APEC Energy Project

Energy Efficiency and Conservation Theme

Compendium of Energy Efficiency and Conservation

Programs and Projects

in Asia Pacific Economic Cooperation (APEC)

Member Countries

Analytic Studies Division
National Renewable Energy Laboratory
Golden, CO 80401 USA

April 1993

MASTER

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Preface

The Asia Pacific Economic Cooperation (APEC) agreement was initiated in 1989 at the ministerial level to promote the economic and social well-being of the APEC region. APEC member nations include Australia, Brunei, Canada, Chinese Taipei, Hong Kong, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, the People's Republic of China, Singapore, Thailand, and the United States.

APEC ministers identified six areas of cooperation:

1. Trade and investment data
2. Trade promotion
3. Expansion of investment and technology transfer
4. Human resource development
5. Marine resource conservation
6. Regional energy cooperation.

Four additional areas have been added:

1. Telecommunications
2. Fisheries
3. Transportation
4. Tourism.

Australia accepted the overall lead responsibility for the Regional Energy Cooperation area. At the first APEC Energy Officials Meeting, held in May 1990, it was decided that the Regional Energy Cooperation Project's objective would be to *maximize the energy sector's contribution to the region's economic and social well-being* by

- Contributing to decision making through frank and open discussions of national

energy policies and planning priorities

- Sharing basic resource demand and supply outlook data
- Considering regional energy policy implications and responses to wide-reaching energy-related issues, such as the greenhouse effect.

A work program based on five main themes was also developed at this meeting, which has been endorsed by the APEC ministers. The theme areas are:

- Energy supply and demand
- Energy and environment
- Energy efficiency and conservation
- Research, development, and technology transfer
- Resource exploration and development.

The United States has accepted lead responsibility for the energy efficiency and conservation (EE&C) theme.

As a result of the second meeting of the APEC energy officials, held in March 1991 in Jakarta, Indonesia, the United States, as part of the EE&C theme, agreed to *publish a Compendium of Energy-Efficiency and Conservation Programs and Projects in APEC Member Countries*. This document was to describe the major energy-efficiency and conservation programs/projects that have been undertaken or are being planned by each APEC country. The U.S. Department of Energy (DOE) has requested the National Renewable Energy Laboratory (NREL) to prepare this compendium.

Material was solicited from member countries and, in addition, information was gathered

from various publications and periodicals. In September 1991, a draft document was circulated. Subsequently, additional information has been submitted by member countries, and some additional material was acquired during travel to the region by NREL and DOE personnel.

Based on the responses to the September 1991 draft and further information gathered by DOE and NREL, a second draft was prepared and distributed in association with the APEC Energy Efficiency and Conservation Theme Expert Group Meeting in October 1992.

The report briefly discusses the energy situation in each country, summarizes energy-efficiency projects, and outlines the country's energy policy and strategy. The objective of this project was to determine the status of energy-efficiency activities in the 15 APEC countries. We hope that this report can be used to identify opportunities for regional coordination and cooperation.

The emphasis of this report is on simplicity of presentation. It provides quick access to basic information about the experiences of nations in the region, including sufficient information to facilitate country-to-country contact.

Table of Contents

Approach	1	People's Republic of China	
Summary Tables	2	Text	120
Definitions for Tables	6	Tables	124
Australia		Philippines	
Text	7	Text	130
Tables	13	Tables	136
Brunei		Singapore	
Text	24	Text	145
Canada		Tables	149
Text	25	Thailand	
Tables	30	Text	153
Chinese Taipei		Tables	159
Text	36	United States	
Tables	40	Text	169
Hong Kong		Tables	173
Text	46	Note on FINESSE	202
Tables	49		
Indonesia			
Text	52		
Tables	57		
Japan			
Text	60		
Tables	66		
Korea			
Text	87		
Tables	92		
Malaysia			
Text	98		
Tables	103		
New Zealand			
Text	109		
Tables	113		

Approach

The information included in this report was collected from both primary and secondary sources. Primary sources were mainly official publications that were furnished by official contacts in each country. In addition, statistical data were taken from the World Bank's *World Development Report*. Secondary sources provided supplemental information on specific projects and, in some cases, more recent developments. These sources included newsletters, books, conference proceedings, etc.

Each chapter, covering one country, begins with a discussion that sets the context for the descriptions of energy-efficiency efforts. Energy use and policy issues are described, along with basic trade and economic information; a brief description of basic energy-efficiency programs and policies is included. Energy use and per capita energy consumption data are represented by million metric tons of oil equivalent (Mtoe) and kilograms of oil equivalent (kgoe), respectively. Following the text, a set of tables is presented. Each table includes specific information on energy-efficiency and conservation projects or programs. These tables are summarized in the summary tables that follow in this section.

The information in the tables was compiled for each project, then the tables were organized by end-use sector. Each table includes a brief overview of the project and the sponsoring organization, along with summary remarks about the economic and/or technical details. These tables are intended to give the reader sufficient information to efficiently identify projects that are of specific interest and to make contact with the appropriate organization.

APEC Country Profiles¹

	Australia	Brunei ²	Canada	Chinese Taipei	Hong Kong	Indonesia	Japan	Korea	Malaysia	New Zealand	People's Republic of China	Philippines	Singapore	Thailand	United States
Population (millions)	17	—	27	20	6	178	124	43	17	3	1,134	62	3	56	250
GDP (\$ mil)	296,300	—	570,150	157,337	82,731 (1991)	107,290	3,373,824 (1991)	236,400	42,400	42,769	364,900	43,860	34,600	80,170	5,392,200
Exports (\$ mil)	35,973	—	125,056	84,280 (1989)	98,430 (1991)	25,553	314,525 (1991)	64,837	29,409	9,045	62,091	8,681	52,627	28,881	371,466
Imports (\$ mil)	39,740	—	115,882	70,360 (1989)	100,507 (1991)	21,837	236,737 (1991)	69,585	29,251	9,466	53,345	13,080	60,647	32,692	515,635
Total primary energy supply ³ (Mtoe)	88.5	2.1	210	45.9	10	46.9	428	92.4	20.3	13.5	633	18.2	9.9	29.6	1,905
Energy consumption per capita (kgoe)	5,041	—	10,009	2,641 (1991)	1,908 (1991)	272	3,635	1,898	974	4,971	598	215	5,685	758	7,822
Land area (thousand km ²)	7,687	—	9,976	36	1	1.9	378	99	332	269	9,561	300	1	515	9,373

¹All data, unless otherwise indicated, are based on the *World Development Report 1992* for 1990.

²Data not available except for total primary energy supply.

³From *International Energy Agency Statistics 1992* for 1990.

Project Distribution by Type and Sector

Project Type	Number	Percent
R&D	87	31
Study/demo	115	41.5
Audit	9	3
Survey	4	1.5
Standards and codes	4	1.5
Certification	1	0.5
Tech transfer	6	2
Education/info	12	4
Policy assessment	39	14
Total	277	99

Sector	Number	Percent
Industry	104	38
Utility	15	5
Transportation	20	7
Residential building	47	17
Commercial building	52	19
Renewable energy	20	7
All sectors	19	7
Total	277	100

Summary Table (by country, end-use sector, and project type)

	Industry	Utility	Transport	Res. bldg.	Cml. bldg.	Renewable energy	All sectors	Total
Australia								
R&D	2			1		4		7
Study/demo	8		3	1			1	13
Audit	1							1
Canada								
R&D	1	1		3	1	1		7
Study/demo				1	3			4
Policy Assess.							1	1
Chinese Taipei								
R&D							1	1
Study/demo					2			2
Standards and codes			1	1				2
Policy assess.	4		1	1	2			8
Hong Kong								
R&D					1			1
Policy assess.					3			3
Education/info							1	1
Indonesia								
R&D					1			1
Study/demo						1		1
Policy assess.	2							2
Audit	1				1			2
Japan								
R&D	5	3	1	2		6	1	18
Study/demo	16	5			2	2		25
Korea								
R&D	4			2	1			7
Study/demo	1	1						2
Policy assess.	3				1			4
Audit	1							1
Malaysia								
Study/demo	3						1	4
Audit	3				1			4
Survey	3			1				4
Education/info					3		1	4
Policy assess.	1							1

	Industry	Utility	Transport	Res. bldg.	Cml. bldg.	Renewable energy	All sectors	Total
New Zealand								
Study/demo	2			2	12			16
Policy assess.	1			1	1			3
People's Repub. of China								
Study/demo	7	1		1	3			12
Policy assess.				1				1
Philippines								
R&D	1		1					2
Study/demo	5				1	2		8
Education/info	2						1	3
Policy assess.	3				1	1	3	8
Standards and codes					1			1
Singapore								
R&D	1				3			4
Study/demo			1					1
Policy assess.					1		1	2
Thailand								
R&D	2	1				2	1	6
Study/demo	4	2		1		1		8
Audit	1							1
Education/info							1	1
Policy assess.	1						5	6
United States								
R&D	11		9	10	3			33
Study/demo	4	1	3	7	4			19
Standards and codes				1				1
Certification				1				1
Tech transfer				6				6
Education/info				3				3

Definitions for Tables

The tables that follow each country section include the following information:

- **Title**—The title gives the exact title of the project or the general aim of the project.
- **Organization**—The organization section describes the government branch, corporation, trade group, or energy administration, research institution, etc.
- **End-use Sector**—The end-use sector section classifies the project's application as industry, utility, transportation, residential building, commercial building, renewable energy, other (multisector), or all sectors.
- **Description**—The description section reports the intent of the project, the background of the project, and a general overview of the project.
- **Results**—The results section gives a synopsis of the results or current status of the project.
- **Project Type**—The project type section classifies the project as research and development; study/demonstration; audit; survey; standards and codes; certification; technology transfer; education/information; and policy assessment.
- **Date**—This section cites the starting and ending dates of the project or classifies the project as ongoing.
- **Affiliated Projects**—This section describes any past or future projects that are connected to the entry.
- **Technology**—This section describes the technology or combination of technologies used for the project.
- **Reference**—A short bibliographical entry.

Australia

Australia is an island continent about the size of the continental United States. There are 17 million people of European and Asian heritage. More than 60% of the population lives in urban settings.

The Australian government is a parliamentary democracy, and a prime minister acts as the head of state.

Australia relies heavily on its natural resources for economic prosperity. With the recent downturn in commodity prices, Australia has been thrown into an extended recession. This slow economic growth has been accompanied by high interest rates, low consumer confidence, and rapidly rising unemployment. Recently, gross national product growth has been below 3%; the average rate of inflation was 7.4% from 1980 through 1990.

Australian gross domestic product (GDP) reached US\$296,300 million in 1990, up from US\$24,220 million in 1965. This represents an average annual growth rate of 1.9%. The GDP came from the following market sectors: agriculture (4%), industry (31%), and services (64%); within industry, manufacturing comprised 15% of the GDP. The GDP rose 1.4% in 1990. A GDP growth of 2.2% was predicted for 1991.

For the period of 1980 to 1990, interest rates averaged 12.8%. After peaking in 1989, the rates fell during 1990 and 1991. The value of building approved for 1990 was 16.5% lower than in 1989; registrations of new vehicles decreased 21%.

In 1990, exports totaled US\$35,973 million and imports totaled US\$39,740 million. Over the period 1980 to 1990, the average annual growth rate for exports was 3.9%, and the average annual growth rate for imports was 4.7%.

For 1992, the *Pacific Economic Outlook* predicts Australia will enjoy stronger GDP growth than in 1991. Domestic-expenditure growth is likely to rise, but the trade accounts are expected to weaken. Inflation is likely to increase, and there will be little change in the unemployment rate.

Energy Use and Policy Issues

In 1989, total energy use in Australia totaled 97.1 million tons of oil equivalent (Mtoe). Australia is a net energy exporter. By the year 2000, this is expected to grow to 107.3 Mtoe.

Australia has vast reserves of coal, Bass Strait crude oil, natural gas, and hydroelectric potential. Energy use by fuel type is: coal 40%, petroleum 37%, natural gas 17%, and renewables 6%. While Australia is a net energy exporter, it imports some oil and is concerned with the effects of disruptions in oil supply.

Per capita energy consumption equaled 5,041 kilograms of oil equivalent (kgoe) in 1990, up from 3,287 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 2.2%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 5%.

The transportation end-use sector accounts for the largest consumption of energy, using 38% of the final energy supply. Other sector uses include manufacturing (34%), residential (12%), agriculture and mining (8%), commercial (6%), and other (2%).

Electricity is about 18% of final energy demand in Australia. Most of this electricity is generated using coal-fired steam turbines. The Department of Primary Industries forecasts electricity growth to increase 2% to 3.8% for the period 1988 to 2000.

Australia is a major producer of uranium and is involved with the front-end cycle of transforming uranium into yellow cake. There are no nuclear power plants in Australia, and the country has no plans to construct them.

Policies, Plans, and Projections

The energy objectives for the 1990s are

- To produce and use energy efficiently
- To improve the environment.

The energy policies for the 1990s are

- To ensure that prices reflect social values of energy production and use in the freely working markets
- To provide full information about efficient technology, practices, and alternatives
- To support R&D in energy efficiency and renewable energy.

Australia also participates in international cooperation projects with the Association of Southeast Asian Nations (ASEAN), Japan, the United States, and other countries.

Ecologically sustainable development is a long-range issue in Australia, and the government is committed to the following goals:

- Minimize or avoid the harmful environmental consequences of energy production and use.
- Establish access to resources that meet economic needs but do not jeopardize the environment.
- Price energy resources to reflect their true value and the full costs of production.
- Enable consumers to make rational decisions about energy use.
- Promote institutional arrangements for the energy supply industries.
- Ensure that energy R&D and information dissemination focus on energy efficiency and new and improved technologies.

- Recognize the place of energy security considerations.
- Support Australia's obligations as a global energy supplier.

Alternative Fuels

Indigenous production of crude oil and condensate is currently 85% of needs and is estimated to remain at about the current level, on average, over the period 2004 to 2005.

Liquefied petroleum gas (LPG) is an established transport fuel in Australia, having sales that are approximately 2.3% that of gasoline. It is typically used by fleet vehicles. Currently, the government does not place a tax on LPG, and it retails for about half the price of gasoline. In most applications, conversion from gas to LPG costs about A\$1,800 and can be paid back in only a few months. Annual growth of LPG use should be around 3% and should eventually reach 7% of gasoline sales.

The government is supporting the use of natural gas in the transport sector. The benefits of natural gas include reduced emissions of particulate matter and carbon dioxide. Although the economics of natural gas appears attractive in some markets, the most likely use for a natural gas vehicle in Australia will be as a replacement for diesel engines. In some states, natural gas is already being trial tested in urban bus fleets, and the use of natural gas in heavy vehicles appears to be an attractive proposition in many applications.

The largest-scale development activity for alternative fuels was the conversion of Australian brown coal into liquid fuels. The governments of Japan and Australia and the state government of Victoria cooperated on the A\$400 million project, which was funded by Japan. This synthetic fuels project provided valuable information on brown coal liquefaction and will be the technological foundation of any future synfuels industry for Japan or Australia.

Energy Efficiency and Conservation

The barriers to energy-efficiency improvements in Australia may be summarized as follows:

- There are distortions in the energy marketplace; prices do not fully reflect all costs of production and use, including environmental impacts. Energy-efficiency equipment is not appropriately valued.
- In the transportation sector, low excise taxes on petroleum are an impediment to greater efficiency. Taxes, exemptions, and fees on various fuels and equipment do not reflect their energy content, efficiency of use, or pollutants.
- Consumers favor equipment with lower capital cost. Other problems related to energy consumers include
 - Lack of useful data and information on options
 - Limited access to investment capital for improving energy efficiency
 - Lack of understanding of new energy-efficient technologies; insufficient training
 - Poor accounting of energy costs, such as when electricity costs are included in a lease and the lessor cannot track costs.

Australia has a federal system of government, and responsibility for energy and energy efficiency is shared between the state/territory and national levels of government. While each state and territory government is autonomous in its own sphere of responsibility, the national government provides a base level of energy conservation and efficiency services nationwide. An established framework exists at the ministerial level for consultation and project cooperation among the governments. Working parties of officials and experts support this framework when needed.

At the national level, current energy management program initiatives comprise the following:

- Technology transfer: Center for the Analysis and Dissemination of Demonstrated Energy Technologies, with a series of national- and state-based government/private sector communications networks; a technology demonstration program, with particular emphasis on buildings; national energy awards; publication of *Australian Energy Management News*; a model integrated energy management advisory center for households and businesses; and information exchange between commonwealth and state governments
- Residential community: Information kit, including *The Energy Guide*; appliance energy-labeling program; a national appliance energy-efficiency data center; development of minimum energy-efficiency standards for domestic appliances; promotion of energy-efficient housing design and urban planning; development of a Home Energy Rating Scheme for new houses; development of national minimum energy-efficiency standards for new residential construction; local community energy-efficiency campaigns
- Industry and commerce: Financial support for energy audits in industrial, commercial, and institutional enterprises; energy management seminar/workshop support, currently being extended to in-house energy management training support; sector energy use and efficiency improvement studies; an energy extension officer program; development of national minimum energy-efficiency standards for new commercial construction; energy management advisory literature
- Transportation: National Average Fuel Consumption Program (in cooperation with industry); fuel consumption guides for passenger and light commercial vehicles; advisory materials and training programs in fleet management; analyses of further policy instruments (taxation systems, mandatory fuel consumption advertising and labeling programs, etc.)
- Energy management in government: Nomination of energy managers in government units; annual reporting of energy use and improvement in government buildings, housing, and leased facilities; energy audit of government vehicle fleets; assessment of alternative fuels; program exchange with other tiers of government.

Each state and territory government has a similar range of complementary initiatives, depending on local needs and priorities. Development of labeling programs, minimum energy-efficiency standards for appliances and buildings, and some broad communications programs are multigovernment cooperative ventures.

Energy utilities in all states are either assessing or have embarked on demand-side management/least-cost planning programs. There is a wide range of services encompassed by these programs, covering

advisory, research, demonstration, and financial support initiatives in all sectors of the economy. Most utilities also provide extensive energy management services on a fee-for-service basis.

From 1978 to 1989, the Australian government supported renewable energy research through the National Energy Research Development and Demonstration Program (NERD&D). It provided nearly A\$33 million for research projects, including associated technologies such as energy storage.

The objective of the NERD&D program was to stimulate energy R&D and to help develop technologies for market applications. The program identified promising areas of research through workshops, studies, and reviews and directed support towards technologies "with the best chances of achieving commercial successes."

In 1990, the Australian government established the Energy Research and Development Corporation to administer publicly funded support for noncoal energy R&D. This action intends "to make Australian energy R&D more responsive to the needs of industry and to provide greater flexibility for government programs." Since October 1990, the corporation has committed A\$4.9 million to renewable energy R&D projects.

Universities in Australia, including the University of New South Wales (UNSW) and Sydney University, actively research renewable energy. UNSW researchers developed the highest efficiency photovoltaics from commercial silicon. Sydney University researchers developed evacuated glazing materials having excellent insulation properties for windows. Other universities actively involved in solar energy research include Murdoch University, University of Melbourne, and University of Queensland.

In addition to the commonwealth programs, several states support renewable energy programs. Renewables make a modest but valuable contribution to the overall energy supply in Australia. The renewable energy industry contributes more than A\$100 million in yearly sales to the Australian economy. It is estimated that 6% of all Australian homes use solar water heating and that in some areas up to 37% of homes use this technology. Photovoltaics and solar-heated swimming pools also represent large markets for renewable energy technologies.

In short, the government's energy policy can be succinctly summarized as follows:

- A national approach to energy policy to remove differences between states and the national objectives (i.e., taxes, resources, royalties, environmental regulations, and pricing)
- Accounting for environmental costs (The government wants to determine how to value and promote environmentally friendly energy technologies, including renewables.)
- Increased energy efficiency by removing distortions in pricing, improving energy management, developing national energy standards, and undertaking energy R&D
- Reform of electricity supply industry, including more use of renewables
- A national strategy for natural gas
- A secure energy future
- Expansion of Australia's energy trade.

Bibliography

An Overview of Energy Research, Development and Demonstration in Australia, 14th Congress of the World Energy Conference; September 1989

APEC—Energy Efficiency and Conservation Theme; Bob Alderson; December 1991

Australian Approaches to the Production of Alternative Fuels, 14th Congress of the World Energy Conference; September 1989

Clean and Safe Energy Forever, Volume 2, Proceedings of the 1989 Congress of the International Solar Energy Society; September 1989

Compendium of Australian Energy Research and Development and Demonstration Projects, 1989

Energy and the Greenhouse Effect, 1990

Energy 2000: A National Energy Policy Paper; Department of Primary Industries and Energy; 1988

Energy and Environment; Response to Community Survey

Energy and Road Transport, 1990

Energy Research Programs in Australia, 1989

Fueling the 21st Century, New York: Hemisphere Publishing, 1989

Global Climatic Change, Issues for Australia, 1989

Issues in Energy Policy: An Agenda for the 1990s; Department of Primary Industries and Energy; June 1991

Launch of the Energy Guide; Louise Sylvan, Australian Consumers' Association

National Energy Management; Alan Griffiths, Minister for Resources; October 1990

Renewable Energy, EPD Discussion Paper No. 3, Energy Programs Division, Department of Primary Industries and Energy; I.J. Walker and M.R. Stevens; November 1990

The Role of Alternative Fuels and Conservation in Australia's Energy Future, 14th Congress of the World Energy Conference; September 1989

The Energy Guide; Australian Government and Australian Consumers' Association

Working Papers:

- Energy Efficiency Measures to Reduce Environmental Impact
- Energy Efficiency Program
- A National Strategy for the Natural Gas Industry

Title: Solar Industrial Process Steam Demonstration Plant	Project Type: Study/demonstration
Organization: University of New South Wales (School of Mechanical Engineering)	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Study/demonstration of a solar industrial steam system	Technology: A pilot system to measure performance, uncover design programs, and test integration with conventional boilers
Results: Development of actual system was riddled with problems concerning data collection and steel corrosion. Refinements are in development.	Reference: Clean and Safe Energy Forever

Title: Energy Use in the Plastics and Rubber Industry	Project Type: Study/demo; tech transfer
Organization: Enman Pty. Ltd., through DPIE	Date: Study completed December 1991; technology transfer phase to begin early 1992
End-use Sector: Industry	Affiliated/Future Projects: None
Description: An analysis of the type, extent and patterns of energy use in enterprises employing powder metals technologies; an analysis of the options for improving energy efficiency and the cost-effectiveness of those options	Technology: Compressed air systems, steam reticulation and use, process heating and cooling, extrusion systems, general energy management improvement
Results: Potential energy savings of almost 20% were identified, arising mainly from the upgrading of technology applications.	Reference: DPIE

Title: Energy Audit Scheme (to 1989); Enterprise Energy Audit Program (since 1991)	Project Type: Audit; study/demo
Organization: Dept. Primary Industries & Energy, energy management consultants	Date: 1980-81 to 1988-89
End-use Sector: Industry; commercial building	Affiliated/Future Projects: Energy management seminar/workshop support program
Description: Initial program provided financial support for small-scale walk-through energy audits of industrial and commercial enterprises (up to 50% of cost to a set limit of \$300 per audit). New program provides similar service for more detailed audits, with a \$5,000-per-audit limit on government contribution.	Technology: Full range of process and control technologies covered
Results: Ratio of savings to audit costs averaged 20:1 for walk-through audits across all industries. Given nature of audits, most savings were low-cost, energy management options. Insufficient data were available from results of new program, but substantially greater savings/outlay ratios have been achieved so far.	Reference: DPIE

Title: Improving Energy Use in the Australian Textile Industry	Project Type: Study/demo; tech transfer
Organization: Energetics Pty. Ltd. (through NERD&D Program)	Date: August 1986 to August 1987
End-use Sector: Industry (textiles, clothing, and footwear)	Affiliated/Future Projects: Dyehouse vessel insulation (a demonstration project arising from the study)
Description: An analysis of the type, extent, and patterns of energy use in the textile industry sector; an analysis of the options for improving energy efficiency and the cost-effectiveness of those options	Technology: Textile stenters and dryers, wet processing technologies and dyehouse heat recovery, wool scouring and drying, carpet printing and drying, continuous drying plant
Results: Potential energy savings of over 20% in the wet processing operations of textile manufacture; 10% savings in other areas. Some firms have achieved savings of 30% and more.	Reference: National Energy Research, Development and Demonstration Program (contact per DPIE)

Title: A Study of Energy Use and Potential for Improved Energy Efficiency in the Australian Foundry Industry	Project Type: Study/demo; tech transfer
Organization: Gas & Fuel Corporation of Victoria (through NERD&D Program)	Date: June 1986 to February 1988
End-use Sector: Industry (basic metals subsector)	Affiliated/Future Projects:
Description: An analysis of the type, extent, and patterns of energy use in the foundry industry sector; an analysis of the options for improving energy efficiency and the cost-effectiveness of those options	Technology: Heat recovery, process control, combustion technologies and management systems, general energy management of operations
Results: A range of energy-efficiency improvement options were identified; overall, potential for energy-efficiency improvement was nearly 10%, based on better management and investments with an average payback of 15 months. A need for further demonstration work, particularly on ladle preheating, was identified (and subsequently undertaken).	Reference: National Energy Research, Development & Demonstration Program (contact per DPIE)

Title: Energy Use and Potential for Increased Energy Efficiency in the Australian Diecasting Industry	Project Type: Study/demo; tech transfer
Organization: Merz Australia Ltd.	Date: Study completed December 1990; technology transfer continues
End-use Sector: Industry (basic metals subsector)	Affiliated/Future Projects: Powder metals industry study
Description: An analysis of the type, extent, and patterns of energy use in the diecasting industry sector; an analysis of the options for improving energy efficiency and the cost-effectiveness of those options	Technology: Heat recovery, process control, furnace burner control and management systems, compressed air systems, general energy management of operations
Results: A range of energy-efficiency improvement options were identified; overall, energy-efficiency improvement potential is approximately 25% through short-term measures, having the potential for an additional 25% if maximum technology upgrade options are exercised.	Reference: DPIE

Title: A Study of Energy Use in Basic Metals Industries Using Powder Metal Technologies	Project Type: Study/demo; tech transfer
Organization: Merz Australia Ltd.	Date: Study completed December 1990; technology transfer continues
End-use Sector: Industry (basic metals subsector)	Affiliated/Future Projects: Diecasting industry study
Description: An analysis of the type, extent, and patterns of energy use in enterprises employing powder metals technologies; an analysis of the options for improving energy efficiency and the cost-effectiveness of those options	Technology: Furnace control, sintering mediums and processes, waste heat recovery, RBO zone development, press design
Results: Potential short-term energy-efficiency improvements of 25% were identified; an additional 25% potential savings is possible if all technology upgrade options are exercised.	Reference: National Energy Research, Development & Demonstration Program (contact per DPIE)

Title: Four Projects Demonstrating Energy-Efficiency Improvement Potential in Furnace Operation	Project Type: R&D; tech transfer
Organization: Gas & Fuel Corporation of Victoria (2); Energetics Pty. Ltd. (2)	Date: 1987 to 1988
End-use Sector: Industry (basic metals, metal products)	Affiliated/Future Projects: None
Description: Projects covered four areas of high-temperature process heating: nonferrous metal extrusions; fastener manufacture; aluminum remelt facilities, and ferrous piecework production. The task was to identify options to improve efficiency through burner control, better heat treatment, and heat recovery.	Technology: The four technologies were (1) a radiation-type waste heat recuperator for a high-temperature furnace in corrosive environment, (b) self-recuperative burners for radiant tube fired furnace, (3) regenerative burners in an aluminum remelt operation, (4) rapid fired heater for metal piecework.
Results: All projects demonstrated substantial efficiency improvements, having an average payback on investments of less than 2 years. The self-recuperative burners in the fastener manufacturing plant had only modest returns on energy grounds but also allowed a 17% productivity improvement, reducing payback of the \$72,000 investment to 2.1 months.	Reference: DPIE

Title: Solar Powered Electrical Services for Remote Aboriginal Homeland Settlements	Project Type: R&D
Organization: Solar Energy Research Institute of WA, Murdoch University (through NERD&D Program)	Date: January 1986 to March 1988
End-use Sector: Renewable energy; residential building	Affiliated/Future Projects: None
Description: Development of a photovoltaic-based power supply system for integration into transportable housing systems and settlements to provide water pumping, radio communications, lighting, refrigeration and cooling for remote, arid and tropical settlements	Technology: Transportable photovoltaic power units and associated electrotechnology
Results: Systems were established and high levels of reliability and performance were demonstrated.	Reference: NERD&D Program/DPIE

Title: Reducing Ferrous Melting Costs with Assisted Melting of Preheating	Project Type: R&D; study/demo
Organization: Metal Trades Industry Association/Gas and Fuel Corporation of Victoria	Date: Completed December 1988
End-use Sector: Industry (basic metals)	Affiliated/Future Projects: Foundry industry study
Description: Project designed to evaluate the extent of further potential efficiency gains in foundry operations, consequent upon a study of energy-efficiency improvement opportunities in that sector	Technology: Preheat technologies, particularly charge bucket preheaters and vibratory bed preheaters
Results: The effectiveness and efficiency of the technology is highly sensitive to type and structure of foundry operations. However, potential for improvement in foundry furnace productivity of up to 18% was identified.	Reference: NERD&D Program/DPIE

Title: Potential for Gantry Systems in Australian Agriculture	Project Type: Study/demonstration
Organization: Darling Downs Institute of Advanced Education/NERD&D Program	Date: 1985 to 1987
End-use Sector: Industry (agriculture, horticultural crops)	Affiliated/Future Projects: None
Description: Gantry harvesting had had limited application in Australia. The purpose of the study was to evaluate the potential of gantry harvesting for use in cropping a wider range of vegetables and lucerne.	Technology: Alternative gantry systems and operating techniques
Results: Modeled gains were seen in productivity: 5% increase in yield; reduced tillage requirements; 10% reduction in picking costs; reduced levels of soil impaction. Energy savings of 50% were realized, principally due to reduced tillage requirements	Reference: National Energy Research, Development & Demonstration Program/DPIE

Title: Energy Management in the Brick Industry	Project Type: Study/demonstration
Organization: NSW Department of Energy/NERD&D Program	Date: June 1986
End-use Sector: Industry (bricks and ceramics)	Affiliated/Future Projects: None
Description: An analysis of the type, pattern, and efficiency of energy use in brickmaking, and an analysis of the potential for further energy-efficiency improvements	Technology: In tunnel kilns, insulation of kiln cars; effective stack penetration by flames and hot gases; heat extraction from fired bricks; gas circulation in preheater. In intermittent kilns, separate dryers using heat recovered from fired bricks; shortened cycle times.
Results: Savings from basic housekeeping and modest investment would allow energy savings of more than 10%. A specific fuel consumption of 10 gigajoules per 1000 units represents a reasonable performance target but would require more substantial investment by a number of enterprises.	Reference: National Energy Research, Development & Demonstration Program/DPIE

Title: LPG-powered Buses	Project Type: Study/demonstration
Organization: Transperth	Date: Commenced early 1980s; continuing
End-use Sector: Transportation (urban)	Affiliated/Future Projects: Natural gas-fueled urban buses
Description: Use of LPG as a fuel for urban bus fleets in Perth.	Technology: Buses with commercially available spark ignition engines designed to operate on LPG
Results: Transperth has operated its LPG fueled city buses for around 10 years and has accumulated over 1 million kilometers of operating experience with them.	Reference: DPIE

Title: Natural-gas-powered Trucks	Project Type: Study/demonstration
Organization: Gas and Fuel Corporation of Victoria, AGL Sydney Pty Ltd., Gaspower Technology Australia Pty Ltd., International Harvester Australia Ltd., Ford Motor Company of Australia Ltd.	Date: Commenced 1988; continuing
End-use Sector: Transportation (road)	Affiliated/Future Projects: Natural-gas-powered buses
Description: Development of natural gas engines and their demonstration in urban and, more recently, line haul trucks.	Technology: Spark-ignition and dual fuel engine technology, refueling systems, and lightweight gas cylinders
Results: Electronically controlled systems have been developed that maximize the substitution of gas for diesel in a dual fuel engine.	Reference: DPIE

Title: Natural-gas-powered Buses	Project Type: Study/demonstration
Organization: Transperth, Gas and Fuel Corporation of Victoria, Brisbane City Council, New South Wales State Transit Authority, South Australian State Transport Authority, Benders Busways	Date: Commenced 1988; continuing
End-use Sector: Transportation (urban)	Affiliated/Future Projects: Natural-gas-fueled trucks
Description: Trials in the use of natural gas as a fuel for urban bus fleets in major Australian cities.	Technology: Buses with commercially available spark-ignition engines designed to operate on natural gas; refueling systems and lightweight gas cylinders
Results: The first of these trials was conducted in Perth, where three buses have accumulated some 250,000 kilometers.	Reference: National Energy Research, Development and Demonstration Program/DPIE

Title: Five-star Design Rating for New Homes	Project Type: R&D; study/demo
Organization: Glass, Mass & Insulation Council of Australia, University of New South Wales, Commonwealth and state governments	Date: Continuing
End-use Sector: Residential building	Affiliated/Future Projects: Passive solar public housing in Sydney growth areas (NERD&D Program project); <i>Energy Efficient Australian Housing</i> (consumers' guide); Home Energy Rating Scheme/minimum energy-efficiency standards for new housing (currently being developed)
Description: Development of design and materials criteria attuned for a range of local climatic conditions to maximize the comfort and energy efficiency of new houses	Technology: Climate mapping and climate/comfort zone profile development; materials characteristics; optimizing of glazing, thermal mass and insulation levels
Results: Detailed profiles covering all elements of design and construction for all temperate zones in Australia; work remains to be done on tropical zones; builders' and designers' manuals completed and marketing package developed.	Reference: DPIE

Title: Passive Solar Housing in Sydney Growth Areas	Project Type: Study/demonstration
Organization: University of New South Wales, New South Wales and Commonwealth governments	Date: Completed December 1986
End-use Sector: Residential building	Affiliated/Future Projects: Five-star design rating for new homes; <i>Energy Efficient Australian Housing</i> (consumers guide); House Energy Rating Scheme/minimum energy-efficiency standards for new housing (currently being developed)
Description: The design, construction, and long-term monitoring of 12 energy-efficient and three standard houses.	Technology: Typical Australian house designs with varying levels of insulation and thermal mass
Results: With appropriate orientation of windows, the use of wall insulation and added thermal mass (concrete slab floors), it was possible to reduce space heating/cooling requirements by 50%-90%. In Australia, houses typically have timber floors and no insulation in the walls.	Reference: DPIE

Title: Organic Rankine Cycle (ORC) Engine for Electricity Generation by Hot Artesian Bores	Project Type: R&D; study/demo
Organization: Enreco Pty. Ltd./University of Sydney (through NERD&D Program)	Date: Completed March 1987
End-use Sector: Renewable energy; residential building; and agriculture	Affiliated/Future Projects: None
Description: Development of a prototype ORC engine for use on remote agricultural properties that have access to (and rely on) artesian bores for water supplies.	Technology: ORC engine designed for low temperature (75°-100°C) artesian bore water
Results: The economics of the system is excellent where hot bores are available. Payback in terms of energy savings on the demonstration model was 6.5 years, but the unit was oversized and lower cost units would be more economical. There also have been productivity gains in the provision of water for stock.	Reference: National Energy Research, Development & Demonstration Program/DPIE

Title: All-vanadium Redox Cell for Remote Area Energy Storage	Project Type: R&D
Organization: University of New South Wales (through NERD&D Program)	Date: Completed December 1986
End-use Sector: Renewable energy; residential buildings; and agriculture	Affiliated/Future Projects: None
Description: Development of a battery storage system that improved the reliability and cost-effectiveness of redox cells for use in RAPS	Technology: Trials of a number of materials for use in electrodes and membranes. The most effective were demonstrated to be (a) carbon felt RVC-2000 for both electrodes (b) Asahi Selemin CMV cation selective membrane (c) single cell consisting of two half-cells containing vanadyl sulphate and sulfuric acid in water connected to a tank containing additional quantities of the vanadyl sulphate solution.
Results: System performed well with none of the poor ampere/hour and watt/hour efficiencies more common to iron/chromium redox cells. Capable of rapid recharging if necessary by draining solutions of discharged electrolyte and replacing with solutions recharged separately. Membrane life estimated to be at least two years. Cost per kWh compares favorably with lead-acid batteries.	Reference: National Energy Research, Development & Demonstration Program/DPIE

Title: ASEAN–Australia Energy Cooperation Project - Technical Group on Biomass	Project Type: R&D
Organization: ASEAN–Australia Energy Cooperation Project - Phase I	Date: 1982; continuing
End-use Sector: Renewable energy (biomass for heat and power)	Affiliated/Future Projects: ASEAN - Australia Energy Cooperation Project - Technical Group on Energy Conservation
Description: A joint project to help ASEAN capitalize on its biomass resources through enhancing ASEAN research capability and developing fluidized bed combustion (EBC) and gasification technologies.	Technology: Fluidized bed combustion; gasification
Results: ASEAN was able to study advanced FBC technology as well as to design prototype to a point where FBC units could be manufactured on a commercial scale. (a) Successful trials on tree species shown that ASEAN could reclaim marginal lands for production of biomass, (b) ASEAN's research capabilities regarding gasification systems are now at an advanced stage.	Reference: Clean and Safe Energy Forever. <i>Proceedings of the 1989 Congress of the International Solar Energy Society</i>

Title: ASEAN–Australia Energy Cooperation Project - Technical Group on Conservation	Project Type: Study/demo; audit; policy assessment
Organization: ASEAN–SCNCER and Australian government	Date: 1982; continuing
End-use Sector: All sectors	Affiliated/Future Projects: ASEAN–Australia Energy Cooperation Project - Technical Group on Energy Conservation
Description: A joint project to help ASEAN develop long-term energy conservation strategies and energy management	Technology: Thermal Energy System Optimization, Linhoff/Pinch Techniques, LPG conversion kits, palm oil processing, building energy management, insulation, and heat pumps
Results: (a) ASEAN agencies can now conduct energy audits. (b) ASEAN can now undertake advanced buildings simulations and modelling to improve designs of new structures and retrofits. (c) Agriculture and transportation sectors have benefitted from studies. (d) Energy Planners have skills and data to develop long-term strategies.	Reference: ASEAN–Australia Energy Cooperation Project - Phase I

Brunei Darussalam

Brunei Darussalam shares the island of Borneo with Malaysia and Indonesia. The land area totals 6,000 km², and there is a population of 256,000.

