New Energy Development and APEC-Related Energy Technology Co-operation Programs in New Zealand and Australia

Prepared for NEDO by
Scitech Publications Pty Ltd, Canberra
March 1995

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Executive Summary

PART ONE: New Zealand

Since the mid 1980s the New Zealand economy has been drastically deregulated so that it is now one of the top performers among OECD countries. As part of this process the Government restructured its former electricity and gas supply organisations into independent corporations, including the Electricity Corporation of New Zealand (ECNZ). It also restructured the former Government science departments into self funding, self managing Crown Research Institutes (CRIs).

The system for supporting energy R&D also has been substantially restructured and the new system can be summarised as follows:

* the Government sets science priorities, with inputs from industry and science providers, and identifies desirable science outputs;

* it provides no direct funding to R&D organisations but provides support through the Public Good Science Fund (PGSF);

* the PGSF is allocated on a highly competitive basis by the independent Foundation for Research, Science and Technology;

* the Government plays no direct role in science/industry developments, which it believes are the responsibility of industry and science organisations.

The New Zealand economy is dominated by agricultural and forest products and the Government is hoping that the new, deregulated system will encourage industry to shift towards much greater production and export of value added goods and services.

The country produces only 40 per cent of its liquid fuel requirements but is self sufficient in all other respects with a 80 per cent of its electricity produced by hydro power and geothermal power. However, the long term outlook is less healthy due to increasing demand for power, depletion of oil and gas reserves and increasing pressure from environmental groups which could limit the development of hydro and geothermal resources.

The Government has recognised the need to promote energy efficiency and conservation, and to develop a wider range of renewable energy resources. However, the total funds allocated to energy research are small and represent only 2 per cent of the PGSF. By comparison the amount spent in New Zealand on energy consumption is equivalent to about 13 per cent of the GDP.

In the non Government sector, ECNZ and the major company Fletcher Challenge are the two largest supporters of energy research. Both organisations track overseas developments in all forms of energy development with a view to identifying technologies suited to their particular needs and adapting them as required. They are also supporting new energy technology research in New Zealand but, for the usual reasons of commercial secrecy, it has not been possible to obtain much detail on these activities.

Representatives of both organisations have indicated that significant private sector investments in new energy technology developments are unlikely until the charges for electricity are more closely aligned with the present day costs of production.

New Zealand's new energy technology R&D is still dominated by its traditional area of geothermal power, with deep seated geothermal offering the most interesting possibilities for future increases in production. There is increased interest in wind power, largely as a result of the Government opening up the power supply market to the private sector. However, the prospects for wind power are limited by two particular considerations: the highly turbulent wind conditions, and, the low costs of existing power supplies.

In spite of the Government's high support for APEC, there are very few new energy technology co-operation initiatives between New Zealand and APEC members apart from the geothermal area and fuel cell technology. The international co-operation in geothermal includes strong linkages with Japanese institutions and training programs in geothermal power for students from ASEAN countries. The fuel cell co-operation involves a number of players including Waikato University, Japan, ECNZ, Fletcher Challenge and support from the PGSF.

The Government is reviewing its international science arrangements at this time but it is unlikely that there will be any significant increases in Government funded support for future co-operation programs. Instead, future international co-operation is more likely to involve the Crown Institutes and the private sector in commercially oriented programs.

PART TWO: Australia

The Australian economy is growing relatively strongly and the long term economic prospects are generally good, although there are some concerns about the high level of overseas debt.

The economy is underpinned mainly by exports of coal, minerals and agricultural products but with increasing volumes of value added goods and services. The Government has substantially deregulated the economy but still plays an important part in determining the direction and funding for R&D in all sectors, including energy.

The Australian Government's support for science, including energy R&D, can be summarised as follows:

* the system for establishing Australian science priorities is loose and unstructured, however, the Government is expected to set up a four yearly process for setting broad directions and priorities for science, with inputs from users and producers of research;

* the Federal Government provides significant amounts of direct, non competitive funding to the CSIRO and the universities;

* it is also actively involved in encouraging strategic links between research organisations and industry through the Co -operative Research Centre program;

* the Federal Government and several state governments provide some competitive funding for energy technology R&D; and,

* the Federal Government and several state governments are actively involved in attempts to establish new science-based industries, including energy technology industries.

With regard to energy, Australia will be self sufficient for many years in all forms except for oil where it is 72 per cent self-sufficient. Therefore, there is little incentive to develop alternative sources of energy to enhance domestic supplies.

However, there has been an increase in Government and private sector interest in new energy technologies. This has been stimulated partly by concern about greenhouse issues but also by the recognition of emerging commercial opportunities for exporting energy technology to Asia.

Pre-commercial energy R&D in CSIRO and the universities is supported mainly by direct bulk funding from the Federal Government and also by specific Federal and state government research grants won by competitive bidding. There is virtually no direction given by Federal Government on the areas of research to be supported under these arrangements. The state governments do identify their priority areas.

The Energy Research and Development Corporation (ERDC) also provides significant support for energy R&D and is highly focussed in terms of its priorities. Generally, it supports more commercially oriented projects than the university-based research.

The main areas of interest in non-coal new energy technologies are solar high temperature and solar photovoltaics; wind; biomass, particularly ethanol production; and, fuel cells. Interest in cogeneration is, for the most part, not concerned with technology R&D but with finding suitable applications for exploiting both the power and thermal components.

For coal based technologies there is substantial investment in coal gasification research through the two new coal-related Co-operative Research Centres. These are funded jointly by the Government and by industry partners including Pacific Power and Generation Victoria.

Recently there has been an increase in private funding for energy research in both the universities and private companies. These projects are mainly commercial R&D and so there is very little information about them.

The two largest private investments in new energy technology developments are Pacific Power's $45 million funding for commercialisation of solar photovoltaics at the University of New South Wales; and, the $100 million syndicated R&D at HRL, Victoria, for generating electricity using Integrated Drying, Gasification and Combined Cycle (IDGCC) technology.

International co-operation appears not to be a significant factor in Government funded energy R&D at present. The principal areas for new energy technology co-operation are in commercial coal gasification projects in China, funded through Australian International Development Assistance Bureau (AIDAB) programs. These programs do not contain any significant R&D components except for adapting Australian technology to local needs.

There are several university based international co-operation programs. These are private arrangements between the participating universities and there is no special source of funding to support such programs.

The ERDC has only one international co-operation program, with a small New Zealand biomass company, but the Corporation is expected to become more involved with international co-operation projects in the future.

The Centre for Applications in Solar Energy (CASE) is a joint Federal and Western Australian Government initiative to promote international co-operation in all renewable energy technologies, not just solar. Its program is still being developed.

Australia's main non commercial co-operation programs with APEC members include several small scale projects with the APEC Energy Working Group; clean coal technology training programs and a biomass fluidised bed combustion (FBC) project with ASEAN; and, two biomass-based projects at Queensland University in co-operation with Korea.

The Northern Territories Government appears to be the only government in Australia with a renewable energy technology agreement with an Asian member of APEC, namely Indonesia.

Introduction

This report is concerned with new energy technology development in New Zealand and Australia, and new energy technology co-operation programs with APEC member countries.

New energy technology includes solar energy; wind energy; geothermal energy; fuel cells; ocean power, including tidal and wave energy; biomass; fuel from coal gasification and liquefaction; and, cogeneration systems.

The expression 'new energy technology' is not generally used in Australia or New Zealand. The nearest equivalent expressions are 'renewable energy technology' or 'alternative energy technology'. These refer to technologies for converting renewable energy resources into higher forms of energy but do not include advanced technologies for fossil fuels. Therefore, for this report the expression 'renewable energy technology' has the same meaning as 'new energy technology' except that it does not include coal-based technologies, which are described separately.

Australia and New Zealand have similar cultural backgrounds of mainly Anglo-Saxon influences dominating minority Aboriginal and Maori indigenous cultures, respectively. Both countries are strongly supportive of the APEC process and have trade development policies focussing primarily on the Asia Pacific region. However, there are marked differences between the science and energy sectors of the two countries.

The population of New Zealand is only about one fifth the size of the Australian population and its research capacity is only about one eighth that of Australia. Among OECD countries, Australia is ranked number 16 and New Zealand number 17 out of the 19 member countries in terms of gross domestic spending on research and development (R&D) as a proportion of GDP.

There are marked differences also in the roles of the two Governments in establishing science priorities, in funding R&D and in promoting science/industry developments. The Australian Government has only a loose set of science priorities but is directly involved in funding R&D and in promoting links between science producers and industry.

By contrast, the New Zealand Government has a highly structured set of science priorities. However, the distribution of Government support for science - the Public Good Science Fund (PGSF) - is the responsibility of an independent organisation which allocates funds on a highly competitive basis. Also, the Government plays no part in establishing science/industry links, which are left to the science producers and industry.

In the energy sector, Australia has excellent long term energy reserves, apart from liquid fuels, and there is no urgent need to

develop alternative energy sources. Therefore the push to develop new energy technologies is based upon three main motives: the commercial prospects for exporting technologies, particularly to the Asia region; the social demand for stand alone systems in remote areas of Australia; and, the need to reduce greenhouse gas emissions by adopting more efficient coal-based technology.

New Zealand has a much less secure energy future. It has the potential to develop more geothermal and hydro resources but there are significant environmental and land ownership problems to be overcome. The gas reserves are likely to be significantly depleted within ten years and the coal reserves could be very expensive to develop.

The New Zealand Government has recognised the need both to promote energy efficiency and conservation and to encourage new energy technology R&D. Recently it issued a strategic priority statement which identifies both areas as high priorities but which acknowledges that the funding allocated for energy through the PGSF is relatively small. There is a further barrier to the development of new energy technology in New Zealand in that the present price for electricity is sufficiently low to discourage serious private sector investment in new energy production facilities.

Most of New Zealand's present power installations, such as dams and transmission grids, were built before the very high inflation of the 1980s. But the present power charges reflect the pre-inflationary rather than post-inflationary capital costs. Therefore, power from new energy installations could not compete economically with power from the existing system without a substantial subsidy, which would be against the Government's non interventionist approach.

The result is that New Zealand's current strength in new energy technology R&D is in its traditional areas of geothermal and hydro power. By contrast, Australia's strengths are in non traditional areas such as advanced coal-based technologies, solar photovoltaics and hybrid systems for remote areas.

This report looks at these issues and specific new energy technology developments in some detail. It is based upon considerable contact and discussion with Australian and New Zealand Government and science representatives. For convenience it is divided into two parts: Part One covers New Zealand and Part Two covers Australia. Each part is in several sections which describe:

* the current political, economic and energy system;
* the current system and future plans for new energy technology;
* specific new energy technology programs and projects; and,
* co-operation programs with APEC member countries.

In addition, Part One includes a description of the new science system in New Zealand.

PART ONE: NEW ZEALAND

SECTION 1: Political, Economic and Energy Situation

1.1 Political, Economic, Energy and Environmental Overview

This section describes the general political, economic and energy situation plus the policy for the environment.

1.1.1 General political situation

The New Zealand political system, which is modelled on the British Westminster style of government, has only a single House of Representatives with some 99 members. Each parliament has a maximum life of three years and the present governing party, the National Party, was re-elected in 1993 so that it now has been in power for four years in a very evenly balanced parliament.

The two main opposition parties, the Labour Party and the Alliance Party, are generally left wing parties with both receiving about 20 per cent of popular support.

In 1994 a referendum of the electorate voted for a new Mixed Member Proportional (MMP) representation voting system which is due to be introduced within the next two years.

This replaces the 'first past the post' system, in which electors vote for individuals, by a system in which electors vote for parties or interest groups. Parliamentary representation will be determined by the number of votes received for each party or group as a proportion of the total votes cast.

This new system is likely to encourage minority government and/or coalition government. The overall impact of the new system is a matter of great conjecture in New Zealand but it seems likely that, in the short term, the National Party will remain the dominant group and will continue with its policies of economic reform.

1.1.2 General economic situation

The New Zealand economy is based mainly on agriculture and the leading exports are agricultural and forestry products which account for about 70 per cent of all export income. Horticulture, fishing and manufacturing are also becoming significant.

Industrial installations include one steel mill, one aluminium smelter, a synthetic petrol plant, cement works, and pulp and paper mills.

1.1.2 continued

Over the last few years the New Zealand economy has been transformed. During the late 1970s and early 1980s it became apparent that the economy was stagnant with economic growth and trade among the lowest in the OECD countries.

In 1985 the then Labour Government started to introduce a range of measures to deregulate the economy which were continued by the National Party Government.

These measures included:

* a plan to progressively remove border controls on imports, starting with Australian trade, with the total removal of tariffs to be completed in a few years;

* removing all industry assistance such as farm subsidies;

* introducing a uniform rate value added tax and removing all wholesale taxes; there are still additional duties on tobacco, alcohol and petrol; and

* infrastructure reforms including privatisation of the transport and telecommunications systems.

* deregulation of oil, banking and transport;

* ending the State monopoly on the supply of electricity and gas;

* labour market reform; and

* privatisation of several State owned enterprises and corporatisation of Government scientific establishments.

The result of these measures is that New Zealand is now among the highest ranked performers in the OECD with an annual growth rate of over 3 per cent which is expected to continue for the next two years or so.

The social consequence of these measures were dramatic. Unemployment soared and there were significant changes in health, education and welfare services. As growth continues there will be pressure to bring back some of these services.

New Zealand is a small and indebted economy and is especially vulnerable to fluctuations in the financial markets. Therefore political leaders of all parties try to allay potential concern in the markets about future economic policies by adopting a cautious approach to public spending.

1.1.2 continued

The proposed introduction of proportional representation (MMP) is an unpredictable factor that could lead to political uncertainty in the future and, in turn, economic uncertainty.

1.1.3 General energy situation

New Zealand is self sufficient in all but liquid fuels and the overall self sufficiency is 81 per cent. Demand is rising by about 1.4 per cent each year.

Electricity provides about 25 per cent of final demand and comes from four sources:
* hydro power provides 60 per cent of the electricity;
* geothermal provides 20 per cent;
* gas fired generation provides 18 per cent; and
* coal fired generation provides 2 per cent.

New Zealand supplies about 40 per cent of its oil requirements and the rest is imported. Petroleum makes up 45 per cent of the final energy demand and 76 per cent of this is used for transportation.

Natural gas represents the largest primary source of energy and is used mainly by the chemical industry and for electricity generation, with about 20 per cent of the total supply is used for reticulated supplies for heating purposes.

Coal provides about 8 per cent of primary energy supplies.

Wind power is not used commercially at present but community and industry interest in the use of wind power is increasing following the ending of the Government's monopoly on supplying electricity.

Solar power for water heating and space heating is widespread.

Wood is widely used for domestic heating and for process heat in the forest-based industries

1.1.4 Environmental policy

New Zealand's environmental policy is dominated by environmental impact controls on resource development and the Government's response to climate change.

The Resource Management Act 1991

The act sets out a system for the sustainable management of physical and natural resources. It is a significant factor constraining the future development of hydro and geothermal resources; it is also a consideration for the possible location of wind farms.

The act defines sustainable management as:

* providing for the well being of people and communities while sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonable needs of future generations;

* safeguarding the life supporting capacity of air, water, soil and ecosystems; and

* avoiding, remedying or mitigating adverse consequences of resource development.

The Carbon Dioxide Action Program

The Government's current domestic target for greenhouse emissions, consistent with the Framework Convention on Climate Change, is to return carbon dioxide emissions to the 1990 level by the year 2000 and to maintain them at that level. The ultimate objective is to reduce emissions to 20 per cent below the 1990 levels.

There are a number of policy measures to achieve these targets. They include:

* using the Resource Management Act to consider carbon dioxide emissions in plans, policies and consents for resource use;

* the energy efficiency strategy to facilitate the adoption of economic energy efficient practices and technologies;
* measures to remove barriers that prevent the increased use of renewable resources, particularly biomass and wind.

1.2 Current Economic Situation, Future Outlook and Plans

1.2.1 Economic policies including industrial development

Economic policy The Government remains committed to its policy of economic reform and trade liberalization. The main economic policies and goals include:

* controlling the fiscal deficit - the Government believes

the deficit remains too large and represents a risk to long term economic recovery;

* keeping inflation in the zero to 2 per cent range;

* economic growth through exports - there is optimism about the prospects for forestry, tourism and manufactured exports;

* strengthening economic relations with Asia and also Australia;

* encouraging direct foreign investment with its linkages to innovation, technology, skills and market access;

* increasing labour market flexibility, productivity and competitiveness;

* reducing unemployment through sustained economic growth;

* continuing the program of privatisation of Government owned corporations (but not postal services or electricity generation).

Industry policy The Government's industry policy is aimed at diversifying the range of exports and reducing the reliance on exports of unprocessed commodities. However, New Zealand is still largely dependent upon exporting commodities including meat, dairy products, forest products, fruit and aluminium.

The industries targeted by the Government for expansion are tourism, forestry, food processing, aviation, value added manufacturing and service industries such as education and training.

The manufacturing sectors showing the most growth are clothing and footwear, chemicals and household appliances.

Over half of New Zealand's manufactured exports go to Australia. The Asian countries mostly import New Zealand's commodities.

1.2.2 Economic statistics

This information is taken from the Economic & Fiscal Update by the New Zealand Minister for Finance, December 1994.

The New Zealand economy is growing strongly. In 1994-95 growth is expected to be 5.8 per cent with an average 4 per cent over the next four years at least. This represents the longest period of growth in New Zealand for decades.

1.2.2 continued

Productivity growth is about 2 per each year.

The exports sector is performing well and exports in the non commodity manufacturing sector are forecast to grow at around 20 per cent each year for the next three years. The main export markets in rank order are Australia, Japan, the United States and Korea.

Unemployment is 7.8 per cent and is expected to fall to 6.5 per cent by 1997-98.

The Government has an agreement with the Bank of New Zealand to keep inflation between 0 and 2 per cent. Currently it is towards the top of this range and inflationary pressures are increasing.

The national public debt is around 40 per cent of GDP. In 1993-94 the Government achieved the first budget surplus since 1978. However, it will not reduce taxation until public debt is around 30 per cent of GDP.

The Government's aim is to reduce public debt servicing costs by 30 per cent by 1997-98 and then to invest the savings in health, education and welfare services.

1.2.3 New Zealand's policy towards APEC

New Zealand's policy towards APEC is illustrated by several recent speeches by Government ministers.

Trade Negotiations Minister, Philip Burdon, in September 1994 said that APEC is central to New Zealand's trade policy strategy. He said that the importance of the APEC nations to New Zealand cannot be overstated.

The Minister for Foreign Affairs and Trade, Don McKinnon, in October 1994 said that APEC is an extraordinarily important grouping for New Zealand to belong to; also, that there are both economic and political reasons for APEC's importance to New Zealand. He emphasised the particular importance of trade relations and investment with APEC members.

In November 1994 the Prime Minister, Jim Bolger, described New Zealand as being very much part of the Asia-Pacific region. He said that New Zealand's vision for APEC was the same as the vision enunciated by President Clinton in 1993, that is: a Pacific community of nations committed to democratic values, to an open and stable trading environment, and to working in a collective way to ensure security for all.

