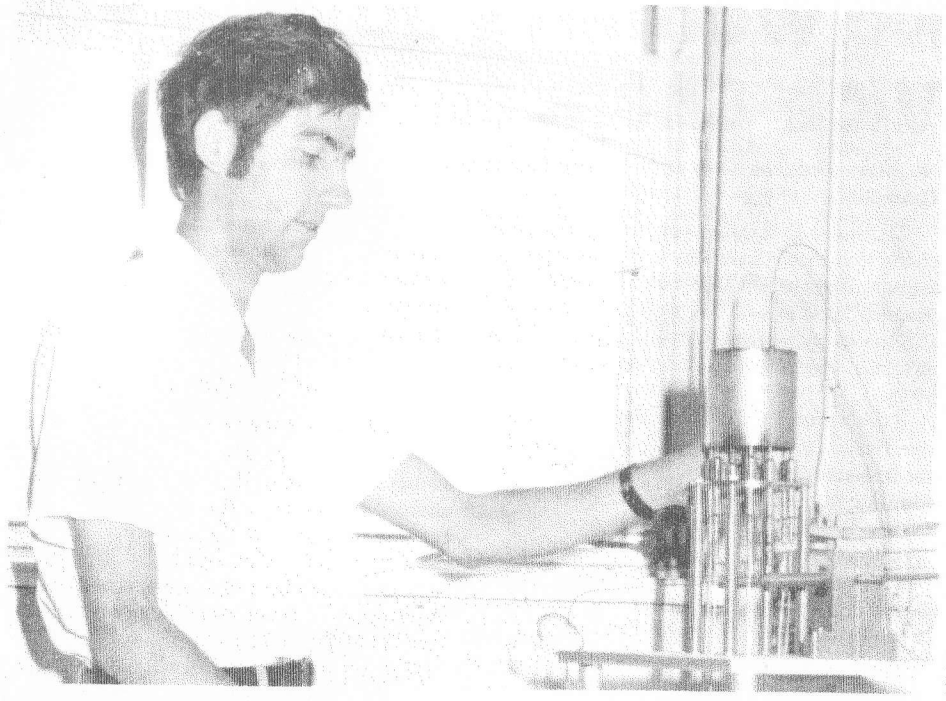
'For example, in order to feed a growth over

plant is economically favourable.

The implementation of solar power generation will have far reaching economic effects on indigenous industries.



Doug Jervis, ANU Reporter



ANU Reporter

can make practical dissociators and heat exchangers at acceptable cost', he said. (The heat exchanger exchanges the heat from the nitrogen-hydrogen mixture leaving the focus to the incoming cold ammonia. This saves the solar energy which would be required to heat the ammonia if it were sent to the mirror focus cold.)

'We are coming to the stage where we can turn to other doubtful areas. One of these still remains the mirror collectors; the costs have to be reduced and we need a way of protecting reflective surfaces from dirt and deterioration. However, we are not too worried about these collectors because there are many avenues to explore and many other groups in other places are working on allied problems.

'Perhaps the next most critical area is the synthesiser-cum-steam generator and we will be looking into this in more depth in the near future.

'Storage of nitrogen and hydrogen in aquifers also needs much work but here again, we should be helped by other groups since storage of hydrogen underground is a generally favoured method of storing energy in the future', Dr Carden said.

Commenting generally on the Energy Conversion Group's work and its relationship with the solar energy research effort in other countries particularly in the USA, Professor Kaneff said: 'Our work is part of a much larger body of research going on throughout the world but it is the part probably most related to conditions in Australia and in many developing nations.

'We are seeking a measure of the viability of a scheme which is representative of a set of similar schemes all relying on thermochemistry for transporting and storing energy. This set of schemes, in turn, is one of several approaches to the problem of generating solar thermal power. Much of our work is common to other approaches but the unique feature of the thermochemical approach is its potential for energy storage. This feature alone warrants a careful assessment. As far as we know, two other groups overseas – in the US – are looking at other thermochemical solar schemes but at present we are probably leaders in the field. We are certainly ahead experimentally and have made significant theoretical and conceptual contributions.'

The Energy Conversion Group summarised some of the implications of its solar ammonia system in its submission to the Senate Standing Committee: 'The system appears to be flexible and therefore the prospective demand for it will be immense and perpetual. Ammonia may also turn out to be a useful liquid fuel.

'There are several other economic benefits which should be mentioned. The major industries which would be involved in the implementation of the solar ammonia method of power generation are those concerned with manufacturing steel pipes, tubes and automobile bodies. The potential is immense.

'For example, in order to feed a growth over 50 years to 10,000 million watts of solar power generation, approximately 1.5 million pressed steel collectors would be required per year, valued at perhaps 500 million dollars. This is comparable to the present Australian motor vehichle body industry.

'The pipe and tube manufacturers would be similarly stimulated as would, of course, the – steel industry. Moreover, Australia's balance of payments position would be improved over the period by an average of $650 million per year through the sale, at the world market prices, of the steaming coal thus saved', the Group's submission says.

The Energy Conversion Group has also summarised the important features of the solar-ammonia system for power generation:

Collectors are steerable dish mirrors press formed from steel sheet. The reflective film will probably be anodised aluminium.

Collectors are to be steered by an advanced method which promises to negate the presently recognised disadvantages of moving collectors.

Long term, loss-less energy storage is possible.

The energy store is adjacent to the collectors. Thus only the collectors and the lines to the store operate at low capacity factor. Among the few proposals that provide for long term storage, none posses this advantage which has important economic implications.

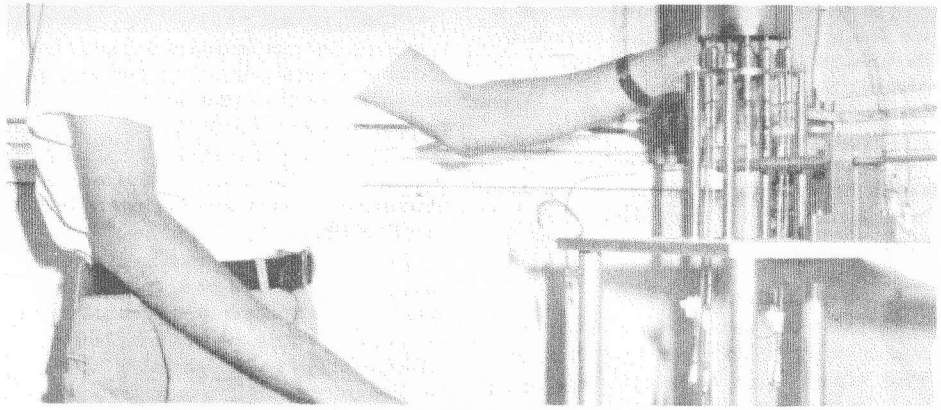
Energy is stored as chemical energy of a gas mixture. The most economical reservoirs for this gas are natural ones occurring underground at moderate depths. Consequently, system pressure is determined by the natural pressures in these structures which are a few hundred atmospheres.

Compactness of system components results from adoption of these pressures.

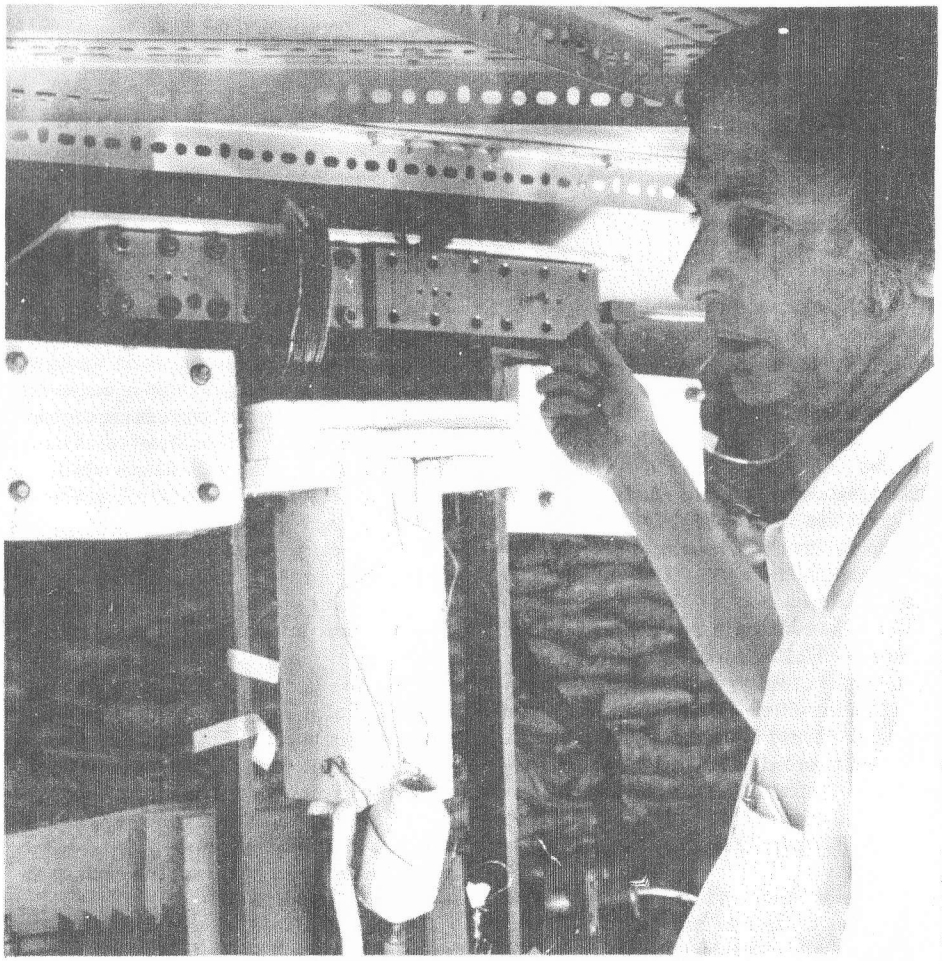
The minimum viable plant size is about 10 million watts.

An early application will be to a remote township.

The system can produce ammonia as well as electricity. Production of both by the same



Doug Jervis, ANU Reporter



David Fetherston, Photographic Services

Top: *Mr Peter Cantor, another member of the Energy Conversion Group, adjusts solar radiation monitoring equipment being used to provide continuous records of solar radiation at various localities.* **Centre:** *Dr Owen Williams with an experimental ammonia dissociator (focal absorber) rated at about three kilowatts.* **Bottom:** *Dr Peter Carden and an early experimental dissociator and heat exchanger.*

Can we harness the sun?

HOPE OF BREAKTH ROUGH

THE centuries-old dream of capturing the sun's inexhaustible free power may be about to become a reality.

Prof. Stuart Butler, head of a solar energy team at Sydney University, claims his team could be on the verge of a breakthrough in canning solar energy and wiping out the need for nuclear power.

The Sydney team is working on a process using liquefied hydrogen.

And scientists at the Australian National University in Canberra have developed the world's first system of storing solar energy for commercial purposes.

Their discovery has brought dramatically closer the day when whole towns could be powered from the sun.

The ANU system is based on the extraction of heat from the sun using a heat absorbing chemical reaction — the decomposition of ammonia into nitrogen and hydrogen.

The gases are transmitted to a central recovery plant where they can be resynthesised to release energy in the form of heat.

They can also be stored for future energy generation and used on cloudy days.

The head of the research team behind the discovery, Dr. Peter Carden, predicted that in future decades it would be possible to pipe solar energy from country storage plants to cities.

It would also be possible to export it to less climatically suitable countries.

ANU scientists believe that within five years they will be ready to build a prototype solar energy collection and storage plant.

TONY BAKER reports on the promises and the realities of solar energy.

More money now needed in race for solar power

THE Case for Australia to make a big investment in solar energy is simple and compelling.

We can capture the sun to do jobs for which oil and natural gas are far too valuable and increasingly too scarce.

And we are ideally placed to do so.

Australia lies almost wholly between latitudes 10 deg. and 42 deg. south and receives up to 4,000 hours sunshine a year.

On average Australia's surface receives 7,000 times our forecast energy needs in the year 2000 AD.

But doing so depends on being able to collect and concentrate this relatively weak, diffuse energy source.

Fortunately as well as being within the right geographic and climatic belt, we have the technical capacity to undertake the task.

A leading authority in the field, Prof. R. E. Luxton, professor of mechanical engineering at Adelaide University, points out that until a few years ago, Australia was in fact the world leader.

This was thanks in large part to pioneering work over 20 years by the CSIRO.

Almost by chance this was principally undertaken in Victoria which had the side-effect of showing that, for many purposes, solar energy does not depend on large spans of direct sunlight.

But, says Prof. Luxton, that lead has now been lost to other industrial countries.

One of the big problems about public discussion of solar energy — as part of the national energy debate — is that it is the subject of many myths and fallacies.

Another is that enthusiastic advocates of it have made sweeping and probably unreal claims which tend to destroy their own case.

Even assuming a huge investment in money and resources and the hoped-for breakthrough in solar technology, the world will still be dependent on oil and gas for a long time to come.

"The point about solar energy is that we can use it to take the load off other energy sources," says Prof. Luxton.

In particular, it is now practical or realistically attainable for use in processes needing temperatures below 150 C.

Domestic hot water supply is the outstanding example. So are operations requiring water temperatures around the boiling point of water which would include most food processing.

Another big area for possible use — one now being looked at very seriously — is space heating and cooling, using sun power to heat and cool homes, offices, and factories instead of using electricity or oil.

Estimates vary but Prof. Luxton believes Australia could cut oil consumption by about 20 per cent. with a commitment to solar energy.

But oil and gas would still be needed for high temperature industrial processes, such as most metal fabricating and heavy industry in general.

And even if that ever-popular topic of speculation, the electric car, proved feasible — which so far it is not — oil will still be needed for interstate transport.

However, in the longer term electric transport has a very rosy future, says Dr. E. L. Murray, senior lecturer in physics at Flinders University and another authority on the subject.

Even where solar energy was used it would have to be supplemented from conventional sources during long periods of bad weather.

Until recently a deterrent to using solar energy in SA, even where it was available was, ironically, that it was too expensive.

Thanks to the Bass Strait field and to Government policy and to abundant coal, this has been the land of cheap petrol and power.

Those days are numbered. And the consequences could be nothing short of revolutionary.

And Bass Strait is fast running out.

Even on the most optimistic projections — and they make large assumptions — it will be dry by 1995.

It has been forecast that the price of petrol could reach $6 a gallon, $1.32 a litre.

Installing solar equipment is expensive. But once installed, provided it is durable, it is extremely cheap to operate.

As with other scientists around Australia, Prof. Luxton is pressing for more funds to be allocated to solar research and development.

He believes a Government commitment in the order of $10 million a year could produce significant results fairly quickly.



THE senior technical officer of the ANU'S engineering physics department, Mr. Bob Whelan, shows the power of a solar reflective dish by setting fire to a piece of wood

Feb. 1977

Sunshine caught...and that puts us ahead in the solar energy stakes

Australian 26/3/77

By GRAEME ATHERTON

SCIENTISTS at the Australian National University in Canberra have developed the world's first system of storing huge quantities of solar energy for commercial use.

Officials at the university claimed yesterday that the breakthrough put Australia years ahead of the rest of the world in solar-energy research.

The discovery has brought dramatically closer the day when whole towns can be powered by solar energy, eliminating the need for nuclear power.

Scientists involved in the project said they had developed the only system in the world capable of short or long-term storage of solar energy on a mass scale.

The head of the ANU Department of Engineering Physics, Professor Stephen Kaneff, said the discovery was ahead of American experiments.

The ANU system is based on the extraction of heat from the sun using a heat-absorbing chemical reaction — the decomposition of ammonia into nitrogen and hydrogen.

ENERGY EXPORTS

The gases are transmitted to a central recovery plant where they can be resynthesised to release energy in the form of heat.

The gases can also be stored or "canned" for future energy generation; especially when there are fluctuations in the amount of sunshine, such as on cloudy days.

The head of the research team that made the discovery, Dr Peter Carden, predicted that in future decades it would be possible to pipe solar energy from country storage plants to cities.

He said it could also be possible to export sunshine by transporting energy products to countries with climates less suitable for solar-energy production.

Scientists at the ANU believe that within five years they will be ready to build a prototype solar-energy collection and storage plant.

The plant would be built near a country town, probably in western NSW, and would produce continuous supplies of electricity and saleable gases.

The discovery comes after more than two years of solid research by Dr Carden's team.

The only immediate problem facing the project is a severe shortage of money. The scientists say they need $2 million over the next five years to fully develop the storage system and they do not know if they will be able to continue their work beyond the end of the year.

So far neither the university nor the Federal Government has agreed to provide the money.

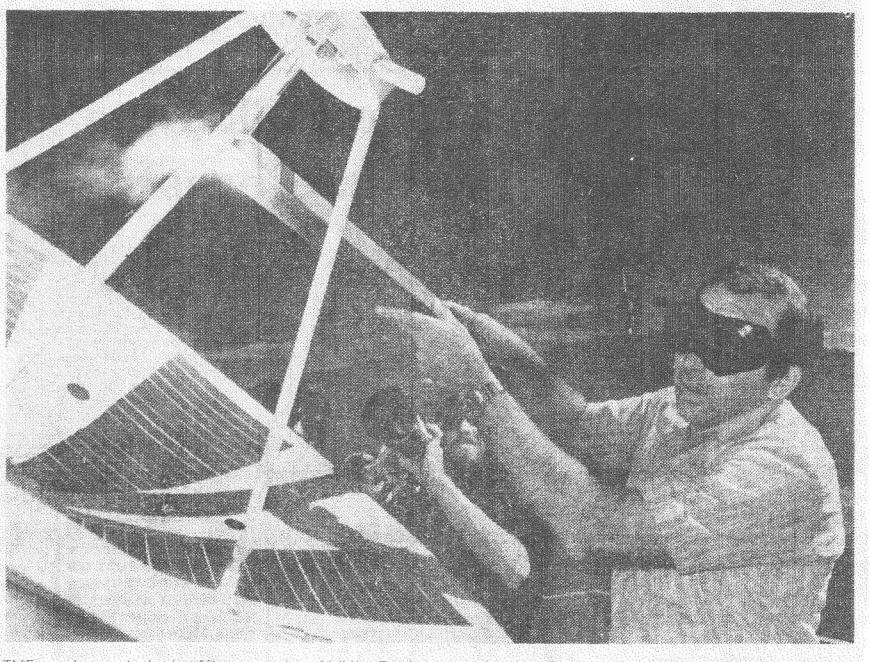
The ANU scientists say they are well ahead of researchers at Sydney University who have also been trying to find a way to "can" solar energy.

The deputy chairman of the academic board at Sydney University, Professor Stuart Butler, reported earlier this week that his research team was close to an answer.

The Sydney team is working on a solar-energy process using liquefied hydrogen.

But the ANU scientists claimed yesterday that this involved a more expensive and complicated process that would not be suitable for mass use.

The ANU method, as well as providing a constant source of electricity, also produces useful by-products such as ammonia, nitrogen, hydrogen, oxygen and rare trace gases.



THE senior technical officer at the ANU's Engineering Physics Department, Mr Bob Whelan, shows a solar reflective dish's power by setting fire to a piece of wood.

DAILY TELEGRAPH, Saturday, March 26, 1977

Plant can store up sun power

Australian scientists have discovered a way to store huge quantities of solar energy for commercial use which could eliminate the need for nuclear power.