Evaluating the economy of Brunei is difficult both because it is a small country and because the country does not make estimates of economic indicators. The World Bank classifies Brunei as an upper-income country.

The economy of Brunei is highly dependent on oil and gas production, and most of the capacity is sold under fixed contract. Government expenditures are closely related to government revenues from the sale of oil. In 1988, the government experienced a fiscal deficit for the first time since 1930. Small fiscal deficits are expected for 1991 and 1992.

Brunei has diversified its economy, but the oil economy contributes about 60% of gross domestic product (GDP). Construction is the next largest sector comprising about 20% of the GDP. Most of the other private sector activity is in the form of government contracts. For example, the government contracts building maintenance, refuse collection, and construction of public works.

The government recognizes the importance of diversification for the long-term economic welfare of the country. In the current five-year development plan, the government has outlined a plan to attract foreign investment and encourage local entrepreneurs.

Moderate growth in the Brunei economy will continue, with a GDP increase of 2% to 3% a year. If the price of oil rises sharply above \$US18 per barrel, the *Pacific Economic Outlook* forecasts growth in the 4% to 5% range. Brunei has accumulated official international reserves of US\$20 to US\$25 billion. These reserves earn a return for the country and could help support a development program. The Malay-Islamic monarchy usually guides development consistent with maintaining the traditional cultural heritage of the nation.

Energy Use and Policy Issues

Brunei is well endowed with natural reserves of oil. At one point, production reached 700,000 barrels per day. The country usually produces 150,000 barrels per day.

Electricity, water, telephones, and postal services are supplied by government departments. The government subsidizes the cost of these services to consumers.

Energy Efficiency and Conservation

No information on the situation of energy efficiency and conservation in Brunei is available, and no data describing energy-efficiency projects have been received from Brunei.

Canada

Canada occupies the northern third of North America, having a total land area of 9,976 thousand km². There are approximately 27 million people.

A parliamentary democracy governs Canada; an elected prime minister acts as the head of the state.

Canadian gross domestic product (GDP) reached US\$570,150 million in 1990, up from US\$52,870 million in 1965. This represents an average annual growth rate of 3.4% for the period 1980 to 1990. The GDP rose 0.9% in 1990. A GDP growth of -1.1% was predicted for 1991.

For 1990, the lending rate averaged 14.1%. The average rate of inflation was 4.4% from 1980 to 1990.

In 1990, exports totaled US\$125,056 million and imports totaled US\$ 115,882 million. Over the period 1980 to 1990, exports grew at an average annual rate of 5.9%, and imports grew at an average annual rate of 8.4%. In 1990, exports weakened as the Canadian dollar appreciated. Manufacturing and construction contracted, and unemployment soared to 10.2%.

For 1992, the *Pacific Economic Outlook* predicted the Canadian gross national product would increase 3.6%. Exports should grow at a rate of 2.1%. Inflation should be around 3%, interest rates should be around 4.5%, and unemployment will stay above 10%.

Energy Use and Policy Issues

Canada's climate, geography, and industry make it a very energy-intensive country. In 1988, Canada's total energy output was 249.5 million tons of oil equivalent (Mtoe). By 2000, this is expected to increase to 331.8 Mtoe.

Per capita energy consumption equaled 10,009 kilograms of oil equivalent (kgoe) in 1990, up from 6,007 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 2.1%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 4.5%. Canada uses the second highest amount of energy per capita in the world.

Canada possesses large quantities of almost every energy resource. Exports of oil, natural gas, and coal increased in 1988, and the International Energy Agency predicts this trend will continue.

In 1985, Canada deregulated its oil and gas industry and opened markets to competition. It hoped to increase the competition and increase the choices available to consumers. The government also deregulated the energy trade between the United States and Canada, which allows bilateral electricity trade.

Canadian electricity generation reached 101 gigawatts (GW) in 1988. The capacity came from hydroelectric (57%), coal (19%), nuclear (12%), and petroleum (11%). It is estimated that Canadian utilities will spend C\$95 million by 1998 to ensure adequate supplies of electricity.

The Canadian uranium industry is the leading producer and exporter in the world. At the end of 1988, there were 18 nuclear power plants having a capacity of 11.9 GW. The government of Canada plans to continue the research and development of nuclear power.

Energy Efficiency and Conservation

The Canadian government and the Canadian universities conduct considerable research on renewable energy and conservation. The scope and accomplishments of their projects are large, and Canada is very advanced in these fields. The Canadian government implements energy efficiency and renewable research and development through Energy, Mines, and Resources of Canada (EMR), in particular the Efficiency and Alternative Energy Technology Branch (EAETB).

Government programs have been a significant factor in promoting energy conservation, fuel switching, and energy-efficiency investments. The large grant programs of the late 1970s and early 1980s allocated more than C\$550 million annually to these programs.

In 1988, a new program was started, Energy Efficiency and Diversity, scheduled to run for five years at a cost of C\$50 million annually. It emphasized information programs to raise awareness of existing and new technologies, and involved consumers, industry, and other levels of government in partnership.

Between 1979 and 1989, EMR supported demonstrations of energy conservation and renewable technologies. This was done through a group of programs that included R-2000 (high-efficiency housing); the Remote Community Demonstration Program; the Solar Energy Demonstration; the Energy Task Forces; the Forest Industry Renewable Energy Program; Pro-Trucker; and the Federal Energy Management Program. These programs covered industrial demonstrations, buildings, transportation, alternative fuels, energy systems, bioenergy, and renewables.

The Canada Centre for Mineral and Energy Technology (CANMET) is the main research and technology development arm of EMR. With more than 550 professional scientists, engineers, and technicians on staff, and research and testing complexes in Nova Scotia, Quebec, Ontario, and Alberta, CANMET is one of the largest technology development centers in the country.

Through exploratory research, commercial and cost-shared R&D, product testing, and technology transfer, CANMET assists Canada's minerals, metals, and energy industries.

Under a new mandate, CANMET is working more closely with Canadian businesses and institutions. CANMET's EAETB includes the Energy Efficiency Division, the Alternative Energy Division, and the Energy Diversification Research Laboratory. The branch is responsible for research, development, and the commercialization of technologies in the fields of energy efficiency, renewable energy, and alternative transportation fuels.

EAETB also provides technical advice to other government agencies and technical support to the policy and program initiatives of EMR, such as the Energy Efficiency and Diversity Initiative and the Panel on Energy Research and Development.

Canada's support of energy efficiency is expected to increase as a result of the energy component of federal environmental policy, which is known as the Green Plan. Environment Canada is the lead agency for implementation of this effort, but other departments, such as EMR, are involved as well.

In 1991, Canada passed the National Energy Efficiency and Alternative Energy Act. The act delivers on the Green Plan commitment that legislation would be introduced to allow the federal government to set minimum energy-efficiency standards on equipment, to require the energy consumption labeling of

equipment, and to gather information and data on Canadian energy consumption and the use of alternative energy.

The current EMR efficiency and alternative energy program has the following main components:

- General
 - Energy Innovators Ventures—to encourage major energy-using organizations to exploit energy-efficiency and alternative energy opportunities by reaching agreements with them on performance and/or prescriptive initiatives they will undertake.
 - National Energy Use Data Base—to improve the knowledge about the use of energy in Canada by organizing and expanding a national data base in this area.
 - Integrated Resource Planning—to improve the effectiveness of resource planning by electrical and natural gas utilities by encouraging the increased integration of demand-side management (DSM), nonutility generation, cogeneration, and district heating and cooling into the utility planning process.
- Energy efficiency in equipment
 - Energy-Efficiency Standards for Equipment—to phase out inefficient equipment from the Canadian market by establishing, in cooperation with provincial governments, national energy-efficiency regulations for equipment.
 - Energy Equipment Labeling—to require manufacturers to affix Energuide labels to equipment to inform consumers about the product's energy consumption.
- Buildings
 - Building Energy Code—to develop national model energy codes and specify minimum acceptable levels of thermal performance; and to promote their incorporation into provincial/municipal building codes.
 - Building Information Transfer—to promote the adoption of energy-efficient technology by increasing public and industry awareness of energy-efficiency opportunities and products available to the building sector.
 - R-2000 Partnership—to promote energy-efficient houses and to train builders in the techniques required to design, construct, and market these houses.
 - Buildings R&D and Technology Transfer—to develop and commercialize energy-efficient and passive solar technologies in the residential and commercial sectors of the economy.
- Industry
 - Industry Energy Efficiency—to help reduce emissions of CO₂ and to enhance Canada's industrial competitiveness by increasing the efficiency of energy use in goods-producing industries.

- Industry Targeted Research and Development—to identify and foster opportunities for energy management research and development, field trials, and technology transfer opportunities that could improve energy efficiency, reduce environmental emissions, and improve industrial productivity.
- Alternative transportation fuels
 - Technology and Market Development—to promote the development and market penetration of alternative fuel vehicles in Canada.
 - Research and Development—to promote research on and development of alternative transportation fuels such as natural gas, propane, alcohol fuel, and electric vehicles.
- Environmental stewardship program
 - Federal Buildings Initiative—to assist federal departments to improve the energy efficiency of their facilities through a variety of techniques, including savings-financing.

Provincial governments and research organizations also support research and development on energy efficiency and renewable energy under mandates to encourage and facilitate scientific and technological development.

Demonstrations of technical prototypes based on these research activities are undertaken by some provincial governments. For example, the Ontario Ministry of Energy has contributed C\$6 million over the last three years toward joint government/industry projects, including initial technical demonstrations of innovative energy technologies under the EnerSearch Program.

All provincial governments mandated with energy technology developments are members of the Interprovincial Advisory Committee on Energy (IPACE). Two IPACE subcommittees are currently in place: (1) Coal Coordination and (2) Conservation and Renewable Energy. The purposes of these committees are for discussions of areas of common concern and coordination of provincial efforts.

Utilities continue to work on projects that promote energy efficiency through both technical and market development demonstrations. DSM is now a major area of interest to the Canadian Electrical Association and its member utilities.

Trade organizations such as the Solar Energy Society of Canada and the Canadian Wind Energy Association actively promote renewable energy and conservation by sponsoring conferences, publishing newsletters, and lobbying the government for support of renewable energy technologies.

Bibliography

CADDET Strategy Plan, December 2, 1991

CANMET IS, Canada Center for Minerals and Energy Technology

Canada's Green Plan (news release dated October 29, 1991)

Energy Partnership: Programs for 1991-92, Ministry of Energy of the Province of Ontario

Energy Solutions for Today: 14th Annual Conference of the Solar Energy Society of Canada Inc. Proceedings; Solar Energy Society of Canada; June 1988

Renewables—A Clean Energy Solution Conference Proceedings, 15th Annual Conference of the Solar Energy Society of Canada; June 1989

Seventh Canadian Bioenergy R&D Seminar Proceedings, Bioenergy Development Program: Energy, Mines and Resources Canada; April 1989

Technologies for a Cleaner Environment, 1991

The Leading Edge '84: The Seventh Annual Wind Energy Symposium Proceedings; National Research Council of Canada; December 1984

Title: The Pyrocore Ceramic Matrix Burner	Project Type: R&D
Organization: Esso Petroleum Canada	Date: 1989
End-use Sector: Industry (Process)	Affiliated/Future Projects: None
Description: Research and development into a low nitrogen oxide emissions burner that would allow industries to comply more cost-effectively with emissions standards.	Technology: Ceramix fiber-matrix burners uses a porous surface of ceramic fibers to burn pre-mixed fuel gas and air resulting in a surface that radiates high levels of infrared energy while reducing nitrogen oxide emissions
Results: High combustion efficiency, low nitrogen oxide emissions, lower investment costs, low maintenance, low noise.	Reference: Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADETT), International Energy Agency (IEA)

Title: Passive Solar Technology	Project Type: R&D; study/demo
Organization: Energy, Mines, and Resources of Canada (EMR), universities	Date: Ongoing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: Low Energy Housing; The Solar Energy Society holds conferences annually.
Description: Researchers developed passive solar homes, modeling systems, demonstration homes, and solar collectors. They also studied daylighting, agricultural drying, and active solar technologies.	Technology: Passive solar
Results: Researchers developed superglazing for windows, computer models, and design guides.	Reference: Solar Energy Society of Canada

Title: Habitsol House	Project Type: Study/demonstration
Organization: International Energy Agency (IEA), Thermtech Incorporated	Date: 1991
End-use Sector: Residential building	Affiliated/Future Projects: Unknown
Description: A 250-m ² factory-built pre-fabricated bungalow uses a fully glazed sunspace, thermal storage, and a small swimming pool to reduce heating costs.	Technology: Passive solar
Results: Passive solar contributed 28% of the heating, internal gains 34%, and electric heating 38%.	Reference: IEA CADDET Program

Title: Solar Light Pipe	Project Type: Study/demonstration
Organization: IEA CADDET, TIR Systems Limited, Konvey Construction	Date: 1991
End-use Sector: Commercial building	Affiliated/Future Projects: Unknown
Description: Eight tracking mirrors funnel light down plastic pipes into an office. A high-powered metal halide bulb provides light for nights and cloudy days.	Technology: Solar light pipe
Results: The solar lighting system illuminates 244 m ² on the fifth floor of an office complex. It provides light without heat and reduces worker fatigue.	Reference: IEA CADDET

Title: Energy Storage	Project Type: R&D
Organization: IEA (Canada, United States, and others)	Date: 1978; continuing
End-use Sector: Utility; residential, commercial buildings	Affiliated/Future Projects: None
Description: R&D, technical, and economic assessments of various energy storage technologies. Current research is on advanced heat storage systems, including those that derive heat from chemical change. Also studying environmental impact of thermal energy storage in water-bearing geological structures.	Technology: Various
Results: Evaluated seven options ranging from heat storage in natural underground basins in Sweden to a chilled storage system at New York's Kennedy Airport. Also operated a thermal storage facility in Switzerland using waste heat from water treatment plant to heat a sports stadium.	Reference: IEA Joint R&D Projects (April 1990)

Title: Demand-Controlled Ventilation in Buildings	Project Type: R&D
Organization: IEA (participants are Canada and seven others)	Date: 1988; continuing
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: A review and assessment of current methods for regulating the quality of indoor air. Goal is to help in the design, operation, and maintenance of new automatically controlled building ventilation systems. Concentrates on demand-controlled systems that use sensors to monitor air pollutants and trigger automatic systems to improve ventilation.	Technology: Sensors, improved ventilation technology
Results: Participants are producing a reference book on the design of demand-controlled ventilation systems, including test results.	Reference: IEA Joint R&D Projects (April 1990)

Title: Passive Solar Design for Buildings	Project Type: R&D
Organization: IEA (participants are Canada, New Zealand, United States, and 13 others)	Date: 1982; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Goal is to achieve better understanding of how technology can be adapted to fit in with building energy systems, including a survey of data from passive solar houses built under different national demonstration programs; evaluation and validation of computer simulations of design performance; development of design and construction guides; construction and demonstration of houses; identification of the specific requirements of commercial buildings.	Technology: Passive solar
Results: Produced more than 20 technical reports, including design information booklets, describing outcomes and experience. Built several micro-computer models.	Reference: IEA Joint R&D Projects (April 1990)

Title: District Heating Technology	Project Type: R&D
Organization: IEA (participants are Canada, United States and eight others)	Date: 1983; continuing
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Studies and information sharing to reduce costs and encourage wider use of district heating. Includes developing better heat energy meters, the best design for coal-fired hot water central distribution units, etc.	Technology: District heating
Results: Produced a conceptual design for a 10-megawatt grate-fired hot water boiler. Participants reviewed the relative advantages of combined heat and power plants between 1 and 25 MW.	Reference: IEA Joint R&D Projects (April 1990)

Title: Strathcona Small Hydro Project	Project Type: Study/demonstration
Organization: Strathcona Park Lodge, Vancouver	Date: 1988
End-use Sector: Commercial building; renewable energy	Affiliated/Future Projects: Unknown
Description: The project uses a 75-kW twin nozzle pelton wheel turbine to supply power to an outdoor education school.	Technology: Mini-hydro, Pelton wheel
Results: The project cost \$236,000. It displaced \$37,000 per year in diesel costs.	Reference: Solar Energy Society of Canada

Title: Computer-controlled HVAC (heating, ventilating, and air conditioning) in Ottawa Courthouse	Project Type: Study/demonstration
Organization: IEA, Ontario Hydro, MCA Architects	Date: 1991
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: The new Ottawa courthouse was built to demonstrate energy-efficient technologies. It uses insulation, passive solar, heat recycling, and electronic controls.	Technology: Conservation, MCC Power Systems Computer-Controlled HVAC, insulation, efficient lighting.
Results: A computer monitors the building and selects optimum operation. The project achieved 34% energy savings. Energy consumption is 133.5 kWh/m ² .	Reference: IEA CADDET

Title: Photovoltaics (PV) in Canada	Project Type: R&D; study/demo
Organization: Industry, EMR	Date: Ongoing
End-use Sector: Renewable energy	Affiliated/Future Projects: Canadians set up a PV manufacturing company in Sri Lanka.
Description: PV systems have been used for irrigation, telecommunications, desalination, remote power, and consumer products.	Technology: PV, batteries, and system design
Results: University researchers developed and tested PV systems. EMR funds resource assessments. There is a small industry involved with installations.	Reference: Solar Energy Society of Canada

Title: Canadian Renewable Energy Demonstration (CREDA) Program	Project Type: Policy assessment; study/demo
Organization: National Energy Program	Date: 1978; continuing
End-use Sector: All sectors	Affiliated/Future Projects: Unknown
Description: A program to provide funding to demonstrate the technical and commercial viability of renewables.	Technology: All renewable energy sources
Results: CREDA funds biomass energy, wind energy, and solar energy.	Reference: Seventh Canadian Bioenergy R&D Seminar

Chinese Taipei

Chinese Taipei occupies an island of some 36,100 km² off the southeastern coast of mainland China. Twenty million people, mostly of Chinese origin, populate the island, making it one of the world's most densely populated countries.

Chinese Taipei possesses very few natural resources. However, through joint efforts among the people, industry, and government, Chinese Taipei has achieved an annual gross domestic product (GDP) growth of approximately 9% over the past 30 years. There are four key reasons for the success: an industrious, well-educated work force, high savings and investment, low labor costs, and sound macroeconomic management.

Chinese Taipei is a small open economy based on manufacturing products for export.

The government keeps tight control on fiscal policy and monetary policy. Revenues at all levels of government, including the state-run companies, typically equal expenditures. Debt service totals approximately 0.5% of exports. Government policies kept inflation to around 4.4% per year during 1980 to 1990.

Over the last 20 years, industry has accounted for 35% to 40% of gross national product (GNP), and manufactured goods exceeded 50% of total export shipments. Today, these goods account for 95% of sales abroad. Leading exports include textiles, machinery, metal products, and transportation equipment.

In 1989, exports totaled US\$84.28 billion and imports totaled US\$70.36 billion. The United States is Chinese Taipei's leading trading partner, buying 32.4% of the country's exports. Japan and Hong Kong also are large trading partners, each accounting for roughly 12% of Chinese Taipei's exports. Another important trading partner is the People's Republic of China; 15% of Chinese Taipei's exports pass through Hong Kong to mainland China.

Banking and financial markets are developing in Chinese Taipei. The country has a fully functioning money market, which began in 1976. It includes T-bills, commercial paper, bankers acceptances, and negotiable certificates of deposit. The total outstanding money was US\$157.9 million in 1990. Short-term debt instruments (less than one year), like government and corporate bonds, started trading in the mid-1980s. Long-term bond issues amounted to \$16.3 billion in 1990.

With a new six-year development plan (1991 to 1996), the government hopes to shift Chinese Taipei's economy towards the domestic and service market sectors. This plan calls for US\$303 billion in spending and expects to raise per capita national income, balance economic growth and development, and continue industrial development. Transportation and communications systems will absorb one-third of the capital inflow.

Energy Use and Policy Issues

Economic growth within Chinese Taipei has increased the demand for energy. Under the Ministry of Economic Affairs (MOEA), the government formed the Energy Commission to execute energy policy, planning, and law. In recent years, the Energy Commission has implemented a wide variety of energy conservation laws and has promoted efficient use of energy.

Total energy consumption in Chinese Taipei increased from 11 million kiloliters of oil equivalent (kLoe) in 1971 to 54 million kLoe in 1991. The annual average growth rate for this period was 8.3%. The Energy Commission predicts energy demand will increase to 112 million kLoe by the year 2010.

Chinese Taipei's per capita use of energy increased from 759 kLoe in 1971 to 2,641 kLoe in 1991, an average annual growth rate of 6.5%.

Chinese Taipei imports 95% of its energy. The energy supply consists of the following: oil (53%), coal (24%), natural gas (2%), hydropower (2%), nuclear (15%), and liquid natural gas (4%). By the year 2010, the Energy Commission predicts the energy supply will consist of the following: oil (35%), coal (26%), natural gas (20%), hydropower (3%), nuclear (14%), and new energy (2%).

Two parastatal companies dominate the energy industry: Taipower and Chinese Petroleum. They operate 57 power stations on Chinese Taipei and the surrounding islands. As of February 1992, these two companies operated 35 hydropower stations, 19 thermal power stations, and 3 nuclear power stations.

Demand for energy came from the following market sectors in 1991: industry (52%), transportation (15%), agriculture (3%), residential (12%), commercial (4%), feedstocks (8%), and others (6%).

Taipower generates, transmits, and distributes electricity in Chinese Taipei. In 1991, the total installed capacity was 18,383 megawatts (MW) and total consumption neared 91.2 billion kilowatt-hours (kWh). Sources were hydro (14%), coal-fired (26%), oil-fired (28%), gas-fired (4%), and nuclear (28%). The peak load in 1991 was 19,174 MW, an 8.6% increase over 1990. The average load was 10,174 MW, an 8.6% increase over 1990. Industry consumed 59% of the electricity, followed by residential users (20%) and commercial users (9%).

In 1973, the MOEA began to establish national energy policies. In 1979, MOEA formed the Energy Commission to enforce energy law and to promote energy technology. In 1990, the Energy Commission revised the national energy policy to minimize environmental degradation. According to the executive order, the national energy policy should

- Assure stable supply of energy by diversifying the sources of primary energy
- Promote rational energy pricing to reflect the true cost of energy
- Increase the efficiency of energy use
- Prevent energy-related environmental pollution
- Strengthen research and development (R&D) and encourage private sector involvement
- Promote energy education.

Energy Efficiency and Conservation

Energy-efficiency programs are seen as being important for the following reasons: economic development depends on imported energy development; electrical shortages have become an important issue in recent years; the energy intensive industry's share of consumption is still high; and the drop in energy prices has adversely affected energy conservation. It is the government's policy that energy prices should reflect actual costs and electricity prices should be structured to promote off-peak use of power and load leveling.

It is the government's policy that the industrial structure should be improved (less emphasis on energy-intensive industry) and energy productivity enhanced. Conservation programs should assist all enterprises in strengthening their energy management and promoting the installation of energy-saving equipment. Technical assistance should be provided to industry to encourage conservation. Inter-urban and urban mass transit should be accelerated, and motor vehicle fuel economy standards are to be continued. Buildings standards, as well as standards for energy-consuming equipment and devices, should be implemented.

R&D policy directs that programs should be undertaken concerning the technical aspects of energy conversion, distribution, storage, utilization, and conservation. R&D should be undertaken with private sector involvement.

Education and publicity should encourage educational institutions at all levels to foster energy-conserving habits among students. Active efforts to promote energy education should be pursued.

Chinese Taipei also has promoted the use of renewable energy. The government has funded R&D to develop and demonstrate uses for renewable technologies. The Energy Research Laboratory (ERL) administers these programs. In 1991, ERL was conducting research in at least 22 fields related to energy use.

The Energy Conservation Program in Chinese Taipei includes pricing policy, utilization policy, R&D, education, and publicity. The government has proposed measures that, if fully implemented, would reduce consumption by 1.8% per year. Based on past experience, the annual increment in peak power could be 1,990 MW; if conservation were fully implemented, that could be reduced by 960 MW. The projects of the Comprehensive Energy Conservation Program for the next six years that have been planned to achieve these energy-efficiency and load-shedding targets include the following:

1. Regulations and Standards

- a. Energy industry efficiency
- b. Energy audit
- c. Appliance efficiency standard
- d. Appliance labeling
- e. Vehicular fuel economy
- f. Government saving activities
- g. Transportation system
- h. Building code

2. Financial and Tax Incentives

- a. R&D in energy-saving devices
- b. Energy conservation investment
- c. Peak-shaving devices

3. Technology Research and Development

- a. R&D
- b. Technology transfer
- c. Certificate service
- d. Technical assistance

4. Information and Education

- a. School education
- b. Professional training
- c. Electricity-saving awareness
- d. Oil-saving awareness
- e. Publicity campaigns

Bibliography

Energy Statistical Data Book 1990; Energy Commission, Ministry of Economic Affairs; March 1991

Energy Conservation Program in Chinese Taipei; Energy Commission, Ministry of Economic Affairs

Energy-Efficiency Improvement in Industrial and Commercial Sectors; Energy Technical Service Center; April 1992

Energy Balances in Chinese Taipei, Republic of China, 1991; Energy Commission, Ministry of Economic Affairs; February 1992

ERL Energy Technology; Industrial Technology Research Institute

Chinese Taipei: Phase II of an Economic Miracle; Susumu Kato, Goldman Sachs Economic Research Group; April 1992

The Energy Situation in Chinese Taipei, Republic of China; Energy Commission, Ministry of Economic Affairs; February 1992

Title: Energy Audit Program	Project Type: Policy assessment
Organization: Ministry of Economic Affairs (MOEA)	Date: 1992; continuing
End-use Sector: Industry	Affiliated/Future Projects: Comprehensive Energy Conservation Programs, Energy Management Information System
Description: According to the energy management law, all firms consuming more than a specific amount of energy must conduct energy audits and submit plans for energy conservation programs. The law affects 3,800 factories using 40% of the total energy in Chinese Taipei and 50% of the peak load.	Technology: Conservation
Results: The program has raised the unit product per unit of energy at factories in at least six industries.	Reference: Energy Technical Service Center (ETSC), APEC questionnaire

Title: Energy-saving Technical Service for Manufacturing Factories and Oil Refineries	Project Type: Policy assessment
Organization: Energy Technical Service Center (ETSC)	Date: 1991 to 1993
End-use Sector: Industry	Affiliated/Future Projects: From 1992 to 1993, more than 600 factories will be audited; technical service programs
Description: The project will conduct energy audits of 820 factories for 100 types of energy equipment and five types of furnaces. A total of 572 suggestions was made for improved efficiency. Efficiency will be improved at oil refineries.	Technology: Conservation
Results: In 1991, 207 factories were audited for a total savings of NT\$68 million or 33.5 million kWh. Unit energy consumption per liter of crude has improved from 149.1 (Mkcal) to 140.6 (Mkcal).	Reference: Energy Technical and Service Center

Title: Cogeneration System Promotion Program	Project Type: Policy assessment
Organization: MOEA, Energy Technical and Service Center	Date: 1988; continuing
End-use Sector: Industry	Affiliated/Future Projects: Technical service programs
Description: A government policy titled "Measures for Promoting Cogeneration Applications" was passed in 1988. The program initiated incentives in the form of low interest loans and tax credits, and guaranteed the buy-back of surplus electricity.	Technology: Cogeneration
Results: Cogeneration capacity increased in the last few years. In 1991, there were 51 plants equipped with 1,517-MW cogeneration capacity. There were also 1,339 MW under construction. About 1,600 potential users were contacted.	Reference: Questionnaire, Energy Technical and Service Center

Title: Vehicular Fuel Economy	Project Type: Policy assessment
Organization: MOEA	Date: January 1988; continuing
End-use Sector: Transportation	Affiliated/Future Projects: Comprehensive Energy Conservation Programs. A mass transportation system is also under consideration.
Description: The government implemented fuel economy standards that have gone into effect in three phases: 1988, 1990, 1992.	Technology:
Results: The savings in fuel are expected to be 5% to 7% for passenger cars and 11% to 13% for motorcycles. The annual gasoline savings will be between 380 and 490 million liters.	Reference: ETSC, APEC questionnaire

Title: Energy-Efficiency Standard for Fishing Boat Engines	Project Type: Standards and codes; policy assessment
Organization: MOEA	Date: 1989; continuing
End-use Sector: Transportation	Affiliated/Future Projects: Comprehensive Energy Conservation Programs
Description: Imported engines and new engines must meet efficiency standards.	Technology:
Results: The cost of fuel will decrease NT\$140 million yearly.	Reference: ETSC, APEC questionnaire

Title: Solar Hot Water System Popularization Program	Project Type: Policy assessment; study/demo
Organization: MOEA	Date: January 1986 to 1991
End-use Sector: Residential building (water heating)	Affiliated/Future Projects: Comprehensive Energy Conservation Programs
Description: The popularization program consisted of technological development, system demonstration, and subsidies. The subsidies can be as much as NT\$1,000 per square meter (m ²).	Technology: Solar hot water
Results: The subsidized installation area of solar hot water collectors reached 247,000 m ² in 1990. Consumers are installing heaters at the rate of approximately 55,000 m ² per year. The number of solar hot water manufacturers has increased from 23 in 1986 to 60 in 1990.	Reference: ETSC, APEC questionnaire

Title: Service for Air Conditioners	Project Type: Study/demonstration
Organization: MOEA	Date: July 1990; continuing
End-use Sector: Commercial building (air conditioning)	Affiliated/Future Projects: Technical service programs. Increased efficiency in vending machines also has been considered.
Description: A task force was organized to service 640 large air conditioning systems.	Technology:
Results: The program should reduce 40 MW of summer peak load.	Reference: APEC questionnaire

Title: Air Conditioning Systems Using Thermal Ice Storage	Project Type: Study/demonstration
Organization: MOEA, Energy Technical and Service Center.	Date: 1990 to 1993
End-use Sector: Commercial building (air conditioning)	Affiliated/Future Projects: Technical service programs
Description: The ETSC will promote the use of thermal energy storage for large central air conditioning users. Ice will be made during off-peak hours for use in air conditioning systems. The project will service 160 out of 300 potential users.	Technology: Thermal energy storage systems
Results: Approximately 90 thermal storage systems have been set up. The project will shift 160 MW of Taipower's peak-load. 160 MW is 4% of TPC air conditioning peak load.	Reference: APEC questionnaire, Energy Technical and Service Center

Title: Five-Year Energy Conservation Program	Project Type: Policy assessment
Organization: MOEA, Energy Conservation Task Force, China Technical Consultants	Date: June 1987 to 1991
End-use Sector: Industry; commercial building	Affiliated/Future Projects: National Six Year Development Plan
Description: A five-year energy conservation program was planned to implement a conservation project, publish information, provide training, and promote conservation. The program has four parts: Regulations & Standards, Financial & Tax Incentives, Research & Development, and Information & Education.	Technology: Conservation
Results: The program has saved NT\$7,617 million worth of energy.	Reference: Energy Technical Service Center

Title: Energy Pricing Policy	Project Type: Policy assessment
Organization: MOEA	Date: 1991 to 1996
End-use Sector: Commercial, residential buildings; industry	Affiliated/Future Projects:
Description: As part of the conservation program, the pricing structure will be revamped so that the price of energy will represent the actual cost.	Technology: Conservation
Results: The utilities have set peak and off-peak tariffs.	Reference: Energy Conservation in Taiwan

Title: Education and Information Program	Project Type: Policy assessment
Organization: Energy and Resources Laboratories (ERL), Energy Technical Service Center	Date: 1980; continuing
End-use Sector: Commercial, residential buildings; industry	Affiliated/Future Projects:
Description: The education campaign has five areas: School Education, Training, Electricity Saving Awareness, Oil and Gas Saving Awareness, and General Publicity Campaigns.	Technology: Conservation
Results: A total of 9,445 persons was trained as energy managers.	Reference: Energy Technical Service Center

Title: Energy Appliances Standard Program and Labeling Program	Project Type: Standards and codes
Organization: MOEA, Energy Technical Service Center (ETSC)	Date: Ongoing
End-use Sector: Residential, commercial buildings (appliance manufacturers)	Affiliated/Future Projects: Comprehensive Energy Conservation Programs
Description: ETSC set minimum standards for appliance efficiency for eight types of appliances. Commercial appliances must meet these standards.	Technology: Air conditioners, refrigerators, kitchen ranges, fans, ventilators, draft fans, motors, clothes dryers
Results: The energy-efficiency ratios of room air conditioners was improved by 44% since 1970. The Commodities Labelling Law requires manufacturers to provide comparative energy labels to customers.	Reference: ETSC, APEC questionnaire

Title: Energy and Resource Laboratories	Project Type: R&D
Organization: MOEA, ERL, ITRI	Date: Ongoing
End-use Sector: All sectors	Affiliated/Future Projects:
Description: ERL is the primary organization for developing and testing energy-efficient products and renewable energy technologies. ERL's core technologies include thermofluid technology, electrotechnology, and combustion technology. The organization also focuses on bringing technologies to market.	Technology: All renewable energy and conservation
Results: ERL transferred 18 technologies to market in 1991.	Reference: ERL Annual Report

Hong Kong

Hong Kong is a territory of about 1,000 km² located off the southern coast of China. There is an efficient infrastructure, a modern communications network, and a population of about 5.8 million people. Hong Kong is the tenth largest trading entity in the world and has a developed financial services sector. It is and will remain, after 1997, a separate customs territory possessing full autonomy in the conduct of commercial activity and trade.

After a period of high economic growth for the years 1986 to 1988, Hong Kong experienced slow economic growth in 1989. The slowdown was largely cyclical, and the economy continued to grow steadily.

Hong Kong's gross domestic product (GDP) reached US\$82,731 million (at current market prices) in 1991, up from US\$2,698 million in 1966. This represents an average annual growth rate of 6.2% for the period 1981 to 1991. The GDP came primarily from the following market sectors: agriculture (0%), manufacturing (17%), and services (70%). GDP rose 4.2% in 1991. GDP growth of 5% was forecast for 1992.

The average rate of inflation was 7.9% from 1981 to 1991. Interest rates are expected to continue to stay low, in line with U.S. dollar interest rates.

In 1991, total exports totaled US\$98,430 million and imports totaled US\$100,507 million. Over the period 1981 to 1991, this represents an average annual growth rate for exports of 20.1% and an average annual growth rate for imports of 18.8%.

Foreign trade is a prime component of Hong Kong's economy. In the first ten months of 1992, re-exports rose sharply by 31% in value terms over the same period in 1991; however, domestic exports recorded a small increase of 2%. Domestic exports to China surged further, while those to the United States recovered to show further growth. On the other hand, domestic exports to Germany, the United Kingdom, and Japan were on a downtrend.

Hong Kong manufactures textiles, electronics, watches, and toys. Tourism, shipping, banking, and insurance also provide significant strength to the economy.

In the first ten months of 1992, imports grew by 24% to US\$100.2 billion, compared to the same period in 1991. China is Hong Kong's chief supplier and accounts for 37% of all traded goods; other key countries are Japan, Chinese Taipei and the United States. Imports consist of raw materials, consumer goods, capital goods, foodstuffs, and fuels.

Hong Kong serves as the most important entrepôt for indirect trade between China and the rest of the world. Eighty-six percent of re-exports consist of goods made in China or being imported to China. Re-exports rose 31% in the first ten months of 1992 compared to the same period a year earlier. The United States is the second largest destination of finished goods for re-export.

The *Pacific Economic Outlook* (1992 to 1993) predicted an economic growth rate of 6.4% for 1993. It cites the conclusion of the Sino-British Memorandum of Understanding on the construction of the new airport in September 1991 as a most significant factor supporting Hong Kong's faster economic growth.

Energy Use and Policy Issues

Per capita energy consumption in Hong Kong equaled 1,908 kilograms of oil equivalent (kgoe) in 1991, up from 930 kgoe in 1979. For the period of 1981 to 1991, primary energy consumption grew at an annual rate of 8%.

Hong Kong depends on oil and gas as primary sources of energy. Its dependence on oil has fallen from almost 100% in 1981 to about 33% in 1991, while dependence on coal has risen from almost 0% in 1981 to about 67% in 1991. Almost all the coal was used for electricity generation.

Energy Efficiency and Conservation

In 1991, the government of Hong Kong formed an Energy Efficiency Advisory Committee. The advisory committee gathered and studied data on energy consumption patterns in commercial sector buildings in Hong Kong. The findings of this work are preliminary in nature because of the limits of the data. Some of the more interesting and instructive findings follow:

- Although there has been a significant increase in electricity use in the sector, the increase primarily associated with the addition of new buildings rather than increased levels of use in existing buildings.
- Changing patterns of demand also are associated with changes in tenancy.
- Floor-by-floor data indicate enormous variations in energy consumption among floors.
- Air conditioning loads appear to average about 60% of total electric load (less in hotels); lighting and appliances account for an average of 36%; and vertical transport accounts for an average of 8%. (Data do not add to 100% because of statistical problems in estimating averages from samples of different sizes, etc.)
- Adjusting for climate, the average Hong Kong building does not compare favorably with similar buildings elsewhere.

The Committee notes that there is much work to be done to assemble better energy use data for Hong Kong and recommends that a multi-sector data base be developed, along with a set of predictive models, and a detailed set of technical and economic descriptions of energy-efficiency measures which could be implemented.

The Committee also began an energy-efficiency information campaign in the form of an *Advisory Note on Energy Efficiency in Existing Commercial Buildings*, which is directed at owners and managers of hotels and office and retail buildings. The note contains information, sometimes somewhat detailed, that could be of use in reducing energy use in commercial buildings. The following are the specific subjects:

- No-cost housekeeping
- Air conditioning
- Miscellaneous plant and equipment

- Lifts and escalators
- Lighting and small power
- Envelope
- Water.

The rationale provided for energy-efficiency activities is threefold: (1) the reduction of reliance on imported fossil fuels, (2) the effect of combustion on the environment (including climate change), and (3) simple economics.