1.3 The Current and Future Energy Situation

This section looks at New Zealand's energy policy, the current energy situation and the future outlook for energy.

1.3.1 Energy policy

The Government's 1992 energy policy objective is to ensure the continuing availability of energy services at the lowest cost to the economy as a whole, consistent with sustainable development.

The outcomes the Government wishes to achieve are:

* effective energy conservation by the promotion and adoption of efficient practices and technology;

* reduced statutory and structural barriers to enterprise and innovation in the supply and use of energy services;

* making basic energy services available to all members of New Zealand society;

* including environmental effects into decisions made by producers and users of energy;

* developing structures and systems that facilitate improved efficiency in the use of energy, minimise adverse environmental effects, and encourage the transition to cost effective sources of energy consistent with sustainable development; and

* effective allocation of research, science and technology to the provision and use of energy services and conservation.

The Government initiatives to achieve these outcomes include removing statutory barriers to competition in electricity and gas distribution, corporatising publicly owned energy distribution systems and controlling environmental effects related to the energy sector. The Government has also established:

* the Energy Efficiency and Conservation Authority;

* the Energy Management Association; and

* energy efficiency performance standards for buildings.

1.3.2 Primary energy supply

The total primary energy supply for 1993 is about 621 PJ.

Primary energy supplies, as per cent of total

Natural gas	33
Oil	28
geothermal	13
hydro power	12.5
coal	8
biomass	5.5

Imports: the only imported energy resource is oil, equivalent to 139 PJ each year.

Cogeneration: the installed capacity is estimated to be 164MW producing approximately 2PJ each year.

1.3.3. Energy consumption

Final energy consumption in PJ, by sector

	Domestic	Industrial	Transport	Total
1991	42	176	160	380
1992	43	178	161	383
1993	44	180	165	403
predicted:				
1995	45	182	178	405
2000	47	221	190	440
2010	50	209	228	487

Note: Industrial consumption includes commercial usage.

1.3.4 Future prospects

The overall self sufficiency is 81 per cent, falling to 62 per cent by 2020.

Liquid fuel self sufficiency is 49 per cent, falling to 24 per cent by 2020.

By the year 2020 a 30 per cent increase in electricity demand is possible.

Geothermal power is expected to nearly double by 2020 but hydro power will show only a modest increase.

Cogeneration is likely to increase to help meet the higher demand for electricity.

1.3.4 continued

The situation for specific energy resources is as follows:

Natural gas

New Zealand is self sufficient in natural gas which is used for synthetic gasoline (32 per cent), methanol (10 per cent), electricity production (36 per cent) and direct combustion (19 per cent).

There are a number of unexplored resources but the prospects for future discoveries are uncertain. Production is likely to be reduced by half by 2020 or earlier.

Oil

Total indigenous crude and condensate production for 1993 was 77 PJ. Of this 37 PJ is exported and another 139 PJ is imported.

Petroleum products provide about 45 per cent of total final energy demand, 76 per cent of this petroleum is used as transport fuel.

Known indigenous reserves are estimated to be equivalent to 781 PJ but it is likely that there will be a number of additional small oil discoveries in the future.

Coal

Coal provides about 8 per cent of primary energy supplies.

There are very large resources of indigenous coal but the capital costs to bring these into production may make it more economical to import coal if further supplies are required.

The demand for coal will depend on future policies regarding greenhouse emissions and the relative costs for alternative resources, such as geothermal power.

Hydro power

The total hydro power for 1993 was 77PJ which is about 60 per cent of New Zealand's electricity demand.

There is significant potential for further development.

1.3.4 continued

Geothermal power

Geothermal power provides about 40 per cent of New Zealand's electricity.

In 1993 geothermal sources provided 80PJ for electricity and 10PJ for direct applications in the domestic and industrial sectors.

There is good potential for further development but exploitation is hampered by uncertainty over environmental considerations and ownership of land.

Wind

There are no commercial wind energy facilities in New Zealand.

New Zealand has a large wind resource potential by world standards and wind appears to be the most promising of the new energy resources, with good prospects for small installations in the medium term. However, large scale schemes appear not to be viable for some long time.

Solar

Space and water solar heating systems are widespread.

There is no electricity generation by solar technologies at the present time.

Biomass

Wood is a major fuel for domestic and forest industry heating systems, estimated to have provided 27PJ in 1993.

There is significant potential for increased use of forestry and wood processing residues, wood plantations and cereal crop straw.

Biogas is produced at several sewage plants and also at land-fills through the decomposition of refuse. These fuels are used mainly for local heating and some limited electricity generation, estimated to be about 82 GWh from an installed capacity of 11MW.

1.3.4 continued

Cogeneration

Cogeneration is well established in New Zealand. There is potential for further development and current industry proposals for new installations are equivalent to 360MW.

Other technologies

New Zealand is well endowed with potential wave power, particularly in the southern areas of the South Island. The electricity utility is collecting wave energy statistics but this energy source is judged to be uneconomic for many years to come.

Nuclear: there is no nuclear power.

Coal gasification: there is no commercial gasification at present but the coal producers are investigating the potential for underground gasification.

Coal liquefaction: there is no commercial coal liquefaction at present.

Fuel cells: are still at the laboratory stage.

Section 2: Science and Energy Technology Policy

2.1 History and Current Status of Science and Technology

This section describes the revolutionary changes that have taken place in the New Zealand science and technology system during the last few years, and the system as it is structured at present.

2.1.1 Development of the science and technology system

Before 1989 the science system was dominated by the Department of Scientific and Industrial Research, the research branches of the Ministry of Agriculture and Fisheries, the Ministry of Forestry and the Meteorological Service. Government funds were distributed directly to those organisations who determined their own priorities and programs. There was no list of national priorities and no competitive bidding for research funds.

The result of this system was a good deal of research duplication, complacency and low productivity. Funds were directed overwhelmingly to research on resources and primary industries, with relatively little spent on industrial research and advanced technologies. As part of the economic reform process, the Government initiated a number of far reaching changes to this science system. The main changes are described next.

The Ministry of Research, Science and Technology

The Ministry was formed in 1989 to provide policy advice and to identify national science priorities. It introduced 40 desirable science outputs to be used for broadly determining funding levels (these outputs were later arranged into 24 Output Classes);

The Public Good Science Fund (PGSF)

PGSF was established in 1990 and the Foundation for Research, Science and Technology was established at the same time specifically to allocate funding from the PGSF on a competitive basis and in compliance with the national priorities.

Crown Research Institutes

On 1 July, 1992 the Government's science departments became restructured into ten Crown Research Institutes (CRIs). In 1993 the CRIs became self funding, autonomous companies with their own Boards of Directors but wholly owned by the Government.

2.1.2 Summary of the present science system in New Zealand

Policy - the Ministry of Research, Science and Technology is responsible for policy advice and for the system of national priorities and outputs which are used to broadly allocate the Government's investment in science (through the PGSF).

Funding - the Foundation for Research, Science and Technology allocates support from the PGSF according to the Ministry's system of outputs.

Research organisations - these include the Crown Institutes, which are independent but Government owned organisations; the universities; and, the non government industry linked research associations. All three groups can apply for support from the PGSF.

The following sections give more details on science and technology policy and the system for determining funding.

2.2 Science and Technology Policy

2.2.1 Ministry of Research, Science and Technology

The Ministry's main functions are to provide advice to the Minister for the following:

* policy and programs for research, science and technology to achieve their potential in contributing to national success;

* to identify science priorities and overall levels of funding for the Government's direct investment in science and technology;

* in conjunction with the Foundation for Research, Science and Technology, to develop an output classification system for government funded science and technology; and

* the development of a long term strategy for science.

The Ministry is also responsible for:

* collecting and disseminating information on inputs and outputs relating to research, science and technology in New Zealand;

* international government to government science agreements and membership of international agencies;

2.2.1 continued

* disbursing grants for international science co-operation and facilitating international linkages in science by action at government level; and

* providing technical advice on government policy development in general through the Chief Scientist.

Output classes - there are 24 output classes which identify science priorities for particular strategic areas. The Foundation for Research, Science and Technology has produced a research strategy paper for each output class to help research organisations meet the Government's strategic needs.

Long term strategy - the Ministry is currently developing a long term science strategy called RS&T:2010 which includes a substantial increase in the public investment in science through the PGSF.

International science linkages - the Ministry aims to support international science linkages by research and professional bodies and to ensure that science linkages contribute to New Zealand's trading and other relationships in the Asia-Pacific region.

2.2.2 Ministerial Advisory Group

The Minister of Research, Science and Technology has appointed a number of individuals from major science and technology organisations and interest groups to an advisory group. The purpose of the group is to enable the Minister to obtain a range of views on issues and policy proposals in research, science and technology.

2.2.3 Crown Company Monitoring Advisory Unit

The Unit was established in 1993 to advise the Minster for CRIs and the Minister for Finance on the performance of the CRIs for which they hold all the shares. It also provides administrative and analytical support for an External Advisory Group on CRIs which is made up of people from outside the bureaucracy.

2.3 Science and Technology Funding

2.3.1 Public Good Science Fund (PGSF)

The purpose of the PGSF is to purchase science, research and development, associated technology transfer and scientific services aimed at providing a base of scientific and technological knowledge and skills to support the economic, environmental and social goals of New Zealand. It is intended to be largely strategic and is aimed at providing skills and knowledge that would not be provided without public investment.

2.3.2 Foundation for Research, Science and Technology

The Foundation was established as an independent statutory authority in 1990. It has three funding functions:

* to allocate funds for research and development and scientific services through the Public Good Science Fund (PGSF) on a competitive basis;

* to allocate funds to the Technology for Business Growth Scheme;

* to allocate funds for Science and Technology Fellowships.

The Foundation's program for competitive bidding for funds came fully into effect in 1991-92. The total allocation for 1994-95 is $283.7 million; funding for the Technology for Business Growth Scheme is $7.5 million; and, funding for fellowships is $3.3 million (these include training and studies overseas).

In order advise research organisations about obtaining research funding from the PGSF, the Foundation has developed 24 research strategies for the period 1993-94 to 1997-98.

Research strategies are the link between the Government's longer term strategic objectives and the Foundation's funding allocation process. They consist of papers which broadly define research priority areas and give criteria by which applications for research funding will be judged. They do not prescribe research priorities at a detailed level.

The Foundation also publishes the annual amounts of funding to be broadly allocated to each output for five years ahead. This is to enable research organisations to adjust their plans to match the Government's long term objectives.

2.3.3 Funding for new energy technology

The Public Good Science Fund support for energy is listed as Output 21 and amounts to $4,620,000 for 1992-93 rising to $5,770,000 in 1997-98.

This output is sub-divided into:

* non renewable energy resources (coal and oil);

* traditional renewable energy resources (geothermal and hydro power);

* non traditional renewable resources (solar, wind and biomass);

* energy utilization and management.

The support for traditional renewable energy resources is $1,234,000 in 1992-93 dropping to $1,135,000 in 1997-98. For non traditional renewable resources it is $51,000 rising to $1,135,000.

Energy utilisation and management funding is $742,000 for 1992-93, rising to become the largest allocation of $2 million in 1997-98.

2.3.4 Technology for Business Growth (TBG) Scheme

The scheme is intended to improve the level and quality of research and development in industry, and improve the uptake of technology. Its main focus is on technological innovation in industry. The TBG part finances industry based projects as well as collaborative projects between industry and research institutions. The main criterion for providing support under the fund is a good probability for a successful commercial outcome.

The maximum grant provided is $500,000 and the majority of grants are less than $100,000. Projects must be completed within three years. Over the last three years support has been given to 230 projects.

There is also around $2.5 million available for transferring technology into businesses in order to solve specific problems or create opportunities for further commercial benefits. This scheme tends to focus more on business sectors or groups of companies rather than individual enterprises.

2.3.5 University research funding

There are seven universities all of which have science research capabilities. There is no specific university science and technology research funding system. Therefore until recently university science and technology research was funded either from the general university appropriation, or by contracts with the Crown Institutes or industry.

In 1991 the total internal funding for university research was about $90 million and the external funding for university based research was about $70 million of which $16.3 million came from the Health Research Council.

Recently the university funding was reduced by 10 per cent in exchange for the universities being able to apply for support from the Public Good Science Fund. In the opinion of several university representatives this raises problems in that most university research is basic research, carried out by individuals, and does not fit within the specific outputs used by the Foundation for Research, Science and Technology in its allocation of funding. There is a further problem in that the Foundation is tending to fund programs rather than projects when a good deal of university research funding is required for seed or pilot projects.

To get around these problems several universities are establishing formal links with Crown Institutes and developing collaborative research programs.

2.3.6 Other funding agencies

There are several other funding agencies which support specialised areas of research all of which are outside the scope of this report. They include:

* the Health Research Council;
* the Animal Health Board; and,
* the Agricultural and Marketing Research and Development Trust;

2.4 Research Organisations

2.4.1 Crown Research Institutes (CRIs)

There are now 9 Crown Research Institutes. They are:

* Industrial Research Limited (IRL) which covers energy, materials science, mathematical modelling, information technology, sensors, communications, transport, natural products processing, packaging and storage;

* Institute of Geological and Nuclear Sciences which covers geothermal energy, volcanoes, oil and gas exploration, minerals, groundwater, geophysics, geographical information systems, isotope tracers, radiation and non invasive analysis;

* National Institute of Water and Atmosphere Research (NIWA) which includes atmospheric science; marine, coastal and freshwater ecosystems; hydrological phenomena; ocean science; and climate research and wind monitoring.

* Pastoral Agriculture Research Institute Ltd (AgResearch) which covers dairy, beef, forage plant improvement, animal health, sustainable production and sheep, deer and equine research;

* Institute for Crop and Food Research Ltd which covers arable products, vegetables, floriculture and seafood;

* Horticulture and Food Research Institute of NZ Ltd which covers plant improvement, crop production and protection, post-harvest and food science;

* Landcare Research Ltd which includes the impact of pollution on soils, water resources and food chains; land management systems; biodiversity and conservation; and the control of pests and weeds;

* Institute of Environmental Science and Research Ltd which covers public health, environmental health and forensic science;

Energy research (PGSF Output 21) is dominated by IRL (geothermal and solar) and the Institute of Geological and Nuclear Sciences (geothermal); there are also small programs in the Forest Research Institute (biomass) and NIWA (wind data).

2.4.2 Universities

The seven universities are:
* the University of Auckland;
* the Victoria University of Wellington;
* the University of Waikato in Hamilton;
* Massey University in Palmerston North;
* the University of Canterbury;
* Lincoln University in Canterbury; and,
* the University of Otago in Dunedin.

The first four universities are on the North Island and the last three are on the South Island.

All the universities have some energy research interests but their work is unco-ordinated and fragmentary according to the Foundation for Research, Science and Technology.

2.4.3 Research Associations

There are 10 research associations:

* Building Research Association;
* Coal Research Ltd. (formerly the Coal Research Association);
* Cement and Concrete Association;
* Dairy Research Association;
* Heavy Engineering Research Association;
* Leather and Shoe Research Association;
* Logging Industry Research Association;
* Meat Industry Research Institute;
* Research Institute of Textile Services; and
* Wool Research Organisation.

Coal Research Ltd has a small program on coal gasification but none of the other research associations have research projects relevant to this report.

SECTION 3: Plans for New Energy Technology

3.1 Government Structure and New Energy Technologies

3.1.1 Agencies responsible for new energy technologies

The Energy Resources Division

The Energy Resources Division is headed by the Minister of Energy, Mr Doug Kidd, and is within the Ministry of Commerce. It is responsible for all energy resources including renewables.

The Foundation for Research, Science and Technology

Energy research is Output Class 21 in the Government's framework for science priorities. The Foundation is responsible for developing the research strategy for Output Class 21 and for allocating grants from the Public Good Science Fund to energy research programs that comply with the research strategy.

The Energy Efficiency and Conservation Authority (EECA)

EECA is an independent authority responsible to the Minister of Energy. Its role is to promote energy efficiency and conservation through measures such as disseminating information on potential energy sources and their applications. This information includes the economic, social and environmental impacts of energy sources and applications.

The Energy Management Association

The Energy Management Association is a private sector organisation established in 1993 with the support of EECA. Its main role is to disseminate information to members on energy management techniques and technologies, including cogeneration. It has no role in energy research at present.

3.1.2 Implementation of programs and projects

Programs and projects are implemented mainly in the Government owned but independently run Crown Institutes, with a few programs also in the universities.

The private organization Coal Research Ltd (formerly the Coal Research Association) implements coal related research activities. The Building Research Association also has a program on building energy utilisation.

There is a trend for New Zealand's research organisations to establish links with overseas producer and research organisations either to share costs for work undertaken in New Zealand, or, to do research overseas that cannot be undertaken within New Zealand.

3.2 Policy for New Energy Technology Development

3.2.1 The Government's new energy technology programs

The Government's investment in energy research is represented by Public Good Science Fund Output 21. This is sub-divided into four groups. They are:

* non renewable energy resources (coal and oil);
* traditional renewable energy resources (geothermal and hydro);
* non traditional renewable resources (solar, wind and biomass);
* energy utilization and management.

The Foundation for Research, Science and Technology has determined a research strategy for Output 21. In general this strategy is based upon a shift of emphasis away from non renewable resources towards the non traditional renewable resources plus a strong focus on energy utilisation and management.

New energy technology research, as defined by NEDO, is eligible for funding in all four groups, with coal gasification coming under non renewable energy resources and cogeneration coming under energy utilisation and management.

3.2.2 The Government's renewable energy policy and objectives

The Government believes renewable energy will contribute to its energy policy goals in the following ways:

* by helping to ensure the continuing availability of low cost energy by exploiting alternative forms of energy that can compete with fossil fuels;

* by increasing the diversity of energy supply, which will improve energy security;

* by helping to ensure that energy services remain accessible to all members of New Zealand society, particularly in remote areas where conventional energy resources may be expensive; and

* by minimising adverse environmental effects of energy use, including greenhouse gas emissions.

The renewable energy policy objective is to facilitate the development of cost-effective renewable energy in order to help ensure the continuing availability of energy services at the lowest cost to the economy as a whole, consistent with sustainable development.

3.2.3 Government initiatives to support new energy technologies

The Government has put in place several initiatives to encourage the uptake of new energy technologies. These initiatives include:

* commissioning an analysis of the resource potential and feasibility of renewable energy in New Zealand;

* enacting the Resource Management Act 1991 which emphasises sustainable management of natural and physical resources;

* the Carbon Dioxide Action Program which incorporates specific measures to reduce emissions consistent with New Zealand's obligations under the Framework Convention on Climate Change; and

* establishing the Energy Efficiency and Conservation Authority to promote energy efficiency and conservation.

Future initiatives include:

* identifying barriers to cost effective forms of renewable energy and taking appropriate action to promote greater use of renewable energy;

* examining how the reduction of greenhouse gas emissions can be incorporated into the decision making of producers and users of energy; and

* identifying further research priorities for renewable energy in future allocations of science funding; this is being done by the Energy Efficiency and Conservation Authority, see below.

3.2.4 Energy Efficiency and Conservation Authority programs

The EECA has a 10 point plan which includes a number of initiatives to improve energy efficiency in buildings, appliances, lighting, industrial machinery and vehicle fuel efficiency. The plan also includes the two following projects.

