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Energy Vulnerability Assessment for the U.S. Pacific Islands

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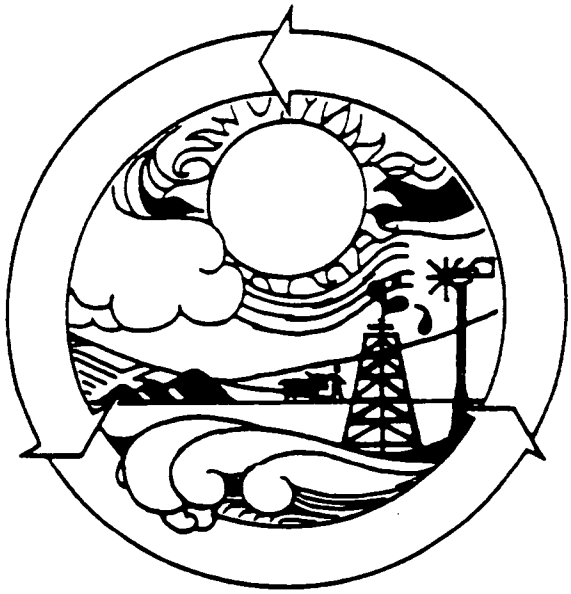

Pacific Islands Energy Project
Program on Resources
East-West Center
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MASTER

DISCLAIMER

FOREWORD

The Pacific Islands Energy Project of the Program on Resources, East-West Center has been engaged in research on Pacific islands energy issues since 1981. Unlike most research projects, the project has had an active role in the evolution of the energy sector in the Pacific islands, including involvement in typical research pursuits such as policy evaluations, training, and data collection. At the request of island governments and the oil companies, project staff have also served as the independent observer in the continuing dialogue between the governments and the oil industry.

The *Energy Vulnerability Assessment of the U.S. Pacific Islands* has been prepared at the request of the United States Department of Energy under a mandate by the Congress of the United States. This report is one of the few assessments which have focused on energy vulnerability issues in the Pacific islands. Although the assessment is for the U.S. Pacific islands, much of the analysis can be applied to the other Pacific island nations and territories.

Because energy data are limited, attention has been concentrated on developing a quantitative understanding of the energy sector and its linkages with the island economies. The vulnerability assessment has attempted to provide a framework by which energy security issues can be evaluated, and which can also serve as a basis for discussions between island governments, the oil industry, and the community-at-large to find workable solutions and response mechanisms during energy emergencies and for management of the energy sector.

The Pacific islands are among the world's most energy import dependent nations and territories. The economies are among the world's smallest and most open and are reliant on imports for basic survival. Thus, and even without an energy emergency, management of the energy sector should be a priority and focused on increasing the efficient use of energy. If this is not recognized, then energy costs will continue to escalate and, during crises, the effects could be staggering. Since the world oil market is totally integrated, any change in one part of market affects the whole. As such, the Pacific islands are subject to international oil market forces much as anyone else. The East-West Center hopes that our qualitative and quantitative assessment of the energy vulnerability of the U.S. Pacific islands will provide a basis for long-term analysis and study of the Pacific islands by the U.S. government and other agencies. It is also hoped that the report will facilitate a greater understanding of the special circumstances and needs of the Pacific islands.

The principal authors for the *Energy Vulnerability Assessment of the U.S. Pacific Islands* are Jim Rizer and Leonard Greer. I would like to gratefully acknowledge the long hours they have spent developing and analyzing the data base as well as in preparing the manuscript.

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Considerable assistance with data collection and policy analysis has been provided by the energy offices and electric utilities in the U.S. Pacific islands. Support from the governors' offices has been essential to completion of the report. The Pacific Basin Development Council facilitated with the organization of the assessment, including access to its library. In addition, Shell, Mobil, BHPPA, and Exxon, the oil companies operating in the islands, have been very helpful, generously providing both data and insight on future development issues. The U.S. Coast Guard, U.S. Navy and State of Hawaii energy officials also provided data and comments. Bank of Hawaii and Bank of Guam provided additional data.

The U.S. Department of Energy has provided funding for the vulnerability assessment. Dr. Inja Paik, Office of Energy Emergencies served as USDOE Project Manager. The Energy Information Administration developed the oil supply disruption scenarios utilized in the assessment.

The authors gratefully acknowledge the contributions of the above agencies and individuals.

The views expressed in this report are those of the authors and may not necessarily reflect those of the United States Department of Energy or contributors to the report.

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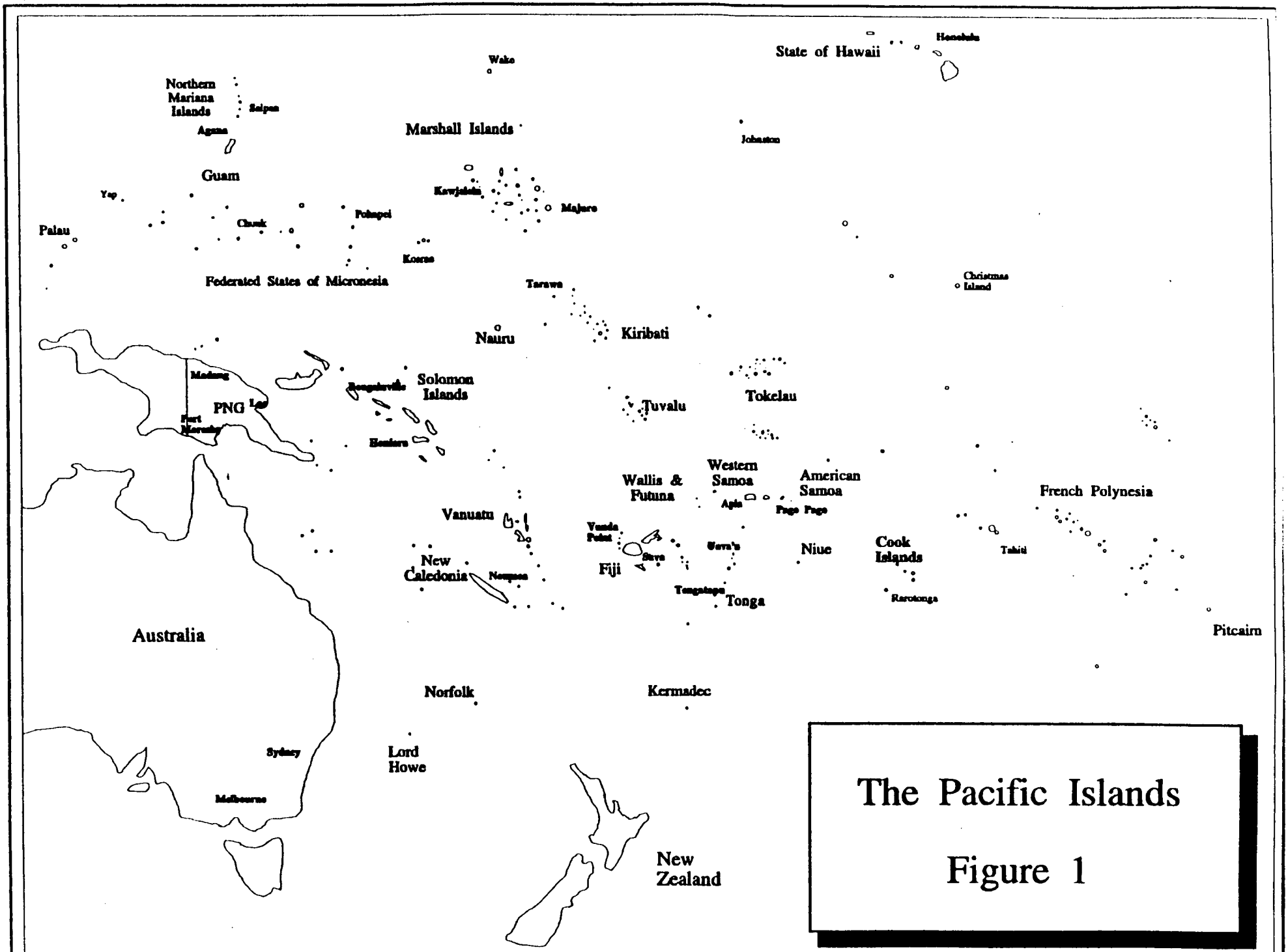

The Pacific Islands

Figure 1

One

INTRODUCTION

PURPOSE OF THE ENERGY VULNERABILITY ASSESSMENT

The study, *Energy Vulnerability Assessment of the U.S. Pacific Islands,* was mandated by the Congress of the United States as stated in House Resolution 776-220 of 1992, Section 1406. The resolution states that the U.S. Secretary of Energy

> shall conduct a study of the implications of the unique vulnerabilities of the insular areas to an oil supply disruption. Such study shall outline how the insular areas shall gain access to vital oil supplies during times of national emergency.

The resolution defines insular areas as the U.S. Virgin Islands, Puerto Rico, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and Palau. The U.S. Virgin Islands and Puerto Rico are not included in this report.

The U.S. Department of Energy (USDOE) has broadened the scope of the study contained in the House Resolution to include emergency preparedness and response strategies which would reduce vulnerability to an oil supply disruption as well as steps to ameliorate adverse economic consequences. This includes a review of alternative energy technologies with respect to their potential for reducing dependence on imported petroleum. USDOE has outlined the four tasks of the energy vulnerability assessment as the following:

1) for each island, determine crude oil and refined product demand/supply, and characterize energy and economic infrastructure;
2) forecast global and regional oil trade flow patterns, energy demand/supply, and economic activities;
3) formulate oil supply disruption scenarios and ascertain the general and unique vulnerabilities of these islands to oil supply disruptions; and
4) outline emergency preparedness and response options to secure oil supplies in the short run, and reduce dependence on imported oil in the longer term.

BACKGROUND OF THE ENERGY VULNERABILITY ASSESSMENT

To date, there have been no comprehensive energy vulnerability assessments conducted for any of the Pacific islands, whether under U.S. flag or independent nation. In fact, there have been only a handful of comprehensive analyses of the energy sector in the Pacific islands. The East-West Center in conjunction with the United Nations (UNDP and ESCAP), the Australian National University and the Forum Secretariat produced the Energy Mission Report series which covered the independent island nations in 1982. USDOE published the *Territorial Energy Assessment: Final Report* in December 1982. Since then, the East-West Center's Energy Program and the Pacific Basin Development Council published Energy

Mission Reports on the energy sectors in American Samoa (1987), Guam (1986), and the CNMI (1986). In addition, Palau was included as one of the 12 island nations which had their energy sectors assessed in 1992 as part of the 13-volume publication by the World Bank, the United Nations Development Programme, the Asian Development Bank, and the Forum Secretariat. (In addition to Palau, the Cook Islands, the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands, Papua New Guinea, the Solomon Islands, Tonga, Tuvalu, Vanuatu, and Western Samoa were included in the assessment).

These previous sectoral studies have focused on the existing energy situation and how it might be improved. "Improved" has often been interpreted in policies and budgets to mean finding an alternative to imported petroleum. Unfortunately, this interpretation has resulted in funds and attention being overallocated to renewable energy projects which will not significantly contribute to baseload power until at least after the year 2000 at the expense of existing priority needs.

Current priority areas include increased data collection and analysis of the energy sector and its linkage with the economy, increased energy efficiency, more attention to least-cost planning, realistic appraisal of long-term energy needs and solutions, introduction of demand side management programs and the institution of integrated resource planning. In sum, there is considerable need and scope to improve the overall management of the energy sector. Improved management and more efficient use of energy could be greatly facilitated if integrated resource planning activities are funded.

Because of the poor performance of renewable energy technologies in the Pacific islands and the very pressing problems in the energy sector, the 1992 World Bank sectoral reviews stressed that the island nations will continue to be dependent on imported petroleum and thus have to become more practical in their interactions with the transnational oil companies. Specifically, the island nations should "improve the surveillance of offshore and onshore transportation and distribution costs, storage safety standards, waste oil disposal, and defining the most effective role for government." The World Bank assessments also determined that performance by the power utilities was inadequate and that the island governments have not successfully provided management or direction for the energy sector.[1]

The experiences of the other Pacific islands are directly applicable to the U.S. Pacific islands: renewable energy technologies have had a very poor performance record, and although all of the power utilities are performing much better than they did several years ago, most if not all of the utilities are still confronting a range of technical and institutional problems and issues. For example, in only one instance, American Samoa, was a U.S. Pacific island government aware of the volume of petroleum products currently stored on-island. It should be noted that in the American Samoan case, the government owns the petroleum storage facility. Thus, if an energy supply disruption were to occur, some effort would have to be made to collect basic data such as stocks currently available, during a period of national emergency.

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[1] *Pacific Regional Energy Assessment: Overview Report*, World Bank, 1992, p. i.

Implicit to the above is the limited availability of statistics essential to the analysis of the energy sector. The statistics are limited because reviews of the energy sector and data collection have not been instituted as regular exercises. Limited data restricts the assessment of energy vulnerability. One of the major recommendations of the energy vulnerability assessment is the need to institutionalize data collection and analysis.

Given the limited data and analytical tools, considerable effort has been made to 1) acquire as much data on energy and the economy as possible; 2) analyze the data with respect to their implications for the energy sector and for the economy as a whole; 3) develop a comprehensive picture of energy-economy linkages; 4) provide a basis for future analyses; and 5) identify practical actions to improve management of the energy sector which can be implemented by the various island governments. In addition to the vulnerability assessment, other major energy sector issues have had to receive some attention because they affect the manner in which responses to an energy supply disruption can be addressed. Thus, discussions are included on the electricity subsector and the use of alternative energy sources.

Organization of the Energy Vulnerability Assessment

In order to provide the context for the analysis of the energy vulnerabilities of the U.S. Pacific islands, the report is organized into the following chapters:

1) Introduction
2) The Asia-Pacific Oil Market and the U.S. Pacific Islands
3) Overview of the Energy Sector and Energy Vulnerability Issues
4) American Samoa
5) Guam
6) Commonwealth of the Northern Mariana Islands
7) Palau

In addition to the above, it should be noted that the operations of the global energy industry are highly dependent on economies of scale, which can only be attained in the islands region when several of the entities are combined. Based on current energy supply patterns, obvious groupings would include Hawaii and American Samoa, and Guam, the CNMI and Palau. Hawaii has not been included in this study but would have a major role in supplying energy to American Samoa and, if the U.S. Strategic Petroleum Reserve becomes the source of supply, to the Micronesian entities as well. In addition, the Federated States of Micronesia and the Republic of the Marshall Islands have to be included in any analysis of Guam because it serves as their supply point.

Finally, it should also be noted that the objective of this assessment is to serve as starting point for discussions and further analysis of the energy sector and the unique vulnerabilities of the U.S. Pacific islands. Further discussions will have to include island energy officials from the governments, the power utilities, and the energy industry as well as representatives from the private sector and the community at-large if major issues are to be satisfactorily resolved.

OVERVIEW OF THE ASSESSMENT

In describing Pacific island economies, the World Bank states that "their development is constrained by small domestic markets, a narrow resource and production base, high unit costs of infrastructure, heavy dependence on external trade, and vulnerability to external shocks and natural disasters."[2] These characteristics also apply to American Samoa, Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and Palau. In addition, the U.S. Pacific islands have unique economic, administrative, and historical links with the United States, which is literally thousands of miles away.

Within the context of their small size, limited resources, open economies, and vulnerability to natural disasters,[3] the U.S. Pacific islands have developed industries which reflect their comparative advantages, including tuna canning in American Samoa and tourism on Guam, in the CNMI and in Palau. However, dependence on tourism, tuna exports, federal programs, and imported manufactures and food does not reduce the vulnerability of the islands to global events. In fact, the very high level of dependence on imports, exports and tourism earnings increases vulnerability to global shocks. Thus, for example, the high economic growth rates enjoyed by Guam and the CNMI[4] over the last decade have resulted in both increased prosperity and higher standards of living as well as far greater vulnerability to recessions in the primary tourist market, Japan. The current economic downturn in Japan has led to a reduction in investment and visitor arrivals and a subsequent loss of government revenues to such an extent that a budget deficit has been forecast for Guam in 1993. However, there are no apparent alternatives to the development of industries which lead to further dependence on external markets and increased vulnerability to external shocks.

STRUCTURE OF THE ENERGY SECTOR

Similarly, the dominant characteristics of the energy sector in the U.S. Pacific islands are its small size and vulnerability to external events. The islands are totally dependent on imported petroleum for the production of electricity and for transport. By contrast, none of the 50 U.S. states are entirely dependent on petroleum for electricity generation. In addition, because of their isolation and small size, the U.S. Pacific islands cannot develop optimally sized power systems. Instead, there are numerous smaller generation facilities which increase security but also reduce efficiency and raise the price paid by consumers. The comparatively small market for petroleum imports means that the islands are "price takers"

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[2]World Bank, March 1993. *Pacific Island Economies: Toward Efficient and Sustainable Growth.* Report No. 11351-EAP, Volume 1. Washington, D.C. p. ix.

[3]Hurricane, tropical cyclone, and typhoon are synonyms for storms with wind speeds of at least 75 miles per hour. Hurricane is commonly used in the northern hemisphere, tropical cyclone in the southern hemisphere, and typhoon is used in areas bordering the China and Philippine Seas, which includes Guam, the CNMI, and Palau.

[4]Guam's total employment increased by 8 percent per year from 1984 to 1992. Gross domestic product is not measured on Guam. The CNMI economy experienced average annual growth rates of 24 percent (in current dollars) between 1980 and 1990.

and are vulnerable to price fluctuations in Singapore, the "swing supplier" in the Asia-Pacific region.

The source for petroleum imported to Guam, the CNMI, and Palau is Singapore. American Samoa is supplied via Hawaii. Guam consumes 18.6 thousand barrels of oil per day (MBD), while CNMI consumes 3.7 MBD, American Samoa 3.4 MBD and Palau 0.7 MBD. Electricity and transport subsectors are the largest end users of petroleum fuels. Guam and the CNMI burn fuel oil for power generation, while American Samoa and Palau use diesel. Because of tourism's important role, jet fuel is another major product import.

Demand for petroleum is anticipated to increase through the 1990s. For example, Guam expects electricity generation to increase by 7 percent per year, the CNMI forecasts growth in generation to exceed 10 percent per year, American Samoa projects annual growth at 3.5 percent, and Palau's power generation is expected to expand by 12 percent per year. The projections for increased electricity generation are similar to demand forecasts for imported petroleum products.

Opportunities to develop alternative energy resources are limited. There are no economic alternatives to imported petroleum for the production of baseload electricity. A small municipal solid waste-to-energy facility is being considered for Guam. A biogas tuna sludge-to-energy facility has been proposed for American Samoa. The use of solar water heating and street lights can be increased. However, geothermal, wind, hydro, and other biomass resources cannot be economically developed as a baseload power source. Ocean thermal energy conversion (OTEC) will not be ready for commercial application until after the year 2000. Coal could be utilized on Guam and Saipan, but costs for handling and storage would be considerable.

Energy Vulnerability

Dependence on imported petroleum also results in vulnerability to petroleum price increases. The combined effect of high growth in the demand for petroleum and moderately rising petroleum prices result in a year 2000 scenario in which the economies in the islands could be paralyzed by an oil price shock. This is the obvious consequence of vulnerability.

Although there is considerable petroleum storage capacity on Guam and in Palau and there is relatively adequate storage capacity in American Samoa and the CNMI, the oil companies supplying and operating the oil storage facilities are not required to furnish essential data or to maintain reasonable inventory levels. The oil companies apparently maintain adequate inventories but minimum volumes have not been specified except in American Samoa.[5]

In order to assess energy vulnerability, the three oil supply disruption scenarios listed below were considered for the islands. Minor supply disruptions appear to have limited

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[5]American Samoa requires 10 days inventory as a minimum. However, 10 days is far less than is maintained in other islands and is not adequate in the event of an oil supply disruption. It should also be noted that inventory fell to under five days when a tanker floundered en route from Hawaii.

impact on the islands. Supply disruptions centered in West Africa and Latin America do not seem to have any long-term effects. On the other hand, a major supply disruption centered in Asia and the Middle East would have major effects because of reduced oil flows to Singapore. The result would probably be at least a doubling in oil prices.

- Scenario I: Major disruption caused by major political turmoil affecting Middle Eastern and Asian producers with a net loss of 4.5 MMBD (9.0 MMBD production loss minus 4.5 MMBD drawdown of global strategic petroleum reserve).
- Scenario II: Medium-scale disruption caused by simultaneous upheaval in West African and Latin American producers with a net loss 4.5 MMBD (production loss of 6.0 MMBD minus SPR drawdown of 1.5 MMBD).
- Scenario III: Minor disruption based on limited upheaval in the Middle East with a loss of 2.0 MMBD (production loss of 4.3 MMBD minus production increase by other countries of 2.3 MMBD).

While an oil price shock would be traumatic, there would likely be even more severe aftereffects. A major oil supply disruption centered in Asia and the Middle East implies political upheaval. In this context, tourism declines because people would be unwilling to travel in the region, and the island economies suffer. Moreover, an oil price shock often leads to recession, which causes further declines in tourism and a continuing downward spiral for the island economies. Finally, the data indicate that the downward spiral lasts longer in the open island economies than in the much larger and more integrated U.S. mainland economy.

VULNERABILITY RESPONSE OPTIONS

Because of the islands' dependence on foreign oil supplies, a number of vulnerability response options were considered. All of the islands indicated a preference for on-island strategic petroleum reserves (SPR). However, given the costs required to develop and maintain on-island SPRs, or to increase commercial stocks, it would appear that a recent proposal which guarantees the islands access to the U.S. SPR warrants further consideration. However, this proposal would require coordination among the island governments and the oil companies as well as the establishment of mechanisms to deliver petroleum from the SPR to the islands, or more likely, to swap the SPR petroleum for products from other sources for delivery to the islands. As indicated, the use of alternative energy resources has limited potential. In order to develop appropriate response policies and mechanisms, it is essential that government energy offices and the utility companies from American Samoa, Guam, the CNMI, Palau, Hawaii, the Federated States of Micronesia, and the Marshall Islands initiate dialogue with the oil companies operating in the region. Although Hawaii, the Federated States of Micronesia and the Marshall Islands were not included in this study, these entities are part of the existing fuel supply network and would have to be considered in the event of an energy emergency. Hawaii could have a major role because of its location and because it has two refineries with nearly sufficient capacity (147.8 MBD) to meet current demand in all of the island entities (168.9 MBD).

The main conclusion of this assessment is that the energy sector in the islands requires considerable attention: data collection and analysis are lacking, planning is very limited, and management systems have not kept pace with growth. Federal funding for the

energy sector in the islands appears to have been substantial since 1976. The results of this support have not been encouraging. Funds allocated to a range of demonstration projects have not addressed basic problems.

It is critical that reviews of the islands' energy sector be initiated in the near future. Although assessments of vulnerability to an oil price shock which may occur once or twice in a decade and solar street lighting projects are useful allocations of funds, there are also other immediate needs. For example, energy officers and offices have not been established by legislative mandate and have not been supported by local revenues. More importantly, brownouts and blackouts occur all too often on several of the islands. These examples indicate the basic fact that the management of the islands' energy sector appear somewhat imbalanced between objectives, needs, resources (including funds), and what can be practically achieved. These problems are not unique to the energy sector or the U.S. Pacific islands: recent assessments of the energy sectors in the South Pacific island nations have indicated similar problems. The islands are small entities attempting to manage a sector which is highly vulnerable to economies of scale. The islands cannot achieve the economies of scale available to larger energy markets which means that management and planning structures must be well established if costs are to be minimized.

Thus, the energy sector and its component management, production and distribution systems require assessment. However, recommending a review of the energy sector is only a partial measure in the right direction. Concurrent and directly linked to a sectoral review is the need to institute an integrated resource planning process which will enable the islands to determine how their energy sector should develop. The review of the energy sector and the institution of the integrated resource planning process should be given the highest priority.

Two

THE ASIA-PACIFIC OIL MARKET AND THE PACIFIC ISLANDS

INTRODUCTION

The oil industry is global, based on very large economies of scale, and views the world as a single highly integrated market. In other words, the global oil industry is greater than the sum of its parts, and its parts are huge. It is within this context that the tiny demand for oil in the Pacific islands has to be analyzed. Excluding Hawaii, all (22 nations and territories) of the Pacific islands together consume only 62 thousand barrels per day compared to world production of nearly 65 million barrels per day (MMBD). Even with Hawaii, total consumption of petroleum products in the Pacific islands region is less than 210 thousand barrels per day, or 0.3 percent of total global demand. While the Pacific islands region covers roughly 10 percent of the earth's surface, it contains only 0.1 percent of the world's population. Thus, the demand for products from an industry which is highly sensitive to economies of scale is very small in a vast region: a marketing and logistical puzzle with very limited potential for high return on investments and yet high risk for the oil industry. Similarly, there are very few opportunities for the islands to reduce their costs for petroleum and their very high dependency on imported petroleum products. These characteristics of the islands combined with their limited resources have resulted in extreme vulnerability to oil supply disruptions.

The first section in this chapter describes key trends in global oil supply. The second section discusses current and projected petroleum prices. The third section considers production and demand of petroleum in the Asia-Pacific region. The fourth section briefly highlights issues in the broader Asia-Pacific energy market which affect the Pacific islands. The final section describes oil supply in the Pacific islands. Chapter 3 presents an overview of 1) the energy sector in the U.S. Pacific Islands, 2) the energy vulnerabilities of the U.S. Pacific islands, 3) some of the likely impacts which the islands could experience in the event of an oil supply disruption, and 4) selected response issues.

GLOBAL OIL SUPPLY

Table 2.1 shows proven global oil reserves and output per day by key producing countries and regions for 1991. Especially important is the fact that although the Asia-Pacific region is currently a major producing region with output at 6.9 MMBD, or 11 percent of total global production, it contains only 4 percent of proven reserves. This implies that the petroleum resource in the Asia-Pacific region will be exhausted in the not so distant future. When combined with the region's increasing demand (see below), it is clear that the Asia-Pacific region will become a major net importer. The potential sources for Asia-Pacific's petroleum imports is a key issue.

Table 2.1 Proven Oil Reserves and Oil Output, 1991

Country/ REGION	YEAR-END RESERVES (bil b) 1991	OIL & NGL OUTPUT (kb/d) 1991
Australia	1.62	584
Bangladesh	0.00	1
Brunei	1.35	162
China	20.86	2,799
India	6.10	718
Indonesia	6.60	1,690
Japan	0.06	15
Malaysia	3.00	660
Myanmar	0.05	12
New Zealand	0.21	55
Pakistan	0.20	67
PNG	0.20	0
Philippines	0.04	6
Taiwan	0.00	2
Thailand	0.15	45
Vietnam	0.50	80
ASIA-PACIFIC	**40.95**	**6,896**
Austria	0.08	24
Denmark	0.80	148
France	0.18	65
Germany	0.40	88
Greece	0.03	17
Italy	0.69	80
Netherlands	0.10	75
Norway	7.60	1,897
Spain	0.02	28
Turkey	0.50	82
UK	4.00	1,927
W. EUROPE	**14.41**	**4,431**
Albania	0.18	30
Bulgaria	0.01	6
Czechoslov.	0.02	2
Hungary	0.16	38
Poland	0.03	2
Romania	1.17	140
Yugoslavia	0.22	43
USSR/CIS	59.91	10,406
E. EUROPE	**61.69**	**10,667**

Country/ REGION	YEAR-END RESERVES (bil b) 1991	OIL & NGL OUTPUT (kb/d) 1991
UAE	98.10	2,605
Bahrain	0.10	38
Iran	92.85	3,288
Iraq	100.00	316
Israel	0.00	0
Jordan	0.02	0
Kuwait	96.50	153
Oman	4.30	717
Qatar	3.70	433
Saudi Arabia	260.30	8,723
Syria	1.70	475
Yemen	4.00	197
MIDEAST	**661.57**	**16,946**
Algeria	9.20	1,328
Angola	1.80	503
Benin	0.10	3
Cameroon	0.40	160
Congo	0.83	156
Egypt	4.50	922
Gabon	0.73	300
Ghana	0.00	0
Ivory Coast	0.10	11
Libya	22.80	1,541
Morocco	0.00	0
Nigeria	17.90	1,918
Sudan	0.30	0
Tunisia	1.70	108
Zaire	0.06	27
AFRICA	**60.42**	**6,977**
E. HEMIS.	**839.04**	**45,917**

Country/ REGION	YEAR-END RESERVES (bil b) 1991	OIL & NGL OUTPUT (kb/d) 1991
Argentina	1.60	492
Barbados	0.00	1
Bolivia	0.10	22
Brazil	2.80	645
Chile	0.30	18
Colombia	1.90	434
Cuba	0.10	18
Ecuador	1.60	289
Guatemala	0.04	4
Mexico	51.30	3,125
Peru	0.40	118
Suriname	0.03	4
Trinidad	0.50	146
Venezuela	59.10	2,468
S. AMERICA	**119.77**	**7,784**
Canada	7.90	1,968
US-PADD-I	0.08	30
US-PADD-II	1.69	744
US-PADD-III	10.72	3,352
US-PADD-IV	1.59	500
US-PADD-V	12.21	2,756
US NGLs/Other	7.70	1,645
(United States)	(33.99)	(9,028)
N. AMERICA	**41.89**	**10,996**
W. HEMIS.	**161.65**	**18,780**
WORLD	**1000.69**	**64,696**

Sources: World Oil, Oil and Gas Journal, Petroleum Intelligence Weekly, 20th Century Petroleum Statistics, US EIA, International Energy Agency

Figure 2.1 indicates the likely sources of petroleum for the Asia-Pacific region's increasing demand. The figure shows the oil reserves of 20 key oil-producing nations which accounted for 96 percent of proven crude oil reserves in 1991. The top five countries are OPEC members located on the Persian Gulf. Supply disruptions in the Persian Gulf have occurred during several political and military conflicts since 1973.

Figure 2.2 indicates leading crude producers which account for 92 percent of global production, and Figure 2.3 shows the estimated rates of depletion (reserves to production or R/P ratio) for the leading producers. Important here is that OPEC members and especially those in the Persian Gulf region will control an increasing share of the world's oil resources. Figure 2.4 more graphically illustrates this concentration. Some of these nations have developed strategies to limit current production so that they can produce for a longer period of time. For example, Kuwait plans on producing oil for the next 150 years.

Kuwait has also been a leader in developing investment strategies for its oil revenues, and has purchased thousands of retail outlets in Europe and other downstream facilities. These investment strategies are significant because they result in both increased revenues for Kuwait and also increased integration with the world economy. Thus, an action, such as a planned major oil price increase, which could lead to a global recession would also prove very expensive to some of the key oil producers, such as Kuwait, which have invested heavily in the world economy.

Figure 2.4 also shows that the amount of proven oil reserves has been increasing over time. However, the fact that proven reserves have been increasing does not mean that this trend should be extrapolated because it represents the results of improved exploration, resource identification techniques, and resource extraction technologies not unlimited oil resources. It should also be noted that some of the recent large discoveries, such as in Latin America, could have very high production costs.

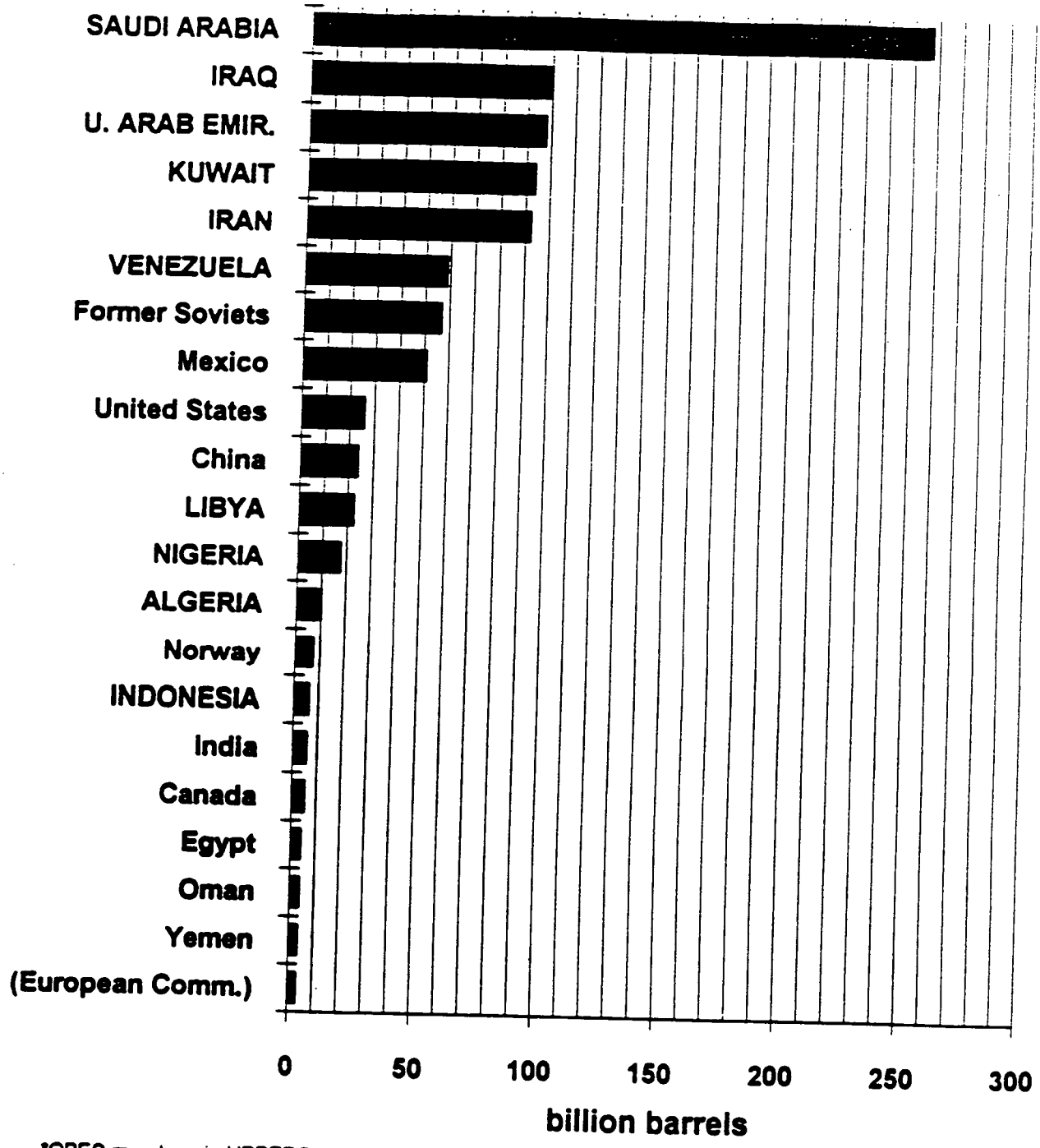
Figures 2.5 and 2.6 summarize global oil production by region since 1918. Global oil consumption rose sharply between World War II and 1979, aside from the levelling off and decline in demand following the 1973-1974 oil price increase and the subsequent global recession. After 1979, production and consumption fell, with 1992 levels still less than the peaks in the 1970s. However, it should be noted that the production increases over the last decade are largely due to increased demand in the Asia-Pacific region. This will be discussed in a later section.

Figure 2.6 also shows the changing dynamics of global oil supply and the declining role of North America in production. Although the Asia-Pacific region's share of production has increased, it is still small when one considers that it is now the second largest consuming region after North America and will become the largest consuming region around the turn of the century.

Oil Prices

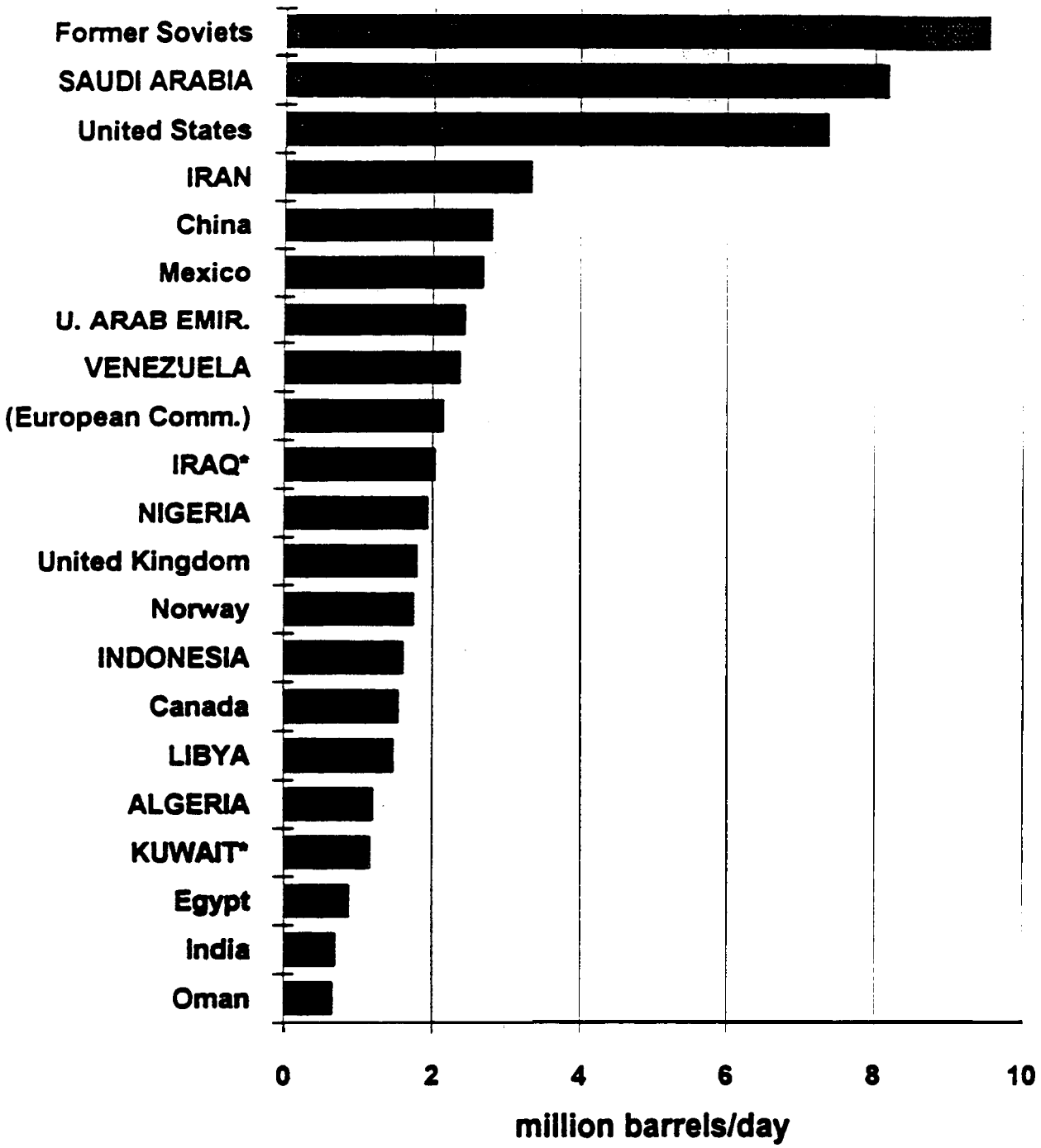
Prices have been major determinants in oil production and consumption. Figures 2.7 and 2.8 show current and real prices for Arab Light, and illustrate how the price of oil is pushed up by major political upheavals. However, the price spikes result in the production valleys shown in Figure 2.5. Increased oil prices have resulted in short-term cutbacks in

Figure 2.1 Top 20 Oil Reserves 1991



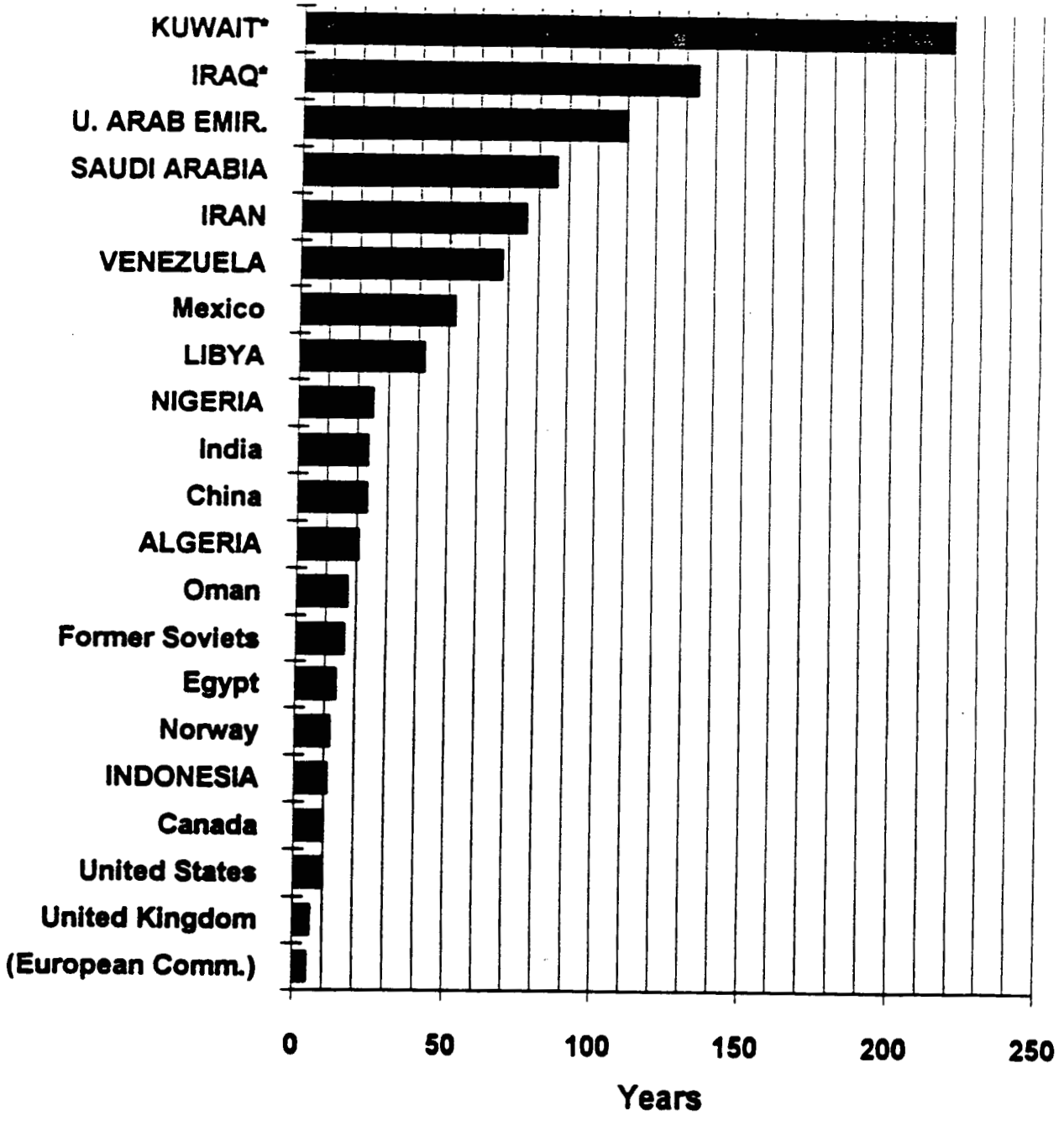
*OPEC members in UPPERCASE. OPEC accounts ofr 77% of reserves. Top 20 account for 96% of reserves. EC shown for comparison.

Figure 2.2 Top 20 Crude Producers 1991



*OPEC members shown in UPPERCASE. Kuwait and Iraq shown at prewar levels. OPEC accounts for 38% of world production. Top 20 countries account for 92 % of world production. EC shown for comparison only.

Figure 2.3 R/P Ratios of To[p 20 Oil Producers 1991



* OPEC members shown in UPPERCASE. Kuwait and Iraq shown at prewar levels.