In addition to energy efficiency in buildings, the government examined waste-to-energy projects, landfill gas, and high-efficiency lighting for the new airport. China Light and Power Company is studying the use of ice storage, as well as electric vehicles, to improve its load factor.

Bibliography

Report from the Energy Data Working Group of the Energy Efficiency Advisory Committee; for the period April to October 1991

Advisory Note on Energy Efficiency in Existing Commercial Buildings in Hong Kong; Energy Efficiency Advisory Committee; September 1991

Departmental Review; Electrical and Mechanical Services Department; July 1991

Economic Trends Report—Hong Kong; U.S. Consulate General; December 1991

An Introduction to the Electrical and Mechanical Services Department

Internal data of Hong Kong government departments

Title: Energy Efficiency Advisory Committee	Project Type: Policy assessment
Organization: Energy Efficiency Advisory Committee	Date: April 1991; continuing
End-use Sector: Commercial, residential buildings; industry	Affiliated/Future Projects:
Description: The committee was established to advise government on proposals to improve energy efficiency as well as to formulate a comprehensive policy in the long term.	Technology: Conservation
Results: Working groups and subworking groups are formed under the committee to tackle specific tasks. The committee meets regularly to review achievements and to set new targets for the groups.	Reference:

Title: Energy Data Working Group	Project Type: R&D
Organization: Energy Efficiency Advisory Committee	Date: April 1991; continuing
End-use Sector: Commercial, residential buildings; industry	Affiliated/Future Projects: The group recommended continued research and the development of a data base to track energy use.
Description: The objective of the group is to collect data concerning the use of energy in Hong Kong; priority is given to the commercial sector.	Technology: Conservation
Results: The group collected data from hotels, commercial buildings, property developers, and the two power companies. The study found that for commercial buildings electricity was used by air conditioning (60%), elevators (15%), and lighting (36%). The average electricity consumption is 22.3 kW/m ² of gross floor area.	Reference: Report from the Energy Data Working Group

Title: Existing Buildings Working Group	Project Type: Policy assessment
Organization: Energy Efficiency Advisory Committee	Date: April 1991; continuing
End-use Sector: Commercial, residential buildings; industry	Affiliated/Future Projects: An advisory note for residential buildings will soon be published.
Description: The group recommends measures to improve energy efficiency of existing buildings. It produces advisory notes for building managers and promotes energy efficiency in government and private buildings.	Technology: Conservation
Results: The Advisory Notes on Energy Efficiency of Existing Commercial Buildings are targeted at such specific groups as manufacturers, architects, engineers, and hotel managers. Energy audits were conducted for some government buildings and will be extended to cover other government buildings.	Reference: Advisory Notes on Existing Commercial Buildings in Hong Kong

Title: New Buildings Working Group	Project Type: Policy assessment
Organization: Energy Efficiency Advisory Committee	Date: April 1991; continuing
End-use Sector: Commercial, residential buildings; industry	Affiliated/Future Projects: An advisory note for residential buildings will soon be published.
Description: The group issues a Handbook on Overall Thermal Transfer Value (OTTV) calculation, which serves as a first step toward the implementation of a comprehensive energy code. An annual award scheme also will be introduced for the most energy-efficient building design in Hong Kong.	Technology: Conservation
Results: The implementation of OTTV control is under consideration.	Reference: The draft handbook on OTTV calculation in buildings

Title: Educational Campaign Working Group	Project Type: Education/information
Organization: Energy Efficiency Advisory Committee	Date: April 1991; continuing
End-use Sector: All sectors (general public)	Affiliated/Future Projects: Establishment of an energy-efficiency display and information center and the introduction of an energy-efficiency labeling system for electrical appliances
Description: The group will be launching a series of educational campaigns on energy efficiency starting February 1993.	Technology:
Results: The public has been informed of the importance and the possible ways of saving energy through TV and radio API, bookmarks, and posters, which were distributed freely to the public during the educational campaign.	Reference: Publicity materials of the educational campaign

Indonesia

Indonesia is an island nation occupying more than 17,000 islands that span some 5,000 km from end to end. There are approximately 180 million people; 60% of the population lives on Java and more than 7 million live in the capital, Jakarta. Indonesia is a member of the Association of Southeast Asian Nations (ASEAN). Recently, Indonesia has been experiencing explosive economic growth and a rapid demand for energy.

Since independence in 1945, Indonesian history has been characterized by attempts to form a unified nation out of the diverse population. Since 1969, the New Order government designed and implemented a series of five-year plans. It has been quite successful and has met between 60% and 70% of its scheduled targets.

Indonesian gross domestic product (GDP) reached US\$107,290 million in 1990, up from US\$5,980 million in 1965. The GDP grew at an average annual growth rate of 5.5% during 1980 to 1990. The GDP came from the following market sectors: agriculture (22%), industry (40%), and services (38%); within industry, manufacturing comprised 20% of GDP. The growth rate of GDP was 7.4% in 1989 and the estimated growth rate for 1990 was 7.1%.

For the period of 1980 to 1990, interest rates averaged 25.8%. The inflation rate for 1989 and 1990 was 6.5%.

A wide-ranging program of deregulation of the economy has been pursued since the early eighties. In particular, the banking sector and the financial sector have experienced an increase in activity. Investment spending has been exceptionally strong, increasing in real terms by 13.4% and 16.2% during 1989 and 1990, respectively. Government investment and Japanese investment were the largest contributors to the Indonesian economy.

In 1990, exports totaled US\$25,553 million and imports totaled US\$21,837 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 2.8% and an average annual growth rate for imports of 1.4%. Recently, exports have exploded, experiencing growth of more than 27% during 1986 to 1990. This trend slowed in 1990 (to a growth of less than 9%) as a result of lower commodity prices and demand for manufactured goods.

For 1992, the *Pacific Economic Outlook* predicted continued growth of the Indonesian economy, with an increase in GDP of 6.6%. Imports will continue their strong growth, and rising external debt-service payments will cause deficits of between 3% and 5% for 1991 and 1992. Private consumption will be the largest source of GDP growth, followed by private investment and government consumption. Interest rates are likely to stay high, and the exchange rate is likely to fall.

Energy Use and Policy Issues

In 1989, Indonesia's total energy output was 38.1 million tons of oil equivalent (Mtoe). This was supplied by oil (68%), coal (6.6%), hydro (4.7%), and other sources (20.7%). By 2000, this is expected to grow to 86.3 Mtoe.

Per capita energy consumption equaled 272 kilograms of oil equivalent (kgoe) in 1990, up from 91 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 4.1%. For the years 1965 to 1980, energy consumption grew at an annual rate of 8.4%.

Indonesia is richly endowed with natural resources, including oil, gas, coal, hydropower, geothermal, and solar. In 1989, it ranked 13th among oil-producing nations, but the government has tried to shift domestic consumption away from petroleum.

Indonesia's oil reserves are estimated to be 70 billion barrels, and there are proven recoverable reserves of 8 to 10 billion barrels. In 1987, production equaled 1.7 million barrels per day. There are 80 trillion cubic feet (2.2 trillion cubic meters) of natural gas reserves, and most of these are independent of oil reserves. Indonesian coal reserves are believed to be 25 billion tons.

Electric power production in Indonesia has increased over 15 times in the past 20 years, from 563 megawatts (MW) in 1968 to 9,108 MW in 1990. Perusahaan Umum Listrik Negara's (PLN), the state electric utility, electricity generating capacity comes from the following sectors: hydropower (21.6%), oil steam (24.3%), coal steam (19%), diesel (19%), gas turbine (13.5%), and geothermal (1.5%).

Industrial users accounted for 70% of all electricity consumed. Despite rapid growth in the energy sector, Indonesia's per capita level of electricity consumption is 266 kilowatt-hours (kWh), and only 33% of the total population has access to electricity. Urban areas account for most of this consumption; Java consumes 80% of Indonesia's capacity. In rural areas, electricity reaches only 13% of the homes.

PLN expects electricity demand to increase fivefold (192,080 gigawatt-hours by 2003). To meet this demand, PLN has planned new coal, geothermal, hydropower, and nuclear power plants. This will add more than 6,000 MW of new power to the Java-Bali system by 2003. The World Bank and Asian Development Bank are financing a large portion of these projects.

Several organizations are active in energy planning. The Ministry of Mines and Energy sets policy; PLN delivers electric power; Pertamina, the state oil company, administers petroleum production. Government committees also set pricing and formulate national energy plans. There are few private power companies.

The fifth five-year development plan, Replita V (1989 to 1993), sets primary objectives for improving the wealth of the entire population, sustaining high economic growth, and maintaining national stability.

The government of Indonesia has established a General Policy on Energy. The main policy objectives are the following:

- To guarantee supply of energy to meet domestic energy needs at affordable prices
- To make available exported energies (e. g., natural gas and oil)
- To develop new and renewable energy gradually to substitute for oil in the country's energy mix
- To use energy more efficiently and wisely
- To reduce the adverse impacts of excessive energy use to the environment.

The main elements of this policy are the following:

- Intensification—increasing the exploration and surveying of resources
- Diversification—reducing dependence on oil by developing non-oil energy resources
- Conservation—using energy efficiently and wisely for the most productive use without sacrificing development objectives.

Energy conservation now is being promoted actively by government, in spite of per capita primary energy levels being below that of other countries. Conservation is viewed as being a cheap, quick, and a relatively painless way to reduce energy costs, stretch supply, and increase foreign exchange. Indonesia is now intensifying its energy conservation program for several reasons, including the following:

- Energy consumption per unit of GDP is higher than that of other countries in the Asian region and in developing countries.
- Based on studies, the potential for energy savings is still high.
- Energy conservation is needed to reduce the rapid growth in domestic demand.

Various conservation programs are operational, and more are being prepared. The programs consist of the following elements:

- Public awareness program using seminars, television, and contests for the design of energy-saving appliances
- Technical capability and skill program for operators of energy-consuming plants and equipment in the industrial, commercial, government, and household sectors
- Demonstration program to introduce new energy conservation technologies
- Research and development program to develop technology for energy management
- Program to encourage commitment to conservation by industrialists, building owners, and entrepreneurs.

In September 1991, Presidential Decree No. 43 was issued to instruct all government ministries and agencies to enforce energy conservation within their areas of responsibility. It is expected that the decree will become a milestone in the enhancement of energy conservation in Indonesia. In July 1992, the president launched a National Energy Conservation Campaign Program that marks the beginning of a vigorous national effort to become energy efficient.

New energy plans, having targets to the year 2000, have been prepared. These programs include the same elements as past programs but have to achieve more definite objectives and concrete targets. For example, the target is to reduce domestic energy use by 17% by the year 2000. In addition, qualitative and quantitative targets are set for each sector to achieve the national target by 2000. Targets for reduction are 20% for industry and 15% for transport and household sectors.

Targets have been set for the demonstration programs, in terms of the dissemination of prototypes in various sectors. Research and development program targets are set in terms of making energy-efficient equipment available in the domestic market. The government also has set targets for the establishment of a testing, standards, and labeling program.

Energy Efficiency and Conservation

Demand for energy in Indonesia has grown faster than supply, and the government has responded with various energy conservation initiatives. Energy conservation policies have been implemented since the third five-year plan (PELITA III), in 1979 to 1980. The program began with an educational campaign to inform the public and to create an understanding of the importance of energy conservation. Various media have been used in the campaign.

Conservation among government agencies was pursued through directives, beginning with Presidential Instruction No. 9 (1982).

In 1983, a program was begun that featured in-depth energy audits and analyses of energy use in selected energy-intensive industries (such as steel, cement, fertilizer, chemical, pulp, and paper), transportation power generation, and the commercial sector. The result of this work was the identification of potential energy savings in specific settings that could also serve as the basis for further policy and program development. Savings of 7 to 11 million barrels of oil were identified, based on 1983 consumption information. In addition, better energy management practices for specific industries were identified, as well as basic information needed to design energy-efficiency laws and regulations.

Currently, there are four main categories of energy-efficiency and conservation activities that are being implemented: (1) public information, (2) training and technical assistance on conservation measures, (3) regulation, and (4) establishing new institutions.

Energy audits have been conducted in industrial plants, ranging from energy-intensive industries to small- and medium-scale industries. These were financed through government funding or through technical assistance funds available from bilateral cooperation. In 1985, audits were conducted in cooperation with the French government that covered more than 130 industrial plants from a variety of sectors. A survey of urban household energy use was also conducted with the assistance of the ESMAP program of the World Bank. Potential energy savings were identified, and information of household appliance efficiency was prepared.

The industrial sector is the largest energy-consuming sector and has been a priority sector for the government programs. In August 1991, with the United Nations Industrial Development Organization (UNIDO), the European Economic Community (EEC), and Japan, the government completed a survey of small- and medium-scale industries. The goal of the survey was to prepare an energy conservation handbook for textile and steel industries. A demonstration is planned as a follow-up to this effort.

With the assistance of the United States Agency for International Development (USAID), the Directorate General for Electricity and New Energy (DGENE) has carried out a study on electricity demand-side management. The study is a preliminary effort, and additional study and implementation on the research is planned.

In 1987, Indonesia created a quasi-private corporation, Pt. Konservasi Energi Abadi (KONEBA), which provides technical assistance and consulting on various aspects of energy conservation.

KONEBA has conducted energy audits on energy-intensive industries, medium-scale industries, and commercial buildings. KONEBA's activities cover identifying the potential for energy savings, training for industrial operators, and implementing energy-saving practices. Also, in cooperation with Gesellschaft für Technische Zusammenarbeit (GTZ), KONEBA has conducted a study to identify cogeneration applications in industrial and commercial buildings and to promote such applications.

KONEBA has implemented some energy-saving measures on a shared savings basis. That is, the savings from implementing efficiency measures are divided between the client and KONEBA. Difficulties were encountered in the measurement of savings—a common problem. Many industrial sectors have shown interest in pursuing this arrangement, including textiles, cement, steel, fertilizer, and oil (seeking energy efficiency for the oil transport fleet).

The current information program features a National Team of Energy Conservation, which is responsible for a nationwide campaign program and for helping the government develop recommendations for policy measures for conservation. In addition, an Energy Conservation Campaign Team also has been set up to prepare the master plan for the campaign program that is expected to be carried out over a five-year period.

In rural areas, fuelwood use is a major concern, and the dissemination of energy-efficient stoves has begun in the last decade. Use of such stoves will protect the environment by reducing fuelwood consumption and will ease the work burden on women by reducing the time spent gathering and transporting fuelwood and making cooking more convenient. A number of efficient stoves have been developed, and various means of distributing them have been used. Distribution efforts were enhanced in Replita V, the fifth five-year development plan.

The Indonesian rural electrification program electrified 4,294 villages during Replita IV, bringing the total number of villages electrified with this program to 12,594, as of 1989. This program has developed several micro-hydroelectric plants, having a combined capacity of 75 MW, and also has used photovoltaics and diesel generators (52 MW total) to supply rural power. The government plans to continue these projects during Replita V—providing electrification for another 11,000 villages and 3 million consumers.

With the help of other countries, Indonesia has been studying and testing biomass, solar, wind, and mini-hydro energy technologies. An international cooperation project with Germany tested solar thermal, biomass, and PV systems. The project constructed several demonstration projects and studied applications and markets for renewable energy technologies. Indonesia also participated in the FINESSE (Financing Energy Services for Small-Scale Users) project.

Bibliography

Clean and Safe Energy Forever, Volume 1, Proceedings of the 1989 Congress of the International Solar Energy Society; September 1989

Indonesia: Asia-Pacific Energy Series Country Report; Widhyawan Prawiraatmadja, Nancy Yamaguchi, Kennon Breazeale; April 1991

Indonesia's Electric Power Sector; Economic Section American Embassy—Jakarta; January 1992

Renewable Energies Indonesia, REI; H. Noetzold, N. Suharta, L.M. Panggabean

Title: Technical Guidance and Consulting for Energy Conservation	Project Type: Policy assessment
Organization: Directorate General of Electricity and New Energy	Date: 1987
End-use Sector: Industry	Affiliated/Future Projects:
Description: The project audited 112 factories.	Technology: Conservation
Results:	Reference: ASEAN-EC Energy Conservation Seminar

Title: Decision and Implementation of Energy Projects	Project Type: Policy assessment
Organization: BAKOREN (National Energy Coordinating Board)	Date: 1987
End-use Sector: Industry	Affiliated/Future Projects: None
Description: A coordinating board (BAKOREN) was established to make decisions on important energy issues.	Technology: N. A.
Results: Decisions are based on the following: (a) maintaining fossil fuels for export, (b) reducing oil dependence by using alternate energy resources, (c) energy conservation, (d) utilizing the most suitable fuel for a given economic activity.	Reference: ASEAN-EC Energy Conservation Seminar

Title: Energy Management Study of Padalarang Paper Mill	Project Type: Audit
Organization: Puslitbank Fisika Terapan Lipi	Date: 1986
End-use Sector: Industry (process energy)	Affiliated/Future Projects:
Description: The audit concentrated on energy consumption in the boiler house during pulp and paper manufacturing.	Technology: Conservation
Results: The report recommended a shift in electricity consumption to off-peak periods.	Reference: ASEAN-EC Energy Conservation Seminar

Title: Energy Audit of Panghegar Hotel	Project Type: Audit
Organization: Puslitbank Fisika Terapan Lipi	Date: 1986
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: The audit studied energy consumption at a hotel. It focused on air-conditioning, lighting, steam, and boilers.	Technology: Conservation
Results: Conservation measures could save 21% of electricity and fuel costs.	Reference: ASEAN-EC Energy Conservation Seminar

Title: Experience with Photovoltaic Pump Systems on Sumba	Project Type: Study/demonstration
Organization: BPP-Teknologi (Agency for the Development and Application of Technology)	Date: 1981 to present
End-use Sector: Renewable energy	Affiliated/Future Projects: Solarvillage Indonesia
Description: A German-Indonesian joint venture assessed problems in pump system designs and introducing solar design.	Technology: Two pump systems to maximize flow rate and efficiency
Results: Solar pump systems are operating successfully in two locations. Improvement of components will result in even greater efficiency.	Reference: <i>Proceedings of the 1989 Congress of International Solar Energy Society</i>

Title: FINESSE (Financing Energy Services for Small-Scale Energy Users)	Project Type: R&D; tech transfer; study/demo
Organization: The World Bank, U.S. Department of Energy, USAID, U.S. Environmental Protection Agency, UNDP, Asian Development Bank, Asian and Pacific Development Center, Netherlands Ministry of Foreign Affairs	Date: FINESSE was launched in 1989.
End-use Sector: Commercial, residential buildings	Affiliated/Future Projects: Sukitani PV Electrification
Description: The FINESSE Project was launched to conduct market studies, promote the manufacture of energy-efficient light bulbs and appliances, examine the institutional environment for alternative energy projects, establish ASEAN project opportunities, establish a multidonor feasibility fund, and host international conferences.	Technology: All renewable energy
Results: FINESSE completed market studies on Malaysia, the Philippines, Indonesia, and Thailand. The studies identified project opportunities for renewable energy.	Reference: FINESSE Country Market Studies, FINESSE Report.

Japan

Japan occupies an island chain in the western part of the Pacific Ocean, covering a total land area of some 377,700 km². Approximately 124 million people live in Japan.

Japan has become one of the world's greatest economic powers, and its growth has astonished experts and laymen alike. Today, the Japanese economy remains strong, and Japan is the largest lending nation in the world.

Japan's gross domestic product (GDP) was US\$2,977,725 million in 1990, up from US\$1,067,294 million in 1980. In 1991, GDP rose 4.4% and reached US\$3,373,824 million. This represents an average annual growth rate of 4.1% during 1980 to 1990. The GDP came from the following market sectors: agriculture (3%), industry (42%), and services (56%); within industry, manufacturing comprised 29%. The GDP rose 5.8% in 1990 and a GDP growth of 3% was predicted for 1991.

In 1991, exports totaled US\$314,525 million and imports totaled US\$236,737 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 8.3% and an average annual growth rate for imports of 5.3%.

The average rate of inflation was 1.7% from 1980 to 1990; and for 1990, the official discount rate was 3.25% (as of July 28, 1992).

Although growth of exports has decelerated since 1990, the *Pacific Economic Outlook* predicts a gross national product (GNP) growth rate for Japan of 4.3% in 1992.

Energy Use and Policy Issues

Per capita energy consumption equaled 3,635 kilograms of oil equivalent (kgoe) in 1990, up from 1,563 kgoe in 1965. For 1980 to 1990, energy consumption grew at an annual rate of 4.4%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 5.9%.

Japan depends greatly on imported energy. In 1991, it imported 84% of the entire energy supply. The total energy supply in 1991 consisted of oil (57%), coal (17%), liquefied natural gas (11%), and hydro, geothermal, and renewables (6%).

Ten power companies supply electricity to Japan and have a generating capacity of 152,715 megawatts (MW). In 1991, there were 69,374,000 customers using 679,237 gigawatt-hours.

Japanese energy policies basically treat the period up to the beginning of the twenty-first century as a critical time to start to overcome pressing issues. Energy policies in accordance with the following goals are expected to be adopted immediately:

- To respond to an expansion, diversification, and sophistication of energy needs prompted by the pursuit of greater leisure time in everyday life; at the same time, to control as much as possible an increase in energy demand by making all-out efforts to use energy efficiently

- To take into account the aim to secure global energy security and continue working toward lowering the dependence on oil; at the same time, to realize a supply structure with greater dependence on nonfossil energy (nuclear energy; new, renewable energies)
- To actively carry out policy coordination and cooperation in the field of energy. During that time, to broaden the focus to all countries in the world and realize comprehensive and effective international cooperation by expanding activities to energy-related fields in general, without being limited to details and individual fields.

The conditions surrounding energy will grow more complex; resource and environmental constraints are issues facing the world as well as all Japanese people.

Since the sum total of everyday life and economic activities constitutes the cause of energy problems (i. e., the manifestation of resource and environmental constraints), Japanese people are expected to tackle these problems together. In order to deepen this awareness, it is considered necessary to hold countrywide informal discussions and various publicity activities concerning energy problems. It also is essential to encourage, on a national scale, discussions and studies on human activities, industrial activities, and social and industrial systems, as well as on the proper use of land marked by overconcentration in Tokyo.

Energy Efficiency and Conservation

1. In the past, Japan has
 - a. Appropriately applied the Law Concerning the Rational Use of Energy (establishment and announcement of standards concerning plant energy management, heat insulation of homes, fuel consumption of automobiles)
 - b. Promoted energy conservation-related technology (Moonlight Project) and extended tax benefit incentives and financial assistance to investment in energy-saving plant and equipment
 - c. Undertaken education and publicity activities concerning energy conservation via publicity activities by government and the Energy Conservation Center (ECC). As a result, Japan's energy consumption to unit of gross national product has improved roughly 37% since the first oil crisis in 1973.
2. In recent years, however, energy demand has risen, and the rate of improvement of energy use is slowing down. This is attributed to changes in lifestyle driven by intensifying production activities that are fueled by booming business conditions and the pursuit of "more leisure time." Meanwhile, the necessity for energy conservation is mounting rapidly, as solutions to global environmental problems such as global warming are sought.

As such, the projected level of energy demand (average annual growth from fiscal years 1989 to 2000: 1.4%), which is a precondition of the Oil-Alternative Energy Supply Targets determined by the cabinet in October 1991, must be achieved. Additionally, the Action Program for Global Warming, which aims at stabilizing per capita CO₂ emissions roughly at 1990 levels after the year 2000, must be realized. For this purpose, it would be considered essential to lower the growth in energy demand as the year 2000 draws near.

3. Global warming is emerging as a problem shared by mankind, and there is concern that the long-term supply and demand conditions of energy will tighten. Against this background, comprehensive energy conservation measures must be promptly implemented to realize sustained economic growth, stability of energy supply and demand, and global environmental protection.
4. Near-term issues include:
 - a. Achieving the goal to stabilize Japan's per capita CO₂ emissions roughly at 1990 levels after the year 2000, as set forth in the Action Program for Global Warming (determined at the cabinet meeting in October 1990)
 - b. Achieving the Oil-Alternative Energy Supply Targets that are indispensable for attaining the above objective in the year 2000, on both the supply and demand front.
5. Japan plans to achieve the levels of energy supply specified in the supply targets by the year 2000 by making maximal government efforts in the future by introducing such nonfossil energy as nuclear energy.
6. Some sources estimate that if additional energy conservation policies are not implemented, demand (420 to 430 million kiloliters (kL) per year) will largely surpass the energy demand level (oil equivalent of 391 million kL per year on a final consumption basis). This demand level is a precondition of the supply targets in the year 2000, based on the growth in energy demand of recent years. Thus, drastic energy conservation measures are expected to be implemented.
7. Under these circumstances, the Energy-Subcommittee of the Advisory Committees for Energy has been meeting since September 1991. The subcommittee is undertaking studies to drastically reinforce energy conservation policies. At the same time, the importance of energy conservation measures was pointed out as an issue to be dealt with swiftly in the near term at the joint meeting of the Industrial Structure Council, Agency of Natural Resources and Energy, and the Industrial Technology Council, held in June 1992.

The Ministry of International Trade and Industry (MITI) and the Agency of Natural Resources and Energy are committed to treat the promotion of comprehensive energy conservation policies as the foremost issue of MITI's near-term policies. In order to smoothly undertake this effort, MITI is

- a. Developing a legal framework for the promotion of comprehensive measures
 - b. Stepping up policy measures by drastically reinforcing financial assistance measures in the budget for fiscal year 1993.
8. MITI also has been promoting technical development to contribute to energy conservation and new energy technologies. Since 1974, the Agency of Industrial Science and Technology of MITI has been promoting the Sunshine Project and promoting technical development to contribute to the development of such recycled energy as solar energy and wind power energy and such oil-alternative energies as geothermal power and coal gasification.

9. Since 1978, the Agency of Industrial Science and Technology of MITI has been promoting the Moonlight Project, a research and development project aimed at saving Japan's energy and rationalizing energy policy. The budget for FY 1990 (¥11,902 million) covers the following projects:
- a. Five large-scale energy conservation projects, including battery storage, fuel cells, heat pumps, superconductors, and ceramic turbines
 - b. Eleven basic-technology research projects at national research institutes. Projects include noncontact thermometry, Diesel-Brayton combined cycle engines, hydride performance membranes, multifuel Otto cycle engines, high lithium ion conductivity, alkali metal thermoelectric converters, aluminum scrap refining technology, new ceramics, and binary fluid power generation
 - c. International Cooperation Projects through the International Energy Agency (IEA), including research on heat pumps and thermofluids. Bilateral cooperation with France, the United States, Thailand, and certain other countries
 - d. Evaluation methods and policy for energy conservation technologies
 - e. Standards for energy efficiency. The standards fall into three categories: standards for testing and terminology, standards for high-efficiency products, and standards for resource conserving products.
 - f. Conditional loans to private enterprise projects "which must focus on developing or improving equipment to promote use of alternative energy or more efficient use of energy."
10. Under the auspices of MITI, the New Energy and Industrial Technology Development Organization (NEDO)—a semigovernmental organization—is carrying out a large-scale technical energy research and development project under the Moonlight Project. NEDO also is exploring new energy development, including development of technology for utilizing such unused energy as waste heat from plants.
11. As an international activity, NEDO is undertaking a joint project with Thailand on phosphoric acid fuel cells. With regard to solar batteries, NEDO is conducting a feasibility study with Australia and advancing joint demonstration development with Thailand, Malaysia, Nepal, and Mongolia. It also is carrying out a joint water supply project with Indonesia that uses solar batteries. In addition, NEDO is conducting a feasibility study on ethanol production (using tapioca) and mild gasification (using peat). In 1992, as part of international cooperation in industrial technology, NEDO started the development of the high-efficiency combustion technology for heavy oil, as well as conservation technology for electric furnaces during the steelmaking.
- NEDO has sent specialists to countries belonging to the Association of Southeast Asian Nations (ASEAN) and has held seminars and exchanged information on new energy technologies with other countries. As a result, an international project for joint research and development of new energy technologies and energy conservation was proposed.
12. Two agencies, the Overseas Economic Cooperation Fund and the Japanese International Cooperation Agency (JICA), administer Japan's official development-assistance funds for

international projects. These projects include energy conservation projects and renewable energy projects. For example, JICA funded rural electrification in Thailand.

13. Japanese policymakers endorse market promotion measures to accelerate domestic diffusion of new technologies. These promotions can include low-interest financing, tax measures, and leasing. Consumers of solar heating and cooling are eligible for low-cost loans, and the Solar System Development Fund involves a solar fund financed by MITI and private companies.
14. ECC provides support and leadership for the energy conservation activities in Japan. The center holds the National Convention for the Promotion of Energy Conservation and publishes literature on energy conservation. One publication, *Successful Cases of Energy Conservation*, details conservation activities in industry and provides references for energy managers.
15. The IEA carries out numerous conservation projects under international agreements. Japan participates in research projects examining working fluids, absorption heat pumps, and heat pump systems. In 1990, Japan participated in the IEA's Heat Pump Center, and they also have participated in the Center for the Analysis and Dissemination of Demonstrated Energy Technologies, IEA (CADET). Technical information provided CADET by Japan includes energy-efficient high rises, energy-efficient gymnasiums, and fluidized bed combustion at a paper mill.

National Energy Laboratories

Japan funds most of the renewable energy and conservation projects through the Sunshine Project and the Moonlight Project. Most of the actual research occurs at universities or national laboratories. The Electrotechnical Laboratory has 700 employees and 250 visiting researchers from industry. One hundred of these employees examine energy-related subjects, including photovoltaics and fuel cells. The Mechanical Engineering Laboratory examines wind turbines and hydrogen energy.

Bibliography

'89 *Successful Cases of Energy Conservation*; The Energy Conservation Center

Fiscal Year 1990 Annual Report: Geothermal Energy Survey and Technology; New Energy and Industrial Technology Development Organization

Fiscal Year 1990 Annual Report: Solar Energy Technology; New Energy and Industrial Technology Development Organization

FY1991 Research and Development Projects [1]; New Energy and Industrial Technology Development Organization; April 1991

NEDO Creates New Energy; New Energy and Industrial Technology Development Organization

Sunshine Journal, R&D on New Energy and Energy Conservation Technology in Japan, No. 3 1992; Sunshine Project Promotion Headquarters, Agency of Industrial Science and Technology; March 1992

The Sunshine Project for Establishing Clean, New Energy Technology; Office of Sunshine Project, Agency of Industrial Science and Technology; March 1991

The Twenty-First Century Energy Vision—Entering the Multiple Energy Era; Ministry of International Trade and Industry

The Moonlight Project: Developing New Technologies for Energy Conservation; March 1990

Title: Reduction in Power Consumption by Forced-Air Blower Systems in Coke Oven	Project Type: Study/demonstration
Organization: Nippon Steel (Kimitsu plant)	Date: 7/87 to 3/88
End-use Sector: Industry (steel)	Affiliated/Future Projects: None
Description: Study and demonstration to reduce power consumption of a forced-air blower system that supplies air for combustion of fuel gas in coke oven batteries.	Technology: Improved combustion control scheme and various combinations of blower and natural draft
Results: Reduction in power consumption: 6 million kWh/yr. Cost savings: 48 million yen/yr. Ratio of energy savings: 58%.	Reference: 1989 Successful Cases of Energy Conservation

Title: Electric Power Saving for Blast Furnace Cooling Facilities	Project Type: Study/demonstration
Organization: Sumitomo Metal Industry Co., Ltd. (Kokura Steelworks)	Date: 1987
End-use Sector: Industry (steelworks)	Affiliated/Future Projects: None
Description: Study and demonstration to find ways to cut back on energy consumption in the iron and steel industry.	Technology: Rationalization of water flow volume; reduction of cooling box water flow volume; series flow of cooling water for tuyere nose and body; modification of slag granulator
Results: Power consumption reduced from 1,222 kWh/h to 805 kWh/h.	Reference: 1989 Successful Cases of Energy Conservation

Title: Low-Cost Control of Fan Pump by Inverters	Project Type: Study/demonstration
Organization: Toyoda Gosei Co., LTD (Production Engineering Department)	Date: 1987
End-use Sector: Industry (production engineering)	Affiliated/Future Projects: None
Description: Study and demonstration to develop a control system that facilitates low-cost control, by classifying fans and pumps into four control groups according to capacity and purpose, for lowering power consumption.	Technology: A control system that facilitates control by using pump discharge side water temperature and discharge pressure rather than using constant discharge pressure control combined with temperature control valves
Results: Power consumption was reduced, the surging of fans was prevented, room noise was decreased, and the combustion control area of the burners was expanded.	Reference: 1989 Successful Cases of Energy Conservation

Title: Energy-Saving Activity on Utility Installation	Project Type: Study/demonstration
Organization: Ohtsu Tire Co., Ltd. (Izumi-Ohtsu Factory)	Date: 1982 to 1988
End-use Sector: Industry (prime power installations)	Affiliated/Future Projects: None
Description: Study of the energy-saving activities related to the so-called prime power installations for generating and supplying utilities, including boilers, compressors, vulcanizers, and coolers. This study applied to the production of tires and tubes.	Technology: Small-capacity pump to reduce pump power consumption of softened water supply to boiler; three-way valves installed on heat exchanger recovery tubes to reduce power of waste heat recovery pump; ventilation duct mounted on compressor motor for discharging the heat from the motor to the outside to reduce power consumption; strainer installed on warm water tank suction tube to remove rubber dust and to increase pump efficiency
Results: Unit improvement from 1982 to 1987 was 11%, compared to 10% target; achievement ratio 110%.	Reference: 1989 Successful Cases of Energy Conservation

Title: Improved Efficiency for Raw Oil Heating Furnace	Project Type: Study/demonstration
Organization: Idemitsu Kosan Co. (Chiba Refinery)	Date: 1988
End-use Sector: Industry (oil refining)	Affiliated/Future Projects: None
Description: Study and demonstration to reduce the amount of O ₂ and improve the overall performance of raw oil heating furnace, a part of a residual oil desulfurization system.	Technology: Modification of equipment and procedures; improved damper blades reduced number of ignition burners.
Results: Reduced O ₂ concentration in flue gas from 5.2% to 2.5%, saving 490 kL/yr of fuel oil.	Reference: 1989 Successful Cases of Energy Conservation

Title: Energy-saving Measures for Pretreatment Drying Oven	Project Type: Study/demonstration
Organization: Nissan Automobile Co. (Murayama Plant)	Date: 1988
End-use Sector: Industry (automobile manufacturing)	Affiliated/Future Projects: None
Description: Study and demonstration to find ways to cut energy consumed in pretreatment drying oven for automobile body coatings. Results will be applied to other drying ovens.	Technology: Improved equipment and mode of operation by reducing oven volume, moving air outlets, reducing size of exit and entrance to reduce air leakage, and installing deflector.
Results: Reduced annual fuel gas consumption by 40% (252,000 m ³). Reduced annual electricity consumption by 32% (55 MWh).	Reference: 1989 Successful Cases of Energy Conservation

Title: Energy Conservation by Improvement of Furnace Control Method	Project Type: Study/demonstration
Organization: Nippon Mining Co., Ltd. (Mizushima Oil Refinery)	Date: 1987 to 1988
End-use Sector: Industry (oil refineries)	Affiliated/Future Projects: None
Description: Study to find out how much excess O ₂ can be reduced from current level of 2.5% and whether continuous stable and efficient operations are possible.	Technology: Use of a micro-computer for a control system to control automatically and simultaneously excess O ₂ and the furnace outlet temperature.
Results: Fuel savings was 1.2%; O ₂ level was lowered to 1.5%.	Reference: 1989 Successful Cases of Energy Conservation

Title: Reduction of Power Consumption through the Use of Low-Temperature Heat from Distilling Tower	Project Type: Study/demonstration
Organization: Idemitsu Kosan Co., LTD (Aichi Refinery)	Date: 1987
End-use Sector: Industry (oil refineries)	Affiliated/Future Projects: None
Description: Study and demonstration to improve or revise the design of residue fluid catalytic cracking to make the most efficient use of energy by recovering waste heat from low-temperature fluid and increasing recovery of liquid petroleum gas.	Technology: Chiller system using lithium bromide that can provide low-temperature fluid at nearly constant temperature throughout a year, distributed control system (DCS), and AI (artificial intelligence); combined computer control with conventional control for labor economy and safer operation.
Results: LPG recovered: 4,400 tons/yr.	Reference: 1989 Successful Cases of Energy Conservation

Title: Energy-saving Measures in Town Gas Works	Project Type: Study/demonstration
Organization: Osaka Gas Company, LTD (Senboku Works I)	Date: 1987
End-use Sector: Industry (factories)	Affiliated/Future Projects: None
Description: Study and demonstration to obtain an energy-saving factory in which energy is utilized most effectively.	Technology: Liquid natural gas vaporizer using hot water to cut down power by means of liquid/gas quality control system; brine preheater to cut down refrigerator power; boiler to supply steam to neighboring businesses
Results: Power reduced to 700×10^4 kWh annually.	Reference: 1989 Successful Cases of Energy Conservation

Title: Furnace Control Methods for Energy Conservation	Project Type: Study/demonstration
Organization: Mizushima Oil Refinery, Nippon Mining Company	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects:
Description: The factory stabilized O_2 in the furnace using computer controls.	Technology: Conservation
Results: The plant saved eight million yen/yr.	Reference: 1989 Successful Cases of Energy Conservation

Title: Recycling Exhaust Air Pressure and Saving Hot Water/Electricity	Project Type: Study/demonstration
Organization: Nippondenso Co. (Anjo Plant)	Date: 2/87 to 7/88
End-use Sector: Industry (manufacture of electrical parts, starters, alternators)	Affiliated/Future Projects: None
Description: (1) Study and demonstration to reduce energy wasted by continuously blowing air to clean up afterwelding. (2) Study and demonstration to reduce flow rate of hot water used for washing work-in-progress. (3) Study and demonstration to automate turning fluorescent lights on and off.	Technology: (1) Adapted cylinders and recycled exhaust air from cylinders; (2) tested lower flow rate and found it was satisfactory; (3) installed circuit to turn lights on and off when winding machine turned on and off.
Results: (1) Reduced cost of welding cleanup from 850,000 yen/yr to 10,000 yen/yr on one production line; expanded to others for total savings of 2.2 million yen/yr. (2) Reduced flow rate of hot water from 420 L/hr to 90 L/hr. (3) Reduced number of lights from 49 to 25.	Reference: 1989 Successful Cases of Energy Conservation