3.2.4 continued

PROJECT: Non Traditional Renewables Research Priorities

Objective: to identify research priorities within the renewable energy sector, particularly solar, wind and biomass.

Contents: distribution of a questionnaire to obtain the opinions of over 700 industry practitioners, professionals and other interested persons; also a consultative workshop to discuss the questionnaire findings.

Funding: $50,000 plus in-house resources.

Status: biomass, solar and wind energies have been identified as priority areas but no further details have been decided as yet.

PROJECT: Resource Consent Guidelines

Objective: to facilitate the approval of planning consents by improving the knowledge of the environmental, social and economic effects of non traditional renewable energy development.

Contents: preparation of a series of guidelines to ease the resource consent process for developers and planning authorities seeking planning permission under the Resource Management Act.

Funding: $50,000 plus in-house resources.

Status: this project is underway and should be completed by the end of the year. It relates to new energy technologies in that adverse environmental effects can hinder the development of, say, wind farms or new geothermal projects.

3.2.5 Intellectual property rights

There are no specific guidelines for intellectual property rights. The Government wishes to ensure that New Zealand benefits from more open systems but acknowledges that there are some complex issues to resolve in the area of intellectual property rights. The Ministry of Research, Science and Technology is responsible for advising the Government on this issue.

Recently the Government recognised the need for a more rigorous approach to intellectual property rights in international cooperation programs and asked the recently formed International Science and Technology Advisory Committee to investigate this problem.

The Crown Institutes are responsible for managing their own intellectual property and, in general, this is done on a case by case basis.

3.3 Budget for 1994 and 1995

The Public Good Science Fund support for energy is listed as Output 21 and amounts to $4,620,000 for 1992-93 rising to $5,770,000 in 1997-98.

Output 21 is sub-divided into four groups with different amounts of funding allocated to each group. The groups are:

* non renewable energy resources (coal and oil): $2,643,000 in 1993-94 down to $2,500,000 in 1994-95;

* traditional renewable energy resources (geothermal and hydro power): $1,234,000 in 1993-94 down to $1,190,000 in 1994-95;

* non traditional renewable resources (solar, wind and biomass): $51,000 in 1993-94 rising to $300,000 in 1994-95;

* energy utilization and management: $742,000 for 1993-94 up to $950,000 in 1997-98.

3.4 Government Supported New Energy Technologies

3.4.1 Future new energy technology priorities

The Government is now in the process of updating its strategic research objectives for energy and, in December 1994, issued its Strategic Statement to Guide Investment through the Public Good Science Fund for the period 1996 to 2001. This sets out two key goals relevant to the energy sector:

* to improve knowledge of technologies for sustainable resource use to ensure waste minimisation, cleaner production and efficient energy use; and

* to maintain and strengthen international scientific and technological networking and collaboration in order to ensure an adequate knowledge of, and access to, external research knowledge and skills, databases and technologies.

At present there is only a broad definition of energy issues to be funded. They are: science and technology focused on energy extraction, conversion, distribution and management; also science and technology oriented towards understanding and ameliorating the impacts of industry on the natural environment or society.

More detailed research priorities are due to be determined by the Energy Efficiency and Conservation Authority (EECA) by mid 1995. These priorities will be used by which the Foundation for Research, Science and Technology to allocate future support from the Public Good Science Fund to energy research programs.

All that is known so far is that the EECA has identified biomass, solar and wind energy as priority areas for research.

3.4.2 Background to current new energy technology programs

The existing new energy technology programs supported by the Public Good Science Fund are mainly those that were inherited by the Crown Institutes from their former existence within the Department of Scientific and Industrial Research.

The current status of these programs varies from institute to institute. The following three examples are quoted to illustrate the current situation:

* the Crown Research Institute AgResearch inherited some high quality waste biogas research facilities which were sold off to form the company Waste Solutions;

* at the Forest Research Institute their work on developing biogas technology was halted at the time of coporatisation but represents a significant potential new energy technology capability requiring new external funding; and

* NIWA, the National Institute of Water and Atmospheric Research Ltd, inherited a wind resource evaluation program that started in the 1970s; this is expected to increase dramatically because of increased interest in wind energy generation following the ending of the Government's monopoly on supplying electrical power.

These organisations, together with other Crown Institutes and the universities, are still evolving their roles, priorities and investments in new energy technology research. Therefore the information given next includes some statements on research capability as well as specific program details.

3.4.3 Solar power programs and capabilities

The IRL has solar energy programs on

* developing transparent insulating materials for use with solar water collectors and as thin films for windows;

* developing advanced selective surfaces for use with high temperature solar collectors;

* developing prism concentrators for solar photovoltaic modules, giving a gain of between 2x and 5x, for use in domestic situations;

* developing electronic devices to interface solar PV modules to the national electricity grid;

* researching artificial photosynthesis using semiconducting liquid crystal porphyrins in a solar cell arrangement.

3.4.4 Wind programs and capabilities

PROGRAM: Wind Energy Resource Evaluation

Objectives: to collect long term wind and turbulence information for alternative energy resource options.

Contents: wind data collection at numerous sites around New Zealand; also wind turbulence and modelling studies.

Funding: averaging about $200,000 per year with $120,000 from FORST and additional support from private clients.

Agency in charge: National Institute of Water and Atmospheric Research (NIWA)

Status: the wind monitoring program is very active and is expected to double in the near future.

PROGRAM: Wind Farm Potential

Objective: to evaluate the potential for wind farms close to electrical grids linked to hydroelectricity stations.

Contents: wind monitoring at a range of elevated sites near the Clutha River and Lake Manapouri.

Agency in charge: Department of Physics, Otago University (Keith Dauber)

Funding: internal funding from the university plus support from electricity utilities.

Status: the program is part of a long term involvement in post graduate research into wind energy. It is progressing well in technical terms but is short of funding support although there is a growing interest in wind.

3.4.5 Geothermal programs and capabilities

The Geothermal Institute at the University of Auckland

The Institute is the main university based group concerned with geothermal studies. It runs several post graduate courses on geothermal issues and is heavily involved with students from Asia funded by the Development Cooperation Division of the Ministry of Foreign Affairs and Trade.

The Geothermal Institute has strong links with the Institute of Geological and Nuclear Sciences (IGNS) and its research activities are usually related to IGNS programs. This year it has received no funding from the PGSF.

The Institute of Geological and Nuclear Sciences (IGNS)

IGNS is very active in geothermal research. Currently it is giving a high priority to deep geothermal research and has support from both the Public Good Science Fund and the Electricity Corporation of New Zealand (ECNZ) for this work.

Staff at IGNS have long standing links with overseas countries, including Japan. Currently there is a good deal of shared interest with Japan in deep geothermal research and volcanic environments.

Industrial Research Limited (IRL)

IRL is involved with management and conservation issues associated with geothermal energy and has close links with IGNS.

PROJECT: Material Damage in a Volcanic Environment

Objective: to assess the damage to materials in aggressive environments to help identify possible materials for use in power production technologies.

Contents: field testing of materials was undertaken at White Island, NZ, to assess the corrosion performance of metals and alloys under the severe conditions encountered in geothermal volcanic environments, with temperatures up to 230 degrees.

Funding: not known

Agency in charge: IRL (Ken Lichti)

Overseas partners: Tohoku National Industrial Research Institute, AIST, MITI, Japan (Yoshiaki Kurata, Norio Sanada, Hiroshi Nanjo and Jun Ikeuchi).

3.4.5 continued

Status: the work is virtually completed and the results so far show that, in a high temperature fumarole, nickel-base alloys containing more than 8 per cent molybdenum and titanium alloys showed excellent corrosion resistance. Lower alloy materials were severely corroded. In low temperature fumaroles duplex stainless steels showed good resistance.

PROGRAM: Deep Geothermal Resources

Objective: to define the characteristics of deep thermal resources in the Taupo Volcanic Zone in order to evaluate their potential as a new, low environment impact energy resource.

Contents: determining the nature of the sub-volcanic basement geology and structure using deep hole data from other fields; multi-disciplinary analysis of cores, cuttings and fluids to determine how geothermal fluids react with basement rocks; developing a hydrologic model for the gas rich systems; modelling the deep geothermal conduits and shallower structures.

Funding: $320,000 from FRST plus ukown support from ECNZ.

Agency in charge: IGNS Wairakei, Taupo (C P Wood)

Status: this is the next phase of an existing program and is due to run from July 1995 to June 1998.

PROGRAM: Magma Ambient Production Environments

Objectives: to characterise the role of magmatic heat sources in the evolution of TVZ geothermal systems.

Contents: developing criteria for assessing magmatic volatiles in geothermal systems; modelling the thermal physics; determining the effects of a dioritic intrusive; radiometric aging of hydro-thermally altered rocks.

Funding: $260,000 from FRST plus unknown support from ECNZ.

Agency in charge: IGNS Wairakei, Taupo (B W Christenson)

Status: this is the next phase of an existing program and is due to run from July 1995 to June 1998.

3.4.5 continued

PROGRAM: Efficient Utilisation of Low Temperature Geothermal Heat

Objectives: to enhance the sustainable utilisation of shallow geothermal resources.

Contents: characterising the low temperature geothermal resources around Taupo; establishing criteria for selecting suitable sites for new heat pump extraction technologies; developing physical and mathematical models of the steam heated aquifer at Tauhara; investigating related thermal impacts on the environment.

Funding: $318,000 from FRST

Agency in charge: IGNS Wairakei, Taupo (C J Bromley)

Status: this is the next phase of an existing program and is due to run from July 1995 to June 1998.

PROGRAM: Optimising Use of Geothermal Effluents

Objective: to extend the use of low and medium temperature geothermal fields .

Contents: examining the precipitation of amorphous silica from super saturated solutions; studying the relationship between deposition rate and particle size and density; characterising precipitation dynamics as a possible control of silica concentration in hot geothermal fluids.

Funding: $239,000 from FRST

Agency in charge: IGNS Wairakei, Taupo (R B Glover)

Status: this is the next phase of an existing program and is due to run from July 1995 to June 1998.

3.4.6 Fuel cell programs and capabilities

PROGRAM: Solid Oxide Fuel Cell Development

Objective: to develop the technology for the fabrication of a SOFC unit.

Contents: studies of anode/cathode, stacking and fuel technology; fabrication methods for an electrode suitable for the oxidation of natural gas; and, development of a working stacking system.

Agency in charge: Fuel Cell Research Unit, University of Waikato (Dr Nigel Sammes)

Funding: $100,000 from the company Fletcher Challenge; $500,000 from FRST (1992-93) plus unknown support from the Electricity Corporation of New Zealand.

Status: the program started in 1992 and has developed co-operative links with the Crown Institute Industrial Research Ltd (IRL) and with groups in Australia, China, Japan, Europe and the United States.

Overseas partners: there is a strong link with Dr Osamu Yamamoto of Mie University in Tsu which includes exchanges of academic staff and PhD students.

3.4.7 Biomass programs and capabilities

Biogas - Waste Solutions Ltd

The company Waste Solutions Ltd was part of the Crown Research Institute AgResearch until 1992. It was originally formed some 15 years ago as a unit within the Ministry for Agriculture and Fisheries. The company is now fully privatised and tenders for waste treatment projects around the world.

It has a particular biogas capability in anaerobic systems for treatment and energy recovery from liquid and solid wastes from primary industries, food processing and domestic sewage.

The company's research facilities are world standard and there are close links with the microbiology laboratory at the University of Otago.

Contact: Managing Director John Campbell
Waste Solutions Ltd
Invermay Agricultural Centre
Puddle Alley, PO Box 144 Mosgiel
New Zealand

PROGRAM: Forest Research Institute Bio Energy

Objectives: to develop the technology to produce biogas and ethanol from wood and wood wastes.

Contents: R&D into technology for the hydrolysis/fermentation of woody biomass for the production of ethanol with biogas as a byproduct.

Funding: the program has halted temporarily pending further funding.

Agency in charge: New Zealand Forest Research Institute

3.4.7 continued

Status: the technology has been successfully demonstrated at pilot plant level with Pinus Radiata. It has potential for use with other cellulosic wastes and municipal solid wastes. The outstanding issue relates to the scaling up of the technology and process optimisation for any particular feedstock and product mix.

PROJECT: Community-Based Bio Energy Systems

Objective: to develop a decision making tool to help communities evaluate pretreatment and anaerobic digestion technologies for their own needs.

Contents: evaluation of a number pretreatment and anaerobic digestion technologies in terms of their suitability for the conversion of cellulosic feedstocks to methane.

Agency in charge: New Zealand Forest Research Institute.

Funding: $94,000 for 1994-95 from FORST

Status: this project is an extension of the work already carried out by the Institute on biogas an ethanol production.

3.4.8 Cogeneration programs

There is a good deal of interest in New Zealand in the economics of cogeneration. However there is no support for research into cogeneration through the Public Good Science Fund and there appears to be no work on cogeneration in the universities.

ECNZ and the private company Fletcher Challenge are both commissioning cogeneration systems but are unwilling to give more information except to confirm that the main task is to make effective use of the cogenerated heat, as well as the power.

3.5 Coal Gasification and Liquefaction Research

3.5.1 Coal Research Ltd

The Coal Research Association of New Zealand (CRANZ) has been the principal organisation responsible for coal research and policy development in New Zealand for over twenty-five years.

On January 1, 1995, the organisation became part of a new company, Coal Research Ltd, which is a strategic alliance between CRANZ and the Australian coal industry research and development company, ACIRL. Under this new arrangement CRANZ holds 70 per cent of the equity and ACIRL 30 per cent.

The total coal research funding received from the Public Good Science Fund for the year ending March 1993 was NZ$406,000 and for 1994 was NZ$507,000. This includes support for the following program.

PROGRAM: Coal Research Ltd Coal Gasification

Objective: to develop a coal gasification research facility.

Contents: the construction of a bench scale gasifier and gas analysis equipment.

Funding: a three year grant from the Foundation for Research Science and Technology (FORST) worth approximately NZ$100,000 per year.

Status: The program was initiated in 1993 and involves approximately one full time research worker.

3.5.2 Coal liquefaction

Richard Sykes of the Institute for Geological and Nuclear Sciences has developed a new technique for characterising lignite coals to assess their potential for coal liquefaction. He has had contact with NEDO about this technique. Currently IGNS is looking for a co-operation partner to help develop this further.

3.6 Non Government Organisations

The Electricity Corporation of New Zealand and the company Fletcher Challenge are the two largest non Government supporters of energy research in New Zealand. Both companies are unwilling to give details of their activities but it is known that ECNZ is contributing around $2 million in support for new energy technologies, including coal gasification but excluding drilling investigations associated with geothermal energy.

3.6 continued

Both organisations believe the New Zealand research base is too limited for their needs. Therefore they monitor developments overseas with a view to adapting overseas technologies they judge to be appropriate for their own needs.

ECNZ's investigations have covered virtually all forms of new energy technology including wave energy and wind energy site investigations and biomass potential (with FRI). The corporation's interest is aimed at long term possibilities and it is unlikely that it would invest significantly in short term new energy technology developments.

ECNZ's support currently includes geothermal activities with IGNS and the fuel cell research at Waikato University, both of which were listed in the preceding text; there is also a collaborative program on underground coal gasification with New Zealand coal producer Glencoal Energy and Energy International (USA).

Fletcher Challenge is also supporting the fuel cell research and is developing 2 cogeneration projects linked to pulp and paper production.

Section 4: Technology Cooperation Programs with APEC

This section describes the current situation and future plans for New Zealand's participation in technology cooperation programs with APEC member economies, particularly Indonesia, Philippines, Malaysia, Thailand, China and Chinese Taipei (Taiwan).

4.1 Governmental Structure for Co-operation Programs

The priorities for future international cooperation in science and technology (S&T) have been identified in a report with the title Strategic Overview of New Zealand's International Science and Technology Links. This was submitted to the Minister for Science and Technology in June 1994 and, in late 1994, the Minister accepted a number of the recommendations and decided to establish an International Science and Technology Advisory Committee (ISTAC) to provide advice to the Government on international S&T linkages and on the allocation of funds.

The ISTAC is due to report towards the end of 1995, however, there are already a number of international co-operation arrangements in place and these are described below.

4.1.1 Government organisations and methods of implementation

The New Zealand Government accepts that it has an important part to play in facilitating international science linkages even though organisations, including the Crown Institutes, are encouraged not to rely on government support for their business activities.

The Government believes that formal government to government linkages are particularly important for dealing with centralised command economies, such as China, and with centrally planned economies such as Japan, Korea and Chinese Taipei.

The agencies responsible for promoting international co-operation are:

* the Ministry of Research, Science and Technology;
* the International Science and Technology Advisory Committee;
* the Ministry of Foreign Affairs and Trade; and
* The Royal Society of New Zealand (on a much smaller scale).

Ministry of Research, Science and Technology

The Ministry's International Science Unit is responsible for maintaining and developing government to government science and technology relations, including co-operation agreements and membership of international and regional science agencies.

International Science and Technology Advisory Committee

Following the restructuring of the science system, the Government commissioned a study on international science co-operation and, as a result of that study, recently announced the establishment of the International Science and Technology Advisory Committee (ISTAC) to provide the Minister for Research, Science and Technology with strategic advice on New Zealand's international science and technology linkages.

Ministry of Foreign Affairs and Trade

When the New Zealand Government is involved in commercial technology transfer activities, it is usually through the Ministry of Foreign Affairs and Trade (MFAT).

MFAT's Development Co-operation Division manages the official development assistance program which includes assistance packages under which new energy technology projects could be initiated.

The Royal Society of New Zealand

The Royal Society is concerned with individual scientists and, therefore, promotes international links between individuals. It also represents the interests of New Zealand's scientists at the International Council of Scientific Unions.

4.1.2 Co-operation involving non Government organisations

The Crown Research Institutes, as independent organisations, determine their own policies and priorities for international collaboration. Some activities are initiated under government to government agreements and some, particularly commercially oriented activities, are agreements between specific institutes and/or organisations. In general the Government encourages, the Institutes to take responsibility for their own co-operation activities.

The universities are in a similar situation to the Crown Institutes but on a much smaller scale. Many international co-operation arrangements are private and informal agreements between individuals or small groups of academics.

4.1.3. New Zealand's science co-operation agreements

New Zealand's current science co-operation agreements include:

* China - 26 areas of co-operation for research in forestry, horticulture, earth sciences, minerals, industrial technology, land use, pastoral agriculture and biotechnology;

* Japan - 71 specific areas of co-operation covering a wide range of subjects including geothermal co-operation with the Institute of Geological and Nuclear Science (IGNS);

* South Korea - 2 areas of co-operation involving forestry and wool carpet research, however, it is expected that co-operation will expand in the near future;

* Chinese Taipei - there is co-operation in medicine;

* Thailand - 13 areas of co-operation including medicine, agriculture, aquaculture, biochemistry and archaeology;

* Vietnam - co-operation in mathematics, however, other areas of co-operation are expected to develop in the near future.