Figure 2.4 Proven Oil Rserves 1960-1992

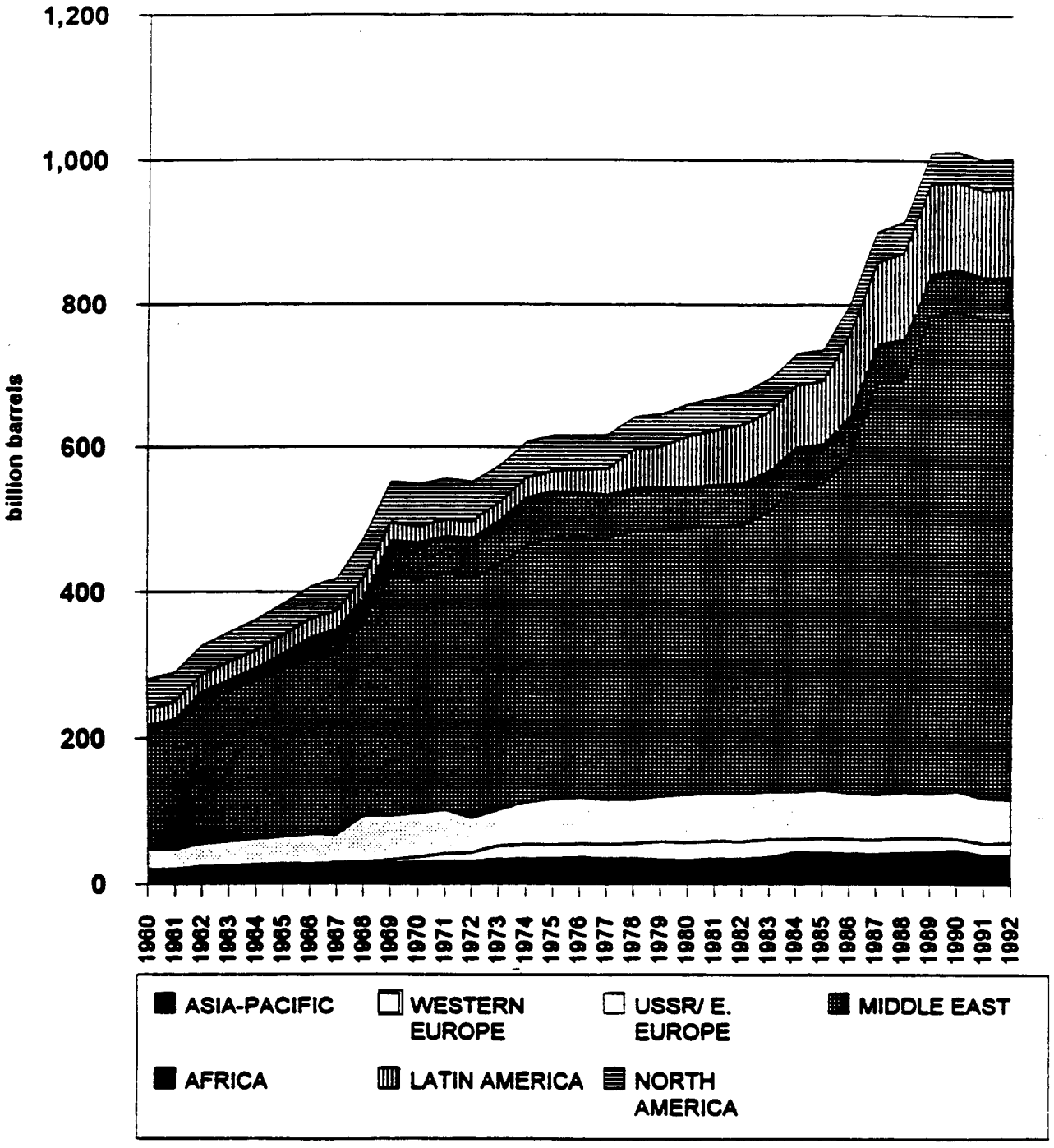


Figure 2.5 Regional Oil Production 1918-1992

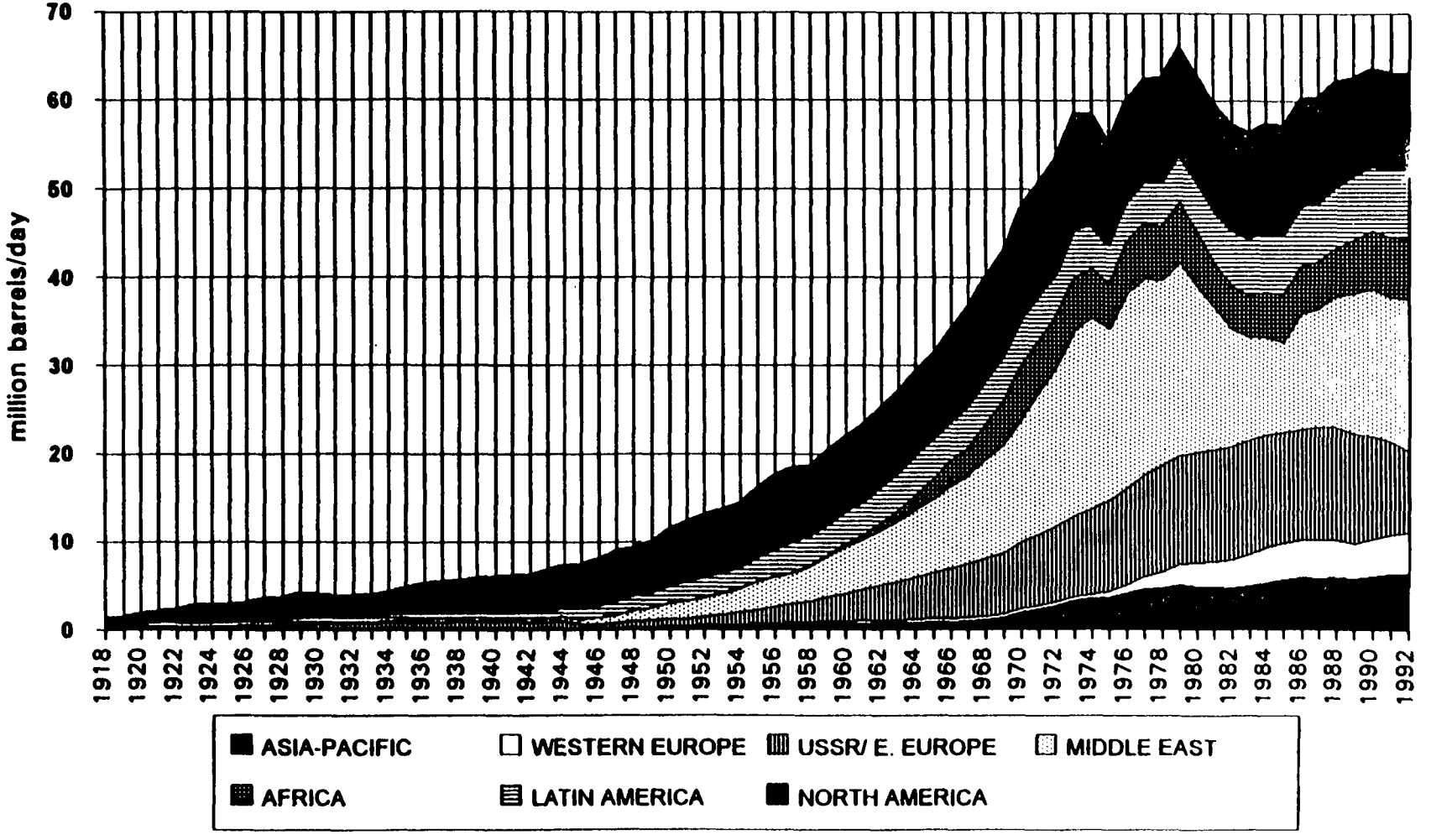


Figure 2.6 Regional Shares of Oil Output 1918-1992

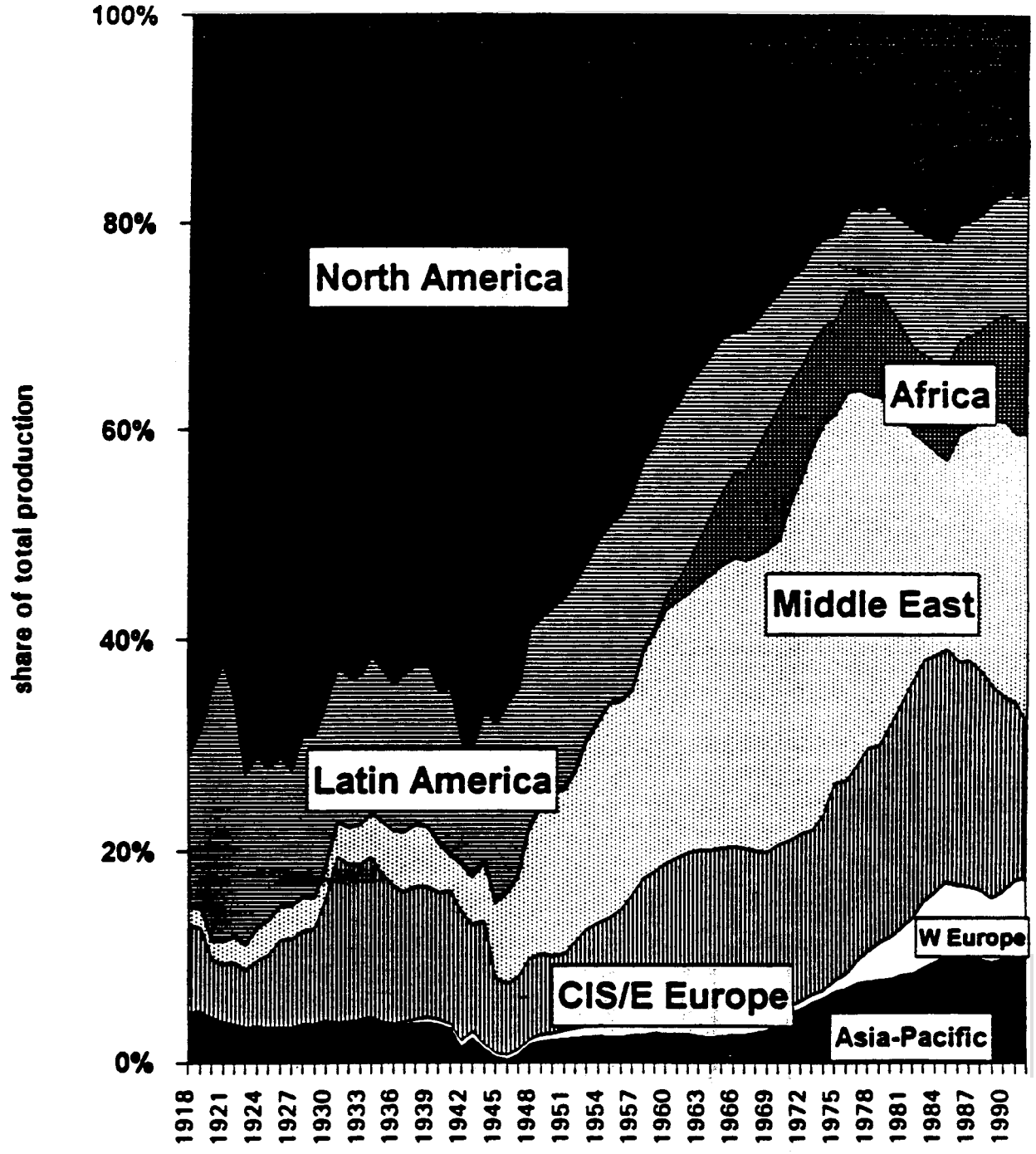
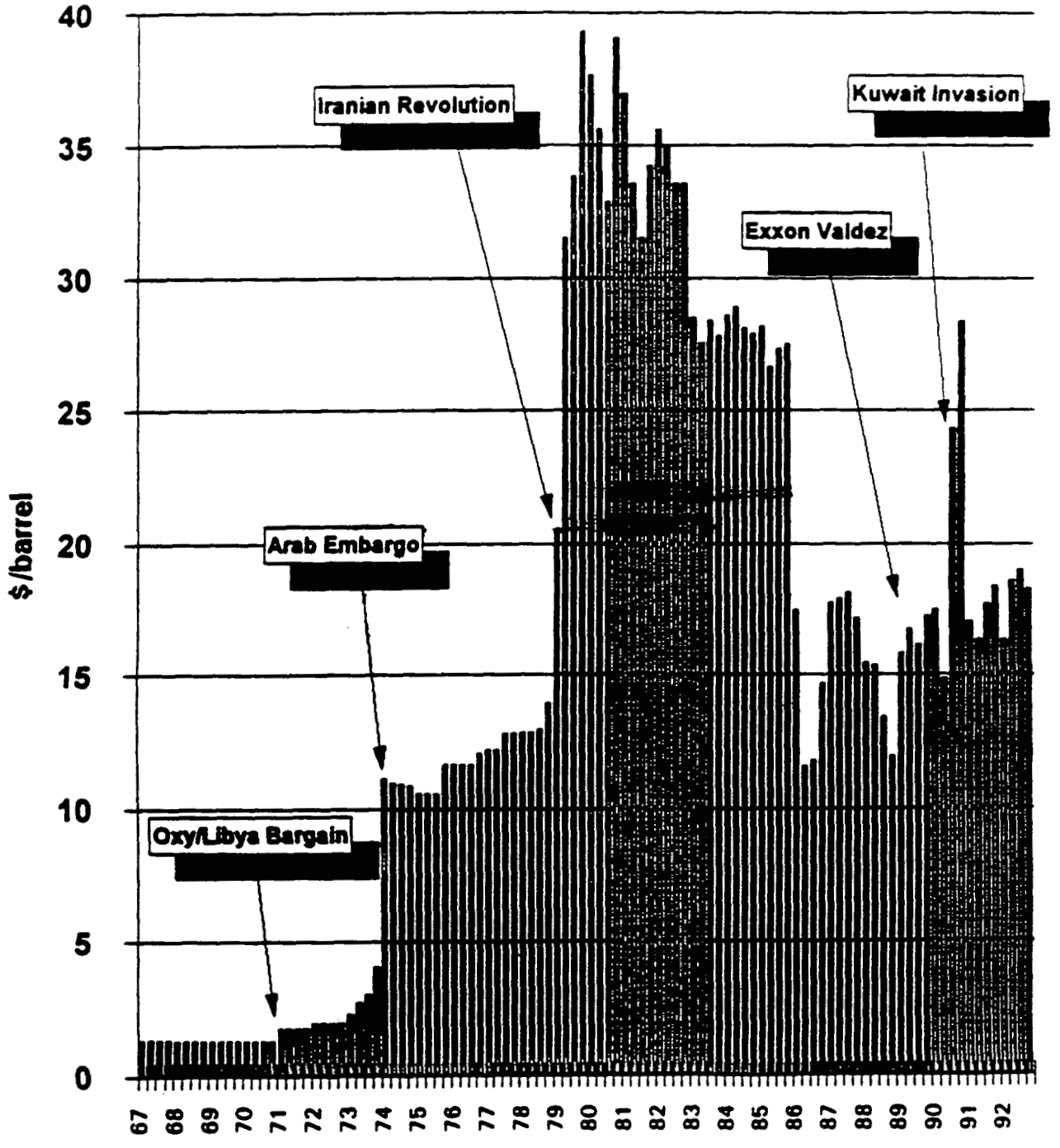
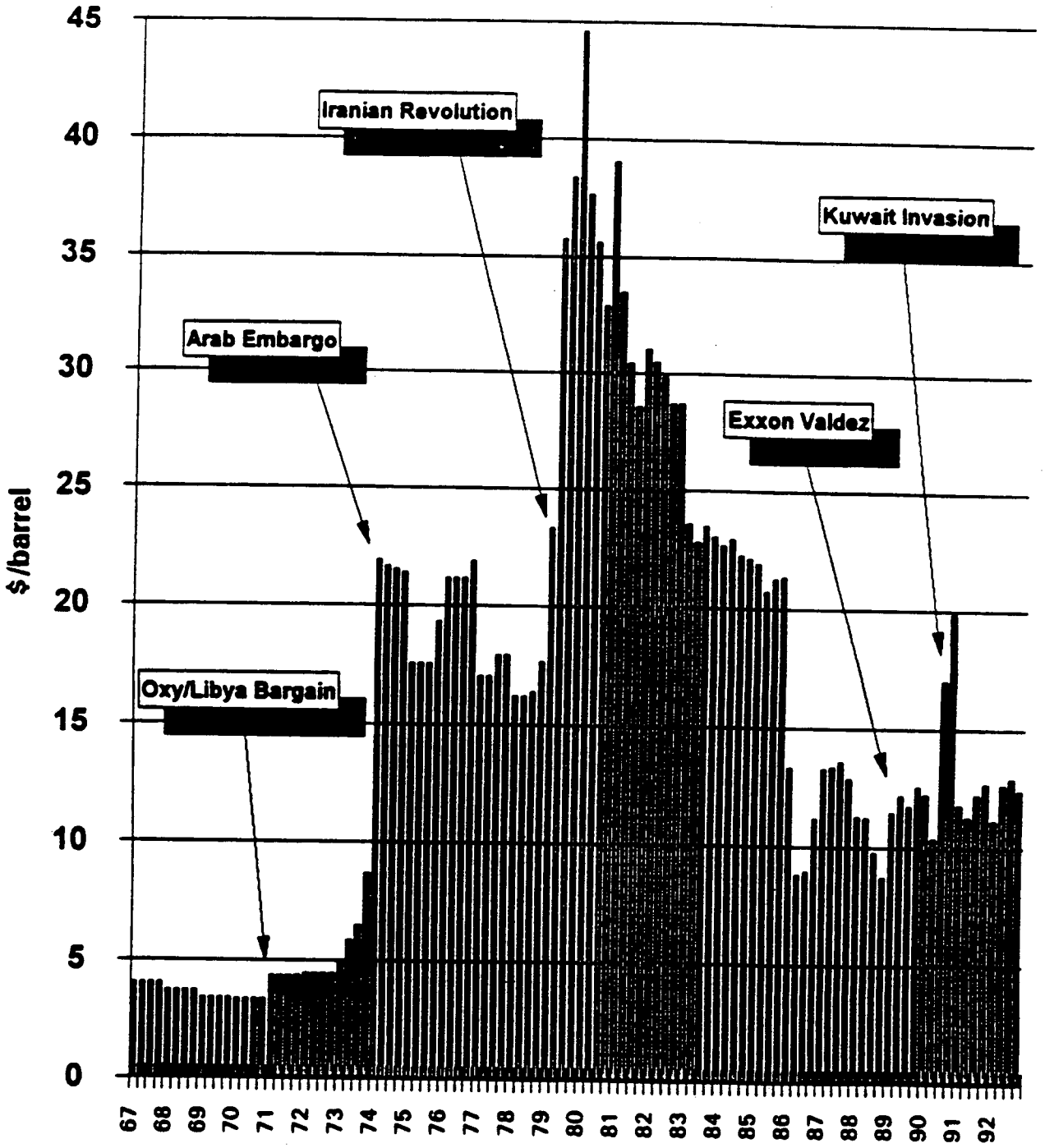


Figure 2.7 Market Prices of Marker Crude 1967-1992*



*Rotterdam Spot Arab Light, 1967-83; Dubai + $0.80, 1984-current

Figure 2.8 Real Prices of Arab Light Crude 1967-1992*



*Prices in 1980 inflation-adjusted dollars. Rotterdam Spot Arab Light, 1967-83; Dubai +$0.80, 1984-

demand, increased conservation, and played a key role in triggering the 1974-1976 and 1979-1982 recessions.

Table 2.2 indicates price forecasts for a range of products and benchmark crudes for the 1992-2000 period. The price forecasts indicate modest increases. However, certain crudes and products will experience greater increases. For example, because refining capacity in the Asia-Pacific region will be nearly fully utilized and demand for gasoline and jet fuel is rapidly increasing, prices for these products will increase more than for some other products. In addition, environmental legislation which limits sulfur emissions will force up the price of low-sulfur crudes while at the same time slowing the price increase for high-sulfur fuel oil (HSFO). These effects will be especiallynoticeable in the Asia-Pacific region because HSFO has been a major fuel for power generation.

While the forecasts indicate that price increases may be relatively modest over the 1990s, an oil price shock could still drive prices up steeply. Oil prices increased sharply twice during the 1970s, following political action taken by key producer nations. The first instance was the embargo against the United States by Arab producers in the aftermath of the 1973 Arab-Israeli war. The second political action was initiated by OPEC with the objective of raising oil prices. In the 1980s, prices jumped following the attacks on oil tankers in the Persian Gulf during the Iran-Iraq war. The 1990s began with an oil price rise following the Iraqi invasion of Kuwait.

Given the fact that there have been four major oil price shocks over the last 20 years, it could be assumed that there will be at least one more price shock between now and the year 2000. The price shocks which occurred in the 1970s were long-lasting and severe. Many nations developed strategies to cope with oil supply disruptions. These include the strategic petroleum reserves held by all OECD (Organization for Economic Cooperation and Development) nations. The later price shocks were much shorter in duration and more limited in scope: impacts were associated with one part of the world and supplies were then provided through increased production in other regions. This led to a fall in prices. In addition, as noted above, some of the key oil-exporting nations had developed global investment strategies which could be negatively effected by a prolonged oil price shock.

Thus, because of increased global integration and energy emergency strategies, an oil price shock during the 1990s is not likely to last as long as those which occurred during the 1970s. However, "likely" is the key word, and any number of localized conflicts have the potential to spill over into other regions and become much larger. Larger conflicts have the potential to seriously affect petroleum supplies and prices. These disruptions to the oil market could ultimately affect the Pacific islands.

Production and Demand in the Asia-Pacific Region

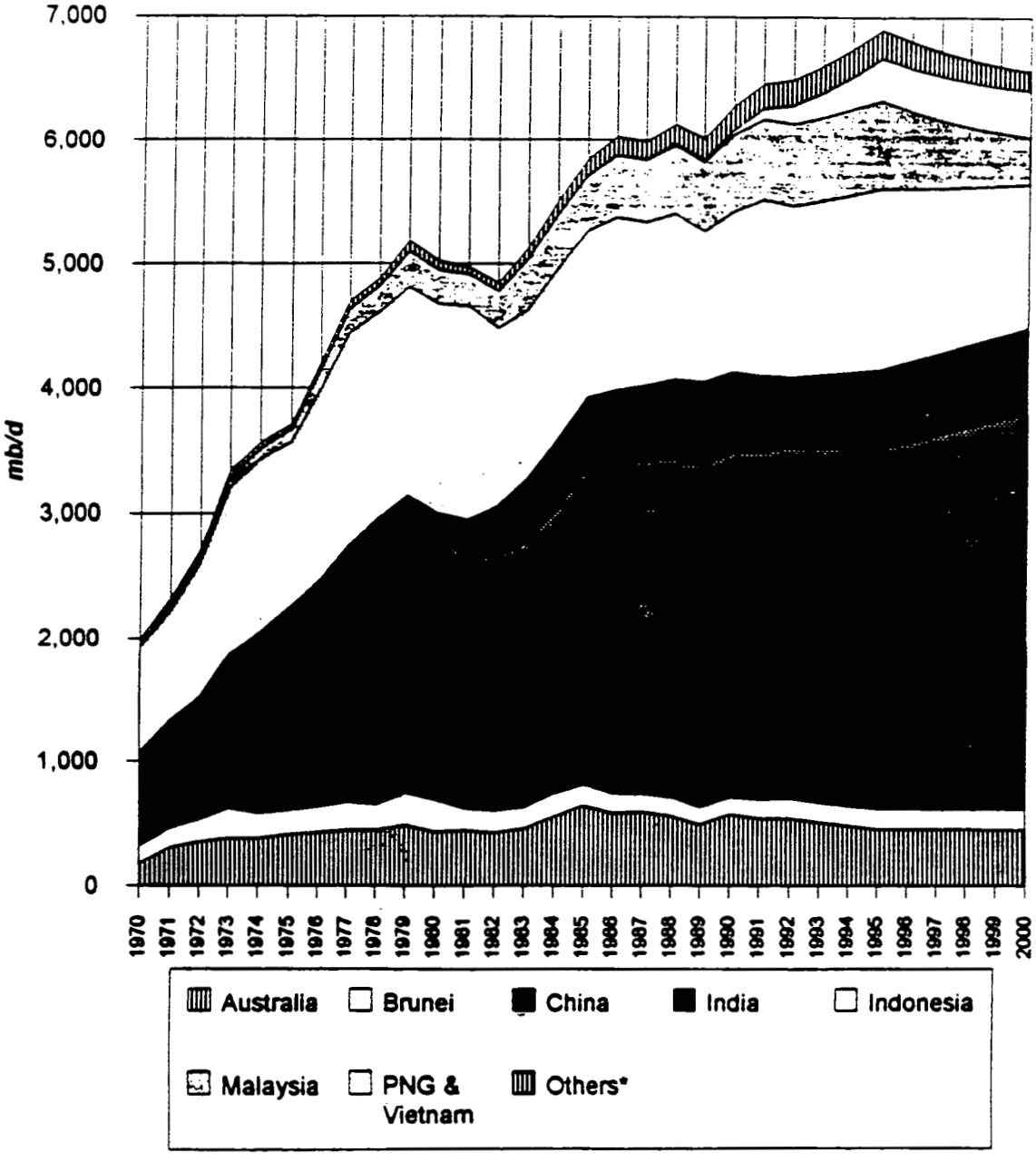
Figure 2.9 shows oil production in the Asia-Pacific region between 1970 and 2000. Even with the development of new fields in Vietnam, Papua New Guinea, China and Myanmar, forecasts indicate that overall production in Asia will begin to fall by the turn of the century. Figure 2.10 translates the impact of declining production and increasing demand on crude exports. If current trends continue, Australia, China and Indonesia, three of Asia's leading exporters, will stop exporting petroleum and a fourth exporter, Malaysia, will see its exports fall sharply.

Table 2.2 Crude and Petroleum Product Price Forecasts

(US$ per barrel in 1992 prices)

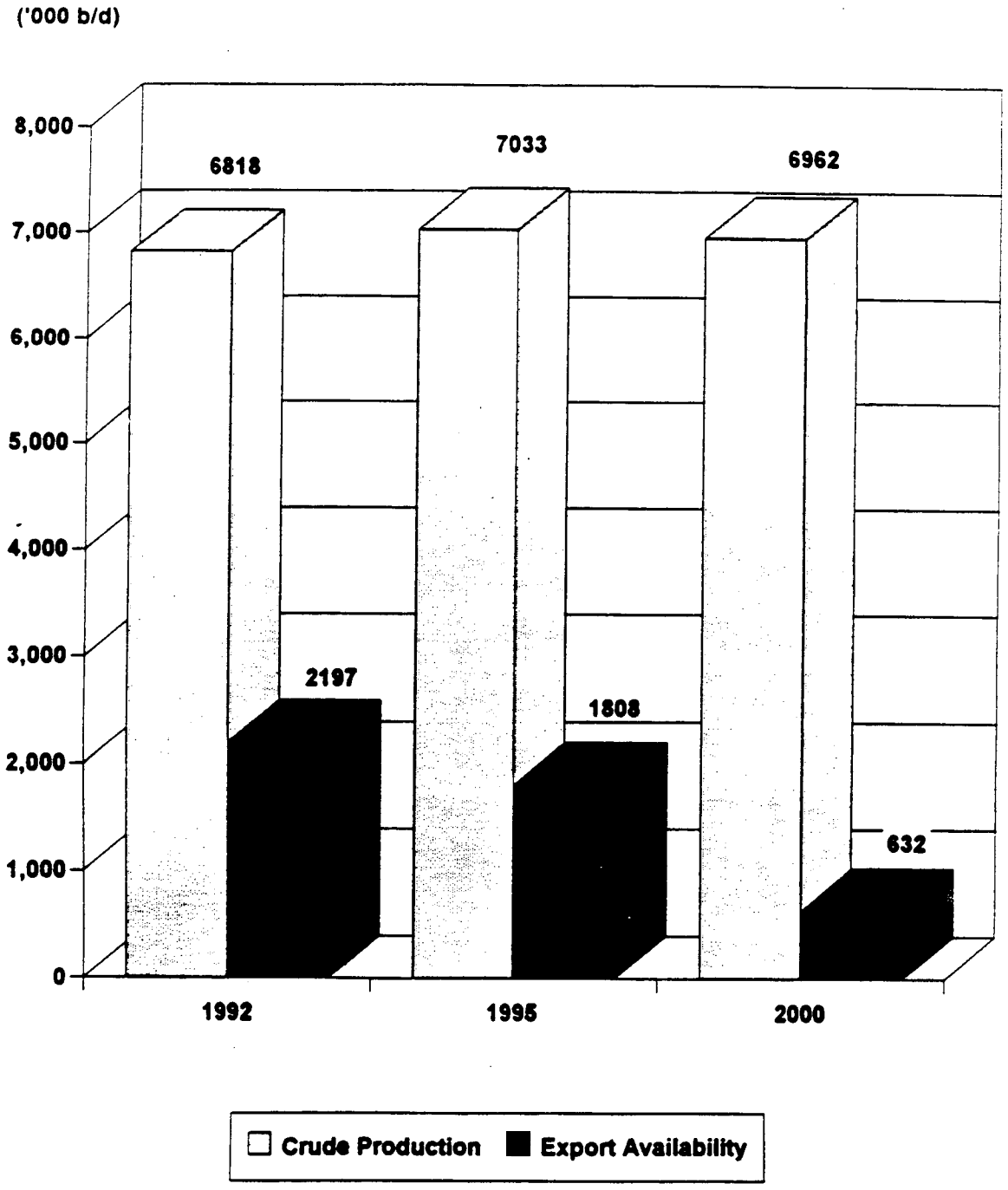
Base Case	1992	1995	2000
Arab Light	17.34	21.00	25.00
Arab Heavy	14.88	19.00	23.00
Minas	19.20	22.80	27.20
LPG	15.10	18.90	22.50
Naphtha	21.68	26.50	31.59
Mogas (92 RON unl)	26.89	30.90	35.39
Kerojet	25.41	30.20	35.00
Diesel	25.13	30.10	34.50
HSFO (380 CST)	13.05	16.50	20.00
LSWR	14.44	19.00	24.00
Low Case	**1992**	**1995**	**2000**
Arab Light	17.34	18.00	23.00
Arab Heavy	14.88	15.50	20.00
Minas	19.20	19.50	26.00
LPG	15.10	16.20	20.70
Naphtha	21.68	22.55	26.50
Mogas (92 RON unl)	26.89	26.58	30.00
Kerojet	25.41	26.68	31.20
Diesel	25.13	26.00	29.50
HSFO (380 CST)	13.05	14.00	16.80
LSWR	14.44	17.00	20.00
High Case	**1992**	**1995**	**2000**
Arab Light	17.34	28.00	33.00
Arab Heavy	14.88	26.50	32.00
Minas	19.20	31.00	36.00
LPG	15.10	25.20	29.70
Naphtha	21.68	32.98	38.82
Mogas (92 RON unl)	26.89	37.01	42.02
Kerojet	25.41	38.01	43.22
Diesel	25.13	36.61	42.02
HSFO (380 CST)	13.05	23.00	28.00
LSWR	14.44	25.50	31.00

Figure 2.9 Near-term Growth, Long-term Decline in Asian Oil Production



Bangladesh, Pakistan, Japan, Taiwan, Philippines, Myanmar, Thailand, and New Zealand

Figure 2.10 Asia-Pacific Crude Production and Export Availability 1992-2000



Tables 2.3 and 2.4 detail product demand for the Asia-Pacific region between 1991 and 2000. Figure 2.11 illustrates the key trend which is that the demand for petroleum products in the Asia-Pacific region will continue to rise. Important is that demand for diesel and gasoline will increase, and these are the products which are in the highest demand in the Pacific islands region. To the advantage of Guam and the CNMI, which use fuel oil for power generation, demand for fuel oil will increase only slightly during the decade. Increased demand for fuel oil will be limited because of environmental regulations affecting its use.

As shown in Table 2.4 and Figure 2.11, demand for petroleum products is increasing in the Asia-Pacific region. In fact, demand in the rest of the world is anticipated to be relatively flat between 1993 and 2000 because of increased energy efficiencies and the enforcement of "cleaner" energy environmental legislation. The Asia-Pacific region already consumes more petroleum products than Europe, and by the end of the century the region will surpass North America and become the largest consuming region in the world.

Especially significant is the fact that demand in the Pacific islands region—even including Hawaii's consumption of 140 MBD—is just over 200 MBD compared to regional demand of more than 13,100 MBD. Even if consumption doubles in the islands region by 2000, and consumption estimates indicate that 325 to 350 MBD is more realistic, demand in the islands region will be dwarfed by demand for nearly 19,000 MBD in the Asia-Pacific region. The needs of the very small Pacific islands market can be easily accommodated in the very large Asia-Pacific market.

The combined effect of increasing oil demand and declining production is increasing oil import dependence. Figure 2.12 shows increasing oil import dependence in relation to oil demand and import requirements for the Asia-Pacific region to the year 2000. Figure 2.13 more graphically shows oil import dependence for the region. In 1992, 50 percent of Asia-Pacific's oil demand was supplied by imports, of which 70 percent was supplied from the Persian Gulf region. By 1995, imported petroleum will supply 57 percent of Asia-Pacific's demand, which will increase to 64 percent in the year 2000. The Persian Gulf region will supply over 90 percent of Asia-Pacific's petroleum imports in the year 2000. Petroleum imports are projected to continue to increase after the turn of the century.

The high growth in demand for oil in the Asia-Pacific region is led by demand for light and middle distillates. Returning to Figure 2.11, diesel, gasoline, and kerosene/jet fuel will increase their shares in the demand barrel. Additions to refining capacity in the Asia-Pacific region have not kept pace with demand. Singapore's refineries have been operating at capacity utilization rates of more than 90 percent, and product imports are rapidly increasing, with a large share being supplied from the Persian Gulf.

Table 2.3 Asia-Pacific Petroleum Demand Outlook 1990-2000 (000 b/d)

('000 b/d)

Country	Year	Others	Fuel Oil	Diesel	Kero/Jet	Naphtha	Gasoline	LPG	Total
Australia	1990	39.7	37.9	174.4	59.3	0.3	294.4	60.8	666.8
	1991	34.0	35.9	170.5	62.7	0.5	290.5	53.5	647.6
	1992	36.1	36.3	175.2	64.9	0.7	295.0	60.7	668.9
	1995	38.4	35.8	193.4	73.9	0.7	310.0	66.0	718.0
	2000	40.6	35.3	222.8	89.2	0.8	333.0	74.9	796.6
Brunei	1990	0.2	0.0	1.4	0.6	0.0	3.7	1.5	7.4
	1991	0.2	0.0	1.2	0.6	0.0	3.8	1.6	7.4
	1992	0.2	0.0	1.0	0.5	0.0	3.8	1.8	7.4
	1995	0.3	0.0	0.7	0.4	0.0	3.9	2.3	7.6
	2000	0.3	0.0	0.5	0.6	0.0	4.5	3.0	8.9
China	1990	132.7	623.5/b	618.7/c	72.7	57.1	454.7	84.0	2,043.4
	1991	133.9	614.6/b	710.4/c	79.3	72.7	514.7	97.9	2,223.5
	1992	147.5	647.4/b	801.3/c	83.9	82.9	562.2	106.8	2,432.0
	1995	138.0	721.4/b	946.4/c	85.0	129.6	701.0	129.0	2,850.4
	2000	190.0	824.0/b	1,342.5/c	99.0	189.5	1,030.0	189.0	3,864.0
India	1990	63.0	166.0	418.0	212.0	90.0	76.0	70.0	1,095.0
	1991	102.3	166.1	431.7	215.0	85.0	85.0	77.9	1,163.0
	1992	113.2	174.6	453.7	220.6	91.8	89.6	81.3	1,224.9
	1995	147.0	191.1	555.8	254.9	126.8	107.8	110.8	1,494.2
	2000	183.8	206.2	660.1	287.8	167.2	126.0	144.3	1,775.3
Indonesia	1990	21.6	72.7	233.2	153.4	12.3	109.6	6.8	609.6
	1991	20.0	87.0	255.8	159.5	15.6	118.3	7.7	663.9
	1992	21.0	87.0	276.0	168.0	18.0	127.2	8.0	705.2
	1995	29.0	82.0	382.0	190.0	36.0	149.0	10.0	878.0
	2000	35.0	65.0	541.0	231.0	45.0	195.0	14.0	1,126.0
Japan	1990	151.0	1,275.0/d	1,102.0	517.0	536.0	766.0	587.0	4,934.0
	1991	146.0	1,225.0/d	1,155.0	532.0	561.0	789.0	607.0	5,015.0
	1992	143.0	1,228.0/d	1,173.0	550.0	603.0	807.0	618.0	5,122.0
	1995	150.0	1,162.0/d	1,323.0	615.0	590.0	870.0	650.0	5,360.0
	2000	150.0	1,029.0/d	1,512.0	663.0	582.0	949.0	710.0	5,595.0
Malaysia	1990	7.0	56.0	72.0	17.0	0.0	57.0	14.0	223.0
	1991	5.4	56.0	75.0	18.0	0.0	69.0	14.2	237.6
	1992	6.2	49.4	78.7	18.5	0.0	74.5	16.3	243.7
	1995	9.4	34.0	91.0	20.0	0.0	94.0	24.7	273.1
	2000	12.0	9.0	116.0	23.0	15.0	98.0	41.0	314.0
New Zealand	1990	3.2	7.2	22.7	15.8	0.0	45.6	4.0	98.5
	1991	6.4	6.2	23.6	13.7	0.0	44.7	4.0	98.5
	1992	3.9	8.5	24.3	15.1	0.0	45.3	3.2	100.3
	1995	4.4	5.5	26.2	17.6	0.0	48.5	3.8	106.1
	2000	4.8	5.5	28.2	22.0	0.0	53.1	3.8	117.5
Philippines	1990	0.8	85.6	71.5	20.9	0.7	35.3	12.6	227.4
	1991	0.9	82.0	81.2	20.5	0.5	30.3	13.0	228.4
	1992	0.9	98.7	100.2	25.2	0.6	36.3	14.7	276.6
	1995	1.0	103.3	89.3	27.5	0.6	38.7	18.7	279.1
	2000	1.1	123.5	111.0	34.7	0.7	47.7	25.4	344.1
Singapore	1990	3.0	233.0	46.0	36.0	22.0	12.0	11.0	363.0
	1991	2.9	259.2	41.2	38.5	20.9	11.4	10.5	384.6
	1992	3.1	257.1	44.5	40.0	22.8	12.1	11.0	390.6
	1995	3.6	251.0	56.0	44.9	29.4	14.6	12.6	412.1
	2000	4.0	265.0	66.0	53.0	37.0	17.0	14.0	456.0

Table 2.3 Asia-Pacific Petroleum Demand Outlook 1990-2000 (000 b/d)

('000 b/d)

Country	Year	Others	Fuel Oil	Diesel	Kero/Jet	Naphtha	Gasoline	LPG	Total
South Korea	1990	16.6	295.5	266.3	108.5	130.0	64.9	97.8	979.5
	1991	20.2	386.2	320.6	116.8	179.9	78.7	118.2	1,220.6
	1992	25.4	408.9	383.8	146.8	259.1	95.3	150.4	1,469.7
	1995	31.4	450.2	485.3	185.3	316.6	150.9	184.9	1,804.6
	2000	39.9	456.3	618.6	223.4	323.3	205.2	180.2	2,046.9
Taiwan	1990	100.0	222.0	80.0	18.0	60.0	94.0	40.0	614.0
	1991	88.0	233.0	86.0	20.0	65.0	102.0	39.0	633.0
	1992	95.0	233.0	85.0	25.0	65.0	107.0	42.0	652.0
	1995	103.0	245.0	94.0	23.0	100.0	120.0	49.0	734.0
	2000	110.0	222.0	95.0	26.0	151.0	135.0	54.0	793.0
Thailand	1990	9.9	88.8	169.0	39.0	0.0	64.0	31.0	401.7
	1991	10.3	104.4	169.0	43.0	3.9	63.1	37.0	430.7
	1992	12.1	121.8	182.0	50.0	4.7	70.3	37.0	477.9
	1995	14.6	196.2	271.2	65.0	28.8	95.5	42.9	714.2
	2000	18.3	216.2	385.9	91.4	44.2	133.9	62.1	952.0
Vietnam	1990	16.0/e	12.5	12.7	4.6	0.0	6.9	0.3	53.0
	1991	20.0/e	13.5	20.0	4.6	0.0	7.5	0.4	66.0
	1992	20.0/e	14.9	35.0	5.7	0.0	8.6	0.4	84.7
	1995	20.8/e	20.1	39.0	11.2	0.0	12.7	0.6	104.4
	2000	20.2/e	24.1	52.1	13.1	0.0	20.5	1.2	131.3
Other Asia /f	1990	9.7	125.0	206.0	114.0	8.8	84.0	12.0	559.5
	1991	10.0	130.0	218.0	118.0	9.5	90.0	13.0	588.5
	1992	10.6	133.3	230.0	123.9	10.0	95.0	13.6	616.3
	1995	12.4	143.5	270.1	143.4	11.8	111.5	15.7	708.4
	2000	14.0	157.7	313.1	166.3	13.3	129.3	18.8	812.4
Total	1990	574.4	3,300.7	3,493.9	1,388.8	917.2	2,168.1	1,032.8	12,875.8
	1991	600.5	3,399.1	3,759.2	1,442.2	1,014.5	2,298.0	1,094.9	13,608.3
	1992	638.1	3,498.9	4,043.7	1,538.2	1,158.6	2,429.3	1,165.2	14,472.0
	1995	703.2	3,641.2	4,823.3	1,757.1	1,370.3	2,828.1	1,321.0	16,444.2
	2000	824.0	3,638.8	6,064.8	2,023.6	1,569.0	3,477.2	1,535.6	19,133.0
AAGR	1990-91	4.5%	3.0%	7.6%	3.8%	10.6%	6.0%	6.0%	5.7%
AAGR	1991-92	6.3%	2.9%	7.6%	6.7%	14.2%	5.7%	6.4%	6.3%
AAGR	1992-95	3.3%	1.3%	6.1%	4.5%	5.8%	5.2%	4.3%	4.4%
AAGR	1990-00	3.7%	1.0%	5.7%	3.8%	5.5%	4.8%	4.0%	4.0%
AAGR	1995-00	3.2%	0.0%	4.7%	2.9%	2.7%	4.2%	3.1%	3.1%

a. 1990-1991 are actual demand.
b. Includes direct burning of crude oil for electricity generation.
c. Includes gasoil-range chemical feedstock.
d. Includes direct burning of crude and NGL for electricity generation.
e. Includes estimated Vietnamese military demand for oil products.
f. Afghanistan, Bangladesh, Bhutan, Cambodia, Hong Kong, Laos, Maldives, Mongolia, Macao, Myanmar, Nepal, North Korea, Pakistan and Sri Lanka, plus Pacific Islands.