Title: Energy-saving through the Use of a Highly Efficient and Inexpensive Priming Device	Project Type: Study/demonstration
Organization: Toyota Motor Corp. (Plant Engineering Division)	Date: 1987 to 1988
End-use Sector: Industry (automobile manufacturing)	Affiliated/Future Projects: None
Description: Study and demonstration to eliminate wasteful energy consumption, during the break between auto manufacturer work shifts, by using an inexpensive priming device to minimize energy consumption.	Technology: Supercharger for an automobile engine that functions like a commercially available vacuum pump; therefore, it is a viable substitute for a vacuum pump.
Results: Running cost was decreased by 47%; equipment cost was reduced.	Reference: 1989 Successful Cases of Energy Conservation

Title: Fluidized Bed Combustion Boiler for Power Generation	Project Type: Study/demonstration
Organization: Tomakomai Mill Oji Paper Co.	Date: 1985
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Study of a fluidized bed combustion boiler that uses pulp sludge and bark as fuel.	Technology: New fluidized bed uses the maximum possible heat energy in sludge and bark to produce steam for generating electricity while disposing of the ashes. A water scrubber and an electrostatic precipitation reduced SO _x and fly ash emissions.
Results: Savings were 10,300 kW; payback period was 2 years.	Reference: IEA CADDET

Title: Photovoltaic Power System	Project Type: R&D
Organization: New Energy and Industrial Technology Development Organization (NEDO)	Date: 1983
End-use Sector: Industry (manufacturing systems)	Affiliated/Future Projects: None
Description: Study to develop a photovoltaic power system for use in the manufacturing sector.	Technology: 500-kW/yr manufacturing system using solar cells
Results: Operational trials of system have been in progress since FY 1983.	Reference: The Sunshine Project

Title: Ceramic Gas Turbine Project	Project Type: R&D
Organization: Japan's Ministry of International Trade and Industry's Agency of Industrial Science and Technology	Date: FY 1988 to 1996
End-use Sector: Industry (cogeneration and power generation)	Affiliated/Future Projects: None
Description: To develop 300-kW ceramic gas turbines applicable to cogeneration and mobile power generation systems to make these systems more energy efficient, compact, and adaptable to a variety of fuels.	Technology: Bonding/joining of components made of highly heat-resistant ceramics; development of full-scale ceramic components; ceramic gas turbine engine system.
Results: Still under study.	Reference: The Moonlight Project

Title: Super Heat Pump Energy Accumulation System	Project Type: R&D
Organization: Japan's Ministry of International Trade and Industry's Agency of Industrial Science and Technology	Date: 1984 to 1992
End-use Sector: Industry (air conditioning)	Affiliated/Future Projects: None
Description: To conduct research and development on ultra-high performance heat pumps and thermal storage systems capable of converting electric power into thermal energy at night, for high-density storage, and releasing the energy during the day for air conditioning and industrial purposes.	Technology: Development of the following: effective working fluids, new materials for use as system components; high efficiency compressor-driven heat pump with energy-conserving compressor; high-temperature output heat pump with a common axial multistage compressor; chemical heat storage with higher heat storage density.
Results: Bench scale plants have been constructed and operating since 1987; pilot system to be developed by FY 1991.	Reference: The Moonlight Project

Title: Waste Tires Processing Technique Coke Oven	Project Type: Study/demonstration
Organization: Hirohata Ironworks, Nippon Steel Corporation	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects:
Description: Waste tires are used as an additive to the burning process to supply coke oven gas. The factory processes 600 tons of waste tires a month. Environmental effects have been small.	Technology: Conservation; municipal solid waste disposal
Results: The factory saved on coal costs.	Reference: 1989 Successful Cases of Energy Conservation

Title: Reduction in Power Consumption by Forced-Air Blower in Coke Oven	Project Type: Study/demonstration
Organization: Nissan Steel Company	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects:
Description: Electricity-consuming equipment at the works uses 40% of the total energy. High voltage motors drive a forced-air blower that supplies air for burning fuel gas.	Technology: Conservation
Results: A new air supply system was installed. The works saved 6 million kWh/yr and 48 million yen/yr.	Reference: 1989 Successful Cases of Energy Conservation

Title: Pulp and Paper	Project Type: R&D
Organization: IEA (Participants are Canada, Japan, New Zealand, United States, and eight others)	Date: 1981; continuing
End-use Sector: Industry (pulp and paper)	Affiliated/Future Projects: None
Description: Research and development and assessments were undertaken that will help reduce the energy used by the pulp and paper industry.	Technology: Sensors, heat pumps
Results: Recommendations led to an annual savings equivalent of about 8,000 barrels of oil for one pulping machine. A new type of sensor for monitoring water removal was developed and tested and is ready for commercial application. Developed a data base of case studies of heat pump applications. Researched powdered wood combustion; a company has marketed a new burner for powdered wood.	Reference: IEA Joint R&D Projects, April 1990, p.32

Title: Fuel Cell Power Generation Technology	Project Type: R&D
Organization: Japan's Ministry of International Trade and Industry's Agency of Industrial Science and Technology	Date: 1983 to 1990s
End-use Sector: Industry; transportation; residential building	Affiliated/Future Projects: None
Description: This was research to develop more efficient, energy-conserving power generation technology.	Technology: Molten carbonate fuel cell; solid oxide fuel cell; alkaline fuel cell
Results: Molten carbonate 10-kW cell stacks and a 1000-kW power-generating system were developed during FY 1986-1987. Alkaline fuel 1 kW cell stack was made and tested in FY 1984. Studies were begun on solid oxide fuel cell in FY 1989.	Reference: The Moonlight Project

Title: Verification of Geothermal Resources Exploration and Other Technologies	Project Type: Study/demo; R&D
Organization: New Energy and Industrial Technology Development Organization (NEDO)	Date: 1987 to 1988
End-use Sector: Utility (resource planning)	Affiliated/Future Projects: None
Description: This was a study to verify potential geothermal resources.	Technology: Computer-based analytical system; verification well
Results: Deep geothermal reservoir was found in 1987, a result of surface surveys. Development of exploration techniques began in 1988.	Reference: The Sunshine Project

Title: Waste Tires Processing Techniques in Coke Oven	Project Type: Study/demo; R&D
Organization: Nippon Steel Corporation (Hirohata Ironworks)	Date: 1987 to 1988
End-use Sector: Industry (coke manufacturing)	Affiliated/Future Projects: None
Description: This was a study and a demonstration to find ways to increase yields of coke oven gas (COG) by using waste tires to alleviate the problem of waste tire disposal. Results to be applied to other coke ovens.	Technology: Waste tires were used in place of a coal charge as a COG-generating additive in coke oven; tires were carbonized with coal and wires were removed by separator and recovered as scrap metal. Desulfurization system was used in coke oven to remove harmful sulfuric compounds from COG.
Results: The production of COG was without any negative effects on coke strength or a less negative effect on environment.	Reference: 1989 Successful Cases of Energy Conservation

Title: Advanced Battery Electric Power Storage System	Project Type: R&D
Organization: Japan's Ministry of International Trade and Industry's Agency of Industrial Science and Technology	Date: Unknown
End-use Sector: Utility	Affiliated/Future Projects: None
Description: This study was to develop "load-leveling" technology for storing electric power at off-peak times, leading to greater plant efficiency and better energy conservation.	Technology: Four new types of advanced batteries: sodium-sulfur, zinc-chloride, zinc-bromine, and redox-flow; 1,000-kW class pilot plant developed for each type of battery; 1,000-kW class power storage system to study energy efficiency, reliability, and protective systems.
Results: The technology is still under study.	Reference: The Moonlight Project

Title: Challenge of Low-Cost Steam Generation	Project Type: Study/demonstration
Organization: Tohoku Seishi Co., LTD (Akita Factory)	Date: 1984 to 1987
End-use Sector: Utility	Affiliated/Future Projects: None
Description: Study and analysis to find a way to generate low-cost steam, to be applied to the recovery boiler.	Technology: Power reduction of auxiliary equipment, using black liquor concentration measures to increase steam generation.
Results: The amount of power required for generating unit steam was reduced.	Reference: 1989 Successful Cases of Energy Conservation

Title: Energy-saving Measures in Town Gas Works	Project Type: Study/demonstration
Organization: Osaka Gas Company	Date: 1988
End-use Sector: Utility	Affiliated/Future Projects:
Description: The Osaka Gas Works vaporizes liquid natural gas into natural gas, which burns more efficiently.	Technology: Conservation
Results: Power consumption was reduced 700×10^4 kWh annually.	Reference: 1989 Successful Cases of Energy Conservation

Title: Saving of Power for Heating Fuel Oil Unloading Pipings	Project Type: Study/demonstration
Organization: Hokuriku Electric Power Co., Inc. (Fukui Thermal Power Station)	Date: 10/87 to 3/88
End-use Sector: Utility (thermal power station)	Affiliated/Future Projects: None
Description: This was a study and a demonstration to reduce the electricity used to heat pipes carrying fuel oil offloaded at thermal power station.	Technology: Change in operations: turning off the heater of infrequently used piping until actually needed, and adjusting temperature setting of frequently used piping to be 5°C above pour point of the fuel oil being offloaded.
Results: Electrical consumption was reduced by 61%, from 1.64 MWh/yr to 1.06 MWh/yr.	Reference: 1989 Successful Cases of Energy Conservation

Title: Superconducting Technology for Electric Power Apparatuses	Project Type: R&D
Organization: Japan's Ministry of International Trade and Industry's Agency of Industrial Science and Technology	Date: FY 1988 to FY 1995
End-use Sector: Utility	Affiliated/Future Projects: Development of the following: superconducting wires improving performance of alloy and compound conductors; superconducting generators; and a refrigeration system.
Description: This was a study of superconducting power apparatuses to produce an electric power generator.	Technology: Superconducting materials
Results: Still under study.	Reference: The Moonlight Project

Title: Hot Dry Rock Power Generation System	Project Type: R&D
Organization: New Energy and Industrial Technology Development Organization	Date: FY 1980 to FY 1989
End-use Sector: Utility (power generation)	Affiliated/Future Projects: None
Description: This was a study to develop a hot dry rock power generation system.	Technology: Hydrofracturing with 1,000 tons of water
Results: Hydrofracturing with 1,000 tons of water was carried out at a depth of 1,800 ft in 1986, two production wells were drilled in 1987 and 1989. A thermal output of 5000 kW was obtained in a heat extraction test by water circulation in 1989.	Reference: The Sunshine Project

Title: Energy Conservation by Operation Improvement of Soot Blowers of Boiler at Coal-fired Thermal Power Plant	Project Type: Study/demonstration
Organization: Hokkaido Electric Power Co. (Ebetsu Thermal Power Plant)	Date: 1987 to 1988
End-use Sector: Utility	Affiliated/Future Projects:
Description: This was a study and an analysis to raise the heat-absorption efficiency of a plant by improving soot blower operations; results are to be applied to other power plants.	Technology: Operate soot blowers independently; change blower sequence and blow soot in two operations
Results: Made 80% energy conservation target accomplishment rate; gross thermal efficiency rate rose 1.2%	Reference: 1989 Successful Cases of Energy Conservation

Title: Alcohol and Alcohol Blends as Motor Fuels	Project Type: R&D
Organization: IEA (participants are Canada, Japan, New Zealand, United States, and two others)	Date: 1984; continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: Participants are sharing information and carrying out tests on the use of alcohols and blends as motor fuels. This project includes assessment of costs, distribution problems, etc.	Technology: Methanol, ethanol blends with gasoline.
Results: Determined acceptable limits for blending alcohol and evaluated the relative economics of these blends. This project includes field tests of methanol use in diesel engines for heavy goods vehicles.	Reference: IEA Joint R&D Projects, April 1990, p. 23

Title: Electric Power Storage Technology	Project Type: R&D
Organization: NEDO Moonlight Project	Date: First phase of project 1981 to 1991; second phase 1992 to 2000.
End-use Sector: Residential building; transportation	Affiliated/Future Projects: The construction of a 1,000-kW pilot plant was started in 1988.
Description: There is research on zinc-bromide, sodium-sulfur, zinc-chloride, redox-flow batteries, and other high-performance battery devices. This 12-year research project is divided into long life (load leveling in homes) and high energy (for use in autos) batteries.	Technology: Advanced batteries, systems technology, and load leveling technology
Results: Each type of battery was developed and tested in 1 kW and 10 kW sizes between 1980 and 1991; 262 million yen is funded for 1992.	Reference: Sunshine Journal

Title: Development of a Solar House	Project Type: R&D
Organization: New Energy and Industrial Technology Development Organization (NEDO)	Date: FY 1980 to FY 1981
End-use Sector: Residential building (renewable energy)	Affiliated/Future Projects: None
Description: Study to develop four demonstration plants for newly built and existing private housing units, large buildings, and collective housing units.	Technology: Photovoltaics, solar thermal
Results: Operation and evaluation of four demonstration plants was completed in FY 1981.	Reference: The Sunshine Project

Title: The Chofu Municipal Gymnasium	Project Type: Study/demonstration
Organization: KUME Architects, Engineers, Tokyo	Date: Completed 1985
End-use Sector: Commercial building (schools)	Affiliated/Future Projects: None
Description: Project to introduce state-of-the-art technology to an "underground construction."	Technology: An underground public gymnasium incorporating energy conservation features such as a construction method that reduces energy load for heating and cooling by using the insulation effect and heating ability of the earth. A gas engine heat pump system, also designed to recover heat, is the main heat source.
Results: Low energy consumption.	Reference: IEA CADDET

Title: State-of-the-Art Conditioning System for TWIN 21 Building in Osaka	Project Type: Study/demonstration
Organization: Nikken Sekkei Ltd., Japan	Date: 1990
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Study of TWIN 21 project that aimed to create a more energy-efficient air conditioning system and to present many new techniques for effective utilization of energy in a large building.	Technology: In the air conditioning system, heat sources comprise a cogeneration system of gas chiller/heater absorption units and a two-staged hot water temperature supply system, as well as an overall use of a variable water volume system with inverter control.
Results: Primary energy savings were 38%; yearly savings were 54,500,000 yen; high-quality internal climate.	Reference: IEA CADDET

Title: Evaluation of Photovoltaic Modules in Downtown Tokyo	Project Type: Study/demonstration
Organization: Science University of Tokyo (Faculty of Engineering)	Date: 12/1/88 to 2/28/89
End-use Sector: Renewable energy (PV)	Affiliated/Future Projects: None
Description: A study of the relationship between the output of 3 PV modules, amorphous, single, and polycrystalline, and the spectral solar radiation at each wavelength in downtown Tokyo.	Technology: PV module evaluation system: pyrometer, global spectroradiometer, data logger, and three types of PV modules
Results: There is a recognized difference between the distribution ratio of spectral solar radiation for clear days and cloudy days. Module efficiencies are changed fairly by the combination with spectral radiation.	Reference: Clean and Safe Energy Forever

Title: Photovoltaic Power Generating Systems	Project Type: R&D
Organization: New Energy and Industrial Technology Development Organization (NEDO)	Date: 1986
End-use Sector: Renewable energy	Affiliated/Future Projects: None
Description: Study to develop centralized locations for PV power generating systems.	Technology: Photovoltaic cells
Results: Operation trial completed by FY 1986; research on system in progress since FY 1986.	Reference: The Sunshine Project

Title: Research Progress in Crystalline Silicon Solar Cells in Japan	Project Type: R&D
Organization: Tokyo University of Agriculture and Technology (Division of Electronic and Information Engineering)	Date: 1986; continuing
End-use Sector: Renewable energy (PV)	Affiliated/Future Projects: None
Description: Advancing research of crystalline silicon solar cells.	Technology: Fabrication of higher quality, cast polycrystalline ingots and realization of crystalline silicon solar cells with an efficiency of 16% using the cast material
Results: Cell efficiencies of mono- and polycrystalline silicon cells were improved close to 20%, and a new four-year government project was introduced for higher-efficiency, crystalline solar cells having a thin substrate and tandem structures.	Reference: Clean and Safe Energy Forever

Title: Industrial Solar System	Project Type: R&D
Organization: New Energy and Industrial Technology Development Organization (NEDO)	Date: FY 1984 to FY 1987
End-use Sector: Renewable energy	Affiliated/Future Projects: None
Description: Study to develop industrial power from renewable energy.	Technology: Fixed temperature heat process, cascaded temperature heat process, advanced heat process
Results: Advanced heat process has been operating from FY 1987.	Reference: The Sunshine Project

Title: Wind Energy Conversion Systems	Project Type: R&D; study/demo
Organization: IEA (Participants include Canada, Japan, New Zealand, United States, and 12 others)	Date: 1977; continuing
End-use Sector: Renewable energy (wind)	Affiliated/Future Projects: None
Description: Two collaborative projects to show that large-scale generating units can be integrated into existing electrical networks: (1) Share operating experience obtained from countries developing megawatt-sized wind energy systems. (2) Share studies and experiments connected with developing wind energy conversion systems. Areas include environmental and meteorological aspects, wind turbine siting, electric grid integration, and several more.	Technology: Wind energy conversion systems
Results: Systems ranging from 2 MW to 4 MW are being monitored in Quebec, Hawaii, Orkney (UK), Denmark, and Sweden. Others are under construction in Germany, Italy, and Spain.	Reference: IEA Joint R&D Projects, April 1990, p. 52

Title: Ceramic Gas Turbine.	Project Type: Study/demonstration
Organization: NEDO Moonlight Project	Date: 1988 to 1996
End-use Sector: Renewable energy	Affiliated/Future Projects: Studies on environmental implications, performance evaluation, and component technology
Description: For 1992, a 300-kW turbine will be developed operating at 1,200°C.	Technology: Ceramic materials, component technology, and gas turbine engine systems
Results: The target is an 80% efficient turbine operating at 1,350°C using cogeneration.	Reference: Sunshine Journal

Title: Solar Heat Power Plant	Project Type: R&D
Organization: New Energy and Industrial Technology Development Organization (NEDO)	Date: FY 1983
End-use Sector: Renewable energy (solar thermal power plants)	Affiliated/Future Projects: None
Description: Study to develop solar heat power plant	Technology: Two 1,000-kW solar heat power systems (curved surface solar energy collection system and the tower-type solar energy collection system)
Results: Operational trials completed in FY 1983.	Reference: The Sunshine Project

Title: Bioenergy	Project Type: R&D (engineering studies)
Organization: IEA (participants are Canada, Japan, New Zealand, United States, and 10 others)	Date: 1978; continuing
End-use Sector: Renewable energy (biomass)	Affiliated/Future Projects: None
Description: Several tasks to enhance the growth and harvesting of cost-effective biomass and bioenergetic feedstocks, including forest biomass, agricultural, and municipal wastes.	Technology: Short rotation crops, conversion of woody feedstocks to high-value fuels, use of municipal solid wastes for energy
Results: Tasks include improving biomass growth and production technology in short rotation forestry; developing improved methods for harvesting, processing, and transporting forest biomass; converting woody feedstocks to high-value fuels; and improving technologies for conversion of municipal solid wastes and straw to energy.	Reference: IEA Joint R&D Projects, April 1990, p. 53

Title: International Cooperation	Project Type: R&D
Organization: NEDO Moonlight Project	Date: Ongoing
End-use Sector: All sectors	Affiliated/Future Projects:
Description: Japan participates in IEA joint projects, Japan-Australia photovoltaic research, Japan-Thailand fuel cell research.	Technology: Conservation
Results: Japan has completed international research projects with the U.S., France, and other countries. Japan provided 171 million yen in funding for international cooperation in 1990.	Reference: Sunshine Journal

Korea

Korea occupies a peninsula on the east coast of Asia and has a population of 42.4 million and a total land area of 99,143 km². Approximately three-fourths of all Koreans live in urban areas.

Korean gross domestic product (GDP) reached US\$236,400 million in 1990, up from US\$3,000 million in 1965. This is an average annual growth rate of 9.7% for 1980 to 1990. The GDP came from the following market sectors: agriculture (9%), industry (45%), and services (46%); within industry, manufacturing comprised 31% of the GDP. The GDP rose 9% in 1990. A GDP growth of 8.5% was predicted for 1991.

For 1990, the average lending rate was 10%. The average rate of inflation was 5.1% from 1980 to 1990.

In 1990, exports totaled US\$64,837 million and imports totaled US\$69,585 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 12.8% and an average annual growth rate for imports of 10.8%. Despite the recent success in world markets, South Korea sustained a constant trade deficit over the period 1965 to 1985.

South Korea and three other newly industrialized countries in Asia—Hong Kong, Singapore, and Chinese Taipei—make up the so-called "Little Tigers." These countries grew rapidly due to export-led economic strategy. For Korea, this meant a shift away from traditional agriculture and towards large-scale manufacturing.

The Heavy and Chemical Industries Promotion Plan fostered growth in heavy engineering and chemical processing. This includes nonferrous metals, shipbuilding, industrial machinery, electronics, and petrochemicals. By 1990, Korea was the sixth largest producer of steel. Other important products include textiles, footwear, and automobiles.

For 1992, the *Pacific Economic Outlook* predicts that domestic inflation in Korea will rise 10%. Construction will moderate, but export growth will continue. GNP growth for 1992 will be approximately 8%.

Energy Use and Policy Issues

Korea's total energy demand equaled 82 million tons of oil equivalent (Mtoe) in 1989. According to forecasts by the Korea Energy Economics Institute in 1990, the total energy demand will grow at an average rate of 3% between 1988 and 2030. The total energy demand should reach 257 Mtoe at the end of this period.

Per capita energy consumption equaled 1,898 kilograms of oil equivalent (kgoe) in 1990, up from 238 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 8.1%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 12.1%.

In 1989, demand for total energy came from the following market sectors: industry (47%), transportation (19%), and residential and commercial (30%).

Korea depends on domestic (12%) and imported (88%) sources of energy. There is a modest hydropower potential (3,200 MW) and significant amounts of coal. The sources of energy in 1989 were coal (30%), oil (50%), nuclear (14.5%), and fuelwood (1%). The government has implemented a policy to reduce the reliance on foreign oil. This program has developed indigenous resources, developed nuclear power, and introduced liquefied natural gas.

The Korea Electric Power Company (KEPCO) is the only electric utility in the Republic of Korea. Its peak load reached 13,658 MW in 1989. The installed capacity was 20,044 MW and consisted of fossil fuel (33%), nuclear (12%) and hydro (6%). Experts expect demand to grow further as the economy expands.

Korea is currently attempting to develop indigenous oil and gas resources. While no oil has been found yet, gas discoveries are promising. In addition, Korean companies are developing petroleum, gas, and coal reserves overseas.

Firewood consumption, which accounted for more than 50% of Korea's primary energy demand in the sixties, now accounts for only 1.3% of total energy demand.

Korea has steadily increased its use of nuclear power since its introduction in 1977. By 1989, nuclear accounted for 14.5% of the country's primary energy supply and more than 50% of electricity generation.

Energy Efficiency and Conservation

Korea, through the Korea Institute of Energy and Resources, pursues energy efficiency and conservation to reduce growth in demand. The institute sponsored research ranging from basic research on energy demand to architectural design. Some of the studies have examined heating methods (Auh P. et al. 1989), floor plans (Kang L. et al. 1990), and passive solar technologies (Chun W. et al. 1990). University researchers have also looked at conservation. These studies include investigations on fuel demand in electricity generation (Chung-Sok Suh 1990) and economic analysis of household energy consumption (Sang-Gon Lee 1989).

Korea pursues four types of programs: Energy Management Audit and Technical Guidance, Financial Assistance, Publicity and Information Service, Education and Training, and Integrated Energy Schemes.

Energy audits are conducted by experts for factories (ceramics, metals, chemicals, foods, paper, and textiles), large buildings, and transport companies to identify inefficient use and losses of energy. Technical guidance is provided to the plants to reduce energy losses and improve efficiencies. The payback period for such audits averages from less than one year (for shipping companies) to 1.9 years for the industrial sector. Approximately 75,000 audits have been conducted.

Financial assistance includes loans at a favorable rate for conservation investments and research and development (R&D) activities. These special loans are provided for such projects as replacement of inefficient industrial energy equipment, construction of central-heating plant and district-heating systems, and insulation of residential buildings. Since 1980, US\$2,730 million has been made available for replacement of inefficient facilities. The payback on these projects is expected to average

3.8 years. Grants are also available for R&D of technologies that are expected to become commercial in the near future. Energy-saving equipment also receives favorable tax treatment.

Publicity and information campaigns for energy conservation have been conducted through mass media, posters, and pamphlets. Various periodicals are published and distributed. In addition, there are 14 consultation centers located in each province and big city to offer free advice to engineers and the public.

Education and training courses are offered for energy managers of energy-intensive firms and boiler/furnace operators. Technicians and professionals working in the energy field are offered seminars as well.

Integrated energy schemes are either district-heating or central-heating plants in industrial complexes. District heating was introduced in 1987 in areas of dense population and has contributed to environmental and energy goals. Savings are estimated to be US\$10 million per year. The government strongly supports the expansion of district heating and plans to heat some 1.55 million households (15% of the households) in 43 areas by 2001. Central-heating plants are now operating in four complexes, and they supply both heat and electricity in 4,718 gigajoules per hour (1,127 gigacalories per hour) of heat and 188 megawatts (MW) of capacity for 372 companies. Savings are estimated to be US\$46 million.

Actual energy conservation projects include R&D and demonstrations. Since 1987, US\$450,000 was provided by grants for 18 subjects that have a common interest to many users and are expected to become commercial within one year. A new, expanded Five Year R&D Plan for Energy Efficiency has been designed for 1991 to 1996, with one-half the budget of US\$54.8 million to be available as subsidies and one-half as loans on favorable terms. Demonstration projects are for new and innovative energy technologies and equipment. Technical support and loans at a favorable rate are available for such projects.

Electric power demand has risen as the economy has developed. Now, however, demand-side investments also are being made. In addition, electricity tariff structures have been introduced with on-peak and off-peak rates. Off-peak rates are approximately 40% the regular period charge. Seasonal rates also are being introduced.

The government also works toward energy conservation and efficiency through regulations and administrative guidance efforts. For example, consumers who use more than 250 tons of oil or fuel/heat or 1 million kilowatt-hours of electricity must submit a report to the Minister of Energy and Resources on their energy-consuming plan and results. In addition, they must employ a licensed energy engineer. At present, there are 3,000 plants or buildings that meet this requirement.

The government provides energy management guidelines for about 80 items, such as combustion-efficiency improvement, heat loss prevention, etc. In case of a failure to meet the guidelines, an energy audit may be undertaken. Other regulations are in effect for new construction and expansion of facilities, motor vehicles, etc.

On a sector-by-sector basis, the needs, capabilities needed to improve efficiency, and barriers can be summarized as follows:

- Industrial sector
 - Needs—restructuring toward less energy-intensive activities; special supervision of energy-intensive industries; and improved energy intensity
 - Capabilities—conducting energy audits of higher-use firms; providing technical assistance following energy audits; strengthening financial incentives; establishing efficiency targets for end-use products
 - Barriers—lower energy prices for industrial use; low willingness to invest in efficiency; and shortage of funds for conservation investments.
- Residential and Commercial Sector
 - Needs—stronger building standards; special supervision of energy-intensive buildings; standards for energy-using appliances
 - Capabilities—implementation of various regulations and standards; implementation of efficiency standards and labels for major energy-using products; and providing rebates for purchase of high-efficiency products
 - Barriers—low energy price; lack of willingness for efficient use among people; and lack of motivation of energy suppliers to participate in conservation programs.
- Transportation
 - Needs—improved transport and traffic systems; improved fuel efficiency of vehicles; expansion of mass transport
 - Capabilities—restructuring of vehicle tax system; preparing high occupancy vehicle lanes; constructing integrated freight terminals; establishing target fuel efficiency for vehicles
 - Barriers—increasing number of vehicles associated with increasing living standard; shortage of budget funds for new roads; lack of mass transport.

Currently, the Korean government encourages ambitious R&D efforts focused on alternative energy sources. The government's goal is to have alternative energy contribute 3% to the primary energy demand by 2000. Results of this policy have been positive. For example, the number of active solar energy systems in use increased from 1,500 in 1986 to 8,660 in 1989. The government hopes this will reach 500,000 by 2001. The number of passive solar systems also grew from 2,000 in 1986 to 2,307 in 1989 and should number one million in 2001.

Bibliography

Application and Field Experience with Photovoltaic Systems for Rural Electrification Report 4.1.8;
Song, J. [Korea Institute of Energy and Resources (Republic of Korea)]

Energy Efficiency and Conservation Programs in ROK; Ministry of Energy and Resources, Republic of Korea; 1991

Energy for Tomorrow. Division 4: Energy and Technology Session 4.1: Energy Research and Development and Other Major Energy Technology Issues, Canadian National Committee; 1989

KEPCO's National Control Center with an Advanced Energy Management System; Kim, Y.H. [Korea Electric Co., Seoul (Republic of Korea)], Fukushima, N. (Toshiba Corp., Hibiya Office, Tokyo 100 (JP)), Dy Liacco; November 1991

Major Economic Influences on Energy, Session 3.2, 14th Congress of the World Energy Conference; September 1989

Proceedings of the 15th National Passive Solar Conference, Volume 15; S.M. Burley, M.J. Coleman, American Solar Energy Society Inc.; 1990

Revised Survey of Energy Efficiency and Conservation; Ministry of Energy and Resources, Republic of Korea; 1991

South Korea Asia-Pacific Energy Series Country Report; Babak Kiani, Julia Culver Hopper; April 1991

Title: Paper Sludge Dryer	Project Type: R&D; study/demo
Organization: Korea Energy Management Corporation	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects:
Description: A fluidized bed dryer for paper mill sludge was demonstrated.	Technology: Biomass, fluidized bed dryer
Results:	Reference: APEC Response

Title: Electric Induction Heater	Project Type: R&D; study/demo
Organization: Korea Energy Management Corporation, Korea Institute of Machinery and Metals (KIMM)	Date: 1987
End-use Sector: Industry	Affiliated/Future Projects:
Description: The project developed an electric induction heater for bolt manufacturing.	Technology: Heat treatment
Results: Energy savings were achieved.	Reference: APEC Response

Title: Ceramic Heat Exchanger	Project Type: R&D; study/demo
Organization: Korea Energy Management Corporation, Daemyungno Industry, Korea Institute of Energy and Resources (KIER)	Date: 1990
End-use Sector: Industry	Affiliated/Future Projects:
Description: The project designed and analyzed the performance of a ceramic heat exchanger.	Technology: Waste heat recovery of furnaces and kilns
Results:	Reference: APEC Response

Title: Thermal Effects of Two Different Heating Methods for Apartment Buildings	Project Type: R&D; study/demo
Organization: Korea Institute of Energy and Resources	Date: 1989
End-use Sector: Residential building	Affiliated/Future Projects:
Description: This study determined the optimal system for space heating of apartment buildings in Korea. They studied intermittent and continuous heating methods for large apartment buildings.	Technology: Thermal conservation
Results: Continuous heating requires 15% less energy than intermittent heating.	Reference: Clean and Safe Energy Forever

Title: Fuel and Heat Recovery System with Waste Wood and Polyethylene Film	Project Type: R&D
Organization: Korea Energy Management Corporation (KEMCO)	Date: 1989 to 1990
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: KEMCO studied fuel mixes to reduce environmental pollutants.	Technology:
Results: The project developed heat recovery system using PE film and wood chips and developed a continuous manufacturing process for the heat recovery system.	Reference: APEC Response

Title: Energy Conservation Research and Development Project	Project Type: Policy assessment
Organization: Ministry of Energy and Resources	Date: 1986; continuing
End-use Sector: Commercial building	Affiliated/Future Projects: A new US\$ 54.8 million conservation R&D project will span 1991 - 1996.
Description: Since 1987, US\$450,000 funded projects in 18 subjects that have a good chance for commercialization. R&D is performed as joint efforts between companies and national research institutes. There is an expected savings of US\$19.6 million.	Technology: Conservation
Results:	Reference: APEC Response, Energy Efficiency and Conservation in ROK

Title: Lignin for Energy	Project Type: R&D
Organization: Korea Energy Management Corporation, Institute of Seoul National University	Date: 1989 to 1991
End-use Sector: Industry	Affiliated/Future Projects:
Description: Develop a method to use lignin as an energy source. Lignin is pollution free and naturally abundant.	Technology: Biomass
Results: Various carbohydrates in lignin decomposition were observed. Lignin-decomposing bacteria were identified.	Reference: APEC Response

Title: KEPCO's National Control Center	Project Type: Study/demonstration
Organization: Korea Electric Power Corporation (KEPCO), Toshiba Power Corp.	Date: 1988; continuing
End-use Sector: Utility	Affiliated/Future Projects:
Description: KEPCO has developed an Advanced Energy Management System to control the electricity grid. It consists of a national center and regional centers, eight computers, real-time data acquisition capability, and other data collection and control systems.	Technology: This multicomputer system is one of the most advanced in the world.
Results: The system determines overloads, system activity levels, transmission losses, etc. The system had 100% reliability in the first year and will be in use until the year 2000.	Reference: IEEE Transactions on Power Systems, November 1990

Title: Electronic Ballasts for Dimming Fluorescent Light Bulbs	Project Type: R&D; study/demonstration
Organization: Korea Energy Management Corporation, Korea Institute of Science and Technology (KIST)	Date: 1991
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects:
Description: A remote control dimming circuit and stabilization circuit were developed for fluorescent lighting.	Technology: Conservation, illumination controls
Results:	Reference: APEC Response

Title: Energy Management and Audits	Project Type: Audit
Organization: Ministry of Energy and Resources	Date: 1980; continuing
End-use Sector: Industry; commercial, residential buildings	Affiliated/Future Projects: A "Survey of Industrial Energy Conservation Status and Free Audit Projects" will ask 1,250 plant operators about energy conservation.
Description: Energy experts conduct energy audits for factories, large buildings, and transport companies to identify inefficiencies and losses.	Technology: Conservation
Results: More than 75,000 audits have saved 1,228 thousand tones of oil equivalent per year. These include 790 audits of industry, 68,000 technical guidance schemes, 794 audits of public buildings, 68 audits of transport companies, and 24 audits of shipping companies. The payback periods ranged from 0.7 to 3.3 years.	Reference: APEC Response, Energy Efficiency and Conservation in ROK

Title: Financial Assistance for Conservation	Project Type: Study/demonstration
Organization: Ministry of Energy and Resources, Petroleum Business Fund	Date: 1983; continuing
End-use Sector: Industry; commercial, residential buildings	Affiliated/Future Projects: 254 demonstration projects received \$215.9 million in loans and have expected savings of \$50 million a year.
Description: Loans at favorable terms, grants, and 3% to 10% tax credits are available to fund conservation activities. These include research and development, replacing old machinery, insulation of residential buildings, and demonstration projects.	Technology: Conservation
Results: US\$2,370 million has funded 7,680 projects. US\$1,920 million came from the petroleum business fund and US\$810 from a Special Banking and Loan Rationalization Fund. The payback periods averaged 3.8 years.	Reference: APEC Response, Energy Efficiency and Conservation in ROK

Title: Conservation Publicity Campaign	Project Type: Policy assessment
Organization: Ministry of Energy and Resources	Date: Ongoing
End-use Sector: Industry; commercial, residential buildings	Affiliated/Future Projects: Energy conservation awards; <i>Energy Management</i> , monthly; <i>New Technology Information</i> , weekly; <i>Industrial Technology</i> , biweekly; <i>Technology Information Guidebook</i> , yearly.
Description: The government promotes energy conservation through mass media, posters, and various periodicals. <i>Energy Management</i> magazine gives technical information on news and energy policy changes to 8,000 subscribers.	Technology:
Results: There are 14 energy conservation centers throughout the country. Each November is energy conservation month. An energy conservation exhibition is held each year.	Reference: APEC Response, Energy Efficiency and Conservation in ROK

Title: Conservation Education and Training	Project Type: Policy assessment
Organization: Ministry of Energy and Resources	Date: Ongoing
End-use Sector: Industry; commercial, residential buildings	Affiliated/Future Projects:
Description: Training of energy managers is required for energy-intensive firms and boiler/furnace operators.	Technology: Conservation
Results: Seminars are held 20 times per year; 22,000 people have received training on boilers, motors, solar collectors, etc.	Reference: APEC Response, Energy Efficiency and Conservation in ROK

Title: New and Renewable Energy Research and Development	Project Type: Policy assessment
Organization: Ministry of Energy and Resources	Date: 1987; continuing
End-use Sector: Industry; commercial, residential building	Affiliated/Future Projects: The government hopes NRSE will supply 3% of energy by 2001.
Description: The New and Renewable Energy Research and Development Act of 1987 funded over US\$375 million for 1988 to 2001.	Technology: Renewable energy
Results: During 1988 to 1990, 17.1 million subsidized 265 projects. US\$79.1 million was loaned for New and Renewable Sources of Energy (NRSE) activities.	Reference: APEC Response, Energy Efficiency and Conservation in ROK

Malaysia

Malaysia occupies 332,000 km² in Southeast Asia and is divided into west and east regions separated by 750 km of the South China Sea. West Malaysia, or Peninsular Malaysia, forms the southern tip of the Southeast Asian land mass and shares common boundaries with Thailand and Singapore. East Malaysia, consisting of the states of Sarawak and Sabah, occupies the northwest section of Borneo. Malaysia is a member of the Association of Southeast Asian Nations (ASEAN).

Malaysia is one of the least populated countries in the world, inhabited by 17 million people. The prime minister feels that a larger population base is necessary to continue development and has granted tax incentives to larger families to promote population growth.

A parliamentary system of government, divided into 13 state governments, governs Malaysia. The 154 members of the House of Representatives elect a constitutional monarch as the head of government. There is also a senate composed of two members from each state.

Malaysian gross domestic product (GDP) reached US\$42,400 million in 1990, up from US\$3,130 million in 1965. For the period between 1980 and 1990, the economy grew at an annual rate of 5.2%. The GDP came from the following market sectors: agriculture (12%), industry (33%), and services (55%); within industry, manufacturing comprised 24% of GDP. The GDP rose 10.0% in 1990. A GDP growth of 8.3% was predicted for 1991.

For 1990, the lending rate averaged 7.2%. The average rate of inflation was 1.6%.