By GRAEME ATHERTON

Scientists at the Australian National University in Canberra believe that within five years they will be ready to build a prototype solar energy collection and storage plant.

The discovery means whole towns could be powered by solar energy.

A plant would be built near a country town probably in western NSW and could produce continuous supplies of electricity and saleable gases.

But scientists say they need $2 million over the next five years to develop the new storage system fully.

Government spending cuts and professional rivalry between solar energy researchers and nuclear physicists have contributed to a serious shortage of funds.

The research team does not know if it will be able to continue its work beyond the end of this year.

The university's research school of physical sciences has refused to allocate any more of its limited funds to the project.

Research

The discovery was the result of more than two years of solid research by a team headed by Dr Peter Carden.

It puts Australia well to the forefront in international solar energy research.

In future years it will be possible to pipe solar energy from country storage plants to Australian cities.

It would also be possible to export Australia's "sunshine" by transporting energy products to overseas countries with climates less suitable for solar energy production.

THE AUSTRALIAN
SATURDAY MARCH 26 1977

Pushing into the solar energy age

IT IS NOW obvious that the development of solar energy is something which Australia must treat as an urgent, major national project. Stories this week, particularly today, show that we are in a position to produce a major benefit not only for Australia but for the world.

This is the fourth time this week The Australian has referred editorially to the need for funds and staff for solar energy research. And we obviously need to make no apology for this. But little did we believe, when we mentioned the matter first last Monday, that by the end of the week we would have exciting evidence that a breakthrough has been achieved and man's old dream of tapping the energy resources of its very life source is in the process of becoming reality.

Let there be no underestimation of the value of such an achievement. The ability to make use, on a large scale, of solar energy will be probably the biggest practical advance man has ever made. It will do away with the need to develop and use nuclear energy, it will do away with the ever-growing fear of the world running out of its natural fuel reserves, it will do away with most major sources of pollution and it will bring beneficial by-products and side-effects on an enormous scale.

But the way in which the solar energy story has come out this week indicates the need for national co-ordination and funding of the work which will be required to put the new discoveries to practical use. The first mention which attracted public attention came in the debate on the vexed question of uranium mining, when Sydney University's Professor Stuart Butler said solar energy research was making great strides but lacked money and researchers.

Then we were told, almost bit by bit, it seemed, of advances that had been made, breakthroughs that were in the offing, prospects that presented themselves. The Deputy Prime Minister and Minister for National Resources, Mr Anthony, announced that the Government would make available the money necessary to press urgently ahead with the work.

Then, yesterday, scientists at the Australian National University announced that they had made a breakthrough, that they had discovered a way to store huge quantities of solar energy for commercial use, that their method was different from, and better than, the method being researched at Sydney University. This is the immediate, exciting news. But the way in which it came to light indicates that research has been fragmented and unco-ordinated. And absurdly short of money. Yesterday the ANU scientists spoke of needing $2 million over the next five years to develop their new storage system but had no idea where they would get it from.

We have to realise, the Government has to realise, that we are in a unique position and we must take advantage of it. Nothing less than a national effort, nationally co-ordinated and nationally funded will do.

It is not going too far to suggest that something along the lines of the Manhattan Project, the all-in effort which produced the first atomic bomb, is needed so that the best brains, the most experienced researchers and the top engineers in the field can be brought together to work with the equipment and the money they need.

And we should do it now, while we can afford it — not wait until the world's dwindling resources force us into panic action which we might find hard to afford.

Certainly, the prize of useful solar energy will be a greater boon to all mankind than the atom bomb.

The Canberra Times
SATURDAY, MARCH 26, 1977



Dr Peter Carden, left, and Professor Stephen Kaneff demonstrate the use of a sun follower, used in solar-energy research, at the ANU yesterday. — Report, Page 3.

Sydney Morning Herald Sat 26/3/77

Lack of funds cuts solar energy plan

CANBERRA. — A lack of funds is threatening the development of a commercial solar energy project at the Australian National University, Canberra.

Scientists at the ANU believe that within 10 years they can produce a solar plant that would supply the energy needs of a remote mining township.

But the university has told them that, for economic reasons, provision of funds for the project by the Energy Research Group, will cease at the end of the year.

The university has said that money will be made available to projects in pure science at the expense of applied science.

Dr Peter Carden, of the university's Research School of Physical Sciences, and Professor Stephen Kaneff, head of the Department of Engineering Sciences, said yesterday that $2 million would be needed in the next five years if the experiments were to come to fruition.

Dr Carden said that provided no major obstacles were encountered the success of recent experiments indicated that a prototype plant for the commercial generation of solar energy could be produced within five years.

If commercial interests then developed the results of the research, solar energy could power a town in four to five more years.

"Our theoretical and experimental investigations so far lead us to believe that a successful prototype system can be built," Dr Carden said, "but until this is realised in actual practice there is no absolute assurance of success."

The research has been going on for about four years. About $250,000 has been spent.

Dr Carden said the university's decision to stop providing funds for the project would mean that $400,000 a year for five years would be needed to complete the project successfully.

Professor Kaneff said outside funds would be necessary to keep the experiment going.

The research group's system is based on the extraction of heat from the sun using a heat-absorbing chemical reaction involving the decomposition of ammonia.

The nitrogen and hydrogen produced are transmitted to a central plant. There they can release energy in the form of heat which can be stored for future energy generation.

The export of Australia's sunshine could become possible by shipping surplus ammonia to countries with climates less suitable for solar energy production.

"We are now approaching a serious situation regarding continuation of this project," Dr Carden said. "Because of the economic situation, physicists in the Research School of Physical Sciences have to reduce their spending.

"If our work is to continue it should be completely paid for from external sources, most probably by an additional grant from the Government."

Dr Carden said the group had given details of its work last year to the Senate standing committee on national resources, but the Government had not yet been asked for financial assistance.

Professor Kaneff said solar energy projects in the United States and some smaller countries, notably Israel, were receiving substantial government finance.

A l'occasion de la Fete nationale francaise

L'Ambassadeur de France en Australie

prie Monsieur le Professeur Carden

de lui faire l'honneur de venir a la reception
qu'il donnera a la Residence
le vendredi 13 juillet 1979 de 11h30 a 13h

6 Darwin Avenue, Yarralumla
Canberra

Regrets only
95 1000

On the occasion of the visit of the Chinese Geologists Delegation and the Chinese Solar Energy Utilization Group

Mr. Wu Fan-wu, Charge d'Affaires a.i. of
the Embassy of the People's Republic of China
requests the pleasure of the company of

Dr. & Mrs. P. Carden,

at a Reception

on Friday, August 25, 1978. at 7:00 p.m.

at the Chinese Embassy, 247 Federal Highway
Watson, Canberra

R.S.V.P. Regrets only 41-2446

On the Occasion of the 29th Anniversary of
the Founding of the People's Republic of China
The Chargé d'Affaires a.i. of
the Embassy of the People's Republic of China
requests the pleasure of the company of

Dr. & Mrs P. Carden,

at a Reception
on Thursday, September, 28, 1978, at 6.30 - 8.00 p.m.
at the Canberra Rex Hotel

Regrets only
41-2446

Big solar energy spending urged

Sydney Morning Herald

25/4/74

By JOSEPH GLASCOTT, Environment Writer

A major study of solar energy policies has concluded that Australia must greatly increase its capital expenditure on the development of solar energy immediately.

The study has found that at least five times the present rate of spending is required to achieve any worthwhile energy and economic benefits within the next 25 years.

Failure to make the increased investment in solar energy would cost Australia less in the short term, but severe disadvantages would emerge in the long term, especially if a fuel crisis developed.

The study, into the economic implications of solar energy policies for Australia, was carried out by the Foundation for Australian Resources, an independent, non-profit research group.

Computer analysis

The report, Solar Energy, Australia at the Crossroads, will be published as a book soon.

The chief executive officer of the foundation, Dr B. S. Thornton, head of the School of Mathematical Sciences at the NSW Institute of Technology, said yesterday the report had been submitted to the Deputy Prime Minister and Minister for National Resources, Mr Anthony.

Dr Thornton said the study was based on extensive computer simulations of alternative energy policies.

It shows that in a fuel crisis, with Australia unable to buy available high-priced imported fuels, at least 10 times more than present expenditure would be required to meet expected energy requirements.

But if Australia had a successful solar-energy program, solar energy in a crisis would be 10 times cheaper than energy from fossil fuels and uranium.

A policy of indifference towards alternative energy resources, particularly solar energy, would result in a staggeing 100-fold increase in capital investment being required to maintain energy supplies with fossil fuels and nuclear energy.

The study evaluated four scenarios.

The first was called the Standard Run, which the report called an apathy policy of continuing the present system without change — a "she'll be right, mate" philosophy.

By the year 2050 and beyond, the study showed that mining and the export of minerals would become almost the sole way Australia could pay its way in world trade.

No major breakthrough would have been made in solar energy.

With an energy consumption rate nine times the 1975 level, sums equivalent to 10 per cent of industrial production would have to be spent on pollution control.

By 2100 Australia would be a very rich nation compared with the rest of the world, but it would be forced to adopt an isolationist policy and a drive for self-sufficiency.

In the second scenario the study looked at the development of an immediate solar-energy policy.

Up to the year 2000 industrial growth would be inhibited and the massive export of fossil fuels and uranium would not materialise.

Boom for industr

By 2000, seven times as much capital would be devoted to energy production compared with the first scenario.

The solar energy policy would require large investments and new attitudes towards energy.

Industrial growth would revive by 2020, and mineral production would be even greater by that time than under existing policies.

Assuming that a solar energy development policy had been implemented in 1975, some impact would have been seen by the year 2000 and a much greater impact around 2065.

A marked reversal would occur by 2100.

"Delays of this magnitude may be intolerable to some people but the very high costs of achieving even this result may be equally intolerable to others," the study said.

The third scenario examined the effect of a fuel crisis.

Australia after the year 2000 would be in a poor state and would not be able to cope if the crisis lasted for 10 years or more.

The fourth scenario, flowing on from this, showed that in a crisis, rapid development of solar energy would be required and could be achieved at reasonable cost if other energy supplies became much more expensive.

A crisis would help overcome the social, economic and technological delays affecting solar energy programs at present.

If solar energy were developed rapidly it would be 10 times cheaper than fossil fuels by the year 2000 and 150 times cheaper by the year 2100.

In terms of international trade, the combination of a solar-energy policy and a potential crisis would produce a boom period for industrialists and farmers.

The massive distortion of trade by reliance on mineral fossil fuel and uranium exports would not take place.

The study concluded that a solar-energy policy was well within Australia's economic ability.

The Australian April 25, 1977

Solar energy or doomsday, says computer

By GRAHAME MORRIS

LEADING scientists aided by a computer yesterday predicted a major energy crisis for Australia by the year 2100 unless solar energy had developed.

The scientists produced a doomsday computer read-out which has Australia struggling to feed 26 million inhabitants while the country is almost at a standstill through lack of an energy source.

Yet according to the computer Australia, despite its hardships, will still be self-sufficient, except for energy, and still a "lucky country."

According to the computer the problems of Australia and the world by then could be solved if energy from the sun could be harnessed.

In the year 2100 most of the world's coal, uranium and oil resources will have expired.

The computer read-out was compiled by the Foundation for Australian Resources, a non-profit research foundation which has just completed a study of the economic implications of solar energy policies.

The report appeals for five times more money to be spent on developing solar energy for Australia.

It claims that if any worthwhile energy and economic pay-offs are to be achieved within the next 25 years the money must be spent now.

If a way is found to store the sun's energy solar power could then be used with other energy sources and the country's uranium and coal deposits would last much longer.

Although the computer operators were interested mainly in Australia's future energy problems they also received other information on the country.

This is a computer's view of Australia in the future unless massive sums of money are spent on solar energy research soon.

YEAR 2000

Population is 18.6 million (14 million now) and is growing at an annual rate of 76,000 natural families, plus 13,000 migrant families. Cities and towns are getting larger as an average of 1000 families a year walk off farms heading for urban areas.

Because towns need room to grow agricultural land is diminishing and rural production has decreased 6 per cent with wood and food exports worth only $0.6 billion compared with the 1976 figure of $1.5 billion.

Industrial exports have fallen and cheap imports continue to flood the country with the average Australian surrounding himself with twice as many material goods as he did in 1976.

A national labor shortage started in 1990 and is beginning to make itself felt. But the economy is very sound because the world wants, and we are giving it, our natural minerals.

2050

The population has moved to 24 million and the average Australian is now buying eight times as many material goods as he did in 1976.

The age of retirement has dropped dramatically and the school leaving age has increased. The labor shortage has become acute.

To enable the 24 million mouths to be fed we have stopped exporting food and the country is importing a third of its comsumption.

The massive rise in imported industrial goods continues and has reached $14,000 million compared with the 1975 figure of $2000 million.

Mineral exports are 20 times greater than in 1976, but for the first time in 100 years, the mineral exporting trade has stopped growing.

Overseas countries are becoming concerned that Australia is exporting only second-class ore because its prime stocks have been mined out.

The country is still offering coal and uranium as a trade-off for overseas oil and there has still been no significant breakthrough in the use of solar energy.

2100

The birth rate has dropped dramatically to 8.5 per 1000 per year and the death rate has risen slightly to nine per 1000 and the nation's population has only risen two million in the past 50 years.

People are materially richer, but are not buying new items as often as they did in the past.

Life has changed very little, but society has a different outlook, mainly related to the state of Australia's trade.

For the past 25 years, international trade in all sectors has been declining and home consumption of energy from fossil fuels has been constant. We are learning to cope with a near stable economy following a century of very rapid growth.

Because we are not able to trade goods for overseas food, the "return to the land" policy is fashionable.

In the five years before 2100, 2.5 million more hectares of land have come under cultivation accompanied by a slow trickle of people back to the countryside.

Australia is still a very rich country but the problem appears to be . . . how to stay that rich?

It appears the only solution is to adopt an isolationist policy and a self-sufficiency drive.

There is still one thing wrong. Australia can be self-sufficient in all forms of existence, except energy.

The brains of the nation are digging through their old files remembering tales of work once done with the sun — "solar energy" it was called. They decide that is the solution and all attention focusses on trying to harness the sun's energy . . . . ."

FOOTNOTE: Subsequent re-runs through the computer, using the premise that Australia introduced a sound solar energy policy, showed that the nation had very few problems with energy.

Study urges immediate spending on solar energy

Canberra Times 25/4/77

SYDNEY: A major study of solar-energy policies has concluded that Australia must greatly increase its capital expenditure on the development of solar energy immediately.

The study into the economic implications of solar-energy policies for Australia was carried out by the Foundation for Australia Resources, an independent, non-profit research foundation.

The report, 'Solar Energy, Australia at the Crossroads', will be published in book form soon.

Failure to make the increased investment in solar energy would cost Australians less in the short term, but severe disadvantages would emerge in the long term, especially if a fuel crisis developed, the study found.

In a fuel crisis following a drastic cut in imported energy and inability of Australia to buy available high-priced imported fuels, at least 10 times more expenditure than now would be required to meet expected energy requirements.

But if Australia had a successful solar-energy program in a crisis situation, solar energy would be 10 times cheaper than energy from fossil fuels and uranium. And capital cost per unit of energy would be seven times cheaper.

Indifference

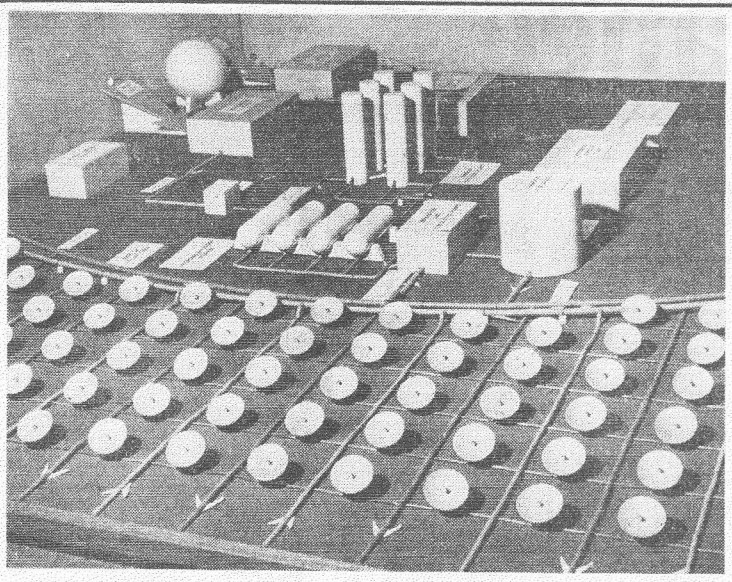
A policy of indifference towards alternative energy resources, particularly solar energy, would result in a 100-fold increase in capital investment being required to maintain energy supplies with fossil fuels and nuclear energy.

The study has found that at least five times the present rate of expenditure is required to achieve any worthwhile energy and economic benefits within the next 25 years.

The chief executive officer of the foundation, Dr B. S. Thornton, head of the School of Mathematical Sciences at the NSW Institute of Technology, said yesterday that the report had been submitted to the Deputy Prime Minister and Minister for National Resources, Mr Anthony.

He said the study was based on extensive computer simulations of alternative energy policy.

If solar energy was developed rapidly it would be 10 times cheaper than fossil fuels by the year 2000 and 150 times cheaper by the year 2100.



THIS is a model of Dr Peter Carden's solar power station at the ANU.

In front are the 20 ft diameter sheet metal mirrors and at back the chemical plant which would convert the sun's rays into energy.

Ammonia flows in pipes at normal temperature from the plant to the dishes. Once it reaches them it goes through a heat exchanger and is raised in temperature to 700 C.

Then the hot ammonia is circulated around small chambers where the energy is trapped.

The ammonia absorbs the energy and is changed into a mixture of hydrogen and nitrogen which goes into another heat exchanger and cooled. The gas then flows back down another pipe to another set of heat exchangers where the energy is extracted by a reverse process.

The energy is then used to boil water to make steam which runs a turbine just like conventional oil or electricity. Meanwhile the reconstituted ammonia is recycled through the same process again.

Surplus energy is piped off at the hydrogen and nitrogen stage and stored underground for future use when the sun is not shining — or for export.

Can we really make the sun work for us?

By CLIVE BOLTON

IF ANYONE can develop solar energy it should be Australia. After all, there's a lot of the raw material around.

With one of the sunniest climates in the world, solar energy could be the answer to the fast diminishing supplies of oil, gas and coal.

But even with today's news that research and development funds will probably be upped to at least $10 million a year, we are still well behind the budgets of other countries.

From being a world leader in the field a few years ago, Australia has slipped behind drastically.

The United States will spend more than $200 million this year. Japan has allocated $100 million a year for what it calls Operation Sunshine.

Even the geographically unsuitable France, on the foggy west coast of Europe, has increased solar energy expenditure to nearly $30 million for 1976-77.

Those sort of cash register figures mean that at long last the much maligned concept of sunshine power is being taken seriously.

But just how feasible is it?

There is the short term domestic use, the medium term industrial use — and the long-term futuristic idea of solar power stations running everything.

For domestic use the technology is already here, mainly in the hot water area.

About 25,000 Australian families now shower in water heated by the sun's rays catching special collectors installed on the roof of the house.