4.2 Policy on New Energy Technology Co-operation

4.2.1 Policy on cooperation programs with APEC members

Both the Ministry of Commerce and the Ministry of Foreign Affairs and Trade are involved with international co-operation programs involving energy technology. However, there is no specific policy for international co-operation in new energy technology.

Energy Resources Division, Ministry of Commerce

The Division is involved with the APEC Energy Working Group but has put a low priority on involvement with new energy technology related programs. The NZ representatives have attended only a few of the Energy Working Group or Expert Group meetings; their attendance includes three meetings on Demand and Supply Statistics and on Energy Efficiency and Conservation.

Development Cooperation Division of Foreign Affairs and Trade

The principal aim of New Zealand's Official Development Assistance (ODA) is to help promote sustainable economic and social progress and justice in developing countries. Emphasis is given to the transfer of skills and knowledge, both as an element of project assistance and through the provision of education and training awards in the partner country.

Asia and the South Pacific are priority regions in Official Development Assistance. Bilateral programs for the Asia region are sub-divided into two groups:

* ASEAN Programs, which include ASEAN regional programs and country programs; and,

* Other Asia Programs, which include the Mekong Committee and the Asia Development Assistance Facility.

Under these programs there are specific new energy technology programs for the ASEAN region as a whole and for Indonesia, the Philippines and Thailand, see below.

4.2.2 Focus of countries and technologies

Ministry of Research, Science and Technology

The Ministry's International Science Unit has put a high priority on establishing links with the Asia region on the assumption that, in time, these will enhance New Zealand's trade relations with the region. However, no specific areas of science have been identified as being particularly suitable for these international linkages.

Development Cooperation Division of Foreign Affairs and Trade

As indicated earlier, the Division rates linkages with Asia as a high priority, particularly with ASEAN members, but it has no specific technology focus.

4.2.3 International co-operation budget

The Government's 1994-95 budget for international linkages is $388,000. This is distributed in amounts of $5,000 to $10,000 to support contact with international organisations, particularly in Asia. This funding is to be reviewed as part of the Government's general review of international science co-operation.

The substantial source of funding for international science co-operation is the Public Good Science Fund (PGSF). There is no specific budget item in the PGSF for international co-operation as such. However, international co-operation is considered in the assessment of research grant applications to the PGSF and is supported provided it is judged to benefit the research.

4.2.4 Future plans for international co-operation

The Government has put a high priority on international science co-operation with Asia but believes the responsibility for developing co-operation programs should be with the research organisations.

Until now the Crown Institutes have been concerned primarily with learning to survive in the new science system. However, in future they are expected to put considerably more effort into establishing international co-operation agreements both for cost sharing on projects and for staying in touch with overseas developments.

4.3 New Energy Technology Co-operation Programs

4.3.1 Development Cooperation Division, Ministry of Foreign Affairs and Trade

The Development Co-operation Division is supporting one gas utilisation program with ASEAN and, also, is sponsoring students from several countries in Asia to study a geothermal course at Auckland University. More details of these initiatives are given below. The Division also is responsible for two assistance programs in Asia with the potential for including new energy technology components. These are described as well.

PROGRAM: ASEAN Natural Gas Utilisation in Transport

The objective of the program is to optimise the use of energy and energy sources and to improve the quality of the environment through the use of natural gas in the transport sector. The program commenced in 1993 and has funding of NZ$306,000 to June 1994 and $360,000 to June 1995. The program is implemented by consultants.

PROJECT: Indonesia - geothermal energy

Objective: to determine the technical, economic and social feasibility of a small scale geothermal electricity plant at Ulumba on Flores Island.

Contents: the project includes an investigation of the suitability of the geothermal energy field to provide steam for a small scale power plant and to plan for the construction of the plant.

4.3.1 continued

New Zealand support includes private consultancy services and equipment and Indonesia is contributing the development of access roads, site preparation and infrastructure development.

Funding: The total expenditure to date is NZ$1.5 million to June 1994. The expenditure this year is NZ$452,000 to June 1995.

Status: Work commenced in 1988-89 and preliminary work is due to be completed at the end of this year.

PROGRAM: Indonesia In-Country Geothermal Training

Objective: to upgrade Indonesia's professional capability in the geothermal area.

Contents: investigating the human resource needs and helping to develop specific training programs, with NZ support, in Indonesia.

Funding: total funding to June 1994 was NZ$88,500; the funding for this year is NZ$65,000 to June 1995.

Status: The project commenced in 1992-93 and this phase is due to finish this year.

PROGRAM: Indonesia Study Awards for Geothermal Training

Objective: to transfer skills and technologies in geothermal development to the appropriate institutions in Indonesia.

Contents: Activities include post graduate diplomas in Geothermal Engineering at the University of Auckland's Geothermal Institute.

Funding: funding is approved on an annual basis. It was NZ$148,600 to June 1994 and, for this year, is NZ$ 150,000 to June 1995.

Status: this program is run every year.

PROGRAM: Philippines Study Awards for Geothermal Training

Objective: to transfer skills and technologies in geothermal development to the appropriate institutions in the Philippines.

Contents: activities include post graduate diplomas in Geothermal Engineering at the University of Auckland's Geothermal Institute.

Funding: total funding, which is approved annually, was NZ$334,000 to June 1994; for this year it is NZ$88,000.

4.3.1 continued

Status: this program commenced in 1990-91 and is expected to be repeated annually.

PROGRAM: Thailand Study Awards

Objective: to transfer skills and technologies in a range of areas to the appropriate institutions in Thailand. Geothermal training is included but there is no indication of any current geothermal component.

PROGRAM: The Asia Development Assistance Facility

This program is for non ASEAN countries of Asia, including China.

Objective: to promote sustainable economic and social progress and justice in the countries concerned, through activities which maximise the involvement of New Zealand enterprises.

Contents: It covers pre-feasibility and feasibility studies, project appraisal and design, sectoral studies, pre-investment studies and training. New energy technology studies are eligible but there are none at present.

Funding: The Facility has total funding of NZ$5 million this year, compared with NZ$4 million last year.

PROGRAM: The Mekong Committee

Objective: to support various forms of resource development, including energy, in the Mekong Basin.

Contents: There have been studies and a pilot facility for micro-hydro power under the program but, so far, no other form of new energy technology has been supported.

Funding: The annual funding varies according to the projects to be supported and has dropped from NZ$530,000 in 1994 to NZ$65,000 in 1995.

4.4 Coal Liquefaction Co-operation Program

There has been some international co-operation involving IGNS on characterising lignites suitable for coal liquefaction. This work is dormant at present, although IGNS would like to continue with it and has been seeking support from Japan.

4.5 Geothermal Co-operation Programs

The following is a list of co-operative research proposals recently developed by the Wairakei Research Centre of the Institute of Geological and Nuclear Sciences (IGNS). Several of these are linked to the research programs currently being evaluated by the Foundation for Research, Science and Technology for funding support in the next round of grants.

4.5.1 PROGRAM: Satellite sensing of geothermal areas.

Objective: To demonstrate the usefulness of Japanese Earth Resources Satellite (JERS-1) imagery for the detection and exploration of geothermal areas in vegetated regions and develop image processing techniques for the identification and mapping of larger surface features and estimating the importance of stressed vegetation.

Contents: Develop methods for Waiotapu and/or Wairakei, then apply them to areas in Japan, Indonesia, Philippines and Mexico.

Overseas partners (proposed): NEDO; Bishimetal Exploration Co, Tokyo, Japan.

Status: this work is an extension of previous joint NEDO/IGNS JERS-1 Taupo project. Further co-operation is required for fieldwork, data analysis and discussions.

4.5.2 PROGRAM: Deep drilling/magma ambient environments.

Objective: To investigate the nature of production environments which are influenced by magmatic inputs.

Contents: Deep drilling in the Taupo volcanic zone (TVZ) for the study of the evolution and sustainability of deep geothermal resources.

Overseas partners (proposed): NEDO.

Status: This proposal is closely linked to the program currently being developed with ECNZ (drilling and deep cores), the Geothermal Institute of Auckland University, Queensland University and Ohio State University (radiometric age dating) and Lawrence Livermore Laboratory (trace metal analysis).

4.5.3 PROGRAM: Magma-ambient geothermal resources, volcano -hydrothermal systems.

Objective: To investigate the nature of shallow, high temperature geothermal system heated by magma at White Island volcano.

Contents: Drilling holes in the main crater floor to sample rock, minerals, fluids and gases to test materials.

Overseas partners: University of California, Los Alamos National Laboratory and Sandia National Laboratory of the United States plus the University of Auckland.

Status: The University of California has applied to the United States National Science Foundation for funding to support this program. It is hoped that other nations also will become involved.

4.5.4 PROGRAM: Efficient use of low temperature geothermal resources

Objective: To produce guides for cost efficient exploration and utilisation of low temperature geothermal resources.

Contents: Development of scientific methods for exploring shallow resources (below 100 degrees) and heat pump technology for their utilisation.

Overseas partners (potential): NEDO, NEF, West JEC and GERD of Japan, Auckland University Geothermal Institute and IRL of New Zealand, and Utah University of the United States.

Status: This is a preliminary proposal.

4.5.5 PROGRAM: Geothermal targeting and fluid tracing technology.

Objective: To publish procedures for targeting fractures and predicting the outcome of fluid re-injection.

Contents: Researching methods to improve the predictability of targeting open fractures in geothermal reservoirs; developing improved tracers to detect geothermal fluid movement through fractures and porous aquifers; developing standard re-injection strategies as a function of tracer results an reservoir simulations.

Overseas partners (potential): NEDO, NEF, West JEC and GERD of Japan, Auckland University Geothermal Institute and IRL of New Zealand, and Utah University of the United States.

Status: This is a preliminary proposal.

4.5.6 PROGRAM: Geothermal resource sustainability
- lifetime and capacity estimation.

Objective: To publish methods of resource assessment.

COntents: Developing techniques for predicting the capacity of geothermal resources and their life span under different energy extraction scenarios by applying improved chemical and reservoir simulation codes.

Overseas partners (potential): NEDO, NEF, West JEC and GERD of Japan, Auckland University Geothermal Institute and IRL of New Zealand, and Utah University of the United States.

Status: This is a preliminary proposal.

4.5.7 PROGRAM: Prediction of the life of an injection reservoir using silica deposition chemistry.

Objective: To publish methods for estimating the life of reinjection aquifers.

Contents: Developing techniques to combine reservoir tracer tests and modelling with well-bore fluid and silica chemistry in order to estimate the expected life of the reinjection horizon.

Overseas partners (potential): NEDO, NEF, West JEC and GERD of Japan, Auckland University Geothermal Institute and IRL of New Zealand, and Utah University of the United States.

Status: This is a preliminary proposal.

4.5.8 PROGRAM: Environmental impacts of geothermal exploration.

Objective: To publish procedures for predicting impacts on thermal features.

Contents: Techniques for predicting impacts on natural thermal features from geothermal developments by improved simulation codes, and studies of case histories of impacts and changes in thermal features.

Overseas partners (potential): NEDO, NEF, West JEC and GERD of Japan, Auckland University Geothermal Institute and IRL of New Zealand, and Utah University of the United States.

Status: This is a preliminary proposal.

The contact for these proposed co-operation programs is Brian Robinson, Waiakei Research Centre, PB 2000, Taupo; phone (647) 374 8211 or fax (647) 374 8199.

PART TWO: AUSTRALIA

Section 1: Economic and Energy Situation

1.1 Political, Economic, Energy and Environmental Overview

This section describes the general political, economic and energy situation plus the policy for the evironment.

1.1.1 General political situation

Australia has a three tier system of government: federal, state and local. The federal parliament and all state parliaments except Queensland have a lower and upper house. At the federal level these are known as the House of Representatives and the Senate.

In general the lower house is the more powerful of the two houses and is the source of most legislative programs. The upper houses are generally used to review legislative proposals and have the power to block legislation on a temporary basis. In extreme situations the upper houses can block the money supply to the Government to force an election.

At present, at the federal level, the Labor party is in power in the House of Representatives but is in a minority in the Senate. A coalition of opposition parties in the Senate could force an early election but, at present, it seems unlikely that this will happen.

At the state level, Labor is in power in Queensland and New South Wales. Coalition groups of Liberal and National Party members are in power in all other state parliaments.

The Labor party has been in power at the federal level for over ten years and, until recently, seemed likely to win the next election which is due before the end of 1996. However, a recent change of leader for the main opposition Liberal party has revived their standing in the electorate and the next election could bring a change in government.

The result will depend mainly on how the economy behaves over the next year or so, particularly with regard to inflation. However, environmental issues are also important and could influence the outcome in an evenly balanced election.

1.1.2 General economic situation

The Government's current policy is to achieve growth with low inflation. This policy includes opening up the economy to greater international and domestic competition.

The policy has produced two years of modest growth with increasingly strong growth into 1995. Maintaining strong growth beyond 1995 will depend upon keeping inflation under control. There is still excess capacity in the labour market and the Government believes that further economic growth can be sustained without excessive upward pressure on labour costs and, therefore, inflation.

The biggest economic uncertainty is on the question of the external debt accumulated during the 1980s. This still imposes significant costs to the economy and most recently has started to grow faster than anticipated through a combination of low savings, excessive domestic spending and imports of industrial and business equipment.

The Government has introduced a superannuation levy to increase national savings and intends to introduce some additional cuts in expenditure to reduce this debt.

Unemployment is a major political issue but has now fallen below 10 per cent and is expected to continue going down. The Government is committed to a policy of achieving low unemployment but this is likely to come under pressure from workers demands for wage increases and other inflationary factors.

The current level of inflation, the lowest for many years, is around 2 per cent but is expected to rise towards the end of 1995.

1.1.3 General energy situation

Australia is self sufficient in all major forms of energy except liquid fuels for which it is 72 per cent self-sufficient.

The long-term average increase in demand has been 2.4 per cent each year, however, this is expected to fall to about 1.7 per cent each year to 2009-10.

The need to import oil is expected to increase but, even so, Australia will continue to be a major net exporter of energy.

Australia has huge energy reserves and resource limitations are not likely to be a significant consideration for many years.

About 80 per of Australia's energy production is exported and so production is dominated by world demand and overseas competition rather than internal considerations.

The future pattern for local energy consumption will still be dominated by oil but there will be increased use of natural

gas for electricity generation.

Renewable energy resources contribute only a small proportion to the total production and this is likely to increase only by 1 per cent or so each year due to the high relative costs of new energy technologies.

1.1.4 Environmental policy

The Government's environmental policy is based on two key strategies: the National Greenhouse response strategy (NGRS) and the National Strategy for Ecologically Sustainable Development (NSESD). These are described briefly below.

The National Greenhouse Response Strategy (NGRS) was endorsed by the Council of Australian Governments in December 1992. The council agreed to devise programs to meet the Government's interim planning target for reductions in greenhouse gas emissions.

One of the principal objectives of the NGRS was to diversify sources of energy and so a number of initiatives have been introduced to:

* encourage the use of cogeneration schemes;
* encourage more use of renewable energy sources for generating electricity;
* encourage the use of renewable energy sources for stand alone power supply systems in remote and rural areas; and
* increase support for research, development and demonstration, particularly for renewable energies and energy efficiency.

In February 1995, after much pressure from industry, the Government rejected the idea of a carbon tax to help reduce greenhouse emissions. In return, it will be pushing industry to speed up the introduction of measures to improve energy efficency as a way of reducing emissions.

The National Strategy for Ecologically Sustainable Development (NSESD) was released in December 1992. Its main aim is to achieve development that improves the total quality of life, both now and in the future, in a way that protects biological diversity and maintains essential ecological processes and life support systems.

The NSESD states that to achieve this aim it is necessary to:

* integrate economic, environmental, social and equity considerations into decision making processes;
* consider the environmental impacts of actions and policies;
* recognise the need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection; and
* recognise the need to enhance international competitiveness in an environmentally sound manner.

The objectives of both environmental strategies have been incorporated into all relevant Federal and State Government programs including international development assistance.

1.2 Current Economic Situation, Future Outlook and Plans

1.2.1 Economic policies including industrial development

The current economic policy was set out in May 1994 in the Government's 'Working Nation' statement. This announced a broad range of industry, science and trade measures aimed at internationalising Australian industry by building up competitive, export-oriented firms.

The three main themes within this policy are:
* the critical importance of innovation to business success;
* the need for a strong science and technology base; and
* the need to diffuse and commercialise new technology.

Working Nation identified the key elements for achieving this policy as innovation, technology uptake, business improvement, access to finance and skills development.

To help strengthen these elements the Government announced the establishment of AusIndustry as an umbrella organisation for a range of business assistance and improvement programs. AusIndustry will be a separate function within the Department of Industry, Science and Technology (DIST).

Working Nation also included additional funding for DIST which is responsible for a number of priority industry development programs. These include: textiles, clothing and footwear; information industries; telecommunications; aerospace; scientific and medical equipment; pharmaceuticals; advanced manufacturing; marine; and agri-food.

These development programs include a wide range of measures particularly suited for each industry. Many cover research and development and training, and all emphasise the importance of improving efficiency, increasing exports and the development of new products and processes.

1.2.2 Economic statistics

GDP growth in 1992-93 was about 3 per cent. It then climbed to an annual rate of about 6 per cent at the end of 1994 but since then has fallen back to around 5 per cent.

Unemployment is about 9.5 per cent and has fallen from a peak of 11 per cent in 1992-93.

Inflation is just under 2 per cent but could go higher before the end of the year.

Official interest rates were raised to 6.5 per cent in October and given the current strength in growth could go a bit higher before the end of 1995. Other rates include 9.3 per cent for overdrafts over $100,000 and 9.8 per cent for ten year Commonwealth Treasury bonds.

The current account deficit is 5.4 per cent of GDP.

The total national debt is approaching 40 per cent of GDP but is unlikely to go over that level.

The breakdown of exports is minerals 36 per cent, rural products 23 per cent, services 22 per cent and other merchandise 18 per cent.

1.2.3 Australia's policy towards APEC

International trade is vital to Australia's economic health and the importance of APEC to Australia is illustrated by the statistic that nearly three quarters of Australia's trade is with other APEC member countries.

The Government's fundamental trade policy is aimed at achieving sustainable economic growth. It recognises that, in the medium term, this will be based on exports of rural and mineral-based products but that, for the longer term, it is vital to diversify exports to include services and value added products.

The Government's National Trade Strategy, introduced in 1991, focused mainly on the Asia-Pacific region and was designed to reinforce the significant growth in Australia's share of international trade, particularly in manufactured exports.

Australia's strong support for the APEC process is essentially an extension of that Strategy. It is based upon the conviction that the APEC process is an appropriate vehicle for enhancing international trade for the mutual benefit of all member economies.

Australia's long term view of APEC, as expressed by the Foreign Minister Gareth Evans, is not as a Pacific equivalent to the European Community but more as a family of like-minded nations working to every member's mutual benefit.

Both the National Trade Strategy and Working Nation are central to the Government's economic policy and the policy objectives are implicit in all the Government programs described in this report.

1.3 The Current and Future Energy Situation

This section reviews the current and future energy siuation in Australia and the Government's future energy plans and objectives.

1.3.1 Energy policy

Australia's current energy policy, as described below, was published in 1991. It was formulated in terms of improving national welfare while achieving a sustainable energy future. This policy is currently under revision but the revised policy is unlikely to be avaialble for several months.