Table 2.4 Asia-Pacific Petroleum Product Balances 1991-2000 (000 b/d)

1991	Production	Imports /a	Exports /a	Demand
LPG	514	615	52	1,095
Gasoline	2,233	249	184	2,298
Naphtha	808	432	190	1,014
Kero /Jet	1,438	279	310	1,442
Diesel	3,592	616	457	3,759
Fuel Oil /b	2,795	691	611	2,891
Others	598	82	75	600
Total	**11,979**	**2,964**	**1,880**	**13,100**
Transp. Fuels	7,263	1,144	952	7,499

a. Intra-region trade is included.
b. Excludes direct burning of crude oil in China and Japan

1995	Production	Imports	Exports	Demand
LPG	1,219	491	389	1,321
Naphtha	1,068	493	110	1,451
Gasoline	2,873	146	191	2,828
Kero /Jet	1,775	185	203	1,757
Diesel	3,944	1,103	224	4,823
Fuel Oil	3,377	320	423	3,274
Other	499	277	47	648
TOTAL	**14,753**	**3,016**	**1,586**	**16,102**
Transp. Fuels	6,786	1,781	536	8,031

2000	Production	Imports	Exports	Demand
LPG	1,358	540	363	1,536
Naphtha	1,032	724	78	1,678
Gasoline	3,560	153	235	3,477
Kero /Jet	2,048	158	182	2,024
Diesel	4,819	1,509	263	6,065
Fuel Oil	3,636	232	513	3,355
Other	580	188	53	715
TOTAL	**17,033**	**3,504**	**1,687**	**18,850**
Transp. Fuels	7,899	2,391	523	9,767

Figure 2.11 The Oil Demand Boom Continues in Asia

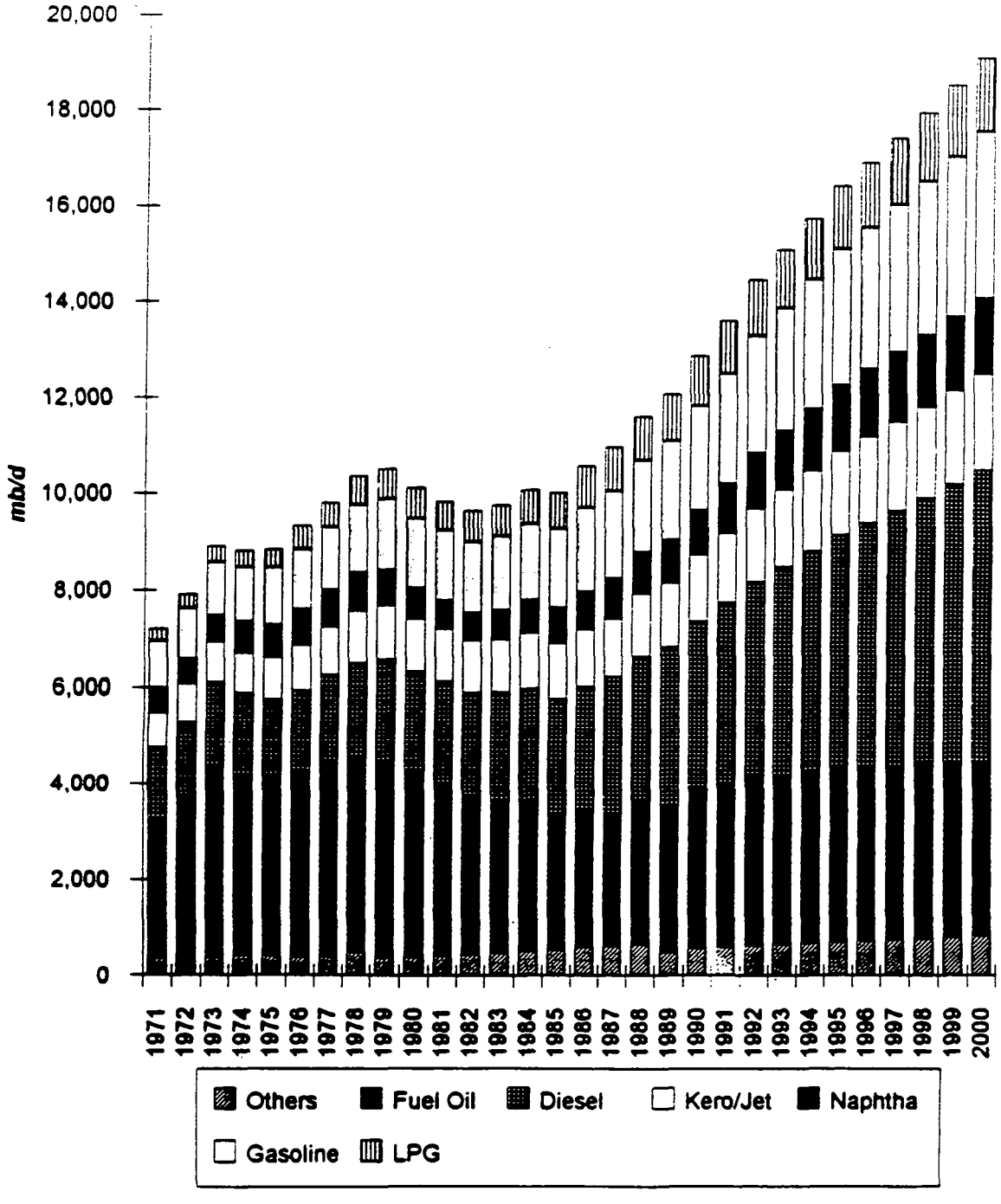
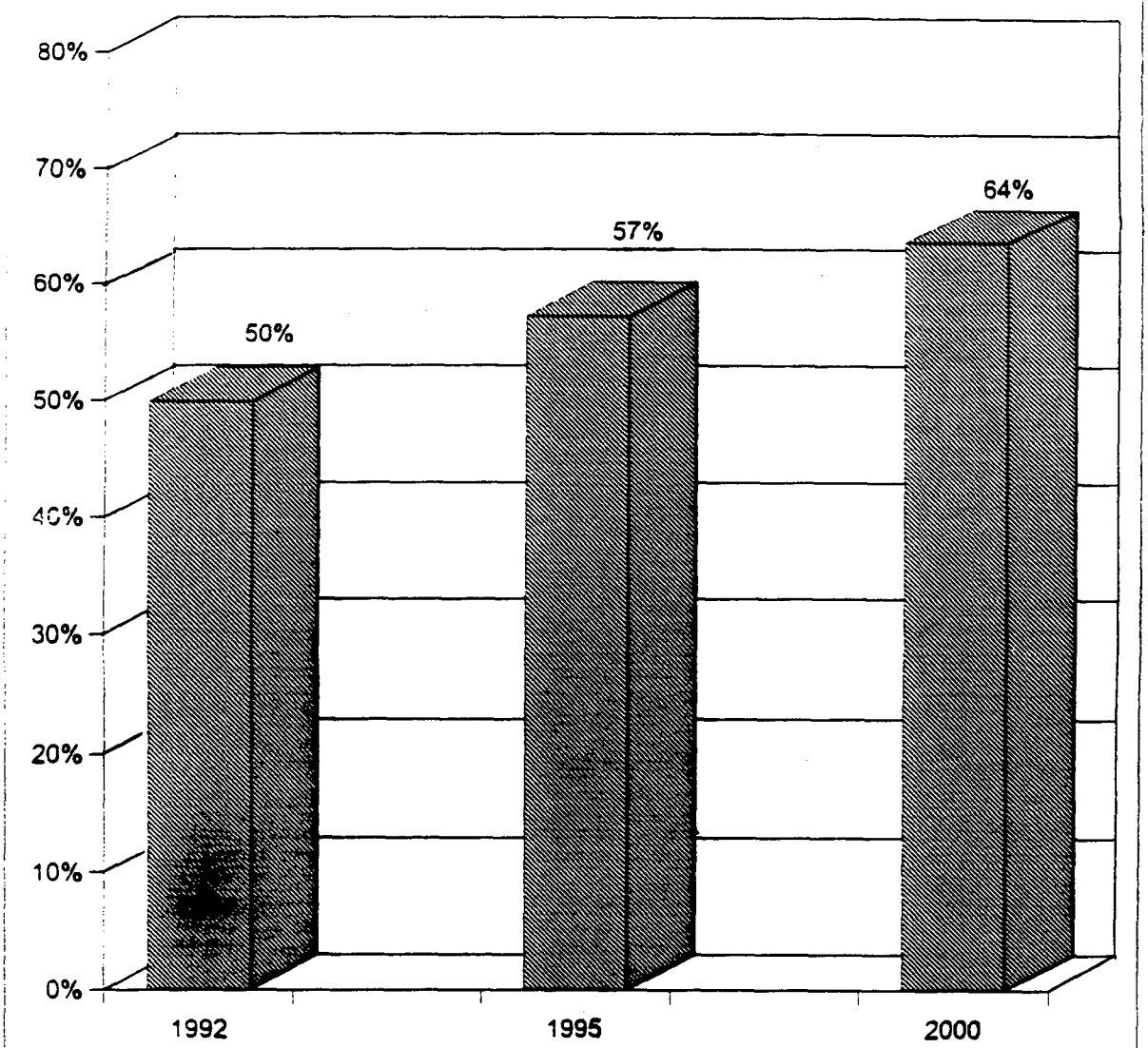
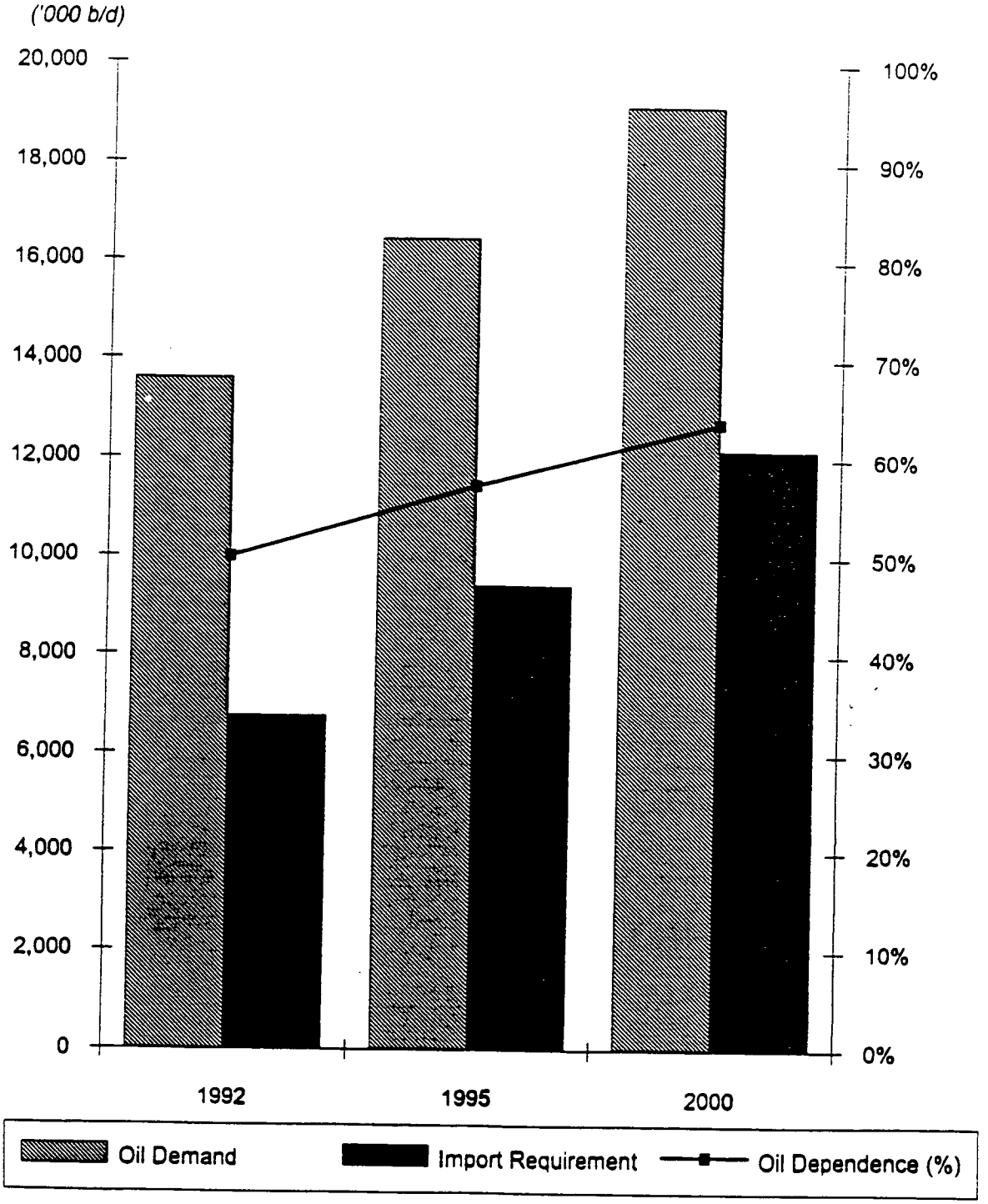


Figure 2.12 Asia-Pacific Oil Import Dependence, 1992-2000



Note: Oil import dependence rate is the share of import requirements in total oil demand.

Figure 2.13 Asia-Pacific Oil Demand Import Requirements and Dependence, 1992-2000



Note: Oil import dependence refers to the share of import requirements in total oil demand.

Following the Iraqi invasion of Kuwait in 1990, prices for crude and petroleum product prices quickly increased. One driving force behind the price escalation was reactive: whether caused by a fear that a long shortage of petroleum supplies might result or by commodity price speculation, prices were pushed upwards. A second driving force behind the price rises was the realization that crude and more importantly refined products from Kuwait and Iraq would not be available to Asia-Pacific markets. While crude could be supplied by increased production in other regions, the loss of refined products had major impact on rising prices. However, the loss of Persian Gulf refined products explains only one part of the equation behind the product price increases. The third factor in the price rise was the very high demand for jet fuel and diesel by the U.S. and allied military forces in anticipation of a war with Iraq, which greatly exacerbated the shortfall in refined products. It should be noted that prices stabilized within a relatively brief period.

However, the key issue in the Asia-Pacific region is that dependence on product imports will increase. This could increase vulnerability to price shocks but at minimum means that events outside the region could have a greater impact on local economies.

Another region which has to be considered in an analysis of the islands region is the U.S. West Coast, or PADD-V (U.S. Petroleum Administration Defense District 5). The U.S. West Coast region includes Hawaii, from which petroleum products are supplied to American Samoa. With crude production of roughly 2,700 MBD, the U.S. West Coast is one of the world's larger oil-producing regions and certainly a key region for the U.S. As Figure 2.14 shows, crude production has been falling and is expected to continue declining as fields in California and Alaska are exhausted. This will result in increased imports and reduced exports. However, refinery production has increased, reflecting the continuing demand for petroleum products in the western United States. Table 2.5 lists sources of crude and products for the region. Asia-Pacific crudes dominate imports, but products are delivered from a number of sources. As shown in Figure 2.10, the Asia-Pacific region will become less able to export crude over the decade because of internal demand growth. This means that alternative sources of supply will have to be developed.

THE ASIA-PACIFIC MARKET AS A CONTEXT FOR THE PACIFIC ISLANDS

The following is a brief overview of key issues and trends which will affect both supply and prices for petroleum products in the Pacific islands. Considerably more information is available on petroleum resources, production, processing and demand. The key issues for the islands include the following:

- The Pacific islands are a very small energy market between the world's two largest oil consuming markets, North America and the Asia-Pacific region.
- Proximity to large markets means proximity to sophisticated supply and distribution networks.
- Thus, considerable petroleum supplies and the means to move them will be nearby.
- Production in the Asia-Pacific region will decline while demand will rise sharply.
- The Asia-Pacific region will become increasingly dependent on petroleum imports. As Figure 2.12 shows, Asia-Pacific dependence on oil imports will increase from 55 percent in 1992 to 64 percent in 2000.
- The major source for supplies to meet increasing demand in the Asia-Pacific region will be the Middle East, which currently supplies approximately 70 percent of the

Figure 2.14 U.S. West Coast Crude Runs are Catching Up with Local Crude Production

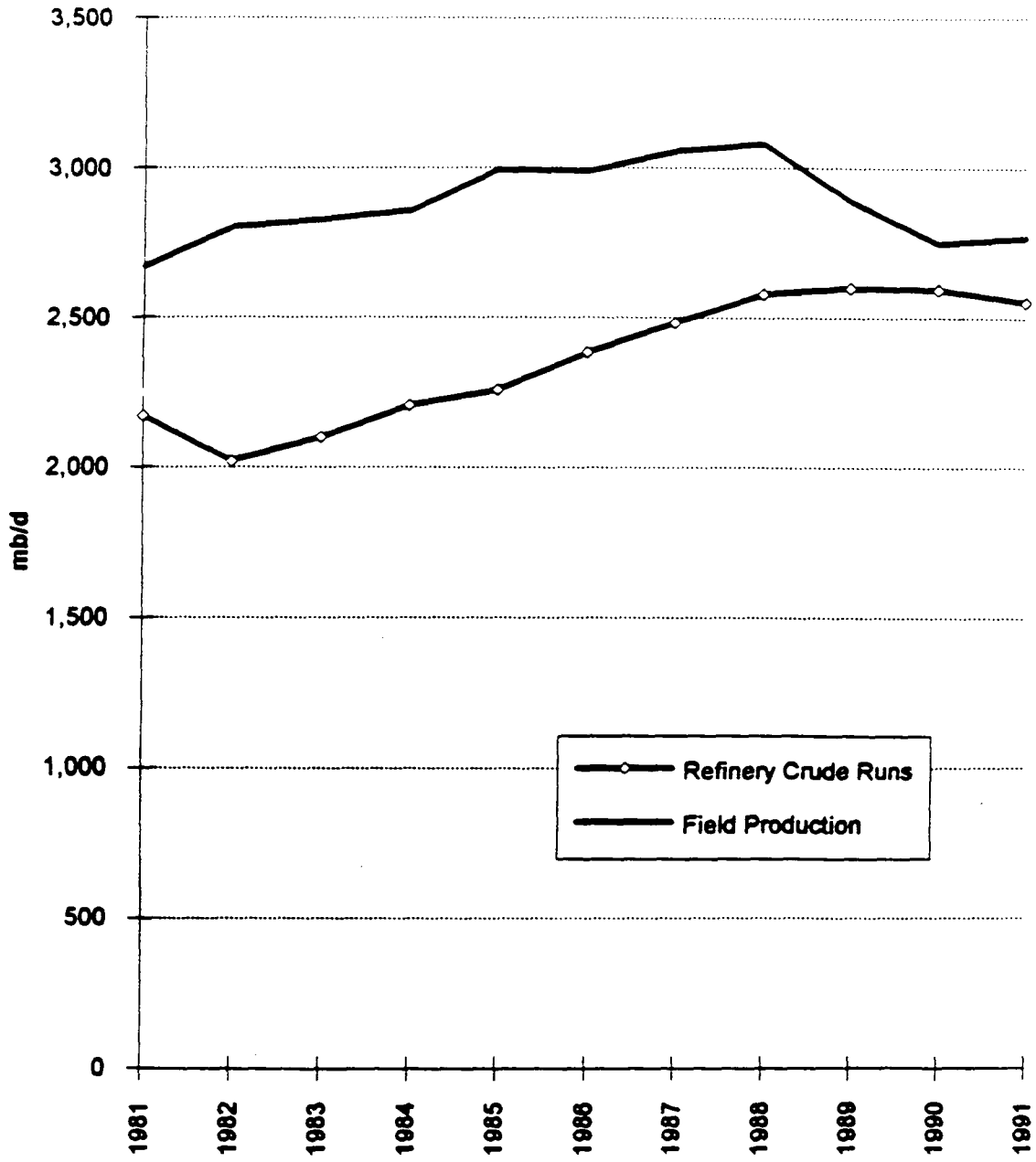


Table 2.5 PADD-V Imports of Crude Oil and Petroleum Products by Country/Region of Origin 1991

(000 barrels)

Country of Origin	Crude Oil	LPG	Unfinished Oils	GBC	Mogas	Jet Fuel	Diesel	Fuel Oil	Naptha & Feedstock	Road Oil	Other	Total	Total Products	% of Crude	% of Products
Asia-Pacific	**42,404**	**0**	**614**	**0**	**1,262**	**0**	**85**	**2,963**	**270**	**0**	**0**	**47,598**	**5,194**	**69.1%**	**26.1%**
Australia	6,436	0	0	0	0	0	0	53	0	0	0	6,489	53	10.5%	0.3%
Brunei	671	0	0	0	0	0	0	0	0	0	0	671	0	1.1%	0.0%
China	2,079	0	0	0	1,262	0	0	0	0	0	0	3,341	1,262	3.4%	6.3%
Indonesia	27,262	0	0	0	0	0	0	1,393	0	0	0	28,655	1,393	44.4%	7.0%
Japan	0	0	0	0	0	0	0	0	96	0	0	96	96	0.0%	0.5%
Korea	0	0	0	0	0	0	0	0	174	0	0	174	174	0.0%	0.9%
Malaysia	5,281	0	0	0	0	0	0	0	0	0	0	5,281	0	8.6%	0.0%
Singapore	0	0	614	0	0	0	85	1,517	0	0	0	2,216	2,216	0.0%	11.1%
Thailand	675	0	0	0	0	0	0	0	0	0	0	675	0	1.1%	0.0%
Canada	**2,679**	**817**	**86**	**60**	**3,069**	**90**	**1,039**	**59**	**70**	**85**	**552**	**8,606**	**5,927**	**4.4%**	**29.8%**
Latin Amer./Caribs	**10,781**	**0**	**1,362**	**0**	**0**	**1,032**	**221**	**3,888**	**0**	**308**	**462**	**18,054**	**7,273**	**17.6%**	**36.5%**
Argentina	0	0	0	0	0	0	0	208	0	0	0	208	208	0.0%	1.0%
Ecuador	7,201	0	164	0	0	0	0	1,111	0	0	0	8,476	1,275	11.7%	6.4%
Mexico	614	0	0	0	0	620	0	80	0	233	23	1,570	956	1.0%	4.8%
Neth. Antilles	0	0	641	0	0	0	0	348	0	0	0	989	989	0.0%	5.0%
Trinidad & Tobago	0	0	0	0	0	0	0	1,192	0	0	0	1,192	1,192	0.0%	6.0%
Venezuela	2,966	0	253	0	0	230	221	949	0	75	439	5,133	2,167	4.8%	10.9%
Virgin Islands	0	0	304	0	0	182	0	0	0	0	0	486	486	0.0%	2.4%
Middle East	**5,158**	**0**	**0**	**51**	**0**	**75**	**0**	**0**	**0**	**0**	**110**	**5,394**	**236**	**8.4%**	**1.2%**
Saudi Arabia	5,001	0	0	51	0	75	0	0	0	0	110	5,237	236	8.1%	1.2%
Oman	157	0	0	0	0	0	0	0	0	0	0	157	0	0.3%	0.0%
Other	**379**	**0**	**646**	**0**	**0**	**0**	**0**	**644**	**0**	**0**	**0**	**1,669**	**1,290**	**0.6%**	**6.5%**
TOTAL	**61,401**	**817**	**2,708**	**111**	**4,331**	**1,197**	**1,345**	**7,554**	**340**	**393**	**1,124**	**81,321**	**19,920**	**100%**	**100%**
Daily Average	168.2	2.2	7.4	0.3	11.9	3.3	3.7	20.7	0.9	1.1	3.1	222.8	54.6		

Source: USDOE Petroleum Supply Monthly

region's oil imports and will supply over 90 percent in 2000.

- The Middle East has been a relatively unstable region over the last two decades; this instability has resulted in a series of oil price shocks.
- Recent price shocks have been less severe and shorter in duration than earlier ones.
- Petroleum price forecasts to the year 2000 indicate modest increases.
- The U.S. is becoming increasingly dependent on petroleum imports.
- Production in Alaska and California will continue to decline, which will require alternative supply sources.

Given the above, the U.S. Pacific islands have the potential to secure petroleum supplies throughout the decade. More importantly, the islands should be able to plan for modest petroleum price increases. However, there could be price shocks which means that measures to reduce vulnerability to their effects should be developed.

Oil Supply in the Pacific Islands

Small size and distance from energy sources are the two most prominent parameters which define the energy sectors in the U.S. Pacific islands. As noted in Chapter One, the islands have small but growing demands for energy, they are without indigenous commercial energy resources, and are very distant from national support systems which make them extremely vulnerable during crisis periods. The limited markets and remote locations have forced the use of smaller less efficient electricity generators rather than a large central generation system; if one unit breaks down, it may take weeks before the correct parts can be obtained. Thus, the diseconomies of scale are an added cost to island consumers in order to improve supply security.

By choosing smaller units, the utilities essentially limit their energy fuel options to petroleum products and small fluidized-bed coal systems. Coal has been studied as an option for Guam and the CNMI, but because of the costs and space required for transport and storage, it was assessed as being considerably more expensive than fuel oil units at the time of recent decisions on system expansion. Although a reassessment of coal to meet system expansion from the year 2000 should be considered, petroleum products will remain the primary fuel for electricity generation through this decade.

As a consequence, the Pacific islands are totally dependent on imported petroleum for their energy needs. Figure 2.15 shows the share of petroleum fuels in electricity generation in the United States in 1990. The District of Columbia, American Samoa, Guam, the CNMI and Palau are all 100 percent dependent on petroleum for electricity generation. Hawaii was nearly totally dependent on petroleum, although renewable energy sources (primarily sugar cane bagasse and a municipal solid waste-to-energy plant) comprised close to 9 percent of power generation. Hawaii has since added a 180 MW coal-fired plant and a 25 MW geothermal facility which now account for about 15 percent of electricity production. In the case of very high oil prices or a disruption in the supply of oil, the District of Columbia could still purchase power from neighboring areas which primarily utilize other fuel sources such as coal. Hawaii and the U.S. Pacific islands do not have this option and must rely on imported energy supplies.

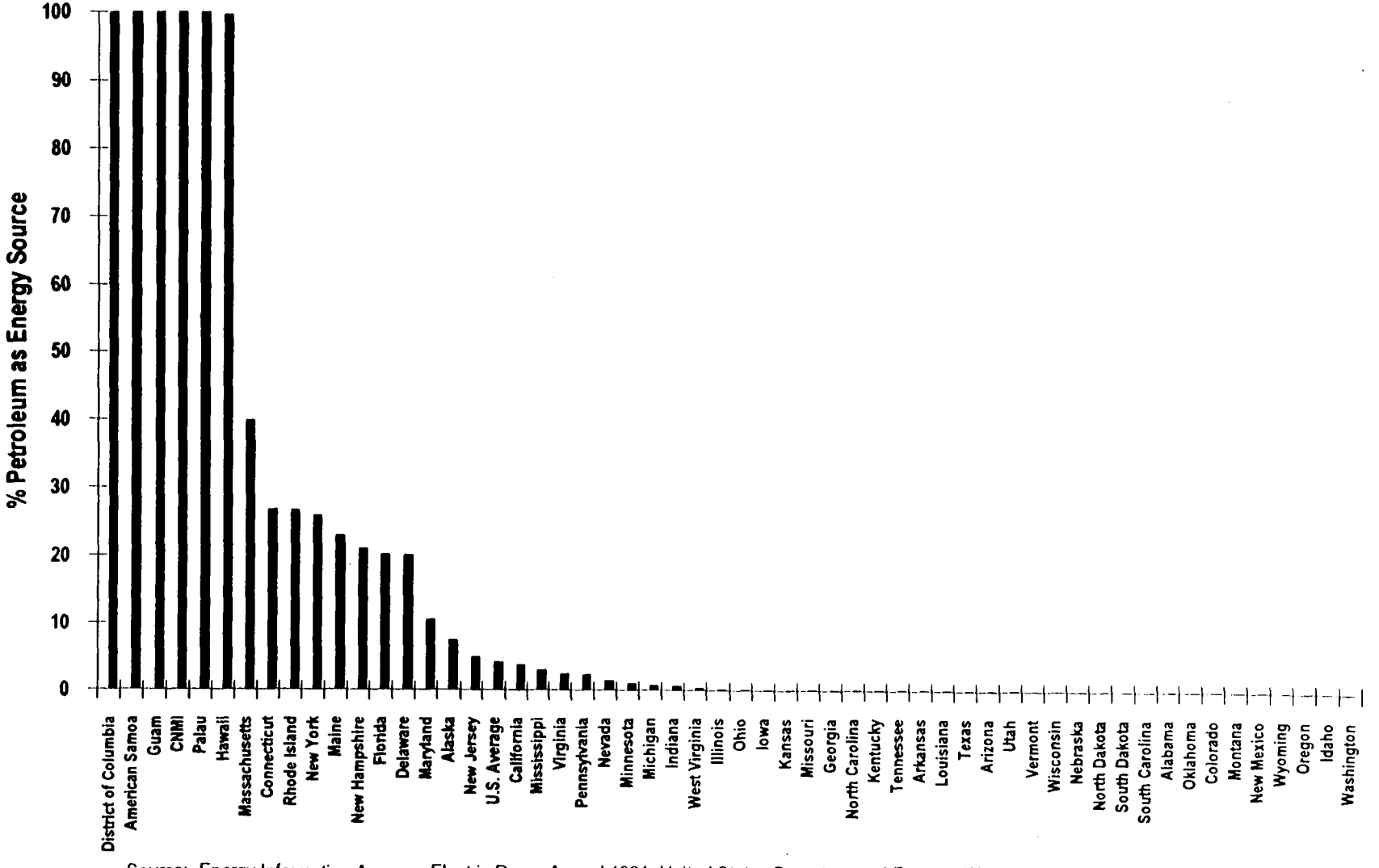
Figure 2.16 shows the tanker supply system for the Pacific islands region excluding Hawaii. Figure 2.17 shows a schematic of the demand for petroleum products, origins of supply, and the oil companies delivering and distributing products in the Pacific islands region. Figure 2.18 indicates supply sources for Hawaii. As already mentioned, the islands region has a very small total market which is scattered over thousands of miles. Australia and Singapore are the key refining and supply centers for the South Pacific islands region. In addition to Asian oil suppliers, Middle Eastern countries are major sources for Singapore refiners. Australian refiners process their own crudes but may purchase foreign cargoes depending on market conditions. In the North Pacific islands region (CNMI, Guam, Palau, Federated States of Micronesia, and Republic of the Marshall Islands), Singapore is the origin for products. Guam is the central distribution point for the North Pacific islands, while Fiji serves as the central distribution point for Polynesia and Kiribati in the South Pacific.

Although there have been some minor changes to supply arrangements, the structure of the islands petroleum market has been relatively stable for several decades. These minor changes include oil companies entering or withdrawing from specific markets, including American Samoa, which was once supplied by three companies but now only BHP Americas delivers products. Total demand in the islands market is increasing. Current forecasts indicate that total growth will approximate 5 percent per year to the year 2000.

Figure 2.19 shows the length of time, 10 to 18 weeks, for a shipment of crude from the Middle East to reach Guam and its secondary Pacific island markets.

Aside from American Samoa which is supplied by only one company, the islands are supplied by at least two major oil companies, with Guam receiving supplies from four companies. As a general rule, the more major oil companies supplying and operating in an area, the greater the energy security. Major oil companies have multiple sources of supply as well as the fleets necessary to move petroleum products from one region to another. In addition, the major oil companies have the financial resources necessary to keep oil flowing. However, a key issue is that Singapore remains the single origin of supply for Guam, the CNMI and Palau.

Figure 2.15 Petroleum as an Energy Source for the Power Sector, 1990



Source: Energy Information Agency. Electric Power Annual 1991. United States Department of Energy. Washiington, D.C.

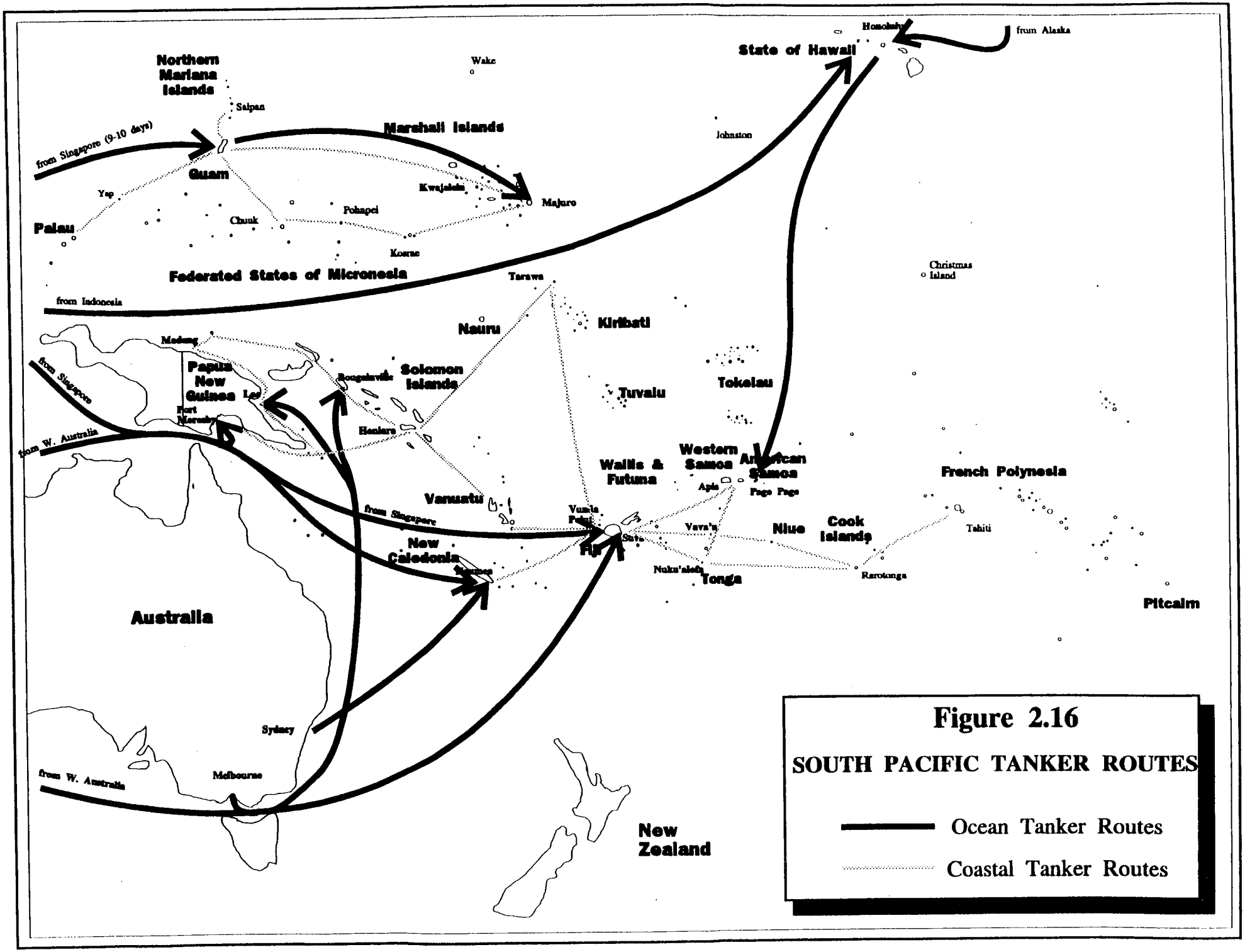

Northern Mariana Islands
Saipan
Wake
State of Hawaii
Honolulu
from Alaska
from Singapore (9-10 days)
Marshall Islands
Johnston
Guam
Yap
Kwajalein
Majuro
Palau
Chuuk
Pohnpei
Kosrae
Federated States of Micronesia
from Indonesia
Tarawa
Christmas Island
Nauru
Kiribati
Madang
Papua New Guinea
Lae
Port Moresby
Bougainville
Solomon Islands
Honiara
Tuvalu
Tokelau
from Singapore
from W. Australia
Wallis & Futuna
Western Samoa
American Samoa
Apia
Pago Pago
French Polynesia
Vanuatu
Vanua Levu
Viti Levu
Suva
Vava'u
Niue
Cook Islands
Tahiti
from Singapore
New Caledonia
Fiji
Nuku'alofa
Tonga
Rarotonga
Pitcairn
Australia
Sydney
Melbourne
from W. Australia
New Zealand
Figure 2.16
SOUTH PACIFIC TANKER ROUTES
Ocean Tanker Routes
Coastal Tanker Routes

Figure 2.17 Crude & Product Oil Flow in the Pacific Island Region 1991/1992 ('000 Barrels per Day)

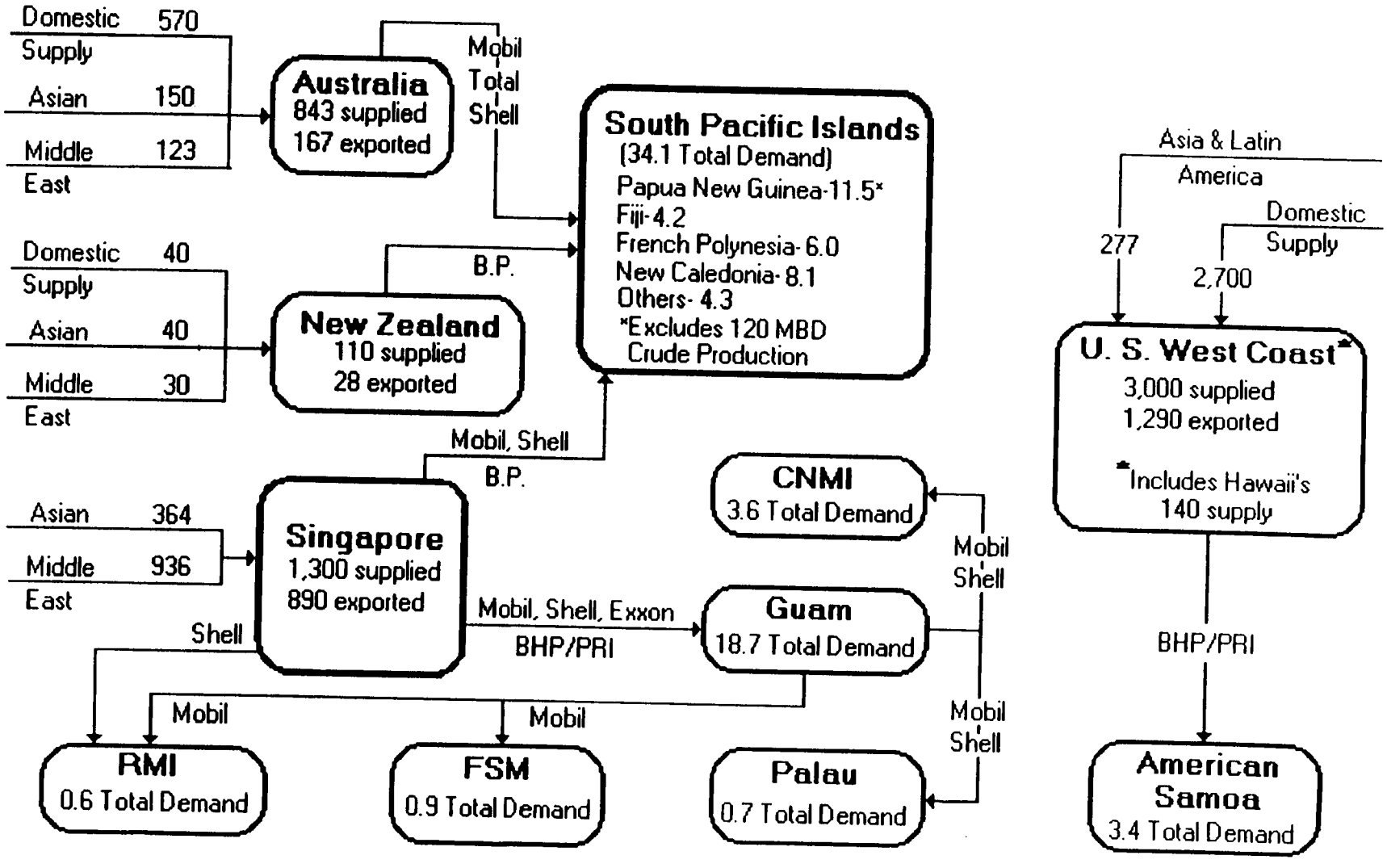


Figure 2.18 Crude Flows to Hawaii (000 MBD)

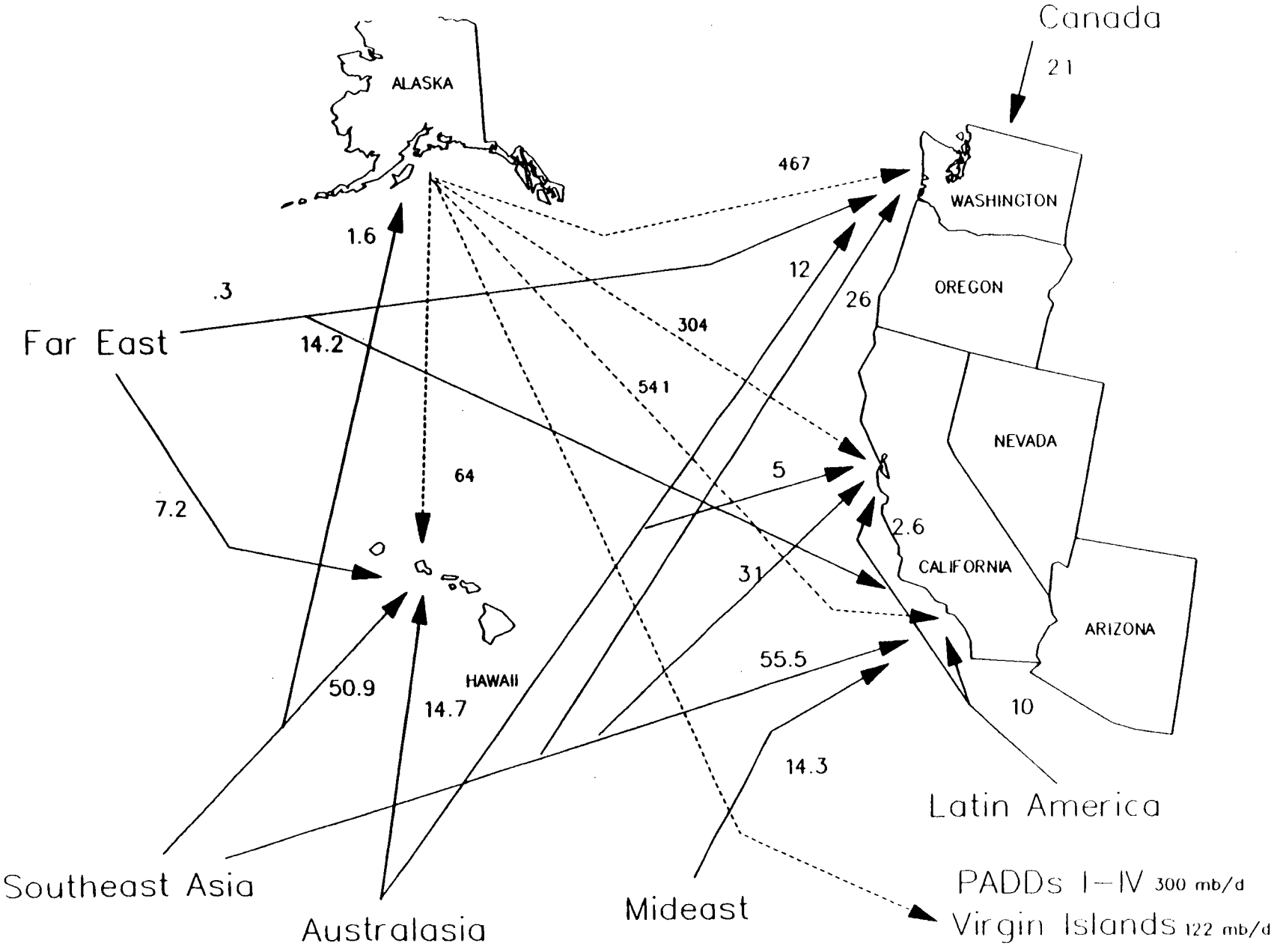
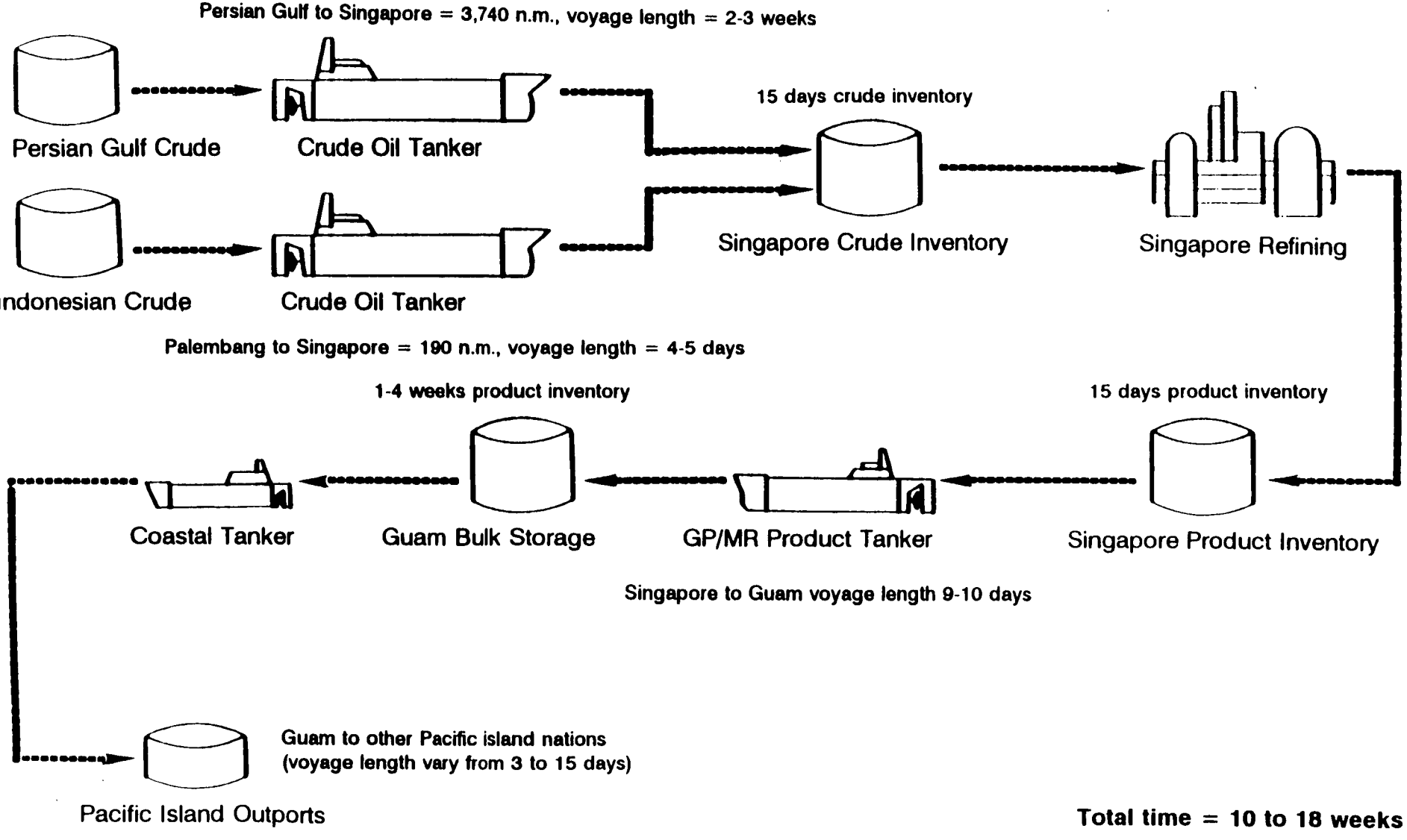


Figure 2.19
Example of Time Buildup for Delivery of Petroleum Products into Pacific Islands



Three

OVERVIEW OF THE ENERGY SECTOR AND ENERGY VULNERABILITY ISSUES

ECONOMIC CONTEXT FOR THE ENERGY SECTOR

The U.S. Pacific islands are small scattered islands with very limited internal markets. Guam, the Commonwealth of the Northern Mariana Islands (CNMI) and Palau are more than 3,000 miles west and American Samoa is well over 2,000 miles south of Hawaii. The combined effects of isolation from the U.S. mainland and the need to import the vast majority of food and all medicine, machinery and other manufactured goods have forced the island entities to develop economies which are linked to international markets and based on tourism and exports. As a result, the islands are vulnerable to economic fluctuations in Asian economies, which in the case of the Micronesian entities (Guam, the CNMI, and Palau) are their main trading partners. Because the islands use U.S. currency and receive considerable funding from the U.S. Federal Government, fluctuations in the U.S. economy also have major impacts including the declining value of the U.S. dollar against the Japanese yen.

Table 3.1 shows key characteristics of the island entities. Population growth on Guam has averaged less than 2 percent per annum since 1980, while Palau's population has grown by roughly 1 percent per year, American Samoa's by 2 to 3 percent since 1985, and the CNMI's population has increased by over 10 percent per year since 1980. The CNMI's economy has expanded at an extraordinary rate of 24 percent per year (in current dollars) between 1980 and 1990, Palau's economic growth was 6 percent per year since 1983, while American Samoa's economy has risen by roughly 7 percent per year since 1985, and Guam's total employment has grown by over 8 percent per year since 1984.[1] Through employment and dispersal of Federal funds, the public sector plays a key role in all of the island economies. Tourism is the leading private sector activity for Guam, the CNMI, and Palau, while the tuna canning industry has this role in American Samoa. The CNMI has also developed a garment industry which is based on alien labor.

Inflation rates for Guam and CNMI were approximately 11 percent in 1992. The high rates of inflation are a result of the recent economic boom, substantial wage increases in the public sector, and the declining value of the U.S. dollar against the currencies of the main trading partners. Although shipping costs to the islands will typically add 10 to 20 percent to the price of a product, a survey of miscellaneous grocery items conducted by Guam's *Pacific Daily News* compared costs on Guam to a similar survey conducted by the *Wall Street Journal* in various U.S. metropolitan areas

[1] Guam uses total payroll employment as its primary economic indicator. GIP, or gross island product, figures have not been computed for Guam since 1985. The rate for American Samoa is based on 1992 GDP figure of $297 million provided by the government; the growth rate is considerably higher than was anticipated.

Table 3.1 Key Economic Indicators

Island (year)	Area	Population	GDP ($Millions)	Leading Economic Sectors (1990 data, exept for Guam)	% of Total Employment (Official Sector Designation)	Sector Business Income or Gov. Expenditure ($Millions)
American Samoa	76 sq miles	49,000 (1991)	$297 (1992)	Tuna Canneries Government	34% (Canneries) 34% (Government)	1990 n.a. $109
Guam	212 sq miles	139,371 (1991)	$1,859 • (1990)	Tourism Government Construction	1992 40% (Retail & Services) 31% (Local & Federal) 15% (Construction)	1991 $1,834 $1,098 (includes Military) n.a.
CNMI	177 sq miles	43,345 (1990)	$1,175 (1990)	Construction Tourism Garment Government	22% Construction 21% (Retail, Entertain. Hotels) 20% (Garment Manufacture) 18% (Public Admin.)	1991 $121 $346 (excludes Entertainment) $255 $128
Palau	191 sq miles	15,122 (1990)	$50 (1990)	Government Tourism Construction Fisheries	24% (Public Utilities & Admin.) 24% (Personal Srvcs & Retail) 15% (Construction) 8% (Fisheries & Agriculture)	1989 $48 (estimate) n.a n.a n.a

Notes

• Guam GDP value is GovGuam Dept. of Rev. & Tax estimate of Total Island Income and is 1 % less than the CNMI GDP, and hence suspected as being too low. The last recorded value of Guam's was done in 1986 and was $1,301,500,000.

and found that prices were 57 percent higher on Guam.[2] Housing costs on Guam are comparable to those in San Diego and Chicago, the sixth and seventh most expensive U.S. metropolitan areas.[3] Saipan also has comparatively expensive housing costs. The high cost for housing is a result of the rapid economic growth on Guam and in the CNMI. The development of the tourism industry by foreign investors has had a major impact on increased land prices. Housing costs are much lower in American Samoa and Palau, although similar data are not available. However, all of the island entities experience higher costs because of shipping. But the major contributing factors to higher prices for imported goods are the distribution costs and especially business markups. These factors are indicative of the small island markets where the number of suppliers and competition between them are limited.