The industry is growing at something like 30 per cent a year as more and more people are converted. But still solar energy only provides 0.1 per cent of the country's energy needs.

Space heating is also increasing in popularity as is the heating of swimming pools.

Present systems work in conjunction with normal electricity supplies which cut in to boost heat on cloudy days.

Users reckon that 80 per cent of their needs are provided solely by the sun and it is estimated that installation costs can be recovered in about 10 years by savings in electricity bills.

The next big development will be in air conditioning which now burns as much energy in the summer as heating does in the winter.

The great advantage is that there will virtually be no need for "topping up" as the unit will always be used when the sun is at its hottest.

Even so, if every house in Australia went to solar water heaters, it would only save 6 per cent of the total energy consumed every year.

So the obvious next move is into industry — a big user of heat which accounts for 50 per cent of all energy produced.

Transport (40 per cent) and electricity with 10 per cent (excluding heat) make up the remainder of the percentage.

One scheme sponsored by the CSIRO, at a soft drinks factory in Queanbeyan, near Canberra, is an enlarged version of the domestic unit and is saving 80 per cent of the total oil that would normally have been used.

It means each factory having its own individual heat collectors and tanks.

But it also means there is a short term future with solar being used in conjunction with conventional supplies to conserve the precious deposits of fossil fuels.

One of the biggest problems as far as industrial use is concerned, has just been solved by a major breakthrough at Sydney University.

The research team has come up with a new method using glass collectors "sputtered" with layers of copper and iron carbide, and which are capable of delivering heat at over 100 degrees C — and heat is where Australia uses about one-third of her energy.

Dr Brian Window, leader of the university's Solar Energy Group, said: "We have found a cheap way of collecting the energy. A lot more design work is necessary and we need the answers to many practical problems."

And, of course, there's the biggest advantage of all. Solar energy is completely pollution free and without any of the dangers surrounding the coal and uranium mining industries.

But there is a snag to the system. And as usual it is economic.

In Western Australia and the Northern Territory, where there has been something of a solar boom over the past few years, solar units pay their way because electricity in remote areas can cost anything between 10 and 20 cents per kilowatt hour.

At those prices the extra cost of having a solar unit installed is recovered very soon.

But in metropolitan areas like Sydney, Melbourne and Adelaide where the electricity charge is between one and two cents a kilowatt hour, solar is uneconomic.

The experts say that if the Government is sincere in its promises to promote solar, then there must be incentives like tax concessions for homeowners or depreciation allowances for industry.

If domestic users and industry can be persuaded to think twice when it comes to installing a new boiler or heater, then it is estimated that within the foreseeable future 30 per cent of Australia's energy needs could be coming from solar sources.

So what about the long term?

Primary energy needs are expected to double by 1985 and quadruple by the year 2000, with the fossil fuels — like oil and coal — becoming scarcer all the time.

One man with a vision about the way we should go is Dr Peter Carden, Head of the Energy Conversion Group at the Australian National University in Canberra.

Dr Carden thinks it would be possible for the whole of Australia to be run by solar power stations and claims the first one could be operating a small town in 10 years time.

He says: "As far as I can see there is no alternative. We have the technology, but need more money to build a pilot scheme to carry on development work.

"The problem is that at the moment solar power would cost more than conventional power. Obviously, like all new developments, it is expensive to begin with until better and cheaper techniques bring the price down.

"I have yet to be convinced that industry could be coaxed into using solar power while there is still cheap electricity available from coal.

"The hard-headed businessman is only interested in costs. By the time the coal runs out he won't be here, so he doesn't care."

Dr Carden's idea is to build solar "farms" collecting the sun's rays through thousands of reflective metal dishes linked to a computer so that they follow the sun across the sky.

Once the energy has been trapped a chemical process transports it to a central point, and from there on it drives a power station just like electricity or oil does at the moment.

While waiting for use, the energy is stored in the form of hydrogen and nitrogen until the power is needed.

Next comes the problem which bedevils every solar project. How do you store the hydrogen and nitrogen for a rainy day?

Dr Carden's answer is to make sure that the "farm" is built in an area suitable for underground storage—a porous layer of rock covered by a hard layer so that the gas cannot escape.

Dr Carden says: "All you are doing really is creating synthetic natural gas and putting it in a storage space instead of just finding it there.

"On any day when the climatic conditions are not right you simply live on your reserves. Or export it.

"There's enough sunshine over Australia to power the world if only it can be harnessed.

"Civilisation has been lucky to have had a bonanza of fossil fuels. But they can't keep on being lucky forever and alternatives have to be tried."

Work is also going on into

Anthony to push for $9m boost to solar energy

By CLIVE BOLTON

THE Minister for National Resources, Mr Anthony, is o press the Federal Government to increase spending on solar energy from the present $1 million a year to at least $10 million.

He will put his proposals to Cabinet when he returns from a tour of Europe and the U.S. on May 9, knowing that some other ministers support his view.

His decision to back solar energy is in line with the findings of a Senate committee on national resources.

The committee, whose report will be released at the end of the month, will recommend that spending on the development of solar energy be increased considerably.

It will also call for the setting up of an energy commission to co-ordinate and plan for Australia's energy potential and needs.

The committee will urge the Government to sponsor any research into the creation of a new fuel to replace oil, which will be the first conventional energy source to run out.

If predictions are correct Australia will run out of oil within 15 years and face a $2500 million a year import bill.

Behind Mr Anthony's thinking is the controversy surrounding uranium, with its risks.

The NSW Premier, Mr Wran, recently granted more than $1 million to scientists at Sydney University who have just announced a major breakthrough in solar energy research.

EDITORIAL PAGE 8

$10m worth spending

THE INDICATIONS from Canberra suggest that Mr Anthony may have his work cut out in persuading Federal Cabinet to spend $10 million a year on solar energy research, as the Deputy Prime Minister proposes to try to do on his return to Australia from his overseas tour. Some of the most powerful figures in Cabinet still remain unconvinced of the value of solar research in Australia.

There is not much room for doubt that on this occasion it is Mr Anthony, not his more cynical colleagues, who correctly perceives the requirements of the situation.

A nation which has more sunshine than any other natural commodity can surely not afford to neglect the opportunities which that fortune will offer in the developing international oil shortage. In less than 10 years we will be importing the bulk of our oil from overseas and paying the current OPEC price for that energy. While it is true that our coal reserves will last us for centuries and provide the major part of our present non-transport fossil fuel requirements, the only likely way to resolve transport problems after the oil runs out looks to be through the co-called "hydrogen economy," which depends on the availability of cheap and abundant electricity.

Solar energy appears the best bet in this direction, being not only cleaner but cheaper than the various nuclear options. It also offers the distinct possibility of energy exports — in the form either of conventional electrical power transported by cable or of electrically generated hydrogen fuel shipped by tanker.

With those glowing opportunities available — and with the proferred hope of retaining energy independence for the future — Mr Anthony's $10 million a year is not an unreasonable request. At the very least it is the kind of investment which a nation with a traditional pride in not only its sporting instincts but its ability to gauge the sporting odds, ought to see as a good bet.

ANU Reporter

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Parliament told ANU solar energy project has potential to fill an important need in Aust.

The Senate Standing Committee on National Resources has told Parliament that the ANU solar ammonia process for harnessing solar energy 'appears to have the potential for filling an important need in Australia'.

In a report on Solar Energy tabled in Parliament last week, the Committee says that if the process can be developed successfully, it would have application for supplying the power requirements of remote rural and mining townships.

An article carried in *ANU Reporter* on 25 March said experiments by the solar energy research group in ANU's Department of Engineering Physics, Research School of Physical Sciences, have indicated that a prototype plant for the generation of solar energy on a commercial scale can be made to work.

In its submission to the Senate Standing Committee, the solar energy group – called the Energy Conversion Group – had said it needed $1.4 million (at May 1976 prices) over the next five years to complete its research program if ANU continued to provide the staff, materials and equipment it did last year. If the University could no longer support the project, $2 million would be needed over the ensuing five years.

The small prototype plant which the Group says can now be made to work, would be built for final experimentation in the five-year period.

The Senate Committee has recommended that until a long run energy strategy for Australia is produced, 'solar energy research at the tertiary level should be maintained in real terms'. '. . . University research should be adaptive of overseas technology or aimed at the development of innovative ideas. It is necessary to maintain a sufficient level of funding to enable Australian scientists to participate in technical exchange programs with other countries', the report says.

The Energy Conversion Group had also told the Senate Standing Committee that is saw an evolutionary process for the development of its system, starting with the installation of solar ammonia plants at remote rural and mining townships to provide their electricity needs and extending to larger cities later with other, bigger plants.

The Senate Standing Committee has reported that 'It is unlikely, however, that medium scale solar power plants to fill these requirements (supplying the power for remote rural and mining townships) could be functional until the 1990s'.

A number of submissions urging the setting up in Australia of solar power stations had been made to it, the Committee reported. 'The Australian National University Department of Engineering Physics is the only research group in Australia that has brought the concept forward to an experimental stage, and is proceeding with plans for a small scale prototype to be built in the next decade, subject to funding', the Committee's report says.

'The scheme proposed by the ANU research group, described briefly as the solar-ammonia process, attempts to overcome some of the major problems associated with solar thermal conversion, in particular, the storage and heat transfer problems.

'. . . At this stage, estimates of the cost of the electricity generated via the proposed solar-ammonia system seem to be based principally on United States system studies undertaken since 1973, which indicate that solar power, using present technology, would cost less than five cents (Australian) per kilowatt hour. Studies undertaken by the ANU research group support this estimate', the report says.

'On this estimate depends also the assertion that solar electric power could already be economic in remote localities where present power costs are above this figure, although it is above current city prices by a factor of two or three.'

The statement by the Standing Committee about the potential of the ANU solar-ammonia process comes in a report which recommends directions for solar energy research and development in Australia.

The report says 'The only areas which the Committee considers worthy of encouragement for commercial (solar energy) development at this stage are low grade heat applications for industrial purposes, heating and cooling of buildings, and small scale power generation for remote and isolated areas. In all other areas there is a need to maintain a watching brief on overseas research and development'.

ANU Reporter today reprints, slightly abridged, the recommendations contained in the report on Solar Energy by the Senate Standing Committee on National Resources:

The Committee is aware of the increasing importance of energy resources for the future and considers it to be important enough to warrant a combined and co-ordinated approach by the Commonwealth and State Governments to energy conservation and to ensure the future availability of energy supplies.

The Committee recommends that:

Energy Policy and Research.

- it is necessary to maintain a group of scientists and technologists in Australia working on solar energy projects and that there is an associated need for the involvement of industry to develop concepts into practical industrial applications.
- the establishment of an energy policy for Australia is an important priority.
- there should be no separate action taken to increase the level of funding or accelerate the development of solar energy until an overall energy policy is established.
- the Commonwealth Government establish a statutory body to be called the Australian Energy Commission to have an overall responsibility for developing and co-ordinating long term Australian energy policy. This authority would be responsible to Parliament through the Minister for National Resources.
- funds be provided to the Australian Energy Commission to enable it to undertake the following functions:

  Determine priorities and allocate funds for research and development of all energy resources.

  Allocate funds for the development of important aspects of energy research and development considered to require special stimulus.

  Direct promotional activities to encourage the conservation of energy and the use of alternative energy resources.

  Encourage the exchange of views between State energy authorities.

  Promote the exchange of technical information between Australian and overseas countries.

  Allocate funds for basic research into energy matters in Government research organisations and tertiary institutions.

  Allocate funds for development and applied research in energy matters including expenditure on demonstration and proof of concept projects either directly or on a contract basis with Government and research organisations and industrial firms. Provide assistance to individuals and organisations to enable monitoring of new projects incorporating alternative energy systems.

  Advise the Government on all matters relating to the pricing and exploitation of fossil fuel and uranium resources.

- the Australian Energy Commission be advised by an Australian Energy Advisory Committee which would provide advice on scientific and economic matters relating to an overall energy policy. The membership of the Advisory Committee would comprise representatives from industry, commerce, Commonwealth Government research bodies, Commonwealth and State Government energy authorities, the Australian Science and Technology Council and universities and tertiary institutions.

Solar Energy.

- the development of solar energy needs to be considered as part of an overall energy strategy. The evidence suggests that solar energy will not make any significant contribution to Australia's energy needs before the end of the century. Solar energy should take its place within an

Continued on page two

Continued from page one

overall energy strategy. The only areas which the Committee considers worthy of encouragement for commercial development at this stage are low grade heat applications for industrial purposes, heating and cooling of buildings, and small scale power generation for remote and isolated areas. In all other areas there is a need to maintain a watching brief on overseas research and development.

- there is a need to maintain spending in real terms on solar energy research at Australian tertiary institutions until the priorities for energy research are established by the Australian Energy Commission.
- the existence and operation of the proposed Australian Science and Technology Council will assist in overcoming and avoiding duplication and unco-ordinated effort. The avoidance of wasteful expenditure and duplication should be considered by the Senate Standing Committee on Science and the Environment as part of its 'Australian Science Policy Inquiry'.

The Senate Standing Committee also made recommendations about low temperature heat for domestic purposes, industrial applications, heating and cooling of buildings and research into alternatives for liquid fuels.

THE USE OF SOLAR ENERGY

Dr Peter Carden, head of the Energy Conservation Group at the Australian National University's Research School of Physical Sciences, Canberra, will be guest speaker at the Forbes Promotion Council meeting tonight.

The meeting will be held at 8 pm.

Secretary of the Promotion Council, Mr John Clarke, said he was very pleased to have Dr Carden as the Council's guest.

Dr Carden will be speaking on the use of solar energy for electricity.

His work deals with heat from the Sun absorbed by a number of mirrors which in turn uses ammonia to create steam generated electricity.

The ammonia is converted into nitrogen and hydrogen and then back into ammonia.

The recycling eliminates pollution and the use of oil and coal as generating fuels.

The mirrors are controlled by a computer.

A number of towns are interested in the use of solar energy for electricity.

Dr Carden said the cost of setting up a solar power station for a population of 5,000 people would be $5 million while a conventional station would be $2 million.

However, the fuel costs

(Continued on page 13)

Energy

(Continued from page 1

of a conventional station over 10 years would be about the cost of the station while a solar power station would be the reverse, with ammonia which can be sold as by product.

Promotion Council Secretary, Mr John Clarke, said it is expected representatives of both Forbes Municipal Council and Jemalong Shire Council will attend the meeting.

He said any interested persons are welcome, especially school students.

The AGE 26/3/77

Threat to major solar energy project

From DAVID BROADBENT

CANBERRA. — a major solar energy project which could make it possible to "export" Australia's sunshine is threatened by lack of funds.

Scientists at the Australian National University have been told the project is "too practical" for a university.

ANU officials believe scarce funds should be reserved for more pure science research, such as nuclear physics, theoretical physics and diffusion research.

The head of the ANU engineering physics department, Professor Stephen Kaneff, said yesterday his research team needed $1.4 million over the next five years to perfect the revolutionary system.

But a spokesman for the deputy vice-chancellor, Professor Noel Dunbar, confirmed that no money would be provided for the project after the end of the year. Professor Dunbar is a nuclear physicist.

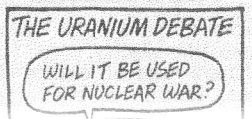
Professor Kaneff said he was confident the ANU team could soon develop a prototype machine which would fill the power needs of a small, remote town.

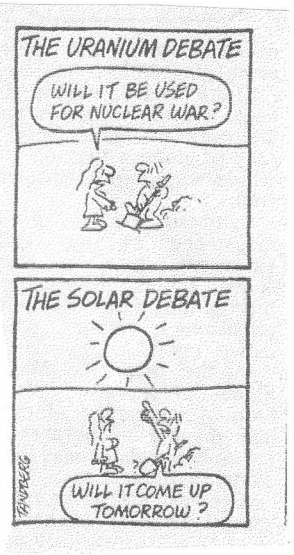
On a large scale, the solar energy system being developed could generate enough heat energy to serve a city the size of Adelaide. But this was "many years" away.

Professor Kaneff's project involves a new method of storing heat which would allow energy to be collected and exported to foreign countries.

The system uses the sun's rays to break ammonia down into nitrogen and hydrogen gas.

When the two gases are resynthesised they release heat energy.





Solar study

WE welcomed your featuring (26/3) our work over the past four years in the Department of Engineering Physics on the mass utilisation of solar energy. Unfortunately, as a misunderstanding appears to have arisen during the inspection and information session on the project, probably as a result of the complexity of the issues and ideas introduced on this occasion, we would value the opportunity to correct any such misunderstanding in case it might harm the cause of solar energy research.

In presenting our work, we made comparison with the USA Central Tower project, but not with any Australian research. In response to a great number of interesting, informed, intelligent questions from the press on the many involved scientific, technological and economic aspects of our project, we discussed how our system could produce, store or export hydrogen as well as ammonia and other products, apart from being able to generate electricity. This seems to have been interpreted as claiming superiority, but we ourselves do not view the situation in this way. Indeed, we stressed specifically that our work is complementary to and not in competition with work being carried on in Sydney University (which we respect and admire).

Rather than consider the present situation as a race (the 'Solar Stakes'), we look on it as a fight for survival of solar energy research; no one is in the luxurious position of being a competitor in a race, with the support which this condition usually implies. We still stand by our view put to the Senate Standing Committee on National Resources in June, 1976, that because solar energy research is still in its infancy, all valid approaches and ideas should be supported to allow them to demonstrate feasibility and provide sufficient information on which to base proper decisions for future utilisation. We believe that eventually solar energy will be used in many ways, all complementary.

Finally, may we thank you for your strong support for solar energy and offer our contratulations on your editorial "Pushing into the Solar Energy Age" in the same issue of **The Australian**. We support your call for Australia to develop solar energy as a major national project. This seems the only practicable way in which solar energy can be developed in time to have a significant impact as a truly alternative energy source.

STEPHEN KANEFF
Professor and Head
PETER CARDEN
Head, energy conversion group, Dept of Engineering Physics, Australian National University.

Grotesque

PICKERING's cartoon of Sir Robert Menzies (24/3) depicting him as a fat, senile cripple shoved off his wheelchair into the mud, with a

AUSTRALIAN 28/3/77

Sydney Morning Herald

26/3/74.

Lack of funds cuts solar energy plan

CANBERRA. — A lack of funds is threatening the development of a commercial solar energy project at the Australian National University, Canberra.

Scientists at the ANU believe that within 10 years they can produce a solar plant that would supply the energy needs of a remote mining township.

But the university has told them that, for economic reasons, provision of funds for the project by the Energy Research Group, will cease at the end of the year.

The university has said that money will be made available to projects in pure science at the expense of applied science.

Dr Peter Carden, of the university's Research School of Physical Sciences, and Professor Stephen Kaneff, head of the Department of Engineering Sciences, said yesterday that $2 million would be needed in the next five years if the experiments were to come to fruition.

Dr Carden said that provided no major obstacles were encountered the success of recent experiments indicated that a prototype plant for the commercial generation of solar energy could be produced within five years.

If commercial interests then developed the results of the research, solar energy could power a town in four to five more years.

"Our theoretical and experimental investigations so far lead us to believe that a successful prototype system can be built," Dr Carden said, "but until this is realised in actual practice there is no absolute assurance of success."

The research has been going on for about four years. About $250,000 has been spent.