The key Australian energy policy objectives are:

* to develop a growing, internationally competitive energy export sector;

* to promote efficient production, distribution and use of energy to maximise its contribution to Australia's performance;

* to integrate economic efficiency in the production and use of energy with environmental goals through the principles of ecologically sustainable development;

* to ensure that prices reflect social values of energy production in freely working markets; and

* to promote domestic research and development (R&D) into energy efficiency and renewable energy technologies.

1.3.2 Primary energy supply

The following information is taken from ABARE Research Report 95.1 Australian energy consumption and production-historical trends and projections to 2009-10.

The total primary energy supply for 1993 is about 9036 PJ.

Primary energy supplies, as per cent of total

Crude oil	36
Black coal	28.7
Natural gas	17.6
Brown coal	11.7
Renewables	6
LPG	less than 1

Imports: the only imported energy resource is oil; the net (imports less exports) amount of imported energy is 422 PJ.

Renewable energy supplies, 1993 (PJ)

Wood	105
Bagasse	81
Hydro	60.4
Solar	2.4

Notes:

* more detailed predictions for the future use of renewble sources of energy are given in 1.3.5.

* there are no figures available for wind although wind powered water pumps are used extensively in rural areas;

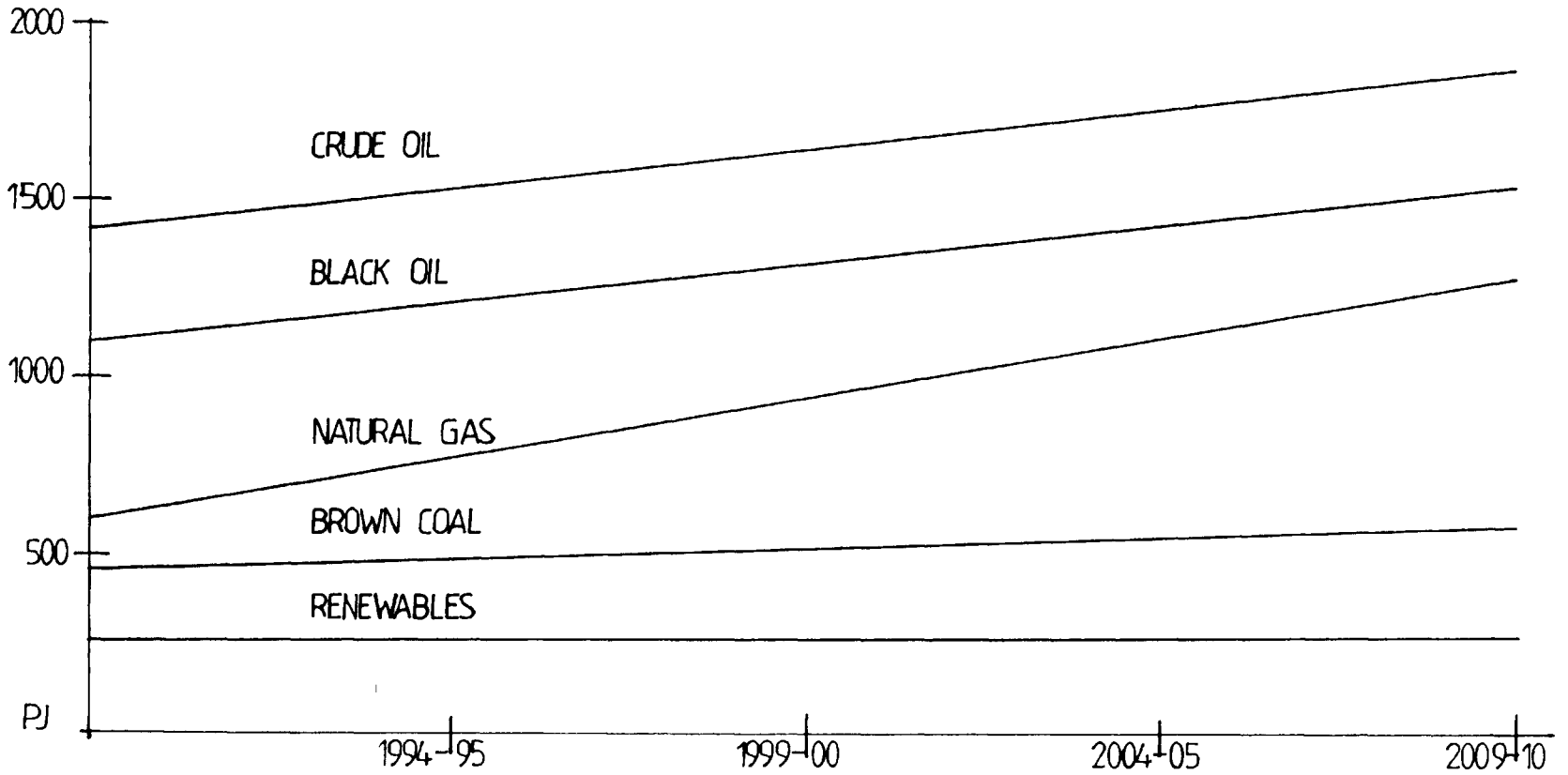
* the amount of renewable energy produced in each state varies widely, for example, about 75 per cent of Tasmania's energy is from hydro-electricity but in Queensland the largest renewable energy source is bagasse.

1.3.3. Energy consumption

Final energy consumption in PJ, by sector

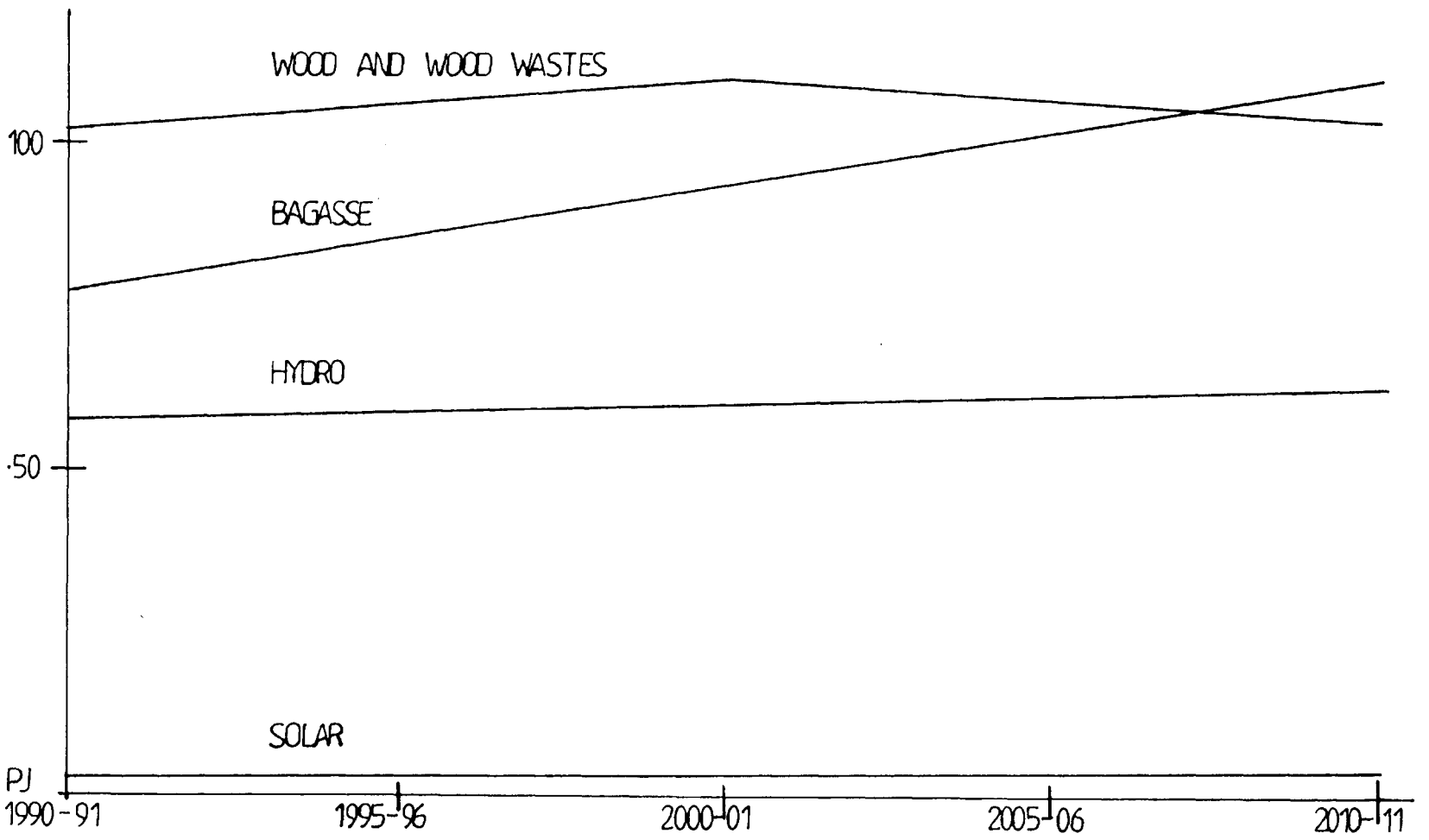
	Domestic	Commerce	Industry	Transport	Total
1992	334	160	1126	1020	2688
1993	347	164	1176	1044	2784
1994	349	169	1206	1072	2853
predicted:					
1995	359	174	1225	1108	2924
2000	392	202	1435	1216	3309
2005	426	230	1473	1320	3570
2010	460	257	1632	1404	3824

PREDICTED ENERGY CONSUMPTION IN PJ



BASED ON ABARE RESEARCH REPORT 95.1 AUSTRALIAN ENERGY CONSUMPTION AND PRODUCTION

RENEWABLE ENERGY CONSUMPTION, PJ



1 PJ = $2 \cdot 8 \cdot 10^8$ kWh

BASED ON ABARE RESEARCH REPORT 95·1 AUSTRALIAN ENERGY CONSUMPTION AND PRODUCTION

1.3.4 Future prospects

Australia has huge reserves of energy and, overall, energy resource availability is unlikely to be a restraint on energy consumption for many years.

These resources are dominated by coal, followed by uranium, natural gas, crude oil and condensate, and LPG.

Total production is expected to increase by 60 per cent above present levels by 2010 due mainly to strong growth in exports, particularly coal.

Australian energy consumption is expeced to grow at about 1.7 per cent each year to 2009-10.

Oil

Oil will continue to dominate the primary fuels and account for about 34 per cent by 2009-10. Net imports are projected to grow by 6.6 per cent each year.

Black coal

About three quarters of Australia's black coal production is exported. Within Australia black coal is used mainly for electricity generation in Queensland and New South Wales. Therefore, the future use of coal within Australia will depend on future electricity consumption and internal competition from natural gas. Electricity consumption is projected to increase by 2 per cent each year to 2010. Competition from gas is expected to increase but this will depend largely on gas pipe developments.

Natural gas

Natural gas will continue to grow from the present 18 per cent share to 23 per cent due to the increased use of gas for electricity generation.

Renewable resources

The predictions for the consumption of renewable energy resources are based upon present growth trends and known plans for the further use of hydro and bagasse resources. They do not take into account new commercialisation initiatives either by governments or the private sector.

The current government thinking is that wind, solar and tidal power appear to be too expensive for any major increases in their utilisation in Australia until beyond 2010, except for remote areas.

Wood and wood wastes - consumption is expected to remain between 102 and 110 PJ per year, with a slight reduction due to more efficient use of timber.

Hydro power - consumption is expected to grow only marginally over the next two decades because most of the favorable hydro sites have been developed and because of resistance from environmental groups to the construction of more large hydro dams.

Solar power - consumption is expected to double from 1990 to 2010 due to increased use of solar hot water heating and solar photovoltaic generation of electricity in remote areas.

Section 2: Plans for New Energy Technology

The expression 'new energy technology' is not generally used in Australia. The nearest equivalent expression is 'renewable energy technology' (also known as alternative energy technology). This refers to technologies for converting renewable energy resources into higher forms of energy and includes technologies that form parts of larger systems, such as batteries and electronic controls. It does not include advanced fossil fuel technologies, such as coal gasification technology.

Therefore, in this report the expression 'renewable energy technology' includes cogeneration and has the same meaning as 'new energy technology' but excludes coal-based technology which is described separately.

2.1 Government Structure and New Energy Technologies

This section lists the main federal and state departments and agencies involved in new energy technology initiatives and programs, apart from the Energy Research and Development Corporation (ERDC). The ERDC has the largest government funded new energy technology development program in Australia. However, because of its size and essentially commercial focus it is described separately in section 2.5. Coal research is also listed separately in section 3.8.

2.1.1 Agencies responsible for new energy technologies

The responsibility for developing new energy technologies is spread across several departments and agencies. The specific responsibilities of each department or agency are based upon the type of activity involved, such as pre-commercialisation or demonstration programs, and not upon the type of technology. The main organisations and agencies are:

* The Department of Primary Industries and Energy (DPIE);
* The Department of Employment, Education & Training (DEET);
* The Federal Government Department of Industry, Science and Technology (DIST, formerly known as DITAC and DITARD);
* The New South Wales (NSW) Office of Energy which manages the State Energy Research and Development Fund;
* The South Australian (SA) Office of Energy; and
* The Western Australian Alternative Energy Development Board.

2.1.1 continued

DPIE - and new energy technologies

The Minister for Primary Industries and Energy is responsible for advising the Australian Government on the development of energy policy and programs. He is advised and assisted by the Department of Primary Industries and Energy (DPIE) whose functions include monitoring and co-ordinating the statutory energy authorities, and collaborating and negotiating with State Governments and their authorities that have extensive responsibilities in the energy sector.

Within DPIE, the Resources and Energy Group contains the Energy Sub-program which itself contains a number of smaller energy programs.

The objective of the Energy Sub-program is to promote an ecologically sustainable and competitive energy sector through:

* greater energy efficiency;

* improved productivity in the electricity supply industry;

* enhanced energy research, development and demonstration;

* promotion of the use of renewable energy resources; and

* international energy co-operation.

The DPIE unit responsible for promoting the use of renewable energy resources is the Renewable Energy and Environment Branch, which is within DPIE's Energy Programs and Fisheries Division.

DEET - and new energy technologies

The Department of Employment, Education & Training (DEET) is responsible for the Australian Research Council (ARC) which manages university research funding in Australia. It has two schemes relevant to this report:

* ARC Research Grants Scheme which provides funds on a competitive basis for academic research projects; and

* the Special Research Centres scheme which encourages concentration of activity in higher education institutions;

ARC grants - about 40 grants are awarded each year for energy projects at universities. Most of these are on topics such as energy economics, exploration, petroleum or coal chemistry which are outside the scope of this report. There are a few relevant projects but most of these are incorporated into larger scale activities such as the Co-operative Research Centres for coal-

2.1.1 continued

based activities, or the Centre for Photovoltaic Devices and Systems, see below. However, several independent ARC funded projects are described later.

Special Research Centre - the outstanding new energy technology research funded under this scheme is at the Centre for Photovoltaic Devices and Systems at the University of New South Wales. The Centre's latest projects are described later.

AIDAB - and new energy technologies

The Australian International Development Assistance Bureau (AIDAB) does not fund technology development programs directly but it does fund major energy related international technology transfer and commercialisation programs through Australia's aid programs.

DIST - and new energy technologies

The Department of Industry, Science and Technology (DIST) established a Renewable Energy Industry Working Group in 1993 to foster the development of the industry in Australia. The group's main function is to liaise with companies involved in the commercial development of renewable energy technologies and to help them become viable enterprises.

NSW Office of Energy - and new energy technologies

The Office is responsible for the State Energy Research & Development Fund (SERDF) which was established to foster the development, demonstration and commercialisation of new energy technologies for the benefit of the NSW State.

SA Office of Energy - and new energy technologies

In September 1994 the South Australian Government determined that the state should obtain 20 per cent of its energy needs from renewable resources by the year 2004. As the first step, the State Minister for the Environment and Natural Resources has established a Renewable Energy Working Group to devise a plan by July 1995. The Group will particularly examine the potential for a greater utilisation of solar and wind energy in the state; also, it will identify opportunities for the local manufacture of renewable energy technologies.

WA Office of Energy - and new energy technologies

In January 1995 an Alternative Energy Development Board was established as a replacement for the former Renewable Energy Advisory Council. The board is administered and assisted by the WA Office of Energy. It provides policy advice on energy efficiency, energy management, and renewable energy and allocates project funds for demonstration, education and other projects. At present its funding does not cover research and development but this is to change and funding will be extended to include R&D.

2.1.2 Methods for implementing projects

DPIE and DIST - and project implementation

There is no single method for implementing new energy technology developments. In general,small initiatives such as seminars and surveys may be implemented within the department. Larger projects are implemented by private consultants or other organisations.

DEET - and project implementation

ARC grants for projects are awarded to individual academics and are implemented by the recipient. They are not awarded to the university.

AIDAB - and project implementation

The Australian International Development Assistance Bureau manages several private sector commercialization programs associated with overseas aid. To receive support private companies may approach AIDAB directly or, alternatively, they may respond to public tenders put out by AIDAB or the international development banks.

NSW Office of Energy - and project implementation

The Office receives applications for grants which are then awarded on a competitive basis from the NSW State Energy Research and Development Fund. The applicant's ability to implement the project is a major consideration in granting support to the applicant.

2.2 Policy for New Energy Technology Development

2.2.1 Government programs and objectives

The Australian Government wishes to see increased development and use of renewable energy technologies because of their advantages compared with conventional energy resources. It believes the advantages are:

* they are sustainable;

* they can contribute to overall economic efficiency;

* they have relatively low environmental impacts; and

* they offer opportunities for developing new industries.

The Government believes that the increased use of new energy technologies is most effectively achieved through normal market forces. Therefore, the programs described in this section are aimed at overcoming market failures and barriers to commercialisation.

DPIE - programs and objectives

The Department of Primary Industries and Energy (DPIE) has three programs aimed specifically at promoting renewable energy technologies. They are:

* the Renewable Energy Promotion Program - this was established in late 1992 to encourage the use of renewable energy technologies, particularly in remote and rural areas; it has a budget of $2 million in 1992/93, 1993/94 and 1994/95 for displays of renewable energy and a training and an accreditation scheme for engineers involved with installing renewable energy technology systems;

* the Solar Water Heater Program - this aims to overcome problems due to the high initial cost of domestic solar water heating systems; it has a total budget of $6 million over three years to 1995/96 to support innovative loan finance schemes to encourage householders to install solar water heaters for domestic use;

* the Ethanol Bounty Scheme - this came into operation in July 1994 and provides bounties on domestically produced fuel ethanol for a period of up to three years; it has a budget allocation of $6 million in 1994/95, rising to $8 million in 1995/96 and $11 million in 1996/97; to be eligible for the bounty the ethanol must be produced from domestic biomass and be used as a transport fuel, with a minimum of 350,000 litres produced a year.