Reflecting the role of the public sector, Table 3.2 summarizes government revenues and expenditures. It is clear from the table that government expenditures based on Federal contributions are essential to the economies of American Samoa and Palau. Although Guam and the CNMI are able to generate the overwhelming majority of their revenues from local sources, these have recently fallen because of decreases in tourism. The drop in visitor arrivals has resulted in a projected budget deficit for Guam in 1993. Guam has several major military installations, including Apra Harbor and Anderson Air Force Base. These bases have been key forward positions for the United States since after World War II.

The performance of the island economies since 1980 can be favorably compared to very modest economic growth in other Pacific island nations and the United States. The obvious conclusion is that the islands are utilizing their comparative advantages to develop open and responsive economies which are able to compete internationally. Integration with the global marketplace results in vulnerability to global economic fluctuations as demonstrated by recent declines in the number of tourists visiting Guam and the CNMI because of the economic slowdown in Japan. The decline in tourism has been aggravated by a number of typhoons and began with the outbreak of the Persian Gulf Crisis in 1990.[4] Despite recent difficulties, the outlook for the economies to the year 2000 is optimistic with growth rates projected to moderate for Guam and the CNMI, increase sharply for Palau upon the signing of the Compact with the United States, and remain at a solid 2 to 3 percent level for American Samoa.

The high growth rates of the 1980s and early 1990s caused serious problems for infrastructure. Ports, roads, electricity, water, and sewage systems were all unable to cope with the rapid growth on Guam and Saipan. As a result, many private businesses, especially hotels, had to develop their own power supply. The islandwide power systems are only now developing sufficient generating capacity to meet peak demand. These problems with infrastructure are indicative of

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[2] *Pacific Daily News*, "Informal survey: Guam prices 57% more than in U.S.," April 9, 1993.

[3] Economic Research Center, Department of Commerce, *1991 Guam Annual Economic Review*, Government of Guam, p. 20, 1993.

[4] The numbers of tourist arrivals initially declined when Iraq invaded Kuwait, then returned to pre-invasion levels, fell again with outbreak of the Persian Gulf War in January 1991, reached record levels by early 1992, dropped by roughly half following a series of typhoons in the last quarter of 1992, and have not returned to previous levels.

Table 3.2 Government Revenues and Expenditures

	American Samoa		Guam		CNMI		Palau	
	1991	% Total Rev.	1991	% Total Rev.	1992	% Total Rev.	1989	% Total Rev.
Revenue:								
Local sources	$42,950,000	41%	$539,188,604	82%	$134,574,964	93%	$8,966,000	18%
U.S. Federal Contributions	$53,914,000	52%	$116,080,290	18%	$10,330,000	7%	$36,565,000	75%
Other	$6,639,000	6%					$3,000,000	6%
Total Revenue	$103,503,000		$655,268,894		$144,904,964		$48,531,000	
Expenditure	$108,555,000		$526,780,267		$141,931,938		$67,656,150	(est)
Surplus/(deficit)	($5,052,000)		$128,488,627		$2,973,026		($19,125,150)	

inadequate economic and energy planning mechanisms. The 1982 *Territorial Energy Assessment: Final Report* states that economic plans have "not given in-depth consideration to future energy requirements" (p. 2). As evidenced by recent deficiencies, lack of planning capacity remains a serious problem. In addition, the use of GDP data nearly ten years old shows that data collection has still not received adequate attention.

STRUCTURE OF THE ENERGY SECTOR

The United States Pacific islands are entirely dependent on imported petroleum as their source of commercial energy. An overview of 1990 census data for the island entities reveals that 96 percent of the households on these islands are now electrified. Electricity is generated on these islands by petroleum burning power plants. Furthermore, 87 percent of all the households have at least one motor vehicle. Although the exact percentages vary from island to island, it is clear that daily life relies heavily on energy provided from imported petroleum fuels.

For three of the entities, Guam, the CNMI, and Palau, the source for fuel imports is Singapore (see figures 2.16, 2.17, 2.18 and 2.19). Four commercial oil suppliers ship petroleum from Singapore to Guam, which is a distribution point for transshipment of oil in the northern Pacific region. This voyage takes nine to ten days. Two companies, Shell and Mobil, then ship their petroleum products to the CNMI (less than one day from Guam) and to Palau (a two to three day voyage from Guam). The source of petroleum for American Samoa is Hawaii, which
sources crude from Alaska (North Slope) and Asia, primarily from Indonesia. The sole supplier of petroleum fuels in American Samoa is Broken Hill Proprietary Petroleum Americas (BHPPA) distributing from Hawaii. BHPPA owns a 95 thousand barrels per day (MBD) refinery.

As shown in Table 3.3, the four island entities currently consume 9.7 million barrels of petroleum per year at a cost of $263.2 million. The two far right columns in the table show fuel imports as percentages of total imports and domestic commodity exports. The share of fuel imports in the value of total imports ranges from 10 percent in American Samoa to 24 percent in Palau. The value of fuel imports as a percentage of domestic exports ranges from 11 percent in American Samoa, which exports canned fish, to 983 percent in Palau, which has limited commodity exports. Tourism earnings are not included in domestic exports. Guam consumed 6.8 million barrels (MMB) in 1992 at a rate of 18.6 MBD, and the CNMI, American Samoa, and Palau consumed 1.4 MMB at 3.7 MBD, 1.3 MMB at 3.36 MBD, and 0.3 MMB at 0.72 MBD, respectively. By the year 2000, overall consumption is expected to increase to approximately 15.3 million barrels, which reflects an average annual growth rate of 6 percent per year for all of the entities, and rates of 1.2 percent, 4.9 percent, 12.5 percent, and 9.5 percent for American Samoa, Guam, the CNMI and Palau, respectively. The growth rates projected for Guam, the CNMI, and Palau reflect strong economic growth and per capita consumption rates similar to those found in high income industrialized nations.

As indicated in Table 3.4, 85 to 93 percent of the imported petroleum fuels are consumed in either the transport or electricity sectors. For the Micronesian entities north of the equator (Guam, CNMI, and Palau), the amount of imported fuel dedicated to electrical power generation is between 33 and 43 percent of total fuel imports, with the transport sector consuming between 47 and 56 percent. The miscellaneous column includes fuel which is used either for home cooking or in a variety of small commercial applications which are difficult to quantify with any precision.

Table 3.3 Key Fuel Indicators

Island [year]	Fuel Imports			Total Imports	Exports	Fuel Imports as % of Imports	Fuel Imports as % of Exports	Fuel Imports as % of GDP
	Value	Volume 000's Barrels	Average Price/Barrel					
American Samoa [1990]	$34,895,868	1,010.5	$34.53	$360,300,000	$306,000,000	10%	11%	12%
Guam [1991]	$140,582,358	6,743.2	$20.85	n.a.	$84,543,162	n.a.	166%	8%
CNMI [1991]	$81,800,000	1,140.0	$71.75*	$392,400,000	$254,700,000	21%	32%	7%
Palau [1989]	$5,900,000	175.0	$33.71	$24,600,000	$600,000	24%	983%	12%

Notes

Years selected for which the most recent COMPLETE data series is available for a particular island.
However, GDP figures for American Samoa are for 1992 and for CNMI from 1990.

* CNMI's cost per barrel appears too high. Data from CUC for 1990 indicate it paid 39.96 per barrel in 1990. Data from Guam indicate that if CNMI paid about the same amount per barrel for fuel as Guam, then the average CNMI barrel would have cost $40.29

	$/Barrel	
GPA =	$16.85	= 3% lights +97% RFO
Guam =	$20.85	= 59% lights+ 41% RFO

	CNMI Mix	Guam Mix	GPA Mix
Year	1991	1991	1990
Lights	80%	59%	3%
RFO	20%	41%	97%
	100%	100%	100%

Table 3.4 Petroleum Demand, End Use, and Storage Capacity

	Petroleum Demand ('000 barrels/year)		Estimated Annual Growth Rate	Sector End Use**			Storage '000 Barrels
	1992	Projected*		Transport	Electricity	Miscellaneous***	
American Samoa	1,228	1,289	1.2%	69%	16%	15%	175
Guam	6,800	10,000	4.9%	47%	43%	10%	5,500
CNMI	1,370	3,515	12.5%	52%	41%	7%	285
Palau	263	544	9.5%	56%	33%	10%	220

* Projections to the year 2000 for Guam, CNMI, and Palau; for American Samoa, projected to 1997.
** Percent of 1992 petroleum demand for Guam, CNMI, and Palau; percent of 1989 demand for American Samoa
*** Miscellaneous commercial applications and home cooking.

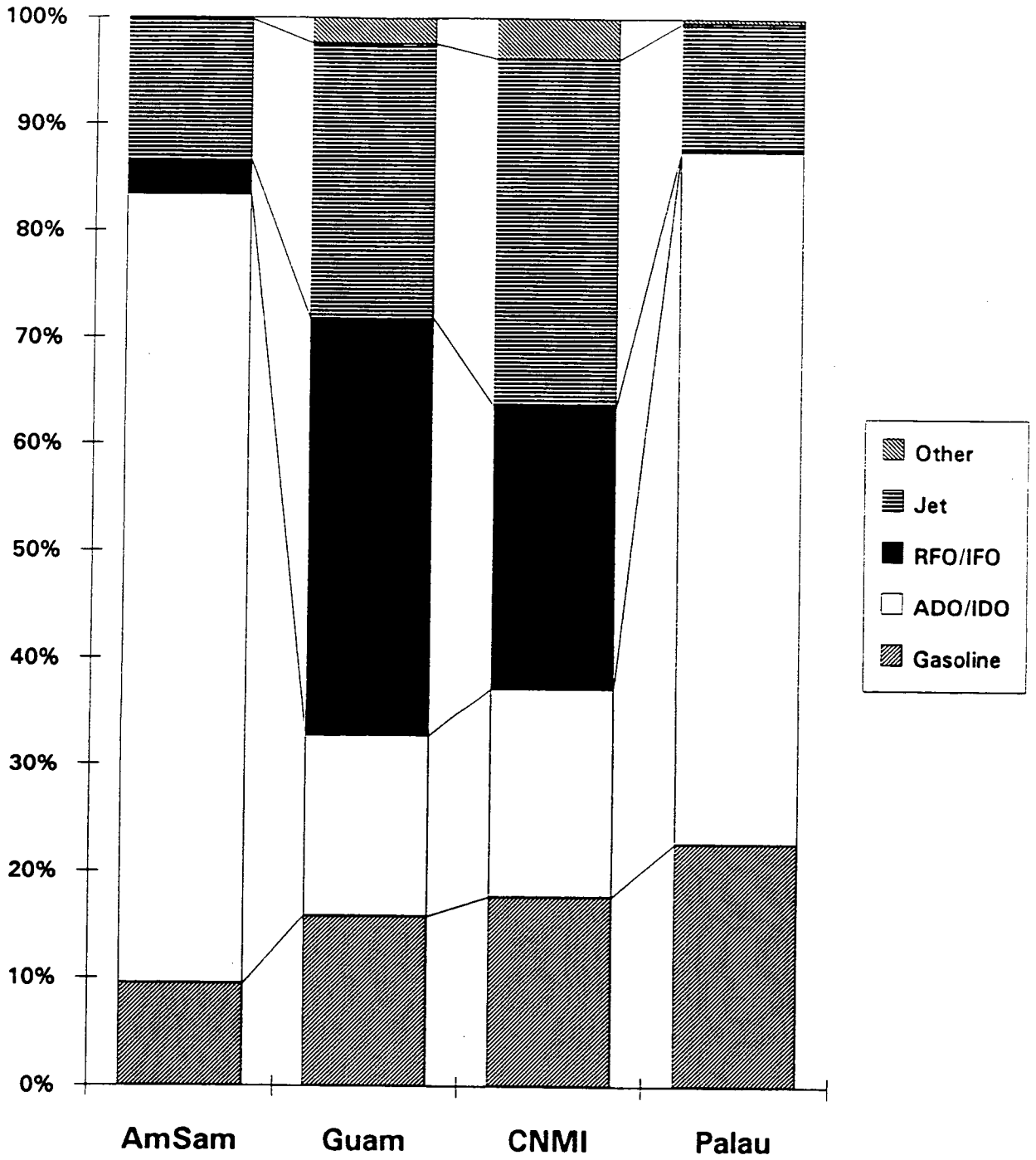
In American Samoa, the transportation sector uses 69 percent of the imported fuel, consumed mainly by the fishing fleet that services the local tuna canneries. The cannery operations also require fuel for food processing, resulting in similar fuel consumption levels for miscellaneous commercial and home applications (15 percent) and for electricity generation (16 percent).

In comparison, transport accounts for roughly 15 percent of total commercial energy demand in European Community member countries, 26 percent in the United States, and between 24 and 40 percent in developing nations. However, in other Pacific islands, the share of transport demand ranges from 34 percent in Papua New Guinea and 80 percent in Western Samoa. The higher allocation of fuel to transport reflects the role which air and ocean transport plays in the small scattered island environment.[5]

Figure 3.1 shows the demand barrels for the islands in 1992. Diesel accounts for the vast majority of fuel consumption in American Samoa (73.7 percent) and Palau (64.8 percent), where it is used for transport and electricity generation. Fuel oil is the leading source for electricity generation on Guam and Saipan. Because of tourism, jet fuel plays a large role on Guam (25.7 percent) and in the CNMI (32.6 percent). The share of gasoline demand is surprisingly high in Palau because it has comparatively fewer vehicles and a much smaller road network than in the other islands. However,

[5] P. Johnston, *Ground Transport in the Pacific Islands: Opportunities for Energy Conservation*, East-West Center, 1993; and, Economic Development Institute, World Bank, *Energy Efficiency and Conservation in the Developing World: The World Bank's Role*, World Bank, September 1992.

Figure 3.1 Demand Barrel, 1992



gasoline is also used for household-size/portable electricity generators and small boats which are common in Palau.

The demand barrels shown for the islands also indicate a reliance on more refined products, except in the case of Guam, where 90 percent of power generation is based on fuel oil. Fuel oil is used to generate roughly 50 percent of the CNMI's electricity. The ability to use fuel oil or crude is an advantage during energy crises because it enables sourcing from more points of supply. Refined products such as diesel are generally supplied from Singapore or Hawaii. Growing demand for refined products in the islands corresponds with Asia's increasing demand for these products. This means that refining centers, such as Singapore, will produce a large supply of refined products for the expanding Asia-Pacific market, and this should facilitate supply of refined products to the islands region.

Petroleum Storage

Although the size and maintenance of petroleum storage facilities varies from entity to entity, there is generally enough in-service storage capacity to accommodate at least 50 days of storage. Complete information on the stock levels typically kept in these tanks is not available. The data which were released by some of the oil companies appear to indicate that the stocks on hand at any given moment represent generally between 20 and 40 percent of the total storage capacity.

However, lack of data on current stock levels could prove difficult during an energy crisis. The American Samoa Government (ASG) requires that at least 10 days demand of petroleum products is always in storage. ASG owns the storage facility and contracts the petroleum supplier to manage and operate the tank farm. Although this arrangement seems to provide the most security for consumers, a tanker from Hawaii lost power while en-route several years ago and stocks were run down to four or five days worth of demand. Nevertheless, the other islands do not have a legal fuel storage requirement for petroleum suppliers and should consider the ASG model.

Guam and Palau have large blocks of storage capacity which are currently unused and could provide additional storage capacity of nearly 99 days on Palau and 165 days on Guam. Guam serves

Table 3.5 Petroleum Storage Capacity in 1993
(Storage in Days)

	American Samoa	Guam	CNMI	Palau
Max. Theoretical Storage (All inservice tanks 100% full)	52	129	75	198
Estimated Average Inventory	>10*	51	31	119
Unused Storage	--	165	--	99

* American Samoan Government requirement.

as the transshipment point for the CNMI, Palau, the Federated States of Micronesia and the Marshall Islands. In addition, Guam's large storage capacity reflects the role it has been given as a forward base for the U.S. military. Military-owned storage facilities on Guam have not been included in the figures but storage which was formerly leased by the military has been included. Palau developed its storage capacity with the intent of becoming a transshipment facility which has not eventuated.

Electricity

The electricity subsectors in the islands have a total installed capacity of 472 megawatts and service approximately 58,000 customers as shown in Table 3.6. The largest utility is the Guam Power Authority (GPA) with 307 MW of installed capacity providing power to 36,000 customers. GPA is an autonomous government utility that annually burns 2.7 million barrels of residual fuel oil a year and 0.24 million barrels of diesel in order to generate 1,500.6 gigawatt hours of electricity. Recent forecasts show GPA's load growth to average 7 percent per year to the year 2000.

The Commonwealth Utilities Corporation (CUC) in the CNMI is the next largest utility with 120 megawatts of installed capacity. This corporation is also an independent government agency, which consumes 0.46 million barrels of fuel annually (56 percent residual fuel oil, 44 percent diesel) to generate 300.1 gigawatt hours of power for its 9,988 customers. Load growth has averaged 17 percent per year for the last two years, and forecasts to the year 2000 indicate growth of at least 10 percent and possibly as high as 16 percent per year.

The American Samoa Power Authority (ASPA) and the power system in Palau are 100 percent diesel based. ASPA, with 30 megawatts of installed capacity, is another autonomous government utility, but the system on Palau, with its 15 megawatts of capacity, is a government-run operation with specific responsibilities for power generation divided among several government departments. Load forecasts for ASPA indicate growth at an annual rate of 3.5 percent to the year 2000. Palau's load forecasts average about 12 percent per year.

All of the electric utilities are experiencing growth, and in general this growth is putting a strain on existing facilities as evidenced by Guam's recent experiences with rolling brownouts and frequent blackouts. Planning to meet the future load and providing reliable electric power today are both priority items in the electricity subsector. Reducing power outages has been identified as essential to those economies (i.e., Guam, CNMI, and Palau) which rely heavily on their competitiveness with other regional tourist destinations. However, this year there are fewer problems than there were last year and island utilities have been able to improve the fuel efficiency of their operations.

Table 3.7 provides an overview of the financial situations of the island utilities. As the figures indicate, ASPA and Palau both had operating losses for the year 1990. A major contributor to ASPA's loss was Cyclone Ofa. Palau has a power plant which is a topic of considerable controversy as evidenced by its asset and debt levels. GPA has had its debt level rise considerably since 1989 to pay for new capacity. CUC's financial situation, while improving, continues to cause concern. Specifics for each of the utilities are discussed in later chapters; however, the point should be made here that none of the utilities are without some financial issues confronting them. ASPA and CUC operate their power divisions successfully, but the water and sewage divisions are costly

Table 3.6 Power Sector Summary

	ASPA (1992)	GPA (1992)	CUC (1992)	Palau (1990)
Total Generation (MWh)	108,168.5	1,500,600.0	300,104.6	47,200.0
Installed Capacity (MW)	29.9	307.0	120.0	14.7
Peak Load (MW)	17.4	240.1	42.0	7.9
Fuel Efficiency (kwh sold/gal)	10.4*	10.5	11.8	11.1**
Number of Customers	8,579	36,364	9,988	2,755

* Assumes 13.2 percent losses

** delivered kwh/gal

Table 3.7 Financial Summaries for the Power Utilities, 1990 ($ millions)

	ASPA	GPA*	CUC	Palau
Revenues	14.1	71.9	24.3	2.4
Fuel Costs	6.6	28.5	13.4	4.2
Other Expenses	10.8	35.9	7.4	6.4
Income/Loss	(3.3)	7.5	3.6	(8.3)
Assets				
Utility Plant	14.2	102.4	45.5	--
Other Assets	33.8	41.2	33.9	--
Total Assets	48.0	143.6	79.5	15.7
Debt/ year	0.4 9/30/90	158 1/5/93	50.8 9/30/90	45.0

Notes: the figures shown are only for ASPA's and CUC's power divisions. Not included are figures for the water and sewage divisions.

- GPA asset data are from 1989.

services. Also, cyclones and typhoons have added major costs for all of the utilities over the lasts several years.

Alternative Energy Resources

Although all of the islands are endowed with indigenous energy resources, they will not replace petroleum as a primary energy source for baseload power production for at least a decade if not longer. Ocean Thermal Energy Conversion (OTEC) technology has obvious potential because these islands are all located near very deep waters. The eventual application of this technology on Guam appears promising, and there is a potential site for such a plant next to GPA's largest power station. The Territorial Energy Office in American Samoa has also studied the use of this technology, and there is interest in locating a plant near the Pago Pago airport. The CNMI and Palau also have potential OTEC sites. However, the economics of such plants demonstrate that this technology is still immature and has not yet been commercially established.

Solar technologies, especially direct hot water heating and photovoltaics for outer island sites, could potentially reduce electrical load growth, but cannot be expected to reduce total demand. During fiscal year 1992, approximately 8 percent of GPA's total generation was used for water heating. As Guam's total electricity consumption is increasing at a rate estimated at approximately 7.5 percent per year until 1995, direct solar hot water heating alone cannot completely arrest Guam's increasing growth in electricity use. However, the use of solar hot water heaters could reduce the rate of growth and especially residential demand for electricity. Although there are a number of solar hot water heaters on Guam and their use is increasing on Saipan, there are some problems, including that solar hot water heaters are potentially vulnerable to typhoon damage and are more expensive to purchase than conventional electric heaters.

Opportunities for solar photovoltaics (PVs) also exist for use at remote locations not serviced by the main electricity grid and especially for government offices such as schools, health and telecommunication facilities. USDOE has had a program to support the use of PVs in the islands. In the areas serviced by the power utilities, PV external lighting technologies may reduce petroleum consumption a small amount. On Guam, which has the largest potential for this application of photovoltaics, commercial lighting and government street lighting represented 2.5 percent of GPA's 1992 sales. Calculations indicate that complete conversion of all government and commercial exterior lighting to photovoltaics would be required to accomplish a reduction in the estimated annual electrical sales growth rate on Guam from about 7.5 percent to 5 percent for just one year. This means petroleum fuel reliance would still increase even following such a major photovoltaic installation effort.

Concern in the islands over the increasing rate of landfill needed to accommodate a growing stream of municipal wastes has motivated interest in municipal solid waste-to-energy (MSW) facilities. In addition, coal, though not indigenous, has been considered as a fuel source to improve energy security by providing diversity to the current dependence on petroleum. However, a major disadvantage to both of these proven technologies is that although they have been proven in larger population centers, a performance record has not been established in the island environment. A coal-fired plant and an MSW facility opened on Oahu during 1992. To date, performance of the plants has been very good, and it is likely that this experience will stimulate interest on Guam and Saipan. A 4 MW to 12 MW MSW plant is currently being considered on Guam.

Coal has been considered for power generation on Guam, Saipan and Tutuila in American Samoa. The economics for coal use on Saipan and in American Samoa are not favorable. However, the economics for coal use on Saipan would greatly improve if GPA were to decide to develop a coal-burning facility. Over the last several years, GPA decided against coal because there was an urgent need to increase current capacity as quickly as possible. This precluded coal. In addition, the short-term economics for fuel oil were better than for coal. However, this situation may change towards the end of the decade, at which time it would be useful for GPA and CUC to reconsider coal as an alternative fuel source.

A proposal to establish a tuna sludge biogasification plant in American Samoa has been under consideration for a number of years, with a recent review indicating positive economics. However, this technology has not been demonstrated in the Pacific islands environment. Recent reports suggest that a pilot project may be developed.

Hydro, wind and other biomass resources are limited and would be very costly alternatives to petroleum.

Institutional Framework

American Samoa and Guam have established energy offices which are well-staffed. The energy offices are headed by directors appointed by the governors. The CNMI has an energy administrator reporting to the governor. Palau has an energy officer under the Public Works Department. The energy offices and officers have been primarily responsible for implementing USDOE renewables and conservation programs.

The utilities in American Samoa (ASPA) and the CNMI (CUC) are responsible for electricity, water and sewage services. In addition, ASPA is responsible for petroleum supply and distribution, including oversight of the oil company which supplies and manages the tank farm. GPA is responsible for electricity services on Guam, and the Public Works Department provides electricity services and oversees petroleum supply in Palau.

Energy statistics are generally handled by statistical offices or officers. The Guam Energy Office has recently begun collecting data on petroleum imports from most of the oil companies. Data are being collected as mandated by an executive order issued under the governor's "emergency powers" which stipulates that in the event of an emergency such as a typhoon it is necessary to know the volume of the various products delivered to and stored on Guam. However, not all of the companies have regularly complied with the executive order. In addition, it should be noted that energy statistics as well as most key economic statistics are not regularly collected or published.

The power utilities also collect and publish data as well as corporate annual reports. Thus, there are generally good records on power production and fuel consumed by the power sector. Data on end uses, however, are limited. GPA recently conducted a demand-side management exercise which has provided considerable end use data. ASPA and CUC also have information on major consumers.

In sum, there are no clearly defined structures for planning and management functions in the energy sector. Instead, one agency takes one role while another agency performs other functions. The

utilities are better staffed than the energy offices, and in general, their objectives are more functionally stated. Although both the energy offices and the utilities have improved their management and planning capacities over the last decade, several key functions have not yet been sufficiently addressed, including:

1) monitoring and review of global energy markets;
2) formulation and analysis of policy options and examination of policy effects on the energy sector's role in the island economies;
3) coordination between existing agencies;
4) coordination among energy sector companies and agencies;
5) formulation and enforcement of quality and safety standards; and
6) monitoring of energy company operations.

The above list is not exhaustive and does not reflect the fact that some islands and agencies are already addressing many of the issues. However, for example, there are no assessments of the effects of a doubling of oil prices on the island economies such as the loss of government revenues through reduced private sector profits or operations, inflation, and the added costs of maintaining government services. Moreover, much of data required for this type of analysis are not available.

The U.S. Federal Government also has a major role in the islands' energy sector. Tables 3.8 and 3.9 show funding from USDOE, United States Department of the Interior (USDOI), and other Federal agencies for island energy activities between 1976 and 1993. As the tables indicate, the amounts have been considerable, although it is not clear that all U.S. Federal support has been included. The bulk of Federal funds have been allocated to the electric utilities, with renewable energy programs also receiving support. It does not appear that funding for data collection, analysis, and sectoral planning and management has been provided.

FUTURE ENERGY SECTOR ISSUES

The demand for electricity and petroleum products is increasing throughout the islands. CNMI and Palau are likely to have double-digit growth in demand for imported petroleum products to the year 2000. Guam's growth will approximate 5 percent per year and American Samoa will experience growth of 2 to 3 percent per year. When combined with projected oil price increases of 2.0 to 6.6 percent per year to 2000, the effects on the trade balance as well as on government operations could be very substantial.

In addition, there will be baseload capacity additions and system upgrading required in all of the utilities. For example, a recent report by CUC indicated that there will be an average capital expenditure of $21 million per year on Saipan's power system between 1993 and 2011. Although the utilities may be able to generate sufficient funds to undertake such expenditure programs, and this will probably be the case for CUC, GPA and ASPA, the magnitude of these expenditures indicates that opportunities to reduce capital costs must receive priority attention.

The projected growth in demand for energy to produce electricity and for transport fuels is likely to result in more attention being given to integrated resource planning (IRP) and demand-side management (DSM) activities. To date, only Guam has initiated DSM activities. There is a pressing need for the other islands to begin similar programs. Energy conservation and energy efficiency activities require more commitment and support.

Table 3.8 U.S. Federal Funding for Island Energy Sectors 1976-1992

(Partial Listing)

	Am. Samoa (1976-1992)	Guam (1976-1992)	CNMI (1976-1992)	Palau (1987-1992)
US DOE				
SEC/EES	$2,733,265	$2,902,172	$2,339,327	$309,758
ICP	$3,540,454	$2,078,875	$1,200,058	$0
Other	$382,456	$452,204	$199,150	$0
US DOI				
Power Programs	$279,000	$20,000	$115,000	$275,000
OMIP Team Visits	$136,364		$136,364	$136,364
Concrete Poles		$9,800,000		
CUC Contributed Capital			$6,689,228	
FFB Guam Note (est)		$14,905,797		
ASPA Fed. Gov. Capital Grants	$29,381,566			
EPA				
CUC Contributed Capital			$3,454,685	
FEMA				
CUC Contributed Capital			$21,971	
US DoAg				
CUC Contributed Capital			$2,059,979	
US DOC				
CUC Contributed Capital			$1,235,763	
Total	$36,453,105	$30,159,048	$17,451,525	$721,122

Table 3.9
U.S. Federal Funding for Island Energy Sectors-1993
(Partial Listing)

	American Samoa	Guam	CNMI	Palau
U.S. DOE				
(Approved)				$90,462
(Requested)	$206,838	$218,339	$206,035	
U.S. DOI				
(Approved)				
OMIP Team Visits	$45,455		$45,455	$45,455
OMIP Programs			$243,000	$334,500
FFB Guam Note (est)		$1,260,000		
Total	$252,293	$1,478,339	$494,490	$470,417

In sum, the U.S. Pacific islands are dependent on imported petroleum products, a situation which is unlikely to change in the foreseeable future. With demand for energy increasing at high rates, it is essential that the efficient use of energy is given priority attention. In some cases, "the efficient use of energy" will be defined through energy conservation programs, while in other cases, demand-side management techniques and technologies should be given prominence. This does not mean that alternative energy technologies should be ignored, but these should be placed in the context of the marketplace: what a society is willing to pay for an alternative to petroleum imports. Decisions on energy efficiency, market prices and costs to society cannot be evaluated until data collection and analyses are systematized and improved. In other words, there is an urgency to design and implement IRP programs for each of the island entities.

Oil Supply Disruption Scenarios for the Pacific Islands

The following sections describe the potential oil supply disruptions scenarios provided by the USDOE for this report, the likely impacts of these supply disruptions on the island economies, and selected response issues. The discussions parallel those in chapters 4 to 7, which also discuss vulnerability response options for the individual island entities. The response issues which are discussed below reflect the larger economies of scale which can be gained by linking Guam, the CNMI, Palau, and American Samoa. Hawaii and the Federated States of Micronesia and the Republic of the Marshall Islands should also be included in any regional groupings because they are also part of the same oil supply system. Unfortunately, the terms of reference for this report did not allow for assessment of these island entities.

Three oil supply disruption scenarios for the Pacific islands are discussed below and evaluated with respect to their potential impacts. Figures 2.16, 2.17, and 2.18 provide the basis for the assessment. The three scenarios are all estimated to last six months and include:

- **Scenario I:** Major disruption caused by major political turmoil affecting Middle Eastern and Asian producers with a net loss of 4.5 MMBD (9.0 MMBD production loss minus 4.5 MMBD drawdown of global strategic petroleum reserve).
- **Scenario II:** Medium-scale disruption caused by simultaneous upheaval in West African and Latin American producers with a net loss 4.5 MMBD (production loss of 6.0 MMBD minus SPR drawdown of 1.5 MMBD).
- **Scenario III:** Minor disruption based on limited upheaval in the Middle East with a loss of 2.0 MMBD (production loss of 4.3 MMBD minus production increase by other countries of 2.3 MMBD).

Before discussing the specific scenarios, several historical reference points should be noted. First, the Asian market is a net importer of oil sourced largely from the Middle East. Second, during previous oil crises, Asian producers such as Indonesia and Malaysia have not diverted supplies. Instead, Asian producers have generally given preference to traditional markets, including Singapore, for their products. Third, most Asian refineries such as those in Singapore are configured to process Middle Eastern crudes and are not as well adapted to refining the lighter, sweeter West African crudes and the heavier, more sour Latin American crudes. In other words, Asia's refining capacity is geared towards supplies from the Middle East, and substitutes are not readily available or easily incorporated. The scenarios are discussed below beginning in reverse order.

Scenario III: Minor Disruption

Under Scenario III, there would be no redirection of Asian oil supplies. Impact on U.S. West Coast supplies would be negligible. However, there would be a drop of 10 percent in supplies for Singapore (approximately 100 to 150 MBD), and a similar reduction in Australian and New Zealand crude imports. The result is an anticipated shortfall of approximately 10 percent for the Pacific islands region.

The effects of this 10 percent shortfall are considered minimal. Oil price rises would be very modest and there should be no appreciable negative secondary effects for the islands region such as a major decline in tourism.

No official response measures would need to be instituted. However, it is recommended that monitoring of supplies and prices should be carried out. It is also recommended that utilities, the oil industry, and governments promote energy conservation programs, including voluntary measures by the population to reduce consumption of electricity and gasoline.

Scenario II: Medium Disruption

Although the volume of oil lost to the market is considerable (4.5 MMBD), because the West African and Latin American producers are linked to other markets, the Asia-Pacific region would be only slightly affected. There would be some redirection of Middle Eastern supplies, but it is anticipated that the net effect would lead to only a 10 percent decrease in supplies for Singapore, Australia and New Zealand. Similarly, the effect on the U.S. West Coast would be minimal.

The results and response measures for Scenario II are identical to those described above for Scenario III.

Scenario I: Major Disruption

A global net loss of 4.5 MMBD based on major political upheaval in the Middle East and Asia and includes a total loss of 2.5 MMBD from Asia oil producers would affect various Pacific Rim markets very differently. The direct impact on U.S. West Coast supplies would be fairly limited (e.g., 5 percent or less) because imports have only a small role in that market. The direct and indirect effects on supplies to Australia and New Zealand should be relatively modest, approximating a 10 percent decline. The Singapore refiners, however, would be severely affected.

In this scenario, Singapore would experience a 30 percent loss in Asian supplies. The cutback in Middle Eastern production would result in an additional 20 percent decrease. The combined loss of 50 percent would greatly affect the islands region both directly and indirectly.

Directly, the islands region would lose at least 50 percent of its supplies from Singapore. Australia would be able to provide some additional supplies, but it would also have to compensate for its own loss of supplies. The net loss to the islands region could well be in the range of 25 to 50 percent.

A secondary impact would be significant price hikes. Under Scenario I, spot prices on the Singapore market would soar. Price doubling and even tripling would be likely outcomes. In the 1979/80 period, the crisis centered on Iran led to an additional 20 percent increase in prices. The short-term consequences of the 1979 oil price rise lead to inflation rates of 7.5 percent in Japan, 11 percent in Australia, 15 percent in Fiji and nearly 30 percent in Tonga and Vanuatu. In other words, inflation rates in some of the islands nearly doubled. If the 1979 experience is applied, it would be reasonable to anticipate a near doubling of inflation rates for Guam, the CNMI and Palau.

Compounding the direct supply and price effects of Scenario I, the political complications of the oil supply disruption have to be considered. Following the onset of the recent Persian Gulf War, the Iraqi President threatened to attack U.S. territory and economic interests throughout the world, and there had been several reports of terrorist activity by Iraqis in Asia which heightened concern. As a result, Guam, the CNMI, and Hawaii experienced a downturn in tourism immediately following the outbreak of the 1991 Gulf War because tourists were frightened to fly to U.S. territory. Whether fact or only perception, people reduce their international travel even to relatively "safe" destinations during crisis periods: if there is political upheaval in a major Middle Eastern or Asian nation, international business and tourist travel will be restricted in order to reduce the vulnerability to terrorist attacks.

Interestingly, the number of tourists to Guam and the CNMI began to revive soon after the Gulf War and by early 1992 tourist arrivals were at record levels. However, in September 1992, Typhoon Omar struck Guam and the CNMI and was followed by several other typhoons. The result was a drop of nearly 45 percent in the level of Guam's tourist arrivals, a loss of 1,500 jobs, and a substantial decline in tax revenues, all of which have been greatly compounded by the continuing slump in the Japanese economy.

These effects would probably be similar to the effects of an oil supply disruption under Scenario I. Although difficult to predict with any level of certainty, tourist arrivals could fall sharply (by as much as 50 percent) if a political upheaval in Asia elevated fears of international terrorist activity and/or resulted in higher travel costs. The near-term effects would be a loss of jobs by roughly 5 percent and a fall in tax revenues by a similar level. However, if a recession were to follow, and this would be a likely outcome, then the downturn would be much more severe and could easily double the effects of the crisis.

With Scenario I, it is very likely that in addition to oil supply shortfalls, oil price increases, inflation, and reduced levels of international tourism resulting from the political upheaval causing the oil supply disruption, a recessionary period in the major economies would ensue. The effects of a major recession would again greatly affect the island economies through reduced levels of tourism and reduced demand for their exports, mainly fresh and canned seafoods. As an example, the 1973/74 oil price rise led to global recession, including a severe downturn in Australia which greatly reduced the levels of Australian tourists to Fiji. In other words, a severe oil supply disruption creates downstream effects which are not felt for several months yet may continue for several years.

Two key questions emerge under Scenario I. The first is whether the islands would experience more severe impacts than the rest of the United States. Although all of Asia would experience inflation and recession, the islands' small open economies would be virtually unprotected from the global market: nearly all food and all medicine are imported. The economies are nearly totally dependent on off-island trade and international tourism; with the exception of Hawaii, the rest of the

United States does not have to rely on ocean transport and other nations for essential goods and services. In sum, there would be no territory of the United States more severely affected by a major Asian oil supply disruption than the Pacific islands.

The second question is how to respond with short-term measures to meet basic demands for petroleum. Oil price and supply monitoring and voluntary conservation programs would be insufficient responses to a disruption of this magnitude. With respect to the oil supply, the U.S. West Coast could divert some of its supplies to the islands. The Australian arrangement for the South Pacific islands may provide a useful guide. In the event of an oil supply disruption which results in a net market loss of crude oil or petroleum products of 7 percent of the total International Energy Agency (IEA) market, the IEA member may elect to activate the Emergency Oil Sharing System, the objective of which is to ensure fair sharing of available supplies among the IEA group of countries (the OECD minus France). As a member of the IEA, Australia is committed to take certain demand restraint measures should the IEA Emergency Oil Sharing Scheme go into effect. The demand restraint is measured as a percentage decrease in total consumption, including traditional exports. This means that if a 10 percent demand restraint measure is instituted, then Australia has to cut its combined own consumption and traditional exports by 10 percent.

The Australian arrangement covers the independent island nations sourced from Australia. It does not cover American Samoa or any of the North Pacific nations and territories sourced via Guam, including the Federated States of Micronesia and the Republic of the Marshall Islands. These nations and territories either have to secure emergency supplies via Singapore or from a nontraditional supplier, the United States.

The United States via its military infrastructure has considerable levels of stocks in the Asia-Pacific region as well as the shipping capacity to deliver supplies. However, as Figure 3.2 shows, the military is cutting back on its commercially leased storage capacity and is also shutting down some of its own storage facilities in certain locations.

Another potential source of crude petroleum is Papua New Guinea whose oil production is now at 135,000 b/d. Currently refined throughout the Asia Pacific region, this crude resource could provide a substantial margin of safety for the Pacific islands. A 30,000 b/d refinery has been approved by the government and could be operating in 1996.

Through the supply capacities of the oil companies operating in the region, other regional suppliers, and the U.S. government (Strategic Petroleum Reserve and the military), the Pacific islands should be able to receive emergency supplies. It is possible that some type of formal assurance to the island governments is required. In May 1992, a bill was introduced to the U.S. Congress, which guarantees access to the U.S. SPR for a percentage of oil demand requirements of the U.S. Pacific islands including Hawaii. This guarantee would ensure access to oil supplies for the islands. Market prices would have to be paid, but basic services could be maintained. The proposal is discussed in more detail on page 75. Although all of the islands would like their own on-island petroleum reserves, the cost to the federal government would be considerable.

THE ECONOMIC EFFECTS OF OIL SUPPLY DISRUPTIONS

In addition to the issue of continued access to oil supplies, the economic impacts of a major oil market disruption can be devastating. The most harmful economic repercussions of Scenario I are: inflation, recessions in major markets, and a simple reluctance of potential tourists to travel because of a perceived vulnerability to terrorist acts stemming from the political upheaval which caused the oil supply disruption. The initial loss of jobs and economic activity could be further worsened by the likely occurrence of a subsequent regional or global recession. The longer the recession, the greater the negative impacts, including increased loss of jobs and tax revenues. Small open economies such as the U.S. Pacific islands are especially vulnerable. Would the United States provide any type of assistance to the Pacific islands to compensate for the downstream effects of an oil supply disruption? Are they eligible for emergency aid? This is a complicated issue and cannot be resolved in this discussion. However, it should be noted that the economic impacts on the islands as a result of Scenario I are due not to a lack of oil supplies but caused by the sudden large increases in oil prices. Thus, it could be argued that it would probably be more useful and more important for the island economies to have a buffer against recessions than an SPR established on Guam or in American Samoa. However, both these options would probably be very expensive.

Discussed below are some of the likely identifiable impacts of an oil supply disruption on the island economies. In order to estimate the economic impacts of Scenario I, the East-West Center constructed a set of data (e.g., GDP) on the island economies. Because none of the islands maintain macroeconomic models, other sources were utilized to estimate the order of magnitude impacts which could then be applied to our scenario analysis for the islands during an oil price shock. The estimated economic impacts are described in the following five subsections. Data have been drawn from a range of sources. Published data from government and private sector sources have been referenced, and estimates generated as part of the energy vulnerability assessment are appropriately noted. Assessing impacts on the islands in the year 2000 based on current economic growth projections is an order of magnitude exercise. However, the best available data have been utilized and these gross estimates can and should be revised when more data become available. The section discusses the effects of an oil supply disruption on the value of petroleum imports, GDP, inflation, employment, and government revenues.

Oil Shocks and the Value of Petroleum Imports

Table 3.10 shows the impact of petroleum price increases and growth in the volume of petroleum imports. The first column shows projected rates of price increases for petroleum products under low price, base price and high price scenarios. The second column shows the most recent value figure for imported petroleum products. The value figure shown in the second column corresponds to a volume figure which is then multiplied by the demand growth scenarios in the third column (e.g., low, medium and high growth in demand for petroleum products) and the three price scenarios to indicate the estimated value of petroleum imports in the years 1995 and 2000. High, medium and low demand growth scenarios were available only for Guam and the CNMI. In addition, among the different scenarios for both 1995 and 2000, there is a scenario which doubles prices for the medium demand growth case. This doubling of prices is a result of a petroleum price increase associated with Oil Supply Disruption Scenario I, a loss of 4.5 MMBD caused by political turmoil in the Middle East and Asia. The price doubling is an estimated price increase which reflects short-term market responses, similar to those following the Iraqi invasion of Kuwait and the 1979/80 oil price increase.

The demand growth (1.2 percent per year) and a base case petroleum price increase (3.9 percent per year) result in a doubling in the value of petroleum imports for American Samoa between 1990 and 2000. The values of Guam's, the CNMI's, and Palau's petroleum imports more than double by the year 2000. The effect of a high oil price and high demand growth is a seven-fold increase in the value of the CNMI's petroleum imports. Although this may seem unlikely, demand increased by 21 percent between 1991 and 1992, and the planned expansion to the power sector indicates that growth will remain high.

Table 3.10 only assumes the indicated growth rates, which is to say that other variables such as the impact of demand-side management programs and other efficiency and conservation activities have not been factored into the analysis because data are not available. The estimates also do not reflect the impact of higher petroleum prices on consumption. For example, when gasoline prices rise, theory suggests that people will drive less. However, the experience during the recent Persian Gulf War indicates that island consumers did not curtail their driving or use of electricity when prices increased. Thus, it has been assumed that consumption rates will not be significantly affected by price increases, a very tenuous assumption.

The result of an oil price shock following political upheaval in the Middle East and Asia is a doubling of the values for petroleum imports. For comparative purposes, in 1990, American Samoa imported goods valued at $360 million and exported items worth $306 million. Under a high oil price scenario generated by an oil shock in the year 2000, the value of petroleum imports increases to $175 million. Guam, which had imports valued at $385 in 1988 and exports valued at $85 million in 1991, would have petroleum imports valued at $742 million under a high oil price and high demand growth scenario. Similarly, the CNMI, with imports at $392 million and exports at $255 million in 1991, would have petroleum imports valued at $503 million under the high oil price/high demand growth scenario. Palau, with imports valued at $25 million and exports at $600 thousand in 1989, would have petroleum imports valued at $37 million under a high oil price and demand growth scenario in the year 2000.

Given the above projected effects of an oil price shock, it is doubtful that any of the economies would be able to sustain the projected rates of growth. The cost of petroleum imports would require the use of public and private sector surpluses simply to maintain existing standards of living. Even if the oil price shock were short-lived, it is likely that the effects would have substantial repercussions on economic activity for an extended period of time. These will be discussed in subsequent sections.