Malaysia ranks among the world's leading producers of rubber, palm oil, tropical hardwood, tin, and paper. Other agricultural products include cocoa, pineapple, natural gas, tobacco, and sugar cane. Malaysia is the third largest producer of semiconductor devices. Televisions, radios, textiles, and petroleum also are important goods in the economy.

In 1990, exports totaled US\$29,409 million and imports totaled US\$29,251 million. Malaysia's chief trading partners are Japan, Singapore, and the United States, but Malaysia has been cultivating trade relations with China, India, Hong Kong, and Chinese Taipei. Between 1980 and 1990, exports grew at an average annual growth rate of 1.4%, and imports shrank at an average annual shrinkage rate of 8.4%. Manufacturing accounted for 60% of total export earnings in 1990.

Malaysia encourages foreign investment and has a variety of incentives, including tax breaks, protective tariffs, and import duty concessions. Over the past decade there has been a special drive for export-oriented electronics. Malaysia is now seeking high technology, capital-intensive investment to balance the economy's reliance on the industrial sector.

For 1992, the *Pacific Economic Outlook* predicts Malaysia will continue to experience GDP growth close to 8%. The government is expected to sustain public expenditures on roads, highways, and bridges, which will continue growth in the construction sector. Private consumption is forecast to grow 7.7% in 1992.

The *Pacific Economic Outlook* also predicts strong performance for exports because of a diversified manufacturing base. Total manufacturer exports should continue to grow faster than imports. The labor market should remain tight (with unemployment around 6%) and a "stable political climate should sustain business confidence in the economy."

Energy Use and Policy Issues

Malaysia's final energy demand reached 14 million tons of oil equivalent (Mtoe) in 1990. The energy supply came from oil (61%), gas (3%), coal (16%), hydro (3%), and renewables (17%). Demand is expected to increase threefold, to about 36 Mtoe by 2005.

Per capita energy consumption equaled 974 kilograms of oil equivalent (kgoe) in 1990, up from 313 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 7.8%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 6.7%.

Demand for energy came from the following market sectors: industry (32%), transportation (42%), commercial (5.6%), residential (6.2%), and other (14.3%). Malaysia has looked toward fuel substitution to conserve fuel in the transportation sector. Liquefied petroleum gas has been unsuccessful because of high conversion costs, but compressed natural gas is now being tried.

The National Energy Balances estimated reserves of oil to be 3.05 billion barrels. Natural gas reserves total 52.4 trillion cubic feet (1.48 trillion cubic meters). Hydroelectric power potential totals 20,000 MW. Electricity is supplied and distributed by three public utility boards: Tenaga Nasional Berhad, Sabah Electricity Board, and Sarawak Electricity Supply Corporation. Electricity demand reached 1.8 Mtoe in 1990. It is expected to reach 5.5 Mtoe by 2000.

The electricity grid extends to most places on peninsular Malaysia. While the National Electricity Board (NEB) has promoted the use of natural gas for electricity generation, efforts also have been made to expand hydroelectric capacity. Demand for electricity came from the following market sectors in 1986: residential (16%), commercial (30%), industrial (42%), and other (12%).

Growing industrialization and urbanization increased the demand for electricity at an average rate of 10.45% between 1973 and 1985. This accounted for 46.3% of the total energy supply.

The NEB participates in a rural electrification program. Peninsular Malaysia is expected to be fully electrified by 1995, but electrification in Sabah and Sarawak is still low. The Ministry of Education also has supplied funding for rural electrification of schools.

Several institutions address various aspects of energy policy in Malaysia. The focal point for implementation and coordination is the Ministry of Energy, Telecommunications, and Posts (METP), which provides the official communications channel between the three electric utilities and the Cabinet. Development and promotion of petroleum and gas are the responsibility of PETRONAS (the national oil company). Research on new and renewable energy comes under the purview of the Ministry of Science, Technology, and the Environment, and the Ministry of Primary Industries—through the Standards and Industrial Research Institute, the Palm Oil Research Institute of Malaysia, and the Forest Research Institute of Malaysia.

The government has adopted three key objectives that constitute a framework for programs in the energy sector:

- A supply objective to provide adequate and secure energy supply
- A utilization objective to promote efficient energy use and to discourage nonproductive and wasteful patterns of energy consumption

- An environmental objective to ensure that in achieving the previous two objectives the environment is not neglected.

Malaysia's energy policy is designed to promote and support the growth and development of the economy, particularly industrialization. The government adopted a four-fuel policy based on hydropower, natural gas, petroleum, and coal to encourage energy conservation and diversification. The greatest emphasis has been placed on natural gas and hydropower because Malaysian coal resources are mainly low-quality lignite. It is now mandatory to conduct an environmental impact assessment on all new energy projects.

Energy Efficiency and Conservation

Malaysia has been involved in energy conservation since 1980. At that time a Working Committee (with METP as secretariat) conducted a national awareness campaign on energy conservation by organizing exhibitions and seminars and by using various communication media. Among the programs supported is the replacement of conventional lamps with sodium vapor units.

The Malaysian government promotes energy conservation through a number of agencies, and a number of surveys and studies have been performed that have lead to a variety of actions.

Some successes in energy conservation include

- 1980—National awareness campaign on conservation (exhibitions, seminars, pamphlets, and advertisements)
- 1982—Formation of the Energy Management and Conservation Committee by the Federation of Malaysian Manufacturers
- 1983—Energy audits in factories funded by the United Nations Industrial Development Organization (UNIDO), the World bank, and PETRONAS
- 1985—Studies on four high-rise buildings funded by the Commonwealth Heads of Government
- 1986—Energy audits of 15 high-rise buildings
- 1987—Feasibility study on conservation in a palm oil processing plant
- 1988—Training courses on energy audits for the commercial sector
- 1989—Publication of *Guidelines for Energy Efficiency in Buildings*.

The 1983 work conducted with UNIDO et al. on energy use in factories indicated that there were very few instances of actual energy conservation activities taking place. Measurement equipment and control equipment either were not provided or were not repaired. Specific recommendations were provided, including specific changes in operations that would reduce energy consumption. Opportunities for waste-heat recovery also were identified. Electrical consumption in most factories was found to have a relatively poor power factor.

Beginning in 1985, the METP offered a series of seminars and training courses in conjunction with other organizations such as the Federation of Malaysian Manufacturers. Other organizations also sponsored training sessions and seminars.

In 1987, METP conducted a survey of industry and found that 47% of the respondents already had invested in energy-saving measures. In general, the investments had been made by the larger firms, and most investments were small.

The government selected the commercial and buildings sector for an energy-efficiency initiative, partly because of the diversity in the industrial sector. A Guidelines for Energy Efficiency in Buildings program was begun in December 1989. Other government activities included the formation of a Core Group for METP audit programs that is intended to increase expertise and continue audits without foreign assistance. Additional survey work, including industrial audits, is being conducted as well.

The fifth Malaysian Plan contemplated funding an Energy Conservation Center in Malaysia. The Standards and Industrial Research Institute of Malaysia and the Ministry of Domestic Trade also have examined the regulations and standards for appliances. Malaysia participates in the ASEAN-United States project on energy conservation in buildings. Energy audit equipment and control software was purchased.

The public sector funds at least 90% of the new and renewable energy projects in Malaysia. Most of these projects use either mini-hydroelectric or photovoltaic technologies. NEB implemented the first pilot project in 1983 with the remote electrification of Langkawi island. Since then, the Malayan railway, the Ministry of Education, the Marine Department, the Federal Land Development Authority, and Syarakat Telekom have used photovoltaics for remote power.

Malaysia has a sizeable potential to use biomass energy. The Malaysian National Committee estimates that 12% of the total energy supply comes from biomass. Energy from palm oil mills, rice plants, and animal dung could exceed 90 million barrels of oil equivalent. Pilot projects on biomass focus on disposing agricultural waste. Cogeneration capacity has been used in palm oil processing mills.

Large hydroelectric projects provide 1,020 MW, and there is a potential for an additional capacity of 29,000 MW. A government-funded mini-hydro program to supply rural electricity has commissioned 16 projects and has identified 125 others. By the year 2000, mini-hydro will be a significant provider of electricity to rural areas.

The Financing of Energy Services for Small-scale Energy Users (FINESSE) identified six projects for possible financing. The projects included efficient lighting, an energy management system for an air conditioning factory, an energy audit and management service for commercial buildings, solar hot water for residential users, solar hot water for commercial users, and charcoal production in rural areas. FINESSE proposed a five-year financing arrangement to provide 90% of the customer's financing.

Bibliography

Correspondence from the Ministry of Energy, Telecommunications, and Posts

Integrated Energy Analysis for Malaysia Using the ENPEP Model, July 1991

Finesse Workshop, Financing of Energy Services for Small-Scale Energy Users, Country Market Study—Malaysia; Salim Sairan, Masitah Hassan, Mohd Noh Dalimin, Nik Rahimah Nik Yacob, Mohd Zamzam Jaafar, Asian and Pacific Development Centre; October, 1991

Malaysia Asia Pacific Energy Series Country Report; U.S. Department of Energy; November 1988

Title: Feasibility Study on Conservation in Palm Oil	Project Type: Study/demonstration
Organization: Malaysian government and Palm Oil Research Institute	Date: 1987
End-use Sector: Industry (palm oil)	Affiliated/Future Projects: None
Description: This was a feasibility study on energy conservation in the palm oil processing industry.	Technology: N/A
Results: N/A	Reference: Overview of Energy Conservation Activities

Title: Energy Audits	Project Type: Audit
Organization: United Nations Economic Social Commission for Asia and the Pacific (UN/ESCAP)	Date: 1985 to 1986
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Industrial energy audits were prepared covering 30 industries.	Technology: N/A
Results: N/A	Reference: Overview of Energy Conservation Activities

Title: Energy Audit Program	Project Type: Audit
Organization: National Electricity Board (with UNIDO)	Date: 1983
End-use Sector: Industry	Affiliated/Future Projects: None
Description: An energy audit program studying nine factories.	Technology: N/A
Results: Very few cases of energy conservation measures were found in factories. Instruments for measuring and control were not provided or not working. Oxygen content in flue gas was too high; a potential fuel saving, without investment, of 6% to 14% was identified.	Reference: FINESSE Malaysia, p. 3-1

Title: Survey of Manufacturers on Industrial Energy Efficiency	Project Type: Survey
Organization: Ministry of Energy Telecommunications, and Post (METP)	Date: 1987 (new survey under way)
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Questionnaires were sent to 700 members of Federation of Malaysian Manufacturers; 255 were received and analyzed.	Technology: N/A
Results: About 47% had already invested in energy-saving measures, small and large. About 50% planned some measures for the next three years (typically those who had already invested).	Reference: FINESSE Malaysia pp. 3-2, 3-3

Title: Energy Audits in Selected Plants	Project Type: Audit
Organization: METP	Date: In progress
End-use Sector: Industry	Affiliated/Future Projects: None
Description: About 30 screening audits were carried out.	Technology: N/A
Results: Initial findings showed that there is generally a low level of awareness about energy conservation matters, particularly for medium- and small-scale industries.	Reference: FINESSE Malaysia, p. 3-3

Title: Energy Use in Industries	Project Type: Survey
Organization: Standards and Industrial Research Institute of Malaysia (SIRIM)	Date: 1985
End-use Sector: Industry	Affiliated/Future Projects: Energy Consumption Reference established in 1986.
Description: Questionnaires were sent to 40 industries to establish energy consumption.	Technology: N/A
Results: The return rate was 10% because of the survey's request for detailed information on energy use and production.	Reference: ASEAN-EC Energy Conservation Seminar, December 1987, p. 32

Title: Energy Consumption Reference	Project Type: Survey
Organization: Ministry of Energy, Telecommunications, and Post (METP)	Date: 1986
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Questionnaires were sent to 200 factories in a continuing attempt to survey industrial energy use.	Technology: N/A
Results: The return rate was 40%.	Reference: ASEAN-EC Energy Conservation Seminar, December 1987, p. 32

Title: Effects of Energy Conservation on Fuel Use	Project Type: Study/demonstration
Organization: National Electricity Board of Malaysia (NEB)	Date: In progress
End-use Sector: Industry	Affiliated/Future Projects: None
Description: The study will quantify the effects of energy conservation on the use of oil, gas, and electricity.	Technology: N/A
Results: N/A	Reference: ASEAN-EC Energy Conservation Seminar, December 1987, p. 32

Title: Technical Working Group on Energy Conservation in Industries (TWGEI)	Project Type: Policy assessment
Organization: Ministry of Energy, Telecommunications, and Post (METP)	Date: June 1987 to present
End-use Sector: Industry	Affiliated/Future Projects: None
Description: The group was formed to coordinate energy conservation activities and to formulate an energy conservation policy.	Technology: N/A
Results: Data from surveys on energy consumption will be analyzed and used for government and industry reference.	Reference: ASEAN-EC Energy Conservation Seminar, December 1987, p. 33

Title: Drying Technology in Agricultural Produce in Malaysia: Solar Option	Project Type: Study/demonstration
Organization: Malaysian Agricultural Research and Development Institute (MARDI), Standard Industrial Research Institute of Malaysia (SIRIM)	Date: 1987
End-use Sector: Industry	Affiliated/Future Projects: None
Description: A study to determine the status of drying technologies and the potential for use of solar energy in the drying process	Technology: N/A
Results: The study concludes that new technology is necessary to reduce the cost of drying. If the cost of energy is high and unpredictable, solar looks promising.	Reference: Proceedings of the 1989 Congress of the International Solar Energy Society, M. Yusof Othman et. al., Solar Energy Research Group, Universiti Kebangsaan, Malaysia

Title: Study on the Incidence of Electrical Appliances in Urban Households	Project Type: Survey
Organization: SERU	Date: 1981
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: A study to determine the distribution of electrical household appliances in selected areas of Peninsular Malaysia.	Technology: N/A
Results: Sample statistics: 79% of respondents owned TVs; 16% owned washing machines. Lower income households used less electricity than upper income households; as income increased, so did electricity consumption. Energy-efficiency ratings for appliances are unavailable	Reference: Finesse Malaysia, pp. 3-2, 3-3

Title: Seminar on Energy Efficiency and Conservation	Project Type: Education/information
Organization: Malaysian government with help of United Nations Economic and Social Commission for Asia and the Pacific (UN/ESCAP)	Date: 1989
End-use Sector: All sectors	Affiliated/Future Projects: None
Description: Training, demonstration, and seminar on energy conservation.	Technology: N/A
Results: N/A	Reference: Overview of Energy Conservation Activities

Title: Guidelines for Energy Efficiency in Buildings	Project Type: Education/information
Organization: METP	Date: December 1989; continuing
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: N/A	Technology: N/A
Results: N/A	Reference: FINESSE Malaysia, p. 3-2

Title: Training Course on Energy Audit and Management	Project Type: Education/information
Organization: Malaysian government	Date: 1988
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Training course was conducted at a local university.	Technology: N/A
Results: N/A	Reference: Overview of Energy Conservation Activities

Title: ASEAN-US Project on Energy Conservation in Building	Project Type: Education/information
Organization: Malaysian government	Date: 1985
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Local researchers carried out studies and attended courses on building energy efficiency.	Technology: N/A
Results: N/A	Reference: Overview of Energy Conservation Activities

Title: Energy Audits	Project Type: Audit
Organization: Malaysian government	Date: 1985
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Energy audits of 15 high-rise buildings around Kuala Lumpur.	Technology: N/A
Results: Unclear	Reference: Overview of Energy Conservation Audits

Title: Study Regarding Center for the National Use of Energy in Malaysia	Project Type: Study/demonstration
Organization: United Nations Development Programme (UNDP)	Date: 1989
End-use Sector: All sectors	Affiliated/Future Projects: None
Description: A UNDP mission looked into the possibility of setting up a center that would include training and energy audits for industry, among other recommendations.	Technology: N/A
Results: Report prepared but no funding available for implementation.	Reference: Overview of Energy Conservation Activity

New Zealand

New Zealand covers two islands in the South Pacific having a total land area of some 269,000 km² and a population of approximately 3.4 million. The government is a parliamentary democracy.

New Zealand's gross domestic product (GDP) reached US\$42,769 million in 1990, up from US\$5,640 in 1965. This represents an annual gross national product (GNP) increase of 1.9% for 1980 to 1990. The GDP came from the following market sectors: agriculture (9%), industry (27%), and services (65%); within industry, manufacturing comprised 19% of GDP. The GDP rose 0.4% in 1990. A GDP growth of 1.5% was predicted for 1991.

In 1990, exports totaled US\$9,045 million and imports totaled US\$9,466 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 3.4% and an average annual growth rate for imports of 3.6%.

The slowdown in the world economy severely impacted New Zealand's commodity exports. Prices of dairy and wool products fell sharply, and farm profits weakened. The industry endured because of an increase in planting and livestock. Falling prices for New Zealand's commodity exports have been offset by a 10% increase in manufactured exports. However, unemployment has risen to 9.9% in 1991, and modest wage increases are expected for 1991 to 1992.

The average rate of inflation was 10.5% from 1980 to 1990.

The government has reacted to the slow economic growth with a stringent fiscal policy. The *Pacific Economic Outlook* predicts that the New Zealand economy will remain sluggish through 1992. Unemployment should remain around 9%, and average annual earnings are expected to rise.

Energy Use and Policy Issues

In 1989, New Zealand's total energy consumption reached 14.9 million tons of oil equivalent (Mtoe). This was supplied by oil (30.9%), coal (9.4%), gas (23.5%), and hydro (36.2%). By the year 2000, total energy consumption is expected to rise to 18.1 Mtoe.

Per capita energy consumption equaled 4,971 kilograms of oil equivalent (kgoe) in 1990, up from 2,622 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 5.4%. For the previous 15 years (1965 to 1980), energy consumption grew at an annual rate of 3.6%.

The people and the government have demonstrated strong apprehension about the effects of energy production and consumption on the environment. There is particular concern about the effect of greenhouse gases.

The overall energy policy is "to ensure the continuing availability of energy services, at the lowest cost to the economy as a whole, consistent with sustainable development."

New Zealand has made a commitment to energy efficiency that is characterized by the following:

- Dramatic institutional reforms, including the deregulation of markets to permit inter-fuel competition

- Reforms that ensure that the actual costs of energy production, conversion, and distribution are reflected in consumer prices
- Acceptance of the economic, environmental, and social equity associated with more efficient energy use
- Use of market facilitation techniques to facilitate access to information rather than regulations.

Alternative Fuels

New Zealand developed a policy to promote alternative fuels for a number of reasons. First, the fluctuating price of oil ripples through the economy, causing uncertainty and reduced economic growth. Second, there is an indigenous supply of natural gas available for motor fuel. Third, the population is concerned about the effects of automobiles on the environment. Fourth, the private sector has a considerable capacity to produce large volumes of liquefied petroleum gas (LPG).

The government of New Zealand first promoted the use of compressed natural gas (CNG) as an alternative fuel after the oil shock in the early eighties. The government established regulatory controls to guide the industry and set a target of 50% self-sufficiency in transport fuels by 1990.

The CNG industry struggled in the early eighties because of a lack of supply infrastructure and demand from consumers. The cost of converting a regular gasoline-powered vehicle to CNG was expensive, and the payback time was long. In addition to the demand problem, there was no distribution network for the fuel. To overcome these obstacles, the government provided consumers with low interest loans to convert automobiles to CNG. As a result, Caltex invested in a distribution network for both the North and South islands.

As a result of the government support and the distribution network, CNG use has grown significantly. The private sector has developed an LPG network and started marketing the fuel. The government withdrew its support of CNG (feeling there was significant support from the private sector), and the industry collapsed. LPG use remained strong because the private sector developed the whole industry, including its own marketing organization.

The story of alternative fuels in New Zealand shows the important role government plays in the delicate balance between the success and failure of an industry. Any change in policy can have tremendous implications throughout the industry. Today, more than 150,000 cars (approximately 10% of the vehicles in New Zealand) run on LPG or CNG.

Energy Efficiency and Conservation

Most renewable energy and conservation activity in New Zealand concentrates on improving existing installations. New Zealand's expertise lies in conservation using control systems and energy-efficient power plants. Suppliers of energy-efficient products are emerging, including one manufacturer of high-efficiency light bulbs. Other conservation activities include companies that provide energy audits and consulting, cogeneration system manufacturing, and heating and heat recovery systems. There is a small solar hot water industry and a few distributors of wind, photovoltaic, and micro-hydro systems.

A recent institutional reform (October 1992) is the establishment of The Energy Resources Monitoring and Conservation Authority (ERMCA), which has as its purpose the promotion of conserving the

energy reserves of New Zealand. Conservation is defined to mean the management of the nation's energy resources such that their productivity is increased through the adoption of energy-efficient practices and technology, and that economic, social, and environmental considerations are taken into account. ERMCA will be an independent authority charged with the implementation of efficiency practices and will be the international liaison on efficiency issues. For greenhouse gas and wider policy issues, ERMCA will be supported by officials from the Ministries for the Environment and Commerce.

The following are functions of the authority:

- To develop, implement, and promote strategies for energy conservation
- To advise the government and the energy industry on matters relating to the development, implementation, and promotion of those conservation strategies
- To monitor known energy sources, their use, and the investigation of potential sources and applications, together with the economic, social, and environmental impacts, in both the short and long term.

The New Zealand government conducted a five-year study, titled *Design to the Sun*, aimed at reducing energy consumption by using energy conservation and passive solar technology. The program's achievements include the following:

- *Design to the Sun* manual for designers and architects
- *Design to the Sun* two-day workshops around the country
- Demonstration programs in 18 conventional homes and 10 solar homes
- Monitoring of energy consumption and comfort level in demonstration homes
- Technical and market assessments from a consumer and national perspective
- Market research on homeowner and builder attitudes
- Solar subdivision for Blenheim.

Design to the Sun staff worked with the Housing Corporation of New Zealand to demonstrate many of the homes in the program. They also compared construction techniques and building materials for passive solar homes. The results show 40% to 50% lower heating bills and very happy residents. Unfortunately, the Passive Solar Market Study showed low levels of consumer awareness.

The Department of Commerce has set up a branch to address energy conservation and energy efficiency. Energy Management (EM) provides policy advice on energy management initiatives and promotes energy management to the government and the private sector.

The following are EM's goals:

- To make businesses more competitive by maximizing energy productivity
- To reduce the waste of energy resources
- To foster increased national security of energy supplies
- To protect the natural environment.

EM has had several significant accomplishments since 1988:

- Nine major energy-saving initiatives in the government
- Twenty-six projects demonstrating the energy savings and performance of new technologies (projects focused on control systems and improving efficiency in conventional energy generation)
- Savings of NZ\$1.5 million in reduced energy spending by the government
- Establishment of a major information program, including a bimonthly newspaper on energy management issues targeted to senior and middle management; an annual reference directory of the energy supply and energy management industries; and several publications for the domestic sector
- A showcase project in one community to demonstrate the value of community education in energy management
- Acceptance of a recommendation to include energy-efficiency performance standards in the proposed building codes.

Bibliography

Energy Management Consultancy Service; Energy Management

Energy Management Energy & Resources Division Ministry of Commerce Business Plan 1990-1991

Energy Management News; Energy & Resources Division, Ministry of Commerce; May 1991

Energy Auditing; Energy Management

Energy Management Demonstration Programme, Project Profile 1-25, Case Studies 1-5; Blenheim Borough Council

Energy Management and the Greenhouse Effect, A Background Paper on Energy Management and the 1988 Toronto Goal; C. Turbott, F. Pool and G. Vickers, Energy Management, Energy and Resources Division, Ministry of Commerce; January 1991

Houses Designed for New Zealand Sun; D.R. Brewer

The Energy Management Yearbook 1992; Energy Management

Title: Conservation for Commercial Laundry Machines	Project Type: Study/demonstration
Organization: Energy Management Demonstration Programme (EMDP), Hawkes Bay Hospital Board	Date: 1989
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: Six commercial laundry machines at a hospital were retrofitted with Washtec controllers. The systems were monitored.	Technology: Conservation, Washtec LC101 controllers
Results: The total savings were \$8,000 per year. The expected payback period was 16 months and the controllers reduced the wash time by 20 minutes.	Reference: EMDP Report #4

Title: Flue Gas Economizers at Laundry Locations	Project Type: Study/demonstration
Organization: EMDP, New Zealand Towel Supply, Newmarket Laundry	Date: 1990
End-use Sector: Commercial building	Affiliated/Future Projects: High-efficiency hot water generators also were installed at New Zealand Towel Supply.
Description: Waste heat from exhaust gases preheat incoming water. The resulting hot water is fully potable.	Technology: Conservation, flue gas re-circulator, Combustion Control Ltd.
Results: Payback period of 2 years.	Reference: EMDP Project Reports #15, #16 and #19

Title: Energy Management and Control System	Project Type: Study/demonstration
Organization: Ministry of Agriculture and Fisheries, (MAF) Energy Management Demonstration Programme	Date: 1988
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: MAF studied the peak/nonpeak tariffs and installed an energy management control system.	Technology: Conservation, energy control system
Results: Peak demands were 70 kW lower. MAF saves approximately \$10,000 per year, for a 2.6-year break-even point.	Reference: EMDP Project Report #3

Title: High-Efficiency Steam Blancher	Project Type: Study/demonstration
Organization: Wattie Frozen Foods, EMDP	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects:
Description: Wattie Foods installed a more efficient blancher for use in industrial food processing.	Technology: Conservation, a high velocity steam blancher to deactivate enzymes
Results: Project resulted in an energy savings of 2,500 tonnes of coal equivalent and a payback time of a little more than a year.	Reference: EMDP Project Report #5

Title: Improved Fuel Combustion Efficiency in Boilers	Project Type: Study/demonstration
Organization: Taumarunui Hospital, Fairfield College, EMDP	Date: 1988
End-use Sector: Commercial building	Affiliated/Future Projects: The hospital installed compact fluorescent light bulbs and achieved a payback of 3.6 years.
Description: Flue gas re-circulator improves burning efficiency, allows different types of coal, and reduces cost at the hospital.	Technology: Conservation, flue gas re-circulation.
Results: Project resulted in a savings at Taumarunui Hospital of \$8,000 per year and a payback time of 1.5 years. Savings of \$430 per year were achieved at Fairfield College.	Reference: EMDP Project Report #6 and #8, Case Study #1

Title: High-Efficiency Gas Heater for Central Heating	Project Type: Study/demonstration
Organization: EMDP, Gas Development Center	Date: 1989
End-use Sector: Residential building	Affiliated/Future Projects:
Description: EMDP is testing and monitoring a furnace having an efficiency of 97%.	Technology: Conservation, gas furnace
Results: Expected payback of 5 years.	Reference: EMDP Project Report #7

Title: Gas Boiler Conversion	Project Type: Study/demonstration
Organization: EMDP, Huttons Kiwi Ltd.	Date: 1989
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: New Zealand-based Energy Services Co. developed a waste heat recovery system that can be added to existing modules. It condenses water vapor and recovers the latent heat.	Technology: Conservation, water vapor condensation of exhaust gas
Results: EMDP installed a prototype conversion kit at the bacon and ham factory of Huttons Kiwi Ltd. It expects a fuel savings of 15% and a payback time of 1 year.	Reference: EMDP Project Report #11

Title: Energy-Efficient Supermarket Refrigeration	Project Type: Study/demonstration
Organization: EMDP, Masterton Supermarkets, Food Technology Research Center	Date: 1989 to 1990
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: EMDP conducted a study of parallel rack refrigerators. The units were retrofitted with waste heat recovery systems, switches, and other innovations. Waste heat is used for space heating.	Technology: Conservation, switches and monitoring
Results: The project saved NZ\$45,000 a year and could be repaid within 3 years.	Reference: EMDP Project Report #9

Title: Blast Freezer's Variable Speed Fans	Project Type: Study/demonstration
Organization: EMDP, AFFCO NZ Ltd.	Date: 1991
End-use Sector: Industry	Affiliated/Future Projects:
Description: A computer-controlled fan regulated freezing in a meat plant.	Technology: Conservation. Fan's airflow is proportional to the fan speed, but power consumption is proportional to the cube of the fan speed.
Results: Project resulted in a 44% energy savings and a payback period of 2.1 years.	Reference: EMDP Project Report #20

Title: Dual Duct HVAC Systems	Project Type: Study/demonstration
Organization: EMDP, Auckland Hospital	Date: 1989
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: The air conditioning system of Auckland Hospital was upgraded with a variable speed fan.	Technology: Conservation, variable-speed HVAC fan
Results: Project resulted in an energy savings of \$6,022 and a payback time of 4 years. The hospital also learned about the system and made other improvements for further savings.	Reference: EMDP Project Report #10

Title: Swimming Pool Insulation Covers	Project Type: Study/demonstration
Organization: EMDP, Moana Pool	Date: 1992
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: EMDP installed covers on three pools having a total area of 138 m ² .	Technology: Conservation, insulation with MacBall Insulating Pool Blanket
Results: Payback time of 30 months was achieved. The reduced humidity also will reduce building maintenance costs.	Reference: EMDP Project Report #23

Title: Insulation Blankets for Hot Water Heaters	Project Type: Study/demonstration
Organization: EMDP, McCracken's Farm	Date: 1991
End-use Sector: Commercial, residential buildings	Affiliated/Future Projects:
Description: Insulating hot water heaters for residential or commercial use saved 46% of the electricity costs.	Technology: Conservation, insulation
Results: Payback period was less than 1 year.	Reference: EMDP Project Report #24 and #25

Title: Valve Insulation	Project Type: Study/demonstration
Organization: EMDP, Newmarket Laundry	Date: 1989
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: Valve insulation blankets were developed by Bestobell for easy removal and durability.	Technology: Conservation, insulation
Results: Newmarket Laundry installed 14 valve blankets costing \$64.99. Payback time was 9.8 months.	Reference: EMDP Project Report #12

Title: Victoria University Lighting Installation	Project Type: Study/demonstration
Organization: Government Energy Management Services, Victoria University	Date: 1991
End-use Sector: Commercial building	Affiliated/Future Projects: Taumarunui Hospital installed compact fluorescent lights for 70% savings. Other initiatives at Victoria University saved \$200,000.
Description: Victoria University's library installed high-efficiency reflectors, compact fluorescent lights, and lighting timers in the stacks.	Technology: Conservation, lighting
Results: Energy consumption was reduced 65% or \$16,000 per year.	Reference: EMDP Case Study #3

Title: Energy Management Demonstration Programme	Project Type: Policy assessment; study/demo
Organization: Ministry of Energy	Date: Ongoing
End-use Sector: Commercial building	Affiliated/Future Projects: EMCS publishes a product catalog for energy services and systems.
Description: EMDP helps individual companies save money and energy. The program is designed to encourage collaboration between energy suppliers and consumers. Projects use extensive monitoring and control technologies.	Technology: Conservation. EMDP supports New Zealand conservation industry and has developed expertise in automated/computer control systems for energy.
Results: EMDP has completed successfully more than 25 projects, case studies for industry, and an information campaign for conservation. It provides services, including walk-through energy surveys, energy technology advice, tariff analysis, feasibility studies, and energy-efficiency plans.	Reference: EMDP Annual Report

Title: 'eta' Awards	Project Type: Policy assessment
Organization: Energy Management	Date: Ongoing
End-use Sector: Industry; commercial, residential buildings	Affiliated/Future Projects:
Description: The Ministry of Commerce gives awards for energy efficiency and productivity in industry.	Technology: Conservation
Results:	Reference: Energy Management News

Title: Residential Energy Code—A New Zealand Proposal	Project Type: Policy assessment
Organization: University of Auckland (School of Architecture)	Date: 1989
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: The proposal was to draft a new residential energy code that will state a mandatory level of acceptability for new house construction.	Technology: Various
Results: Unknown	Reference: Clean and Safe Energy Forever

Title: Design and Construction of Low Energy Housing	Project Type: Study/demonstration
Organization: Energy Management Demonstration Programme, Blenheim Borough Council	Date: 1989
End-use Sector: Residential building	Affiliated/Future Projects: Unknown
Description: The project developed 32 units for elderly housing. Solar design provided low energy costs and was within the housing corporation's budget.	Technology: Passive solar, active solar hot water heaters, trombe walls
Results: Savings were achieved of 60% on water heating and 70% on space heating.	Reference: EMDP Project Profile #1

Title: Low Energy Library for Nelson City	Project Type: Study/demonstration
Organization: EMDP, Nelson City Council. Victoria University's Energy Research Group	Date: 1989
End-use Sector: Commercial building	Affiliated/Future Projects: Unknown
Description: The architects worked with the EMDP, and Victoria University designed a new library for Nelson City.	Technology: Passive solar
Results: The library will reduce capital costs by \$40,000 and will achieve energy savings of \$4,000 per year.	Reference: EMDP Project Report #13

People's Republic of China

China has a population of more than 1 billion people, an undeveloped infrastructure, and growing energy needs. At the present time, there is a severe energy shortage caused by increased economic activity both in urban and rural communities. This energy shortage is especially acute in rural areas, where 80% of the households rely on firewood as the major source of cooking fuel.

To meet the growing energy demand, China has maintained its investment in new energy plants and has championed conservation and renewable energy.

According to the constitution, the People's Republic of China is "a socialist state under the people's democratic dictatorship led by the working class." Structurally, two separate bodies govern the country—the National People's Congress and the State Council.

China's economy gained momentum in 1990. Spurred by a second year of record harvests, increased industrial output, and growing exports, China's gross national product (GNP) grew by 5%. Inflation was 2.1%. Foreign exchange reserves grew to US\$29 billion, which is equal to at least six months of imports.

China's gross domestic product (GDP) reached US\$364,900 million in 1990, up from US\$67,200 million in 1965. This represents an average annual growth rate of 9.5% during 1980 to 1990. The GDP came from the following market sectors: agriculture (27%), industry (42%), and services (31%); within industry, manufacturing comprised 38% of GDP. The GDP rose 5% in 1990. A GDP growth of 5.7% was predicted for 1991.

The eighth five-year plan (1991 to 1995) emphasizes development of agriculture, basic industry, transportation, and communications. The program calls for an economic system that combines the traditional centralized government planning with market forces. The government will continue to operate two-thirds of China's industry but will also allow private ownership.

The average rate of inflation was 5.8% from 1980 to 1990.

In 1990, exports totaled US\$62,091 million and imports totaled US\$53,345 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 11% and an average annual growth rate for imports of 9.8%. China's main exports include apparel, toys, and telecommunications, and the main imports from the United States include aircraft, computers, fertilizer, and wood products. China's 1991 trade balance was US\$8.1 billion. The United States-China trade balance favored China by US\$12.8 billion.

The Chinese economy is in transition, changing from a planned economy to a market-driven economy. Although the initial outlook is optimistic, the central government has made little progress towards tighter macroeconomic control. The greatest fear is double-digit inflation, which has plagued the reform-minded administration in the past. There are ample opportunities for U.S. investors and exporters in certain sectors, but securing access to raw materials, credit, and the domestic market is difficult.

The *Pacific Economic Outlook* predicts growth in China will reach 6.8% in 1992. Imports will grow faster than exports. The inflation rate should remain around 6.4%.

Energy Use and Policy Issues

China began to utilize petroleum and natural gas as fuels as early as the fourth century B.C. Today, China possesses the third largest energy system in the world, which produced 1,016 million tons of coal equivalent in 1989. Since 1949, 21.2% of the investment in the nation has been put to use in the energy sector. This caused a 9.7% average annual growth rate in production between 1949 to 1989.

Per capita energy consumption equaled 598 kilograms of oil equivalent (kgoe) in 1990, up from 178 kgoe in 1965. For the period 1980 to 1990, energy consumption grew at an annual rate of 5.6%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 9.8%.

China's energy sector is dominated by the use of coal. The country has proven coal reserves totaling 901.5 billion tons. In 1988, domestic consumption of coal reached 982.2 million tons; 25.6% of the coal generates power. The coal industry employs more than 7 million people. Because of the great reliance on coal, there are great pressures on the transportation system and the environment.

China exploits 233 oil fields and 68 gas fields. In 1989, it produced 137.65 MT of crude oil and 14.49 million cubic meters of natural gas. There are 37 medium-sized refineries that have a total processing capacity of 110 MT. In 1989, the refineries processed 102.9 MT, which produced 20.65 MT of gasoline, 25.81 MT of diesel fuel, and 32.1 MT of fuel oil.

China's electric power industry has an installed capacity of 126.6 gigawatts (GW) (92 GW of thermal and 34.6 GW hydroelectric). There are, however, significant power shortages, especially in some regions of the nation that lack hydropower or adequate coal transportation facilities.

In rural areas, about one-half of the energy use is commercial energy and one-half is noncommercial biomass. Approximately 236 million tons of firewood and 273 million tons of straw are used annually.

Energy Efficiency and Conservation

In the late seventies, China adopted several new policies to encourage energy efficiency and conservation and, thereby, reversed a long-standing trend of energy consumption growing 1.5 to 2 times more rapidly than the economy. The rapid growth of energy consumption was a result of the development of heavy industry, the lack of a rational pricing policy or other mechanism to balance supply and demand, and the general lack of attention given to resource use by national planning institutions. Since 1978, however, the rate of growth for energy has been only one-half that of the economy—a significant result.

In 1979 and 1980, Chinese energy experts were assembled in a series of meetings sponsored by the China Research Society. Out of these meetings came a new energy policy and new measures for energy conservation and efficiency. The proposed program was based on six major components:

1. Specific energy-efficiency requirements
2. Information campaigns
3. A shift to less energy-intensive industry
4. Price reform

5. Establishment of energy conservation centers
6. Creation of investment funds for energy management and efficiency investments.

The government created a specific investment plan that had investment criteria based on the cost of producing 1 ton of coal—criteria that equated the cost of producing a unit of energy with the cost of saving a unit of energy. The original cost was calculated to be \$340 yuan per ton, and it has been revised as the cost of producing coal has increased over time. The State Planning Commission and the banks established an interest rate of 2.5% for energy conservation loans having a term of four to six years; the rate is about one-third lower than the prevailing rate at the time.

The government made loans for new equipment and modernization as well, and used pre-feasibility studies to identify projects that met the lending criteria. A total of 10 billion yuan were allocated to the projects in the sixth five-year plan; two-thirds of the funds came from the central government and one-third from local administrations and enterprises. As a result of the program, of the approximately 12 to 13 billion yuan invested in energy in China in 1981 to 1982, 2 billion yuan was explicitly devoted to saving energy.