Dr Carden said the university's decision to stop providing funds for the project would mean that $400,000 a year for five years would be needed to complete the project successfully.

Professor Kaneff said outside funds would be necessary to keep the experiment going.

The research group's system is based on the extraction of heat from the sun using a heat-absorbing chemical reaction involving the decomposition of ammonia.

The nitrogen and hydrogen produced are transmitted to a central plant. There they can release energy in the form of heat which can be stored for future energy generation.

The export of Australia's sunshine could become possible by shipping surplus ammonia to countries with climates less suitable for solar energy production.

"We are now approaching a serious situation regarding continuation of this project," Dr Carden said. "Because of the economic situation physicists in the Research School of Physical Sciences have to reduce their spending.

"If our work is to continue it should be completely paid for from external sources, most probably by an additional grant from the Government."

Dr Carden said the group had given details of its work last year to the Senate standing committee on national resources, but the Government had not yet been asked for financial assistance.

Professor Kaneff said solar energy projects in the United States and some smaller countries, notably Israel, were receiving substanti government finance.

26/3/75

ANU study brings solar power nearer

...w solar-energy research ... like fossil and nuclear fuels ... By JACQUELINE RUES ... ing is much smaller. ...

From The Canberra Times of July 1, 1975

ANU work on solar energy threatened

By ROSS ANDREWS

A research team at the Australian National University that has experimentally developed an international breakthrough with a system of chemically "canned" solar energy might be forced to close down because of financial cuts.

The team has been working at the Research School of Physical Sciences at the ANU. However, its continued work there was now threatened by a policy of the school that it should limit its funding to "pure" research related to the nature of the universe, two solar researchers said yesterday.

Another ANU solar-energy initiative threatened by financial cuts is the proposed construction of a sun-heated house in Kambah by Jennings Industries Ltd which is floundering for want of $25,000.

The ANU team's system is revolutionary because it links chemical reactions with solar energy.

This closed, "perpetual-energy" system involves the decomposition of ammonia into nitrogen and hydrogen. At the same time, solar heat is absorbed.

The nitrogen and hydrogen are later resynthesised to release energy in the form of heat. Alternatively, the chemicals may be "canned" for future energy generation. This gets over the hurdle of cloudy days that proved to be a bugbear in earlier solar-energy methods.

The system involves the collection of solar energy for breaking down the ammonia by a "steerable" array of parabolic mirrors, managed by a shared computer-controlier. Cheap, pressed steel, plated with reflective film, can be used to make the collection mirrors.

The solar-ammonia system was outlined last year in a submission to the Senate Standing Committee on National Resources by Dr P. O. Carden, head of the energy-conversion group at the university's department of engineering physics, and Professor S. Kaneff, head of the department of engineering physics.

Pilot scheme to prove system

The scientists believed that after a five-year experimental program they could gain enough "sound" knowledge to start a solar-ammonia pilot scheme to prove the system.

A total of $2 million would be needed over the five years. Additional funds could speed the development of the process.

However, the ANU scientists are funded only to the end of this year.

Meanwhile, in the United States, the nearest comparative advanced research — into "central-tower" solar energy — is receiving funds to the tune of more than $5 million for each of at least three feasibility studies.

Dr Carden says the final proof of the ANU concept would come with the building of a 10-million watt solar-ammonia "stand-alone" system to run a remote town, possibly a mining town.

The Australian study started four years ago, in the university's department of engineering physics, to determine the feasibility of "mass utilisation" of solar energy.

Gathering energy

Three years ago, it was found that "thermo-chemical energy transfer", using ammonia, seemed to be the best solution to the problem of gathering energy from each solar collector.

"Then everything else started to fall into place", Dr Carden commented yesterday.

The involvement of chemical energy in the process meant that the long-standing problem with solar systems (extreme difficulty in storing energy) had been theoretically solved. Only the basic chemical reactants had to be stored.

The nitrogen-hydrogen mixture has to be stored under pressure below the ground, possibly using natural or man-made reservoirs. Disused oil or gas wells, or existing water bores, are possibilities.

The initial "bootstraps" staff of one person in the first year of research, and two more in the second, was boosted two years ago to a total of six.

Since The Canberra Times published a report (above) on the system on July 1, 1975, the team's research has dramatically advanced.

Work has advanced in experiments on the breakdown of ammonia at high temperatures and pressures, and improved on the original mirror-array system.

The conclusion of the team, couched in the normally reticent language of scientists, was, "It seems that a prototype system can be made to work".

'Way ahead' of US

In spite of their small grant, the ANU researchers believe they are "way ahead" experimentally of the US, which has not yet reached the experimental stage, Professor Kaneff said.

In their Senate submission, the ANU scientists said of their US counterparts, "We can invoke their results as being relevant to our system as regards economic aspects and can point to technological features which are at least as favourable as those of the central-tower concept".

A major advantage of the ANU solar-ammonia system over the US method is "that it can provide practicable storage to cope with daily fluctuations, with variations due to weather, and even with seasonal fluctuations in insolation".

Present evidence suggests the ANU system's mass utilisation of solar energy might be achieved, using present technology, at a cost of 5c a kilowatt hour. US estimates range down to about 3c a kilowatt hour.

The figure is two or threefold above current city prices, but "there are, even now, remote towns in Australia where the present power costs are greater than 5c a kilowatt hour".

The Senate submission points out that development of specialised manufacturing industry, assisted by increasing demand and economies of scale, should lead to cost reduction "so reducing the price of this form of solar power".

Solar energy can produce large-scale electricity, nitrogenous fertilisers from air, water and energy, refined metals (through reduction of ore by solar-powered hydrogen, or electrolytic refining) and transportable fuels like hydrogen, methanol and ammonia.

The submission called for "generous" funding of fundamental studies and applied research in Australia comparable on a per capita basis with that in the US.

Basically, a future solar-ammonia plant would consist of collectors, an energy-gathering "corradiative" network converging on a central station, an energy store, means for recovering solar energy (as in heat) and means for converting the recovered energy into a usable form (like a steam generator coupled with a conventional turbo-alternator).

Apart from power-generating industries, major manufacturers in steel pipes, tubes and automobile bodies (their methods can be used to press steel plates for collector mirrors), could benefit from the solar-ammonia process.

The submission said, "For example, in order to feed a growth over 50 years to 10,000 million watts of solar-power generation, approximately 1.5 million pressed-steel collectors would be required per year, valued at perhaps $500 million. This is comparable to the present Australian motor-vehicle-body industry.

"The pipe - and - tube manufacturers would be similarly stimulated as would, of course, the steel industry. Moreover, Australia's balance-of-payments position would be improved over the period by an average of $650 million per year through the sale, at world market prices, of the steaming coal thus saved".

20/7/77

Official stop to solar funds

The ANU officially announced yesterday that it would stand by the decision to financially abandon its unique solar-ammonia project at the end of this year unless outside funds were invested.

If "appropriate bodies" were negotiating for an involvement in the project at the end of 1977, and if their interest could take the project to the stage of proving the feasibility of building a 10-megawatt electricity-generating station, the ANU would consider a "further extension of support".

'Matter for other organisations'

The decision was reported by The Canberra Times last week.

In yesterday's press statement (the first official statement on the issue by the University), the Vice-Chancellor, Professor D. A. Low, said:

"It must, however, now be for organisations, which are geared (as a university research school is not) to consider whether it is feasible to take the project forward, to determine whether they should take an interest in doing so".

The Member for Fraser, Mr Fry (Lab), said last night he was "extremely disappointed" with university authorities who gave him an undertaking on Wednesday that they would give sympathetic consideration to keeping the solar-ammonia project research going for the first six months of next year.

ANU to axe top solar project

22/7/77

By ROSS ANDREWS

One of Australia's leading solar energy research projects will be abandoned by the ANU at the end of this year.

The project at the university's Research School of Physical Sciences had developed an international breakthrough by chemically "canning" solar energy. By the 1980s, the system could have powered a remote Australian town with a 10 million watt solar-ammonia "stand-alone" plant.

The system (it is the most advanced project on a self-contained solar power-generating process in the country) has an Australian patent pending. It attracted inquiries from State and municipal authorities and leading firms around the country and has had queries from as far afield as Saudi Arabia, India, Indonesia and the Philippines.

But it is not yet far enough advanced to be supported by investment from private sources.

The university and the head of the Research School of Physical Sciences, Professor Robert Street, have decided the project should receive no more funds past the end of this year, university sources said yesterday.

The project is already winding down and its technicians are seeking jobs elsewhere.

The Canberra Times reported four months ago on the possibility that the project could be closed down because of financial stringencies and because of a policy in the research school that it should limit its funds to work on "pure" research into the nature of the universe.

The project is headed by Dr Peter Carden, and Professor Stephen Kaneff, who is head of the research school's department of engineering physics and intimately connected with the energy-conversion group.

The project was the ANU's only commitment to solar energy. Its fate was sealed by the research school's regular review committee late in 1976 — which has kept its findings confidential.

The ANU Students Association newspaper, Woroni, quoted yesterday Professor Street, who chaired the review committee, as saying the solar project had entered its "development stage" of research and he expected costs to multiply tenfold.

Dr Carden and Professor Kaneff disagree, saying they want only $200,000 next year or the maintenance of the same level of spending the project is getting at the moment.

Research funds problem

Over five years, it would need $2 million.

Some of the greatest interest shown in the project so far has been from a State government energy authority — but it found it could not aid the project financially because of complaints this would have brought from solar researchers working in its own universities.

The Senate Standing Committee on National Resources said in its solar energy report that "the ANU solar ammonia process appears to have the potential for filling an important need in Australia", and it would have "application for supplying the power requirements of remote rural and mining townships".

Dr Carden and Professor Kaneff believe the system could ultimately supply large population centres (like Adelaide) with electricity.

The ANU solar system is revolutionary because it links chemical reactions with solar energy.

This closed, "perpetual-energy" system involves the decomposition of ammonia into nitrogen and hydrogen. At the same time solar heat is absorbed. The nitrogen and hydrogen are later resynthesised to release energy in the form of heat.

Alternatively, the chemicals may be "canned" for future energy generation. This gets over the hurdle of cloudly days that proved to be a bugbear in earlier solar-energy methods.

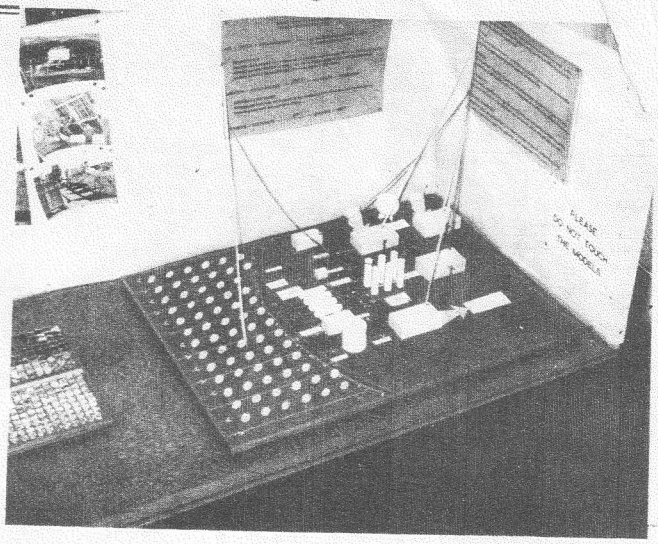
The total system involves the collection of solar energy for breaking down the ammonia by a "steerable" array of parabolic mirrors, managed by a shared computer-controller. Cheap pressed steel, plated with reflective film can be used to make the collection mirrors.

The ANU team has worked on its process for four years and the system is now widely-regarded as the world's leading thermo-chemical solar power system.

A university spokesman said last night that he could not comment on the situation.

Safe storage of N-waste seen, an two energy reports. — Page 3.

ANU ABANDONS SOLAR ENERGY



In the Foyer of the Oliphant Building of the Research School of Physical Sciences there is a model of a solar energy based power station. A small working station was to be the culmination of the research by the Energy Conversion Group of the Engineering Physics Department within the Research School. However the University and the Head of the Research School have refused to fund the project past the end of this year. Since then the University has attempted to keep the decision under wraps.

The project headed by Dr Peter Carden uses concentrated solar energy to induce a chemical reaction in ammonia that can later be reversed, yielding energy for the production of electricity. Because the solar energy is concentrated, and the energy product can be stored and transported the process developed by the ANU Solar Energy Project seems to have the potential for overcoming most of the inherent difficulties associated with solar power. The Senate Standing Committee on National Resources stated in a report on Solar Energy that *'The ANU Solar ammonia process appears to have the potential for filling an important need in Australia'* and that it would *'have application for supplying the power requirements of remote rural and mining townships'*. Dr Stephen Kaneff, Head of the Department of Engineering Physics says the Senate Committee underestimated the potential of the project in relation to large scale systems. Project head Dr Peter Carden predicts that ultimately large population centres could also be supplied with electricity. The head of the Sydney University Solar Energy project described the ANU Solar Energy Project as *'the only one in Australia working on large scale power generation and storage'*. A number of private companies, including uranium and chemical firms have expressed interest and potential support – so has the Victorian Government. Australian patents have been taken out for the process.

Yet, despite all this Professor Street Head of the Research School since late 1974, backed up strongly by Vice Chancellor Professor D.A. Low, has decided that the project should not be funded past the end of this year. This makes it almost certain that the project will finish at the end of this year.

The project is already winding down with members already seeking alternative employment. Professor Street has said that all the staff of the Energy Conversion Group could be redeployed elsewhere in the School. But Vice-Chancellor Professor D.A. Low has given no such guarantee of redeployment to staff generally and some group me mbers have expressed an unwillingness to stay within the School after the project is killed.

The decision to end ANU's only commitment to solar – or any non nuclear energy followed a review of the Research School late last year. The review, which has remained confidential, apparently recommended that although the social value' of research projects should be considered, those projects that verged on applied science should not be funded.

Allied by some academic politicking the Review Committee's attitude to applied research has been adopted by the Research School Faculty Board as its policy.

> 'Faculty Board believes work of an applied nature may properly have a place in the School. Such research can however, be supported by the School only during an initial exploratory phase and on the understanding that separate funding must be obtained for any extension of the project beyond this phase . . .'

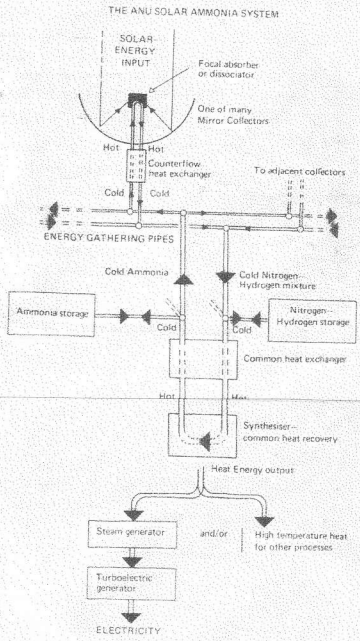
The Review's concession to 'social relevance' is also enshrined in Faculty Board's policy statement. However, Faculty Board is forced to note the obvious contradiction between its lukewarm commitment to 'social relevance' and its committed aversion to 'applied research'.

> '. . . a difficulty arises in that (socially relevant) research is often of an applied or developmental nature . . .'

Some have said 'The Review was a very poor document' Others say that the Review Committee did not have the expertise to make a worthwhile evaluation of the Solar Energy project and that their comments also showed a lack of awareness of the project's uniqueness.

Faculty Board's guidelines for resource allocation 1977-9 show that the Department of Engineering Physics has been cut back to the benefit of other Departments within the School, and that the Review has been used to justify this process. Solar Energy Research has been the principal victim.

Professor R. Street who both chaired the Review Committee and acted on its recommendations, says that the Solar Energy Project had entered the 'development stage' of research where he expected cost to multiply by a factor of 10. According to Department of Engineering Physics proposals this charge is nonsense. They want only $2 million over the next five years and about $200,000 next year or the maintenance of the same level of spending the project already receives. The maintenance of spending in real terms incidentally one of the recommendations of the Senate Committee Report on Solar Energy. Dr Carden says that the project wants only to continue until the 'proof of concept' stage is reached. Professor Street told me that in his opinion the proof of concept stage had already been reached and that the team now wanted to engage in research and development work. Dr Kaneff says that proof on paper is not 'proof of concept' but a small working prototype will be. According to Dr Kaneff other universities do accept a responsibility to demonstrate the feasibility of research concepts. Many within the School feel that Professor Street – a solid state physicist – has a distinct bias against any applied science beyond 'applied mathematics'. This aversion to applied science or 'research and development' seems to have affected both the Review and the allocation of funds within the Research School.



Above the model in the foyer and ,diagramatically, how electricity can be produced.

The project has now been thrown onto its own resources and Dr Kaneff and Dr Carden are working towards finding alternative funding. As stated before, a number of large and well known firms with interests in uranium chemicals and engineering have studied and expressed interest in the project. The assessment of economic viability has also been confirmed by these groups.

A widow with three children and 'two young kids from Berrima' have been amongst members of the public who have made unsolicited donations to the project. The project is probably the only research within the Research School that is an attractive proposition to potential outside interests. The question in the current economic climate is whether money will be forthcoming before the end of the year. Professor Street's claim that it is not for the universities to fund applied research may have left a situation where the universities won't fund it, the government won't and it's not far enough advanced for private corporations to enter the field. There are some indications that Professor Street has not been pulling his weight on attempts to obtain outside funding.

For instance, Faculty Board states '. . . . it would be appropriate for the School to seek University support and endorsement to obtain external funds for (applied research)' . . . However, despite this 'policy' Professor Street told me that it would not be approp riate to approach either the University or the Universities Commission. It would not be appropriate, he said, because of the method of University funding, and in any case, what could the University do. It seems that Professor Street is policy bound to approach the University without presuming in advance that the University can do nothing.

The ANU seems determined to abandon its very limited commitment to any non-nuclear future – because a Review Committee and the Head of a Research School with no real expertise in the area decided that the purity of a scientific project must outweigh its Social Relevance.

To quote Dr Carden from The Canberra Times 'Without breeding, uranium will probably take us only another 15 to 20 years beyond the lifetime of the world's coal reserves assuming world economic growth will continue as it has so far this century. . . .' and Dr Edward Teller 'Father of the H Bomb' "after one billion dollars and 20 years of work the breeder reactor does not work."

The University can without too much pain undo this decision. If they do, *Woroni* will then be as congratulatory as it is now derisive.

Phil Dickie.

August 1977

Canberra Times 23/7/77



Professor Street at the ANU yesterday . . . not necessary to discover the wheel again.

US interest in ANU solar project

By ROSS ANDREWS

A powerful United States company is considering a cash interest in one of Australia's leading solar energy projects — which will be financially abandoned by the ANU at the end of this year.

Involvement of the US interest may mean the departure of the research team from its cramped quarters at the university to private laboratories.

The head of the Research School of Physical Sciences at the university, Professor Robert Street, said yesterday that negotiations were advanced in seeking outside funds for the project, which combined several solar and chemical processes to "can" solar energy.

As for the university, it will devote much of its physical research money from next year to pursuing plasma physics, in the hope that Australian research eminence will involve the country in the global "fusion club". One school of thought in the alternative energy debate is that fusion will become the world's virtually-inexhaustible energy source next century.

Professor Street hoped a far-larger injection of external funds would accelerate the solar-ammonia project to early fruition.