2.2.1 continued

DEET - programs and objectives

The main criteria for assessing ARC grant applications are:

* the quality of the researcher or research group;

* the excellence of the proposal and the likelihood it will lead to a real conceptual advance and/or an important discovery or innovation or solution to an important practical problem;

* its potential economic or social benefit to Australia; and

* the relevance of the proposal to priority areas, designated each year by the council.

Energy research is not a priority for 1995 but a number of energy related projects have been funded.

New South Wales Office of Energy - programs and objectives

The Office of Energy is responsible for the State Energy Research and Development Fund. This was established to foster the development, demonstration and commercialisation of new energy technologies, manufacturing processes and related expertise and services which will benefit the State. Projects supported vary from basic research through all phases of development, but emphasis and priority is given to projects which aim to:

* minimise energy costs to consumers through more efficient energy supply and end use;

* permit more cost effective use of indigenous energy resources;

* enhance security and safety of energy supply;

* promote employment growth through increased industry competitiveness and local manufacture and export; and

* reduce any adverse environmental and social impact of energy production, distribution and use.

Funding is provided for a wide range of energy R&D projects including renewable energy, coal utilisation, environmental studies, electricity technologies, alternative transport fuels, energy resources, energy efficiency and greenhouse projects. Priority is given to projects involving a commitment from industry and to collaborative projects involving significant cost sharing between industry, commerce and research organisations.

The office also has a remote area power supply assistance scheme which has subsidised the purchase of several thousand solar PV arrays, battery banks and chargers, inverters and water heaters for stand alone power systems for remote communities.

2.2.2 Intellectual property rights

The Federal and State Government agencies fund their approved projects on the basis of seeking a return for the benefit of the nation or state. They accept that new energy R&D projects are mostly long-term investments and that the returns, if any, will be in the form of employment opportunities, reduced environmental impact or savings on capital investments for generation capacity based on fossil fuels.

As a general rule, agencies do not seek equity in return for their funding support. However, the agencies review all projects on a case by case basis and in the future could take equity in projects that are near commercialisation.

In general, the intellectual property rights remain with the R&D groups. However, the funding agencies can negotiate conditions on how intellectual property is used in the future to ensure that the national or state interests are protected.

2.3 Budgets for 1994 and 1995

Department of Primary Industries and Energy:

* Renewable Energy Promotion Program is $2 million per year;
* Solar Water Heater Program is $2 million per year; and
* Ethanol Bounty Scheme is $25 million over three years.

DEET budget:

ARC grants average around $40,000 each but there is great variation between grants. The total amount going to new energy technology projects is about $200,000.

Office of Energy SERDF:

* the funding for new energy technologies is about $750,000 each year (there is no fixed annual budget, funding is allocated by project rather than by year).

2.4 Government Supported New Energy Technologies

2.4.1 New energy technology priorities

Apart from the ERDC and the NSW Office of Energy, there has been no systematic setting of priorities for new energy technologies. Recently the Government has put research on ethanol production as a high priority because of ethanol's potential to reduce theamount of lead in vehicle fuels. There is also support for renewable energy technologies in general, on environmental grounds, with particular support for solar heaters as a developed technology. Remote area or stand alone systems also tend to be a high priority on social grounds.

The NSW Office of Energy priorities reflect local technology research strengths and the state's remote area needs. They are:

* solar thermal electricity generation;

* remote area power supplies;

* wind energy technology; and

* energy storage.

2.5 The Energy Research and Development Corporation (ERDC)

2.5.1 Role of the ERDC

The Energy Research and Development Corporation was established in 1989 as a statutory authority directly responsible to the Minister for Primary Industries and Energy. Its principal purpose is to manage the Federal Government's investment in energy research and development (R&D) by:

* stimulating interest in energy R&D in industry;

* improving the adoption of R&D results; and

* ensuring that R&D programs are consistent with industry needs and objectives.

The Corporation has a Renewable Energy Sources and Systems Research Program which constitutes about one quarter of its total program load. It is also responsible for the Government's Ethanol R&D program. Both programs are described in more detail later.

2.5.2 ERDC and project implementation

The Energy Research and Development Corporation uses two principal methods for implementing projects. For small projects such as surveys and reports it commissions groups in the universities and private consultants to undertake the work. For larger projects it acts as a broker to bring interested organisations together for collaborative work. The private sector is involved in virtually all ERDC projects.

It regards its funding support as an investment made on behalf of the Government. It is very flexible in the way it works but, in general, it does not identify projects and then call for tenders.

2.5.3 ERDC programs and objectives

The Energy Research and Development Corporation (ERDC) aims to involve industry in research projects from the beginning through to commercialisation. Its corporate objectives are:

* to use the ERDC's funding to increase investment in quality energy innovation projects; this includes a five year target to contract out at least 80 per cent of its project funds into larger projects worth over $300,000 and to increase its non Federal Government funding by $1 million a year;

* to maximise the returns from ERDC's investments for the benefit of Australia. This includes achieving export or import replacement sales of products from projects of $100 million a year and achieving a project funding ratio of $2 from industry for every $1 of ERDC funds; and

* to establish and manage a balanced portfolio responsive to Government policies and industry trends. Also, to be accepted as the investment manager for additional Federal Government energy related innovation initiatives.

2.5.4 Renewable energy sources and systems program

The program objective is to develop renewable energy sources and systems that are cost competitive compared with conventional energy sources, in order to assist their adoption by the energy market on a large scale.

2.5.4 continued

The corporation has set itself a 20 year plan with 5 year milestone objectives. They are:

within 5 years

* to set up consortia in high priority technologies for coordinated R&D activities;

* to demonstrate the cost competitiveness of renewable electricity systems in niche markets in the 0.1 to 10 MW power range (suitable for isolated townships and mining companies);

* to demonstrate the cost competitiveness of renewable systems for process heat in selected industrial markets;

* to set up commercial pre-conditions for marketing renewable electricity systems in the MW range.

within 10 years

* to develop and commercialise renewable technologies so that at least 100 MW of renewable electricity systems are used instead of diesel fuel in isolated diesel powered grids;

* to develop economic short-term energy storage systems which are economically suitable for renewable energy sources and systems;

* to explore long-term energy storage options suitable for renewable energy systems.

within 15 years

* to develop and commercialise renewable technologies so that at least 300 MW of renewable energy systems are installed in isolated diesel powered grids;

* to develop economic long-term energy storage systems which are economically suitable for renewable energy sources and systems;

* to achieve cost competitive renewable electricity systems for some applications in Australian State electricity grids;

* to install at least 200 MW of renewable electricity systems (not including existing hydro) in Australian State grids;

* to have an export industry based on renewable energy technology.

within 20 years

* to have 10 per cent of Australian electricity and 20 per cent of process and domestic heat generated from renewable energy resources.

2.5.5 Ethanol research and development program

The ERDC has been appointed to manage the Government's Ethanol R&D program which is separately funded and includes:

* developing standards and tests for ethanol fuel blends;

* field trials of ethanol fuel blends in vehicles;

* improving ethanol fuel blends; and

* processes for deriving ethanol from vegetable biomass.

2.5.6 ERDC budget

There is no specific amount set aside for renewable energy projects but usually the renewable budget is about 25 per cent of the total ERDC budget. For 1994-95 it is $10 million, compared with $15.9 million for 1993/94. The difference is due to the distribution of a $5 million accumulation of funds in 1993-94.

The Ethanol R&D program funding is $4 million for three years starting in July 1994.

2.5.7 ERDC new energy technology priorities

The ERDC priorities were determined according to:

* the potential impact of the research in terms of the developing expertise and the potential for improving the technology;

* the commercialisation prospects both in Australia and for export; and

* the potential pollution benefits in terms of helping to meet the Government's interim greenhouse target and in terms of the investment pay-back time.

2.5.7 continued

The ERDC high priority new energy technologies are:

* high temperature solar thermal - parabolic dish systems;

* high temperature solar thermal - parabolic trough systems;

* biomass technologies;

* short term energy storage;

* photovoltaics (PV) - poly and single crystalline bulk silicon cells; and,

* power conditioning and control technology (over 30 kW).

The medium priority technologies are:

* photovoltaics - concentrator systems;

* photovoltaics - silicon crystalline thin film cells;

* long term energy storage;

* wind turbines; and

* low temperature solar hot water systems.

Fuel cell technology is listed as a high priority in the ERDC's electricity program (rather than the renewable energy program).

Section 3: New Energy Technology Programs and Projects

This section describes specific new energy technology programs and projects together with their objectives and budgets.

3.1 Solar energy

PROGRAM: Pacific Power/Unisearch Solar PV Technology

Objective: to research and develop the technology for the mass production of low cost, high efficiency solar cells.

Contents: developing the use of thin film, multi layer cells on low cost substrates, also, buried contact technology for connecting layers of like polarity and techniques for connecting adjacent cells in parallel.

Funding: $45 million from Pacific Power plus $19 million from Unisearch, over five years.

Agency in charge: Pacific Power and the Centre for Photovoltaic Devices and Systems.

Status: the project was announced at the end of 1994 and is due to finish at the end of 1999.

PROGRAM: Solarch Research Centre, Little Bay, Sydney

Objective: to demonstrate the use of solar PV cells for the generation of electricity for private use and to provide supplementary power for the main grid.

Contents: a 4kW array of solar cells and a 50kWh battery storage system are to be used to generate and supply electricity to the facility, with excess daytime supply being stored and delivered to the grid at times of peak demand.

Agency in charge: the University of New South Wales Solar Architecture Group (Solarch).

Funding: Sydney Electricity contributed an initial $85,000 for the construction of the facility and is contributing another $240,000 over three years for the photovoltaic system.

Status: the project started in 1993; electricity was successfully integrated into Sydney's grid on October 17, 1994.

3.1 continued

PROGRAM: Pacific Power Solar Energy

Pacific Power is managing a program involving two separate projects. They are CSIRO's Thermochemical Storage Project and the Australian National University's Dish Solar Concentrator project, both of which are described below. The results of the program so far are very good and it is likely that a small scale demonstration plant will be built.

PROJECT: CSIRO Thermochemical Storage

Objective: to develop a novel technology for the storage and transfer of solar energy using the reversible thermochemical reactions of CO2 and CH4.

Method: the effectiveness of the reaction is determined by the optimum design of catalysts and the catalytic converter and their performance under intermittent solar conditions when used in association with the ANU Solar Dish Concentrator.

Agency in charge: Pacific Power and CSIRO Division of Coal and Energy Technology (Mr Jim Edwards).

Funding: $150,000 from the NSW State Energy Research and Development Fund; $150,000 from the ERDC; $200,000 from Pacific Power and about $500,000 from CSIRO through cash and in-kind support.

Status: this two year project started in 1993 and is just coming to an end. The decision whether to move to the next phase will be made sometime during March 1995. The results so far are very good.

PROJECT: Large Dish Solar Thermal Power Concentrator

Objectives: to determine an optimum dish size in terms of structural strength, assembly and technical performance; also, to test high temperature chemical reactors for use with the concentrator.

Contents: the dish is hexagonal in shape and has an area of 400 square metres and a design capacity of 50 kW; it is computer controlled to direct it at the sun. Part of the project involves optimising the reactions of the high temperature chemical reactor and linking it to the solar thermal system.

Agency in charge: the project is under the direction of Professor Stephen Kaneff of the Australian National University. Pacific Power and the power authorities in Queensland and South Australia are also involved.

3.1 continued

Budget: ERDC 1994-96 $100,000 and the NSW State Energy Research and Development Fund $376,000 (total to date).

Status: this is the second phase of this project; at present the dish is undergoing trials which are expected to be completed in mid 1995. There is the possibility of a larger scale installation in a remote area of Australia with support from the NSW Government and energy organisations in Queensland, South Australia and the Northern Territory.

PROJECT: Solar PV Parabolic Trough Concentrator

Objective: to develop and commercialise a low cost parabolic trough concentrator system with solar PV collectors.

Contents: the project involves integrating a number of previously designed components including mirrored concentrator, solar PV collectors, solar tracking system and cooling system.

Funding: $554,000 from the ERDC plus approximately $1 million from a commercial investor.

Agency in charge: Australian National University (Dr Andrew Blakers).

Status: this is a three year project which started in early 1995.

PROJECT: Thin Polycrystalline Silicon Solar Cells

Objective: to produce low cost photovoltaic cells.

Contents: developing techniques for growing polycrystalline silicon solar cells on a low cost substrate to significantly reduce the overall material costs.

Funding: $297,000 from the ERDC, $255,000 from the NSW SERDF plus additional in-house support up to December 1995.

Agency in charge: Australian National University (Dr Andrew Blakers).

Status: the project started in 1993 and has funding until December 1995. So far it has achieved 17 per cent conversion efficiency.

3.1 continued

PROJECT: Thin Film Silicon Solar Cells

Objective: to develop thin film crystalline silicon solar cell technology with 15 per cent conversion efficiency.

Method: the process involves depositing films on glass substrates at temperatures below 500 degrees.

Agency in charge: Centre for Photovoltaic Devices and Systems, University of New South Wales.

Funding: NSW State Energy Research and Development Fund $480,000 and ERDC $480,000.

Status: the present phase of this project finishes in June 1995. Cell efficiency above 16 per cent has been demonstrated and a new multilayer cell structure is being developed.

3.2 Biomass

PROJECT: Coconut Oil as A Diesel Fuel Substitute

Objective: to determine the usefulness of a novel method for extracting coconut oil for use as an alternative to diesel fuel.

Contents: the project is a field trial in Fiji of an oil extraction device for use in remote villages in the South Pacific and coconut growing areas of Asia.

Agency in charge: Australian National University (Dr Dan Hetherington).

Funding: $14,000 from the ARC plus support from the Government of Fiji and the university.

Status: the extraction method has proved highly successful in the laboratory and the oil has been shown to be a very effective diesel substitute. Further research on aspects of oil extraction and use is continuing in co-operation with the CSIRO and the Universities of Wollongong and Southern Queensland.

PROJECT: Biomass Gasification for Electricity from Cotton Waste

Objective: to demonstrate the economic and environmental benefits of this technology.

Contents: developing and testing mechanisms for feeding cotton waste into a gasifier, gasification plant trials and detailed design of large commercial units.

Agency in charge: Biomass Energy Services and Technology with assistance from Sinclair, Knight and Merz and also from Pacific Power and North West Electricity.

Funding: $253,756 from the NSW State Energy Research and Development Fund.

Status: this project is based on the extensive experience of the company Biomass Energy Services and Technology. It is due to last three years; starting March 1995.

3.3 Ethanol

The ERDC has allocated $2.5 million from the Government's Ethanol R&D Program to several linked projects which are listed below. Funding is also provided to APACE Research Ltd for field trials of ethanol/petrol blends for vehicle fuels and for work on emulsifiers for use in hydrated ethanol/diesel and hydrate ethanol/petrol blends.

In addition, the ERDC is to provide $2 million for an ethanol production facility at the Morwell Enterprise Centre. This is to receive additional support from an industrial consortium headed by the La Trobe Regional Commission.

PROJECT: Bioconversion of Cellulosic Materials to Ethanol

Objective: to reduce the cost of bioconversion of cellulosic materials to ethanol.

Method: the work includes researching a variety of routes for converting lignocellulose feed stocks to ethanol, including direct microbial conversion of lignocellulose and developing strains for fermenting hemicellulose.

Agency in charge: Department of Biotechnology, University of New South Wales (N W Dunn).

Funding: $1.036 million from the ERDC.

Status: this project is based on substantial earlier successful research and should be regarded as a high priority project.

PROJECT: Fermentation of Lignocellulose Hydrolysates.

Objective: to develop an organism for the total fermentation of lignocellulose hydrolysates.

Contents: researching organisms suitable for the fermentation process.

3.3 continued

Funding: $254, 355 from the ERDC.

Agency in charge: School of Biochemistry, La Trobe University.

Status: this project started in early 1995 but is based on previous work in the department.

PROJECT: Fermentation of Hemicellulose Hydrolysates.

Objective: to develop organisms for the fermentation of hemicellulose hydrolysates.

Contents: research into suitable organisms and techniques for the fermentation process.

Funding: $233,853 from ERDC.

Agencies in charge: Department of Chemical Engineering, Melbourne University, and the Department of Food Technology at the Victorian University of Technology.

Status: this project started in early 1995 but is based upon considerable previous experience in fermentation technology.

PROJECT: Direct Conversion of Lignocellulose to Ethanol.

Objective: to develop a fungus capable of direct economic conversion of lignocellulose to ethanol.

Contents: research into the genetics of natural fungus strains and genetic engineering.

Funding: $195,489 from ERDC.

Agency in charge: Department of Genetics, Adelaide University.

Status: the project started in early 1995 but is based upon considerable prior experience in genetic engineering.

3.4 Wind energy

PROGRAM: Wind Generated Electricity Demonstration

Objective: to demonstrate the feasibility of grid connected wind power on a commercial basis.

Contents: a 150kW Windmaster generator is connected to a 11kV ring main to obtain experience with this form of technology; later it will be used to test wind generator sub-systems.

3.4 continued

Funding: in-house by Pacific Power and Sydney Electricity.

Agencies in charge: Pacific Power and Sydney Electricity.

Status: the system has been operating for several months.

PROJECT: Wind Turbine Development

Objective: to improve the design of a novel wind turbine and so reduce the cost of wind generated electricity, particularly for remote areas.

Contents: the project is based on a wind turbine developed at Newcastle University which is suitable for small scale electricity generation. The first stage is to provide power for flood lighting a local tourist attraction and also to continue to refine the blade design.

Funding: $105,429 from the NSW State Energy Research and Development Fund.

Agency in charge: collaboration involving Newcastle City Council, the University of Newcastle and Orion Electricity.

Status: the project is based on technology developed over several years at the University; this phase is expected to last three years, starting in 1995.

PROJECT: A 20 kW Low-Speed High-Torque Wind Generator

Objective: to develop a 20kW low-speed high-torque permanent magnet wind generator suitable for use hybrid power systems for remote areas.

Contents: designing and building a prototype generator using permanent magnet technology for use in direct-coupled wind generator applications.

Funding: $52,000 from the Minerals and Energy Research Institute of Western Australia (MERIWA).

Agency in charge: Westwind Turbines and the Power Electronics Research Unit at Curtin University.

Status: the project in early 1995 and is due to run for one year.

3.5 Fuel cells

PROJECT: Development of Solid Oxide Fuel Cells

Objective: the commercialisation of solid fuel oxide technology in Australia.

Contents: research and development on materials and the fuel cells and stacks; there is a sub-project on an intermediate temperature fuel cell.

Funding: $3.5 million from the ERDC plus over $25 million from the other partners to June 1997.

Status: the project was established in 1991 and is run by a consortium made up of BHP, CSIRO, Pacific Power, the ERDC, the Strategic Industry Research Foundation, Generation Victoria, the Electricity Trust of SA, the State Energy Commission of WA (now Western Power), and the Queensland Electricity Commission.

3.6 Cogeneration

Pacific Power and other electricity producers are studying the prospects for using cogeneration technology. In general the problems are not with the technology but in finding a suitable use for the cogenerated heat. Pacific Power is also looking at possible problems from additional atmospheric pollution where cogeneration/stand-by systems are used in metropolitan areas. Overall, there appears to be little research into cogeneration technology but plenty of interest in the economics of cogeneration.