The overall energy-savings accomplishments of the sixth five-year plan are estimated at 14 million tons of coal per year from the technology modernization program, at a cost of about 3.7 billion yuan or 260 yuan per ton per year. Capital construction programs averaged 620 yuan per ton per year. It is estimated that the annual growth rate for consumption was 4% and that it would have been 7% without the program.

To achieve improved energy efficiency four main technology areas have been identified:

1. Improving efficiency in the power industry through such measures as improving production management, reduction of transmission losses, and upgrading existing power equipment
2. Introducing high-efficiency fans, pumps, and electric motors into the Chinese market and transferring the appropriate technology associated with them
3. Introducing high-efficiency air conditioning equipment into China to replace existing low-efficiency equipment
4. Introducing high-efficiency illuminating technologies into the Chinese market.

Under the seventh five-year plan (1986 to 1990), the government continued those policies that had made remarkable strides in the past 10 years. Twenty institutes are devoted to renewable energy research. China's national efforts have been complemented by international exchanges. As of 1989, China had completed 23 cooperative projects with the European Economic Community (EEC), Italy, Belgium, Germany, England, Denmark, Japan, the Netherlands, and the United States.

Renewable energy has reached the stage of commercialization in China. More than 100 factories are devoted to manufacturing solar heaters, photovoltaic cells, and wind generators. China manufactures 100,000 solar cookers per year and 30,000 wind generators. China also has photovoltaic manufacturing capacity of 7 MW_p (peak watts), but currently only produces 0.5 MW_p per year.

Bibliography

APEC Energy Team Schedule; April 1992

China World Trade; U.S. Dept. of Commerce; March 1992

Energy Conservation Programs in the People's Republic of China, Mark D. Levine and Liu Xeuyi

Energy in China; Ministry of Energy, People's Republic of China; 1990

Foreign Economic Trends and Their Implications for the United States; The American Embassy
Beijing; May 1991

The Development of New and Renewable Sources of Energy in China; Chinese Solar Energy Society;
1991

*The Illustrated Book of China's Large Hydropower Construction Management Organizations and
Their Contracted Projects*; The Department of Hydroelectric Power Development; 1991

Yu Lixing, Deputy Division Chief, Department of International Cooperation, Ministry of Energy,
People's Republic of China - correspondence

Title: Recovery of Waste Heat and Gases	Project Type: Study/demonstration
Organization: State Planning Commission	Date: Sixth Five Year Plan, 1981 to 1985
End-use Sector: Industry	Affiliated/Future Projects: Unknown
Description: Two hundred million yuan was invested in recovering coal gas from blast furnaces, rotating furnaces, and coke ovens. In the case of the Beitai Steel project, an investment of 3.24 million yuan permitted the recovery of the equivalent of 20,000 tons of coal equivalent per year.	Technology: Various improvements and new equipment
Results: For the Beitai steel project, savings were the equivalent of 150 yuan per ton per year; other projects had costs averaging 465 yuan per ton per year.	Reference: Levine & Liu

Title: Recovery of Waste Heat and Gases	Project Type: Study/demonstration
Organization: State Planning Commission	Date: Sixth Five Year Plan, 1981 to 1985
End-use Sector: Industry	Affiliated/Future Projects: Unknown
Description: In the chemical industry, especially in sulfuric acid plants, heat and gases were recovered to generate 0.25 billion kWh of electricity. In the paper and sugar industries, 250 MW of generating capacity was installed.	Technology: Cogeneration and heat recovery
Results: Unknown	Reference: Levine & Liu

Title: Renovation of Industrial Boilers and Furnaces	Project Type: Study/demonstration
Organization: State Planning Commission	Date: Sixth Five Year Plan, 1981 to 1985
End-use Sector: Industry	Affiliated/Future Projects: Unknown; it is estimated that there are 110,000 industrial furnaces in China.
Description: More than 12,000 boilers were renovated during the period. Some units were fitted with cogeneration equipment; in some installations, several small boilers were replaced with larger more efficient equipment, and others were cleaned and tuned.	Technology: Cleaning, tuning, and replacing boilers and furnaces
Results: Average efficiency gain was 10% to 15%.	Reference: Levine & Liu

Title: Other Technology Modernization	Project Type: Study/demonstration
Organization: State Planning Commission	Date: Sixth Five Year Plan, 1981 to 1985
End-use Sector: Industry	Affiliated/Future Projects: Unknown
Description: Altogether 250 yuan was devoted to the purchase of more efficient specialized equipment for a wide variety of industries during the plan period.	Technology: Improved equipment
Results: Average project saved coal at an equivalent price of 340 yuan per ton.	Reference: Levine & Liu

Title: Recovery of coal wastes	Project Type: Study/demonstration
Organization: State Planning Commission	Date: Sixth Five Year Plan, 1981 to 1985
End-use Sector: Industry	Affiliated/Future Projects: Unknown
Description: Wastes were used to produce both electricity and heat and were used in the manufacture of bricks and cement.	Technology: Various
Results: Saved energy at the equivalent cost of 140 yuan per ton of coal; an additional benefit was the cleanup of the coal waste piles.	Reference: Levine & Liu

Title: Improved Fertilizer Plant Efficiency	Project Type: Study/demonstration
Organization: State Planning Commission	Date: Sixth Five Year Plan, 1981 to 1985
End-use Sector: Industry	Affiliated/Future Projects: Unknown
Description: Much of the nitrogenous fertilizer produced in China comes from small, inefficient plants. In 1985 the industry consumed approximately 5% of the total energy consumed in China. An investment of 542 million yuan resulted in about a one-third reduction in coal use at small fertilizer plants.	Technology: Unreported
Results: A 22% reduction in coal use at an estimated 475 yuan per ton of coal per year. (Does not include productivity gains.)	Reference: Levine & Liu

Title: Development of Solar Cookers	Project Type: Study/demonstration
Organization: State Science and Technology Commission, State Planning Commission, and Ministry of Agriculture, Department of Rural Energy	Date: Ongoing
End-use Sector: Residential building	Affiliated/Future Projects: Passive solar
Description: The agricultural sector of local governments has been coordinating production, demonstrations, and quality control of solar cookers. A joint R&D team from 18 ministries developed CAD modeling techniques, screened materials, and designed five standard cookers for scale production.	Technology: The first solar cooker was produced in 1956. Since then a variety of cookers have appeared in China: bread-box types, concentrators, automatic tracking, cement, plastic, and portable. Most use glass fiber reinforced plastics for the cooker shell, aluminum thin film and glass mirror for the reflective surface, and gelatin adhesive for insulation.
Results: Since 1985, yearly production of solar cookers has remained near 100,000 sets. The payback time is between one and two years when compared with firewood.	Reference: Chinese Solar Energy Society

Title: Solar Projects in Tibet	Project Type: Study/demonstration
Organization: Chinese Solar Energy Society	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects: 1990 to 2000 Tibet Sunshine Project plans to produce solar-powered goods.
Description: Development of solar energy projects	Technology: PV and passive solar
Results: Solar greenhouses multiplied vegetable output. Solar baths were built. Over 10,000 solar cookers were developed; PV power generation was installed.	Reference: <i>Sun World Magazine</i>

Title: Photovoltaic Development	Project Type: Study/demonstration
Organization: PV Division of Solar Energy Society	Date: Ongoing
End-use Sector: Utility, industry, and residential	Affiliated/Future Projects: The government is engaged in PV demonstrations for commercial uses such as railway beacons and in communications, and the military. It has invested US\$8 million since 1975.
Description: There are 40 research institutions and factories engaged in PV R&D. Seven factories have a manufacturing capacity of 7 MW production per year. Four PV power stations with a capacity of 5-10 kW have been built.	Technology: The kinds of cells China has been producing include PESC c-Si, c-Si, BSFR c-Si, polycrystalline c-Si, GaAlAs/GaAs, CuS/Cd, a-Si.
Results: Costs of production were reduced to US\$4.8 per picowatt (pW) for amorphous and US\$8.65/pW for c-Si cells. Efficiencies of 18% were achieved in research and 11% in production.	Reference: Chinese Solar Energy Society

Title: Biomass Development: Fuelwood and Efficient Stoves	Project Type: Policy assessment
Organization: Chinese government, Chinese Biomass Development Center, Ministry of Forest, Chinese Center for Rural Energy Research and Training (CCRERT).	Date: 1986; continuing
End-use Sector: Residential, commercial building, industry	Affiliated/Future Projects: Continued distribution of stoves
Description: In China, 70% of rural energy used is generated from biomass. The government has passed a number of laws aimed at conserving forests, planting, and maximizing volumetric yield. The government has also developed 20-30% efficient stoves which reduce consumption of firewood by 30-50%.	Technology: Biomass, efficient stoves, alcohol production
Results: 5.7 million hectares of fuelwood forests were planted of which 40% were rapid-growing high-yield plantations. As of 1989, 114 million rural households (57%) were using efficient stoves. CCRERT set standards for manufacturers of stoves.	Reference: RERIC news and Chinese Solar Energy Society

Title: Biomass Gasification	Project Type: Study/demonstration
Organization: Chinese government and Chinese Academy of Agricultural Mechanization Science	Date: Ongoing
End-use Sector: Commercial building; industry	Affiliated/Future Projects: None
Description: Gasifiers fueled by rural waste were developed that have outputs ranging from 200,000 kilojoules per hour (kJ/hr) to 800,000 kJ/h.	Technology: Draft-up and downdraft biomass gasification systems
Results: A 650,000 kJ/h downdraft gasifier using wood chips was developed and is used in a furniture factory.	Reference: Chinese Solar Energy Society

Title: Geothermal Utilization in China	Project Type: Study/demonstration
Organization: Ministry of Geology and Mineral Resources	Date: Continuing
End-use Sector: Commercial, residential building, electrification	Affiliated/Future Projects: Geothermal Utilization in Tibet
Description: More than 3,000 fields of hydro-thermal potential were studied by the Chinese government. The resource is used in industry, agriculture, aquaculture, space heating, and public baths.	Technology: Geothermal electricity generation. Most plants use water below 100°C, except for Yangbajing (165°C) and Alee (110°C).
Results: Forty-five geothermal fields have been exploited which generate 20.8 MW of electric power and provide 89.6 tons of water for direct heat, approximately 41,222 terajoules per year. Yangbajing Geothermal Plant generates 19.18 MW of electricity. Most sites directly use the geothermal resource, which yields approximately 17.5% efficiency.	Reference: Chinese Solar Energy Society

Title: Geothermal Utilization in Tibet	Project Type: Study/demonstration
Organization: Geothermal Development Corporation of Tibet	Date: Early 1980s - continuing
End-use Sector: Commercial, residential buildings	Affiliated/Future Projects: Geothermal utilization in China
Description: There are 1.2 million km ² in Tibet containing geothermal resources. In the mid-seventies, these resources were explored.	Technology: The exploration strategy is focused on searching for deep reservoirs for fluid that could be used for geothermal plants.
Results: Six hundred geothermal areas were found.	Reference: Chinese Solar Energy Society

Philippines

The Philippines occupies more than 7,000 islands inhabited by about 62 million people. These islands traverse more than 1,600 km from north to south along the southeastern rim of Asia. Only 154 of these islands exceed a land area of more than 13 km², and 95% of the population resides on 11 of the islands. The Philippines is a member of the Association of Southeast Asian Nations (ASEAN).

The government operates through a constitutional presidential/congressional system. The president operates through a cabinet system, which carries out executive orders and the laws of Congress.

The Philippines has had an average gross domestic product (GDP) growth rate of 2.2% over the past 10 years. This growth also has been very cyclical; zero or negative growth occurred during 1983 to 1986 and nearly 5% growth occurred from 1987 to 1990.

The Philippines GDP reached US\$43,860 million in 1990, up from US\$6,010 million in 1965. The GDP came from the following market sectors: agriculture (22%), industry (35%), and services (43%); within industry, manufacturing comprised 25% of GDP. The GDP rose 3.1% in 1990. A GDP growth of 1.9% was predicted for 1991.

The average rate of inflation was 14.9% from 1980 to 1990.

In 1990, exports totaled US\$8,681 million and imports totaled US\$13,080 million. During 1980 to 1990, this represents an average annual growth rate for exports of 2.5% and an average annual growth rate for imports of 2.3%. The United States is the largest trading partner of the Philippines (35% exports/25% imports) followed by Japan (18% exports/17% imports) and the European Economic Community (EEC) (19% exports/11% imports).

The Philippine government has passed extensive investment regulations and trade legislation. These regulations limit foreign direct investment in utilities, public works, and lands in the public domain. Trade regulations include tariffs between 5% and 80% on imported goods. Registered exporters receive tax credits and tariff reductions.

The Pacific Economic Outlook predicts that the cyclical nature of the economy in the Philippines will continue in the near future. The political elections scheduled for 1992 should provide a short-run stimulation for the economy. Some improvement in the trade balance is expected, and the deficit should decline. Privatization of government enterprises may occur at an accelerated rate, but interest rates will continue to be above 25%. Inflation is projected at 8.3%.

Energy Use and Policy Issues

In 1990, the Philippines' total energy consumption was 120.1 million barrels of oil equivalent (Mboe). By 2000, the energy output should grow to 217 Mboe, and the government hopes the country will rely less on imported oil. In 1990, the imported oil cost the Philippines US\$1,930 million, representing 16% of total imports.

The Philippines use both imported and domestic sources of energy. Imported energy supplied 65.3% of the total energy, and domestic sources supplied 34.7%. Imports consisted of oil (63.4%) and coal (1.91%). Domestic sources included agri-waste (8.7%), hydro (8.41%), geothermal (7.5%), bagasse (4.51%), domestic coal (3.8%), and domestic oil (1.2%).

In 1985, the share of imported oil in the energy mix reached a new low (51%) for the 1973 to 1990 period because of a confluence of positive and negative factors that include the increased availability and use of alternative energy sources, energy conservation that was induced by both price and government intervention, and the general slowdown in the economy. In 1990, dependence on imported oil rose to 64% because of a prolonged drought that limited hydro capacity, the unavailability of indigenous power supply from coal or geothermal to compensate for hydropower capacity loss, and a government decision to mothball a 620-megawatt (MW) nuclear plant. No alternative was available but to install diesel-powered generators.

Per capita energy consumption equaled 215 kilograms of oil equivalent (kgoe) in 1990, up from 158 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 2.3%. For the period between 1965 and 1980, energy consumption grew at an annual rate of 5.8%.

The industrial sector consumes 50% of the energy, followed by residential/commercial (27%) and transportation (18%).

Electricity grew from 8.5% of final energy consumption in 1973 to 16% in 1990. The latest electricity forecast is for an annual average growth of 7.7% from 1991 to 2000, while energy demand for the same period is estimated to be 6.9% per year. Perhaps a more significant indicator of rapid energy growth is the annual growth rate of commercial energy demand—6.7% over the period 1986 to 1990 as compared to 1.2% during the period 1976 to 1985.

Three major grids supply approximately 5,600 MW. Electricity consumption accounts for 36% of total energy demand. The electricity demand is expected to increase at an average annual growth rate of 5.4% from 1988 to 2000.

The Philippines is the world's second largest geothermal energy producer, having a total capacity of 894 MW. Although very little is known about the resource, there is a proven capacity of 1,614 MW and potential reserves of 6,818 MW. Philippine Geothermal Inc., a private company, produces 80% of the geothermal steam. The Philippine National Oil Company (PNOC)-Energy Development Corporation produces the other 20%. At the present time, geothermal energy seems to be the most cost-effective method of increasing capacity.

Energy Efficiency and Conservation

Barriers to energy conservation include

- Insufficient information in the domestic sector
- Insufficient capital—investment in better production favored over investment in energy savings
- Inadequate training—lack of trained bank personnel to evaluate energy conservation projects; lack of company employees trained in specialized equipment
- Uncoordinated and overlapping functions of new and existing institutions implementing energy conservation activities
- Excessive bureaucratic procedures.

After the 1974 oil crisis, the Philippine government called on the industrial and commercial sector to become involved in a nationwide effort to conserve energy. The first step was the formation of the Energy Conservation Movement of the Philippines (ENERCON), which encouraged research, testing, development and the adoption of energy-saving equipment and materials and alternative energy sources.

The government developed initiatives aimed at energy conservation in the transportation sector. These included studies on driving habits, maintenance, and road conditions. ENERCON also has regional and district energy chairmen who promote and monitor energy efficiency in the transportation sector.

The Energy Management Association of the Philippines (EMAP) also studies and promotes energy conservation. One report studied energy efficiency in the steel industry and made recommendations to improve efficiency using burners, preheating, and computer controls. EMAP also proposed tighter cooperation with the ASEAN Iron and Steel Industry Federation and the establishment of an ASEAN Energy Conservation Agency.

In 1980, an omnibus energy law (*Batas Pambansa Blg. 73*) was passed that requires energy conservation programs for high energy consumption industrial establishments. In 1991, Executive Order No. 418 was issued to monitor consumption of government and private establishments and reduce consumption of electricity and fuel. In the same year, House Bill No. 31312 was proposed to institutionalize energy conservation and define the government role. In addition, a bill proposing the creation of a Department of Energy that would facilitate implementation and coordination of policies and programs for the entire energy sector was certified by President Aquino for urgent enactment.

Today, the National Electrification Administration (NEA) encourages energy conservation by providing technical assistance programs and incentives. As a general policy, the Office of Energy Affairs (OEA) centers its energy conservation activities on the most energy-intensive industries. There are government assistance programs to aid with auditing, monitoring, and purchasing conservation equipment.

More specifically, for the buildings sector, there is a Room Air Conditioner Energy Certification Program. Under this program, products that comply with the minimum requirements for ratings on cooling capacity, amperage, and wattage bear the Philippine Standard certification mark. Air conditioners are being tested at the Fuels and Appliance Testing Laboratory of OEA. Additionally, building energy use standards were developed. Upon approval by the Department of Public Works and Highways, the standards will be incorporated in the National Building Code as referral code.

In the transportation sector, the focus is on metro Manila, where a significant portion of the fuel is consumed. A number of measures are being taken into consideration in order to minimize fuel consumption in transportation, including improving road system performance by enforcing traffic management measures and necessary control devices and road signs; increasing capacity and productivity of public transport; encouraging ridesharing or carpooling; instituting flexitime and staggered work and school hours; adopting transport pricing policies; and encouraging the use of bicycles. In the long term, transportation research will center on the research and development of alternative fuels such as alcogas, coco-diesel, automotive liquified petroleum gas, and other possible combinations of petroleum-based and nonpetroleum-based fuels.

OEA, in existence since 1987, generally sets energy policy in the Philippines. The Medium Term Energy Plan (1990 to 1992) has three fundamental objectives:

1. Supply—to ensure the availability of energy to the markets in the country at reasonable prices
2. Demand—to promote the judicious and efficient use of energy resources
3. Environment—to accomplish both of the above objectives with minimal adverse effects on the environment.

The policies that will be followed in pursuit of these objectives include (1) the promotion of energy self-reliance, (2) endeavoring to provide the poorest sectors of the economy with energy at an affordable price, (3) encouragement of conservation measures to promote efficiency, (4) participation of the private sector in energy projects, and (5) maintenance of environmental and safety measures for energy projects.

In support of these policies, the strategies to be pursued include such actions as continuing indigenous energy-resource exploration and development, completing committed projects, departing from oil-based generation, reviewing sector efficiency in all stages, continuing viable energy conservation programs and projects, upgrading oil refinery capacity, restructuring power rates, recognizing marginal costs, pricing domestic petroleum products consonant with international prices, streamlining operations of electric cooperatives and utilities, maintaining the evaluation and implementation procedures on environmental aspects, and reducing public investments by inviting private capital to participate.

Other entities active in the energy industry include the NEA, the Bureau of Energy Development, the Bureau of Energy Utilization, and PNOC. Rural electrification cooperatives also exist.

Executive Order No. 215 established new regulations regarding private power. The National Power Corporation must now draft plans to buy private power. The OEA will enforce Executive Order No. 215.

The OEA promotes both renewable energy and conservation as part of the national energy policy. There also is a small industry involved with photovoltaics, solar water heaters, biomass-fired generation systems, biogas systems, mini-hydro, energy-efficient lamps, and energy consulting services.

In 1985, "nonconventional energy sources" accounted for 18% of all energy consumed in the Philippines. Almost 98% of this was biomass. A law was proposed to strengthen the nonconventional energy development program and will provide PH\$3.3 billion to develop "indigenous energy" sources over a five-year period. It also would give incentives to local manufacturers, dealers, and users of nonconventional energy equipment, which would include exemptions from tariffs, custom duties, and the value-added taxes.

The Philippines possesses a significant biomass waste resource from the production of sugar, coconuts, rice, and bananas. The Ministry of Agriculture estimates that there are 36 million metric tons of biomass resource.

The sugar processing industry of the Philippines seems extremely promising for biomass applications. At least 40 factories process cane and produce waste, having 81 megajoules (MJ) of energy potential. The National Food Authority has used rice hulls in their processing plants and Prince of Songkhla University has built wood-waste power plants. Private industry also has installed biogas and anaerobic digestion power systems.

Comprising more than 7,000 islands, the Philippines represents a large potential market for rural electrification. The NEA administers a large rural electrification program, which will continue to expand. Most of the systems are operated by rural cooperatives, and there is a large potential for photovoltaics.

The Oil Industry

The Philippines possesses very few petroleum resources, but has been exploring for offshore oil. There are also three major refineries possessing a capacity of more than 280 thousand barrels per day.

PNOC was formed in response to the oil crisis of 1973. Its first responsibility was to transport, refine, and market crude. Today PNOC owns the largest refinery, transports 75% of the inter-island oil product, and holds nearly 40% of the domestic petroleum market. PNOC has expanded into non-oil energy sources and is composed of a number of subsidiaries:

- PNOC Coal Corporation—explores, mines, trades, and processes coal
- PNOC Energy Development Corporation—develops geothermal and non-oil resources
- PNOC Exploration Corporation—focuses on on-shore oil exploration in Central Laesione, Cebu, and Mindoro
- Malangas Coal Corporation—mines and processes coal
- Bislig Coal Corporation—explores, mines, and processes coal
- Transport and Logistics Group—eight corporations involved in the transport of crude and the maintenance of vessels
- Petroleum Refining/Marketing Group—many corporations that market and refine oil products.

Caltex and Shell Philipinas also refine crude oil in the Philippines.

Bibliography

Country Paper: Philippine Policies, Programs, and Approaches to Promote Energy Conservation; March 1991

Draft Business Plan for Photovoltaics Manufacturing and Distribution Company in the Philippines; Energy Conversion Devices Inc.

Draft Market Study for Energy Conservation Technology

Finesse Workshop, Financing of Energy Services for Small-Scale Energy Users, Country Market Study—Philippines; Conrado S. Heruela, Ma Eloida C. Balamiento, Marites I. Cabrera, Christopher G. Zamora, Socrates-Apollo P. Botictic, Reuben Emmanuel T. Quejas, Reynaldo V. Liganor,

Angelito I. David, Charisse B. Tablante, Jesus Anunciacion, Asian and Pacific Development Centre; October, 1991

Philippines: Asia Pacific Energy Series: Country Report; Sharon Hoffman, Energy Program Resource Systems Institute; November 1988

Renewable Energy Market Survey: The Philippines; U.S. Export Council for Renewable Energy; February 1987

Transportation Energy Conservation Activities in the Philippines; A.A. Gimenez, Office of Energy Affairs, Bureau of Energy Utilization, Philippines; December 1987

Title: Energy Management Video Service	Project Type: Education/information
Organization: Office of Energy Affairs, Philippines-German Rational Use of Energy Project	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects:
Description: Fifteen videotapes showed successful cases of energy conservation.	Technology: Conservation; coal, biomass, furnaces, insulation, refrigeration, metering, lighting, motors, building controls
Results: The films detail burners, boilers, pipe insulation, heat recovery, compressed air, waste for fuel, coal, refrigeration, lighting, motors, and controls. Each film is 15 to 20 minutes.	Reference: Pamphlet on video services

Title: Energy Management Advisory Service (EMAS)	Project Type: Education/info; policy assessment
Organization: Office of Energy Affairs, Philippines-German Rational Use of Energy Project	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects: The Energy Bus
Description: The service helps industries analyze their patterns of energy use.	Technology: Conservation; energy monitoring instruments, library, computer-data analysis
Results: EMAS conducted a boiler efficiency program and published information on fans and blowers.	Reference: Pamphlet of service

Title: The Philippine Steel Industry on the Upturn—Energy Conservation Essential to Remain Competitive	Project Type: Study/demonstration
Organization: Energy Management Association of the Philippines	Date: 1987
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Energy profile of the steel industry in the Philippines; contains recommendations for conservation.	Technology: Various
Results: The steel industry should make conservation a priority. Waste heat utilization, use of alternative/cheaper energy, improvement of operating efficiency, effective combustion control, use of process computers, better refractory materials, and continuous linkage of processes are all applicable measures. Estimate of annual energy savings using these measures is 23.58 million liters of oil.	Reference: Estefanio M. Gacad, ASEAN-EC Energy Conservation Seminar, December 1987

Title: Energy Conservation Awards	Project Type: Policy assessment; education/info
Organization: Philippine government	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects:
Description: The Don Emilio Abello Awards recognize companies demonstrating commitment to energy conservation or using indigenous energy in innovative ways.	Technology: Conservation
Results:	Reference: Philippine Policies, Programs, and Approaches to Remote Energy Countries

Title: Rice-Hull-Fired Power Plant	Project Type: Study/demonstration
Organization: National Food Authority	Date: Built and tested between 1986 and 1988
End-use Sector: Industry	Affiliated/Future Projects:
Description: The National Food Authority uses 3 tons of rice hull per hour to generate 2.1 MW.	Technology: Biomass. There are at least 600 biogas plants in the Philippines.
Results: The plant is operating successfully.	Reference: RERIC News

Title: Transportation Energy Conservation Activities	Project Type: R&D
Organization: Department of Transportation and Communications, ENERCON	Date: 1978 to 1980
End-use Sector: Transportation	Affiliated/Future Projects: Energy management seminars
Description: Research examined the effects of maintenance, driving habits, road conditions, and fuel consumption of cars.	Technology: Conservation
Results: Taxi companies and buses enacted energy conservation programs. The government also plans to develop alternative fuels and increased capacity of public transport.	Reference: ASEAN-EC Energy Conservation Seminar, A. A. Gimenez, December 1987

Title: Room Air Conditioning Service Program	Project Type: Policy assessment; standards and codes; certification
Organization: Philippine government	Date: Ongoing
End-use Sector: Commercial, residential buildings	Affiliated/Future Projects:
Description: The government tests air-conditioners and sets standards for cooling capacity, usage, and voltage.	Technology: Conservation
Results:	Reference: Philippine Policies, Programs, and Approaches to Remote Energy Countries

Title: Technology Transfer for Energy Management (TTEM)	Project Type: Study/demonstration
Organization: Office of Energy Affairs	Date: 1990; continuing
End-use Sector: Industry	Affiliated/Future Projects: There was more than P\$40 million in funding. Some of the funds were provided through TTEM loans.
Description: TTEM is a pioneer project to promote the adoption of energy-efficient technology.	Technology: Conservation
Results: EMAP expects the 12 projects under way to save 56,008 barrels of oil. The projects include work in the telephone, carpet, glass, cement, and steel industries.	Reference: EMAP Energy Manager

Title: Building Energy Standards	Project Type: Standards and codes
Organization: Office of Energy Affairs	Date: Ongoing
End-use Sector: Commercial building	Affiliated/Future Projects:
Description: The government developed energy standards for commercial buildings.	Technology: Conservation
Results:	Reference: Philippine Policies, Programs, and Approaches to Remote Energy Countries

Title: The Energy Bus for Energy Audits	Project Type: Study/demo; policy assessment
Organization: Philippines-German Rational Use of Energy Project	Date: 1987; continuing
End-use Sector: Commercial building; industry	Affiliated/Future Projects:
Description: A bus holding measuring equipment to conduct energy use audits.	Technology: The bus is equipped with a stack gas analyzer, measuring equipment for motors, temperature, pressure, and volume flow measuring devices, and water testing equipment.
Results: The Energy Bus allows a small team of engineers to analyze a company's energy use. The Energy Bus cost \$130,000.	Reference: The Making of an Energy Bus

Title: Energy-Efficient Lighting	Project Type: Policy assessment
Organization: EMAP, industry	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects: NEA
Description: Three subsidiaries of foreign lamp manufacturers dominate the lighting market.	Technology: High-efficiency lamps
Results: The market is undeveloped, but the NEA has promoted high-efficiency lighting. In the FINESSE study, three market options were discussed. The lamp market could be over 100,000 units a year. EMAP also has issued guidelines for office lighting to improve the lighting environment, reduce eye fatigue, and maximize daylighting.	Reference: FINESSE Country Market Study, ENMAP Energy Manager

Title: Renewable Energy Association of the Philippines (REAP)	Project Type: Policy assessment; tech transfer
Organization: OEA, REAP	Date:
End-use Sector: All sectors	Affiliated/Future Projects:
Description: The OEA helped organize REAP, an organization of manufacturers, importers, distributors, and energy service firms.	Technology: Conservation and renewable energy
Results: REAP has promoted nonconventional energy sources and secured financial assistance from the OEA.	Reference: FINESSE

Title: Photovoltaics in the Philippines	Project Type: Policy assessment; study/demo
Organization: Industry	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects: SAPMASOPCO, a rural solar cooperative, financed 100 solar homes; USAID water pumping projects.
Description: There are at least five PV suppliers in the Philippines, but local manufacturing and expertise is lacking.	Technology: Photovoltaics
Results: The import duty was reduced from 40% to 3% and might go as low as 0%. Industry estimates demand to be around 273 kW _p if financing were available. Approximately 42,000 kW _p were installed in the last 18 years.	Reference: FINESSE Country Market Study

Title: Solar Electric Company, Inc. Projects	Project Type: Study/demonstration
Organization: Solar Electric Company, Inc.	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects: Contact Solar Electric in Manila, Philippines
Description: Solar Electric has been supplying photovoltaics (PV) to the Philippines since 1977. Current projects include PV power for a seven-building business park, a hotel, and a garbage dump site.	Technology: Photovoltaic systems
Results: Not available	Reference: PV News

Title: Philippine German Solar Energy Project; Burias Island and Verde Island PV Projects	Project Type: Study/demonstration
Organization: OEA - GTZ	Date: 1988
End-use Sector: Renewable energy	Affiliated/Future Projects: The demand for solar home systems should reach 200 units a year on Burias Island.
Description: The commercial development of PV started with the GTZ-supported 13.3 kW _p central Pulong Sampalac installation. A rural electrification project used 50 W _p home systems.	Technology: A 50-kW _p photovoltaic solar home system was developed.
Results: On Burias Island, PV systems have been used for refrigeration, communications, and home electrification. The project also provided a model financing scheme.	Reference: FINESSE Country Market Study

Title: Biogas Developments in the Philippines	Project Type: Study/demonstration
Organization: Ministry of Energy	Date: 1985
End-use Sector: Renewable energy	Affiliated/Future Projects: There are at least 600 biogas plants in the Philippines.
Description: Total biogas output in 1985 totaled 10,000 m ³ per day. At Maya-Farms, the world's largest biogas system provides all of the energy for a hog farm and meat packing complex.	Technology: Biogas
Results: A distillery and an ice plant also use biogas.	Reference: Bioenergy Systems Report

Title: Rice Hull Gasifier	Project Type: R&D; study/demo
Organization: Philippine Department of Agriculture, UC Davis, and International Rice Research Institute	Date:
End-use Sector: Industry	Affiliated/Future Projects: Biogas. There are at least 600 biogas plants in the Philippines.
Description: The program carried out design, production, and performance testing of gasifiers.	Technology: Open core downdraft gasifier
Results: The program developed a small gasifier for demonstration, commercial cooking, and food processing. A larger gasifier (0.77-m inside diameter) also was tested.	Reference: RERIC News

Title: Rice-Hull-Fired Onion Dryer	Project Type: Study/demonstration
Organization: Forest Products Research and Development Institute	Date: 1987 to 1991
End-use Sector: Industry	Affiliated/Future Projects: Twenty more units are planned for installation.
Description:	Technology: Biomass
Results: An experimental dryer was installed on a farm. The capacity was 126 onion boxes. The dryer can cure a load in 48 to 60 hours.	Reference: RERIC News

Title: Geothermal Energy Incentives	Project Type: Policy assessment
Organization: Office of Energy Affairs	Date: 1991
End-use Sector: Renewable energy	Affiliated/Future Projects: Geothermal Development by PROC and NAPOCOR
Description: Twenty percent of the energy in the Philippines is supplied by geothermal, but development is below expectations. Efforts are under way to pass a law to give incentives to the private sector to develop geothermal.	Technology: Geothermal
Results: Philippine geothermal output is supposed to reach 1,750 MW by 1995. Current output is 850 MW.	Reference: RERIC News

Title: FINESSE (Financing Energy Services for Small-Scale Energy Users)	Project Type: Policy assessment
Organization: The World Bank, U.S. Department of Energy, USAID, U.S. Environmental Protection Agency, UNDP, Asian Development Bank, Asian and Pacific Development Center, Netherlands Ministry of Foreign Affairs	Date: FINESSE was launched in 1989.
End-use Sector: All sectors	Affiliated/Future Projects: Sukitani PV Electrification
Description: Project FINESSE was launched to conduct market studies, promote manufacture of energy-efficient light bulbs and appliances, examine the institutional environment for alternative energy projects, establish ASEAN project opportunities, establish a multidonor feasibility fund, and host international conferences.	Technology: All renewable energy
Results: FINESSE has completed market studies on Malaysia, Philippines, Indonesia, and Thailand. The studies identified project opportunities for renewable energy.	Reference: FINESSE Country Market Studies, FINESSE Report

Title: Energy Management Association of the Philippines (ENMAP)	Organization: ENMAP	End-use Sector: All sectors	Description: ENMAP is a professional organization of energy managers, engineers, and consultants that shares information on energy management and conservation practices.	Results: ENMAP publishes <i>The Energy Manager</i> newsletter and sponsors trade shows and conventions.	Reference: ENMAP pamphlet
Project Type: Education/info; tech transfer	Date: 1979	Affiliated/Future Projects: Projects with Bureau of Energy Utilization, Association of Energy Engineers (Atlanta, USA), Japan Trade Center, and other trade and professional organizations	Technology: Conservation		

Title: Energy Management Consulting Service (EMCS)	Organization: Bureau of Energy Utilization	End-use Sector: All sectors	Description: This service conducts energy audits, appliance testing, energy monitoring, and training; it also produces publications and presents awards.	Results: They provide the following services: energy audits, oil-fired boiler retrofitting, waste heat recovery, process design, appliance testing, and detailed engineering. Since 1983, EMCS has audited 133 plants or buildings for a total energy savings of 57.8 Mboe.	Reference: Pamphlet from EMCS
Project Type: Policy assessment; education/info	Date: 1983; continuing	Affiliated/Future Projects:	Technology: Conservation		

Singapore

Singapore occupies an island with an area of 619 km² off the southern coast of peninsular Malaysia. It is populated by 2.6 million people of mixed ethnic backgrounds from China, Malaysia, and India.

Singapore is a charter member of the Association of Southeast Asian Nations (ASEAN) group and a member of international organizations, including the Asian Development Bank and the United Nations.

Singapore experienced rapid economic growth in 1990 with a growth in gross national product (GNP) of 8.2%. The demand for energy grew at 8.8% during this same period.

Singapore's strategic location, political stability, and industrious population give the country an important economic position in Southeast Asia. The annual growth rate of gross domestic product (GDP) during the seventies was close to 10%. It dipped to 8.5% between 1980 and 1984, but rebounded to 11% in 1988.

Singapore's GDP reached US\$34,600 million in 1990, up from US\$970 million in 1965. This represents an average annual growth rate of 6.4% for the years 1980 to 1990. The GDP came from the following market sectors: agriculture (0%), industry (37%), and services (63%); within industry, manufacturing comprises 29% of GDP. The GDP rose 8.3% in 1990. A GDP growth of 7.0% was predicted for 1991.

In 1990, exports totaled US\$52,627 million and imports totaled US\$60,647 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 8.6% and an average annual growth rate for imports of 6.7%.

In 1988, the United States was Singapore's largest trading partner. Major exports included rubber, electronics, and textiles. Imports from the United States included machinery and other manufactured products. Singapore imports most of its food except for a small portion of vegetables.

The United States also is the largest source of foreign investment in Singapore, representing nearly one-third of all private investment and one-quarter of total investment. U.S. activities include oil refining, shipping, banking, and hotels.

Singapore has emerged as a leading financial and business services center because banks can bridge the gap between the New York/London and Tokyo/Hong Kong markets. Over 100 branches of foreign banks and 50 merchant banks operate in Singapore. It is the world's main Asia-dollar market and a large foreign exchange center. Singapore also offers an around-the-clock link with the Chicago Mercantile Exchange.

Singapore has successfully diversified and opened its economy since 1985. One example of this purposeful shift is the international economic cooperation in the "growth triangle" with Indonesia and Malaysia. Singapore also actively seeks investment from ASEAN members and Latin American countries.

Energy Use and Policy Issues

In 1988, Singapore's total energy consumption was 9.51 million tons of oil equivalent (Mtoe). By the year 2000, this is expected to be 14.3 Mtoe.

Besides its strategic location in the shipping lanes between Asia and the west, Singapore has no natural resources and relies completely on imported oil for domestic energy production.

Per capita energy consumption equaled 5,685 kilograms of oil equivalent (kgoe) in 1990, up from 2,214 kgoe in 1965. For the period of 1980 to 1990, energy consumption grew at an annual rate of 5.8%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 5.7%.

Fuel oil constitutes the largest component of Singapore's domestic product demand. For example, in 1986, fuel oil constituted more than 70% of total domestic energy consumption. Fuel oil was used for electricity generation, industry, and maritime transport. Residential users consumed 20% of the total domestic energy demand, using automobiles, cooking, and electricity.

The Public Utilities Board (PUB) runs four power stations having a total generating capacity of 3,627 megawatts (MW). The board plans on adding two additional gas turbines, which will bring the total capacity to 4,633 MW.