It was reported yesterday that the ANU researchers, headed by Dr Peter Carden, believe the self-contained power-generating system could supply a remote Australian town with 10 million watts of electricity in the 1980s.

External support could also provide the ANU team with a wide range of expertise in the half dozen fields of technology that its self-contained process would require. Detailed research is needed in the geology of aquifers, mechanical engineering, chemistry and the computer control of mirrors.

Professor Street would not comment on a suggestion that the US company was interested in the promising solar-ammonia project because of fears of enormous costs in the advanced American "power-tower" solar system. (This involved mirrors reflecting sunlight up to the top of a sky-scraper size concrete tower in a desert region).

Another expensive American scheme would involve solar collectors sent into orbit.

University sources say the ANU solar-ammonia process is widely regarded as the world's leading thermo-chemical solar power system.

Professor Street said if external financial interests were decided upon, the matter of royalties and the preservation of Australian equity in the process would be dealt with from the outset.

"You have got to have a high level of funding to get quality", he said "There is no use scratching at the process for 40 years on low funds.

"It is essential to get a lot of technical expertise into the project. I don't think it is necessary for the team to discover the wheel again".

If negotiations with the US company fell through, Professor Street believed a special fund might have to come into existence in Australia and the ANU process would have to go through an assessment process before receiving future finance.

Senator Ryan (Lab, ACT) called on the Minister for Science, Senator Webster, yesterday to make special funds available to the ANU solar project.

"If the university can no longer fund the project, then it is the responsibility of the Federal Government to step in", he said.

"With conventional fuel sources running out and uranium too hazardous to develop, the development of a safe alternative energy source is crucial.

"The project, if continued, could result in a solar energy system for which there would be a ready market throughout Australia and among our Asian neighbours.

"The Minister for Science has repeatedly committed himself to solar energy research. By securing funds for the ANU project, he would be giving substance to these commitments".

Head of ANU school leaving

26/7/77

By ROSS ANDREWS

Uncertainty about the future of the solar-ammonia project at the ANU increased yesterday when it was learnt that the head of the Research School of Physical Sciences, Professor Robert Street, was leaving the university.

He has been appointed Vice-Chancellor of the University of Western Australia.

Professor Street told The Canberra Times last night that he would take up the position "early in the new year".

A spokesman for the University of Western Australia said at 6.30pm (eastern time) that the identity of the new Vice-Chancellor was not known there yet. Pressed on the matter, he admitted there had been a rumour earlier in the day that Professor Street would take the position.

The Canberra Times reported late last week that Professor Street and the ANU had decided to financially abandon the solar-ammonia project from next year.

The project's funding would be redirected to the research school's larger project connected with nuclear fusion.

The solar-ammonia project was the ANU's only commitment to solar energy. The rot set in for it several months ago when a review committee chaired by Professor Street recommended it should be taken only to the proof-of-concept stage.

The solar-ammonia process is regarded as the world's most experimentally advanced solar-power system. It is certainly Australia's most advanced self-contained solar-power project.

The relative simplicity of the solar-ammonia process (which "cans" solar energy chemically) has attracted considerable interest from the United States, where technologically and financially expensive solar-energy systems are being experimented with.

Policy

However, the solar-ammonia project finally fell foul of the research school's policy to limit its funds to work on "pure" research.

Professor Street told The Canberra Times last week that much of the university's physical-research money would be directed to pursuing plasma physics, in the hope that Australian research eminence would involve the country in the global "fusion club".

Scientific opinion varies widely on the power-generating role nuclear fusion would achieve next century.

In some quarters it is seen as a vastly expensive pie-in-the-sky, while other schools of thought believe it will become an almost Utopian, "clean" and virtually inexhaustible energy source based on isotopes won from the raw materials of water and lithium.

[Lithium has been known to science since 1817 but never occurs in a pure state. The soft, metallic element is usually deposited with other metals in pegmatite ore.]

The industrial nations in the "fusion club" are spending many hundreds of million of dollars each year on highly complex nuclear-fusion research.

At present, the staff working on plasma physics at the ANU is several times greater than that working on the solar-ammonia process.

The more modest solar-ammonia project would require funds of only around $200,000 next year. Over five years it would need $2 million.

However, Professor Street believes the project needs far greater finance than the university can manage.

"There is no use scratching at the process for 40 years on low funds", he said on Friday.

The leader of the ANU solar-ammonia team, Dr Peter Carden, said yesterday that if his team had to leave the university it would lose the resources of specialists in a wide variety of fields that it could call on at present.

Knowledge

The solar-ammonia process involves specialised knowledge in fields as diverse as the geology of aquifers, chemistry, and mechnaical engineering.

But the project is winding down now.

University sources did not know yesterday whether Professor Street's departure would mean a change of policy for the research school — there is every possibility that several years could pass before a successor is found.

Professor Street has been head of the research school for three years. He was preceded in the position by Sir Ernest Titterton.

Professor Street said last night he thought the future of the solar-ammonia project at the ANU would depend on the availability of outside funds.

He was "very much" pleased by the appointment to Perth and was "looking forward to going there".

"I think the university is good and I know many people there", he said.

As for solar research at the University of Western Australia, he said he would have to find out what the local situation was. He had heard of a State funding scheme for solar research.

Vol 29 No 11 15 Aug. 1977

Woroni

for ANU Students' Ass'n

SOLAR ENERGY – not even 6 months extra

After a lot of adverse publicity in the national press following the Solar Energy story in the last *WORONI* and some annoyance at Chancelry and the Research School of Physical Sciences, the University has publicly gone some way to extending funding for the ANU's solar energy research. The Australian Capital Territory's two Labor members of Parliament expressed immediate concern at the impending funding cut off, Senator Susan Ryan immediately issued a statement saying that she would take the matter up with Minister for Science John Webster. Mr Ken Fry took the matter up with Professor R. Street, the Director of the Research School of Physical Sciences and received a verbal undertaking of six months extra funding for the project – "subject to Faculty Board confirmation", which Ken Fry understood was largely a formality. But to the best of *WORONI's* knowledged the matter was never raised before the Faculty Board. Instead, Ken Fry, Professor Street and Kaneff met with the Vice Chancellor Professor D.A. Low. Subsequent to this meeting the Vice-Chancellor issued a press statement which conceded that "if discussions were in hand with some appropriate bodies which showed promise of leading to a program for determining the feasibility of a first production stage, further extension of support by the University could be provided". Ken Fry tackled the Deputy Vice-Chancellor Professor Ian Ross on the rather ambiguous wording.

The translation according to Professor Ross is that if negotiations are proceeding at the end of this year, an interim extension of funding will be considered. It certainly did not mean the respite of six months for the Solar Energy Group that would probably be forthcoming, according to what Professor Street told Ken Fry.

Professor Low is stressing the recommendations of the Review Committee of the Research School of Physical Sciences. This review was the first of any school or department within the A.N.U. and it was received with considerable opposition and was, to quote Professor Street, quite a traumatic experience. At the moment, several such reviews have just been completed and others are proceeding. Comprehensive reviews of the ANU's schools and departments are known to be one of the most deepfelt policy ambitions of the Vice Chancellor and the latest and current reviews are a lot less secretive than that at the Research School. Professor Low probably overuled Professor Street's six months extension of funding to uphold the recommendations of that first Review Committee.

The ANU has changed its public stance on the issue. Previously the University had maintained that without outside funding the Solar Energy Project would be terminated at the end of the year. The Vice-Chancellor's press release now says that funding may be extended past the end of the year – if negotiations for outside funding are proceeding. However in reality the University's attitude remains the same. Research School Faculty Board Guidelines state "Depending on the actual stage of negotiations for external funding consideration may be given to the extension of support for a specific extra period as deemed appropriate". The ANU has not given anything away and is still not willing to make any commitment to Solar Energy Research, or even act according to the recommendations of the Senate Standing Committee on Solar Energy.

plasma physics?

While the University was on the receiving end of so much adverse publicity the red herring of 'plasma' research was brought up and a couple of newspapers (notably *The Australian*, mentioned it. It is hoped that research into plasma physics will contribute to the eventual utilization of nuclear fusion as an energy source. However the ANU's Plasma Research (also within the Department of Engineering Physics) has been going for more than ten years without a great deal having been achieved. Feasible nuclear fusion energy is a lot further off than feasible solar energy. Nuclear fusion research is also one of the areas where Australia c nnot compete on equal terms with say the USA, whereas Australian research into solar energy is equal to, or above world standard.

The ANU's suddenly vaunted Plasma Research project uses expensive machinery and employs about 25 people and according to Professor Street quoted in *The Australian* the energy payoff may be 30 years away.

The ANU still has some questions to answer. Why is there an all or nothing proposition applying to the funding of Solar Energy Research.

There is nothing intrinsically wrong with seeking to obtain outside funding, but why not support the project and it's hard to gather research teams until such external funding as can be obtained in a difficult economic climate comes through. What will happen to the approximately $200,000 used to fund the "Director's Unit" when Professor Street leaves to become Vice-Chancellor of the University of Western Australia at the end of this year. (The Directors Unit specializes in Solid State Physics – there was already and still is a Department of Solid State Physics within the School).

One last plug for the nationalists amongst us – if Australian funding for the project cannot be obtained the fruits of an Australian research breakthrough in that most valuable commodity, energy, will accrue to the USA, or possibly, the Arabs.

Phil Dickie.

24/9/74

'Effort' on solar project

THE

The Australian National University is putting "a good deal of effort" into attempts to interest companies in the construction of a prototype of its solar-ammonia power plant, the university's Vice-Chancellor, Professor Anthony Low, has told members of his staff.

By ROSS ANDREWS

Professor Low was replying to a letter signed by Dr Bob Brissenden, a reader in the university's English department, and 12 other members of the ANU academic staff, calling for the university to find a way to keep financing the threatened solar-power research project.

The letter, and Professor Low's reply, were tabled at the latest University's Council meeting, yesterday's edition of the ANU Reporter said.

The solar-ammonia project, in the university's Research School of Physical Sciences, is considered Australia's most advanced research toward the creation of a self-contained solar-power plant.

Although the project is the university's only solar-power research, the ANU has not provided for its funding next year. It will not provide financial support, according to past statements, unless it can win the interest of companies who want an involvement with a prototype power plant.

There are doubts, however, that corporate finance could be won at present because the project is only in its laboratory stages.

In recent months, scientists involved in the project stressed that another 10 years' work may be needed before a large prototype power station could be built.

In a statement on July 29, Professor Low said the university had decided that if a company was interested in involvement in a feasibility program for a first production stage of a 10-megawatt power station by the end of this year, then the university might consider a "further extension of support".

No mention was made of the fate of the project if outside interests were not found.

The scientists involved in the project have said in past submissions that only $200,000 would be needed to keep the project going next year.

The "laboratory stage" could be continued for another five years at a cost of $2 million, and could culminate in the construction of a small pilot power plant. After 10 years, they envisaged the building of a 10-megawatt plant at a cost of some $10 million to power a remote town — if the solar-ammonia system proved economic.

Yesterday's ANU Reporter said that in their letter tabled in the University Council meeting, the 13 academics called on the Vice-Chancellor to give some special consideration to continued university support for the project because it "appears to be of such national and international importance as to warrant some special consideration".

They asked if Professor Low, possibly assisted by a committee, could investigate two issues.

How the university could continue supporting the project without threatening its ability to pursue pure research work (in the light of its financial pressures).

If a way to continue its support for the project was found, how the research could be funded "and in particular the question of what sources of finance the university should turn to if it needs to seek special assistance from outside".

The academics said, "There would appear to be a growing volume of authoritative opinion to support the belief that the solar-energy project being developed by the group is potentially of considerable value and significance.

"It therefore seems — at least on the face of it — regrettable that this university is apparently unable to continue supporting the project".

Professor Low sent the academics copies of his statement of July 29 and told them, "From this you will see that the position is not as it has been publicly represented. After protracted consideration the conclusion was reached, if I may be brief, that the prime necessity now was to have the feasibility of moving towards a production stage on the basis of the work already done considered by those with the technological and industrial expertise which this would require".

Considering that the university's solar researchers believed a successful prototype of the system could eventually be built — but there was no absolute assurance of success until this was done — Professor Low said it seemed to him that:

"We are moving on the right lines in seeking to interest in taking the matter forward substantially those who would be better geared to contemplate constructing an actual prototype system than a university can be.

"A good deal of effort is currently going on in this direction, and I would hope, as you would, I think, too, that before very long some response of real promise along these lines will be forthcoming".

University could continue solar energy research in RSPhysS if. . . .

The University could extend its support of the solar energy project in the Department of Engineering Physics, RSPhysS, if discussions with appropriate outside bodies, such as private sector firms, show promise of leading to a program for determining the feasibility of a first production stage of the project – a 10 million watt solar power station.

The Vice-Chancellor, Professor Anthony Low, announced this in an ANU Information Release to the news media last week. He was commenting on recent media reports about solar energy research in the University's Research School of Physical Sciences. The reports have said that ANU funding of the solar energy project will cease at the end of this year.

'Research into new sources of energy is of considerable national and international importance, and it is natural that there should be keen public interest in the solar energy research at ANU', Professor Low said in the Information Release.

'Lately the University has instituted a number of formally-constituted reviews of the work of various of its Departments and Research Schools. One of the first of these was the Research School of Physical Sciences', Professor Low continued.

'It was begun in 1975, and was conducted by a distinguished team of 11 scientists nominated by the Faculty Board of the Research School, half of whom came from outside the University. This Committee consulted very widely with a large number of Australian and overseas referees and assessors, some of whom were nominated by the Departments concerned. The Committee reported to the Faculty Board of the Research School of Physical Sciences in July 1976 on the varied aspects of the work of the School. Its findings were extensively considered by the Faculty Board during the latter part of last year, and in December 1976 the Faculty Board agreed on a series of guidelines for the determination of resource allocation in the Research School of Physical Sciences during 1977–79.

'One of the many research activities considered in the course of this protracted investigation was the solar energy project of the Department of Engineering Physics.

'The prime conclusion reached about this was that the point had now come when it was necessary to determine the feasibility of achieving a first production stage (a 10 MW electrical generating station) based on the scientific research which had been done. It seemed clear that this would entail investigation of the scientific and economic viability of the processes. It was also apparent that this would require technological and industrial expertise, and financial resources, of a kind which are not presently available to a School concerned with and funded for basic research.

'It was at the same time agreed that the project should be continued in its present form for the current year whilst these matters were actively explored. It was also agreed that if discussions were in hand with some appropriate bodies which showed promise of leading to a program for determining the feasibility of a first production stage, further extension of support by the University could be provided', Professor Low said.

'These arrangements stand', he added.

'By now, the potentialities of the University's research into solar energy have been expounded by the specialists in the School's Department of Engineering Physics to the Senate Standing Committee on National Resources as part of their investigation of solar energy, to Government Departments, and to interested industrial concerns. It can be made available to other appropriate bodies for their consideration as well.

'It must, however, now be for organisations, which are geared (as a University Research School is not) to consider whether it is feasible to take the project forward, to determine whether they should take an interest in doing so.

'The Department of Engineering Physics, the Research School of Physical Sciences, and the University, stand ready to assist further to than end', Professor Low said.

SOLAR POWER FOR TOWN 'IN 10 YEARS'

2/10/77 Sun Herald

Electricity from the sun could be powering a NSW town within 10 years if university research in Canberra is successful.

By BRENDAN DONNELLY

Results so far are encouraging, says Dr Peter Carter, head of the Energy Conservation Group at the Australian National University's Research School of Physical Sciences.

Dr Carden said four towns want to be the first to try electricity produced by harnessing the sun's rays through hundreds of computer-controlled mirrors.

Heat from the mirrors is used to convert ammonia into nitrogen and hydrogen, which later can be formed back into ammonia, giving out heat to drive a steam generator for electricity.

He wouldn't name the towns interested in the scheme because he said, "they might not be ready for the publicity."

He said although the system had been given "thumbs up" by engineering firms and plant manufacturers, the future of the research program was in doubt.

'$2m needed'

Between $1.4 million and $2 million was needed from the Federal Government over the next five years to prove the system conclusively.

Its promised advantages included elimination of pollution and of oil and coal as generating fuels, since it operated by recycling ammonia.

Dr Carden said the research, which had been in progress for two years, had been receiving support from the university, but there were doubts that the support would continue next year.

The research was needed to assess the economic viability of the scheme, the cost of plant and its lifetime and reliability.

Fertiliser

He said: "We couldn't build the power station if given the money next year."

Already it was clear the cost would be two or three times as great as a conventional power supply, he said.

For a township of 5,000 people with light industry, a 5-megawatt, solar-electricity supply would cost about $5 million compared with about $2 million for a conventional system.

However, after 10 years of operation, because of fuel costs, the bill for the conventional station would be the same as for the solar plant.

And while increases in fuel costs would add to bills for electricity from the conventional station, it would be possible to reduce bills from the solar plant, he said.

Ammonia could be produced at a solar plant as a by-product of electricity and sold for the manufacture of nitrogenous fertiliser.

Dr Carter said because the price of ammonia was linked to coal and oil prices, any increases which would add to bills from a conventional station, would reduce bills from a solar plant by the same factor.

However, depreciation and maintenance of equipment would be more expensive at a solar plant.

Academic staff members ask VC to investigate solar energy funding

Thirteen members of the University's academic staff have asked the Vice-Chancellor, Professor Anthony Low, to investigate ways of continuing ANU support of the solar energy project in the Department of Engineering Physics, RSPhysS.

Professor Low has replied that 'a good deal of effort' is going towards interesting outside companies in contemplating the construction of a prototype solar energy power plant and he hopes 'that before very long some response of real promise along these lines will be forthcoming'.

Both letters were before the University Council at its last meeting.

The letter to the Vice-Chancellor was signed by R.F. Brissenden, Reader, Department of English; Stephen V. Boyden, Professorial Fellow, Centre for Resource and Environmental Studies; H.C. Coombs, Visiting Fellow, Centre for Resource and Environmental Studies; Ian Cowan, Professorial Fellow, Department of Environmental Biology; Keith Crook, Reader, Department of Geology; Jeremy Evans, Senior Lecturer, Human Sciences Program; Robin Gollan, Professor, Department of History; Stuart Harris, Professor, Centre for Resource and Environmental Studies; J.N. Jennings, Professorial Fellow, Department of Biogeography and Geomorphology; John Molony, Professor, Department of History; R.O. Slatyer, Professor, Department of Environmental Biology; P.N. Troy, Fellow, Urban Research Unit, and Donald Walker, Professor, Department of Biogeography and Geomorphology. Their letter read:

Dear Vice-Chancellor,

In recent months, as you know, considerable interest both within and without the university has been aroused by the work of the Energy Conversion Group in the Department of Engineering Physics. There would appear to be a growing volume of authoritative opinion to support the belief that the solar energy project being developed by the group it potentially of considerable value and significance.

It therefore seems – at least on the face of it – regrettable that this University is apparently unable to continue supporting the project. We are aware that those involved in reaching a decision concerning the future of the project have had to take into account a number of things – the present economic straits in which the University finds itself, the necessity of maintaining certain areas of the University as places for pure rather than applied research and the importance of preserving the independence and integrity of Schools within the general University structure. The right of a School to determine its own programmes and activities with as much freedom as possible is, we acknowledge, essential to the academic life of this institution.