PROJECT: Gas Cogeneration Demonstration Program

Objective: to demonstrate the benefits of gas cogeneration to potential industry users.

Method: a number of gas fired cogeneration systems are being installed in industrial locations to serve as demonstration units.

Agency in charge: NSW Office of Energy

Funding: $500,000 over two years from the NSW State Energy Research and Development Fund.

Status: the program is due to commence in early 1995.

3.7 Tidal power

PROJECT: Tidal Power Study

Objective: to investigate the possibility of harnessing the tidal power of Apsley Straits, to the north of Darwin.

Contents: collecting information on water flow characteristics and designing and testing devices for harnessing the kinetic energy.

Funding: $225,000 for three years from March 1993 to 1996, provided by the Northern Territory Power and Water Authority.

Agency in charge: Centre for Energy Studies, NT University.
Status: the project is progressing well, the water data has been collected the conclusion is that 10kW could be collected from a single Darius type turbine (similar to the Darrius vertical axis wind turbine). The next stage is the construction of a prototype Darius rotor and generator to make accurate measurements of the tidal energy.

3.8 Geothermal energy

PROGRAM: Hot Rock Program

Objective: to test the feasibility of deriving useful thermal energy from sedimentary basins in Australia.

Contents: the program includes the drilling of an injection well and a production well, at a site near Musswellbrook in the Hunter Valley, in order to extract hot water.

Funding: the total budget is of the order of $20 million for a three year program.

Agency in charge: ERDC and Fallon Group, Sydney.

Status: this program is a follow-up to a preliminary survey organised by the ERDC. The plan is now much bigger than originally anticipated and includes a hot water production facility in addition to an exploratory well. There are several industry partners involved. The program is still being developed at this time.

3.9 Coal Gasification Research

The Australian Government influences coal technology research policy through its greenhouse gas policy, its international trade policy and by encouraging a national approach to research. It makes a direct funding contribution into coal research through its support for the CSIRO Division for Coal and Energy Research and for the two Cooperative Research Centres (CRC) for coal-based activities.

There are two main groups undertaking coal technology research, one for black coal and one for brown coal. Both groups are very closely linked to industry and are involved in coal gasification research.

3.9.1 Black coal research organisations

There are three principal organisations involved in black coal research. These are closely linked to each other and also to university groups involved in black coal research. They are:

* the Australian Coal Association Research Program which is responsible for about 15 per cent of the total funding for black coal research;
* CSIRO's Division of Coal and Energy Technology; and
* the CRC for Black Coal Utilisation.

Australian Coal Association Research Program

This program is administered by the Australian Coal Association and all Australian black coal producers have agreed to pay a levy of five cents a tonne to fund R&D. This is paid to Australian Coal Research Ltd which has been set up specifically by the association to collect the levy and run the research program. These arrangements are on trial until June 1997.

The selection of research projects and allocation of research funds is done through the Research Committees of the NSW Coal Association and the Queensland Mining Council which are also responsible for developing strategic priorities. About $8 million was committed to new coal projects in 1993/94, including $200,000 for coal gasification research. Information about grants for 1994-95 is not yet available but the total funding available for research is about $9 million.

Contact: Ross Graham
Australian Coal Research Ltd
PO Box A244
Sydney South NSW 2000
Phone (02) 267 6488 Fax (02) 264 1121

3.9.1 continued

CSIRO Division of Coal and Energy Research

CSIRO is a semi-autonomous organisation which receives approximately two thirds of its funding from the Government and one third from the private sector. The Division determines its own energy R&D research policy and programs to some extent, but, where it is funded by industry it has to comply with industry policy.

The Division has a strategic objective to support the marketing of Australian coals in advanced technologies for the power and metallurgical industries. It has a Coal Utilisation program which includes two coal gasification projects: one at normal atmospheric pressure and a longer term project for advanced power generation at high pressures and temperatures.

At present and for the foreseeable future, the Division has no projects on coal liquefaction. Also it has only one new energy technology research project apart from the coal gasification project. This lack of new energy technology research has received some criticism in the media.

The Division is heavily involved with the Cooperative Research Centre (CRC) for Black Coal Utilisation which was established in December 1994 (see below). Eventually it is likely that the two organisations will, in effect, merge into one.

Contact: Chief, Dr John Wright
North Ryde Laboratories
PO Box 136
North Ryde NSW 2113
Phone (02) 887 8666
Fax (02) 887 8909

CRC for Black Coal Utilisation

The centre was first funded in December 1994 in order to coordinate research and improve the understanding of black coal utilisation processes. It aims:

* to optimise the Australian black coal export industry by developing and transferring value adding technology; and

* to develop strategies for environmental issues, including climate change.

The research program are still being developed but coal gasification research will be a priority activity.

3.9.1 continued

The basic objective of the CRC program is to foster collaboration between research groups and industry. Therefore, the CRC for Black Coal Technology embraces all the significant industry and research organisations involved in black coal. They include CSIRO's Division of Coal and Energy Technology; Queensland University's Department of Engineering; BHP Australia Coal Ltd; Coal and Allied Industries Ltd; CRA-ATD Ltd; Arco Coal Australia Ltd; Oakbridge Ltd; Pacific Coal Ltd; Pacific Power; Pacific Power International; Peabody Resources Ltd; Newcastle University's Engineering Faculty and Institute of Coal Research; UNSW's School of Materials Science and Engineering; Queensland Department of Minerals and Energy; and Queensland Electricity Commission. ACIRL is a supporting participant.

The Government funding for the centre is $1.7 million a year but, with industry contributions, the total funding over the next seven years is estimated to be around $30 million.

Contact: Dr Peter Alfredson
Advanced Technology Centre, University of Newcastle
Callaghan NSW 2308
Phone (049) 41 5364
Fax (049) 41 5489

3.9.2 Black coal gasification projects

PROJECT: CSIRO Coal gasification

The coal gasification project aims to evaluate NSW coals for advanced power generation technologies. The work includes support and collaboration with a number of agencies including NEDO and several universities. The research work is still building up but the funding will average approximately $1 million per year, taken over several years. Its component projects are described below.

PROJECT: Behaviour of Coal Ash Under Slagging Gasification Conditions

Objective: to assess the slagging characteristics of coals for use in integrated gasification combined cycle technology.

Method: the study involves testing bore samples provided by NSW coal companies in the CSIRO high temperature slag viscometer. The results will be used to establish models for predicting slag behaviour based on the chemical composition of the ash.

Agency in charge: Division of Coal and Energy Research.

3.9.2 continued

Funding: $414,000 from the NSW State Energy Research and Development Fund; there is additional assistance from CRA and the University of Newcastle is collaborating in the research.

Status: the current project started in mid 1993; the major funding started in mid 1994; the project is still developing.

PROJECT: Construction of an Entrained Flow Pressurised Gasifier

Objective: to establish an advanced gasification test facility to support the NSW coal evaluation project.

Method: the Division of Coal and Energy Research is working with Pacific Power to select the gasifier and then to evaluate coal samples.

Agency in charge: Pacific Power and Division of Coal and Energy Research.

Status: the specification is ready but the selection process is not yet complete.

Funding: the project will cost a total of $5.4 million; Pacific Power is providing the bulk of the funding; the Australian Coal Research Program is providing $200,000 and the NSW State Energy Research and Development Fund is also providing $200,000.

3.9.3 Brown coal research organisations

There are two very closely linked organisations involved in brown coal research. They are:
* the CRC for New Technologies for Power Generation from Low Rank Coal; and
* HRL Ltd of Victoria.

CRC for New Technologies for Power Generation from Low Rank Coal

The centre is developing the science and engineering needed for the development of new power generation technologies. Its activities include coal gasification, combustion and drying.

The partners in the centre include Monash University's Departments of Chemical Engineering and Chemistry; Adelaide University's Department of Chemical Engineering; Swinburne University of Technology's Departments of Engineering and Chemistry; Generation Victoria; the Electricity Trust of SA; CSIRO's Division of Mineral and Process Engineering; Transfield Technologies Pty Ltd; Lurgi (Australia) Pty Ltd; and Memtec Ltd.

3.9.3 continued

The Government funding is $2 million a year but with industry contributions the total funding will be at least twice this amount.

Contact: Dr David Brockway
Herman Technology Park, Unit 8, 677 Springvale Road
Mulgrave VIC 3170
Phone (03) 565 9724
Fax (03) 565 9740

HRL Ltd

HRL Ltd was established in 1993 by the merger of the Coal Corporation of Victoria R&D facility at Morwell and the Herman Research Laboratory (formerly the R&D Department of the Victorian State Electricity Commission, now Generation Victoria).

The company has been contracted on behalf of a syndicate of investors to build a coal gasification development facility in the La Trobe Valley as part of a research and development program into Integrated Drying Gasification Combined Cycle technology (IDGCC).

Contact: Managing Director, Graeme Pleasance
HRL Ltd, Herman Research Laboratory Park
677 Springvale Rd
Mulgrave VIC 3170
Phone (03) 565 9888
Fax (03) 565 9777

3.9.4 Brown coal gasification projects

PROJECT: Gasification Development Facility

Objective: to plan and design a major coal gasification development facility.

Contents: the facility is for R&D project into IDGCC technology. The project is to provide information for the design and operation of a full scale IDGCC demonstration power plant.

Agency in charge: HRL Ltd

Funding: the facility is part of a $100 million R&D project funded by a syndicate of investors.

Status: construction work is due to start in May 1995 and be completed by mid 1996; the research project will last a further 3.5 years.

Section 4: Cooperation Programs with APEC Members

This section describes the current situation and future plans for Australian participation in new energy technology cooperation programs with APEC member economies, particularly Indonesia, Philippines, Malaysia, Thailand, China and Chinese Taipei (Taiwan).

4.1 Governmental Structure for Co-operation Programs

4.1.1 Methods for establishing co-operation programs

There are four methods for establishing technology cooperation programs with APEC member economies. They are:

* multilateral arrangements under the APEC process;

* bilateral agreements - Australia has several bilateral science and technology (S&T) agreements with APEC member countries; there are also a range of bilateral agreements at the state level of government; between organisations; and, between universities.

* overseas aid - several of Australia's overseas aid programs managed by AIDAB have the potential to fund cooperation projects involving advanced energy technologies;

* supplementary assistance - international development organisations including the World Bank, the Asian Development Bank, UNDP and ESCAP frequently seek supplementary assistance for specific projects; for example, the ESCAP Regional Energy Development Program received significant supplementary assistance from Australia both in cash and in kind.

Each of these methods are described below in terms of the agencies in charge, methods of implementation, policy on cooperation programs with APEC members, and, their focus on specific countries and technologies.

The International Centre for Applications of Solar Energy, located in Western Australia, also has an important part to play in establishing cooperation on new energy technologies. However, it is different from the above methods in that it is more like a private sector organisation than a government program. Therefore it is described separately in a later section to avoid any confusion with the following programs.

4.1.2 Co-operation programs - agencies and implementation

APEC programs - agencies and implementation

The APEC Energy Working Group (EWG) is chaired by Australia's Department of Primary Industries and Energy (DPIE).

The APEC EWG program is sub-divided among four Expert Groups, with each Expert Group responsible for pursuing a specific basic theme. They are:

* the Expert Group on Technology Co-operation which is responsible for the Energy Research, Development and Technology Transfer theme. For this report the Expert Group on Technology Co-operation is the most important as it has a particular focus on new energy technologies.

* the Expert Group on Energy Supply and Demand which is concerned with APEC energy statistics and coal policy;

* the Expert Group on Energy and the Environment which is concerned primarily with clean coal technologies; and

* the Expert Group on Energy Efficiency and Conservation which is concerned with issues such as urban transportation, cogeneration and energy management.

Projects are proposed by the Expert Groups and approved by the full Energy Working Group committee. They may be managed by any of the member countries and implemented by Government Department officers, private consultants or private industry. All Working Groups are trying to get the private sector more involved in their programs.

Bilateral agreements - agencies and implementation

The Department of Industry, Science and Technology (DIST) is responsible for Australia's Bilateral S&T agreements. Projects carried out under these agreements can be implemented by government officers, the CSIRO, universities or the private sector.

The Department of Employment, Education and Training (DEET) is responsible for the Targeted Institutional Linkages program, described later, which has funded bilateral agreements between Australian and overseas universities, particularly in Asia.

There are no specific arrangements for bilateral agreements at the state level of government, although agreements of this type are likely to increase for mainly commercial reasons.

4.1.2 continued

Overseas aid projects - agencies and implementation

The Australian International Development Assistance Bureau (AIDAB) funds and manages Australia's overseas aid projects. The large projects usually involve private sector companies. Some small scale projects are implemented by Non Government Organisation (NGO) representatives in the recipient country.

AIDAB also manages the ASEAN-Australia Economic Co-operation Program which has a new energy technology component. This program comes under the ASEAN-Australia Forum which is evolving from an aid relationship to a partnership of mutual benefit and so the ASEAN Secretariat is also closely involved in the implementation of this project, together with the private sector.

Supplementary assistance - agencies and implementation

Projects funded by supplementary assistance are under the control of the donor agency and/or the relevant UN agency or development bank. They may be implemented the agency or the private sector.

4.1.3 Other (non Government) co-operation programs

In general, private sector involvement in international technology cooperation programs is through the AIDAB programs which are described later.

The company Pacific Power is becoming very active in new energy technology initiatives and is also developing links with Asian countries. It has been involved in running clean coal technology training programs for ASEAN member countries under ASEAN/Australia co-operation programs managed by AIDAB.

Recently it published a Technology Development Plan that includes becoming involved in the development of sustainable (renewable) energy technologies. One of its objectives is to achieve leadership in the Asian market for the delivery of environmentally sound energy technologies and services. The extent to which this will involve co-operation with Asian countries is not known.

An increasing number of small Australian companies have commercial arrangements with Asian countries involving new energy technologies but these cannot be classed as cooperation programs.

Most Australian universities have established academic cooperation agreements with overseas universities, particularly in the Asia region. Some of these agreements may involve new energy technology but there is little public information available about these at present.

4.2 Policy on New Energy Technology Co-operation

4.2.1 Policy on cooperation programs with APEC members

Apart from the APEC process, Australia does not have a current policy for new energy technology co-operation with APEC member economies. Instead, co-operation programs are developed by individual agencies within the broader context of the Government's policies for trade development, the environment and aid to developing countries. The trade and aid programs are focused particularly on the Asian members of APEC.

Australia in Asia - this policy indicates the Government's strong support for developing co-operation programs with the countries of Asia. It was established in 1993 and includes about twelve initiatives to promote cooperation with Asia through educational, environmental, professional and trade linkages but, as yet, none of these have included new energy issues.

Australia's aid program - the aid program aims to help developing countries, particularly those in Asia, to achieve sustainable development that is economically, environmentally and socially sound. The Government recognises that sustainable growth in developing countries will provide economic opportunities for Australia and so funding is available in the aid program for projects that both improve the environment and encourage commercial links between Australia and the recipient country. Therefore new energy technology projects will be supported under the aid program provided they meet these conditions.

The Energy Research and Development Corporation - the ERDC has restricted its support almost entirely to Australia based activities. However it is now considering its policy on international collaboration projects. Recently it extended its support to a project involving a New Zealand company and, in the future, is likely to extend its support to cooperation programs involving other APEC members, particularly in Asia.

4.2.2 Focus of countries and technologies

APEC programs - countries and technologies

The APEC EWG Expert Group on Technology Co-operation has a particular focus on new energy technologies for the Asia region. At the Expert Group's November 1994 meeting the members agreed that the group should continue to focus on maximising the assimilation of new energy technologies by member economies, particularly the Asian members.

4.2.2 continued

The Group agreed also that the key elements to achieve the assimilation of new energy technologies should be:

* human resource development and training;

* specific hardware (technology) projects; and,

* information exchange.

The group stressed the need for demonstration projects in these three key elements; also the need for greater involvement by the business sector.

Each country representative identified their particular requirements. Almost every representative included biomass, wind and solar PV in their lists of priorities, with solar PV being emphasised because of its potential for remote areas power supplies and also as a source top-up power supply at times of peak air conditioning loads. More details of individual member's reports are included in the Appendix.

Bilateral S&T agreements - countries and technologies

There are national agreements which cover some aspects of energy technology with China, Taiwan (Chinese Taipei), Indonesia and Japan. However, the only agreement involving a specific new energy technology program is with Indonesia.

In January 1995 the Northern Territory Government signed a unique Alternative Energy Co-operation Agreement with Indonesia's Agency for the Assessment and Application of Technology (BPP Tecknologi). This agreement was facilitated by the Australia-Indonesia S&T collaboration (COSTAI) program. Further details about activities under this agreement are given in 4.3.3.

Aid programs - countries and technologies

The aid program has a strong focus on the developing countries of Asia. However, the only specific new energy technology supported so far is coal gasification in China which has the potential to reduce the serious environmental impact from existing coal based power generation. This initiative is being funded by the Development Import Finance Facility (DIFF).

Small amounts of funding are available to Non Government Organisations for renewable energy technology projects under AIDAB's Environmental Assistance Program but the focus is on reducing environmental impact rather than energy technology.

4.3 Future plans, objectives and budgets

4.3.1 Introductory note on future co-operation plans

This section describes both the specific plans and the programs under which new energy technology projects could be initiated. It also gives details of the International Centre for Applications of Solar Energy (CASE).

Australia's specific plans for international cooperation in new energy technology are represented by the programs of the APEC EWG Expert Group on Technology Co-operation program and one component of the ASEAN-Australia Economic Co-operation Program.

In addition, new energy technology projects could be developed within the bilateral programs and the aid programs, and by supplementary assistance. The objectives for these programs are defined mainly in terms of environmental advantage, commercial development and/or international co-operation. Therefore new energy technology projects could receive support provided they have commercial potential and/or environmental advantages.

4.3.2 APEC programs - plans, objectives and budgets

The APEC EWG Expert Group on Technology Co-operation meeting in November 1994 reviewed several future projects. It agreed to develop proposals in two general areas:

* human and technology resource development programs for the maintenance of new energy technology based systems; and

* remote area power supply systems, and associated training, suitable for installations such as health clinics or schools.

In addition the United States offered to organise and fund a tour for members of renewable energy installations in the US, plus, a workshop on renewable energy as it relates to sustainable development.

Specific project proposals will go forward for approval and funding at the next Energy Working Group meeting in May 1995. The APEC budget for these programs is small. Typically, each project is awarded about $20,000 from central APEC funds and is usually supported by additional donations from individual member countries.

4.3.3 Bilateral agreements - plans, objectives and budgets

Bilateral S&T agreements - the agreement between the Northern Territory and BPP Tecknologi is aimed at facilitating access to Indonesian markets by Northern Territory renewable energy companies. A proposal incorporating support from AIDAB is being developed for the installation of 5 power stations based on Powercorp's remote area power supply technology; the estimated value is $10 million. Also, the company ITS is providing training, with assistance from BPP Technologi, for installing solar systems to encourage more use of solar technology products in Indonesia.

Targeted Institutional Links Program - The Department of Employment, Education and Training (DEET) manages this program which provides seed grants to Australian higher education institutions to form links with Asian advanced research and technology institutions. It is designed to support projects which will generate economic gains for Australia through closer linkages between science and industry. Special emphasis is placed on mutually beneficial research and technology links between Australian higher education institutes and Australian and overseas industry.