The Impacts of Oil Price Shocks on GDP

USDOE estimates of the effects of a high oil price shock indicate a recession in the U.S. economy of 2.5 percent during the first quarter of impact, averaging out to a 1.2 percent decline over a 12 month period. A 2.5 percent decline has been utilized to assess the impacts of Oil Supply Disruption Scenario I on the island economies for the year on which data were most recently available and for the economies in 1995 and 2000. The projected economies are based on medium growth case rates. In addition, because it is difficult to apply the rate of decline for the U.S. economy as a whole to the small island economies, the recession rates of 3.0 and 4.7 percent have also been used to estimate the effects of an oil price shock on the island economies. The 3.0 percent recession rate is derived from the effect of an oil price doubling on the Fijian economy. The 4.7 percent decline also

Figure 3.2 Leased Storage, Defense Fuel Region--Pacific

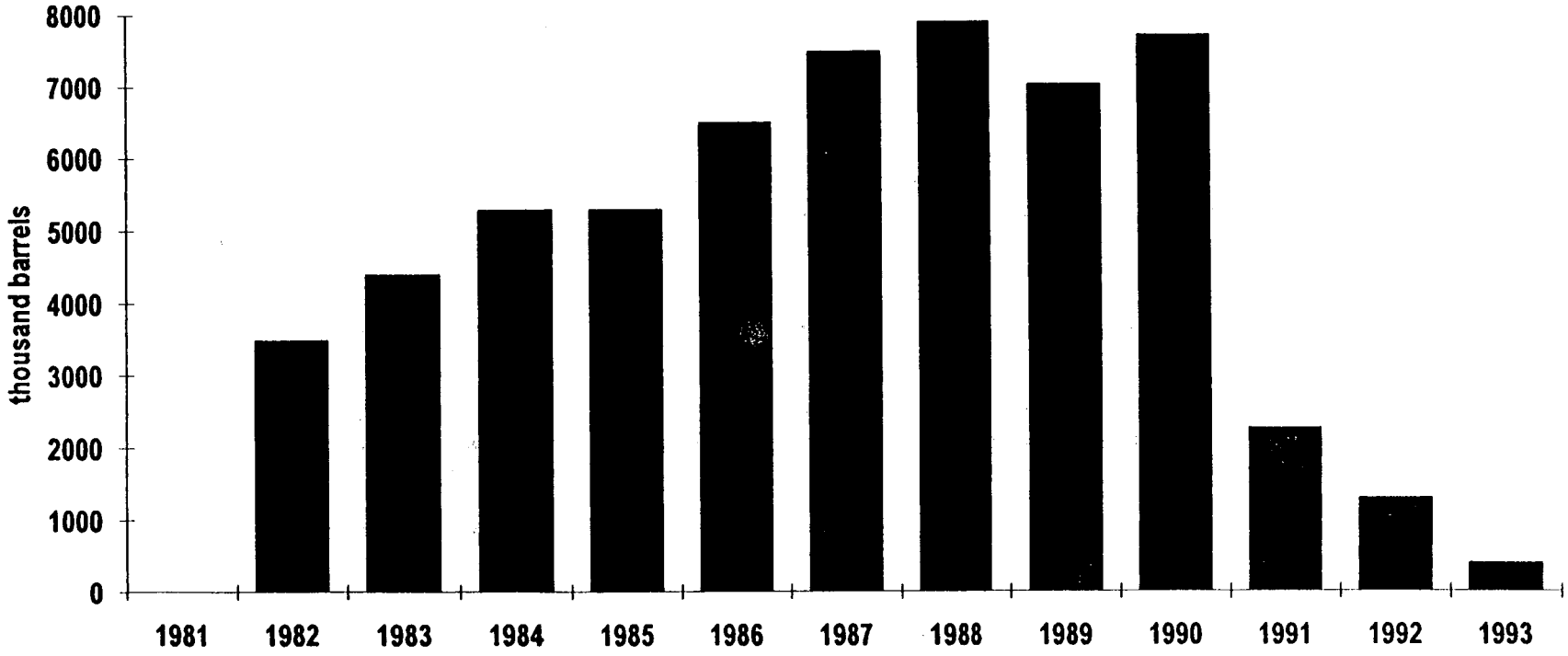


Table 3.10 Impact of Petroleum Price and Petroleum Demand Growth

Price Scenarios		Petroleum Imports 1995 $ M				Petroleum Imports 2000 $ M			
% Annual Increase in Petroleum Prices	Value of Petroleum Imports (Base Year)								
American Samoa	$34.9 (1990)	Demand Growth Scenarios-1995 Low n.a.	Medium 1.2%	High n.a	Doubling of 1995 Medium Growth Scenario	Demand Growth Scenarios-2000 Low n.a.	Medium 1.2%	High n.a	Doubling of 2000 Medium Growth Scenario
Low Case 2.0%			$50		$100		$56		$113
Base Case 3.9%			$53		$105		$68		$135
High Case 6.6%			$60		$120		$87		$175
Guam	$140.6 (1991)	Demand Growth Scenarios-1995 Low 2.0%	Medium 4.9%	High 7.5%	Doubling of 1995 Medium Growth Scenario	Demand Growth Scenarios-2000 Low 2.0%	Medium 4.9%	High 7.5%	Doubling of 2000 Medium Growth Scenario
Low Case 2.0%		$164	$178	$191	$356	$199	$249	$303	$499
Base Case 3.9%		$176	$192	$206	$383	$235	$295	$358	$589
High Case 6.6%		$195	$212	$228	$424	$297	$371	$451	$742
CNMI	$45.9* (1991)	Demand Growth Scenarios-1995 Low 7.0%	Medium 12.5%	High 18.0%	Doubling of 1995 Medium Growth Scenario	Demand Growth Scenarios-2000 Low 7.0%	Medium 12.5%	High 18.0%	Doubling of 2000 Medium Growth Scenario
Low Case 2.0%		$73	$85	$98	$170	$113	$169	$248	$339
Base Case 3.9%		$79	$92	$106	$183	$134	$200	$293	$400
High Case 6.6%		$87	$101	$117	$203	$169	$252	$369	$503
Palau	$9.40 (1992)	Demand Growth Scenarios-1995 Low n.a.	Medium 8.0%	High n.a	Doubling of 1995 Medium Growth Scenario	Demand Growth Scenarios-2000 Low n.a.	Medium 6.0-8.0%**	High n.a	Doubling of 2000 Medium Growth Scenario
Low Case 2.0%			$12		$24		$18		$36
Base Case 3.9%			$13		$26		$21		$41
High Case 6.6%			$14		$28		$25		$51

* Estimate based on 1991 CNMI price of $40.29 per barrel.

**8% growth 1992-1995, then 6% growth from 1996 to 2000.

Source: Low, Base, and High Cases from Energy Advisory # 110, Program on Resources: Energy and Mineral, East-West Center, June 20, 1993

applies to Fiji but is based on the combined effects of a price increase plus a 10 percent decline in visitor arrivals. The use of a modelling exercise on Fiji's economy has obvious limited application to the U.S. Pacific islands, including the fact that tourism has a much more dominant role on Guam and in the CNMI than in Fiji. Similarly, the export of fish from American Samoa has a much larger role than in Fiji, and by using the Fiji experience, it is assumed that the impact on the fishing industry will be similar to the effects of a 10 percent decline in tourism. This will obviously not be the case. In addition, Fiji has a comparatively more diversified economy. However, using the results of the Fijian exercise is useful because it provides a range of the potential effects of an oil price increase on the island economies beyond the experiences of the huge U.S. economy. Moreover, none of the U.S. Pacific islands have modelled the effects of an oil price shock.

The results of the analysis of the oil price shock are shown in Table 3.11. The near-term effects are relatively moderate because the assumed rate of growth for the economies is relatively high: 2.5 percent per year for American Samoa, 9 percent per year for Guam, 10 percent per year for the CNMI, and 10 percent per year for Palau. These estimates were taken from a range of sources, including documentation for infrastructure bond issues (Guam), visitor industry economic projections (CNMI), comments from government officials (American Samoa), and consultancy reports (Palau). Thus, the rate of economic growth is slowed by an oil price shock, but the actual momentum of the economy would still drive the economy forward.

Specific losses to the American Samoa economy from an oil price doubling range from $7 to $14 million in the base year to $9 to $17 million in the year 2000. Similarly, losses to the Guam economy range from $47 to $88 million in the base year to $110 to $206 million in 2000. Losses to the CNMI economy range from $29 to $55 million in the base year to $76 to $143 million in 2000. Palau's losses range from $1 to $2 million in the base year to $4 to $6 million in 2000.

However, there are problems with this analysis. The USDOE estimates for the U.S. economy assume that the oil price increase will end over a six month period and that by the end of a 12 month period the effects would have been assimilated. The experiences of Guam, Fiji, Tonga, Vanuatu and Australia during the 1979/80 oil price increase indicate that the effects of an oil price shock last much longer in smaller economies. Thus, it should be assumed that the effects of an oil price shock on the island economies will last roughly twice as long as for the U.S. economy as a whole. Figure 3.3, which compares island inflation rates with the U.S., illustrates the longer lasting effects of the 1979/80 oil price increase on the Guam economy.

Further to the argument that economic effects are longer lasting in the small island economies is the fact that once visitor arrivals begin to decline, it is difficult to quickly revive them. In January 1994, Hawaii experienced its twenty-first month of declining visitor arrivals. The cause is the economic recession on the U.S. mainland and in Japan. Would a doubling in oil prices result in a worldwide recession? The 1979/80 oil price shock was a major contributor to the ensuing recession. Similarly, the 1973/74 oil embargo and price increase was a leading cause of the subsequent economic downturn. Thus, the short-term impact of an oil price shock is to slow economic growth. However, this is only part of the equation because the world economy as a whole begins to slow through the combined effect of an oil price shock and the ensuing fall in private sector profits and personal consumption.

Table 3.11 Impacts of Oil Price Increases on Gross Domestic Product

	Base Year				1995				2000			
	GDP ($Millions)	Decline 2.5%	3.0%	4.7%	GDP ($Millions)	Decline 2.5%	3.0%	4.7%	GDP ($Millions)	Decline 2.5%	3.0%	4.7%
American Samoa 2.50%	$297 (1992)	$290	$288	$283	$320	$312	$310	$305	$362	$353	$351	$345
Guam 9%	$1,859 * (1990)	$1,812	$1,803	$1,771	$2,860	$2,789	$2,774	$2,726	$4,400	$4,290	$4,268	$4,194
CNMI 10%	$1,175 (1990)	$1,146	$1,140	$1,120	$1,892	$1,845	$1,836	$1,803	$3,048	$2,971	$2,956	$2,904
Palau 10%	$50 (1990)	$49	$49	$48	$81	$79	$78	$77	$130	$126	$126	$124

* Guam GDP value is GovGuam Dept. of Rev. & Tax estimate of Total Island Wage Income

Tourism is especially vulnerable to the combined effects of direct oil price increases which raise the costs for visitors to travel to the island destination and the secondary impacts of a worldwide economic slowdown which further reduces the number of visitor arrivals. Once tourism begins to slide in the island economies, then other industries also begin to decline as workers are laid off and personal consumption falls. Dependency on a handful of sectors results in increased vulnerability to economic fluctuations. The island economies have few other options than tourism.

The Impacts of Oil Price Shocks on Inflation

The effects of Oil Supply Disruption Scenario I on the U.S. economy have been estimated by USDOE to result in a first quarter increase in the rate of inflation of 3.8 percent, and over the course of 12 months the result is an increase in the rate of inflation of 1.8 percent. As Figure 3.3 shows, inflation rates in the United States increased by roughly 2 percent following the 1979/80 oil price increase. However, rates for Guam nearly doubled, jumping from over 12 percent to roughly 20 percent following the oil price increase. As important as the initial shock, Guam's inflation rate remained high through 1981. This could indicate that once oil price-induced inflation has been imported, then prices will remain high longer in a small trade dependent economy than in a larger continental economy such as the mainland United States, because the larger, less open economy can more readily utilize other sources of energy. Thus, the diversity and complexity of a larger economy enable it to more easily assimilate short-term price increases than smaller open economies such as those in the Pacific islands.

Guam's experience parallels those of Fiji, Tonga and Western Samoa following the 1979/80 oil price increase. Japan and Australia experienced jumps in their inflation rates similar to the U.S.rate of 2 percent. Fiji's inflation rate doubled to nearly 15 percent, Tonga's increased from 10 to roughly 28 percent, and Vanuatu's jumped from under 12 percent to nearly 28 percent. Although rates fell quickly once the effects of the price shock wore off, they remained higher for all of the island economies. Japan's inflation returned quickly to pre-price shock levels, while Australia's inflation rate actually increased. The longer lasting effects of the inflationary impact of the oil price shock on the island economies could be explained by the fact that these are all relatively small economies which are largely driven by a narrow range of export industries and tourism.

The Impacts of Oil Price Shocks on Employment

In order to assess the likely effects on employment, projected economic growth rates have been applied to private sector employment and extrapolated to the years 1995 and 2000. Public sector employment has been held constant. A 5 percent decline has been used as a measure to reflect short-term contractions in the economy. Following Typhoon Omar, Guam experienced a loss of 1,500 jobs or 5 percent of private sector employment. This provides the basis for the use of 5 percent as a measure of oil price shock impacts. A 10 percent decline has also been used to reflect longer-term impacts and is based on the Fiji modelling exercise mentioned above.

As Table 3.12 shows, the absolute loss of jobs in American Samoa ranges from 453 to 906 in the base year to 580 to 1,160 in 2000. Guam would lose between 2,400 and 2,700 jobs in the base year, and 4,700 to 9,400 in 2000. The CNMI would lose between 1,100 and 2,100 jobs in the base year and 2,700 and 5,400 in 2000. Palau's job losses would total between 200 and 300 in the base year and 400 and 900 in 2000.

Figure 3.3 Island Inflation Rates

Palau inflation data not available.

Table 3.12 Impacts of Oil Shocks on Employment

	Base Year			1995			2000		
	Employment (Year)	5% Decline	10% Decline	Employment	5% Decline	10% Decline	Employment	5% Decline	10% Decline
American Samoa	13,461 (1990)	13,008	12,555	14,652	14,139	13,627	15,999	15,419	14,839
Guam	68,870 (1992)	66,498	64,125	82,869	79,797	76,724	115,967	111,240	106,512
CNMI	25,965 (1990)	24,896	23,827	39,016	37,295	35,574	60,036	57,264	54,491
Palau	5,599 (1990)	5,425	5,251	7,726	7,445	7,165	11,152	10,700	10,248

The Impacts of Oil Price Shocks on Government Revenues

One of the key effects of an economic slowdown resulting from an oil price shock is the loss of government revenues. In order to estimate losses, a base year for which most recent data are available is used and the effects of a 4.8 percent decline on that year's revenues and the resulting impact on the budgetary surplus or deficit is computed. For 1995 and 2000, estimated government revenues are computed using the base year multiplied by the medium growth rate cases for the economies. This assumes that direct taxes will increase in proportion to economic growth. The 4.8 percent decline has been taken from the Fiji experience. No attempt has been made to assess the effects of an oil price shock on indirect taxes.

Table 3.13 shows the effects of an oil price shock on government revenues. In the base year, American Samoa has a decline of $2.1 million which leads to a larger budget deficit of $7.1 million. By the year 2000, the loss of revenues totals $2.6 million. Guam experiences a fall of $25.9 million in the base year and $56 million in 2000. Although in the base year 1991 there was a budget surplus, 1993 will likely have a budget deficit. The CNMI will experience a drop in revenue of $6.5 million in the base year and $13.8 in 2000. As a result, the budget surplus in the base year becomes a $3.5 million deficit. Palau's revenues fall $400 thousand in the base year and $1.2 million in 2000.

PHYSICAL VULNERABILITIES

The physical vulnerabilities of the islands are very straightforward: typhoons or, in the Southern Hemisphere, tropical cyclones, oil spills and tsunamis are the major local threats to the supply and distribution of petroleum products. There have been no recent incidents of tsunamis which have severely damaged port facilities including petroleum storage. The location of storage facilities is such that it would be very difficult for a tsunami to impact at the level of energy necessary to destroy the storage tanks because of the protection provided by reefs fringing the islands. However, the possibility of a tsunami, although remote, remains an issue.

The major vulnerability is to typhoon damage which could result in boats and small ships being tossed throughout the port areas and subsequent destruction of fuel docks. Saipan has had a small tanker run aground during a typhoon in its main port area. Smaller craft and equipment could be thrown into some of the tanks and docks on Saipan and Guam. Guam has experienced typhoons with wind speeds exceeding 180 miles per hour. However, Guam has multiple fuel docks which provide additional options if one dock is damaged.

Oil spills could also close a harbor. However, only Guam and Saipan are major users of fuel oil, and they are more able to respond to a spill than the other islands.

The issue with physical vulnerabilities is not necessarily the closure of a harbor or the destruction of storage facilities. Rather, what needs to be addressed is adequate storage of petroleum products in the event of a typhoon or some other natural disaster which affects docking and storage facilities. Given the size of the tank farms, all the islands have sufficient storage capacity. The oil companies always keep at least 10 days worth of supply and generally more is kept in inventories. This should be sufficient to weather the effects of a natural disaster. However, this amount would be insufficient in the event of a major supply disruption.

Table 3.13 Impacts of Oil Price Increases on Government Revenue

	Base Year			1995		2000	
	Local Revenue	Loss of Direct Taxes 4.8%	Resulting Budget Surplus (Deficit)	Local Revenue	Loss of Direct Taxes 4.8%	Local Revenue	Loss of Direct Taxes 4.8%
American Samoa	$43.0 1991	$2.1	($7.1)	$47.4	$2.3	$53.6	$2.6
Guam	$539.2 1991	$25.9	$102.6	$761.1	$36.5	$1,171.1	$56.2
CNMI	$134.6 1992	$6.5	($3.5)	$179.1	$8.6	$288.5	$13.8
Palau	$9.0 1989	$0.4	($19.6)	$15.9	$0.8	$25.6	$1.2

Finally, it should also be noted that in August 1993, Guam experienced an earthquake that registered 8.2 on the Richter scale. There was considerable damage to infrastructure, especially water and sewage systems. However, damage to the electricity system was limited to some downed transmission lines which were quickly repaired, and more importantly, one of the main power plants sustained large cracks in the floor and had to shut down one of the largest generators. Although the commercial docks at Apra Harbor sustained damage and some of the pilings collapsed, the fuel docks were reportedly not damaged. In addition, none of the fuel storage facilities appeared to receive major damage. All of the islands are in areas subject to earthquakes. To date, there have been no reports of fuel storage facilities being damaged by earthquakes. Guam's storage facilities withstood an 8.2 quake, one of the world's strongest earthquakes over the last several decades.

Vulnerability Response Issues

This section considers response issues in regards to the energy vulnerabilities which have been described in previous sections, including options to provide energy supply during a crisis, longer term alternatives to oil dependency, and policy issues relating to the management of the energy sector.

Before continuing, it should be noted that Energy Security is a concept which has been defined differently over the last several decades. Several components of energy security have emerged: physical availability of energy supplies, price security (or price stability), and economic security, or being able to insulate an economy from the effects of a supply disruptions. With the expansion of the integrated global energy industry, most observers believe that physical supply will be available. However, observers also acknowledge that regional and smaller sub-regional markets could experience major disruptions. Price security also seems to have been resolved in the context of the global energy industry and coordinated management of SPRs throughout the world. As evidenced by the 1990/91 oil price rise, prices can also decline very quickly. Economic energy security, or being able to insulate an economy from the economic effects of a price shock seems a far more difficult issue. The small islands have open economies dependent on tourism and international trade. As such, the economies are vulnerable to changes in the economies of their larger trading partners, namely Japan and the U.S. In simple terms, the sputtering coughs of a recessionary U.S. or Japanese economy causes pneumonia in the Pacific Islands. No mechanisms have been identified which can eliminate or even greatly reduce this impact. Prudential fiscal management is an important tool to reduce negative effects, but the fact remains that the islands are very vulnerable to oil price shocks.

Short-term Response Measures: Providing Energy Supply in Crisis Situations

The U.S. Pacific islands are heavily dependent on foreign suppliers for their petroleum product requirements. In the context of the large and expanding Asia-Pacific oil market, the U.S. Pacific islands will have to compete with a number of countries much larger than themselves for oil. A possible advantage of the islands over the other nations is that their small share of demand (e.g., 0.2 percent of Asia's total demand) can most likely be met without too much difficulty. On the other hand, disadvantages for the U.S. Pacific islands are that 1) the markets are so small that they could be overlooked; 2) in an environment of escalating prices, the islands lack the financial resources to effectively compete against large wealthy nations such as Japan for a scarce commodity, and; 3) the oil companies currently supplying the islands are multinational and thus may be inclined to respond first to other countries rather than a U.S. territory which presumably would be assisted by the U.S. government during a crisis.

Based on analysis of the global oil industry and specifically current and projected oil flows in the Asia-Pacific region, there are several scenarios which would prove very difficult for the U.S. Pacific islands. These scenarios are: 1) major political turmoil in the Middle East and in Asia, resulting in a net loss of at least 4.5 MMBD over a 6 month period; and 2) global catastrophe, e.g., a major war, or regionalized/localized conflicts which effectively result in the closure of major oil-producing regions such as the Persian Gulf. In both cases, Singapore refiners would have their supplies reduced by at least 25 percent, with the actual reduction probably reaching as high as 50 percent. The result would be a loss of petroleum from Singapore to the Pacific islands of at least 25 percent and possibly even exceeding 50 percent. The short-term effects would be considerable because of a doubling or tripling of prices on the now oil-short Singapore market. In addition, if there is political turmoil in Asia, then the tourism industry would be greatly affected both by higher fuel prices and the reluctance of people to travel.

Other oil disruption scenarios, including loss of production in certain West African and Latin American regions, would have limited impact on supply. Prices would increase, but the effects would probably be only temporary because of the expectation that the market would be able to adjust (e.g., oil prices first skyrocketed and then returned to near-normal levels following the Iraqi invasion of Kuwait).

Local oil supply disruptions could be caused by typhoon damage to docking and storage facilities. However, facilities have survived severe storms relatively unscathed. Thus, unless a typhoon much stronger than any storm over the last five decades directly hits the oil facilities, it is doubtful that a local event would cause a major disruption.

Guam experienced an earthquake registering 8.2 on the Richter scale in August 1993. Apra Harbor's main dock sustained considerable damage, including large cracks in the dock itself and damage to some of the pilings. There was no damage to the fuel docks or storage facilities. Although there was damage to some power facilities, including transmission lines, and cracks in the floor of one of the power plants, partial electricity services were quickly restored.

Given these potential impacts of possible disruption scenarios, there are several options to increase energy security in the islands region. These include developing a strategic petroleum reserve (SPR) on various islands, increasing the volume of on-island stocks, military assistance, access to the U.S. SPR, developing alternative supply arrangements, and reducing demand. These are discussed below as well as in the chapters on the individual island entities. In addition, the relationship between oil companies and governments and their capability and willingness to work together under crisis conditions are also addressed.

It should be stressed that the U.S. Pacific islands have not had an interruption in the supply of petroleum products since the end of World War II. There have been occasions when a tanker arrived later than anticipated because of engine failure, with the result that inventories declined to four or five days worth of supply. Prices for petroleum products in the islands have jumped sharply during oil crises (e.g., 1973/74 and 1979/80), but the supply of petroleum has been continuous.

However, it should be remembered that the islands are dependent on international transport over thousands of sea miles for the supply of basic survival items including food and medicine. During World War II, these links were interrupted for several islands, which were also occupied and

suffered a considerable loss of civilian lives. Many families still have unpleasant memories from this period of hardship. Thus, while it could be argued from a cost-benefit perspective that a regional strategic petroleum reserve would not materially improve the welfare of the Pacific islands, there is an emotional element which reflects the basic fact that no territory of the United States was occupied, attacked or threatened with attack by large contingents of enemy forces during World War II except in the Pacific islands. The contingency planners in the islands have to take account of their history and again 50 years ago, survival links were interrupted for several of the islands.

Strategic Petroleum Reserves in the Islands

Proposals to establish SPRs in the islands have included: 1) SPR sites on each of the island entities, 2) for both Guam and Hawaii to serve as regional supply centers, 3) for Hawaii only, and 4) for Guam only. In addition, there is the obvious fifth option, which is not to establish an SPR. The objectives of an SPR are to provide local supplies of petroleum products over a given time period and to provide a mechanism to affect short-term petroleum prices. However, an SPR in the islands would not be able to affect prices. An SPR could ensure some supply of petroleum but at a cost. These issues are discussed below.

The arguments to establish an SPR in the islands are based on the premise that it is necessary to have sufficient supplies of petroleum available in order to avoid deterioration in the quality of life. An SPR would provide a reserve to ensure that key health and safety functions could be maintained. Additionally, the SPR could provide a buffer against short-term petroleum price volatility. The arguments against an SPR focus on the costs of establishing and maintaining the facility. The cost issue becomes even more pronounced if the islands have other less expensive options for a secure supply of petroleum products.

Before discussing cost issues, the size of an SPR has to be discussed. SPRs have been created in some countries with storage capacity exceeding six months of demand. Some countries have established SPRs with roughly one year's supply placed in storage, while the South Pacific countries do not have SPRs and generally require the oil suppliers to keep a minimum of six weeks inventory. A three month SPR would equate to a total of roughly 2 million barrels for Guam, the CNMI and Palau, and 300 thousand barrels for American Samoa. The three month figure is used as a measure for energy security discussions. However, questions have been raised as to whether three months storage is too little or too much. The point is that there is no clear reference point to indicate the necessary size of an SPR.

With respect to costs, recent estimates indicate that it would cost $30 per barrel to build a 1 million barrel facility, or $30 million, excluding land acquisition costs. In addition, maintenance costs would be roughly $2 per barrel per year. Petroleum products would also have to be purchased, and a rough estimate of the product mix suggests a price of $25-30 per barrel. Thus, establishment costs of a 1 million barrel SPR would range between $55 and $60 million. A 1 million barrel facility could meet the combined demand for petroleum fuels on Guam, the CNMI, Palau, the Federated States of Micronesia (FSM), and the Marshall Islands for approximately 40 days. However, there is already considerable storage on all of the islands. Guam has 129 days of storage capacity, the CNMI has 75 days of capacity, Palau has 198 days of capacity, and American Samoa has 52 days of storage capacity. Guam also has 165 days of "moth-balled" (out of service) storage capacity, and Palau has 99 days of "mothballed" capacity. Current average inventories are 51 days on Guam, 31 days on Saipan,

119 days in Palau, and American Samoa requires a minimum of 10 days inventory although the average inventory is generally much higher.

The figure of $60 per barrel enables a cost estimate for a three month supply, or 2 million barrels for Guam, the CNMI, and Palau, and 300 thousand barrels for American Samoa. The cost would be $120 million plus $4 million annually for Guam, the CNMI and Palau, and $18 million and $0.6 million annually for American Samoa.

Given the existing capacities, at the cost of establishment at $60 per barrel excluding land prices, an SPR facility—whether at 1 or 4 million barrels—in the islands appears difficult to justify. Palau and Guam already have substantial storage capacity which is unutilized. The CNMI also has unutilized capacity. American Samoa may wish to build additional storage capacity but again, it appears that there is already unused capacity. However, rationalization of the storage facilities is currently under way, with some older tanks being torn down, some being repaired, and some being replaced with larger new tanks. This indicates that adequate storage to meet short-term needs will be available.

A regional SPR on Guam and/or in Hawaii also has certain cost factors. On Guam, with considerable unused and "mothballed" storage capacity already available, it would be a simple exercise to convert some of this capacity to an SPR. No additional capital costs would be required to convert the out-of-service storage facilities. However, maintenance costs would still be $2 per barrel per year plus the cost of purchasing the petroleum products. This represents a substantial savings over the cost of building a new facility. However, the cost of the petroleum for a 1 million barrel facility and the first year's maintenance would cost $30 million. At present consumption levels, this cost could be recouped by adding a surcharge of 8 to 9 cents per gallon for all fuels including those used by the power utilities and government purchased on Guam, in the CNMI, Palau, the FSM, and the Marshall Islands. However, the basic question of whether this would increase energy security by providing 40 additional days of petroleum inventory remains unanswered. Neither has it been ascertained if voters would be willing to pay more for gasoline and electricity.

It is assumed that similar cost factors would apply to the development of an SPR in Hawaii. However, because there would be more consumers using a Hawaiian SPR, there could be some savings through economies of scale.

It should also be noted that Shell Guam has indicated (February 1994) that it plans to dismantle its storage facilities in early 1995. Shell Guam's storage accounts for three-quarters of Guam's total storage. This reduction in storage would leave Guam vulnerable to a supply disruption.

Increasing On-Island Inventories

Another option to improve energy security is to increase on-island inventories. The other Pacific islands use a minimum inventory measure of six weeks or 40 days; however, a larger inventory could be maintained in order to provide a margin of safety against a major supply disruption. Price increases for the additional inventory would probably approximate the $2 per barrel per year maintenance charge mentioned above plus the cost of the petroleum products. Spread over the volume of total imports, this would not add substantially to the cost of petroleum products because stocks already average 51 days on Guam, 31 days in the CNMI, and 119 days in Palau. In other words,

Guam and Palau should be able to meet this minimum inventory level without additional cost, and the CNMI would have to add only nine or 10 days worth of inventory, or roughly 30 MB, spread over the entire year's demand of 1,140 MB. This would add only 2 cents per gallon to the price of all fuel consumed in the CNMI. The cost for American Samoa cannot be determined based on available information.

Military Assistance

Another supply option is to consider developing supply arrangements with CINCPAC. In the event of a crisis, the military's supply network, which includes tankers, could be used to guarantee the islands source access to oil suppliers. However, an international crisis may also require the full utilization of the military's tanker fleet.

Guaranteed Access to the U.S. SPR

In May 1992, a bill was introduced to the U.S. Congress, which guarantees access to the U.S. SPR for a percentage of oil demand requirements of the U.S. Pacific islands including Hawaii. What would not be guaranteed would be the transport and processing of the crude, but would be provided by petroleum suppliers. In addition, the bill indicated that the Jones Act would not be applied during emergency situations.

Under the proposal, the price paid for the petroleum would be an average of the bids submitted by the oil companies trying to acquire supply, or, in other words, the price would be the market rate. Thus, the islands would be paying at the same price but would be guaranteed supply. Also under the proposal, the U.S. Pacific islands would have priority status at SPR docking facilities. As noted above, the suppliers to the islands would be responsible for processing and chartering tankers. Oil companies could be contracted to provide ships and process crude. Crude could be processed on the U.S. Gulf Coast, the U.S. West Coast, or in Hawaii. However, it is more than likely that "wet barrels" would not be shipped between the U.S. SPR and the Pacific islands. Instead, it is probable that the oil suppliers would trade access to the U.S. SPR "wet barrels" with another supplier for access to "wet barrels" in the Asia-Pacific market.

Hawaii's refineries have a capacity of 147.8 MBD. Current demand in Hawaii approximates 140 MBD. Current demand for Guam, the CNMI, American Samoa and Palau is 18.6 MBD, 3.7 MBD, 3.4 MBD and 0.7 MBD respectively. Thus, there would be a shortfall in refining capacity of 18.6 MBD if only Hawaii's refineries were utilized to process SPR crude. With the Federated States of Micronesia and the Marshall Islands added, the total shortfall becomes 21.1 MBD at current consumption levels. However, it must be stressed that it is doubtful that consumption levels would remain at current levels if widespread political upheaval occurred in Asia and the Middle East. In addition, it is very probable that conservation programs could also reduce current consumption levels. Thus, it is quite possible that Hawaii's refineries could meet the short-term demand for petroleum products in the island entities. Although future prices for SPR petroleum during crisis situations could be substantial, this option ensures some degree of increased energy supply security for the U.S. Pacific islands. In order for this option to be implemented, the U.S. Pacific islands would have to coordinate their efforts and develop strategies to access tankers during crisis periods.

Alternative Supply Options

As mentioned in an earlier section, Papua New Guinea (PNG) is currently producing 135 MBD of crude, which is being refined in a number of Asia-Pacific markets including Australia, South Korea, Japan, Taiwan, China, Thailand, Hawaii, the U.S. West Coast, and Singapore. In December 1993, the PNG government decided to build a 30,000 bd refinery near Port Moresby.

As with other oil-exporting nations, PNG would like to receive the highest value for the exploitation of its national resources. However, if market prices are paid for PNG crude, then it might be possible to initiate discussions on some type of guaranteed supply arrangement between PNG and all of the Pacific islands. The supply agreement would have to stipulate that in the event of an oil crisis (and crises would have to be well-defined), PNG would guarantee access to supply which could presumably continue to be refined in PNG, Australia and Singapore for export to the islands. PNG may be willing to consider this arrangement if all of the Pacific islands (independent nations and territories) jointly make the proposal. However, PNG may also wish to consider some type of reciprocal arrangement whereby its access to certain goods or services would be guaranteed. This could include preferential status for trade, official lending, or other assistance mechanisms provided by the United States. It should also be noted that the PNG crude is of very high quality and would be a very good match to the configuration of the now closed GORCO refinery on Guam.

Other Asia-Pacific nations such as the Philippines and Japan might also be able to offer alternatives to supply from Singapore. Both nations have major refining facilities which could be utilized to process crudes provided via alternative suppliers. Some additional assessment of this option may be warranted.

Demand Management

A demand management plan can effectively stretch out scarce supplies, thereby reducing the negative impacts of a supply disruption. It should be stressed that demand management can be a valuable component of a response strategy.

In the event of an oil crisis, energy conservation and rationing programs, such as odd-even days for driving, would presumably go into effect. Guam has adopted Hawaii's energy emergency plan as an interim measure and is considering developing its own. The other islands do not have an emergency plan.

With respect to demand management, the data which are required to develop and implement a comprehensive program are lacking in all of the U.S. Pacific islands. However, it should be noted that Guam Power Authority has recently completed a demand-side management assessment and is developing appropriate implementation plans. Considerable reduction in petroleum consumption can be achieved by reducing the speed of automobiles, turning off certain appliances, or by setting air-conditioning thermostats at 76°F instead of 72°F. However, it is essential that more attention be given to developing an emergency plan which would include conservation programs and prioritizing end users (e.g., hospitals, security and safety) and the amounts of energy which they would be allocated.

Oil Company Relations with Government

Regardless of whether a local or regional SPR is established or if demand management plays the lead role in the next oil crisis, major oil companies will manage the bulk of the supply and distribution networks necessary to maintain the islands' access to oil. Relations between the oil companies and governments in the U.S. Pacific islands are generally very good. However, some of the oil companies do not provide the governments with all product supply and cost information. This is interesting because similar information is routinely provided to South Pacific governments. Moreover, these data are essential to planning for and managing an energy emergency. If unwilling to voluntarily provide information, the oil companies should be directed to furnish volume, value and storage data. In addition, it is suggested that consideration be given to establishing a minimum inventory level. Both of these issues will require cooperation between the oil companies and governments.

Having noted that the oil companies should provide more information and other services, it should also be stated that one of the least-cost yet most effective measures to ensure petroleum supply is to establish an attractive operational and investment environment for major oil companies. This does not mean surrendering control, but it does require government monitoring and constant interaction. Although relations are generally good between the oil companies and governments, the quality of the interaction could be improved in several islands.

Economic Buffer Fund

Although it is not a measure which would provide additional fuel supplies during a petroleum supply disruption, an economic buffer fund could be established to reduce the higher cost of petroleum during oil price shocks. Alternatively, the buffer fund could be used to offset the negative economic effects of an oil price shock by providing a Keynesian mechanism to stimulate the economy. This could include providing funds to government budgets for public sector short-term employment such as construction projects and injecting funds into key industries such as tourism. The tourism industry could use the money to offset the higher costs of air travel or to provide reduced travel packages.

Other countries have taken ,measures to protect their economies from price shocks. South Korea has established a buffer fund to offset high oil prices. In addition, there are a number of countries, including the United States, which have established commodity price support funds. Thus, there are examples of mechanisms to help offset price fluctuations. As noted in the previous chapter, higher oil prices would lead to greatly increased petroleum import bills. The cost of developing a fund based on an amount equal to a 40, 90 or 180 day supply of petroleum would be cheaper than the cost of developing an SPR, and if wisely invested, the funds could be earning interest or dividends.

However, establishing the triggering mechanisms for a buffer fund would require considerable discussion for each island entity. Furthermore, it could be argued that it would be wiser to develop a well-managed economy than to allocate limited financial resources to an event which would occur sometime in a vague future.

Summary of Short-term Responses

The following provide a summary of short-term response measures to ensure the supply of petroleum products:

- Given the costs of establishing and maintaining an SPR in the islands, it would seem that the proposal to guarantee access to the U.S. SPR should be given further consideration.
- The issue of delivering SPR petroleum products to the islands during crisis periods should be discussed with the major oil companies.
- Discussions should be held with the oil companies on establishing minimum on-island inventory levels for petroleum products. These discussions should also consider expanding current inventory levels.
- The governments should establish a format for the regular and systematized collection of data on the volume and value of petroleum product imports, cost build-ups for products, major product purchasers, an inventory of current on-island storage, and frequency of tanker arrivals.

Medium to Long-term Response Measures: Reducing Dependence on Oil

Medium to long-term response measures to the islands' energy vulnerability include developing alternative energy sources and integrated resource planning. As discussed in the overview of the energy sector (Chapter 1) as well as in more detail for each of the island entities, alternative energy options are limited. Until the economics of OTEC or photovoltaics greatly improve, the islands will remain tied to fossil fuels. Small coal units could be viable options for Guam and the CNMI. In addition, there is some scope for waste-to-energy facilities in American Samoa (i.e., tuna sludge gasification), Guam (municipal solid waste) and the CNMI. Furthermore, more use can be made of solar water heating and lighting technologies. Other alternative energy resources such as geothermal, hydro, wind and biomass have limited potential because the resources are currently uneconomic.

Considerable attention should be given to integrated resource planning including least-cost assessments of technologies and developing strategies to more efficiently plan and manage energy use. Demand-side management techniques are but one step in a process in developing a broad-based program aimed at energy conservation, energy efficiency, and cost reduction. Savings can be substantial. Traditionally, investments in the supply side have payback periods from seven years onwards, while investing in energy efficiency technologies provides paybacks in one to four years. Only when energy use is effectively managed can renewable energy technologies provide for baseload demands.

Immediate Priority: Strengthening Management of the Energy Sector

Substantial sums have been allocated to the energy sector over the last 15 years with mixed results. There is a major need to develop plans and management structures for the energy sector which reflect both short- and long-term issues and, most importantly, provide some consistency in direction for the sector. Moreover, management and planning for the sector require immediate attention.

Organization and Focus

The energy sector in each of the island entities consists of three primary players: the oil companies, the electric utilities and the government energy offices or energy officers. Although responsibilities for each have been specified, there does not seem to be any overall coordination of the sector. There are no legislative mandates for the energy offices and officers on Guam, in the CNMI, and in Palau. The American Samoa energy office has been established by the legislature but its functions seem limited to those for which funds are provided by USDOE for the conservation and renewables programs.

In some instances, the energy offices have been politicized and there has been considerable change in direction from one administration to the next. Furthermore, the energy offices have too often focused on how to end dependence on oil rather than providing a basis to manage the sector. The resulting instability reflects the lack of legislative mandate including specified functions.

Funding for the energy offices is provided from the Petroleum Violations Fund, and this money will soon (1994/95) be exhausted. It is unclear whether the costs of the energy offices will be assumed by island governments.

It is recommended that the island governments initiate dialog to determine whether or not an energy office should exist, how it should be funded and staffed, and how it should function. The results of the dialog would also enable the role of the utilities and the oil companies to be more clearly defined.

Specific consideration could be given to assigning a mandate to assess energy security issues to economic planning offices. A component of this mandate would include data collection and incorporating energy supply and demand projections into economic development planning (see below). Statistics offices and customs departments could assist with data collection. The quantity and quality of skilled personnel in the power utilities could be utilized to assist with maintaining and analyzing data. Additional funds to support this reorganization may not be required if functions are clearly defined and activities are reallocated. As part of this type of reorganization, environmental, safety, and regulatory or oversight functions for the sector must also be assessed.

Planning and Data Collection

There is an urgent need to collect volume, value, cost build-up (e.g., f.o.b., c.i.f., and shipping charges), and inventory data on petroleum products. The data should be regularly collected and represent a coordinated effort between port authorities and customs, energy, statistics, and economic planning offices. In addition, data from the utilities should be integrated with the petroleum data to establish measures to assess the role of energy in the island economies.

Assessing the role of energy in the island economies implies that considerably more emphasis has to be given to planning for the energy sector. This would include assessing the need for and costs of economic development strategies such as those promoting tourism growth. Guam, the CNMI, and Palau have all been experiencing the effects of a lack of planning for the sector. These effects are typified by the proliferation of private generators on Guam and Saipan.

It is not the purpose of this energy vulnerability assessment to suggest to island governments what their responsibilities should encompass. However, if it is determined that an energy office or administrator or an economic planning office is to be given a legislative mandate, then it is recommended that its functions should include planning and coordinating data collection.

Future Directions

It is strongly recommended that the island governments initiate a review of the energy sector. A review would provide the abovementioned dialog with considerable information on key issues and options, including an administrative structure and financing mechanisms. USDOE should be requested to participate in the review. To date, millions of dollars have been spent on the energy sector and there are numerous "demonstration projects" which are no longer working. Meanwhile, some of the islands cannot provide information on what is typically their largest import item--petroleum. This situation needs to be addressed, and it is recommended that a sector review begin within the next 12 months.

The review of the energy sector, if correctly defined and managed, would provide the basis to establish the integrated resource planning (IRP) process. This would encompass demand-side management activities, least-cost assessments of technologies and energy sources, and energy security options. Establishing the IRP mechanism should also begin during the next 12 months and be directly linked to the energy sector review. If properly defined at the outset, a sector review and the IRP process will utilize the same data and resources to provide an analysis of the current situation as well as future goals and objectives and implementing mechanisms.

These are long-term activities which should receive priority attention. The projected increases in petroleum demand and petroleum prices imply greater economic vulnerability to oil supply disruptions and oil price shocks. Combining the costs of the power systems and the bills for imported petroleum, substantial amounts are invested in the energy sector. These investment levels indicate that the energy sector should receive more attention than it has received to date and a specific emphasis should be placed on improving the management and planning for the sector.

Vulnerability issues and response options are discussed for individual island entities in chapters three through six. However, it should be noted that some of the issues and response options cannot be adequately addressed on an individual level: the international oil companies do not, for example, view Guam, the CNMI and Palau as separate isolated markets. Similarly, supply for American Samoa will be via Hawaii until fuel standards become uniform throughout the South Pacific. The economies of scale for the global energy industry dictate prices and supply arrangements which often supersede policies and plans.

Thus, the Pacific islands are "price takers" and wholly dependent on the oil industry. The oil industry would not consider this a vulnerable situation because it has provided supply without interruption. However, many governments would view this situation as being extremely vulnerable.

Four

AMERICAN SAMOA

INTRODUCTION

The Territory of American Samoa, an insular possession of the United States, comprises the eastern islands of the Samoa group; the western islands constitute the independent nation of Western Samoa. Specifically, the chain of islands known as American Samoa includes Tutuila, the main island, Aunu'u off Tutuila's southeast coast, the Manu'a group 63 miles to the east, and the Rose and Swains atolls. Total land area is approximately 76 square miles. These seven tropical islands have the distinction of being the only part of the United States in the Southern Hemisphere and are in fact closer to New Zealand than to Hawaii.

The main island of Tutuila is comprised of a continuous, irregular volcanic ridge that rises steeply from the ocean. It is about 20 miles long and from one to six miles wide, with very little area suitable for settlement. On Tutuila where more than 90 percent of the population lives, eight of the total 53 square miles of the island have ground slopes of less than 20 percent. However, what is lacking in habitable land is compensated for by Pago Pago Harbor, which has proven to be well-suited for a commercial port.

The tropical climate of Samoa is subject to seasonal dry and wet cycles, but the temperature remains relatively constant at an average of 80° Fahrenheit. Humidity tends to be high, but its effects are reduced through frequent trade winds. Rainfall averages about 125 to 250 inches per year. These islands are subject to severe storms as illustrated in 1990 by Cyclone Ofa which devastated Tutuila with recorded winds of 107 mph.

The population of American Samoa has increased 58 percent in the period between the 1980 and the 1990 censuses. The 1990 census count of the total population of American Samoa was 50,900, an increase of 58 percent over the 1980 census count of 32,297. This increase represents an average annual population growth rate of 4.7 percent. Prior to the late 1980s, population growth typically averaged less than 2 percent per year. Since 1985, however, growth has accelerated primarily due to emigration back to American Samoa. Economic recession on the U.S. mainland has increased the attractiveness of American Samoa to Americans of Samoan descent. In addition, and possibly having more impact then returning citizens, immigration from Western Samoa adn Tonga has been substantial over the last decade. The population is projected to keep growing at a rate exceeding 2 percent per annum.