Nonetheless, the solar energy project appears to be of such national and international importance as to warrant some special consideration. We ask therefore, whether it would be possible for you, perhaps assisted by a committee, to look into the matter. If such an investigation could be carried out we should hope that it would be directed towards two main issues: (1) the question of how the University, without abrogating the general academic principles to which we have already alluded, can find a way of continuing to support the work of the Energy Conversion Group; (2) if such a way can be found, the question of how the operation is to be funded, and in particular the question of what sources of finance the University should turn to if it needs to seek special assistance from outside.

If you think it appropriate we should greatly appreciate it if this letter could be brought before the Council at its next meeting.

The Vice-Chancellor replied:

Dear Dr Brissendon,

Thank you for the letter of 1 August, signed by a number of our colleagues, on the work of the Energy Conservation Group.

From the date of your letter I would imagine that it may have been prompted by a remarkably misleading report in *The Canberra Times* of a statement I issued on this topic on 29 July. At all events I include thirteen copies of that statement in full for you and your co-signatories.

From this you will see that the position is not as it has been publicly represented. After protracted consideration the conclusion was reached, if I may be brief, that the prime necessity now was to have the feasibility of moving towards a production stage on the basis of the work already done considered by those with the technological and industrial expertise which this would require.

The University's Energy Conservation Group stated to the Senate Standing Committee on National Resources that 'the major unknown factors have been resolved', and its leader, Dr Carden, has said that he believes 'a successful prototype system' can be built, but that until this is done there can be no absolute assurance of success.

Given these convictions on the part of those directly involved, it would seem to me that we are moving on the right lines in seeking to interest in taking the matter forward substantially those who would be better greared to contemplate constructing an actual prototype system than a university can be. A good deal of effort is currently going on in this direction, and I would hope, as you would, I think, too, that before very long some response of real promise along these lines will be forthcoming.

I shall be glad to lay your letter before Council, along with a copy of this reply – which please feel free to show to your co-signatories.

Large-scale use of solar energy remote

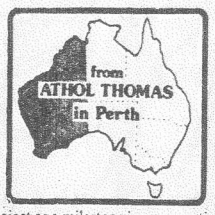
IN APRIL Western Australia's State Energy Commissioner, Mr J. B. Kirkwood, went abroad to make a study of nuclear power development, including methods of waste disposal, in Germany, France, Britain and Sweden.

He came back convinced that Western Australia, with its limited coal reserves, would eventually need nuclear power — and the Premier, Sir Charles Court, has forecast the building of a nuclear power station in the 1990s.

But Mr Kirkwood had documents in his briefcase relative to another power source, the sun.

And so Western Australia will soon take a major step in solar energy development by installing commercial-scale solar energy plants at Meekatharra, in the near-north and Perth. Meekatharra will get about 20 per cent of its power needs from an 80-kilowatt plant designed in West Germany by the MAN organisation. It is expected to be completed in two years.

A 35-kilowatt solar plant designed in Italy by Ansaldo will be installed at the State Energy Commission's northern gas depot in Perth, where it will be evaluated. The installations are expected to cost about $3.5 million. According to the Minister for Fuels and Energy, Mr Mensaros, contracts will be signed almost immediately.



Mr Mensaros regards the MAN project as a milestone in co-operative energy research with West Germany. That country, through its Ministry of Fuel and Technology, will contribute half the total cost of $2.8 million. The rest will be provided by the SEC, which has been given a $56,000 contribution by the Western Australia Solar Energy Research Institute. The SEC has also sought a grant of $105,000 from the National Energy Research Development and Demonstration Council.

It has not been lost on critics of the State Government's nuclear policy that the proposed solar power stations may be a public relations exercise designed to show that Sir Charles has not closed his options on sources of future power. In fact, Sir Charles indicated soon after the Harrisburg disaster that, at any time in the immediate future, his Government could turn to another option if it proved better.

But he mentioned the only "significant certainties" as being oil, gas and coal. Clearly he regards the widespread use of solar energy as being well into the future.

The harnessing of the sun on a big scale may well be as remote as harnessing tidal power. At present, the commercial use of solar energy will be only to augment, on a small scale, conventional power.

At the Perth installation, the Ansaldo solar plant will also feed on waste heat from diesel-engine exhausts. If it operates successfully, it will be moved to a country site to be used as a fuel-saver associated with a diesel power station.

The Ansaldo plant will cost $693,000. Ansaldo will contribute 30 per cent of the cost, with the SEC paying $397,000 and the Solar Energy Research Institute $63,000. The NERDDC is being asked for a support grant of $35,000.

No one can quibble at attempts to use the sun to eke out dimishing fossil fuels, if only for outback areas with limited power demands.

Nevertheless Dr Everingham (Lab, Qld) whose State is almost as sunny as Western Australia, has accused the Western Australian Government of "commercial treason" in spending $3.5 million on outdated solar power plants for an output of 115 kilowatts of electricity.

He said that Western Australia had turned down the advanced technology of the ANU, which would provide 25 kilowatts for only $220,000 in western NSW. The ANU system would run a conventional steam engine — as easy to maintain as a tractor engine — to provide most of the power for an outback township.

"Either the Court Government is flirting with foreign interests to gain trade advantage over other States or less legitimate political benefits or they are trying to kill the ANU project, which promises an alternative to nuclear fuel", he said.

He pointed out that the Italians had taken more than 15 years developing their solar technology, and that they would charge double the price of the ANU system per kilowatt of electricity. Their plant could have the added disadvantage of more specialised and costly maintenance of a turbine motor.

The West German plant included in the Western Australian program would cost four times as much per kilowatt as the ANU system, he said. The ANU system could get more engine efficiency because it used a cheap manufacturing breakthrough to form its aluminium reflector as a paraboloid dish — shaped like the reflector of a lighthouse light.

The technicalities of Dr Everingham's arguments are well beyond the grasp of the average outback consumer. He could well be right.

But Mr Mensaros has retaliated by saying that the West German and Italian companies suppling the equipment were world leaders in solar development. Similar equipment was being installed elsewhere.

Both companies were involved in a major demonstration project now in progress under the auspices of the European Community in southern Spain.

Mr Mensaros said that it was important to distinguish between fundamental research, the development of equipment and devices and demonstration projects involving complete systems.

He said that Western Australia saluted the efforts of solar researchers at the ANU, and looked forward to the time when they would be in a position to provide firm offers in terms of cost and delivery times.

Which, I suppose, is a way of saying that we should all look to the sun without wearing blinkers.

Solar research: into the light

By our Science Correspondent

AFTER almost two years of uncertainty and official indifference the ANU's solar ammonia project has finally won the support of the Federal Government.

The research team has received two grants totalling $104,700 over the next six months to develop the process, with the prospect of further substantial funding for at least the next three years.

Dr Peter Carden, head of the ANU's energy conversion group within the department of engineering physics of the Research School of Physical Sciences, is delighted at the size of the grant considering the effort to promote interest and the struggle to keep the project afloat during recent years.

The grant will give the team a chance to almost double its research strength, move into a larger laboratory, and develop two main aspects of the process — the mirror collectors and the chemical heat pipes, which are an integral part of the solar-ammonia process.

It also will provide funds for an industrial feasibility study which will determine if it is economic and practical to continue with the project in its present form.

The original process conceived by Dr Carden nearly six years ago involves a unique method of using and storing solar energy on a mass scale which could be particularly useful in remote areas.

The team believes it could lead to the development of a power system which could provide electricity for small outback towns and eventually supply a surplus of energy for export as solar fuels and fertilisers to countries less well endowed with sunshine.

The basic system involves using the sun's energy to decompose ammonia into nitrogen and hydrogen. This is a heat-absorbing chemical reaction and the hydrogen and nitrogen can be transmitted through cold pipes to a central area where they can be resynthesised to ammonia to release energy. This is called a chemical heat pipe.

This can then be used to make steam to power a generator and produce electricity in the same way as oil and coal does at present.

Power from the sun would be harnessed with paraboloidal mirrors, computer-controlled to follow the sun and mass produced cheaply from sheet metal.

The government grant, through the National Energy Research, Development and Demonstration Council (NERDDC), has come in two parts. The first of $53,200, is earmarked particularly for the development of inexpensive mirror collectors with the specific aim that they could be used for the production of heat energy of more than 200°C for industrial uses and steam generation.

The team plans to use the grant to build a prototype press for the mass production of the 3½m diameter collectors. These, Dr Carden believes, could be used quite independently of the solar-ammonia process to provide heat energy, such as the power to drive a steam engine.

At present the group is working in conjunction with the pet food company, Uncle Ben's of Australia — incidently one of their few supporters during the recent lean years — to provide a collection system to heat air in a food-drying process at its factory in Bathurst.

So far Uncle Ben's has allocated $19,000, with the promise of a further $25,000, and the collectors will be used to produce hot air well above 200 C through presurised water.

This says Dr Carden, will give the team a good chance to try out the mirror collectors and adapt the design if necessary.

"The company has been quite magnificent. They don't expect any return at all. Their aim has been to invest in what they considered a worthwhile research project which, if successful, could possibly be useful to them", he said.

In support of the project the NSW Government has promised $11,000 for the monitoring of the food-drying process.

Another of the team's plans is to collaborate with Tom Pritchard, the Melbourne inventor of a steam car, and use the collectors in conjunction with his engine to produce power.

The Western Australian Government had also shown interest in co-operating in these projects.

The second half of the grant — $51,500 — is for the development of the chemical heat pipes for the solar-ammonia process.

The grant will allow the hiring of a team of consultants to carry out a feasability study to look at the costs, practicality or production and other problems that might arise in an industrial production situation.

During the next two years the group plans to build a prototype chemical heat pipe as a demonstration project in the laboratory. It will generate 5kw or possibly 10kw of heat energy.

This year will be taken up with the design of the heat pipe which the group hopes to build next year after taking into consideration the findings of the feasibility study and making any necessary adaptations to the design.

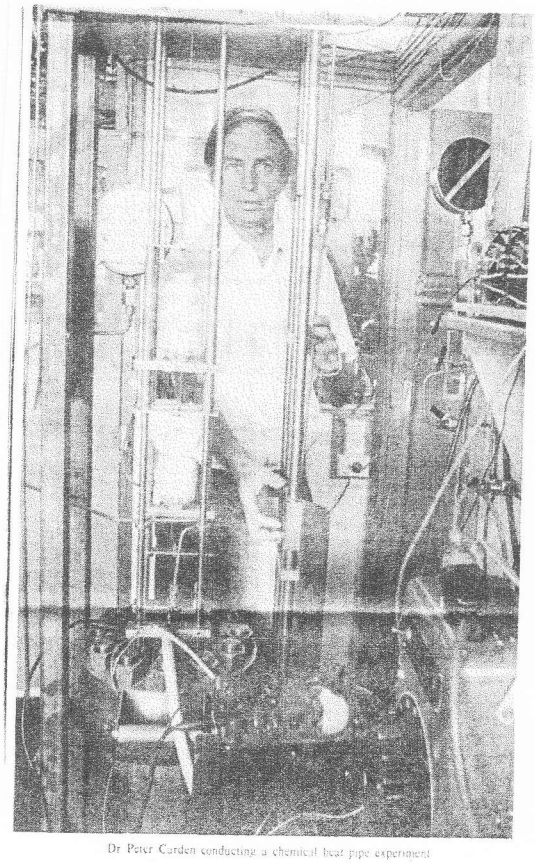
Dr Carden believes that is is to plan too far ahead but hopes if the mirror collector produ and the chemical heat pipes p viable, they can be combined tog er as a solar-ammonia plant w could eventually power a smal mote outback town.

Dr Carden said US scientists now become interested in u chemical heat pipes to generate tricity and had so far done work sulphur trioxide as an alternati ammonia.

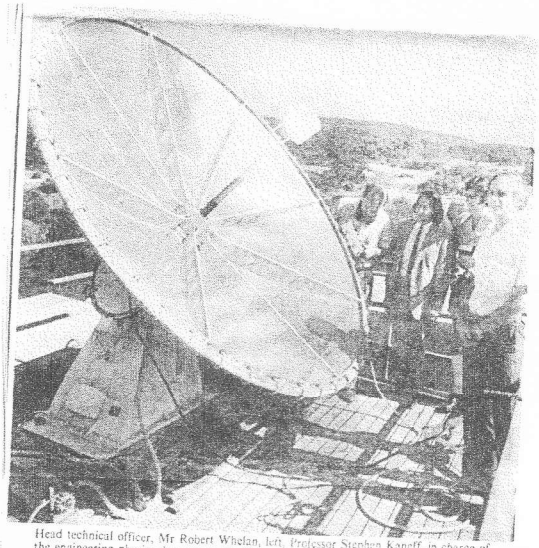
However, one group had bec interested in the use of ammonia wanted to co-operate with the A so that they could build a pilot p in the States.

"We've been the pioneers of pressure and two-phase chem heat pipes and we've probably g lead on the US in many ways fact, we have the patents on thes the US and several other countri he said.

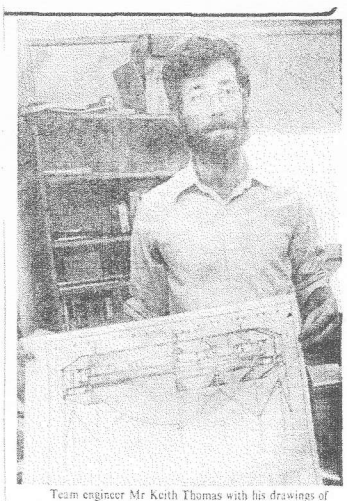
The Director of the School Physical Sciences, Professor J Carver, hopes that the governm funding will continue for the three years.



Dr Peter Carden conducting a chemical heat pipe experiment



Head technical officer, Mr Robert Whelan, left, Professor Stephen Kaneff, in charge of the engineering physics department, Dr Owen Williams, a member of the team, and Dr Peter Carden with an experimental mirror collector on the roof of the Research School of Physical Sciences.



Team engineer Mr Keith Thomas with his drawings of a vacuum press of the type that might be used to manufacture inexpensive mirror collectors.

19/7/79

Solar energy group formed

23/1/79

A national solar-energy industries association has been established in Canberra, according to the Metal Trades Industry Association's latest bulletin.

The association would promote and encourage the advancement and development of solar-energy industries in Australia and make representations to the Federal and State Governments on legislation and policy matters affecting the industry.

"It will maintain and encourage a respectable public image for the industry and foster close working relationships and flow of information between members and promote business interests", the bulletin said.

GANG GANG

Sun shines on energy empire



ssor Kaneff . . . solar solution

THE sun might have been just shining in Canberra yesterday but the energy gloom was thick at the Australian National University.

Professor Stephen Kaneff, professor of engineering physics in the ANU Research School of Physical Sciences, was giving a lunchtime speech at the uni.

Bigger and "better" petrol shortages and continued price rises for energy would be with us unless we switched from non-renewable energy sources to renewable, he said.

The clouds parted and the gloom lifted. Solar energy was the answer, Professor Kaneff said.

Professor Kaneff, whose department at the ANU was recently awarded $800,000 by the NSW Government to build a prototype solar power station in outback NSW, said that a national energy policy, preferably based on solar power, would be a recipe for a new society.

While the sun shone rather feebly outside, Professor Kaneff said an energy policy was a plan for life.

"Many people have said why worry about the next generation and the one after when we can't solve our own problems?" he said. "If that is the case I think we are headed for disaster".

Ideally, he would like to see the Federal and State Governments spend $2,000 million a year for the next 40 years on a solar-energy program.

One of the great things about solar energy was that it could be exploited without a highly sophisticated technology.

Australian industry could easily handle solar-energy projects, whereas it did not have the expertise to become involved in nuclear energy.

Sun power study goes on

1/7/78

The ANU will continue to fund its solar-energy research project while negotiations with several potential backers continue.

Funds for the project were to have ceased at the end of last year but the university agreed to continue its funding until yesterday.

Dr Peter Carden, head of the energy conversion group in the university's department of engineering physics, said yesterday that the project had received another reprieve until negotiations which were pending with several government and private organisations, including overseas bodies, were finalised.

The great snag about getting energy from hydrogen

6/7/80

*By PETER CARDEN**

MOST people concerned about energy, pollution and the environment will by now have heard of the proposed "hydrogen economy" and the benefits it has to offer mankind. But how close is this panacea, and who is working for its realisation?

I have just attended the third in a series of biannual World Hydrogen Energy Conferences. This one was held in Tokyo. Living for five days in the murky soup that passes for Tokyo's atmosphere I thought how apt was the choice of venue on this occasion.

At the conference 600 scientists and engineers from 30 nations exchanged views and impressions and reported on their research work. Most went away with new knowledge and resolve, and a better understanding of how far we have come.

The great snag is that hydrogen is not an energy source in itself. Hydrogen must be generated as fast as it is consumed. This means that primary energy sources, such as the sun or nuclear power, have to be harnessed to the hydrogen production process.

The primary motivation is to provide a clean fuel system: that is, one which eliminates or at least controls air pollution. As the president of the sponsoring International Assocation for Hydrogen Energy, Dr T. N. Veziroglu, declared in his keynote address, "The hydrogen system is the natural system. It is compatible with nature and the environment". This is because the source of hydrogen is water and the combustion of hydrogen leads merely to the reconstitution of water vapour as the exhaust gas.

The versatility of hydrogen is immense. It can be used for home heating and cooking, for cars, aircraft, ore-reduction, manufacture of basic chemicals and for generating electricity.

Hydrogen is far more versatile than electricity in those applications which now need urgent attention: those related to transportation.

But the snag remains. The proponents of the hydrogen economy desperately need a primary energy source that is economical and is itself "clean". Embarrassingly, the cheapest primary source at present is coal. Hydrogen is produced by "burning" coal in steam — but so, unfortunately, are the usual pollutants associated with coal burning. It rather defeats the purpose of the hydrogen concept.

This problem and many others, together with the success stories and the optimistic projections, were the subjects for discussion in the convention rooms of the fashionable Kio Plaza Hotel, situated in the throbbing Shinjuku district of Tokyo. The delegates presented more than 200 technical papers in four parallel sessions lasting four days. Despite very individualistic interpretations of English (the official conference language) by many delegates, the majority — including Indians, Arabs, Japanese, Germans, French, Italians and Russians — managed to get the gist of what the others were saying. Comprehension was less a problem for the large contingent of north American delegates, the few British and three Australian.

The conference benefited from excellent organisation provided by our Japanese hosts and any difficulties that might have arisen were quickly smoothed over by their courtesy and hospitality.

In the vestibule outside the conference rooms there was exhibited a small sedan car fuelled by liquid hyrogen. It had an 1100cc two-stroke engine adapted for direct hydrogen injection. The car could travel at 135 km/h and had a range of 400km on its 65L tank. The oxides of nitrogen emission were considerably lower than from its gasoline counterpart. Dr Peschka from West Germany described a larger car and also an automatic liquid-hydrogen service station which was successfully operating in Stuttgart. Refuelling takes eight minutes, but further modifications are planned to halve this time.

One speaker summarised the experience gained so far with hydrogen engines: they are generally 40 per cent more efficient than gasoline engines and are, of course, much cleaner. Hydrogen also has the advantage in energy-to-weight ratio and this has stimulated several aircraft manufacturers to look into hydrogen fuel. A representative of Lockheed described plans to have a hydrogen aircraft flying by about 1985. An additional benefit is that the cold liquid hydrogen may also be used for cooling the wing surfaces and thus dramatically reducing drag.