The PUB also produces and distributes piped town gas. As of 1986, there were approximately 190,000 customers in the following market sectors: residential (54%), commercial (40%), and industrial (10%). The PUB had a capacity of 735,000 cubic meters per day and plans to double its number of customers by 1990.

No official policy or energy forecast exists in Singapore, but several agencies shape the energy sector. The parastatal Singapore National Oil Company (SNOC) is supposed to ensure reasonable protection of the oil supply for continued growth in Singapore's economy. SNOC also maintains a cooperative relationship with the ASEAN Council on Petroleum and the Public Utilities Board.

The Oil Industry

The Singapore oil industry began in the colonial period when the island served as a storage, trans-shipment, and distribution center for the Far East. In 1961, Shell opened the first refinery having a capacity of 20,000 barrels per day. Today, Shell continues to operate in Singapore; other companies like Esso, Mobil, Caltex, and BP also have major refineries. The country's combined capacity is more than 1 million barrels per day. The petroleum industry's output in 1990 was US\$4.7 billion, 14.7% of Singapore's total manufacturing output.

Energy Efficiency and Conservation

Office and commercial buildings account for about 25% of the total electricity consumption. Therefore, insulating chilled water pipes, cold air ducts, and building walls and other such measures are important to improve the efficiency of energy use in Singapore. Problems arise with air conditioning from high ambient temperatures and high relative humidities and moisture during frequent heavy rains.

The PUB publishes pamphlets on energy and water conservation. *Electricity and You* describes energy production and *Save Energy and Money* illustrates easy ways to save energy around the home. The PUB also publishes average consumption levels and estimated energy-cost information for selected home appliances.

A major energy-efficiency effort is the ASEAN-Australia Program, which was implemented in two phases.

Phase I (1982 to 1989) consisted of four program areas:

- Energy analysis and modeling of buildings—refined and improved a microcomputer program to analyze and model energy usage, including air conditioning systems. Program now in use by building control authorities. Singapore is the center for the software development network for ASEAN.
- Industrial energy management—compiled energy consumption data for several industries; found areas for improvement, particularly through heat recovery.
- Optimization of insulation materials—developed equipment to measure thermal properties of insulations; worked on standard testing and evaluation methods.
- Heat pumps testing—used heat pumps in buildings to produce domestic hot water by recovering heat from air conditioning systems. Researchers developed a better method of testing capacity rating of these water-to-water heat pumps.

Phase II (1990 to 1995) includes three program areas:

- Industrial energy management—develop local expertise in the design and manufacture of heat exchangers for drying applications in food processing and fish/prawn feed industries. Planned activities include developing prototypes, field demonstrations, and techno-economic analysis.
- Energy analysis and modeling of buildings (standards)—continue Phase I to complete Building Energy Performance Standards and Codes of Practice. Planned activities include more energy audits and further testing and development of microcomputer modeling software. Other ASEAN countries will participate in training and workshops.
- Energy analysis and modeling of buildings (air handlers)—test and modify, as necessary, a new type of air handler (currently marketed in Australia) to improve the efficiency of dehumidification in Singapore buildings.

University researchers have studied solar cooling, insulation, and conservation. Researches also have completed work on recycling sludge for construction material and using palm oil waste as fuel.

Renewable energy firms, including biomass and geothermal, from the United States and other nations are represented in Singapore, even though Singapore itself is not viewed as a substantial market for these technologies.

Bibliography

Electricity & You; Public Utilities Board

Energy Conservation & Exhibition Centre; Public Relations Division

Public Utilities Board At Your Service; Public Utilities Board

Public Utilities Board Annual Report 1990

Republic of Singapore Government Gazette Subsidiary Legislation Supplement; Published by Authority; August 1979

Save Energy & Money; Public Utilities Board

Singapore: Asia Pacific Energy Series: Country Report; Tilak Doshi, Energy Program Resource Systems Institute; June 1988

Singapore's Petroleum Industry: The Quiet Achiever; The Embassy of the United States of America, Singapore; July 1990

The Building Control Act 1989 and The Building Control Regulations 1989

Title: Mass Transportation System	Project Type: Study/demonstration
Organization: Government of Singapore	Date: 1987; continuing
End-use Sector: Transportation	Affiliated/Future Projects:
Description: There has been a preliminary study to evaluate the impact of a mass transportation system on energy usage.	Technology: Light rail
Results: Forty-six stations were planned to open by 1990.	Reference: ASEAN-EC Conservation Seminar

Title: Energy Conservation Using Heat Pumps	Project Type: R&D
Organization: National University of Singapore	Date: 1988; continuing
End-use Sector: Commercial building	Affiliated/Future Projects: The department of mechanical engineering of the University of Singapore has undergraduate and graduate courses on energy and renewable energy.
Description: Researchers developed computer programs for steady-state performance of heater pumps. Their results are being verified against actual experiments.	Technology: Heat pumps
Results: The next step of the project was to determine heat pump operating conditions over a range of operating conditions.	Reference: RERIC News

Title: ASEAN–Australia Economic Cooperative Program (AAECP)	Project Type: R&D; study/demo
Organization: PUB; Nanyang Technological Institute, National University of Singapore; AAECP.	Date: 1985 to 1988
End-use Sector: Commercial building	Affiliated/Future Projects: The department of mechanical engineering of the University of Singapore has undergraduate and graduate courses on energy and renewable energy.
Description: AAECP provided US\$540,000 for the program.	Technology: Conservation
Results: The research included energy analysis and modeling of buildings (Chou), industrial energy management (Ho), optimization of insulating materials (Wijeysundera), and heat pumps (Bong).	Reference: RERIC News

Title: The Building Control Code of 1989	Project Type: Policy assessment; standards and codes
Organization: Government of Singapore	Date: 1989
End-use Sector: Commercial, residential buildings	Affiliated/Future Projects: The Handbook on Energy Conservation in Buildings calls for standards in the overall thermal transfer value.
Description: The government amended the 'Building Control Act of 1974 to include energy efficiency.	Technology: Conservation, daylighting, and ventilation
Results: The building codes call for natural light, ventilation, and insulation. There will be energy auditing and standards for thermal transfer values.	Reference: The Building Control Code of 1989. APEC reply

Title: Energy Technologies Research	Project Type: R&D
Organization: National University of Singapore. ASEAN-Australia Economic Cooperation Program	Date: 1986; continuing
End-use Sector: Industry; commercial building	Affiliated/Future Projects:
Description: Projects have researched energy modeling of buildings, industrial energy management, insulation materials, and heat pumps.	Technology: Renewable energy and conservation
Results:	Reference: ASEAN-EC Energy Conservation Seminar

Title: Moisture Effects on Insulation	Project Type: R&D
Organization: National University of Singapore	Date: 1988
End-use Sector: Commercial building	Affiliated/Future Projects: The department of mechanical engineering of the University of Singapore has undergraduate and graduate courses on energy and renewable energy.
Description: The project measures vapor diffusion and moisture condensation in pipe insulation. It also tests heat transfer characteristics of moist insulation.	Technology: Insulation
Results: Heat flux variation and moisture condensation were measured and methods of moisture removal were tested.	Reference: RERIC News

Title: Energy Conservation and Exhibition Center	Project Type: Policy assessment; education/info
Organization: Singapore Public Utilities Board	Date: 1987; continuing
End-use Sector: All sectors	Affiliated/Future Projects:
Description: The Public Utilities Board runs an information center and provides education to the public on energy and water conservation.	Technology: Conservation
Results: The center provides a museum-like atmosphere with audio/visual displays, exhibits, and quiz machines. The center produces pamphlets and publications and established an answering service.	Reference: Conservation Center pamphlet

Thailand

Thailand is a charter member of the Association of Southeast Asian Nations (ASEAN) group; it covers some 515,000 km² and has a population of approximately 57.6 million. About 65% of the population is involved with agricultural production. Thailand has been experiencing rapid economic growth, having a 1990 growth in gross national product (GNP) of 10.0%. During this same year, energy consumption rose 8.9%.

Thailand has been a top economic performer in the ASEAN region, having gross domestic product (GDP) grow at an average rate of approximately 7.5% over the past 20 years and achieving double-digit growth from 1987 to 1990. Thailand's GDP reached US\$80,170 million in 1990, up from US\$4,390 million in 1965. The GDP came from the following market sectors: agriculture (12%), industry (39%), and service (48%); within industry, manufacturing comprised 26%. GDP rose 7.5% in 1991.

Traditionally, Thailand's economy has been based on agriculture, but the service sector is becoming increasingly important. In 1980, agriculture accounted for 23% of the GDP and manufacturing accounted for 21%. By 1990, agriculture had dropped to 12% of GDP and manufacturing had grown to 26%.

The average rate of inflation was 4.5% from 1980 to 1990.

In 1990, exports totaled US\$28,881 million and imports totaled US\$32,692 million. Over the period 1980 to 1990, this represents an average annual growth rate for exports of 26.6% and an average annual growth rate for imports of 18.1%.

Thailand's exports are well diversified. The largest export is textiles, followed by electronics, electrical appliances, rice, rubber, tapioca, processed food, integrated circuits, jewelry, footwear, furniture, and plastics. Thailand also exports mineral products, including tin, zinc, and gemstones. Thailand's imports are concentrated in capital goods for industrial projects. There are also substantial imports of petroleum, chemicals, iron, vehicles, parts, and scientific instruments.

Export-based industrial investment from Japan and the Republic of China contributed to the recent period of intense economic growth. In 1990, foreign investment totaled US\$15 billion. Reasons for this investment include a stable currency, a diversified economic base, and abundant cheap labor.

United States investment in Thailand is highly concentrated. About 20 firms account for 80% of the \$3 billion in investment. Fifty percent of U.S. investment was in the energy sector.

Japan also was Thailand's leading trading partner, having US\$14.1 billion in total trade. The United States was Thailand's second largest trading partner, having US\$8.9 billion in total trade. The United States is the largest market for Thailand manufactured products. During 1991, the U.S. trade deficit with Thailand reached US\$1.8 billion.

Thailand has taken steps to attract foreign investment; for example, the Board of Investment (BOI) grants various tax incentives to projects that meet national objectives. In 1990, the Thai government planned to replace the current business tax, reduce import duties on raw materials, and eliminate the BOI tax incentives. These measures are hoped to boost the manufacturing and trading sectors of the economy.

In 1990, the Thai government took steps to adjust to the economic climate following the Persian Gulf crisis. The government liberalized foreign exchange controls and raised interest rates. Energy policies changed, and oil prices increased to diversify the country's energy needs. These measures helped the Thai economy survive a mild recession and continue its growth.

The National Economic and Social Development Board of Thailand predicts Thailand's economy will grow 7.6% during 1992. Exports should rise 15%. Private investment should increase 3% to 5%. The inflation rate should be close to 4.5%, and the trade deficit is expected to be 11.0%.

Energy Use and Policy Issues

During 1981 to 1991, Thailand's final energy consumption nearly doubled to 30.5 million tons of oil equivalent (Mtoe). Continued economic growth is expected to double energy consumption again by the year 2000.

In 1991, Thailand's total primary energy supply amounted to 43.9 Mtoe, an increase of 6.4% over the previous year, of which 58% came from indigenous sources and 42% from imported sources. Crude oil and other petroleum products accounted for 98% of the total energy imported totaling 19 Mtoe in 1991. Domestic energy was supplied by conventional energy (57.1%) and renewable energy (42.9%). Most of the renewable energy was biomass from firewood, paddy husk, and bagasse, totaling 10.9 Mtoe.

Per capita primary energy consumption equaled 758 kilograms of oil equivalent (kgoe) in 1991. For the period of 1980 to 1991, energy consumption grew at an annual rate of 10%.

In 1990, energy consumption was concentrated in three main sectors: transportation, residential, and industrial. The transportation sector used 11.9 Mtoe or 39.1% of Thailand's final energy consumption. The residential and commercial sectors used 23.7% of final energy consumption; renewable energy supplied 59.4% of the energy to these sectors. Industry consumed 30.4% of Thailand's energy, a rise of 8.7% over 1990; 32.2% of the manufacturing energy consumption was renewable energy.

Thailand's total installed electricity generation capacity was 9,707 megawatts (MW) in 1991, up 11.2% over 1990. Industry consumed 45.7% of the electricity, followed by commercial uses (32.2%), and residential uses (21.1%). An electricity tariff includes both peak and off-peak prices.

In 1973, the government adopted a plan for rural electrification, which proposed the electrification of all villages by the end of the century. By 1981, more than 5,000 villages per year were being electrified; in 1987, the plan was revised to electrify 19,000 more villages by 1991.

At least seven government organizations are active in the Thai energy situation:

- The Ministry of Prime Minister Office's National Energy Policy Office, the secretariat of the National Energy Policy Council shared by the prime minister, recommends energy policy to the council. The Electricity Generating Authority of Thailand (EGAT) generates electricity.
- The Ministry of Science, Technology and Environment (MOSTE) supervises the Department of Energy Development and Promotion (DEDP). The DEDP implements new and renewable energy development and energy conservation policy.

- The Ministry of Industry's (MOI) Department of Mineral Resources (DMR) regulates oil and gas supply. The Petroleum Authority of Thailand (PTT) supplies oil and gas. The Provincial Electrical Authority (PEA) and the Metropolitan Electrical Authority (MEA) distribute electricity.
- The Ministry of Commerce licenses petroleum-products traders.
- The Royal Forestry Department in the Ministry of Agriculture regulates issues related to fuelwood supply.

The private sector is very involved in oil and gas exploration and owns about 50% of the refining capacity within Thailand. The electricity sector is almost wholly owned by the public sector.

Energy policies in the Seventh National Economic and Social Development Plan (1992 to 1996) pursue the following goals:

- Stable energy supply at appropriate prices
- Efficient use and conservation
- Increased private role and unification of governmental systems in energy management.

Energy Efficiency and Conservation

In January of 1989, the government began looking seriously at conservation as a solution to the electricity demand problem. A detailed work plan was proposed in January of 1990 to improve energy efficiency in all market sectors. The major recommendations included the establishment of the Energy Conservation Center of Thailand, low-interest-rate loans for energy-efficiency improvements, public relations and information campaigns, and tax reductions and financial support for conservation equipment.

Beginning with the Fifth National Plan (1982 to 1986), the Thai program has been aimed primarily at promoting energy efficiency in the industrial sector. The focal agency for this activity is DEDP. In the Sixth Plan, conservation activities in commercial and residential buildings were added. Based on the experience of DEDP and related agencies, the following are the chief problems that slow progress in conservation:

- Low energy prices due to low taxation
- Insufficient public awareness of the benefits of conservation
- Lack of public information on how to implement conservation measures
- Lack of interest in energy audits, perhaps based on a fear of losing commercially confidential information
- Even after audits are conducted, an unwillingness to invest (probably because of the desire of business owners to respond to production orders or to gain market shares)
- Insufficient energy conservation training

- Small budget for energy efficiency compared with the production budget
- Lack of sufficiently skilled people (technical and engineering) to implement needed changes in factories.

In response, government programs have concerns about information programs, incentives, training, and new regulations and laws. A substantial increase in petroleum taxation is only a remote possibility at the moment because of the lack of public support for such a policy.

Energy audits of 695 factories and 210 buildings were conducted to identify problems and recommend measures. Technical publications were prepared, along with pamphlets, posters, and newsletters, which are distributed to concerned organizations. Video and TV also were used in the last two years.

Energy conservation training seminars regarding fuel and electricity savings and energy management were provided to more than 4,000 persons from factories, buildings, and governmental organizations. Studies were conducted on various topics, including high-efficiency lights, ballasts, freezers, and building codes.

Since 1983, duties have been reduced on 138 items of imported energy equipment, for a total of 318 million baht. Since 1984, low-interest loans have been given to eight factories that serve as energy conservation demonstration sites. The total of the loans is 8.7 million baht.

In 1985, with the cooperation of DEDP and the Federation of Thai Industry (a nongovernmental organization that represents Thailand industries), the government established the Energy Conservation Center of Thailand (ECCT). ECCT's objective is to promote and provide services to energy conservation programs in the industrial sector.

An energy conservation law was announced in early 1992. It represents a very aggressive approach to energy conservation in industrial factories and buildings and in setting standards for energy-efficient equipment.

Facilities that have energy demand equal to or higher than 1 MW or 20 million megajoules (MJ) are designated facilities that are required to hire qualified energy managers and to improve efficiency of energy use (electricity and process heat) through improving the efficiency of fuel burning, reducing energy losses, recycling waste energy, and using high-efficiency machines, etc. Owners are required to inspect their facilities, analyze energy use, and establish goals and a plan for achieving energy conservation. The plan must be submitted to DEDP.

Similarly, building owners are required to pursue actions to reduce solar loading on buildings; use efficient air conditioning to maintain proper indoor temperatures; and use energy-conserving building materials, equipment, and lighting. Minister orders specifying standards for air conditioning and water heating equipment; other building materials also are authorized.

Standards will be set for energy-using machinery and equipment; distributors and producers of such equipment will receive investment incentive and promotion assistance from the government.

After three years, those not in compliance are subjected to special fees being levied on their electricity consumption.

An Energy Conservation and Development Fund was established recently; the funding will come from a variety of sources, including transferred money from the Oil Fund, special fees associated with noncompliance with the law, and fees on oil production. One and one-half billion baht was transferred from the Oil Fund to the Energy Conservation Fund. And 0.07 baht from every liter of gasoline, diesel, fuel oil, and kerosene sold in the country was collected and put into the fund since November 1992. This will contribute approximately 1.5 billion baht to the fund annually. The fund will be used to make grants and provide financial incentives that encourage the investment in operating facilities to save energy and solve environmental problems associated with energy use. It also will provide grants to encourage research and development in the areas of clean energy and energy conservation technologies.

EGAT is implementing a five-year Master Plan for demand-side management (DSM), which will demonstrate electricity conservation projects, build organizational capability to deliver large-scale DSM programs, and increase the involvement of utilities in environmental protection. The proposed budget for the program was 4.57 billion baht, for an estimated saving of 225 MW of capacity and 2,000 MW of additional capacity over 10 years. The 4.57 billion baht will be used to provide incentives to homeowners, businesses, and industry to buy more efficient electricity-using technologies. The budget also includes funds to train utility management and technical staff—marketing the DSM programs to consumers, program management, and local management research. The first two years of the plan will consist of planning and pilot projects to provide information about energy-saving technologies and program strategies. Years three to five, and thereafter, will see full-scale implementation of the program.

Two government agencies (Department of Energy Development and Promotion; Thailand Institute for Scientific and Technological Research) have conducted work on R&D on several renewable energy technologies: microhydro, PV for lighting, solar drying, wind turbines for water pumping, energy-efficient stoves, rice-husk-burning stoves, biogas digesters, rice husk briquets, and an alcohol production pilot plant.

EGAT includes renewable energy in the long-term plan for Thailand's energy sector. At this time, the program consists of geothermal, solar, wind, biomass, and fluidized bed combustion. The government also has proposed energy conservation as part of the solution to Thailand's spiraling energy demand.

King Mongkut's Institute of Technology Thornburi (KMUTT) organized the membrane technology group to research and develop polymeric and ceramic membranes. The group researched ultrafiltration and reverse osmosis membranes, developed membrane casting techniques, and produced ceramic membranes. KMUTT also has studied the use of membranes in agro-industrial waste effluent, developed mathematical models of membrane processes, and formed a literature data base on membrane technology for ASEAN researchers.

The Biotechnology Engineering Center (BEC) develops biosensors, instrumentation, and control mechanisms for use in bioprocessing. Some of the past projects included robotic controls, computerized data acquisition for a soy flour plant, and liquid chromatography for sugar analysis.

Other research activities at KMUTT include

- Enzyme technology
- Bioreactor design

- Bioleaching and metal extraction
- Pilot plant development and training institute
- Algal biotechnology
- Genetic engineering
- Training courses
- International cooperation projects.

KMITT started research activities on biogas technology in 1979. It has worked with other ASEAN researchers and the ASEAN–Australia Economic Cooperation Program to develop high- efficiency bioreactors that produce biogas from agricultural wastes. KMITT researchers have studied organic wastes and different types of reactors; they have developed pilot reactors ranging from 30 to 200 liters.

In 1985, 5,000 family-sized biogas digesters were generating 1 to 2 m³ of biogas per day. Ten community-sized digesters were operating, and studies were being conducted for biogas use in agro-industrial plants. These plants use a variety of fuels, including rice husks, corn cobs, and sugar cane. The NEA and the United States Agency for International Development funded the majority of the newest plants.

Bibliography

The Energy Conservation Promotion Act (Draft)

Annual Report 1990; Electricity Generating Authority of Thailand

EGAT's Role in New Energy; Jivacate Chaya et al.

Electric Power in Thailand 1990; National Energy Administration, Ministry of Science, Technology and Energy

Electricity Savings Plan for the Industrial Commercial Residential Sectors; Thailand National Energy Administration, Ministry of Science, Technology and Energy; January 1990

Energy Conservation Activity in Thailand

Finesse Workshop, Financing of Energy Services for Small-Scale Energy Users, Country Market Study—Thailand; Charit Tingsabadh, Phol Sagetong, Somchai Ratanakomut, Mark Cherniack, Peter Brimble, Peter du Pont; Asian and Pacific Development Centre; October, 1991

Oil and Thailand 1990; National Energy Administration, Ministry of Science, Technology, and Energy

Thailand Energy Situation 1990; National Energy Administration, Ministry of Science, Technology, and Energy

Thailand: Asia Pacific Energy Series: Country Report; David Fridley, Energy Program Resource Systems Institute; November 1988

Title: Energy Conservation Demonstration Program	Project Type: Study/demonstration
Organization: National Energy Administration (NEA)	Date: 1984 to present
End-use Sector: Industry	Affiliated/Future Projects: October 1986 expansion of the program included energy substitution by domestic sources, conservation in commercial buildings, and production of energy-efficient equipment.
Description: Demonstration projects in eight food, paper, fabricated metals, and textile factories to encourage implementation of energy conservation in industries.	Technology: Various
Results: Estimated annual conservation from eight factories is 7.84 million liters of fuel oil; 0.85 million kWh of electricity.	Reference: ASEAN-EC Energy Conservation Seminar, December 1987

Title: Energy Conservation Unit	Project Type: Audit
Organization: National Energy Administration (NEA)	Date: 1982 to present
End-use Sector: Industry	Affiliated/Future Projects: Training courses on energy conservation are regularly presented to factory managers, engineers, and technicians through the Energy Training Center of the NEA.
Description: Examination and analysis of the potential for energy conservation in 285 factories to date.	Technology: Various
Results: N. A.	Reference: ASEAN-EC Energy Conservation Seminar

Title: National Energy Saving Goals for Industry	Project Type: Study/demonstration
Organization: National Energy Administration (NEA)	Date: 1986
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Study on technical potential for energy savings.	Technology: Various
Results: The study recommends that technical potential be achieved by implementing changes in housekeeping, process improvement measures, and major equipment.	Reference: ASEAN-EC Energy Conservation Seminar, December 1987

Title: Industrial Energy Conservation in Thailand	Project Type: Policy assessment
Organization: Thai government, National Energy Administration (NEA), and the Energy Conservation Center of Thailand (ECCT)	Date: Ongoing
End-use Sector: Industry	Affiliated/Future Projects: N. A.
Description: The government promotes conservation through energy audits, training, demonstration, public relations, and conservation incentives.	Technology: Conservation
Results: The NEA conducted 300 energy audits of some of the larger Thai factories and started 9 demonstration projects. The demonstration programs saved 7.84 million liters of fuel per year. Other activities include the establishment of the Energy Conservation Center of Thailand, an Energy Conservation Unit, the Energy Conservation Information Service, and an Energy Conservation Demonstration Program.	Reference: RERIC News

Title: ASEAN–Australian Economic Cooperation Programme (AAECP) for Food Waste Materials	Project Type: R&D; tech transfer
Organization: AAECP, King Mongkut's Institute of Technology Thornburi (KMITT)	Date: 1988
End-use Sector: Industry	Affiliated/Future Projects: KMITT research activities. There are at least 5,000 biogas systems in Thailand.
Description: AAECP sponsored a working group to perform cooperative research to develop technology for converting organic wastes into useful products.	Technology: Biogas reactors
Results: KMITT developed high-efficiency biogas reactors and an industrial biogas pilot plant.	Reference: RERIC News

Title: Tapioca Starch Waste Treatment Water Project	Project Type: Study/demonstration
Organization: King Mongkut's Institute of Technology Thornburi (KMITT)	Date: Since 1988
End-use Sector: Industry	Affiliated/Future Projects: KMITT biogas research
Description: The Ministry of Science, through the National Center for Genetic Engineering, provides 4.0 million baht for research treatments of tapioca starch wastewater.	Technology: Biogas
Results: The Ban Pong Tapioca Starch Industrial Co. Ltd. built a 160-m ³ capacity filter bed biogas plant and four high rate 118-m ³ capacity algae tanks. Methane is used to dry tapioca starch.	Reference: RERIC News

Title: Industrial Solar Fruit Dryer	Project Type: Study/demonstration
Organization: KMITT, AIT, NUTEC	Date: 1991
End-use Sector: Industry	Affiliated/Future Projects:
Description: Three industrial-scale solar fruit dryers were developed.	Technology: The dryer consists of a solar collector plate, a burner for biomass, a heat exchanger, and two dryer cabinets.
Results: The solar dryers were built and compared with conventional ovens.	Reference: RERIC News

Title: Rural Renewable Energy Project	Project Type: R&D
Organization: Brace Research Institute of McGill University, Canada and Khon Kaen University, Thailand	Date: Research cooperation
End-use Sector: Utility (rural electrification)	Affiliated/Future Projects: August 1987 to March 1992
Description: The two universities developed a linkage program to develop renewables in rural Thailand. The program planned staff exchanges, research transfer, training for energy monitoring, R&D into renewable technologies, field projects, field training, an information campaign, and an information exchange.	Technology: The agreement will cover the following technologies: (1) biogas, a feasibility study for rice hull gasification plant in Northern Thailand and biogas lab/workshop fabrication; (2) biomass, a charcoal/wood stove study to design more efficient stoves, and (3) solar, solar food processing, nocturnal coolers, and solar cookers.
Results: The project completed 39 staff exchanges, a project library, and tests on solar disinfection of water. The project developed 5-kW and 15-kW gasifiers, a solar steamer for rice, and improved wood stoves.	Reference: RERIC News

Title: Solar-Powered School in S. Thailand	Project Type: Study/demonstration
Organization: BP Solar, Thai government	Date: 1991
End-use Sector: Utility (Rural electrification)	Affiliated/Future Projects: Fourteen more panels will be installed to supply battery charging to villagers.
Description: A Japanese monastery donated solar panels to the Baan Sai Kao School in Chumphon.	Technology: Photovoltaic
Results: BP Solar Thai installed 60 modules that deliver an average power of 20 kW per day.	Reference: RERIC News

Title: Household-Scale Charcoal Gasifier	Project Type: Study/demonstration
Organization: Songkla University, University of Bangkok, USAID	Date: 1985
End-use Sector: Residential building	Affiliated/Future Projects: There are at least 5,000 biogas systems in Thailand.
Description: USAID funded the design and construction of a charcoal gasifier power system.	Technology: Biogas
Results: The gasifier uses approximately 1.5 kg/h of charcoal to power a 5-horsepower engine. The system operated for 1,200 hours with fuel that costs only 25% of the cost of gasoline.	Reference: Bioenergy Systems Report

Title: Geothermal Energy Projects	Project Type: R&D; study/demo
Organization: Electricity Generating Authority of Thailand (EGAT), Department of Mineral Resources, and Chiang Mai University	Date: Since the 1970s
End-use Sector: Renewable energy	Affiliated/Future Projects: San Kamphaeng Geothermal Energy Project, Fang Geothermal Power Plant, cool storage using geothermal fluid
Description: EGAT is interested in renewable energy technologies. Its strategy is to use foreign experts to help local institutions.	Technology: Geothermal
Results: EGAT completed a feasibility study of the San Kampaeng geothermal field and completed a 300-kW binary cycle demonstration plant.	Reference: RERIC News, EGAT Alternative Energy Technology Status

Title: San Kamphaeng Geothermal Energy Project	Project Type: R&D; study/demo
Organization: EGAT, Department of Mineral Resources, and Chiang Mai University	Date: Since 1977
End-use Sector: Renewable energy	Affiliated/Future Projects:
Description: Geothermal exploration	Technology: Geothermal
Results: The project dug six geothermal wells having depths up to 500 m. In cooperation with Japan, a 1500-m well was dug in 1986.	Reference: RERIC News

Title: Solar Kiln in Thailand	Project Type: Study/demonstration
Organization: Asian Institute of Technology, Thai Plywood Company (TPC)	Date: 1988
End-use Sector: Renewable energy	Affiliated/Future Projects:
Description: TPC constructed the biggest solar kiln in Thailand as a pre-drying system to minimize total drying time of timber for use as door frames.	Technology: A 20-m ³ kiln using passive solar is covered with low density polyethylene foam; four fans circulate air.
Results: The performance is being investigated to determine drying schedules. TPC developed a mathematical model to predict drying rate.	Reference: RERIC News

Title: AIT-GTZ Biocoal Project	Project Type: R&D; study/demo
Organization: Asian Institute of Technology, German Agency for Technical Cooperation	Date: Since 1987
End-use Sector: Industry; commercial, residential building	Affiliated/Future Projects: There are at least 5,000 biogas systems in Thailand.
Description: The project studied biocoal utilization and opportunities in Thailand.	Technology: Biocoal manufacturing
Results: The project published reports on state-of-the-art biocoal technology: <i>A Comparison of Options for Producing Biocoal, Economic Report for Biocoal in Thailand, Test Run of Biocoal Kiln in Thailand, Market Opportunities in Thailand.</i>	Reference: RERIC News

Title: Energy Conservation Activity in Thailand	Project Type: Policy assessment
Organization: Thai government, National Energy Administration (NEA), Energy Conservation Center of Thailand (ECCT)	Date: 1992 to 1996
End-use Sector: All sectors	Affiliated/Future Projects: Activities at the National Energy Administration, Energy Conservation Center of Thailand, Technological Promotion Association, Industrial Finance Corporation, and various universities
Description: Thailand has an energy conservation policy in its seventh national plan (1992 to 1996). It calls for energy pricing policy to reduce investment in energy production; improved petroleum pricing to reflect true economic cost; laws to encourage efficiency; and a stronger role for energy conservation organizations.	Technology: Conservation. The NEA and the ECCT conducted energy audits of 695 factories and 210 buildings, provided an energy conservation training program, provided low interest-rate loans to eight factories for conservation, reduced import tariffs on conservation equipment, provided technical information, and studied high-efficiency systems.
Results: The government has implemented energy conservation since the fifth national plan (1982 to 1986).	Reference: Energy Conservation in Thailand

Title: National Energy Administration's (NEA) Conservation Activities	Project Type: Policy assessment
Organization: NEA	Date: Ongoing
End-use Sector: All sectors	Affiliated/Future Projects: The NEA promotes energy conservation through the Energy Conservation Center of Thailand (ECCT).
Description: The NEA activities include identifying energy conservation potential; formulating energy policy; and providing research, energy audits, training, and incentives for conservation.	Technology: Conservation
Results: In January of 1990, an <i>Electricity Savings Plan for Industrial, Commercial, and Residential Sectors</i> outlined a three-year plan to save 159 MW. The government rejected the plan. In other areas, the NEA has trained factory personnel.	Reference: Energy Conservation in Thailand

Title: Water Pumping Gasifier	Project Type: Study/demonstration
Organization: USAID, Songkla University, International Foundation for Science	Date: 1985
End-use Sector: Utility	Affiliated/Future Projects: There are at least 5,000 biogas systems in Thailand.
Description: USAID funded the university to build a charcoal gasifier to pump water in an unelectrified village.	Technology: Biogas
Results: A charcoal gasifier powered a 5-horsepower engine to pump water for the village.	Reference: Bioenergy Systems Report

Title: Biogas Data Base	Project Type: R&D
Organization: King Mongkut's Institute of Technology Thornburi, (KMITT) Bangkok	Date: 1988
End-use Sector: All sectors	Affiliated/Future Projects: KMITT biogas research
Description: A regional data base was set up at the KMITT library to track biogas projects, research, and developments.	Technology: There are at least 5,000 biogas systems in Thailand.
Results: As of 1988, 1,500 articles were collected.	Reference: RERIC News

Title: FINESSE (Financing Energy Services for Small-Scale Energy Users)	Project Type: Policy assessment
Organization: The World Bank, U.S. Department of Energy, USAID, U.S. Environmental Protection Agency, UNDP, Asian Development Bank, Asian and Pacific Development Center, Netherlands Ministry of Foreign Affairs	Date: FINESSE was launched in 1989.
End-use Sector: All sectors	Affiliated/Future Projects: Unknown
Description: Project FINESSE was launched to conduct market studies, promote the manufacture of energy-efficient light bulbs and appliances, examine the institutional environment for alternative energy projects, establish ASEAN project opportunities, establish a multidonor feasibility fund, and host international conferences.	Technology: All renewable energy
Results: FINESSE has completed market studies on Malaysia, the Philippines, Indonesia, and Thailand. The studies identified project opportunities for renewable energy.	Reference: FINESSE Country Market Studies, FINESSE Report

Title: Energy Conservation Center of Thailand (ECCT)	Project Type: Education/information
Organization: ECCT is privately managed under National Energy Administration supervision.	Date: 1986 to present
End-use Sector: All sectors	Affiliated/Future Projects: Various
Description: ECCT was established to promote and strengthen energy conservation.	Technology: Various
Results: N. A.	Reference: ASEAN-EC Energy Conservation Seminar, December 1987

Title: The Energy Conservation Promotion Act	Project Type: Policy assessment
Organization: Thai government, National Energy Administration (NEA), Energy Conservation Center of Thailand (ECCT)	Date: 1991
End-use Sector: All sectors	Affiliated/Future Projects: NEA and ECCT activities
Description: The act gives the Minister of Science, Technology, and Energy power to promote conservation, calls for the appointment of energy managers for all controlled factories, starts a fund from an oil tax for conservation under the Ministry of Finance, and sets methods to prosecute violators of the law.	Technology: Conservation
Results: The law was passed.	Reference: Draft copy of the Energy Conservation Act

Title: Energy Conservation Information Service	Project Type: Policy assessment
Organization: National Energy Administration	Date: 1982; continuing
End-use Sector: All sectors	Affiliated/Future Projects: Various
Description: The service provides information on conservation.	Technology: Conservation
Results: N. A.	Reference: ASEAN-EC Energy Conservation Seminar

United States

The United States occupies the central part of North America and has a total area of 9,373 thousand km². The population of 240 million people is geographically dispersed, requiring its people to drive farther for commerce and leisure than do people in most other countries. The modern infrastructure of U.S. cities, highways, and industries was developed with abundant and relatively inexpensive energy resources. Two-thirds of the 90 million U.S. households live in single-family homes, which are more energy intensive than multifamily structures.

The continuing national dependence on oil arises from the use of motor fuels to transport people and products. A little more than one-quarter of U.S. energy use and about two-thirds of all petroleum use are accounted for by the transportation sector. Overall, the pattern of energy use in the United States is commensurate with its large land area, low population density, and significant indigenous resources.

Energy Use and Policy Issues

The U.S. economy includes certain energy-intensive industries, such as steelmaking, that account for much of its industrial energy use. Nine of these industries account for 70% of the industrial energy use but less than 15% of the economic value of industrial output.

Electricity supplies nearly 70% of the energy used by the commercial buildings sector. Much of the recent growth in electricity use can be attributed to increasing use of air conditioners in commercial buildings. Besides electricity, natural gas is the other major fuel used in commercial buildings.

In recent years, many renewable energy resources, such as solar, wind, and geothermal power, have increased their respective contributions to the U.S. economy by very large percentages; however, except for biomass and hydroelectricity, they still represent very little input in absolute terms.

The U.S. government started funding research and development of renewable energy with \$20 million in 1974. In the late 1970s, this commitment increased to nearly \$140 million. In addition, tax credits for renewable energy systems also began in the late 1970s.

In 1988, renewable energy provided 8% of the total energy supply. The resources used included hydropower (46%), geothermal (4%), biomass electric (7%), biomass buildings (14%), biomass industrial (26%), and wind, PV, solar thermal, and alcohol fuels (3%). Hydropower provided 71,533 megawatts (MW) of electricity-generating capacity in 1990. In at least five states, more than 40% of the electricity generated comes from hydropower.

In 1990, total energy use in the United States equaled 1,982.7 million tons of oil equivalent (Mtoe). This was supplied by oil (40.1%), coal (27.3%), gas (22.3%), nuclear (6.9%), and hydro (3.3%). In 2000, energy consumption is expected to be 2,192 Mtoe.

Per capita energy consumption equaled 7,822 kilograms of oil equivalent (kgoe) in 1990, up from 6,535 kgoe in 1965. For the period 1980 to 1990, energy consumption grew at an annual rate of 1.5%. For the years between 1965 and 1980, energy consumption grew at an annual rate of 2.3%.

Crude oil production declined 18% between 1986 and 1990. Total production in 1989 averaged 7.6 million barrels per day. Crude oil and product imports rose 8% from 1988 to 1989, accounting for 41% of the U.S. supply.

Natural gas production in 1988 rose slightly to 16.7 trillion ft³ (tcf), while gas consumption increased to 18 tcf. The United States imported about 6% of its gas from Canada and exported small quantities of liquefied natural gas to Japan.

The coal resources of the United States represent about 30% of the world's coal resources. In 1988, coal production reached a record 860 million metric tons and will continue to be the mainstay of domestic energy supply. The Department of Energy's (DOE) Clean Coal Technology Program funds \$3.75 billion of research and demonstrations to develop technology to keep coal clean, competitive, and convenient.

During 1988, U.S. utilities produced 2,701 billion kilowatt-hours of electricity generated by 743 gigawatts of installed capacity. Eighty percent of these utilities were investor owned, and they supplied almost 75% of the power generated. The electricity generation in 1989 came from coal (56%), oil (5%), natural gas (9%), nuclear (19%), and hydro (10%). A small amount of electricity was imported. The development of private power was given new impetus by the passage of the Public Utilities Regulatory Policy Act in 1978. This legislation, under certain prescribed conditions, forces utilities to buy private power from nonutility producers.