According to the most recent census data, 89 percent of the population are Samoans, with other Pacific islanders (mainly Tongans) making up 4 percent, while the white and Asian groups each account for less than 2 percent of the total population.[1] However, 30 percent of the population (14,241 persons) are citizens of Western Samoa residing in America Samoa.[2]

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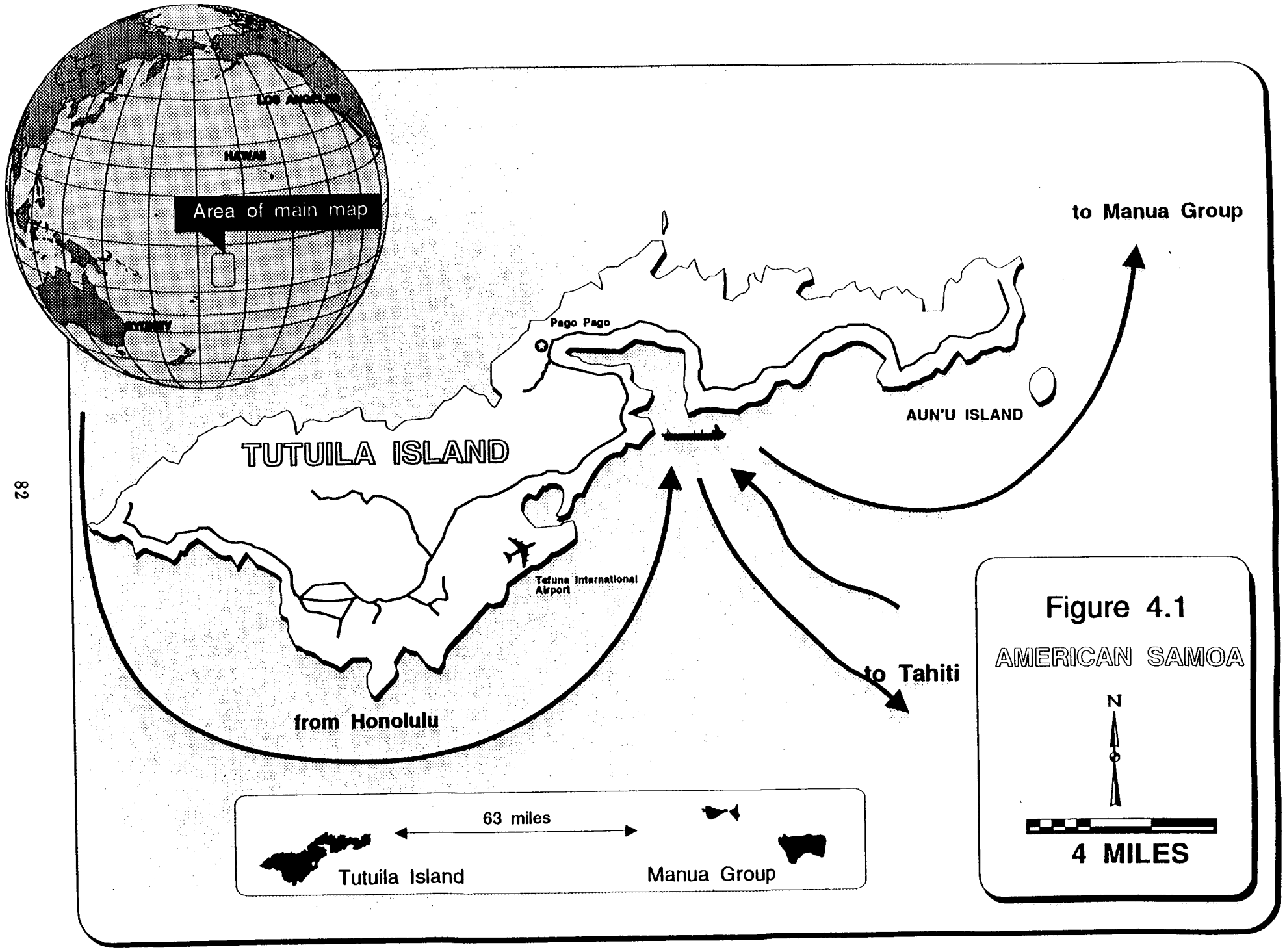
[1]Racial classifications used here are taken from the U.S. Department of Commerce Bureau of the Census, *The 1990 Census of Population and Housing for American Samoa.*

[2]*The 1990 Census of Population and Housing: American Samoa*, Table 47.


Area of main map
HAWAII
to Manua Group
Pago Pago
AUN'U ISLAND
TUTUILA ISLAND
Tafuna International Airport
to Tahiti
from Honolulu
63 miles
Tutuila Island
Manua Group
Figure 4.1
AMERICAN SAMOA
N
4 MILES

The original inhabitants of the Samoan islands were Polynesian seafarers estimated to have arrived in the islands some 1,600 years before the birth of Christ. These people—closely related to Tongans, Tahitians, and Hawaiians—evolved their own complex social structure, which even today affects land use and ultimately has a bearing on the patterns of energy use. The social structure is built on the extended family, which can include hundreds of relatives. Heading these larger family units are the *matais*, or chiefs, who guide the traditional economy and oversee land use and the overall well-being of the people. Since more than 90 percent of the land is communally owned, the massive influence of the extended family system can be easily understood.

Economic Overview

In American Samoa the collection and maintenance of economic and financial data have only recently begun. Economic data are limited and the lack of commonly used economic statistics, such as those on the gross domestic product and its components, make quantitative evaluations of the standard of living in American Samoa difficult. However, a sampling of other indicators presents a picture of an economy growing at a very slow pace.

American Samoa's economy generates income from two principal sources: the American Samoan government and the two tuna canneries located in the islands. Other economic activities, primarily trade and services, are supported by the two dominant sectors. Agriculture, although a primary sector, is so small in American Samoa that its contribution to cash income is negligible and generally provides only for subsistence needs.

Tourism is not a major factor in American Samoa's economy. The islands have not shared in the tourist boom experienced in the western Pacific in the 1980s. American Samoa has little tourist infrastructure and needs to increase promotion of tourism and improve its international travel services.

American Samoa's current narrow economic base is not adequate to meet the demand for employment by its young people. The American Samoa government has sought to diversify its economy by seeking outside investments in light industries, farming and fishing, tourism and regional trade and services. However, the disadvantages of a remote location, the lack of skilled manpower, limited infrastructure and the lack of significant comparative advantages (such as labor cost) over other Pacific sites have yet to be overcome.

GDP and Income

American Samoa does not measure the gross domestic product.[3] However, other indicators point to gains in the standard of living since 1980. Mean income for individuals has increased from $6,159 in 1980 to $9,298 in 1990. Median household income has increased from $9,718 in 1980 to $16,114 in 1990. According to revised 1990 census data, the total income earned in American Samoa equaled $154,481,500[4] indicating that American Samoa's per capita income is $3,035, up from $1,845 in 1980.

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[3] *A Report on the State of the Islands*, U.S. Department of the Interior, June 1992, p. 10.

[4] *The 1990 Census of Population and Housing: American Samoa*, Tables 95 and 108; and communication with the Territorial Energy Office on 22 October 1993.

that American Samoans enjoy what may be considered an adequate standard of living, given the limitations within which they produce goods and services. Isolation, a lack of mineral resources, limited infrastructure and a shortage of skilled labor in scientific and technological areas make economic development and rising income levels difficult to achieve. A steady flow of U.S. federal funds has helped keep income levels up and provided a very favorable sense of equitable income distribution. There are also obviously a great number of intangible attributes of the territory that cause the local standard of living to be higher than can be measured by dollar incomes.

Employment

The American Samoa economy is concentrated in a handful of sectors. As Figure 4.2 shows, the government and the tuna canning industry are the major employment sectors. Of the total labor force of 14,198 workers (about one-third of the population), 33 percent are employed by either the American Samoa government or the federal government. The tuna canneries employ almost the same number of people in their food manufacturing process. Several other large companies exist that primarily service, repair, and fuel the fishing boats, and a secondary economy exists consisting of retail establishments and service businesses. There are approximately 1,500 private businesses in Samoa.

Data from the recent census also revealed that 54 percent of the employed work force in American Samoa were not American Samoans, but alien residents living in American Samoa. Most of these employed aliens (94 percent) have permanent residence in American Samoa. Eighty-six percent of all the resident aliens in American Samoa were born in neighboring Western Samoa.[5]

Prices

The American Samoa consumer price index (CPI) was first developed in the early part of 1974 and the selection of weight distribution was based on data on the imports of merchandise into American Samoa in 1970/71. The weight distribution of this index was later updated using household expenditure patterns from a household income and expenditure survey conducted in 1982 by the American Samoa Economic Development Planning Office. On the average, the CPI index for American Samoa has been climbing at an annual rate of about 4.2 percent since the new CPI was developed in 1982. Figure 4.3 shows both the American Samoan and U.S. inflation rates over the past ten years.

Trade and Business Growth

In 1990, the value of imports into American Samoa reached $360.4 million dollars, representing a decrease of 5 percent over the previous year. Imports for the tuna canneries accounted for the item with the largest value at $187.2 million and represented 52 percent of the value of all imports that year. The primary export from American Samoa was canned tuna, which had a value of $296.6 million and accounted for 97 percent of total exports. In 1990, the value of American Samoa's imports exceeded the value of its exports by $54.3 million or 18 percent.

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[5]*The 1990 Census of Population and Housing: American Samoa*, Tables 47 and 78.

Figure 4.2 American Samoa Employment by Sector

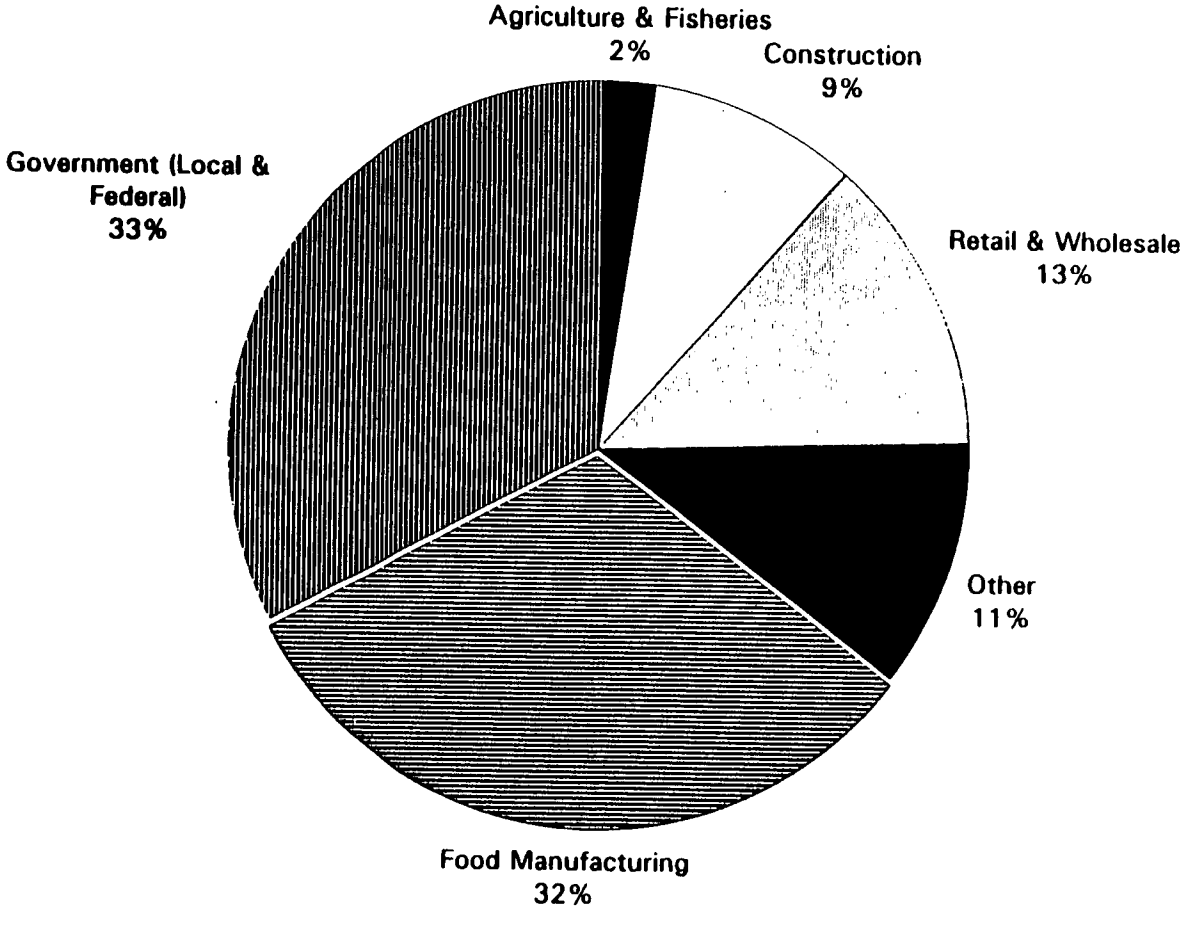
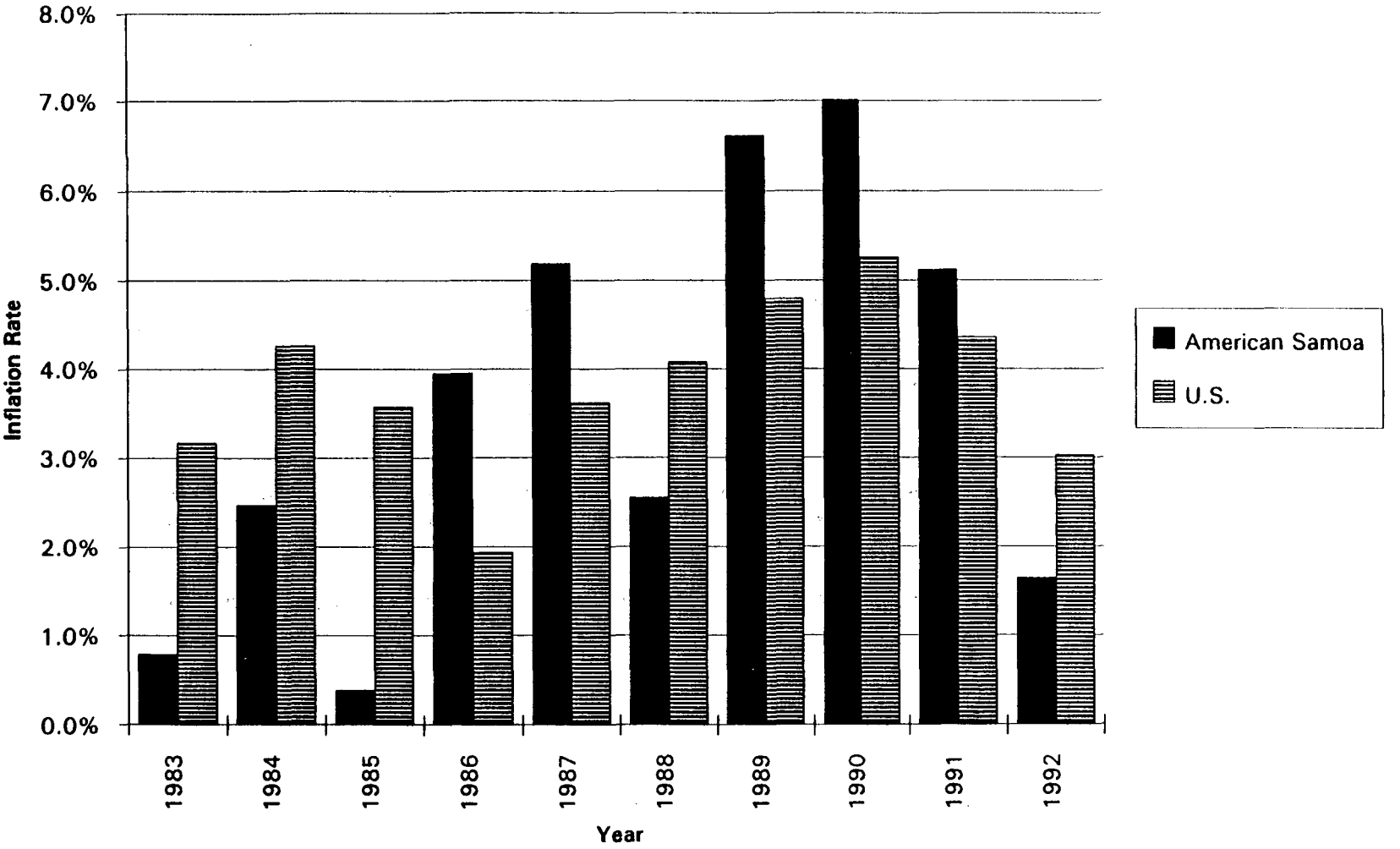


Figure 4.3 American Samoa and U.S. Inflation Rates



The fish canning industry is clearly the major source of income for American Samoa. The American Samoa government is aware, however, of the vulnerability of an economy with just a handful of industries and has instigated efforts to diversify the economy through a variety of development projects. These include the Senator Daniel Inouye Industrial Park, which is a 95 acre park totally committed to industrial usage. A planned expansion of this industrial park by about 10 acres for small manufacturing is under way. Another project involves the construction of an access road through the Tafuna Industrial Park that will require nearly $1 million from the U.S. Economic Development Administration. This road will facilitate the rebuilding of damaged industrial structures and allow for full development of this industrial park.

Many other smaller projects are under consideration for development. These include the airport shop reconstruction, an agricultural marketing and supply system for Manu'a, an aerial survey of America n Samoa, a waste management initiative, a wetlands management plan, an investment brochure, a slaughterhouse, and a national park economic development plan. These projects have not been discussed in detail due to the small nature of the funding; however, this does not imply that the impact may not be large. In the case of national park development, such a plan could enhance the visitor industry and eventually increase economic activity.

Key Sectors

The Tuna Industry

Canned tuna and related fish products account for virtually all exports from American Samoa in both quantity and dollar value. Fish canning is also American Samoa's principal manufacturing activity and the mainstay of the private sector economy. Within the tuna industry, two large canneries, Samoa Packing and StarKist, employ almost 32 percent of the labor force and generate over $25 million in wage income. Both canneries have expanded their production capacity and now export over $300 million worth of canned tuna and related products, approximately 98 percent of American Samoa's total exports. The two canneries also account for over half of the imports to the island. A new can-making plant has been built by StarKist and will require approximately 4 MW of power.

The attraction of Pago Pago's harbor and American Samoa's special access to U.S. markets under Headnote 3(a) of the U.S. Customs Schedule drew the canneries to American Samoa in the 1970s. Canned tuna may be imported into the United States free of any duties or quotas, provided 30 percent of its value has been added in American Samoa. These plants provide one-half of the domestically canned tuna consumed in the United States which represents an enormous market share.

In recognition of the economic benefits of the two canneries, the government of American Samoa has provided a variety of incentives. Among them are long-term lease agreements and exemptions from certain taxes. The canneries for their part have also made large investments in plant and equipment, although virtually all of the canneries' employees are alien workers from Western Samoa.

Government

The Constitution of American Samoa defines the basic governmental and legal organization of the territory. It provides for executive, legislative, and judicial branches. The governor and lieutenant governor heading the executive branch are popularly elected to four-year terms. The American Samoa government (ASG) provides all the services offered by the city, county, state and even federal levels of

government in the United States. It is responsible for the usual governmental services such as public safety, public works, and community development. However, it also has Agriculture, Immigration, and Marine Resources departments. It owns and operates the electric utility, a water and sewer utility, the port, the airport, the phone company, the hospital, a public school system, a college, and the television station. In total, there are 24 offices and departments, including the Territorial Energy Office (TEO), which report directly to the executive branch.

The ASG has been reported to perceive its role in the social and economic development of the island as a provider of jobs and income rather than a provider of services.[6] ASG counters that it plays the key role in attracting, guiding and controlling new investments and enterprises. However, the use and distribution of federal funds has, in fact, been a primary function of the ASG over the last 30 years.

An account of the revenue and expenditure streams of the American Samoa government can be found in Table 4.1. The American Samoa government's 1991 revenue stream of $103 million represented a decrease from the 1990 level of $128 million; expenditures also decreased from $127 million to $108 million, generating a deficit of over $5 million. It should be noted, though, that only 41 percent of the American Samoa 1991 revenue came from local sources. Contributions from the U.S. federal government accounted for most of the rest of the 1991 revenue. The primary areas of spending are education and culture, health and welfare, and general government.

The American Samoa government currently has severe budgetary problems. Although local revenues have shown some steady, if modest, growth, government spending has far outstripped these gains. Tax collections lag far behind assessments, and additional revenues from new taxes have failed to contribute significantly to the reduction of the deficit. The government has resorted to tapping special funds, like the government employees' pension fund, to make up for some of the shortfalls.[7]

Reliable estimates place American Samoa's cumulative budget deficit in the $20 to $30 million range. The inspector general of the U.S. Department of the Interior, who was invited to audit the local government accounts by the governor, estimated the total debt of the American Samoa government to be as high as $60 million. This figure, however, includes $25 million in government debts to vendors which are not due yet and a $5 million loan from the retirement fund.

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[6]*An Economic Assessment of American Samoa*, Bank of Hawaii, Fall 1988, p. 6.

[7]Michael Eastly, "100th Issue Special Report—AMERICAN SAMOA," *Pacific Magazine*, July/August 1993, p. 35.

Table 4.1 American Samoa Government Revenues and Expenditures
($ thousands)

	1991	1990	1989	1988	1987
Local Revenue	$42,950	$46,441	$35,457	$40,261	$37,167
U.S. Federal Revenue	$53,914	$79,953	$52,198	$48,789	$51,079
Other Revenue*	$ 6,639	$ 1,700	$ 801	$ 1,270	$ 1,599
Total Revenue	$103,503	$128,094	$88,456	$90,320	$89,845
Total Expenditure	$108,555	$127,312	$97,533	$93,157	$86,309
Surplus (deficit)	($5,052)	$ 782	($9,077)	($2,837)	$3,536

*"Other Revenue" is defined as transfers of funds between Governmental Fund groups, per *American Samoa Government Comprehensive Annual Financial Report*, September 30, 1991, p. 13.

Tourism

While tourism does not rank in economic importance with the tuna industry or the government, it is discussed here mostly due to its growth potential. The local tourism industry is small, and there are only 205 hotel rooms in the territory. While tourism declined in the early 1980s, it recently began to increase with 11,461 tourists visiting in 1991. Much of the decline in the 1980s was due to reduced air access from the United States, Australia, and New Zealand as a result of the airline industry's progression to long-haul jet aircraft which now bypass American Samoa.

Environmental tourism has been identified as a specialty market which could bring more tourists to the islands. The American Samoa Office of Tourism and International Affairs has helped fund a market analysis to develop more tourist attractions in American Samoa. It is hoped that on-going improvements in jet transportation, continued upgrades in the local Rainmaker Hotel and expansion of government tourism development assistance (national park development) will create a growth industry in tourism.

ENERGY SECTOR

Overview

American Samoa is completely dependent on imported petroleum for commercial energy. Petroleum is the energy source that powers American Samoa's transportation sector and generates its electricity. Data from the 1990 census show that 94 percent of American Samoa's households are electrified and over half have at least one motorized vehicle. The island's tuna canneries also rely on petroleum as the source of energy for the steam raising and refrigeration critical to the canning process. Because of petroleum's importance, a "fuel coop" consisting of the oil company supplying American Samoa, Broken Hill Propietary Petroleum Americas (BHPPA), the Attorney General and the American

Samoa Power Authority, has been formed to coordinate issues regarding petroleum supply, prices and storage.

The purpose of the American Samoa Petroleum Cooperative (COOP) is to ensure that there is a reliable and consistent supply to uniform high quality petroleum products at a reasonable cost. The COOP also oversees maintenance and management of petroleum storage and dock facilities. In addition, the COOP has a major role in the implementation and monitoringof relevant Federal acts including OPA90 and the Clean Air Act. It should also be noted that American Samoa is not covered by the Jones Act, which means that transport costs between the U.S. West Coast and Singapore are not significantly different.

In America Samoa, biomass, solar, geothermal, and hydro resources have little to offer for large-scale power systems and their use will probably be confined to small-scale applications in the foreseeable future. The utilization of tuna sludge to generate methane has been proposed over the years as well as the employment of OTEC technology, but these ideas are still in the feasibility-study stage. Alternative renewable energy sources cannot realistically be expected to replace petroleum as the primary fuel of American Samoa in the near term.

Supply and Demand for Petroleum Products

According to information supplied by the oil company operating in American Samoa, the 1993 demand for petroleum was 1.234 million barrels. Ten years ago, in 1983, American Samoa consumed 1.06 million barrels of petroleum products, which indicates an annual average growth in petroleum consumption of less than 1.6 percent over the past decade. Petroleum fuels are shipped by tankers from Hawaii to American Samoa solely by Broken Hill Proprietary Petroleum Americas (BHPPA). Shell Oil also supplied the islands until its recent withdrawal because the market is too small to support several suppliers. Mobil Oil was at one time involved in the market; however, it too has withdrawn, leaving only BHPPA. Prices are based on spot prices (Singapore and Los Angeles) plus charges for freight, handling and profit margin. Prices are ultimately controlled by the *Maximum Allowable Price* (MAP) formula, which is stated in the operating permit and supply agreement between the American Samoa government and BHPPA. The MAP formula is reviewed annually in order to establish competitive pricing for American Samoa.

In 1993, American Samoa's demand is heavily weighted towards diesel. In fact, diesel comprises 72 percent of demand, while Mogas and jet fuel comprise 10 percent and 15 percent, respectively, of demand. Diesel demand is associated with the two canneries, the fishing fleet of 500 vessels which support the canneries, and American Samoa Power Authority's fuel needs for electricity production. Jet fuel requirements are essentially for Hawaiian Airlines, Polynesian Airlines, and the Military Airlift Command; aviation gas is used for the single- and twin-engine aircraft which operate between Pago Pago and Apia as well as the outlying islands of Manu'a. In addition, avgas is also used by the helicopters in the tuna fleet.

The most recent figures quantifying the end use of petroleum products are for 1989 and are shown in Table 4.2. However, recent audits indicate that in 1989 figures could vary by 8.6 percent. Most of the petroleum imported into American Samoa (68 percent) is consumed in the transportation sector which includes the fuel sold to the fishing vessels associated with the canneries. The rest of the fuel consumed is split fairly evenly between that which is used to generate electricity and that used forother miscellaneous purposes, including cannery applications.

Storage and Distribution System

The government of American Samoa stipulates that there must be a 10-day supply of fuel on hand at all times. To honor this agreement and keep the island supplied, BHPPA Hawaii ships petroleum products on 30,000 deadweight ton ships every three to six weeks. Tankers are off-loaded at a facility adjacent to the Rainmaker Hotel.

While there are product storage tanks maintained by the canneries and American Samoa Power Authority (ASPA), the predominant capacity is at the Utulei Tank Farm (Figure 4.4, which is not drawn to scale). Table 4.3 lists the tank storage capacity available at the tank farm in addition to the satellite storage facilities at the airport. As of February 1993, 168,000 barrels of storage capacity were available. This represents a decrease in capacity from prior years due mainly to the aging of the tanks. Ten days worth of oil supply on American Samoa amount to almost 34,000 barrels, or about 20 percent of the current storage capacity. In addition to this storage capacity, ASPA has two tanks at Tafuna with capacity totaling 571 barrels and one tank at Satala with a capacity of 2,300 barrels. The American Samoa government and BHPPA plan to build two additional 55,000 barrel diesel tanks within the next 18 months (now 1/3 completed), and one or two more tanks could be added over the next several years. With this incremental storage, American Samoa will have 60 days of storage for all petroleum products.

There are three fuel lines running along and crossing under the coastal highway from the off-loading dock to the Utulei Tank Farm, which is government owned, yet operated by BHPPA Hawaii. Products are trucked from the terminal to the various end users, which include ASPA, the tuna canneries, airport, and the vehicles on island. The fishing fleet is supplied by pipeline. According to the American Samoa Department of the Treasury, there were ten gasoline service stations on the islands in 1990.

While the Territorial Energy Office has monitored this petroleum supply activity in the past, its primary focus has now been shifted to the development of alternative energy and conservation policies. ASPA currently monitors the petroleum supply activity in American Samoa.

Future Developments

Demand Projections

The proportion of demand associated with each product is not seen to change significantly in the future. An estimated growth rate of 1.2 percent per year has been suggested by BHPPA which suggests that total demand will grow from 1.228 million barrels in 1993 to 1.289 million barrels in 1997. Of this 61,000 barrel increase, diesel demand is projected to account for half. Diesel demand is estimated to rise from a 1993 level of 882,000 barrels per year to approximately 912,000 barrels in 1997. However ASPA Officials have also urged caution on using the demand projections because the large swings in consumption by the tuna fleet.

Table 4.2 End Use of Petroleum Products in American Samoa, 1989
(thousands of barrels)

Product	Transportation	Electricity Generation	Other (Includes Canneries)	Total
Gasoline	118.0	--	--	118.0
Jet Fuel	164.0	--	--	164.0
AvGas	2.6	--	--	2.6
IFO	5.2	--	34.9	40.2
ADO	556.6	200.8	155.1	912.5
Total	846.4	200.8	190.0	1237.3
Percent	68%	16%	15%	100%

Table 4.3 Major Petroleum Storage Facilities in American Samoa
(as of February 1993)

Location	Volume (barrels)	Fuel
Utulei Tank Farm and Airport	24,000	Gasoline
	38,000	Jet Fuel
	91,000	Diesel
	2,000	AvGas
	13,000	IFO
ASPA (Tafuna & Satala)	7,000	Diesel
Starkist Cannery	≈530	IFO

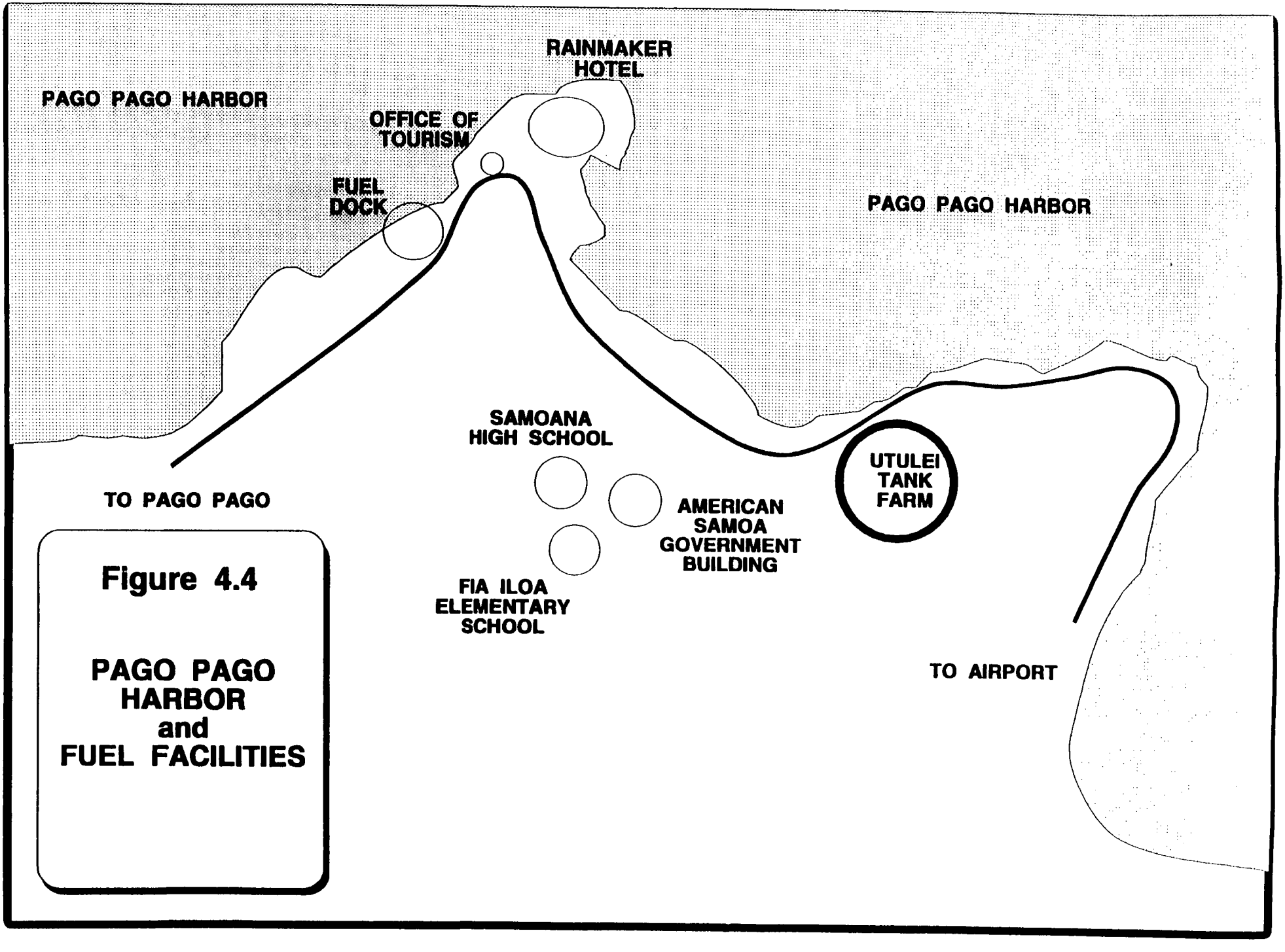


Figure 4.4

PAGO PAGO HARBOR and FUEL FACILITIES

Fuel Dock Reconstruction

The existing fuel dock was built in 1942 by the U.S. Navy administration and has deteriorated. This dock is the territory's only facility for fuel discharge and loading. A $4.6 million project of the U.S. Economic Development Administration , Department of the Interior, and ASG will repair the facility and allow for safer transfer of fuel.

Faleasao Boat Relief Harbor

The U.S. Department of the Interior and the American Samoa government have also planned a $1.2 million project to construct a relief harbor at the village of Faleasao to provide safe berthing of interisland cargo vessels during periods when navigation is hazardous at the existing harbor on the island of Ta'u.

The Oil Spill Pollution Act of 1990

Regulations that are to be promulgated under the Oil Spill Pollution Act of 1990 (OPA 90) have the potential to significantly affect the American Samoan petroleum sector. This legislation was largely a congressional response to the Exxon Valdez spill in Alaska. It focuses heavily on defining the financial responsibilities of the owners/operators of oil tankers and shore facilities (tanks and tank farms). This law places the burden of establishing and maintaining adequate containment and cleanup capabilities on these owners/operators. It also requires that these owners/operators obtain certification of financial responsibility to prove they could cover potential liabilities from the cleanup of a spill and from the losses resulting from a spill, including environmental damage and losses of income (both cash and subsistence) for those who depend on the resources damaged by the spill.

On the mainland United States, oil companies have responded to this law by forming a group called the Marine Spill Response Corporation (MSRC). By banding together to manage catastrophic spills and to meet the other demands of this bill, these companies are able to lower the cost facing individual companies that try to comply with this legislation.

The oil spill act has resulted in a number of activities in American Samoa. First, U.S. Coast Guard and EPA OPA 90 compliance manuals have been approved and put in place by appropriate BHPPA. Second, agreements have been undertaken with the MSRC in California to provide back up support for clean up activities from Hawaii, where petroleum products are sourced. Third, in Hawaii, the Clean Island Council is on standby to address Tier 4 spills and clean up in American Samoa. Fourth, over $1 million worth of oil response equipment has been sited in American Samoa to meet the clean up requirements specified in OPA 90. Fifth, appropriate American Samoa government, ASPA, and BHPPA staff have received training in oil spill response.

Electricity

On the main island of Tutuila there are two diesel generator power plants, one at Satala near the canneries on Pago Pago Bay and the other at Tafuna near the airport. The Satala plant is the older of the two stations; its first generator system was installed in 1962. The first generator in Tafuna was installed in 1974. The grid from these two stations serves all of Tutuila, and an underwater cable connects the grid to Aunu'u Island. In the Manu'a island group there are two generators each on Ofu and Ta'u. All villages in the Manu'a group are connected to the grid. Swains Island has only a small diesel generator.

These power generating stations are all owned by the American Samoa Power Authority. Until 1981 the stations were operated and maintained by the Electric Utility Division (EUD). In 1981, the EUD was replaced by the American Samoa Power Authority (ASPA), which was funded by the U.S. Department of the Interior. ASPA is governed by a five-member board of directors that is responsible to the governor of American Samoa and has the right to enter contracts, purchase and lease property, and suggest rates. Public hearings are held for charge rate increases.

ASPA can use rate increases to supplement its budget or it can request money from the legislature. However, ASPA receives no subsidies from government. In addition, as in the past, money can be obtained from the U.S. Department of the Interior or for large capital improvement projects.

Total installed power generation capacity in American Samoa is approximately 29.9 MW (Table 4.4). The peak load has increased from 15.3 MW in 1989 to approximately 17.38 MW in 1992. Commensurate with this increase, the system generation has grown from 87.23 GWh to over 108 GWh in 1992. Electricity consumption continues to increase.

Table 4.4 Selected American Samoa Power Sector Indicators

Selected 1992 Data			
Installed Capacity	**Peak Load**	**Fuel Efficiency (kwh-sold/gal)***	**Fuel Consumed (barrels)**
29.9 MW	17.4 MW	10.36	215,778
1990 Electricity Consumption by Sectors (MWh)			
Total Consumption	**Government**	**Residential**	**Commercial**
86,432.0	20,062.9	24,198.5	42,170.7
	23%	28%	49%

* Assumes 13.2 percent losses.

While power generation has increased, line losses have been reduced from 13.5 percent of gross generation in 1989 to 13.2 percent in 1990. This continues a trend toward lower line losses resulting from improvements in the distribution system and correction of metering deficiencies.

Of particular interest is the fuel consumption in power generation. Fuel consumption in power generation has actually decreased since 1991, despite an increase in demand. This is primarily due to the improved efficiency of the new generators being brought on line. ASPA has its own diesel storage facilities with a capacity amounting to some 124,000 gallons, or about 3,000 barrels. This amounts to approximately a 6 day fuel supply. ASPA does not currently have the intention to build more storage since no supply disruptions have occurred and the agency wants to keep its working capital at an economic level.

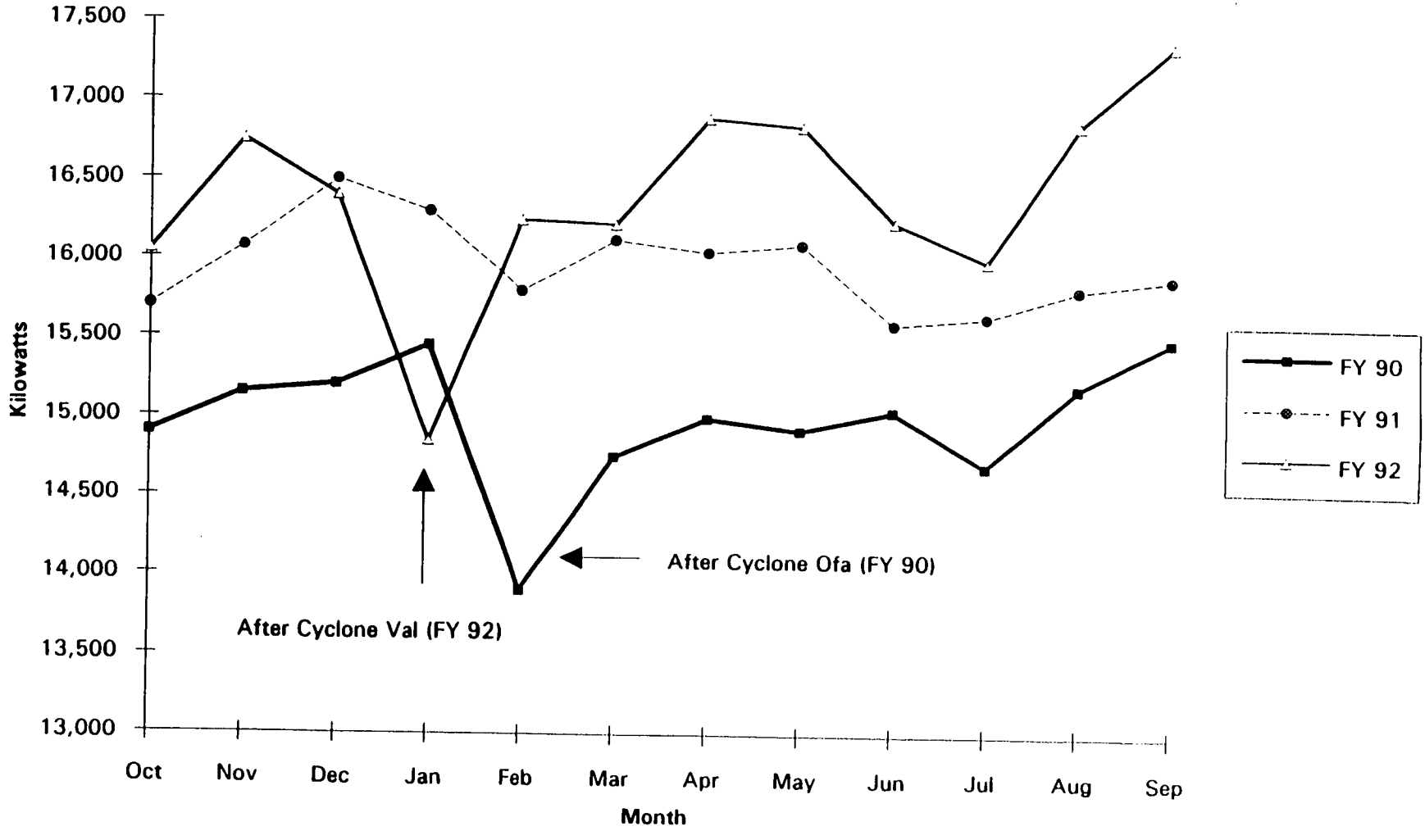
Information from ASPA's annual report is provided in Table 4.5. The percent of the power division's operating cost represented by fuel was 38 percent in 1990. However, during this same year large expenses due to cyclone damage and equipment write-offs were also recorded.

Table 4.5. ASPA Financial Highlights

1990 ASPA Finances		
	Power Division	ASPA (Total)
Total Revenues	$16,335,879	$19,012,358
Operating Expenses	12,666,090	14,584,730
of which, Fuel	6,602,931	
Nonoperating Expenses	(6,972,883)	(7,882,175)
ASPA Income (Loss)	($3,303,094)	($3,457,215)
1990 ASPA Assets & Debt		
Electric Plant	$14,151,080	
Other Utility Plant Assets	$27,305,033	
Other Assets	$6,523,661	
Total Assets	$47,979,774	
ASPA Debt 9/30/90	$437,465	

• Includes 1990 cyclone damage and equipment write-offs.

Figure 4.5 Tutuila Peak Load



UNIQUE VULNERABILITY TO OIL SUPPLY DISRUPTIONS

There are four characteristics of American Samoa and its energy sector which demonstrate unique (compared to rest of the United States) vulnerability to oil supply disruptions. First, American Samoa is totally dependent on imported petroleum and does not have any realistic economic alternative to petroleum. Second, there are no useful indicators to assess the comprehensive effects of an oil supply disruption or oil price increase because the data are lacking. Lack of a means to measure these effects is a major vulnerability because there is no guide for the future. Third, American Samoa is highly vulnerable to tropical cyclones, which are the most frequent and obvious threats to oil supply. Fourth, a severe supply and presumably price disruption would devastate American Samoa's economy which is based on imported goods and the tuna canneries.

Data on the impacts of past oil crises on the American Samoa were unavailable because data have been collected only for the last several years. However, in order to provide a reasonable basis for assessment, the effects on the 1973/74 and 1979/80 oil crises on Fiji, Tonga and Vanuatu were analyzed based on a study of these economies which utilized a social accounting matrix (SAM) model. While the independent island nations have economies which are not as monetized as the U.S. Pacific Islands, there are a number of similarities including the openness of the economies, concentration of economic activity in but a few sectors (Fiji and Vanuatu have comparatively large tourism sectors), dependence on oil imports for commercial energy, relatively large public sectors, dependence on imported manufactures, machinery, medicine and food. All of the Pacific islands are "price-takers" subject to external events which they are unable to control. Although there are differences between the economies of the U.S. Pacific islands and those of independent island nations (e.g., per capita income is much higher in the U.S. Pacific islands), the results of the 1973/74 and 1979/80 analyses provide order of magnitude indications as to how the U.S. Pacific islands could be impacted by oil price shocks. The order of magnitude indications were corroborated by the data which were available as well as by comments by government and private sector officials including on-island banks. Thus, estimates on the economic impacts of oil price shocks have been made using the best available information.

Oil crises in 1973, 1979/1980, and in 1990 did not result in any supply interruptionsfor American Samoa. The oil company which supplies American Samoa believes that it will be able to meet the basic demand for petroleum products during crisis periods.

Vulnerability to Natural Disasters

Vulnerability to cyclones requires a different set of planning and supply considerations, including the hardening of storage and distribution facilities as well as the capacity to quickly repair damage to basic services. It also requires the holding of sufficient petroleum stocks to compensate for short-term supply interruptions.

While no recent formal plan exists for dealing with a petroleum supply disruption, the vulnerability of American Samoa to natural disasters has been recognized and managed. Federal assistance funds to American Samoa for cyclone damage have been in the tens of millions. In 1990, a 1000-mile wide storm, Cyclone Ofa, caused widespread damage. For two days, winds held steady at 46 mph, gusting at 92 mph, and peaking at 107 mph. Associated wave damage created substantial residential and infrastructure losses. In 1991 Cyclone Val followed, and battered Tutuila with 100 mph wind for twelve hours. High surf and waves destroyed 375 houses and damaged 3,500 housing

units. Damage to the electrical power system, primarily to the distribution feeder and transmission lines, was severe, as many of the power poles are located less than six feet from the ocean. With the power system damaged, the water and sewer systems were also rendered nonfunctional. Figure 4.5 clearly shows the effect that recent cyclones have had on American Samoa's peak electrical load over the past several years. However, it should be noted that ASPA was able to repair all services within 4 weeks. In addition, the petroleum storage facilities were not damaged by the cyclones.

Vulnerability to Oil Supply Disruptions

The energy supply depends on the delivery of petroleum products to American Samoa from Hawaii. This supply route has proven reliable in the past. Uninterrupted petroleum supply has been effectively sustained through the regularly scheduled shipments of petroleum products which have generally been refined on Oahu. While there is an awareness of the dependency on petroleum and its ramifications, there is not a sense of urgency or panic regarding supply disruptions. While there is a master plan for fire and hazardous materials management, and mitigation and response to natural disasters by the Federal Emergency Management Agency, these do not address oil supply disruptions.

In the case of an oil supply disruption, it is possible that supply could still be obtained either from Hawaii, the U.S. West Coast or Singapore. Premiums might have to be paid in addition to transport differentials. However, this would be true for all of the Pacific and not just in American Samoa. Historically, American Samoa's consumer demand for oil has been fairly price inelastic. Following the Iraqi invasion of Kuwait, when prices increased, demand did not decrease. Given the small size of the island, vehicle owners apparently did not curtail their driving patterns. ASPA has passed on fuel surcharges to its customers.

Economic Effects of Energy Supply Disruptions

It is very difficult to assess the economic effects of oil supply disruptions on the small and very open American Samoan economy since there is a lack of historical and applicable data. Certain estimates from other locations can be utilized, however, to indicate several likely economic effects.

Similar to the other U.S. Pacific islands, a moderate (less than 2 MMBD) supply disruption centered on Latin American, African or Middle Eastern producers would result in minimal effects. There is no reason to believe that the supply would be sufficiently restricted to result in major price increases. What is more likely is that American Samoa would experience very modest inflation based on price rises for imports in their country of origin.