A development that was seen as particularly significant for the hydrogen system is a 4.5-megawatt fuel cell to be installed in the heart of New York. This plant will run on hydrogen extracted on the spot from natural gas. Fuel cells are silent, safe, clean, and apparently economical as suppliers of the short bursts of power which would otherwise overload the large base-load plants. Fuel cells can deliver this peaking power close to the point of consumption.

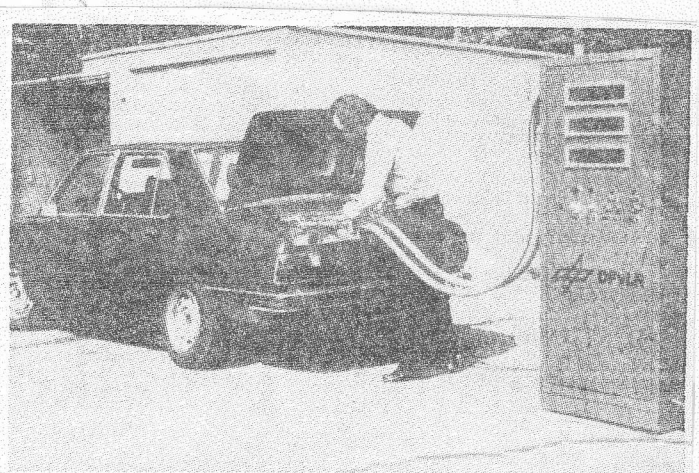
The main production methods for hydrogen that were reported included the direct use of heat from nuclear and solar energy systems in order to split water into oxygen and hydrogen. Several of these thermochemical systems that were described obviated the need for extreme temperatures. But they did appear to be rather complicated. However, each one was said to be capable of converting heat to hydrogen energy with an efficiency of at least 50 per cent. Some had advanced to the stage of a bench-sca demonstration.

Another route to hydrogen production is b electrolysis of water. This is a satisfactory metho if cheap electricity is available, for example of peak (night time) electricity from a large powe station. It may also be an attractive method fo utilising small hydroelectric sources.

But solar energy is the most favoured sourc in the long run and in this respect Dr Rone (USA) presented an encouraging report o OTECs. OTEC stands for Ocean Therma Energy Conversion. It is envisaged that larg floating platforms "graze" the tropical ocean converting the heat of the warm surface wate to hydrogen energy via a heat engine, electri generator and electrolysis. A supply of coolin water is drawn from the ocean depths, which ar up to 24 degrees C cooler than the surface Tankers would call at the platforms to transpor the liquified hydrogen (or a product such a ammonia) to centres of consumption. The cost o OTECs seems to be comparable to nuclear powe stations (excluding a provision for reprocessing nuclear fuel and waste disposal) and have th important advantage over other solar-energy technologies in that both the solar collectors and energy storage are provided by nature.

The process of electrolysis is now in a very advanced state. Very compact and economical cells are available which contain solid polymer electrolytes faced with special catalysts, a far cry from the two wires dipping in a beaker of salty water which many of us remember from our student days.

The storage of hydrogen received less attention than at previous conferences, indicating perhaps that storage is no longer regarded as a problem. Storage methods include absorption in metal hydrides and containment, in liquid form, in large "vacuum flasks". Storage of the gas itself in high-pressure containers is not economical unless large natural containers can be brought into use. This was the subject of the two papers presented by myself and Lincoln Paterson, also of the ANU. We showed that it was reasonable to expect that large-scale underground storage of hydrogen in aquifers was a very practical and economical method but in order to make sure a substantial research effort was required.



Filling with hydrogen fuel. The lines from the bowser are insulated by vacuum.

Perhaps the most valuable observation from this conference was that the hydrogen economy is rapidly gaining status and that the Hindenburg syndrome (an unreasonable fear for the safety of hydrogen systems) has almost disappeared.

The search for methods of water-splitting is a respectable goal and the search is gaining intensity.

Given an economical source of hydrogen, the technology now exists for its widespread adoption. The necessary consumer goods such as cars, cookers and room heaters would be priced well within our pocket (a complete demonstration hydrogen village is being fitted out in the USA) and in most cases would result in a cost benefit as well as a health benefit. But the present oil-based distribution infrastructure would have to be dismantled and replaced, a task which cannot be done overnight.

The best that can be hoped for is that a hydrogen system will evolve as the inadequacies of the present system force changes within it. A likely evolutionary process might arise from the present growing use of natural gas followed by its supplementation with hydrogen. Consequently, shortages in the supply of natural gas would eventually force an increase in the percentage of hydrogen and a final change to the hydrogen economy. In this evolutionay process the sources of hydrogen are whatever is economical at the time. Electrolysis using off-peak power seems to be a prime candidate and solar energy is the natural ultimate source.

In the meantime hydrogen advocates must reluctantly accept that hydrogen from coal will be a necessary and indeed vital step. This is because the alternative to hydrogen from coal is oil from coal and this is perceived as being a disastrous path for mankind. For one thing the capital required for the oil-from-coal conversion plants is enormous and this is capital that could be better spent building a hydrogen infrastructure.

Most importantly, and this is stressed over and over by the hydrogen advocates, hydrogen from coal is cheaper than oil from coal, and we are talking about now, not some time in the distant future.

** Peter Carden is head of the Energy Conversion Group, Department of Engineering Physics, Australian National University.*

SUN WILL POWER LUCKY TOWN

The tiny far west NSW township of Pooncarie, on the Darling River may be the first town in the world to get all its power from the sun.

Cheap electricity for bush folk on the way

By C. J. McKENZIE

A high-temperature solar power station — the world's first — will be built at one of three small towns in NSW's far-west by the end of next year.

The other two sites being considered are Tilpa, also on the Darling, about 250km north of Wilcannia, and Wanaaring, on the Paroo River, about 300km west of Bourke.

Each has a population of between 40 and 100.

For the town selected electricity cost will bt slashed by up to 75 per cent. Hot water will be freely available, as will air-conditioning, heating and, equally important, bore water will be able to be desalinated.

The system to bt used is the brain-child of Professor Stephen Kaneff of the Australian National University in Canberra.

It uses a series of disc collectors which track the sun and produce very high temptratures.

Collector systems used in other parts of the world are flat and produce lower temperatures at very high cost.

The NSW power station will cost $800,000 but when producted in numbers could be installed for as little as $30,000, Professor Kaneff says.

The system will be built by Professor Kaneff's staff at the Departmmtnt of Engineering Physics of the Research School of Physical Sciences, using shb-contractors.

Prof Kaneff estimates the solar power station will provide electricity for about 7c a kilowatt hour compared with the 10 to 30c kWh cost with the diesel stts uses in country areas.

He saio the collectors will supply super-heated steam to an engine which will drive an alternator to produce 25 kilowatts of tlectricity — enough to supply all the needs of 10 or more houses.

The unit will have a back-up "flash" boiler for when there is no sunshine and the storage is exhaustid.

The Premier, Mr Wran, announming the project yesterday, said hundreds of such power stations eventually will bring cheap power to hundreds of small, isolated towns throughout Australia.

Mr Wran said that by the turn of the ctntury 15 to 20 per cent of NSW's energy needs will come from the sun.

"Although Australia is endowed with great resources of coal, limited resources of oil and natural gas, we must encourage people to make greater use of other energy rtsources.

"Because of the increasing cost of petrol and diesel oil many small places in the bush, with the best will and the best seasons, just won't be able to compett in productivity.

"The project is for real. It will go ahead. Wt will turn on the lights."

BIG SWITCH-ON WELCOMED

The news that Pooncarie could become the world's first solar-powered town came as a surprise to its 40 residents yesterday.

"Haven't heard of that," said Mr Bill Holmes, licensee of the town's only pub, The Telegraph.

Neither had ony of the half-dozen drinkers in the 50-ytar-old pub in the town's main street, Tarcoola St, by the banks of the Darling.

But they agreed that anything that would provide cheaper elttricity fould be welcome.

Pooncarie, 200km up river from Wentworth on the Victorian border, boasts one general store, a police station, a post offict, a Bush Nursing Service and a few houses.

Most of the men are shearers or work for the Tarcoola Shire Council.

14/5/1979 SUN POWER FOR N.S.W. TOWN

ANU team to build big solar station

A prototype solar-energy power station is to be built by ANU scientists in far-western NSW, the NSW Government announced yesterday.

The announcement will mean that a small far-western NSW town will, in about two years, be using electricity derived entirely from the sun's rays.

Professor Stephen Kaneff, of the Australian National University's Research School of Physical Sciences, who will head the team, said yesterday, "It's the first time in the world this type of system has been used.

"It's an economic approach to using solar collectors to produce power".

The $800,000 project is being funded by the NSW Government.

Professor Kaneff said the station was being developed to provide a "cheap alternative in those areas where electricity is expensive to generate now using oil".

"This project became practicable as a result of the research in the department of engineering physics over the past six years by our energy conversion group led by Dr Peter Cardin", he said.

Fourteen pairs of "tracking concentrating collectors" would supply superheated steam to an engine driving an alternator capable of producing 25 kilowatts.

The electricity generated would be sufficient for about 10 houses, and would later be able to provide hotwater, space heating, possible airconditioning, "but certainly the desalination of water, which could be used to irrigate arid regions", Professor Kaneff said.

Although the development and research would cost $800,000 — the station itself costing $220,000 — a commercial production run of about 500 systems would cost about $30,000 a unit.

In a commercial form electricity would cost about 7c a kilowatt hour.

The entire development was being "approached from the point of view of economics".

One of the breakthroughs was the development by Dr Cardin of a collector-dish made from very thin metal.

Cheaper electricity

Professor Kaneff described the possible developments from this initial project as "having the potential to satisfy the needs, more cheaply, of those who now rely on oil-produced electricity".

Asked if it was possible that solar energy could be produced in large quantities in central Australia and the electricity supplied to coastal cities and towns in the future, he said that "if our dreams come true, that's what will happen".

Describing a thermo-chemical method of transporting superheated steam over long distances, Professor Kaneff said, "When our solar-ammonia approach reaches fruition, the possibility will be for building really large power stations, and in about 10 to 15 years time we could have a station capable of producing 10 megawatts; enough power to power a town of about 10,000 to 20,000 people.

"Perhaps by the turn of the century these solar stations are going to become more economical than other power stations".

In the next 20 years there could be a "significant" number of solar power stations.

"The technology is not easy, but it's straight-forward", he said. "It's going to make a difference to inland Australia.

"This industry is pretty labour intensive; uranium and coal and oil are very low users of manpower, and it's the one chance the Government has of solving its unemployment problem".

The Premier of NSW, Mr Wran, said at a press conference in Sydney yesterday that a site for the initial power station would be decided in the next few weeks. Sites being considered included Pooncarie, on the Darling River, Tilpa and Wanaaring, on the Paroo River.

The project should be completed by December, 1980.

Mr Wran announced also that the Government was considering incentives to encourage people to make greater use of solar energy, including rebates on rates and cash subsidies to offset the cost of home solar-energy units.

14/9/1979 →

The Daily Telegraph

A sunny outlook

IF THERE is one thing Australia has in abundance, it is sunshine.

So where better to pioneer the conversion of a town to solar power?

The White Cliffs project, in which an entire outback town will be powered by solar energy, is an exciting experiment – all the more so because it is a world first. While politicians and scientists in other countries are still talking about the potential of solar energy, here in NSW we are actually doing something about it.

It is, of course, a small start. White Cliffs was a cautious choice because it is a town with a regular population of only 45, which is swelled to about 300 by its transient mining community. And because of its location, it is a town that gets more than its share of sunshine with temperatures sometimes soaring to 45°C.

But it shouldn't be long before we know if the experiment is a success. If it is, then the benefits should quickly flow to other towns and cities.

The important thing, now that White Cliffs has been chosen as the pioneer town for this project, is that there be no delays. The NSW Governmment must insist that the results of the experiment are known as quickly as possible so that, if it is feasible, work can begin on more solar power stations. It is encouraging to know that results can be expected within a year.

At the same time, more should be done to encourage the use of solar energy. While it may not be the complete answer to our future energy needs – we believe there must be parrallel research into nuclear power – there are hopeful signs that there are many areas in which the sun can provide us with an economical power source.

Already, many people are using solar energy as an economical source of hot water and others, more ambitious, have their whole homes powered by the sun.

The State Government has shown its interest by initiating the White Cliffs scheme. It (and the Federal Government) could now do more by seeing that companies manufacturing solar-power equipment are given the necessary incentives to make it worth their while.

Mr Michael Whelan, MP, has suggested a solar energy committee to promote the use of solar power, and low-interest loans and tax incentives for manufacturers. His suggestions are worth considering.

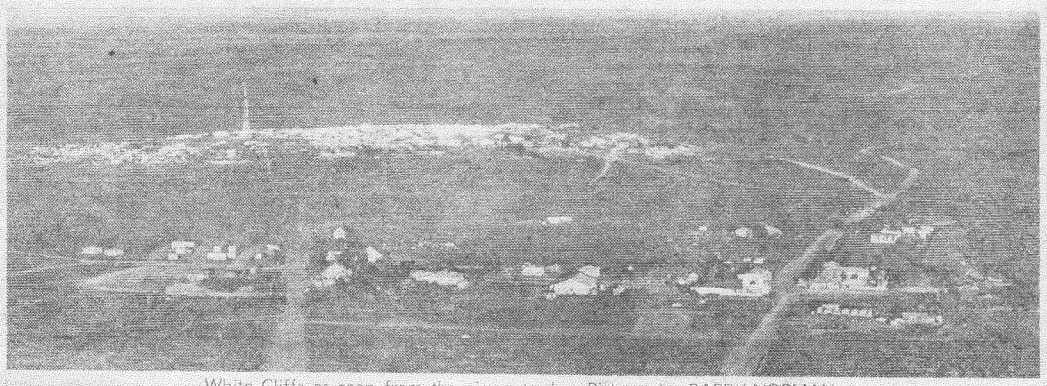
Let us hope White Cliffs is, as yesterday's announcement indicated, just the first of many such projects.

Phone 2 0924 SYDNEY, FRIDAY, SEPTEMBER 14, 1979 Price 15c

Mary Kathleen for sale — P3

GOLDEN YEARS 1979

White Cliffs (Pop 45): the world's first experiment in solar living



White Cliffs as seen from the air yesterday. Pictures by BARRY NORMAN

SUNTOWN NSW

By Political Reporter JOHN WESTACOTT

The NSW far-west town of White Cliffs has been chosen as the world's first town to be powered by solar energy.

Construction of the solar power station has begun in Canberra. It will be installed in the town, 95km north of Wilcannia, in about 18 months.

The State Government commissioned the Australian National University last May to build the station to serve the town's 45 permanent residents and floating population of about 300 miners.

The town has 13 houses, a school, hospital and hotel and draws its electricity from several small diesel generators.

The solar unit, with 14 pairs of solar collectors supplying super-heated steam to a steam engine, will drive an alternator with a 25 kilowatt output.

The Premier, Mr Wran, said the prototype solar installation, which would be the world's first high temperature, high concentration solar power station, was designed to supply power to a town of about 50 people.

White Cliffs will gain other benefits from being chosen for the site for the solar station.

Mr Wran said: "Waste heat from the installation can be used for water desalination which can help overcome water shortages."

He expected the solar power station to be a tourist attraction.

"White Cliffs already attracts many tourists to see the opal mines and the solar power station will increase the number of visitors," Mr Wran said.

Meanwhile government backbencher, Mr Michael Whelan (Ashfield) has called on the Government to form a solar energy committee to promote the use of solar power.

Mr Whelan wants housing commission flats and government buildings converted to solar heating.

ANU scientists and technicians from the Department of Energy and Technology will monitor the White Cliffs project closely for about 12 months.



Postmistress Ann Carson . . . a super switchboard.

'We might even run to two pubs now'

By BRIAN PHILLIPS

White Cliffs went wild last night. The bush hamlet, destined to be the world's first solar-powered town, turned it on for young and old.

With an official population of 45 — but nearer 300 — the town, 160 km down the dirt road from Broken Hill, kicked up its heels as it celebrated the advent of the 21st century.

Graham Wellings, publican, pilot, gun shearer, "sheriff," and undertaker, supplied the grog — at $75 a tonne, road freighted from Adelaide — and the residents supplied the mayhem.

Half of White Cliffs lives underground in dugouts to escape the searing heat. Locals claim the temperature has climbed to 45 degrees, and sun hours average 14 a day.

Founded in 1902 on an opal boom, White Cliffs has not changed much since the Scott family — still there on Coona-Coon station — named it after the white ridge which dominates the place.

Pockmarked with the diggings of the

Continued Page 5

STATE: Cool, mild. CITY: Fine. Top temps: City, L'pool 19 (details, map P18). TV P26. Lotteries: Jackpot 1885 P42, Special 3169 P49. TA



Professor Kaneff at the White Cliffs solar power station . . . little enthusiasm generated for his dream

The mystery at White Cliffs

By TERRY BRANSDON

AUSTRALIA'S first major solar power station — built by researchers from the Australian National University at a cost of $1 million — sits unused in the sun-parched desert 850km north-west of Sydney.

Strangely, the Energy Authority of NSW appears reluctant to take it over and begin reticulating the first solar power to Australian consumers.

Those consumers — 175 residents of the remote opal mining town of White Cliffs — are puzzled and annoyed at the delay. They were promised solar power by the end of 1981.

All they have so far is a futuristic-looking tourist attraction, the novelty of power lines running through the heart of the town, street lights that are not switched on at night and the reassurances of the scientists that despite the rumors, the prototype solar power station does work.

The Wran Government initiated the project in 1979 when it allocated $800,000 (since increased to $1,025,000) to the ANU to build the plant. At the time it must have seemed a good public relations exercise as NSW was having more than a few problems with power generation.

Bedevilled by strikes, the dilemma of growing conventional plant breakdowns and inflated world oil prices it was good for the government to be seen to be doing something innovative.

So what went wrong?

The Energy Authority confirmed last week that it still had no idea when the solar power station would be commissioned. A spokesman said the authority was "waiting to hear from the researchers" who had to show that the required number of hours operation had been achieved.

"So the ball's still very much in their park at the moment," he said.

But the leader of the ANU team, Professor Stephen Kaneff, said at White Cliffs that he has been waiting since March for the evaluation and handover.

The last Prof. Kaneff heard from the authority was that they would send a team out "right after Easter".

Since the solar power project was initiated, it appears that the State's electricity problems have diminished somewhat. In fact, after NSW spent $1 million telling consumers to use less power, supply improved and a new advertising campaign became necessary to try to change the electricity conservation habits thriftily created.

Another problem would seem to be that the authority wants and expects the alternate energy plant to be fully automatic and 100 per cent efficient.

White Cliffs' community leaders, such as publican Graham Wellings, are critical of the authority on this point, saying any power would be better than none. So what does it matter if there are breakdowns, Mr Wellings said.

But it all boils down to the fact that according to the ANU team, the White Cliffs solar power station is ready to come on line. It can and has produced the 25kw of electricity promised for the town.

While the stalemate continues, the power being generated is something of an embarrassment. It is being used to run air-conditioners, lights and displays at the station and to pump and desalinate bore water.