The nine national priority areas for funding include energy technology but, as yet, there are no energy specific projects funded under the program. The total funding for 1994-95 is $1.8 million for 12 projects. This is the same as last year.

4.3.4 AIDAB programs - plans, objectives and budgets

Development Import Finance Facility (DIFF)

AIDAB manages this scheme which is focused mainly on countries in Asia and the Pacific. The facility provides grants to Australian firms supplying Australian made goods and services to high priority public sector infrastructure projects, including remote area power.

A DIFF grant is normally equal to 35 per cent of the total Australian content of the project and can range from $500,000 to $75 million. The DIFF funding for 1994-95 is about $110 million.

In mid 1994 a four year $20 million 'green' DIFF initiative was introduced to support the transfer of environmentally friendly technology to developing countries and to finance important environmental infrastructure developments. In total the DIFF funding has increased by $10 million over the 1993-94 funding.

4.3.4 continued

Private Sector Linkages Program

AIDAB manages this program which was launched in early 1993. It aims to promote sustainable development and economic growth in the Asian region through activities which link private sector companies in Australia and selected developing countries. Target countries include China, Indonesia, Malaysia, the Philippines, Thailand and Vietnam. Support is provided for eligible activities, from a minimum of $25,000 up to $250,000 for a maximum of 50 per cent of the total costs incurred.

Activities which qualify for funding support include:

* training, secondments and work attachments for representatives from market oriented enterprises in developing countries; and

* demonstration, adoption and supply of proven and appropriate Australian technology.

The budget allocation for 1994-95 is $6 million which is the same as last year.

For 1994-95 an ASEAN specific version of this scheme has been introduced, see below.

ASEAN Australia Economic Cooperation Program

The ASEAN-AECP aims to foster the development of science and technology networks within the ASEAN region and enhance their access to Australian expertise. Phase III of the program started in mid 1994 and runs to mid 1998. It contains six projects including one on energy production from biomass and wastes.

To support the commercial orientation of Phase III, AIDAB has developed a customised version of the Private Sector Linkages Program with funding of $14 million to support private sector involvement in the program. Activities can include demonstration, adaptation and supply of ASEAN and Australian technology. They should have a regional focus and involve Australia and at least two of the ASEAN countries, or be a joint Australia-ASEAN pilot activity in one ASEAN country with the potential for regional benefits. Support will normally be in the range of A$25,000 to A$250,000.

4.3.5 International Centre for Applications of Solar Energy

The International Centre for Applications of Solar Energy (CASE) is a statutory authority, based in Western Australia, aimed at promoting the use of renewable energy technologies in developing countries. It develops project proposals and assists in arranging finance and project management. It also helps arrange training for local communities to install and maintain renewable energy systems, and where appropriate, assists in skills and technology transfer.

The centre's work program includes detailed market evaluation of the energy service needs of selected developing countries, evaluation of the most appropriate technologies to meet these needs, and how these technologies can be implemented and funded. It is particularly interested in the supply of power to remote communities by renewable energy hybrid systems, involving wind, solar and diesel.

It has held preliminary discussions with the ASEAN Solar Energy Network (ASEN) on solar testing and standards - ASEN is closely associated with ASEAN's Sub-Committee on Non Conventional Energy Research (SCNCER).

The Centre is backed by the UN Industrial Development Organisation (UNIDO) and, in the longer term, will liaise with UNIDO to establish other similar centres around the world to form a cooperative network.

CASE is funded initially by the Australian and WA State Governments and, in the future, will seek funding for specific projects from other organisations such as AIDAB, the multilateral development banks, non government aid organisations and private industry.

Contact: Gordon Thompson
CASE, Level 3, 81 St George's Terrace
Perth WA 6000
Phone (09) 321 7600
Fax (09) 321 7497

4.4 New Energy Technology Co-operation Projects

This section describes specific current and future new energy technology co-operation projects and initiatives involving APEC member countries. They are arranged as follows:

* APEC EWG Expert Group on Technology Co-operation;

* bilateral projects;

* AIDAB projects;

* university projects; and,

* private sector projects.

4.4.1 APEC EWG Expert Group on Technology Co-operation

The Group has several projects underway which are due to be completed by June 1996 or earlier. These are described below.

In addition, at least three more project proposals are expected to go forward for approval and funding at the next Energy Working Group meeting in May 1995. At least one of these is likely to focus on remote area power supply systems and associated training.

PROJECT: Technology Cooperation Guide

Objective: to improve information flow on the availability of new energy technologies and of the needs and capabilities of APEC member countries.

Contents: this is a priority list of needs, capabilities and contacts on a country by country basis.

Budget: $US10,000 from APEC Central Fund

Agency in charge: Department of Primary Industries and Energy

Overseas Partners: APEC member countries provided information.

Status: the Guide is virtually finished at the time of writing this report.

Evaluation of Results: the draft version of the guide was well received by the Expert Group.

4.4.1.continued

PROJECT: Survey of Impediments to the Use of New and Renewable Technologies

Objective: to assess the human and institutional and human resource barriers to the increased use of renewable energy resources, with a view to developing strategies for overcoming these barriers.

Contents: Still undecided due to inadequate budget which is estimated to require an additional $US30,000.

Budget: $US20,000 from APEC Central Fund (1994) plus $US10,000 from Australia.

Agency in charge: Australia DPIE and Indonesia (LEMIGAS)

Overseas Partners: EWG member countries

Status: this project is not progressing until either further funding is available or it is reduced in scope.

PROJECT: Renewable Energy Resource Assessment Workshop

Objective: to provide training for countries in assessing renewable energy resources.

Contents: not yet determined

Budget: $US20,000 from APEC Central Funds (1995) which is considered by the Expert Group to be inadequate.

Agency in charge: DPIE

Overseas Partners: China

Status: further funding is being sought prior to developing a management plan for the project.

PROJECT: Compendium of Renewable (New) Energy Technology Programs in the Asia-Pacific Region

Objective: to improve understanding of the developments and opportunities available in new energy technologies.

Contents: information on the current energy balance, policy and institutional considerations, enabling organisations and details of new energy programs.

Budget: $US 20,000 from APEC central fund plus a supplement of $US 30,000 from the United States.

Agency in charge: US Department of Energy

Overseas partners: Member countries of EWG

Status: a questionnaire is to be circulated by the EWG Secretariat during early 1995; the final document should be available by the end of 1995.

4.4.2 Bilateral cooperation programs

The Department of Industry, Science and Technology (DIST) is co-operating with the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) on the ESCAP Asia/Pacific Renewable Energy Symposium to be held in July, 1995. A number of other Australian agencies and organisations are supporting the symposium including the Electricity Supply Association of Australia; the Department of Primary Industries and Energy (DPIE); the NSW Office of Energy; and, the Solar Energy Industries Association of Australia.

AIDAB is sponsoring 20 ESCAP delegates to the symposium and also is funding them to visit a number of new energy technology firms during their stay in Australia.

4.4.3 AIDAB co-operation projects

PROJECT: AAECP Phase III - Biomass from Wastes

Objectives:
* to assist ASEAN members in the commercial development of fluidised bed combustion (FBC) technologies for the production of combined heat and power (CHP);
* environmentally sound disposal of biomass wastes;
* to improve the viability of rural industries and their working environments, especially for women;
* to enhance th capability of ASEAN countries to design, construct, install and operate and service FBC technology;
* to develop an industry to manufacture reliable, high efficiency steam engines for small scale FBC CHP plants.

Contents:
* a series of workshops;
* development of a low cost control system;
* development of a FBC for rice husks that eliminates the problem of slagging and tube erosion; and,
* development of a low cost steam engine.

Budget: a total of $3 million from Australia (AIDAB) and $1.5 million in kind from ASEAN members.

Agency in charge: Sinclair, Knight and Merz (Australia)

Overseas Partners: the ASEAN Secretariat

4.4.4 University cooperation projects

PROJECT: Integrated Solid Waste-Methane System

Objective: to develop and install, both in Australia and Korea, test scale systems for the rapid digestion of municipal solid wastes coupled with methane gas separation processes in order to model the characteristics of digestion and separation and so determine the economic feasibility of the optimum system.

Contents: research to establish design criteria and operational characteristics; design of component systems for pre-treatment, control, adsorption bed sizing, monitoring and analysis; installation of test facilities; testing and data analysis.

Budget: each partner provides their own funding which is reviewed on an annual basis, according to the progress made. For this first year the costs are relatively low and there is no specific budget as yet. Later in the project applications will be made to the respective Governments for funding support.

Agency in charge: this is a collaborative project between the the Department Chemical Engineering of Queensland University and the Korea Institute of Energy Research (KIER).

Overseas partners: the Korea Institute of Energy Research (KIER).

Status: this is a phased, 6 year project which started in late 1994.

PROJECT: Fluidised Combustion of Bagasse and Fibrous Solids.

Objective: to study and verify the conditions permitting the fluidisation of bagasse with inert particles.

Contents: tests on a bubbling FBC cold model apparatus, to be followed by testing on a hot model apparatus.

Agency in charge: Department of Chemical Engineering, Queensland University (Dr V Rudolph)

Funding: Australian Research Council grants of $55,000 (1994) and $30,500 for 1995 and 1996.

Overseas partners: research groups in Goungzhou, China; also universities in South Africa and the United States.

Status: the technology is well developed and this phase of the development is intended to find the optimal conditions for the commercial fluidised bed combustion of bagasse.

4.4.5 Private sector cooperation initiatives

Biomass Energy Services & Technology P/L

The company specialises in developing biomass fuelled devices for developing countries. Its products include steam co-generation units based on biomass; entrained flow biomass gasification systems; briquetting of biomass and coal; wood stoves and wood furnaces for firing bricks. It has been involved in many overseas programs funded by AIDAB and international development agencies.

Contact: Stephen Joseph, Managing Director
Phone (043) 851 190 or fax (043) 843 996.

Powercorp

The company Powercorp, based in the Northern Territory, specialises in applying electronic and computer systems to manage remote area power systems including hybrid systems incorporating solar and wind devices. It has received a good deal of assistance from the Northern Territory Government and is involved in the NT Government's renewable energy cooperation program with Indonesia.

It has a contract with the Indonesian technology assessment agency BBP Technology to supply hybrid power plants for remote operation. It also has projects in Malaysia and China. These are commercial contracts and no further details are available.

Contact: Alan Langworthy, Managing Director
Phone (089) 82 32 4230 or fax (089) 32 1134

Integrated Technical Solution (ITS)

The company ITS is also based in the Northern Territory and specialises in smaller scale solar technology applications. It exports solar powered water pumps and solar house-hold power systems for remote communities in Eastern Indonesia.

Suntron Energy Company P/L

The company is based in Melbourne and specialises in solar powered water pumps. The technology includes a system for orienting the solar arrays at the sun and a high performance, submersible motor to drive the pump. The company is starting to export its products into Asia on a commercial basis.

Contact: Susan Saunders, Managing Director
Suntron Energy Company
Phone (03) 894 2544 or fax (03) 894 3370.

4.5 Coal gasification cooperation: current and future

CSIRO Division of Coal and Energy Technology

The Division has a formal agreement with the Korean Institute of Energy Research (KIER) for cooperation on advanced power generation. This involves information exchange and exchange visits and includes work on high temperature coal gasification.

PROJECT: The Australia-UNDP PACE-E program

Object: to provide technology transfer and training in coal technology, including coal gasification.

Method: the PACE-E program is an Australian funded extension of the ESCAP Regional Energy Development Program.

Funding: $3 million over three years.

Agency in charge: the NSW and QLD Joint Coal Board.

Status: progress is satisfactory; the program ends this year

Partners: Malaysia, Thailand, Indonesia, Philippines and China.

PROJECTS: AIDAB's Development Import Finance Facility

* a $9.2 million contract in 1993 for PWT Asia Pacific to install a coal gasification plant near Beijing, the DIFF contribution is $3 million;

* a June 1994 contract awarded to Australian companies CMPS&F Pty Ltd and Energy Equipment Pty Ltd for gasification plant for Henan Province, the DIFF contribution is over $31 million; the Australian contribution includes designing the processes and supply of the gasification equipment, fuel oil recovery unit and fluidised bed boilers plus training.

These are commercial projects and it is not possible to get more technical details or information on future contracts. However it is very likely that there will be more coal gasification contracts in the region.

REFERENCES FOR PART ONE

New Zealand: The Turnaround Economy, published by the Institute of Directors, London, 1993.

Research Strategy for the Public Good Science Fund 1993/94 to 1997/98: Energy, published by the Foundation for Research, Science and Technology, September 1993.

Country Economic Brief: New Zealand, published by the Department of Foreign Affairs and Trade, June 1994.

Economic and Fiscal Update 1994, by the New Zealand Minister for Finance, December 1994.

Sectoral Projections: Medium Term Outlook to 1999, published by the New Zealand Institute of Economic Research, September 1994.

Resource Management: Guide to the Act, published by the Ministry for the Environment, August 1991.

Climate Change: The New Zealand Response, published by the Ministry for the Environment, September 1994.

Energy Supply and Demand Scenarios to 2020, published by the Ministry of Commerce, Wellington, July 1994.

Energy Efficiency and Conservation Authority 1993/94 Annual Report and 1994/95 Business Plan, published by the EECA.

Corporate Plan 1994/95 for the Ministry of Commerce,

Corporate Plan 1994/95 for the Ministry of Research, Science and Technology, Publication No 11, September 1994.

Investing in Science for Our Future: Statement on Science Priorities for the Public Good Science Fund, published by the Ministry of Research, Science and Technology, October 1992.

Science and Technology: The Way Forward 1996-2001, the Government's Strategic Statement to Guide Investment through the Public Good Science Fund, published by the Ministry of Research, Science and Technology, December 1994.

The Science System in New Zealand, published by the Ministry of Research, Science and Technology, August 1994.

Public Good Science Fund Research Contracts 1994/95, published by Foundation for Research, Science and Technology, August 1994.

New Zealand Official Development Assistance: Program Profiles 1994/95, published by the Development Cooperation Division of the Ministry of Foreign Affairs and Trade, Wellington.

REFERENCES FOR PART 2

Most of the information for this report was provided by private communications. However much useful information was obtained from the following publications.

Australian Science and Technology Council, Energy Research and Technology in Australia, ASTEC Occasional paper No 28; published by the Australian Government Publishing Service, 1994.

Energy Research and Development Corporation, R&D Plan 1994-95 to 1998-99; published by the ERDC, 1994.

Energy Research and Development Corporation, Research Strategy for Renewable Energy Sources and Systems; ERDC, November 1993.

Energy Research and Development Corporation, Annual Report 1993-94; published by the ERDC, September 1994.

Department of Primary Industries and Energy, the Australian Renewable Energy Industry; published by the Australian Government Publishing Service, 1993.

Australian Bureau of Agricultural and Resource Economics, Commodities: forecasts and issues; ABARE, December 1994.

Australian Bureau of Agricultural and Resource Economics, Australian energy consumption and production: historical trends and projections to 2009-10; published by ABARE, February 1995.

Priorities for Energy Research, Development and Demonstration in New South Wales, a report by the Energy Research and Development Advisory Committee; published by the Office of Energy, NSW, 1992.

New South Wales Energy Review No 2; NSW Office of Energy, 1994.

Potential for Increased Gas-fired Cogeneration in New South Wales, by the NSW Office of Energy, 1992.

Energy Research, Development and Information Centre of the University of New South Wales, Annual Report 1993; ERDIC, 1994.

Centre for Photovoltaic Devices and Systems, UNSW, Annual Report 1993; published in 1994.

APEC Energy Working Group: current focus and future directions; draft report, October 1994.

APEC Energy Working Group - Expert Group on Technology Cooperation: Summary Record of Fifth Meeting, November 1994.

APPENDIX 1

At the November 1994 Meeting of the APEC EWG Technology Transfer Expert Group the country representatives described in outline their national priorities and activities for new and renewable energy resources. These are their reports.

Indonesia

New energy development activities are undertaken by several government departments and universities - Directorate General of Electricity and Energy Development (DJLDP), Agency for the Assessment and Application of Technology (BPPT), Institute of Aeronautics and Space (LAPAN), Institute of Sciences (LIPI), Institute of Technology Bandung (ITB), Institute of Technology Sepuluh November (ITS).

Priorities include:
* Biomass: all technologies but particularly cost reduction and agricultural and forestry resource management;
* Solar PV: efficiency improvements, cost reduction and resource data;
* Wind: materials improvement, cost, design, siting and resource data;
* Geothermal: exploration, extraction and cost;
* Ocean: tidal dams - materials, technology and cost.

Korea

In 1987 the Korean National Assembly established an act for promoting New and Renewable Sources of Energy (NRSE) with the aim of supplying 3 per cent of total energy demand by NRSE by the year 2001.

Basic research is undertaken mainly by universities and research institutions and the development and application of these technologies is to be undertaken mainly by industry.

The focus is on conservation technologies, such as cogeneration, and fossil fuel substitution technologies. Most recently the government has supported the manufacture and test of an 800kW vertical wind power system and a 40 kW fuel cell system. An IGCC pilot plant is about to undergo test operation.

Malaysia

Malaysia has no policy on the development and use of renewable energy sources. Some research has been undertaken on biomass conversion including, for example, anaerobic fermentation of palm oil and animal wastes. Also, about 640kW of solar photovoltaic (PV) systems have been installed.

The research priorities are reported as follows:
* planned fuel plantations for biomass supplies;
* remote area solar PV systems; and,
* large scale solar PV systems connected to supply grids to meet air conditioning demands loads on hot sunny days.

Philippines

There is a New and Renewable Energy Program which, through the Department of Energy, supports the research, development, promotion and commercialization of NRSE including new energy technologies.

* Solar PV: there is a Philippine-German water pumping program of totalling about 20kW of power; also, about to be established, a Philippine-Dutch cooperation program for installing 15,000 household systems in rural un-electrified areas; also, negotiations with the World Bank to displace about 470 MW of conventional (diesel) power systems by solar PV under the FINESSE (Financing Energy Services for Small-Scale End-Users;

* Biomass technologies: these are the most developed and commercialised of the new energy technologies but some research is continuing in this area; there is a Philippine-Japan cooperation demonstration program for a 700 kW fluidised bed gasifier system utilising agri/wood residues being implemented by the Department of Science and Technology (DOST);

* Wind technology: there is renewed interest by both DOST and the United Nations Development Program (UNDP) in small and large scale wind turbine installations.

Chinese Taipei (Taiwan)

The government is developing an Independent Power Production (IPP) scheme to allow independent producers to supply local power markets to help cope with the peak electrical power demand, particularly for summer air conditioning.

Therefore, for new energy technologies, grid connected solar PV systems would be the most suitable under the IPP scheme.

Other priorities include solar, wind and biomass systems for remote areas, plus, information exchange and training on new energy technologies.

Thailand

The National Energy Policy Council has approved an Energy Conservation Promotion Fund for the promotion of new energy technologies and energy efficiency improvement for small energy users in rural areas, also, for improving the energy efficiency of large buildings.