In the event of a major global supply disruption, the economic effects could be devastating. First, oil price rises could be severe to reflect shortages in international oil markets, and especially in the Singapore market. The direct effect of an oil price doubling would lead to nonfuel price increases of approximately 2 percent in larger nations, a level similar to that experienced in the United States following the 1979/80 oil price increases. However, in the islands, the inflation rates for Guam, Fiji, Tonga and Vanuatu nearly doubled following the 1979/80 oil price increases. Thus the inflation rate should roughly double during a major oil supply disruption. Moreover, as Figure 4.5 (Guam vs. U.S. Inflation rates) shows, inflation rates in the islands remained high for approximately two years, or twice as long as the U.S. inflation rate. Using the oil crisis of 1979 as a guide for inflationary effects, then a doubling in American Samoa's inflation rate could be anticipated.

The effect of an oil price doubling on ASPA's operations would also be severe. In 1990, fuel costs accounted for 38 percent of total operating expenses. Thus, oil price doubling would require tariff increases or subsidies to pay for a 38 percent increase in operating expenses. With ASG's current budget deficit, a subsidy would seem difficult. Following the 1990 oil price increases, demand for power did not decrease.

A secondary effect of a major supply disruption is that it would most likely lead to economic downturns in the regional economies. Similar to the effects experienced in other open economies, a severe oil supply disruption creates secondary effects which are not felt for several months yet may continue for several years.

Table 4.6 shows estimates of the economic effects of an oil price shock on American Samoa. The first row shows projections of the rates of price increases for petroleum under low price, base price and high price scenarios. The most recent value for imported petroleum products is also in this row. The value of the oil imported into American Samoa in the years 1995 and 2000 is estimated by assuming that the 1990 demand escalates by 1.2 percent per year and then multiplying this demand by the projected price of oil in the respective year. The projected price is obtained by using the three price scenarios. The table shows that demand growth of 1.2 percent per year and a base case petroleum price increase of 3.9 percent per year results in a doubling in the value of petroleum imports for American Samoa between 1990 and 2000.

Although gross domestic product (GDP) is not regularly measured in American Samoa, it was estimated to be $297 million in 1992. Economic expansion at 2.5 percent per annum would theoretically raise this value to $320 million in 1995 and $362 million in the year 2000. As described in Chapter 3, oil shocks have been thought to cause GDPs to decline by anywhere from 2.5 to 4.7 percent. Table 4.6 shows the resulting GDP based on these approximations. In order to assess the likely effects on employment, the estimated economic growth rate of 2.5 percent has been applied to the private sector employment and extrapolated to the years 1995 and 2000. Public sector employment has been held constant. The employment levels on the island after an oil shock that results in a loss of 5 percent or 10 percent of the private sector jobs are also shown for the years 1995 and 2000.

One of the key effects of an economic slowdown resulting from an oil price shock is the loss of local government revenues. It has already been pointed out that Fiji experienced a 4.8 percent loss of tax revenue during an oil price shock. In order to estimate the magnitude of this loss, 1990 government budget data was used and the effects of 4.8 percent revenue decline on the deficit was computed. For 1995 and 2000, the government local revenue was calculated assuming a annual growth of 2.5 percent per annum. An assumption was also made that direct taxes will increase in proportion to economic growth.

The key question regarding the economic effects of an oil supply disruption is whether American Samoa experiences more severe dislocations than the rest of the United States. While the United States would experience inflation and possibly recession, American Samoa's small open economy would be totally exposed to global market forces: nearly all food and all medicine are imported. Furthermore, a prolonged long-term price rise could result in American Samoa loosing its only and most important industry, the tuna canneries.

Table 4.6 Economic Impacts of an Oil Price Shock - American Samoa

		$ Millions		
		1990 (Base)	1995	2000
			Value of Petroleum Imports	
			Demand Growth: 1.2% per year	
Oil Price Increases				
2.0% per year		$34.9	$50.0	$56.0
3.9% per year			$53.0	$68.0
6.6% per year			$60.0	$87.0
		(1992)		
GIP-base	($ millions)	$297.0	$319.8	$361.9
decline of 2.5%	($ millions)	$289.6	$311.8	$352.8
decline of 3.0%	($ millions)	$288.1	$310.2	$351.0
decline of 4.7%	($ millions)	$283.0	$304.8	$344.9
		(1990)		
Employment		13,461	14,652	15,999
decline of 5%		13,008	14,139	15,419
decline of 10%		12,555	13,627	14,839
Local Government Revenues	($ millions)	(1990) $43.0	$47.4	$53.6
4.8% Loss of Direct Taxes	($ millions)	$2.1	$2.3	$2.6
Resulting Budget Surplus (Deficit)	($ millions)	($7.1)		

Notes:

1. Value of petroleum imports calculated by multiplying estimated average annual demand growth by estimated petroleum price increases.
2. Estimates for gross island product, employment and government revenues, utilize average annual increases of 2.5 percent.

Because of delayed tanker arrivals, the tuna canneries have experienced brief fuel shortages. The canneries assert that a prolonged lack of fuel, and therefore a plant shutdown, would result in lost revenues and wages of up to $250,000 per week. The fishing fleet associated with the tuna industry is the major consumer of fuel; however, energy is also used in tuna processing in two major forms: as electricity and to generate process steam. The chief electrical uses include refrigeration, lighting, materials handling, and operation of electric pumps and motors. Process steam is used mainly in the initial cooking and in the subsequent retort sterilizing of the canned produce.

The two tuna processors in American Samoa have adopted different approaches to meeting their energy requirements. As a result of the power reliability problems which plagued ASPA in the 1980s, Samoa Packing now produces 60 percent of its electricity. StarKist still purchases electricity from ASPA under a bulk power arrangement. If a petroleum disruption were extended to ASPA, the damages would be far greater to the StarKist cannery, which would be without power as would the remainder of the island.

Aside from the physical shortage of petroleum, adverse effects to the American Samoan economy could occur should the operating costs of the tuna canneries in the Pacific island become disproportionately higher than in other tuna canning areas which have access to local petroleum supplies such as Thailand. While energy costs account for approximately 4 percent of tuna processing costs (fish accounts for 69-75 percent of costs, labor 11 percent and cans 13 percent), it is still an important variable cost.

Price effects from petroleum shortages could have major effects in American Samoa. If the price effect of the fuel shortage is prolonged, the fishing fleet may fuel at another port. Some boats have already begun fuelling in Fiji because of cheaper fuel. Due to diseconomies of scale, decreased diesel demand due to the loss of the fishing fleet business would increase overall diesel costs to the island and also increase the cost of diesel use to the canneries. This could have the effect of rendering the canneries in American Samoa less profitable than those in other sites. Potentially, management could choose to relocate the facilities to a site where all other things being equal, fuel costs are lower. This option probably represents the worst case scenario where a petroleum supply disruption and long-term high diesel prices cause the departure of this industry from the island. However, the combined effect of trade agreements (e.g., GATT, NAFTA) and higher fuel prices could lead to the worst case scenario.

Options for Accessing Oil Supplies in Emergencies

An analysis of the global oil industry and specifically current and projected oil flows in the Asia-Pacific region provides several scenarios which would prove very difficult for the U.S. Pacific islands including, possibly, American Samoa. These scenarios are: 1) major political turmoil in the Middle East and in Asia, resulting in a net loss of at least 4.5 MMBD for a six month period; and 2) global catastrophe, e.g., a major war, or regionalized/localized conflicts which effectively result in the closure of major oil-producing regions such as the Persian Gulf. In both cases, Singapore refiners would have their supplies reduced by at least 25 percent, with the actual reduction probably reaching as high as 50 percent. The result would be a loss of petroleum supplies from Singapore to the Pacific islands of at least 25 percent and possibly even exceeding 50 percent. The short-term effects would be considerable because of a doubling or tripling of prices on the now oil-short Singapore market. American Samoa could be less affected by an oil supply disruption than other islands because it receives it supplies from Hawaii rather than Singapore. However, there would be some shortages

experienced throughout the Asia-Pacific region, thus American Samoa's advantage would be in relative rather than absolute terms.

Other oil disruption scenarios including a moderate loss of production in certain West African and Latin American regions would have limited impact on supply in the Pacific islands. Prices would temporarily increase but the market should be able to adjust, especially if the disruption is short-lived.

Local oil supply disruptions could be caused by cyclone damage to docking and storage facilities. However, the American Samoan facilities have survived severe storms relatively unscathed. Thus, unless a typhoon much stronger than any storm over the last five decades directly hits the oil facilities, it is doubtful that a local event would cause a major disruption.

Given these effects of possible disruption scenarios, there are several options to increase energy security in American Samoa. These include developing a regional petroleum reserve (RPR) on the island, increasing the volume of on-island stocks, access to the U.S. SPR, and reducing demand. These are discussed below. In addition, the relationship between the oil company and the American Samoa government and the capability and willingness to work together under crisis conditions are also addressed.

However, it must be stressed that the U.S. Pacific islands have not had an interruption in the supply of petroleum products since the end of World War II. There have been occasions when a tanker arrived later than anticipated because of engine failure, with the result that inventories declined to four or five days worth. Prices for petroleum products in the islands have jumped sharply during oil crises (e.g., 1973/74 and 1979/80), but the supply of petroleum has been continuous.

Building Regional Petroleum Reserves (RPR)

The options to establish 1) a strategic petroleum reserve on American Samoa, and 2) a joint strategic reserve shared with other island entities were analyzed. In American Samoa, storage sufficient for 90 days of supply would have a capacity of approximately 300 thousand barrels and would cost about $18 million to build and stock and about $0.6 million per year to maintain. It is assumed that similar cost factors (approximately $60 per barrel for construction and stocking and $2 per barrel for maintenance) would apply to the development of a strategic petroleum reserve in Hawaii. However, because there would be more consumers using a Hawaii regional reserve, there could be some savings through economies of scale. Still, the cost for either of these options are substantial, and thus an SPR seems currently uneconomical.

Increasing Commercial Stocks

Another option to improve energy security is to increase on-island inventories. The other Pacific islands use a minimum inventory measure of six weeks or 40 days; however, a larger inventory could be maintained in order to provide a margin of safety against a major supply disruption. Price increases for the additional inventory would probably approximate a $2 per barrel per year maintenance charge mentioned above plus the cost of the petroleum products.

If the viability of building extra storage capacity in American Samoa is to be considered, it is necessary to first assume that there will be a disruption for a given length of time. Assuming an average length of disruption, it is then imperative that this storage complement current capacities to

provide coverage for that period. If the cost of the storage capacity and working capital for diesel is less than the expected product price increases, it makes economic sense to build it. Otherwise, American Samoa could rely on the market to procure petroleum, albeit at a higher price. The major factor to consider under a business-as-usual scenario would be how many days of consumption would be optimal to have in reserve. This could be managed either through current storage capacity with higher inventory levels or increased storage at an acceptable average inventory level.

If the decision-making process and funding for extra storage capacity were under governmental auspices, other alternatives may be available. Currently, there is an Oil Co-op in Samoa comprised of BHPPA, ASPA and the American Samoa government which collects terminalling fees and channels this money to an account designated for terminal and storage maintenance. If extra storage capacity would be desired as a hedge against petroleum disruptions, a mechanism is already in place to fund it. This would entail increasing fees beyond current levels; however, the people of American Samoa may be willing to pay given the serious consequences of potential supply disruptions.

Guaranteed Access to the U.S. SPR

In May 1992, a bill was introduced to the U.S. Congress which guarantees access to the U.S. SPR for a percentage of oil demand requirements of the U.S. Pacific islands including American Samoa. What would not be covered in this proposal is the transport.

According to the proposal, the price paid for the petroleum would be an average of the bids submitted by the oil companies trying to acquire supply, which means that the price would be the market price. This means that the islands would be paying at the same rate as everyone else but would be guaranteed supply. Also under the proposal, the U.S. Pacific islands would have priority status at SPR docking facilities. However, the islands would be responsible for processing and chartering tankers. The oil companies could be contracted to process products and provide ships.

American Samoa would have no additional establishment or maintenance costs under this proposal. Future prices for SPR petroleum during crisis situations could be substantial, although this option ensures some degree of access to the U.S. Pacific islands. In order for this option to be implemented, American Samoa will have to coordinate its efforts with the other U.S. Pacific islands and develop strategies to process products and access tankers during crisis periods.

Access to Military Stocks

There are no military fuel storage installations located in America Samoa. The closest installations are in Hawaii. During periods of major political upheaval in Asia and the Middle East, it is doubtful that the military's fuel supplies could be transferred to civilian populations except in cases when the health and safety of civilians were at risk.

Energy Emergency Planning

There are no energy emergency plans currently operational in America Samoa. ASPA and other government departments under the coordinating role of the Department of Public Safety, have implemented natural disaster response plans. Although the Emergency Energy Conservation Plan was implemented in 1982, it has not been updated nor incorporated into other emergency response initiatives. An energy emergency plan would assist ASG decision-makers in allocating fuel supplies

during an energy emergency.

Demand Management

A demand management plan on American Samoa can effectively stretch out scarce supplies, thereby reducing the negative impacts of an oil supply disruption. Examples of demand management programs include switching to energy efficient lighting and machinery, reducing air-conditioning, and shifting electrical loads to off-hours. It should be stressed that demand management can be a valuable component of a response strategy. However, the data which are required to develop and implement a comprehensive program are lacking in all of the U.S. Pacific islands including American Samoa.

LONG-TERM ENERGY VULNERABILITY RESPONSE OPTIONS

Because of American Samoa's extreme dependence on imported oil, the Territorial Energy Office (TEO) has focused its efforts on alternative energy sources. The TEO was created by Executive Order 2-1977 to serve as an advisory and functional body of the American Samoa government. By October of 1978, the TEO was staffed by six local employees, taking over the responsibilities of administration and implementation of the State Energy Conservation Program (SECP), the Supplemental State Energy Conservation Program (SSECP), and the Energy Extension Services Program (EES). All of these programs were funded by the U.S. Department of Energy.

In 1979, the TEO applied for and was approved funding for the National Institutional Conservation Program (ICP) for schools and hospitals. Through this program the TEO performed renovations and retrofits in public schools and the hospital. Later, the program was extended to serve private and parochial institutions in the territory. In 1985, funding was appropriated to the TEO from the U.S. Department of Health and Human Services (HHS) to implement the Low Income Home Energy Assistance Program (LIHEAP), a program targeted to provide energy-related services to American Samoa's low-income population.

The Territorial Assistance Program (TAP) was also administered by the TEO. This program was targeted to nurse, plant and maintain eucalyptus and other imported seedlings as well as some local tree species for the purpose of alternative heating fuel (firewood) sources. At the expiration of the land lease contracts, two of the three plots reverted back to the landowners. The remaining plot, situated behind the American Samoa Community College Land Grant Office, is still maintained and harvested by that agency.

Alternative Energy Resources and Options

Alternative energy from indigenous resources such as biomass, hydropower, geothermal, wind, ocean thermal energy conversion (OTEC), solar, and biogas could potentially contribute to the island's energy needs. Each of these energy sources is considered below in detail.

Biomass

More than 75 percent of the land mass on Tutuila has a greater than 30 percent slope, and the slope is even steeper on the outer islands. Thus, large-scale biomass crop production is made unattractive by the terrain, which prevents large-scale planting and harvesting. In addition, the land tenure pattern of American Samoa and the already pressing need for land suitable for agriculture,

housing, and economic development further detracts from the viability of biomass production.

Hydroelectricity

Unlike its neighbor, Western Samoa, American Samoa does not possess bountiful hydro resources. In fact, a general study by the U.S. Army Corps of Engineers in conjunction with earlier studies by the U.S. Geological Survey and Dames & Moore, indicates that only six streams in five of the twenty-three drainage basins merit investigation. None of the rivers have enough year-round flow to ensure adequate and reliable hydroelectric power. However, as hydroelectric technologies are proven for use in the Pacific region, both for baseload and peak production, the development issues will tend to revolve around cost, environmental effects, land availability, parts maintenance and support. As a possible intermittent supply system, hydropower could merit consideration, but is not a priority at this time.

Geothermal

Geothermal energy was last examined in the U.S. Department of Energy's 1980 study, *Geothermal Energy for American Samoa*, which basically stated that American Samoa has unmeasured but promising geothermal resources. In fact, the study identifies the Samoan Islands as one of five Pacific sites where volcanism has occurred in historic times. No hot springs have been discovered, but one temperature anomaly was found when a 300-foot water well was being drilled. To properly identify and quantify geothermal resources, drilling and investigatory work would be necessary. Aside from the expense of drilling, other constraints include land availability, possible environmental effects, and the role of traditional land ownership in American Samoa. Operating costs might be manageable, but capital costs could be prohibitive. As geothermal production of electricity makes inroads in locations such as Hawaii and New Zealand, its potential and application may become more attractive in American Samoa.

Wind

American Samoa has prevailing southeasterly trade winds throughout the year. From December through March, the winds tend to be directly from the east; during the rest of the year, winds come predominantly from the east-southeast and southeast. Average wind speed measurements recorded at the Tafuna airport NOAA station have ranged from 6.7 mph in April to 13.6 mph in June with an annual average of 10 mph. While the wind resource in American Samoa has perhaps only marginal potential, there are some uses such as for power generation at remote locations like the TV repeater station in Manu'a.

Ocean Thermal Energy Conversion (OTEC)

The TEO has been quite interested in the possibility of locating an OTEC plant at the lagoon near the airport (and therefore near the Tafuna power plant). The water is deep enough to provide the necessary temperature gradient. A 10-MW plant has been suggested, and in the *1981 Territorial Energy Assessment*, the American Samoa government prepared a proposal indicating preference to the U.S. Department of Energy for such a plant. Currently, the economics of an OTEC plant could prove to be a limiting factor; however, ongoing discussions appear to be keeping the option open.

Solar

Small-scale solar power systems are defined as those small enough to serve end uses such as household lighting and communication. Larger scale photovoltaic systems are not economical due to the present widespread electrification of households, so small solar power systems in households tend to be installed for water heating only. The TEO at one time administered the Solar Energy Conservation Bank Program, which provided financial subsidies as incentives to residents and homeowners to switch from electric to solar-powered water heaters. No legislation was developed to enable tax incentives for homeowners to convert; thus, the program was discontinued after funding sources were exhausted. The Lyndon Baines Johnson Hospital also employed a solar air-conditioning system. However, due to maintenance and operating problems, successful implementation of the project has not occurred.

Biogas

Given the extent of the tuna industry in American Samoa, a substantial quantity of tuna sludge is generated. The two canneries combined generate some 30 tons of tuna sludge per day. This sludge is shipped out and dumped at a five-mile mark outside the harbor. There have been incidents in the past when high tides and winds pushed the sludge back to the shoreline. Given the positive environmental effects of sludge conversion in combination with potential energy production, a tuna waste to methane plant has been proposed several times over the last decade. A recent initiative has proposed building a pilot project.

The municipal solid waste (MSW) resource in American Samoa is small, approximately 94 tons per day. Even if complemented by tuna sludge, only a small power facility could be operated. However, when the direct and indirect effects of eliminating both the tuna sludge and landfill problems are factored in, the idea of such a facility becomes attractive. However, to date, no definitive action has been taken.

OTHER MEASURES FOR IMPROVING ENERGY SECURITY

In addition to options for accessing oil supplies during energy emergencies and long-term response options, consideration should also be given to improving overall management of the energy sector. Specifically, data collection on energy supplies and end uses, continuing the current dialog with oil companies, and integrated resource planning are activities which could provide substantial short- and long-term benefits at very little cost. These are discussed below.

Data Collection

The American Samoa government should establish a format for the regular and systematized collection of data on the volume and value of petroleum product imports, cost build-ups for products, major product purchasers, an inventory of current on- island storage, and frequency of tanker arrivals. Most of this data is currently provided by BHPPA. However, the data have not been included in statistical publications nor does it appear to be used in economic development plans and projects. Thus, it is a matter of formatting and utilizing data which are already being received.

Table 4.6 shows that even with a modest growth rate in petroleum consumption throughout this decade, the amount of money American Samoa will spend on oil in the future warrants a systematic evaluation of whether or not this money is being spent wisely. Simultaneous with this growth in fuel cost is ASPA's plan to expand its generation capacity by some 50 percent to approximately 45 megawatts by the year 2000. When both of these factors are considered, it is clear that American Samoa's energy sector will be one of the most, if not the most expensive sector in its economy. Because of this, there is a critical need to regularly format and utilize volume, value, cost build-up (e.g., f.o.b., c.i.f. and shipping charges), and inventory data on imported petroleum products. As noted above, most of the data are already received but need to formatted. Power sector data from ASPA need to be integrated with the petroleum data to establish a method of regularly assessing the role of energy in the local economy. This type of an assessment should include the evaluation of the needs and costs of any future or ongoing economic development strategies. Although some of the data and analyses have been under taken, their availability has been limited.

Oil Company Relations with Government

Regardless of whether an SPR is established, or if demand management plays a lead role in the next oil crisis, major oil companies will manage the bulk of the supply and distribution networks necessary to maintain American Samoa's access to oil. Relations between the oil companies and governments in the U.S. Pacific islands are generally very good, including those in American Samoa.

One of the least-cost yet most effective measures to ensure petroleum supply is to establish an attractive operational and investment environment for major oil companies. This does not mean surrendering all control, but it does require government monitoring and constant interaction. Relations are generally good between BHPPA and the American Samoa government and should be maintained.

Integrated Resource Planning

Integrated resource planning should be given considerable attention, including the concept of least-cost assessments of technologies. Developing strategies to more efficiently plan and manage energy use is also critical. Demand-side management techniques represent one step in a process toward developing a broad-based program aimed at energy conservation, energy efficiency, and reducing cost. Savings from such programs can be substantial. Traditionally, investments in the supply side have payback periods from seven years and up, while investing in energy efficiency technologies provides payback in one to four years.

It is often overlooked that only when energy use is effectively managed that renewable energy technologies can provide for baseload demands. Until then, renewables will have only limited potential to reduce dependency on oil.

Substantial sums have been allocated to the energy sector over the past years with very mixed results. There is a major need to develop plans and management structures for the energy sector which reflect both the short- and long-term issues and most importantly provide some consistency in direction for the sector. Moreover, management and planning for the sector still require immediate attention.

There are three primary players in the energy sector in American Samoa: the oil company (BHPPA), ASPA, and the government energy office. Responsibilities for each have been specified,

but there does not seem to be any overall coordination of the sector. The American Samoa Energy Office has been established by the legislature, but its functions seem limited to those for which funds are provided by the USDOE conservation and renewables programs. It is time to determine whether or not an energy office should exist, how it should be funded, what the staff levels and functions should be. This dialog would also help the roles of ASPA and the oil company to be more clearly defined in the local energy sector.

America Samoa should initiate a review of its energy sector with the USDOE invited to participate in this review. A well-managed review would provide the basis to establish the integrated resource planning process which encompasses demand-side management activities, least-cost assessments of technologies and energy sources, and energy security options. The economic and fiscal consequences of a future oil price shock may initiate such an evaluation, but it is clearly preferable to have finished such an assessment and have taken any possible preventative measures prior to the damage being done.

Summary of Energy Emergency Response Options

Table 4.7 summarizes various energy emergency response options including accessing oil supplies, long-term alternatives, and other measures which could facilitate improved management of the energy sector. As indicated in the previous sections, securing oil supplies during energy emergencies requires considerable planning and/or investment. One option would be to access the U.S. SPR, which would require no additional capital and up-front fuel costs. However, premiums would have to be paid in the event of an energy emergency for both fuel and transport, and possibly for refining. The major disadvantage to this option is that if swaps cannot be made, supplies may have to be sourced from the U.S. Gulf Coast via the Panama Canal. The other low-cost supply option is to access military stocks. However, supplies would be limited to the level required to preserve safety and sustain life, which means that the economy would remain totally exposed to a potential loss of supply. Building a regional petroleum reserve would be an expensive undertaking. Increasing commercial stocks is a lower cost option which warrants further discussion with the oil industry.

Alternative energy sources will have limited impact on energy security during this decade. Fluidized-bed coal plants with capacities as low as 25 MW, have been determined as technologically and financially viable. Thus, some consideration may be given to evaluating this option in future years.

The other response measures including energy emergency planning, demand side management, improved data collection and analysis, expanding dialogue with the oil industry, and integrated resource planning are all focused on improving management of the energy sector in a cost-effective manner. Regardless of energy supply options (e.g., accessing the U.S. SPR, building a regional petroleum reserve), these measures warrant implementation.

Table 4.7 Summary of Energy Emergency Response Options

	Response Action	Advantage	Disadvantage	Cost
Options for Accessing Oil in Emergencies				
Building Regional Petroleum Reserves (RPR)	develop 1 to 3 months extra storage	on-island or closer than U.S. SPR	cost	$30/barrel to build, $2/barrel per year to maintain, plus land costs and fuel costs
Increasing Commercial Stocks	develop 1 to 3 months extra storage	on-island	cost	same as RPR
Guaranteed Access to the U.S. SPR	develop refining and transport arrangements with oil companies or other island governments	least cost	distance	unknown
Access to Military Stocks	arrange level of supplies with military	limited on-island costs	supply limited to minimum to prevent loss of life	unknown
Energy Emergency Planning	develop energy emergency plans	low cost, complements any supply options	doesn't ensure emergency supplies	unknown but assume less than $50,000
Demand Management	develop demand side management program	cost-effective, valuable for energy conservation even without energy emergency	doesn't ensure energy supplies	assume $200-300,000
Long-term Responses: Baseload Power from Alternative Fuels				
OTEC	build baseload OTEC plant	local renewable energy source	very high cost, experimental technology	upwards to $40 million per installed MW
Biomass/Biogas	build biomass/biogas plant	use local resource	small volume, high cost	unknown but assume costs are similar to higher than coal per installed MW

Coal	build coal-fired plant	available energy resource	high cost for handling and storage	Unknown: roughly $3 million per installed MW, plus unknown costs for port handling and storage facilities
Other Measures for Improving Energy Security				
Data Collection	collect energy supply and end use statistics	low cost, useful for overall sector planning/ management	limited impact on energy emergency	unknown but assume less than $50,000 per year
Oil Company Relations	establish working group with oil companies, which focuses on long-term investments/solutions to energy supply	limited direct cost	potential tax concessions	unknown
Integrated Resource Planning	develop energy supply and demand scenarios which assess options for efficient resource allocations within energy sector	cost-effective, valuable for energy conservation even without energy emergency	requires constant monitoring and revision	unknown but assume roughly $200-300,000

Five

GUAM

INTRODUCTION

Guam, an unincorporated territory of the United States, is the largest and southernmost island in the Marianas Archipelago. The island is 30 miles long, ranges from 4 to 12 miles in width, and has a total land mass of 209 square miles. Guam lies 3,700 miles west-southwest of Honolulu, 1,500 miles east of Manila, 1,500 miles south-southeast of Tokyo, and 3,100 miles north-northwest of Sydney.

Guam was formed through the uplift of undersea volcanoes and is surrounded by coral reefs near the shore. The island is composed of two distinct geologic areas of about equal size. The northern part of the island is a high coralline limestone plateau rising up to 850 feet above sea level. This area contains the northern water lens, which is the main source of fresh water on Guam. The mountainous southern region is of volcanic origin with elevations of 700 to 1,300 feet. Apra Harbor, one of the largest protected harbors in the Pacific, is located on the central western side of the island.

Guam's tropical climate is warm regardless of the time of year: temperatures range between 75° and 92° Fahrenheit, with a mean annual temperature of 85°. May and June are the hottest months, with most of the rainfall occurring in July through October. Yearly precipitation ranges between 80 and 110 inches. Constant trade winds blow during the dry season, January through June. Drought-like conditions can occur during the middle and late parts of the dry season. Although the subterranean water lens has provided sufficient fresh water in the past, there have been some recent water shortages.[1]

The U.S. Bureau of the Census has announced that the 1990 population on Guam was 133,152, representing an increase of 26 percent over the 1980 figure. The census shows that the indigenous Chamorros/part Chamorros constitute the largest ethnic group on the island with 57,648 people, or 43 percent of the total population.[2] Chamorros have increased by 9,803 persons between 1980 and 1990 (20 percent), though their share of the population fell by 2 percentage points during this same period. The next largest group was the Filipinos with 30,043 persons, or 22 percent of the population, followed by whites with 19,160 persons (14 percent). Other Pacific islanders made up 5 percent (6,509) of Guam's population, and Koreans comprised 3 percent (3,198). No other ethnic group claimed as much as 3 percent of the population. Comparing the ethnic breakdown between censuses is difficult because of changes in tabulations and procedures. The 1970 census did not ask for race, and the 1980 census asked only for ancestry and not race.

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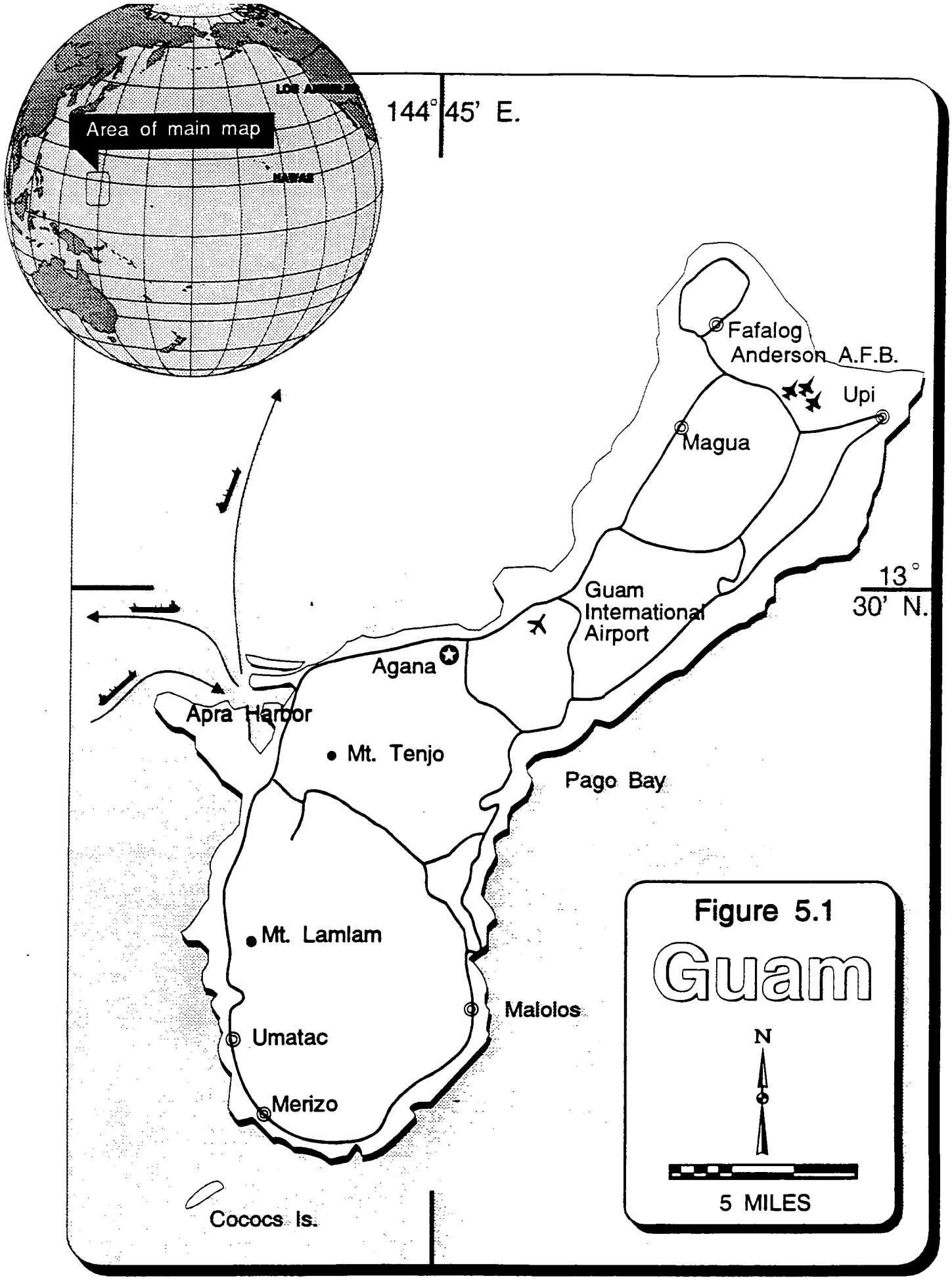
[1] *1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, p. 1; and, communication with Guam Energy Office, 19 November 1993.

[2] Racial classifications used here are taken from the U.S. Department of Commerce, Bureau of the Census, *The 1990 Census of Population and Housing for Guam.*


Area of main map
144° 45' E.
Fafalog
Anderson A.F.B.
Upi
Magua
13°
30' N.
Guam
International
Airport
Agana
Apra Harbor
Mt. Tenjo
Pago Bay
Mt. Lamlam
Malolos
Umatac
Merizo
Cococs Is.
Figure 5.1
Guam
N
5 MILES

The above population count includes nonimmigrant aliens and members of the U.S. armed forces and their dependents living on post in Guam.[3] In 1990, there were 9,688 active duty military personnel on Guam, along with 9,780 dependents, indicating that 14.6 percent of Guam's total population is military.

The Census and Population Division of the Guam Department of Commerce has made population projections for Guam that exclude all immigration and emigration and assume that the rate of growth remains constant at 2.31 percent per year over the next decade. According to these calculations,[4] there will be 167,292 people living on Guam in the year 2000. This represents an increase of 25 percent over the 1990 population.

ECONOMIC OVERVIEW

Even though the pace of Guam's economic growth has been moderate in the last two years, it is difficult to characterize Guam's economy as anything other than a success. Guam's economy has undergone a remarkable change since the mid-1980s. In the past, the economy was dominated by the government sector, while today the private sector plays at least as much of a role in the economy as do government expenditures. The primary driving forces behind Guam's growth are outside investment, primarily from Japan, and its continuing popularity as a tourist destination.

Since 1984, total employment has registered an average annual growth rate of over 8 percent. Job creation has outpaced growth in the labor force and has resulted in some multiple jobholding. Currently the rate of multiple jobholding is unknown but it seems to have increased since 1984.

Typhoon Omar on August 28, 1992 initiated a dramatic drop in Guam's hotel occupancy rates which is still in evidence. Four smaller typhoons that have struck Guam since then as well as Japan's current economic problems have frustrated the Guam visitor industry's marketing efforts to draw record numbers of Japanese tourists. This has resulted in a slump in Guam's economy which is expected to last until larger numbers of visitors start arriving.

Tourism and construction are expected to flourish in the long run. Tourism should remain strong due to the island's proximity to Japan, and the construction industry is expected to move away from hotels and condominiums and toward single family housing, which is currently in tight supply.

GIP and Income

The gross domestic product is not regularly computed for the Territory of Guam. Also, total personal income figures are not available for Guam after 1986 (when the per capita income was

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[3] *1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, Note on p. 97.

[4] Ibid., p. 98.

calculated to equal $8,781[5]).[6] Statistics from the 1990 census show a per capita income of $9,928, but the inclusion of large amounts of unreported income could raise this number to over $15,000.[7] The research department at the First Hawaiian Bank has suggested that there is a greater than average potential for the development and existence of an "underground economy" on Guam.[8] This term does not necessarily connote illegal or illicit economic activity, but rather unmeasured economic activity, including trading of goods and services. However, both the Guam Department of Commerce and Bureau of Labor Statistics question speculative income measures, with the Bureau of Labor Statistics indicating that reported per capita income was $11,589 in 1992.

Guam's Department of Revenue and Taxation does compile some statistics on income for internal use which serve as a basis for estimating Guam's islandwide personal income. Calculations by the Department of Revenue and Taxation of the total island income are then performed by multiplying the estimated per capita income by the number of exemptions claimed on the tax forms. Table 5.1 is a summary of available information from the Guam government. Bureau of Labor Statistics also publishes a series entitled "Current Employment Report," which describes reported per capita income and employment by sector

An indication of the growth in paid employment and personal income is the reduction of the number of food stamp recipients by more than half from 23,901 in 1983 to 11,514 in December of 1992. During this same period there was also a 12 percent drop in the number of recipients of the Aid to Families with Dependant Children Program.[9]

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[5]*Pacific Island Economic Trends*, Report to the Pacific Business Opportunities Conference, Honolulu, Hawaii, January 16-17, 1992, Bank of Hawaii Economics Department, p. 13.

[6]*An Economic Assessment of Guam*, Bank of Hawaii, Spring 1991, p. 8.

[7]ibid.

[8]Guam Profile, *Supplement to Economic Indicators*, First Hawaiian Bank Research Department, November/December 1992.

[9]*1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, p. 160, and *Quarterly Economic Review*, Volume 14, No. 4, 4th Quarter Calendar Year 1992, Economic Research Center, Department of Commerce, Government of Guam, pp. 7-8.

Table 5.1. Total Island Income Estimate[10]
(Government of Guam, Department of Taxation & Revenue)

Year	Reported Per Capita Income	Estimated Per Capita Income	Total Exemptions Claimed*	Estimated Total Island Income
1986	$6,759	$8,786	102,995	$904,910,000
1987	$7,928	$10,306	--	--
1988	$8,892	$11,737	--	--
1989	$10,388	$13,422	--	--
1990	$11,130	$14,469	128,469	$1,858,300,000

*This is an estimate of Guam's population based on the number of exemptions claimed on tax returns. The 1990 census showed the population of Guam to be 133,152

Employment

A basic indicator of the economic expansion on Guam is the civilian job count. In fact, according to the director of the Guam Department of Revenue and Taxation, the total payroll employment (which is the number of jobs filled) has been selected as the primary growth indicator of the Guam economy.[11] In the first half of the 1980s, total payroll employment grew a total of 9.2 percent. But since 1986, it has grown by a total of 67 percent. For the last three years (1990 through 1992) the average annual growth in total payroll employment has been 7.4 percent, although the increase in employment in 1992 leveled off to 3 percent.

The territory's rapid economic growth is reflected in the increase in private sector jobs, which more than doubled from 22,650 in 1985 to 47,450 in 1992. Construction, services (including tourism and hotels), and the retail sector contributed heavily to this growth of employment in the private sector. In this same period, the number of public sector (federal and government of Guam) jobs has increased by approximately 25 percent. The growth in total payroll employment has been sustained by immigration, Micronesian alien workers under the Compact of Free Association, multiple jobholding, increased labor force participation rates, and a substantial decline in unemployment.[12] By the end of 1990, the territory's unemployment rate had declined to 1.9 percent, down from more than 9 percent in 1983. At the beginning of 1993, unemployment reachedn early 5 percent as a result of Japan's

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[10]Correspondence to the *Asian Wall Street Journal* from J.G. Blaz, Director, Department of Revenue and Taxation, Government of Guam, September 1992.

[11]Correspondence to the *Asian Wall Street Journal* from J.G. Blaz, Director, Department of Revenue and Taxation, Government of Guam, September 1992.

[12]*An Economic Assessment of Guam*, Bank of Hawaii, Spring 1991, p. 6.

recession. However, unemployment surged to 6.6 percent at the end of 1993. This was a direct result of the August 1993 earthquake which damaged tourism facilities and led to a further slowdown in visitor arrivals. The industry slowdown resulted in "temporary layoffs."

Total payroll employment at the end of 1992 was reported at 69,530, with 47,950 jobs in private industry.[13] Approximately 70 percent of the employees work in private industry, while 30 percent work in federal or local government jobs. Although the local government performs functions in Guam not normally performed by such bodies in the mainland United States (such as issuing passports, conducting customs inspections, and operating water, electric, and telephone utilities[14]), the number of persons employed in the local government sector is relatively low compared to other Pacific islands at 20 percent of the total employed work force. This percentage has decreased from 25 percent in 1985.

The growth in employment by sector over the last ten years, as shown in Figure 5.2, is another indication of the trends in Guam's economy. Construction jobs have increased more than fivefold in the last ten years. Employment in the retail trade has more than doubled, and the service industry (including tourism and hotels) has more than three times the employees it had ten years ago. Figures 5.3 and 5.4 illustrate that ten years ago, half of the jobs on Guam were government jobs, but now over half of the jobs are in the construction, retail, and service sectors.

Not all of the new jobs generated in the past ten years have been filled by a growing labor force. Statistics from the 1990 census show the magnitude of the current trend of multiple jobholding. In December 1990, there were 59,030 jobs on Guam, but only 52,144 people who were employed in April[15] (including 4,378 alien temporary resident workers).[16] This means that roughly 5 percent (and possibly a higher level) of all jobs on Guam were held by people who had more than one job. Additions of workers in the hotel and related industries have been substantial, but often far below what would ordinarily be considered sufficient. This disparity was particularly evident in the period from 1987 to 1990 when only 810 new hotel workers were hired on Guam while the total visitor arrival count increased from 477,000 to 770,000 in the same period.

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[13]*Current Employment Report*, September 1993, Bureau of Labor Statistics, Department of Labor, Government of Guam.

[14]*1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, p. 37.

[15]*1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, p. 120, and the *1990 Census of Population and Housing, Guam*, Table 17.

[16]*1990 Census of Population and Housing, Guam*, Table 78.