Prof. Kaneff points out that back-up systems have been included at White Cliffs in case of breakdowns. These include banks of batteries that can store up to one day's energy reserves, a flash boiler powered by low grade fuel, and a diesel generator.

Also, White Cliffs' opal cutter and science graduate, Peter Thompson, who helped build the plant is available to act as trouble-shooter when problems occur.

The ANU team will not be drawn into further criticism of the delay in commissioning the station, but Prof. Kaneff is critical of the thinking of governments in Australia when it comes to renewable energy resource projects.

He points out that every 20 minutes the amount of solar radiation hitting the earth is equivalent in energy value to all the non-renewable fossil fuel used in the world each year.

Solar power technology in detail

THERE are 14 paraboloidal reflectors 5m in diameter at White Cliffs, each concentrating the sun's rays from their 20sq.m. collector surface onto an absorber at the focus of each dish. The dishes are controlled by computer and track the sun as it moves across the sky.

The dishes must face the sun squarely at all times so that the energy is focused properly on the absorber. A simple sensor has been developed to provide signals to the two drive motors which move the dishes on both the horizontal and vertical axes.

Water, desalinated and pumped from a bore sunk at the White Cliffs site, is fed through each of the stainless steel absorbers where the sun's heat converts it to steam.

This generated steam with a temperature of 550C and a pressure of 7 megapascals is transmitted along insulated stainless steel pipes to drive a specially-designed, high performance steam engine. This has been developed to give twice the efficiency of a commercial steam turbine of the same power.

The steam engine drives an alternator which provides 50hz electric power at 240 volts. As well as generating 25kw of electricity the system generates an additional 140kw of thermal power which can be used to provide hot water, to desalinate bore water, and in other industrial applications.

The solar collectors were built in Canberra and transported by road to White Cliffs. The origianl plan was to construct them from aluminium sheeting, but this failed and a fibreglass mould was made for each dish with thousands of carefully-cut mirrors then being glued into place.

Construction of the steam engine proved one of the most difficult tasks as there has been little advancement over the centuries. But steam car enthusiast, Mr Graham Vagg, eventually managed to modify an ordinary diesel engine to operate on steam power.

Experimenting

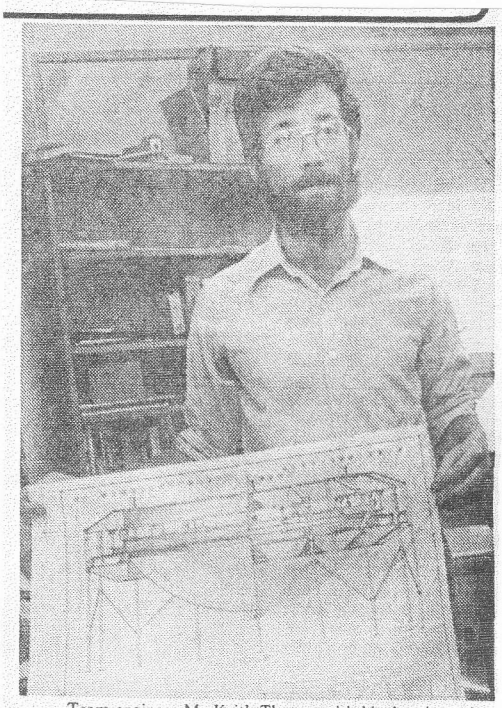
To give an example of what is being done overseas, Prof. Kaneff cites the Southern California Edison Company in the United States. It aims to produce 2150 megawatts of electricity from alternative energy sources by 1992, much of which will be from second generation solar energy plants.

"Southern California Edison now uses eight primary energy resources to provide electricity to its consumers who number more than the population of Australia," Prof. Kaneff said.

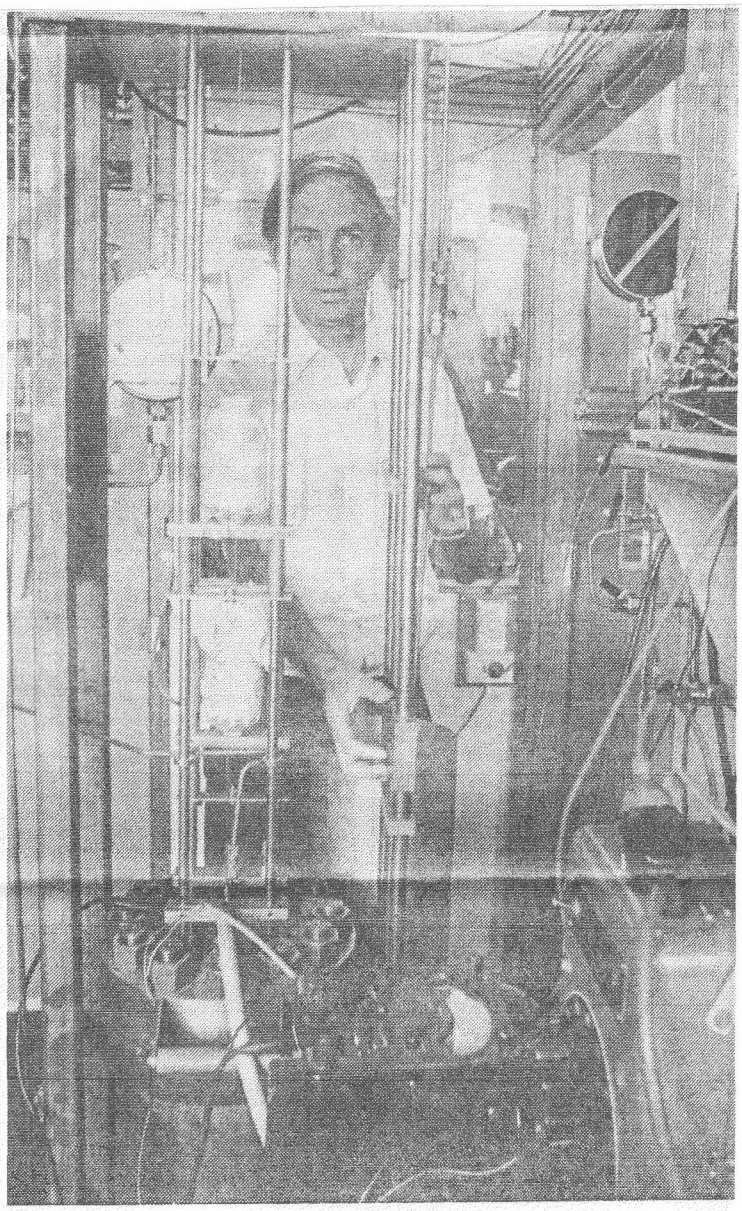
"The company uses oil, natural gas, coal, water, nuclear, wind, geothermal and solar power. It is experimenting with biomass systems and land-fill methane gas to produce electricity.

While the White Cliffs prototype will power only the street lighting, the town's dozen or so conventional above-ground houses (most people live underground in dug-outs to escape the 50C summer heat), the post office, school and general store, it is a forerunner of huge second generation plants.

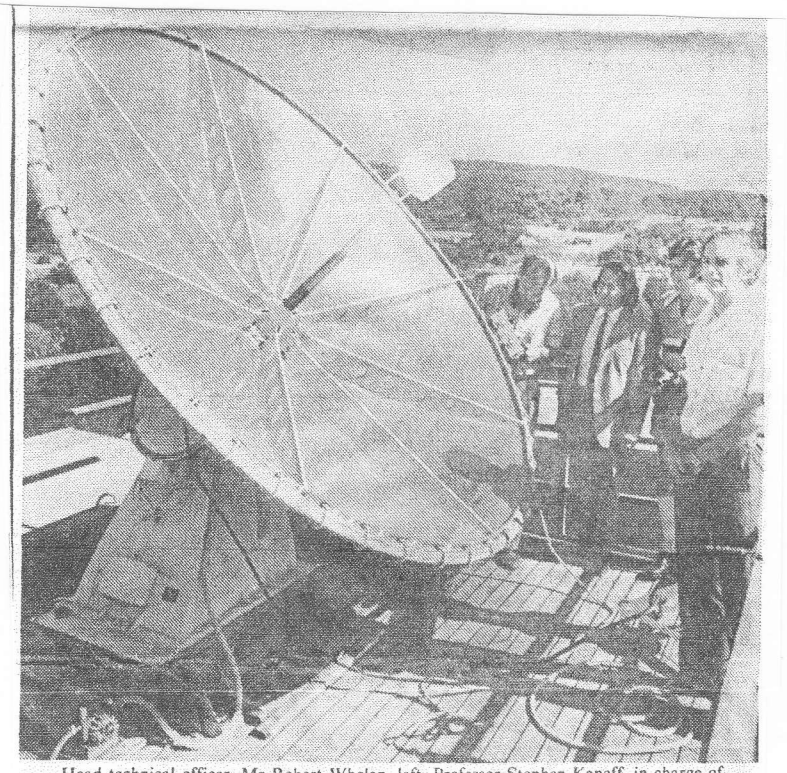
However the biggest obstacle to the professor's dream appears to be the lack of enthusiasm so far generated for the White Cliffs experiment.



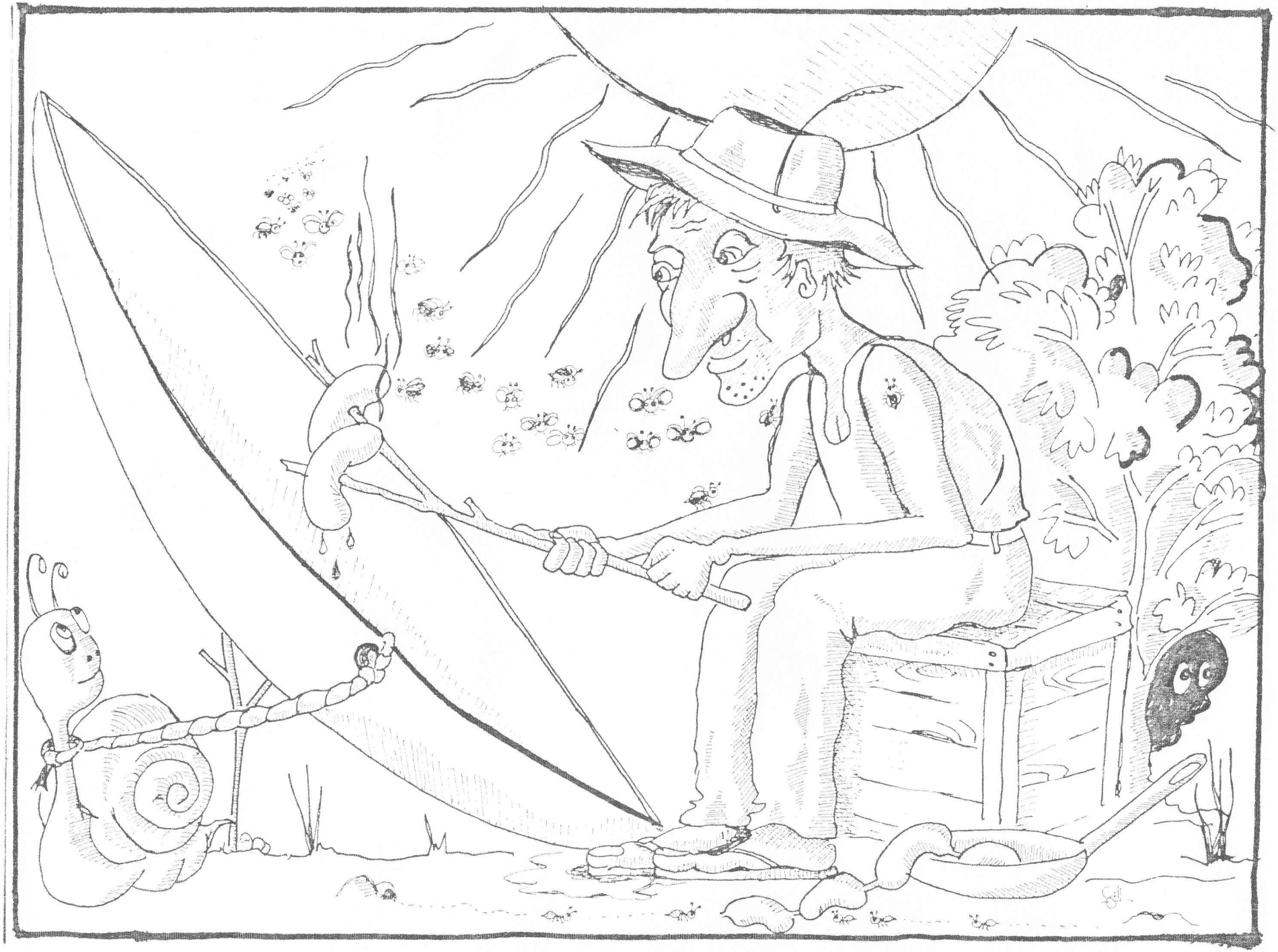
Team engineer Mr Keith Thomas with his drawings of a vacuum press of the type that might be used to manufacture inexpensive mirror collectors.



Dr Peter Carden conducting a chemical heat pipe experiment.



Head technical officer, Mr Robert Whelan, left, Professor Stephen Kaneff, in charge of the engineering physics department, Dr Owen Williams, a member of the team, and Dr Peter Carden with an experimental mirror collector on the roof of the Research School of Physical Sciences.



The Canberra Times - Sunday 13/9/87

Organic farming is an issue worth living for

By PETER CARDEN*

CONSIDERING that this month's dirty word is "organo-chloride", isn't it paradoxical that one meaning of organic is "grown without any man-made agricultural chemicals"?

This usage is persistent enough to be recorded in my *Oxford Dictionary*. Besides avoiding the above substances, organic growers are also concerned with two other issues of our time: soil and energy conservation. Their ultimate goal is to create a stable and perpetual agricultural system based on natural ecosystems.

For one such as I who has a professional interest in renewable energy sources such as solar energy, it has been easy to extend those interests to embrace renewable agriculture and the organic movement.

Here in our capital city, the Canberra Organic Growers Society (COGS) has been expanding steadily since its birth almost a decade ago. There are now more than 100 members: backyard gardeners, hobby farmers and a few brave professionals, all drawn together because of a sincere and often grave concern for the deleterious effects of conventional agriculture.

COGS is a corporate member of a regional council representing NSW and the ACT which in turn is a member of a fledgling nationwide body. Elsewhere the movement is particularly prominent in the US and UK as well as many non-English speaking countries. Two international bodies are the Henry Doubleday Research Association and IFOAM. The main activities of all these bodies are the dissemination of information through conferences and publications and the creation of standards for organic produce.

Evidently the organic movement is widespread and well organised. It is a visionary movement with several far-reaching concerns. Perhaps it should be listened to at this time when the nation is beginning to share one of them — chemically contaminated food.

So what is the alternative to chemical pesticides and herbicides? Organic growers scratch their heads when asked this question. It is like saying "how should I put wheels on my horse?" The answer is that you must first change your horse for a car. To use a trendy colloquialism, the organic approach is holistic. Its attack on agricultural pests, for example, is multi-pronged: (1) replace monoculture with multiculture; (2) select appropriate plant varieties; (3) improve plant health by improving soil health; (4) encourage natural predators; (5) employ physical barriers, and: (6) employ non-poisonous dusts and sprays.

There is not enough space to elaborate on these factors or to point out relevant interrelations between them. For those that are interested, COGS will be conducting a seminar and workshop on November 6 and 7 (contact the secretary of COGS on 821706).

What about an alternative to herbicides? Many organic growers would not recognise a need for herbicides of any form. Weeds may be a nuisance but they also cover the soil, protecting life and inhibiting evaporation. Weeds recycle leached nutrients which they store in their leaves. Weeds are therefore prized ingredients of compost.

To those who may doubt the practicability of the methods advocated here, let me point out that modern organic agriculture is, after all, largely a revival of methods once used everywhere during the pre-chemical era — methods still to be witnessed in countries such as China.

Modern organic growers derive great strength from the certain knowledge that their methods work, that these once fed the world and still do to a significant extent.

The question is not will these ways work but how cheaply can they be made to work. It is only because chemo-agriculture is, on the face of it, more profitable that it has supplanted the organic methods. (China gives the lie to the criticism that organic agriculture is not sufficiently productive.) The challenge to modern organic growers is to apply new knowledge to existing organic technology so as to lower its cost.

At the same time, the organic movement is bringing to the notice of the community the hidden costs associated with chemo-agriculture that must be properly assessed and accounted for. Cleaning up chemical contamination, testing food, loss of arable land due to contamination, increased medical expenses, loss of human health and life — these are just some of the hidden costs of chemo-agriculture that the community will be forced to bear. The community must react by tightening controls on chemo-agriculture in order to reduce the hidden costs. At the same time, this action will reduce the competitive edge chemo-agriculture now enjoys.

Finally, I would like to take you to a 2000-acre property located in mid-NSW and relate a real-life case history of a longstanding professional organic farmer. This should remove any lingering incredulity that you may still possess. This farmer changed over in 1962, stopping the use of artificial fertilisers, weedicides, pesticides and fungicides (DDT, dieldrin, aldrin, diazinon, malathion, arsenic, 2,4-D, 2,4-DB, 2,4,5-T), stubble burning, pickle fungicide on seeds, all antibiotics and artificial sex hormones, dips and drenches. He changed to a system based on the diligent care and creation of soil using animal manure, legumes as "green manure", lime and mineral fertilisers (eg rock phosphate, rock dust).

Today he writes that while the Australian Wheat Board has great difficulty selling any wheat to Europe, he has just sold 40 tonnes of his wheat to Norway at a rate of 23 per cent above the Wheat Board price. Of the flour millers' tests on his wheat, he is informed that his wheat is scoring very high results in all tests. Both his hard wheat and soft wheat registered 15.3 per cent protein compared with 8 to 10 per cent for the district average.

Twenty-three years ago when he stopped using superphosphate, his yields fell dramatically to around three to four bags per acre. But, slowly, as soil fertility built up over the years, yields increased four-fold until now they are equal to or just below those of the crop competition winners.

'So what is the alternative to chemical pesticides and herbicides? Organic growers scratch their heads when asked this question. It is like saying "how should I put wheels on my horse?" The answer is that you must first change your horse for a car.'

The stock is also much healthier now. There are very few deaths from bloat or pulpy kidney, no milk fever, and fly-strike in sheep is much reduced. Lambing and calving percentages have increased greatly. There is next to no skin cancer compared to two to four per year. (It may be noted that sheep dips are based on poisons such as arsenic or diazinon which are carcinogenic.) "Once, when delivering stock to the abattoir," he writes, "I helped unload the semi-trailer in front of me. Fully one-third, maybe half the sheep were suffering from obvious skin cancer."

Just after the changeover, this farmer and his family began a struggle for financial survival. If it had not been for their iron faith, they would have given up many times. But today things are different. They sell their organic wheat at a premium, yields are good and costs are rockbottom. They have organic beef and lamb available for sale (by the truck load). For them and the inheritors of their farm, things can only get better whilst all around them the opposite is true.

These brave souls and a few others like them deserve great honour for their pioneering achievements. Organic growers believe that the sooner the rest of the farming community take heed and follow, the better it will be for all of us and for the generations to follow.

* Dr Carden, of the ANU Department of Engineering Physics, is treasurer of the Canberra Organic Growers Society and delegate to the Regional Council, Organic Groups Council of NSW and the ACT.