Energy Efficiency and Conservation

The U.S. National Energy Strategy (NES) states that no feasible combination of domestic or international energy policy options can make the United States completely invulnerable to foreign oil supply disruptions during the foreseeable future and that reducing this vulnerability requires a broad array of actions.

Such actions include maintaining adequate strategic reserves, increasing U.S. petroleum production in an environmentally sensitive manner, and further deregulating the natural gas industry. The NES also aims to reduce the importance of oil to the U.S. economy through conservation, efficiency improvements, and oil displacement (using improved technologies and alternative fuels).

The United States has several laws on energy conservation. The main ones are the Energy Policy and Conservation Act of 1975, followed by the National Energy Conservation Policy Act of 1978. In 1987, a new National Act on the Efficiency of Appliances was adopted (revised in 1988).

New legislation, the Energy Policy Act of 1992, was signed into law by the President on October 24, 1992. The act is extremely wide ranging and includes many provisions dealing with increasing energy efficiency in housing and other buildings (including buildings owned by the U.S. government) and encourages investments in efficiency by both gas and electric utilities. In addition, the act establishes an electric vehicle commercial demonstration program.

The energy-efficiency gains in the United States between 1973 and 1985 are estimated to be 30%, compared with the situation without energy-efficiency measures. Industrial sectors and households contributed most.

DOE is the main sponsor of energy-efficiency and renewable energy programs in the United States. At DOE, these programs are located in the Office of the Assistant Secretary for Energy Efficiency and Renewable Energy (EE). An important focus of these programs is research and development, but data analysis, planning, and technology transfer efforts support the research programs and increase the quantity and quality of information on energy conservation available to the public and U.S. industry.

In EE, the building technologies programs are designed to improve the efficiency of the building envelope, the equipment used in buildings, and the community systems that deliver energy to the building. These programs also seek to stimulate the use of renewable energy in buildings and to develop methods of mitigating indoor air quality hazards without sacrificing energy efficiency.

The Energy Policy and Conservation Act of 1975, as amended, established an energy conservation program—including test procedures, labeling, and standards—for these 13 types of household appliances: refrigerators, refrigerator/freezers, and freezers; room air conditioners; central air conditioners and heat pumps; water heaters; furnaces; dishwashers; clothes washers; clothes dryers; direct heating equipment; kitchen ranges and ovens; pool heaters; television sets; and fluorescent ballasts. The act established a three-part program: test procedures, energy-conservation standards, and appliance labeling. The standards must be technologically feasible and economically justified. The labeling program is managed by the Federal Trade Commission. This program requires manufacturers to affix energy-efficiency labels to appliances to make consumers aware of the energy costs of operating them.

The transportation technologies programs are focused on three areas: (1) advanced automotive propulsion systems, including gas turbines, low heat rejection diesel, and electric vehicle technologies; (2) advanced materials development and tribology research; and (3) research, development, demonstration, testing and evaluation, including field testing in fleet operations, of alternative fuels.

The industrial technologies programs emphasize three major areas: (1) industrial process efficiency; (2) waste energy reduction, including energy lost in heat and material wastes; and (3) industrial heat and power generation.

The utility technologies programs deal with increasing the efficiency of the electric system and address the financial and regulatory problems of utilities and the question of how to increase the mix of renewable energy supply for utilities.

Finally, EE manages several programs designed to ease the way of new renewable energy and energy-efficiency technologies into the marketplace. These programs are located in the Office of Technical and Financial Assistance (OTFA), which works cooperatively with state and local government energy offices and energy-related private and nonprofit organizations. This office provides technical and financial assistance to these groups and encourages their feedback regarding EE programs.

The overall management of the U.S. activities related to the International Energy Agency (IEA) Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADET) also resides in this office. The program is assisted by experts from the other EE technology programs and by Oak Ridge National Laboratory, which is under contract to OTFA to support CADET. Private sector participation, which is at the heart of the U.S. CADET program, is generated through the activities of the U.S. CADET National Team, consisting of officials from private companies, utility organizations, DOE national laboratories, federal agencies, state and local agencies, trade and professional organizations, universities, and information agencies. Many of these organizations fund and/or undertake their own energy conservation programs (e. g., the Electric Power Research Institute, the Gas Research Institute, and the State Energy Offices).

Bibliography

A Compendium of Energy Conservation Success Stories 90; DOE/CH10093-83, Golden, CO: Solar Energy Research Institute; December 1990

National Energy Strategy Executive Summary, February 1991

Programs in Renewable Energy Fiscal Year 1989, U. S. Department of Energy

Title: Heat Transfer and Heat Exchangers	Project Type: R&D
Organization: International Energy Agency (IEA) (participants are United States and six others)	Date: 1977; continuing
End-use Sector: Industry	Affiliated/Future Projects: None
Description: R&D and assessments of heat transfer and heat exchanger technology.	Technology: Heat exchangers
Results: Completed initial research into heat transfer from extended surfaces, design of heat exchanger networks, and vibration problems in heat exchangers. Studied deposits that foul surfaces; carried out tests in wind and water tunnels to study sources of vibration. Research results are available for application in industrial process design.	Reference: IEA Joint R&D Projects, April 1990, p. 33

Title: Ceramic Recuperator Recovers Heat from Exhaust Gas	Project Type: R&D
Organization: Office of Industrial Programs, Conservation and Renewable Energy, DOE	Date: 1982
End-use Sector: Industry (metals and mineral)	Affiliated/Future Projects: None
Description: Development of a ceramic recuperator for industries with high-temperature exhaust gas streams to produce energy savings.	Technology: Ceramic matrix composed of alternate layers of ceramic passages oriented at right angles to each other; allows core to be replaced or removed for easy cleaning and maintenance.
Results: Energy savings were 40% to 50%. This process is suitable for many industrial applications and is durable at temperatures up to 1425°C.	Reference: IEA Center for the Analysis and Dissemination of Energy Technologies (CADDET)

Title: Induction Heating and Melting	Project Type: R&D
Organization: Electric Power Research Institute	Date: 1989
End-use Sector: Industry (metal)	Affiliated/Future Projects: None
Description: Study of induction heating and melting for production of iron and steel castings to save energy and increase production.	Technology: Design of coreless induction furnace includes induction coil, insulating refractory, refractory cement, and a crucible. Design of channel induction furnace includes inductor, insulating refractory, backup refractory, and monolithic refractory.
Results: Project results included decreased energy consumption per unit of product, higher yield of high-quality products, cleaner melting, improved working environment, declining capital costs. Thermal efficiency is 55%-65%; net dollar benefit from converting to induction furnaces is \$34,800.	Reference: IEA CADDET

Title: Foam Processing	Project Type: R&D
Organization: United Merchants and Manufacturers, South Carolina	Date: 1989 to 2010
End-use Sector: Industry (textiles)	Affiliated/Future Projects: None
Description: Project to accelerate the development of a more energy-efficient process for the application of pigments and other chemicals to textiles, and to disseminate the benefits of the technology by using independent energy audit sites within the textile industry.	Technology: Concentrated mix of finishing chemicals foamed by a mechanical or static foam generator. Foam is then applied to fabrics. Mechanical force causes collapse of foam, distributing chemicals evenly through the fabric.
Results: Project resulted in reduced energy for drying, increased plant productivity, more efficient utilization of chemicals, reduced water consumption, and greater savings on pollution abatement.	Reference: IEA CADDET

Title: Membrane Processes for Industrial Separation and Drying	Project Type: R&D
Organization: Bend Research, Inc., Oregon	Date: 1989
End-use Sector: Industry (separation and drying)	Affiliated/Future Projects: None
Description: This study determined the feasibility of developing membrane processes as energy-efficient alternatives to conventional treatment of wastewater streams in the corn-sweetener industry.	Technology: Preconcentrating wastewater streams and membrane processes; drying systems feature modules with membranes permeable to vapor but not to air.
Results: Reduces energy usage (50%); increases waste energy recovery (30%); versatile for many industrial applications.	Reference: IEA CADDET

Title: Cooling System for Fruit and Vegetable Storage Plant	Project Type: Study/demonstration
Organization: Kirk Produce, Inc., California	Date: 1986 to 1987
End-use Sector: Industry (cooling system)	Affiliated/Future Projects: None
Description: Study and demonstration of a new cooling system that incorporates energy efficiency and saves floor space.	Technology: Cooling produce before packing it to reduce fragility and bruising while maintaining proper relative humidity in a microprocessor.
Results: This project resulted in a 50% reduction in refrigeration costs, enhanced market life of produce, increased profits from produce. The system has a 14-year payback.	Reference: IEA CADDET

Title: High-Temperature Materials Laboratory	Project Type: R&D
Organization: U.S. Department of Energy	Date: 1987; continuing
End-use Sector: Industry	Affiliated/Future Projects: None
Description: Laboratory serves as a focal point for multidisciplinary research on new ceramics and metal alloys that show potential for high-temperature applications.	Technology: N/A
Results: During the first year-and-a-half of operation, 27 universities, 24 industrial companies, and 3 government facilities signed agreements to use the facility.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Gel Casting	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Industry (ceramic manufacturers)	Affiliated/Future Projects: None
Description: A new method of gel casting ceramic powders is fast and economical and allows product dimensions to be controlled closely.	Technology: Gel casting separates the mold-filling and setting operations and uses a water-based vehicle.
Results: Tensile and other alumina oxide ceramic specimens were produced successfully using this method in the laboratory.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Microwave Processing of Ceramic Materials	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Industry (ceramics manufacturers)	Affiliated/Future Projects: None
Description: Large pieces of high-purity alumina can be heated uniformly and sintered in microwave ovens quickly and at lower temperatures than when using conventional infrared methods.	Technology: Microwave oven uses a frequency of 28 ghz.
Results: The material densified more rapidly, and the activation energy required was much lower than that required in current processing techniques.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Hyperfiltration of Food	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Industry (food processing)	Affiliated/Future Projects: None
Description: Thin-film composites that can withstand higher temperatures, operate within a wider pH range, and have increased resistance to biological degradation can be used to concentrate fruit and vegetable juices.	Technology: The membranes were tested in selected high-temperature food-processing streams to characterize membrane performance as a function of time.
Results: A prototype unit for concentrating tomato juice was built and tested successfully.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: PET Bottle Separator	Project Type: Study/demonstration
Organization: U.S. Department of Energy Procedyne Corporation	Date: N/A; continuing
End-use Sector: Industry	Affiliated/Future Projects: None
Description: A combination of separation processes can sort bottles and cans by those made of PET (polyethylene terephthalate), high-density polyethylene, or aluminum.	Technology: N/A
Results: The separator currently sorts 12 to 18 million pounds (5.4 million to 8.1 million kg) of PET annually. Energy savings from recycling waste plastic is estimated at 13.8 trillion Btu annually by 2010.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Dew-Point Hygrometer	Project Type: Study/demonstration
Organization: U.S. Department of Energy with Trans-Met Engineering	Date: N/A
End-use Sector: Industry	Affiliated/Future Projects: None
Description: New hygrometer withstands dust and grease, temperatures up to 500°F, and relative humidities between 50% and 100% to monitor humidity and temperature of exhaust gases in drying operations.	Technology: N/A
Results: Prototype was successfully tested at a textile mill and now is being used commercially in various industries. Energy savings are projected at 10.5 trillion Btu in 2010.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Optical Humidity Sensor	Project Type: Study/demonstration
Organization: U.S. Department of Energy with Spectral Sciences and Pacer Systems	Date: N/A
End-use Sector: Industry	Affiliated/Future Projects: None
Description: New hygrometer measures the absorption of ultraviolet light (a property of water vapor in air or process gas) to determine humidity in various industrial processes.	Technology: Optical elements of the sensor do not directly contact the medium, protecting the sensor from contamination.
Results: Hygrometer is commercialized and installed in several pulp and paper mills. Energy savings are projected to be 217.3 trillion Btu in 2010.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Rapid Solidification of Metals	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Industry	Affiliated/Future Projects: None
Description: A gas stream impacts and breaks up a stream of molten metal into fine droplets to solidify rapidly and, thus, strengthen metal alloys.	Technology: The repetitive process produces a high concentration of atomic vacancies, which would normally anneal out of the alloy at high temperatures. The dissolved gas entrapped during rapid solidification stabilizes the vacancies in clusters.
Results: Austenitic stainless steels processed this way increase their service lives 60-fold. The technique could also be used to process iron, aluminum, nickel, and other metal alloys.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: A Computerized Tribology Information System (ACTIS)	Project Type: R&D
Organization: U.S. Department of Energy with the National Institute of Standards and Technology	Date: N/A
End-use Sector: Industry	Affiliated/Future Projects: None
Description: ACTIS is a data base that will provide a central location for information on tribology research and products.	Technology: Software is being developed to work on IBM (or compatible) personal computers and will be commercially available to the tribology community soon.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Raccoon Mountain Pumped-Storage Plant	Project Type: Study/demonstration
Organization: Tennessee Valley Authority	Date: 1970 to 1979
End-use Sector: Utility	Affiliated/Future Projects: None
Description: Study to build a facility that would best meet the growing power demands of the Tennessee Valley region.	Technology: A pumped-storage plant that produces energy at a high rate during high demand, and recharges when demand is low to ready itself for the next high demand period. Total cost: \$287 million.
Results: Replaces more expensive forms of power generation at peak load times; provides quick start-up emergency power generation capability.	Reference: IEA CADDET

Title: Electric Vehicle Site Operations Program	Project Type: R&D
Organization: U.S. Department of Energy	Date: 1976; continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: The program evaluates the effectiveness of technological advances in electric vehicle research.	Technology: The program has evaluated more than 20 electric vehicles and 16 product improvements.
Results: Research objectives are being met and often exceeded. Electric vehicle energy consumption was reduced by more than 50%; reliability levels increased by 78%; maintenance costs were reduced by 60%; and overall life-cycle costs were reduced by 67%.	Reference: <i>A compendium of Energy Conservation Success Stories 90</i>

Title: Dual-Shaft, Advanced Alternating-Current Propulsion System	Project Type: R&D
Organization: U.S. Department of Energy, Eaton Corporation, Eagle-Picher Industries, ASC, Inc.	Date: N/A
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: An advanced propulsion system will drive an electric lightweight van.	Technology: An industrial research team designed, built, and tested three advanced, proof-of-concept propulsion systems that were installed in Chrysler T-115 minivans. Major emphasis was to advance existing battery and power train technologies through integrated development of a nickel/iron battery, an alternating-current motor and controls, and an automatic two-speed transaxle.
Results: Vehicle performance goals for acceleration, gradability, top speed, range, and energy efficiency were reached or surpassed.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Gel-Cell, Lead-Acid Battery-powered Electric Vehicles	Project Type: R&D
Organization: U.S. Department of Energy	Date: 1982; continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: Gel-cell batteries reduce maintenance requirements and improve safety conditions and efficiency levels.	Technology: DOE, along with universities, the private sector, and other federal agencies, developed technology to reduce maintenance costs.
Results: The batteries reduced vehicle maintenance costs by 50%, increased energy efficiency by more than 50%, and increased operating safety.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Engine Materials	Project Type: R&D
Organization: IEA (participants are United States and two others)	Date: 1979; continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: This project tested materials used to make ceramic engine parts, including silicon nitride and silicon carbide powders. Test procedures were standardized.	Technology: Advanced ceramics
Results: All test results are being shared among participants (weak).	Reference: IEA Joint R&D Projects, April 1990, p. 23

Title: Federal Methanol Fleet	Project Type: Study/demonstration
Organization: Oak Ridge National Laboratory	Date: 1985 to 1988
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: Demonstration of the level of maturity of methanol fuel vehicle technology.	Technology: Thirty-nine vehicles make up the fleet: 20 methanol powered, 4 vehicle models. Some methanol engines utilize high-compression-ratio pistons, some have turbochargers. Vehicles were operated on fuel methanol (M85).
Results: Lower flammability = greater safety, higher octane yields greater power. Energy efficiency is equal between methanol and petrol vehicles; methanol cars have lower ease-of-starting rating.	Reference: IEA CADDET

Title: Federal Methanol Fleet	Project Type: Study/demonstration
Organization: U.S. Department of Energy	Date: 1985 to 1989; continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: Demonstrates the technological feasibility of methanol-fueled cars. Fleet contains 20 methanol-fueled and 19 gasoline-fueled cars.	Technology: Retrofitted gasoline-fueled cars. Fuel mixture is 85% methanol, 15% unleaded gasoline.
Results: Performance was virtually trouble-free, although methanol-fueled cars consumed slightly more fuel than gasoline-fueled cars because of different driving cycles. Maintenance statistics compare well. Methanol is a viable substitute for imported petroleum products.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: 1989 Methanol Marathon	Project Type: Study/demonstration
Organization: U.S. Department of Energy with Society of Automotive Engineers	Date: 1989
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: Competition among college students to engineer and race methanol-fueled cars. The competition included static tests and a 1100-mile (1770-kilometer) road rally.	Technology: Chevrolet Corsicas were retrofitted to run on a blend of 85% methanol and 15% gasoline.
Results: Results: The winning car averaged 36.7 miles per gallon (59 kilometers per 3.8 liters). More than 200 students learned about alternative transportation fuels.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: High-Temperature Liquid Lubricants	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A, continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: New synthetic oils being developed will allow engines to operate in temperature ranges three times those of conventional oils.	Technology: N/A
Results: New lubricants will decompose oil cleanly, form less soot, emit fewer particulates, and reduce engine wear.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Spark Plug Instrumented with Fiber Optics	Project Type: R&D
Organization: U.S. Department of Energy with Chrysler Corporation	Date: 1987; continuing
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: Special spark plug installed in standard automobile engines can observe flame propagation in the combustion chamber. Subsequent measurements will help engineers improve combustion efficiency.	Technology: N/A
Results: Flame development measurements showed the flame to be more asymmetric than expected.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Advanced Inverter Technology	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: The new inverter to be used in electric vehicles is smaller and weighs less than existing inverters.	Technology: A metal-oxide semiconductor-controlled thyristor power switch and high-voltage multilayer capacitors give the inverter greater power efficiency and better thermal management while reducing capacitor volume and heat loss.
Results: Development of an inverter and control system for a diesel/electric drive motor for the radiator cooling fans on commercial diesel/electric locomotives.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Battery Combustion-Attenuation Material	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Transportation	Affiliated/Future Projects: None
Description: The material fills the headspace of basic and electrolyte batteries, preventing the battery cases from rupturing if gases within the battery cells should ignite during charging or operation of an electric vehicle.	Technology: The material was tested with nickel-iron battery modules.
Results: The material clearly reduced the level of risk and was patented and incorporated into the nickel-iron battery packs being designed for dual-shaft electric propulsion systems.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: A Computerized Tribology Information System (ACTIS)	Project Type: R&D
Organization: U.S. Department of Energy with the National Institute of Standards and Technology	Date: N/A
End-use Sector: Transportation; industry	Affiliated/Future Projects: None
Description: ACTIS is a data base that will provide a central location for information on tribology research and products.	Technology: Software is being developed to work on IBM (or compatible) personal computers and will be commercially available to the tribology community soon.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Program for the Energy Analysis of Residences (PEAR)	Project Type: Technology transfer
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: Computer program enables builders and designers to estimate the annual energy use of new houses equipped with typical conservation measures.	Technology: Using this program, builders can choose home insulation levels, window types and glazing layers, infiltration levels, amount of thermal mass, and equipment efficiency.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Computer-based Conservation Standards for New Federal Residential Buildings	Project Type: Standards and codes
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: Using this software program, builders can submit the most cost-effective combination of energy conservation measures when bidding on federal housing projects.	Technology: The user-friendly program calculates the most cost-effective combination of conservation measures and checks compliance with standards for federal housing projects.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Building Foundation Design Manual	Project Type: Education/information
Organization: U.S. Department of Energy	Date: 1986
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: The manual contains information on the cost-effectiveness of foundation insulation in most U.S. climates.	Technology: The manual covers energy-efficient building foundation design and recommends practices for structure, drainage, waterproofing, radon mitigation, and termite control.
Results: National savings derived from adopting designs recommended in the manual could approach 0.5 quad annually.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Single-Family Retrofit Research and Technology Transfer Program	Project Type: Technology transfer
Organization: U.S. Department of Energy	Date: N/A; continuing
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: The program provides information on the latest research in residential energy conservation.	Technology: The program leverages state and private resources to improve conservation programs, provides better technical training of weatherization providers, and increases research activities in the field and in national laboratories.
Results: The program improved the energy savings and cost-effectiveness of 27 state weatherization programs and provided training to 1,600 energy auditors and private heating contractors in new efficiency technologies. More than 20,000 homes were retrofitted through this program.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: High-Efficiency Refrigerator Compressor	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: The development of a more efficient refrigerator compressor has led to a more advanced compressor.	Technology: Design changes include the refrigerator motor and suction muffler.
Results: First redesign achieved a 44% improvement over conventional compressors. Advanced compressor is rated at more than 5 Btu (5.3 joules) per watt-hour. Energy savings are estimated at about 0.21 quad per year by 2010.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Appliance Efficiency Test Procedures	Project Type: Certification
Organization: U.S. Department of Energy	Date: 1975; continuing
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: Procedures developed are used to test and label energy consumption and efficiency of 12 categories of major household appliances.	Technology: N/A
Results: Four national trade and professional associations adopted procedures. Consumers are rejecting less efficient appliances; and manufacturers are producing appliances that are up to 50% more energy efficient than older models.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Ground-coupled Heat Pumps	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: A ground-coupled heat pump was developed that was more cost-effective and more energy efficient.	Technology: Two experimental prototypes
Results: The advanced design reduced the payback period from 6 to 10 years to 3 to 5 years and will save about 0.32 quad of energy by 2010.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Flame-Retention Oil Burner	Project Type: Education/information
Organization: U.S. Department of Energy	Date: Late 1970s, N/A
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: The energy conservation benefit of the flame-retention-head oil burner was established and communicated to the public in a consumer-oriented booklet.	Technology: Oil burner
Results: The number of burners in use increased from 100,000 in 1979 to more than 4.2 million in 1989, saving about 71 trillion Btus (75 trillion joules) annually.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Radiant Barriers for Single-Family Housing	Project Type: Study/demonstration
Organization: U.S. Department of Energy and Tennessee Valley Authority	Date: N/A
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: A low-cost, easily installed aluminum foil product promises significant reductions in attic heat transfer.	Technology: Product has two reflective surfaces.
Results: Cooling energy requirements were reduced by 17% and heating energy requirements by 9%, yielding a payback in energy savings of two years if installed by homeowner.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: New Image and Lower Energy Bills in Manchester Inner-City Neighborhood	Project Type: Study/demonstration
Organization: Carnegie-Mellon University (Center for Building Performance and Diagnostics)	Date: Late 1970s to 1983
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: Project demonstrating and promoting benefits of inner-city revitalization using energy-efficient retrofits for existing housing units and energy-conscious new construction.	Technology: Homes clustered to reduce exterior exposure; higher thermal quality of walls, roofs and windows; homes oriented so living area can take advantage of sun; careful insulation; wind barrier continuity provided by wrapping house in vapor-porous windbreaker.
Results: The project achieved a 75% to 80% energy savings over detached standard-construction homes, reduced fuel subsidies, and renewed the use of an urban infrastructure.	Reference: IEA CADDET

Title: Super-insulation, Thermal Storage and Passive Solar Gain at Brookhaven House	Project Type: Study/demonstration
Organization: Brookhaven National Lab, New York	Date: 1990
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: Study and demonstration to provide technical data about how to use thermal storage in the building structure as an acceptable option for reducing the costs and energy for space conditioning of small buildings.	Technology: Brookhaven house incorporates natural thermal storage of common building materials with passive solar strategies in a tightly constructed, super-insulated house.
Results: Auxiliary heating was reduced 75% using standard building techniques and common construction materials.	Reference: IEA CADDET

Title: Low-Mass, Purgeable Boiler	Project Type: R&D
Organization: U.S. Department of Energy with Energy Kinetics Corporation	Date: 1980 to 1990
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: A redesigned boiler that purges hot water from the boiler into a reservoir of usable heat to counteract off-period cycling losses when the burner is off.	Technology: (1) A low-mass boiler with a 10-foot-long hollow, coiled section that acts as a heat exchanger. (2) A microprocessor control that purges the heat from the boiler and sends it to separate zones in a house for heating.
Results: Boiler operates with a steady-state efficiency of 83.3%. Purging mode increases seasonal efficiency from 71.9% to 82.5%.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Low-Cost Analyzer for Oil-Burner Flames	Project Type: R&D
Organization: U.S. Department of Energy with Canadian Mortgage and Housing Corporation	Date: 1988; continuing
End-use Sector: Residential building	Affiliated/Future Projects: None
Description: An optical flame monitor incorporated into a furnace that shows when combustion air is set for the highest efficiency and indicates when the burner needs adjustment or servicing.	Technology: Improves residential oil-fired furnace energy performance using optical detectors and common electronic devices.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Supermarket Refrigeration Systems	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: An advanced system offers multiple, unequal, parallel compressors for supermarket refrigeration.	Technology: System features microprocessor controls.
Results: System reduces energy consumed by more than 40%. Primary energy savings are expected to be between 0.25 and 0.37 quad annually by 2000.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Energy Management Program at the World Bank	Project Type: Study/demonstration
Organization: International Energy Agency (World Bank, U.S.)	Date: 1987 to 1990
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Energy management program at the World Bank to improve the operating efficiency of headquarters building.	Technology: \$1.5 million in capital projects: computerized lighting control system, expansion of computerized energy management system, installation of return air fan and balancing dampers, installation of variable speed motor drives on handling units, installation of supplemental air conditioning system, interconnection of existing boiler plants, installation of high-efficiency fluorescent lamp ballasts, installation of evaporative cooling system, installation of gas-fired hot water heaters.
Results: During FY 1987, \$1 million saved in energy costs, a 20% reduction in the energy budget.	Reference: IEA CADDET

Title: A Desiccant-Based Cooling System for Supermarkets	Project Type: Study/demonstration
Organization: HE Butt Grocery Company, Texas	Date: 1987
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Study to find alternative ways of cooling supermarkets to lower consumer costs.	Technology: A gas-fired, desiccant air conditioning system for supermarkets, which integrates gas humidification with electric air conditioning. Cost savings at one location was \$8,800/yr, or 211,000 kWh/yr.
Results: Savings through decreased energy consumption and power demand; energy costs reduced 7% to 10% for air conditioning and refrigeration; improved indoor climate for shoppers; more attractive refrigerated products.	Reference: IEA CADDET

Title: Energy Management at the Dubal/Beck Office Building	Project Type: Study/demonstration
Organization: International Energy Agency (Dubal, Beck, Harris and Assoc., Oregon)	Date: 1988
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Energy management program to build new energy-efficient commercial buildings.	Technology: Design features included increased wall and roof insulation; motion detectors that turn off lights in unoccupied rooms; low emissivity window glazing; a double-entry vestibule to minimize outdoor air infiltration; energy-saving lighting fixtures; and lamps and ballasts. Construction costs for the Dubal-Beck building: \$516,000.
Results: Annual energy costs reduced 31.5%, (27,800 kWh/yr).	Reference: IEA CADDET

Title: Thin-Walled Hollow Spheres from Powders	Project Type: R&D
Organization: U.S. Department of Energy	Date: N/A, continuing
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: Small, hollow spheres called aerospheres that are used as thermal insulators and structural materials.	Technology: Made from alumina, partially stabilized zirconia, ferrite, and kaolin clay powder slurries. The uniformity, density, and quality of the spheres can be controlled during production.
Results: Thermal conductivity was measured as low as 0.13 W/m-K; can be used for insulation at temperatures >1500°C. Production costs could bring costs down to 50¢/lb.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Miami District Cooling Project	Project Type: R&D
Organization: U.S. Department of Energy with urns and Roe Company and the Joseph Technology Corporation	Date: N/A
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: A study to determine the feasibility of linking the primary, chilled-water plants of several hospitals through a common underground distribution system.	Technology: N/A
Results: District cooling would save about 15% on total electric use, reduce operation and maintenance costs, and offer a payback period of six years.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Geothermal Surface Spring Provides Heating for Colorado Lodge	Project Type: Study/demonstration
Organization: Hot Springs Lodge and Pool, Inc.	Date: Completed 1986
End-use Sector: Commercial building	Affiliated/Future Projects: None
Description: To design and implement a heating and cooling system that would take advantage of the available low-temperature geothermal surface spring, reducing energy costs and saving nonrenewable energy resources.	Technology: A mechanical system designed for use with low-temperature geothermal surface spring containing 51°C water, low-cost heat exchangers, and copper tubing coils.
Results: Saves \$36,500/yr in energy costs; 50,000 therms nonrenewable energy were saved.	Reference: IEA CADDET

Title: Solar-5	Project Type: Technology transfer
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Computer program allows building designers to assess the effect of different design strategies on energy performance.	Technology: Solar-5 uses a matrix to display data and provide the results of its energy analysis. Users can combine up to nine different schemes into one design and see a graphic display of the resulting energy flows.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: WINDOW Computer Program	Project Type: Technology transfer
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: WINDOW can determine the thermal performance of window systems.	Technology: The IBM PC-based series of programs calculates thermal transmission, shading coefficients, and surface temperatures of glass.
Results: The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) used WINDOW to calculate new guidelines for window performance. The program is facilitating work on superwindow technology.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: A Simplified Energy Analysis Method (ASEAM-2)	Project Type: Technology transfer
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: ASEAM-2 is nonproprietary and is used to design heating, ventilating, and air-conditioning (HVAC) systems in commercial and residential buildings.	Technology: ASEAM-2 can simulate 13 different types of HVAC distribution systems, model up to 10 energy load zones within a building, and size systems automatically. The program is modular and can be integrated with other software programs.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Indoor Air Quality Field Studies Data Base	Project Type: R&D
Organization: U.S. Department of Energy, the Environmental Protection Agency, Electric Power Research Institute, Gas Research Institute	Date: N/A, continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Data base makes it easier to access information on indoor pollutants and their effect on people.	Technology: Data base contains field studies of efforts on monitoring concentrations of indoor air pollution concentrations in buildings in the United States and Canada. Information is from more than 300 references. The data base can calibrate, verify, or modify macromodeling efforts designed to predict or characterize indoor pollutant concentrations.
Results: N/A	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Energy Institutes	Project Type: Education/information
Organization: U.S. Department of Energy	Date: 1980; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Two institutes provide resources to help university faculty train students to design energy-efficient buildings.	Technology: The Institutes on Energy and Engineering Education help engineering faculty teach students how to design, construct, and operate energy-efficient buildings. Institute participants, using case studies, analyze the heat flow patterns and energy budgets of buildings, review building plans and equipment data, and identify alternative energy conservation options. The Summer Institutes on Energy and Design help architecture faculty teach students how to design energy-efficient buildings. Institute participants attend workshops and take field trips.
Results: The Institutes on Energy and Engineering Education have held nine four-day sessions; about 380 faculty members attended.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: City-wide Energy Conservation: Phoenix, Arizona	Project Type: Study/demonstration
Organization: U.S. Department of Energy	Date: 1978; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: The city of Phoenix is demonstrating a commitment to energy conservation with a series of U.S. Department of Energy grants.	Technology: Individual projects focused on energy savings in the areas of wastewater treatment, water treatment and pumping efficiency, and heating and cooling efficiency in municipal buildings. The city also demonstrated a small-scale cogeneration project that used thermal energy storage and absorption cooling and completed a district cooling assessment.
Results: The grants resulted in more than \$3 million in energy savings and cost avoidance since 1981.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Solid-State Ballast for Fluorescent Lighting	Project Type: Study/demonstration
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Solid-state ballasts improved performance of fluorescent lamps.	Technology: Solid-state ballasts demonstrated in office buildings
Results: Prototype ballasts improved lighting efficiency by 25%. More than 2 million are being used in U.S. buildings, saving 200 million kWh.	Reference: <i>A Compendium of Energy Conservation Success Stories</i> 90

Title: Surface Wave Lamp	Project Type: R&D
Organization: U.S. Department of Energy	Date: 1980; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Very high (gigahertz) frequencies concentrate radiation generation close to the outer walls of a fluorescent lamp and improve the efficiency of its phosphor in converting ultraviolet radiation into visible light.	Technology: Surface-wave fluorescent lamp
Results: New lamps are 40% more efficient than conventional fluorescent lamps and promise a 50% reduction in energy use and >40,000 hours of lamp life.	Reference: <i>A Compendium of Energy Conservation Success Stories</i> 90

Title: Low-Emissivity Window Coating	Project Type: R&D
Organization: U.S. Department of Energy	Date: Mid-1970s to 1983
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Research on low-E coatings include computer simulation of alternative window designs, creation of coating test facilities, and technology transfer programs to disseminate results.	Technology: Low-emissivity window coatings
Results: Low-E coatings reduce window heat loss. Research stimulated glass and window industries to invest in technology. It is anticipated that 50% of all residential window sales will be low-E windows by 1992.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Measurement Device for Thermal Resistance of Insulation	Project Type: R&D
Organization: U.S. Department of Energy	Date: 1979, N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: A 1-meter line-source guarded hot plate accurately measures thermal resistance of insulation up to 15-inches thick.	Technology: The hot-plate measuring device
Results: Accurate heat-transfer measurement eliminates overinsulation, saving consumers \$90 million annually.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: District Heating and Cooling Development	Project Type: Study/demonstration
Organization: U.S. Department of Energy	Date: N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: Research, demonstrations, and feasibility assessments were done in more than 50 communities to redevelop district heating and cooling systems.	Technology: N/A
Results: The program currently yields energy savings of 5 trillion Btus (5.2 trillion joules) annually in the United States and is being adopted by several U.S. cities.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: District Heating and Cooling Development: Kent County, Michigan	Project Type: Study/demonstration
Organization: U.S. Department of Energy, Kent County, Michigan	Date: 1986; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: A waste-to-energy cogeneration facility serves 320,000 people in six communities.	Technology: State-of-the-art pollution-control equipment.
Results: The facility processes 625 tons of waste daily, delivers about 115,000 lb (52,155 kg) of steam hourly, and generates 14 MW of electricity. Tipping fees estimated at \$38 per ton increase the county's revenues.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Acoustic Leak Detection System	Project Type: R&D
Organization: U.S. Department of Energy, Consolidated Edison, Fluid Conservation Systems Corporation	Date: N/A
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: A computer-based acoustic monitoring system can accurately locate underground pipe leaks.	Technology: Data fed into a computer provide information on location, size, and type of leak.
Results: Water leaks can be detected from 500 feet (152 meters) away and escaping steam from 1500 feet (457 meters) away. The detector system could save utilities thousands of dollars weekly.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: Infiltration Model	Project Type: R&D
Organization: U.S. Department of Energy	Date: 1980; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: An infiltration model provides simple techniques for estimating infiltration rates in residential buildings.	Technology: The model uses leakage properties of the building envelope and site weather data to predict performance of air infiltration in the building shell.
Results: The model, accurate to within 20%, is used by building designers and is incorporated into major energy-performance computer programs. Residential designs using the model are typically 10% to 15% more energy efficient. The model is being extended to analyze infiltration in commercial buildings.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Title: DOE-2	Project Type: Technology transfer
Organization: U.S. Department of Energy	Date: 1977; continuing
End-use Sector: Residential, commercial buildings	Affiliated/Future Projects: None
Description: DOE-2 is a building energy simulation program for designing buildings and evaluating their energy use, efficiency, comfort, and cost.	Technology: DOE-2 works on personal and mainframe computers.
Results: The program has been used in developing building industry standards, as an aid in developing simplified analytical tools, and as a training tool. It is recognized as the most accurate building energy simulation program available.	Reference: <i>A Compendium of Energy Conservation Success Stories 90</i>

Note on the FINESSE Project

The FINESSE Project (Financing of Energy Services for Small-scale Energy Users) was begun in 1989 by the U.S. Department of Energy's Committee on Renewable Energy, Commerce, and Trade (CORECT) in cooperation with the World Bank. It was founded on the notion that traditional energy sector lending for large-scale coal and hydropower faced increasing obstacles. Moreover, the large-scale program did not meet the needs of households, cottage industries, and other enterprises in the developing world.

Alternative energy technologies—energy efficiency and renewable energy—offer a choice that matches the scale of the need. National energy planning and international financing tend not to incorporate these technologies, however.

FINESSE offers replicable models for financing and institutionalizing alternative energy services. These models are based on channeling donor funds through a range of utility, private sector, nongovernmental, and commercial intermediaries.

The FINESSE Project encompasses several key activities:

- Conducting ASEAN country market studies
- Initiating efforts to promote the upstream manufacture of energy-efficient light bulbs and appliances
- Examining the institutional environment for setting up and operating alternative energy projects
- Identifying ASEAN project opportunities and financial strategies
- Establishing an international forum assembling key members of the development and financial community.

In October 1991, a FINESSE workshop was held in Kuala Lumpur, Malaysia. The purpose of the workshop was to address institutional, policy, and educational barriers hindering alternative energy (energy efficiency and renewable energy) deployment in developing countries and to offer replicable financial models for project implementation. The workshop targeted Indonesia, Malaysia, the Philippines, and Thailand. More than 200 delegates attended.

Three main conclusions emerged from the workshop.

1. Developing countries are taking an aggressive role in planning their own energy futures and are reducing their dependence on outside advisors. They are increasingly recognizing that renewable energy and energy-efficient technologies can contribute to the energy mix of their countries.
2. FINESSE offers the World Bank, the Asian Development Bank, bilaterals, and other donors replicable strategies for financing small-scale energy projects. These strategies rely on existing in-country intermediary organizations to channel donor funds to individual consumers.

3. It was demonstrated that significant investment opportunities exist for alternatives that meet the test of financial and economic viability. Approximately \$825 million in bankable alternative energy project opportunities were identified by Malaysia, the Philippines, Thailand, and Indonesia.

A number of activities, under way at the time of the workshop, gathered momentum as a result of the event:

- Establishing a FINESSE unit at the World Bank, with secure financing
- Obtaining host country commitment to FINESSE
- Conducting project appraisal/preparation
- Expanding FINESSE to other Asian countries and regions.

The following are sponsors of the project:

- The World Bank
- U. S. Department of Energy
- Netherlands Ministry of Foreign Affairs
- United Nations Development Programme
- Asian Development Bank
- U. S. Agency for International Development
- U. S. Environmental Protection Agency
- Asian and Pacific Development Centre.