Figure 5.2 Employees per Sector, 1982 and 1992

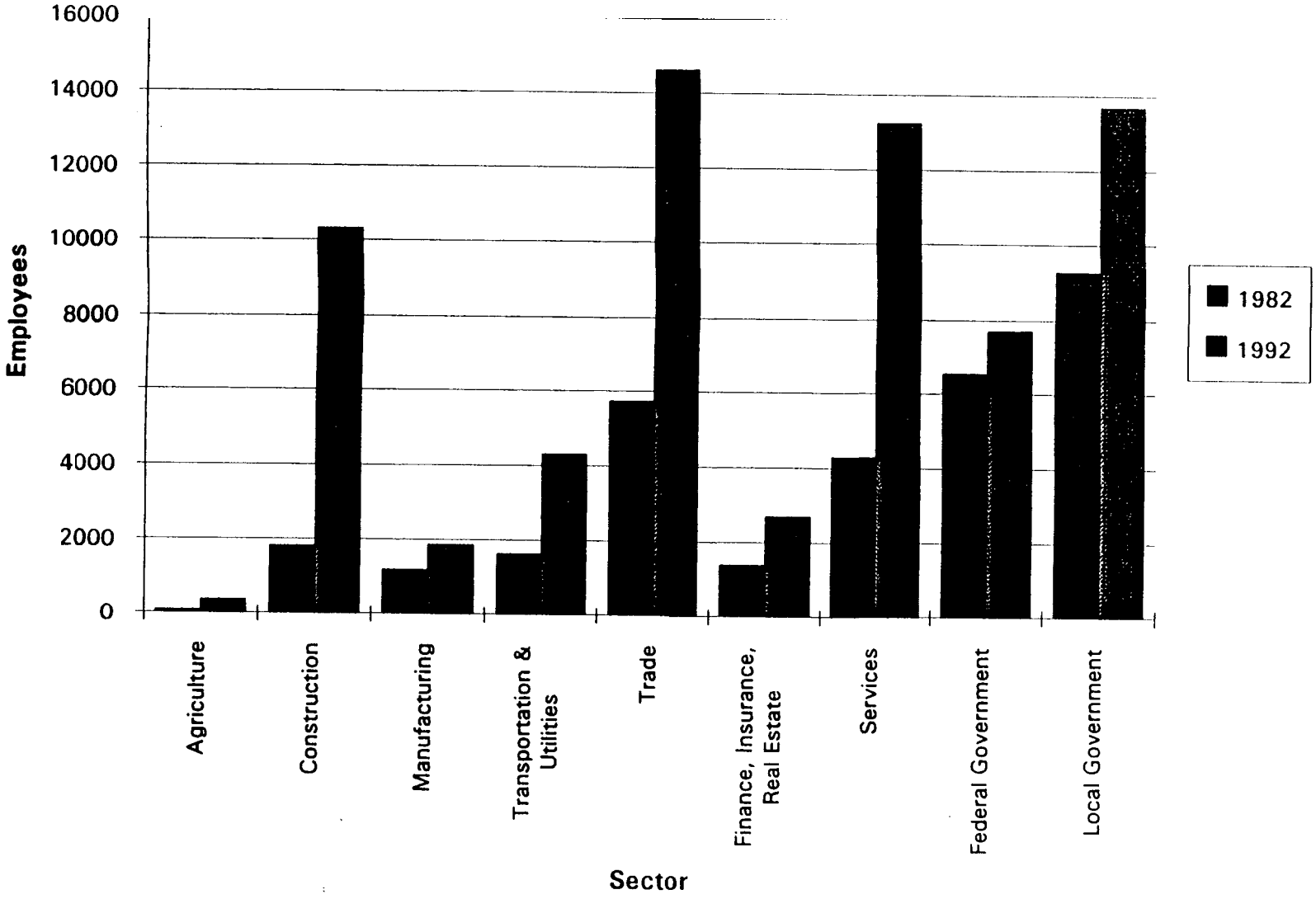


Figure 5.3 Guam Employment by Industry, 1982

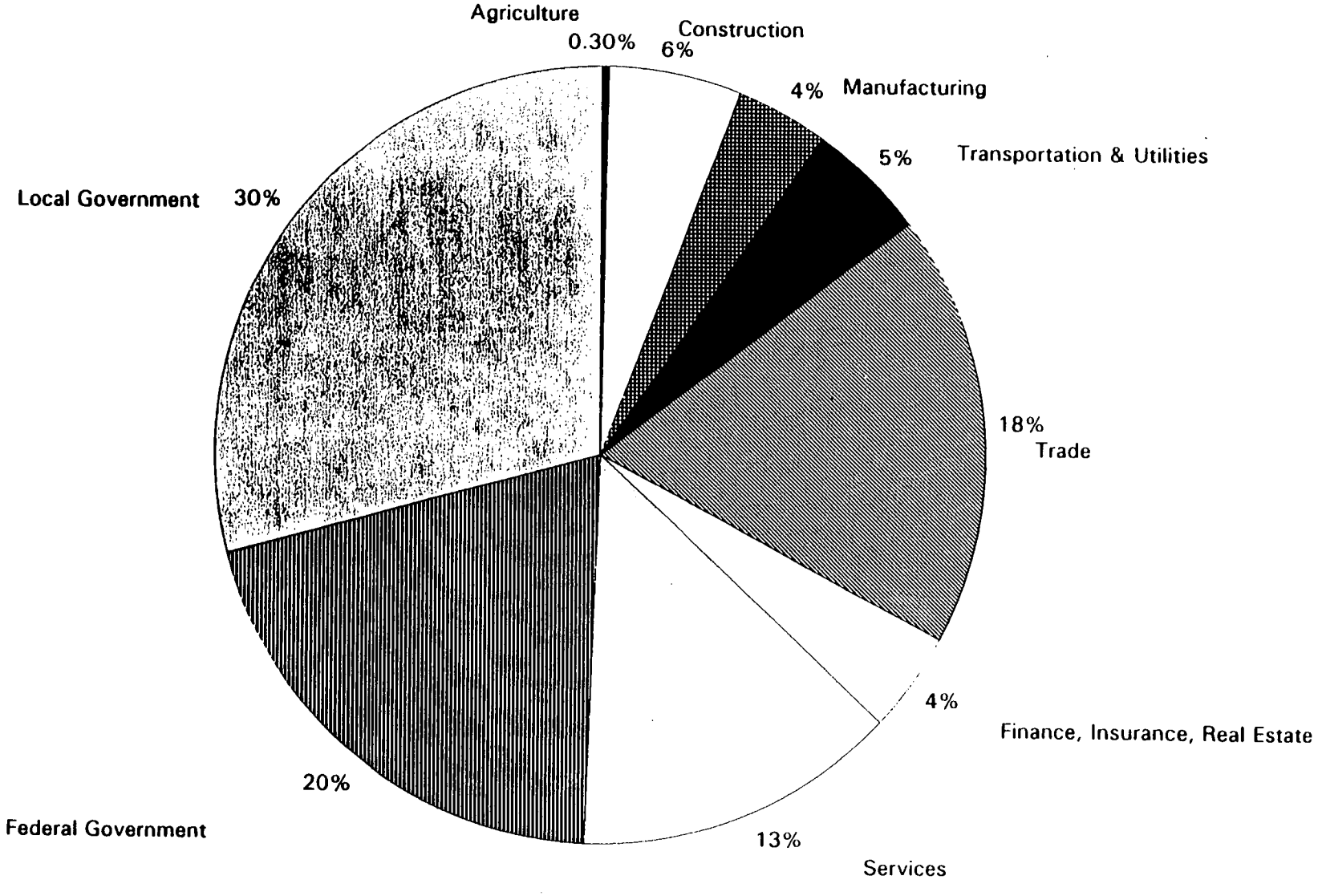
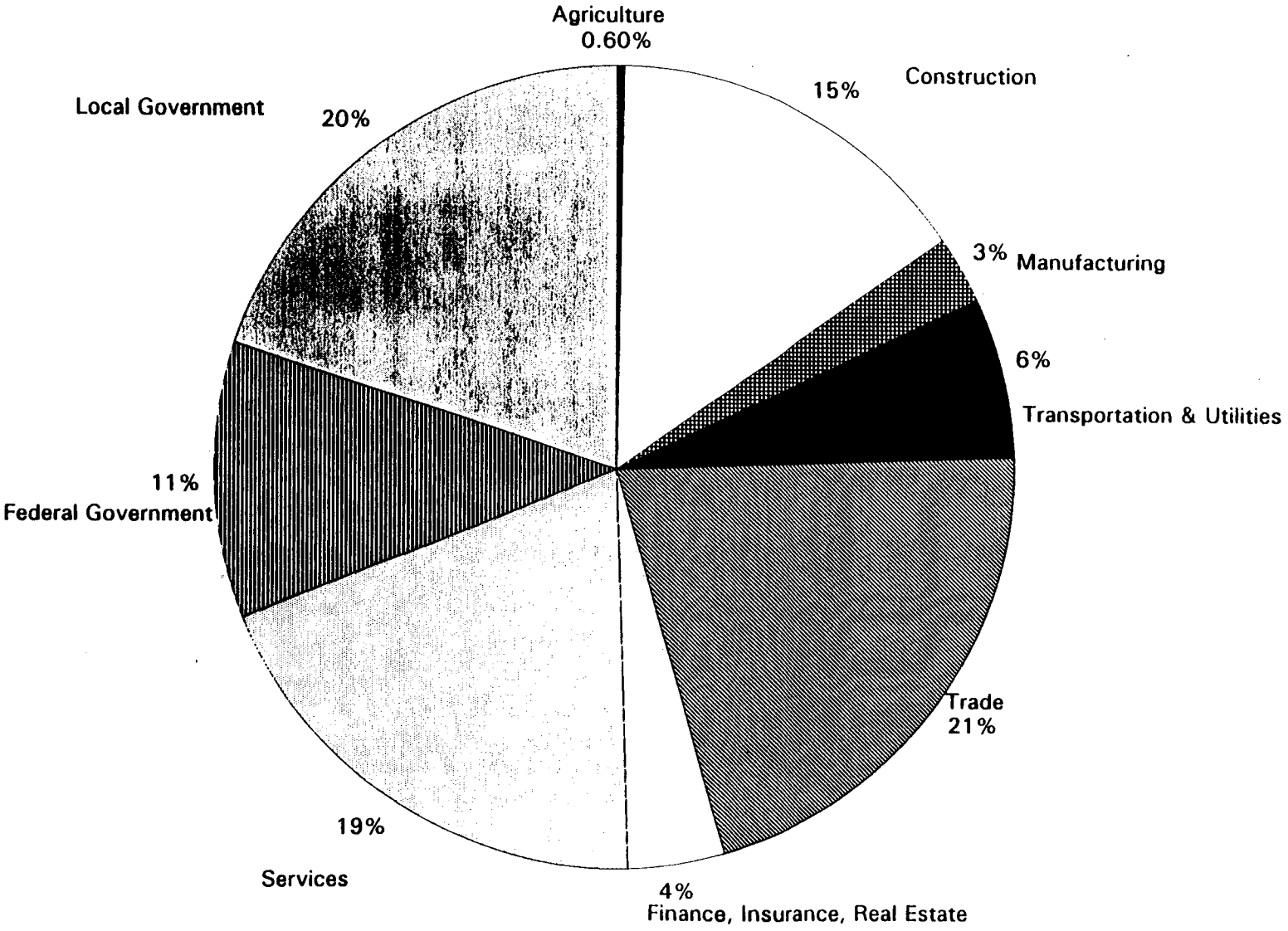


Figure 5.4 Guam Employment by Industry, 1992



Prices

The combined effects of a tight labor market, wage increases, and rising costs for housing have caused inflation to escalate over the past four years (refer to Figure 5.5). After averaging just above the U.S. inflation rate between 1985 and 1988, the Guam consumer price index rose 10.9 percent in 1989, more than twice the U.S. rate of 4.8 percent. In 1990, inflation continued to increase chiefly as a result of the decision by the government of Guam to give all of its employees a $5,440 salary increase. This amounted to an average salary increase per worker of about 20 percent[17] and was issued primarily to provide workers with a cost of living adjustment. Because the government of Guam jobs account for one-fifth of the total payroll employment, the sudden increase in consumer purchasing power was felt throughout Guam's economy. Economists at the Bank of Hawaii have indicated that high inflation may continue through most of this decade.[18] Guam also imports inflation from its main suppliers, the U.S. mainland and Japan.

Prices are higher on Guam than they are on the U.S. mainland, as illustrated in Figure 5.6, even when the expected 10 to 20 percent mark up for shipping costs is considered, largely because of wholesale price increases. Althought the data is now somewhat dated, in March of 1993, the *Wall Street Journal* tallied the average prices of miscellaneous grocery items across the nation. The *Pacific Daily News* of Agana, Guam, repeated part of this same survey in six stores on the island and found that prices on Guam are about 57 percent higher than the prices on the mainland reported by the *Wall Street Journal*.[19] Guam housing costs, particularly rents, are similar to those in the U.S. mainland's more expensive urban areas. A recent comparison of the rents for two bedroom units on Guam and those surveyed by the U.S. Department of Housing and Urban Development shows that the rents on Guam are comparable to those in San Diego and Chicago, the sixth and seventh most expensive U.S. metropolitan areas.[20]

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[17]*Pacific Island Economic Trends*, Report to the Pacific Business Opportunities Conference, Honolulu, Hawaii, January 16-17, 1992, Bank of Hawaii Economics Department, p. 11.

[18]J. Blum, "Guam's inflation to stay high, study says," *Honolulu Advertiser*, June 6, 1991, p. A-13.

[19]J. McCarthy, "Informal survey: Guam prices 57% more than in U.S.," *Pacific Daily News*, April 9, 1993.

[20]*1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, p. 20.

Figure 5.5 U.S. vs. Guam Inflation Rate

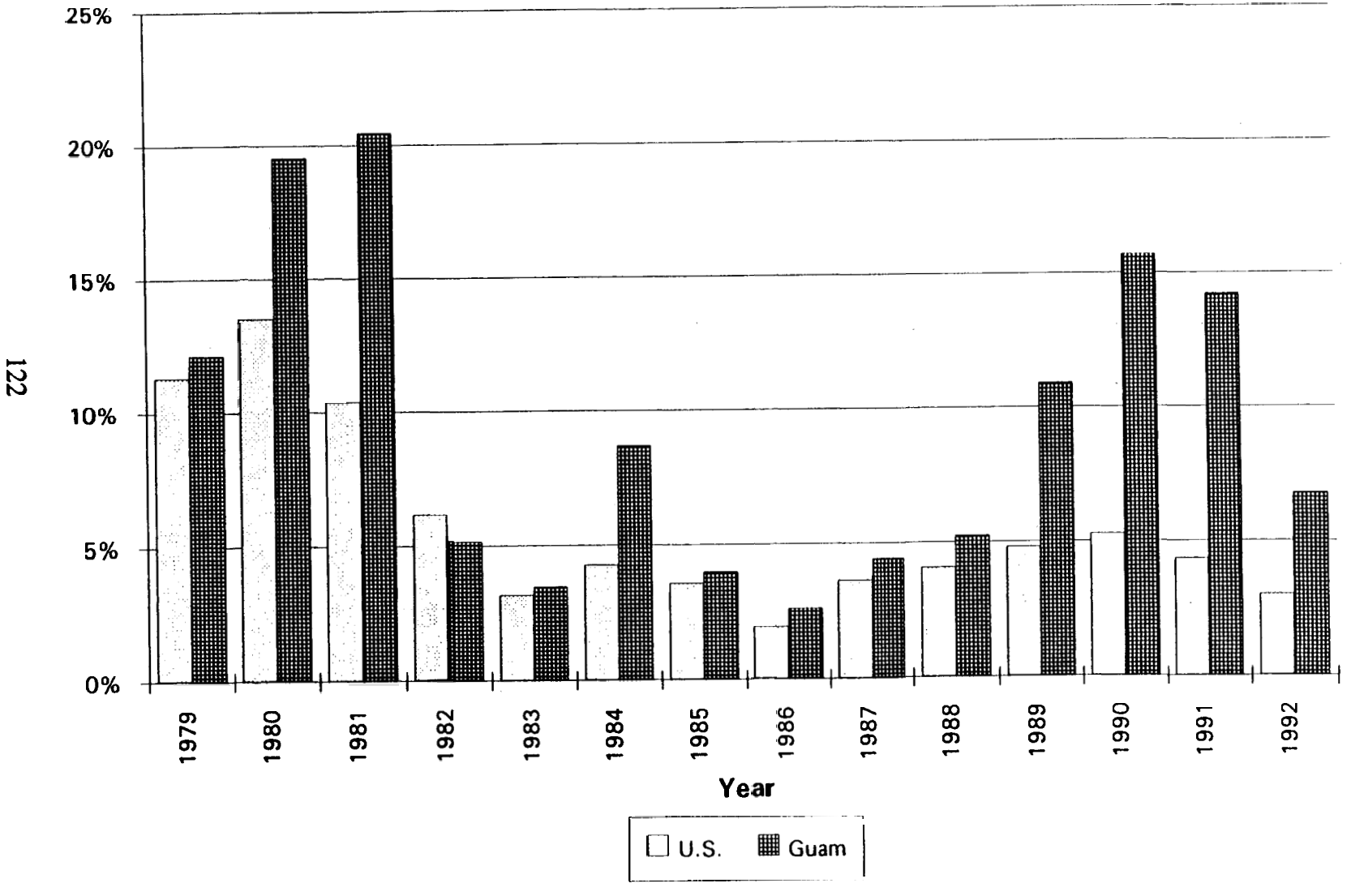

Figure 5.6 CPI for Guam and U.S. Mainland

Trade and Business Growth

Guam imports almost all of its goods since it is an island with little manufacturing or agriculture. However, from the early 1970s until recently, Guam has not had a requirement to record the commodity classification nomenclature on invoices submitted to the local customs office, so consequently the recording of trade statistics has been sporadic and inconsistent.[21] Guam now has written rules and regulations to establish local import and export procedures to improve the recording of trade statistics. These recently established procedures require that the proper nomenclature be recorded on the Guam Shipper's Import/Export Document. The Foreign Trade Division of the U.S. Department of Commerce coordinated the application of these new rules and published them in the Federal Register.[22] The first fruits of this effort are seen in the publication of statistics on Guam's exports for calendar year 1991[23] by the Economic Research Center of Guam's Department of Commerce. Import statistics are still forthcoming.

The Port Authority of Guam and the Guam Airport Authority have maintained records on the movement of cargo in and out of Guam recorded in units of weight. A review of these statistics (see Figure 5.7) indicates that the level of exports from Guam has not changed appreciably over the last ten years, but that imports to the island have doubled (when measured in revenue tons) since 1988.[24] Concurrent with this increase in import tonnage flowing into Guam, total gross business revenues have increased at a very high average rate of 21 percent per annum between 1988 and 1991. Figure 5.8 shows that the value of the total gross business revenues reported in 1991, $4.5 billion, is four and a half times its 1981 level.[25]

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[21]Quarterly Economic Review, Volume 12, No. 3, 3rd Quarter, Calendar Year 1990, Economic Research Center, Department of Commerce, Government of Guam, p. 3.

[22]ibid., p. 4.

[23]Total value of 1991 exports equals $84,543,162, *1991 Guam Annual Economic Review*, Table 108, Economic Research Center, Department of Commerce, Government of Guam.

[24]*1991 Guam Annual Economic Review*, Table 86, Economic Research Center, Department of Commerce, Government of Guam.

[25]*1991 Guam Annual Economic Review*, Economic Research Center, Department of Commerce, Government of Guam, p. 4.

Figure 5.7 Guam Import vs. Export Tonnage

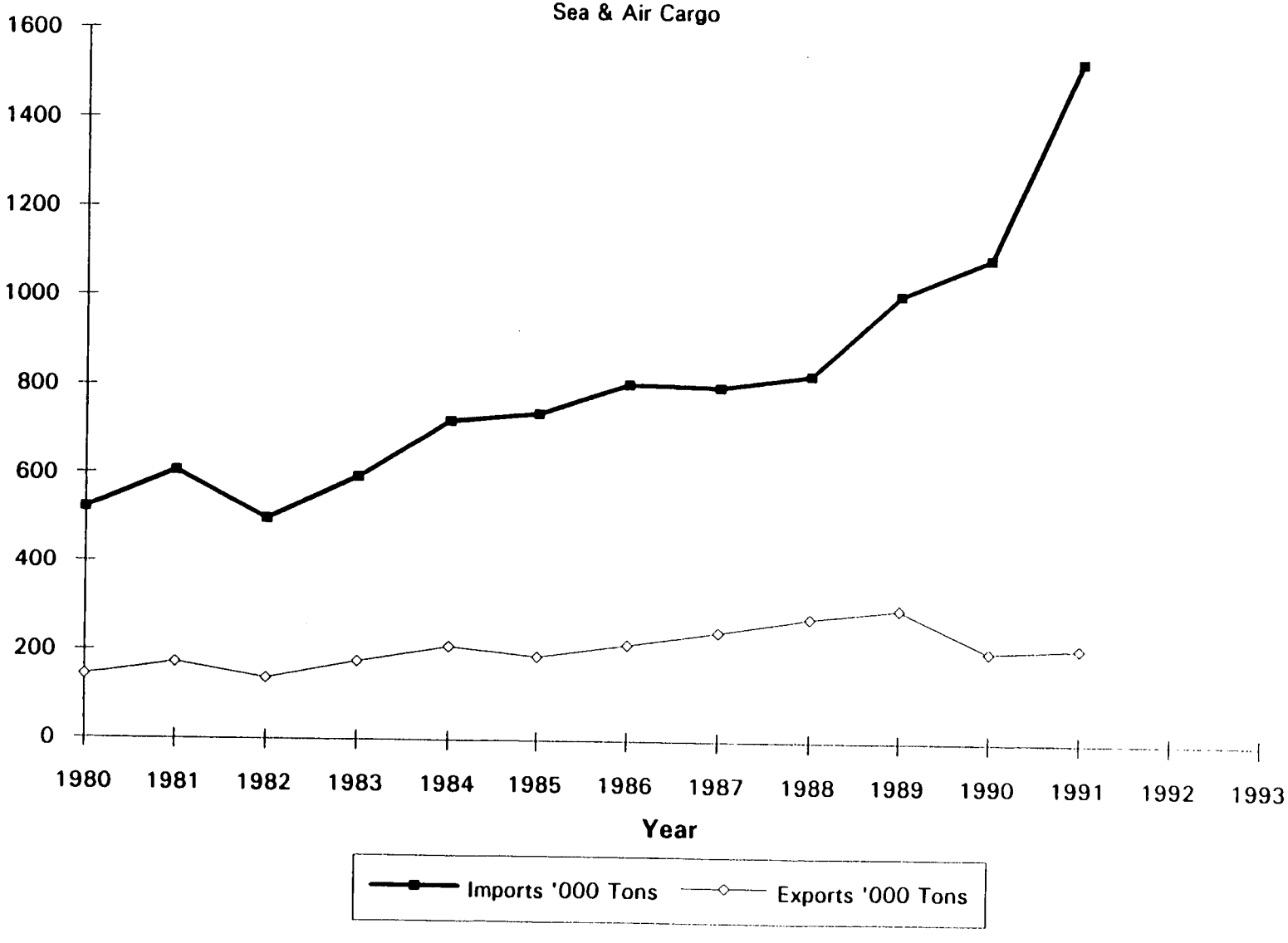
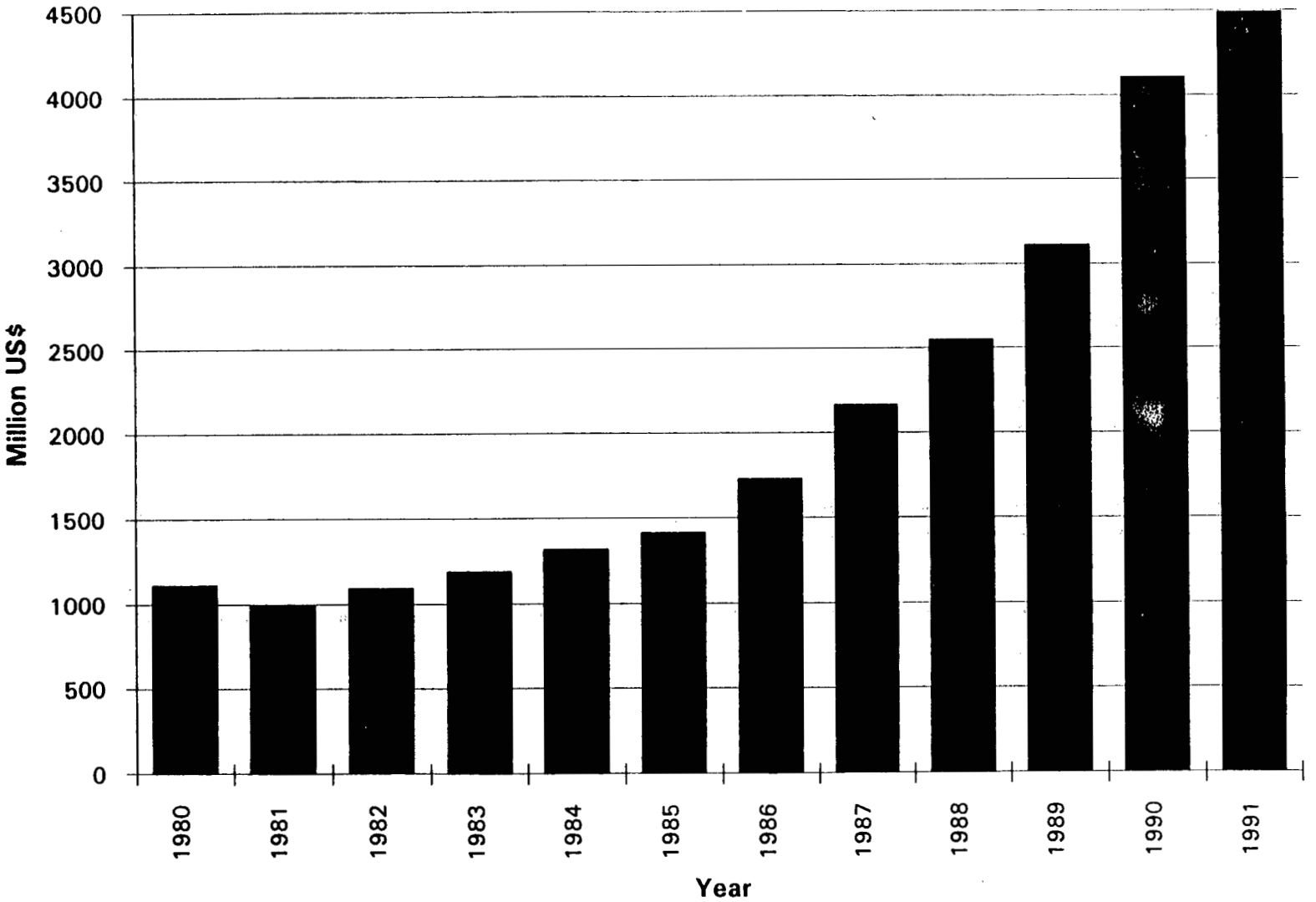


Figure 5.8 Guam Gross Business Revenue



Key Sectors

Tourism

Driving the expansion of the Guam economy is tourism, which in recent years has been experiencing extremely rapid growth and represents a significant share of the economic activity on Guam. A 1986 study estimated that tourism accounted for 38 percent of the total number of jobs on Guam.[26] Historically, the majority of the visitors to Guam have been from Japan, Korea and Taiwan. Nonstop airline service is provided to Guam from seven Japanese cities, which are about three hours from the island by air. Because of the large number of tourists coming from Japan, the trends in Guam's tourist industry are closely linked to Japanese travel patterns. Guam has maintained a fairly consistent share of the destinations for Japanese overseas travel, capturing between 3.8 and 4.0 percent of the total Japanese overseas travel market in all the years from 1986 to 1989.[27]

Factors explaining the recent upsurge in travel from Japan to Guam include:

- Strong Japanese domestic economic growth, which in real terms averaged 4.2 percent annually from 1984 to 1991;
- the appreciation of the Yen against the U.S. Dollar;
- Japanese government policies to encourage overseas travel as a means of reducing Japan's international trade surplus;
- significant Japanese investments in Guam; and
- a program initiated in 1988 by the United States waiving visa requirements for most short visits to Guam by Japanese.

Currently, and even though visitor arrivals are increasing from South Korea and Taiwan, Guam is going through a tourist slump which is blamed on the sluggish Japanese economy. Hotel occupancy rates are down, and some businesses on Guam have reduced the number of employees or eliminated overtime. Even though the number of Japanese tourists in 1992 exceeded the pre-Gulf War 1990 Japanese tourist count by 6 percent, the Guam Visitors Bureau stated that in January and February 1993 total tourist arrival figures were down by 8 and 16 percent, respectively, over the same periods in 1992.[28] Estimates of how long this slump will last vary from a few months to more than a year.

Despite this current slump, it is expected that the Japanese overseas travel market will continue its expansion after the Japanese economy picks up. The reasons for this fundamental optimism include the following:

- According to the Japan Travel Bureau, Guam's proximity to Japan renders the overall price of a Guam vacation substantially lower than the price of a vacation to most

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[26]SRI International study quoted in Guam Airport Authority General Revenue Bonds, January 27, 1993, p. 41.

[27]Guam Airport Authority General Revenue Bonds, January 27, 1993, p. 45.

[28]P. Runquist, "Businesses cut cost, employees," *Pacific Daily News*, April 9, 1993, p. 68.

- The Japanese government is expected to continue to encourage increased leisure time for workers (the government is currently trying to institute a five-day work week) and increased overseas travel as a means of balancing international trade. In fact, the Japanese government offers tax incentives to companies that sponsor employee overseas vacations of four days or less. According to the Guam Visitors Bureau, 20 percent of all Japanese visitors to Guam in 1991 were company-sponsored travelers. Guam's proximity to Japan makes it an ideal destination for travelers participating in this "long weekend" program.
- The Japanese population is growing older. In 1995, 35 percent of the population in Japan will be at least 50 years old, compared with about 30 percent in 1990. Thus, as the Japanese population reaches retirement, a larger share of the population will have time available for travel.
- According to the chief economist of the Bank of Hawaii, as the growth in disposable income of Japanese consumers slows in the current recession, vacation destinations such as Guam, which are close to Japan and relatively inexpensive, become attractive alternatives to Europe and the mainland United States.
- About 70 percent of the Japanese visitors to Guam surveyed in December 1991 indicated a likelihood of returning to Guam.
- There has been significant investment in Guam by the Japanese. According to Kenneth Leventhal and Company, 8 percent (or about $1 billion) of the total Japanese investment in U.S. real estate occurred on Guam. Furthermore, 20 percent of the 1990 Japanese investment in U.S. hotels and resorts occurred on Guam, and most of Guam's luxury hotels are Japanese owned and operated.

The number of visitors from places other than Japan has also increased significantly in recent years. It is expected that Pacific Rim nations, particularly Korea, Taiwan, Hong Kong, the Philippines, and Australia, will provide more visitors to Guam in the 1990s as a result of their increased economic prosperity and proximity to Guam. Forecasts by the International Air Transport Association indicate that passenger traffic from these countries will increase by about 10 percent a year until the year 2000. This projection is based primarily on continued strong economic growth in Asia. Guam is expected to benefit from this growth in traffic since the new "Guam-only" visa waiver program allows travelers from 14 countries, including virtually all of Guam's top tourist markets, to visit Guam for up to two weeks without a visa.

Construction

A critical element in realizing the expected visitor demand is the development of tourist support facilities, particularly hotels. Because of the rapid increase in visitors to Guam, a significant amount of new hotel development has occurred (see Figure 5.9), and more is planned or already under construction. The government of Guam has estimated that foreign investment will exceed $3 billion dollars before the current construction boom declines. However, according to the Senior Economist at the Bureau of Labor Statistics, many of the larger approved projects have not moved to the construction stage, and may not be built for several years (communication with the Guam Energy Office 12 November 1993).

The value of the total construction permits increased rapidly in nominal terms from 1984 to 1991 at an average growth rate of 48 percent per annum (see Figure 4.10). Increases in permits for

new hotel construction accounted for a major part of this growth. Comparable increases occurred in permits for condominium construction, which was virtually nonexistent on Guam before 1987. Between 1987 and 1991, permits valued at over $225 million were issued for condominiums, compared with less than $5 million over the preceding two decades. A large portion of this construction has been purchased by foreign investors, but much of it as well as the record swell in apartment construction has been directed at the extreme shortage of housing on the island.

Figure 5.10 indicates that foreign investors have targeted high priced luxury condominiums for their investments in 1991. However, it now appears that the market for luxury condominiums has been saturated. In 1992, the value of permits for the construction of condominiums plunged 95 percent and accounted for a large part of the 54 percent overall drop in the value of all construction permits issued that year. Financial difficulties of the funding groups in Japan and concern that the growth in the hotel room count may be moving a little ahead of the market (or at least ahead of the staff required to service the market) have placed some hotel and condominium construction plans on hold.

Another area of uncertainty is the construction of nonhotel commercial space. Between 1986 and 1991, this category registered a total of $250 million in new or alteration construction permits. In nominal terms, this is more than double the amount reported in the preceding 15 years. Although commercial space was in high demand, some properties appear to have been ill-conceived or inappropriate for the market, which, when combined with the economic slowdown, led to a drop in the value of permits for commercial construction by over 40 percent in 1991 and 1992.

Even though the value of construction projects started in 1992 is less than half the value of projects for which permits were issued in 1991, it appears that the construction industry will maintain higher levels of production than those reached prior to the wild surges in the recent past. Hotel construction is still ongoing, and, as shown in Figure 5.11, if only those developments currently under construction are actually completed, then the number of hotel rooms on Guam will grow by 30 percent by 1995. By 1998, the current number of hotel rooms on Guam will almost double if only those developments under construction or already approved for construction are completed. There is also a backlog of 17 announced or approved golf courses for which construction has not yet commenced.

Over the next five to ten years, certain key issues will help determine to what extent the planned and speculated hotel and resort development will actually occur. These issues include:

- the capacity of Guam's infrastructure (e.g. water, sewer, roads, and power) to support continued development;
- the capacity of Guam's labor market to support continued development; and
- the continued growth in visitor arrivals, given increased competition from other Pacific Rim tourist destinations.

Figure 5.9 Guam Hotel Room Inventory

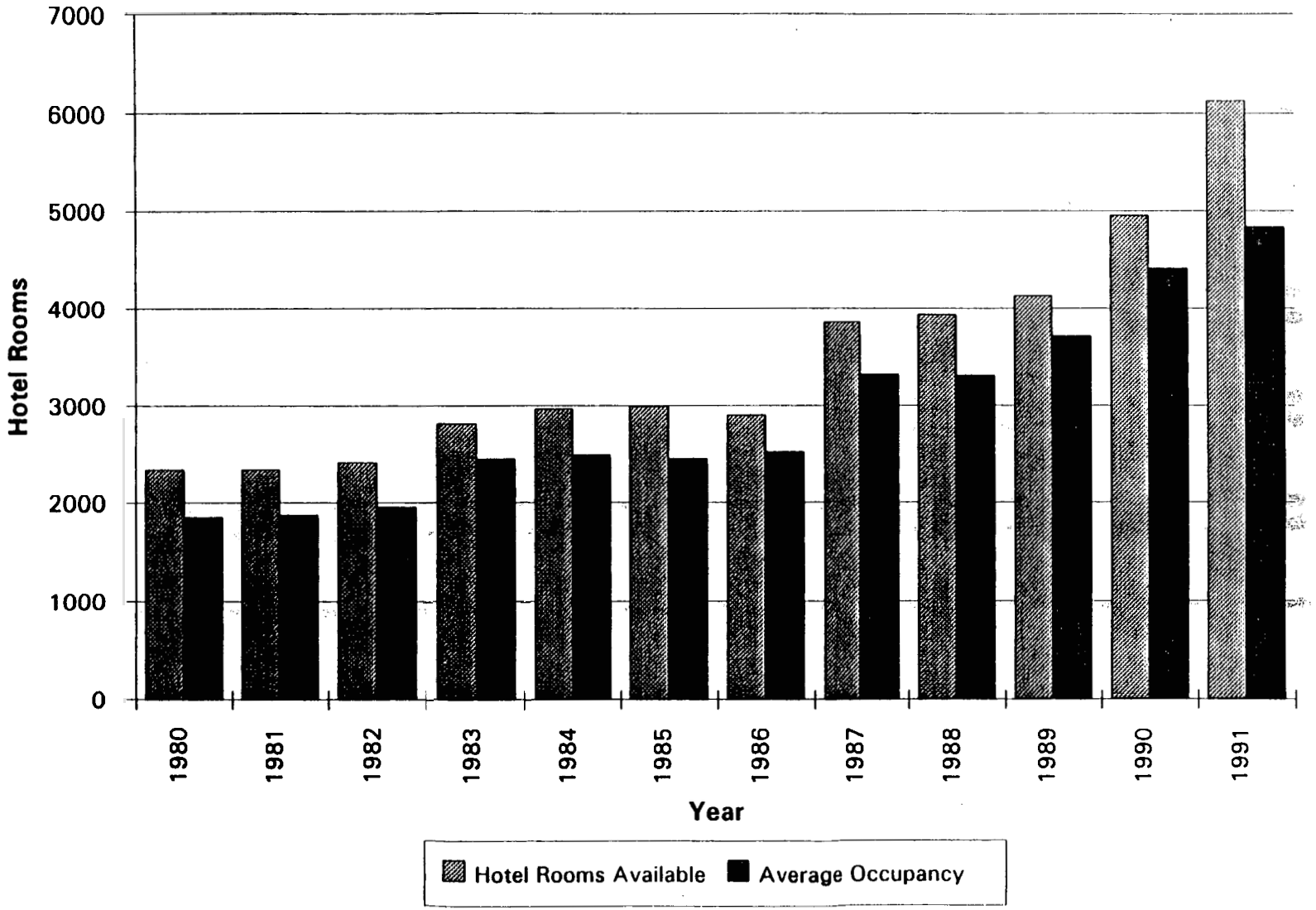
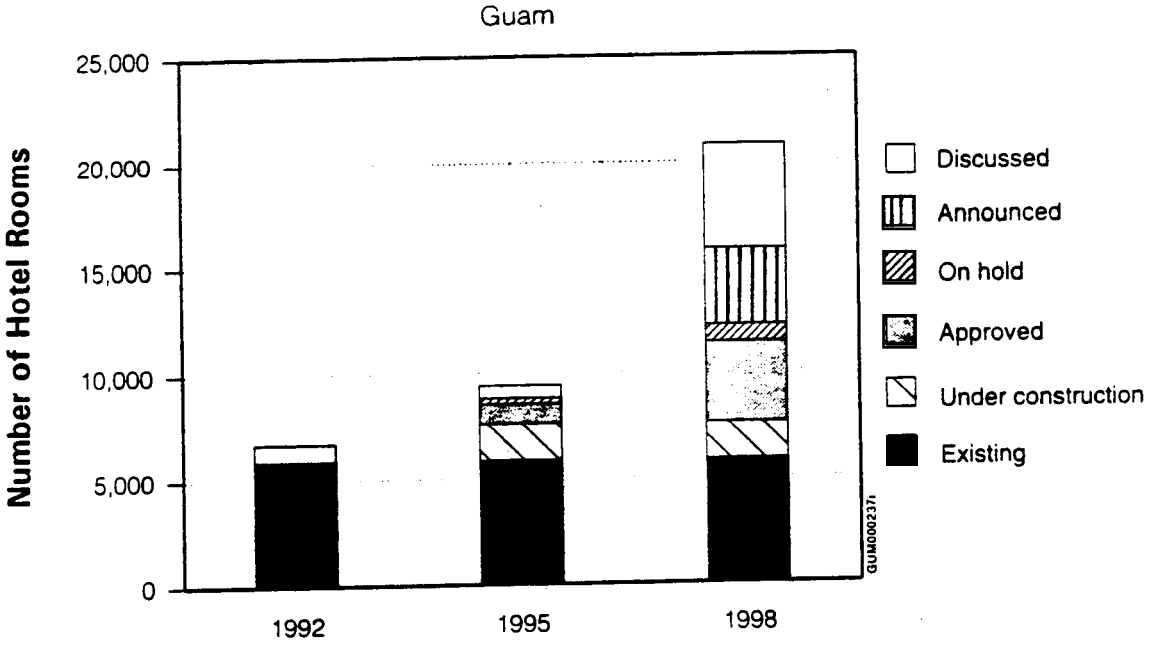


Figure 5.10 Value of Guam Building and Construction Permits

Figure 5.11 Projected Supply of Hotel Rooms*



*As of April 1992.

Source: Government of Guam, Department of Commerce, Division of Economic Development and Planning.

ENERGY SECTOR

Overview

Guam is almost completely dependent on imported petroleum products as the source for commercial energy. Data from the 1990 census indicate that over 98 percent of Guam's housing units are electrified, and over 95 percent of the households have at least one motor- operated vehicle. Petroleum is the only energy source for Guam's transportation and electricity generation subsectors.

Generally speaking, energy from renewable sources, especially for electricity generation, has been judged to have a limited amount of cost-effective potential on Guam.[29] Efforts have been made, however, to demonstrate the potential of some renewable energy sources, such as the 24 solar-powered lamps erected at the governor's Adelup Complex by the Guam Energy Office (GEO) in the late 1980s. Other avenues still open for evaluation are municipal solid waste-to-energy, cogeneration, and ocean thermal energy conversion (OTEC) projects. GEO is also interested in exploring the feasibility of developing the deep ocean water resource (DOWR) and low-head and conventional hydroelectricity.

The strain of the continued load growth on Guam's electric grid is one of the most serious issues facing Guam's energy sector. Guam's rapid economic growth coupled with escalating power demand has placed a real burden on the power system. The threat of typhoons is also present which requires investment in capital improvements to harden the system so that it can withstand the most adverse weather conditions.

Collection of energy statistics needs to be improved. Critical petroleum supply and storage data are not always provided by some of the oil companies which handicaps planning and management of the energy sector. However, recent efforts by the Guam Energy Office and the Guam Power Authority (GPA) to strengthen data collection, including the identification of end uses by power consumers, are positive steps. These data will facilitate the development of effective energy conservation programs as well as integrated resource planning. Similar effort needs to be given to identifying petroleum end-uses.

Supply and Demand for Petroleum Products

In 1991, Guam consumed over 6.7 million barrels of petroleum products with a value of $140.7 million (see Figure 5.12). This value is two-thirds greater than the value of all the commodities Guam exported that same year. In 1992, consumption rose to 6.8 million barrels. Demand for petroleum products rose to 7.3 million barrels in 1993. This represents a 7.4 percent increase over 1992 demand. The data available for Guam's petroleum consumption in earlier years are questionable as it is difficult to corroborate the values of different sources. The major suppliers of petroleum products are listed in Table 5.2. In addition to these commercial suppliers, the military imports strategic fuels (diesel and jet fuel) for official military use directly from the U.S. Navy Supply Depot via the Department of Defense procurement system.[30] Data on the volume and value of such

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[29]*Guam Power Authority Generation Expansion Study: Twenty-Year Resource Plan*, R. W. Beck and Associates, October 1990, p. 3.

[30]March 1993 communications with G. Tavanavanua.

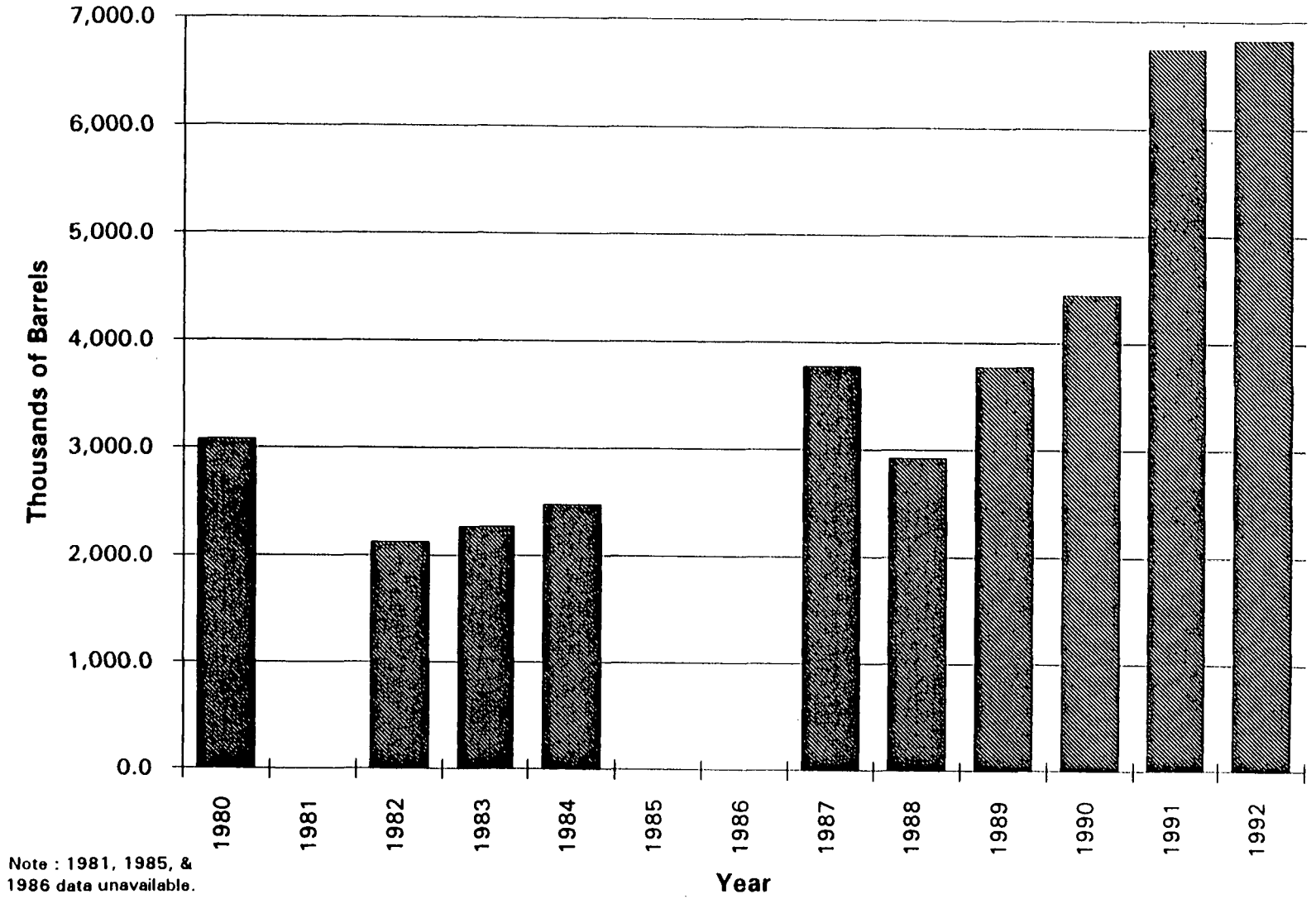
military fuel are not available and are not included in this analysis of Guam's energy vulnerability but are obviously important.

Recent estimates of the end uses of commercially imported products are difficult to obtain. However, half of the island's petroleum suppliers have provided broad approximations on the end uses of their products. The estimates provided by the local petroleum marketers, together with the reported fuel consumption by the Island-Wide Power System (IWPS), enable a rough accounting to be made of the end uses of the fuel commercially imported into Guam. From Table 5.3, it can be concluded that over 90 percent of the island's petroleum fuel is consumed either for transportation or for electricity generation.

Within the transportation sector, further information is available on the end uses of various products on Guam. According to statistics provided by one of the oil companies operating on Guam, over 99 percent of the gasoline is used for land transportation, and nearly 100 percent of the jet fuel is dedicated to aviation. About 80 percent of the diesel used in transportation is for marine applications, with the rest going to land transportation.

The fact that two-fifths of the imported diesel is in the miscellaneous end use category is an indication of the multiple uses for this fuel on Guam (and hence the reluctance of most suppliers to define its end uses in specific quantitative terms). In 1982, 87,000 barrels of diesel were imported for commercial purposes, and this represented 4 percent of all the petroleum fuel used on Guam. By 1992, however, the amount of imported diesel had increased more than thirteenfold and now accounts for more than 16 percent of the island's petroleum fuel used. Figures 5.13, 5.14, and 5.15 illustrate Guam's petroleum product usage in 1982 and 1992. End users include hotels, laundries, construction projects, and other commercial establishments as well as the GPA for some electrical power generation. The "Other" fuels category in Table 5.3 includes products such as LPG and AvGas with end uses including home and restaurant cooking and aviation.

Figure 5.12 Guam's Petroleum Consumption



Note : 1981, 1985, & 1986 data unavailable.

Table 5.2. Major Petroleum Product Suppliers to Guam

Major Suppliers	Products Supplied	Sources
Mobil Oil Guam Inc.	MoGas, Jet, ADO, AvGas, Lubes	Fuels-Singapore Lubes-Hong Kong
Esso Eastern Inc.	MoGas, Jet, ADO, Lubes, LPG	Singapore
Shell Guam, Inc	MoGas, Jet, ADO, Lubes, Avgas, LPG	Singapore
Broken Hill Proprietary Petroleum Americas (Formerly Pacific Resources Inc.)	MoGas, ADO	Singapore
Petroleum Distributing Company (PEDCO)	IFO	Singapore

Table 5.3. Estimated Guam Petroleum Product Commercial End Usage, 1992
('000 Barrels)

Product	Transport	Electricity	Miscellaneous*	Total
MoGas	1081.0	--	--	1081
Jet Fuel	1751.3	--	0.7	1752
IFO	24.0	2648.0	--	2672
ADO	362.4	310.4	484.0	1157
Other	7.0	--	160.0	167
Total	3225.7	2958.4	644.7	6829
Percentage	47.2%	43.3%	9.5%	100%

* Hotels, restaurants, home cooking, construction, marine bunkers (not fishing), avgas, power.

Storage and Distribution Systems

Guam has a very large petroleum storage capacity compared to other Pacific islands. Its commercial storage capacity is currently estimated at 5.5 million barrels, which is equivalent to over 75 percent of Guam's total 1993 petroleum consumption. Translated into consumption days, this aggregate storage capacity indicates that Guam has (in theory) 274 days of petroleum fuel storage. However, a closer look into the make-up of this 5.5 million barrels of storage capacity shows that Guam's fuel storage capacity in days is not accurately represented by the above simple calculation.

Three-quarters of Guam's storage capacity is owned by Shell Guam, Inc. Shell is a recent newcomer to the Guam and Micronesian markets, beginning operations in 1987. In 1988, Shell purchased the assets of the Guam Oil and Refining Company (GORCO). The GORCO refinery originally came on-stream in 1970 and was designed to satisfy the military fuel requirements of the U.S. Air Force and Navy for jet fuel and other light products. The original GORCO investors received government of Guam tax incentives and took advantage of the Small Business Act provisions in the U.S. military fuel contracts to successfully bid for military business. The loss of a major military supply contract forced the closure of GORCO's refinery operation in March 1984, but GORCO continued to operate the oil terminal and lease storage facilities to the U.S. military until 1988, when these properties were sold to Shell. These storage facilities are comparatively large, with a capacity of 3.9 million barrels. Shell also uses its Guam storage facilities to supply its markets in the CNMI and Palau.

Shell is currently considering downsizing or closing its storage facilities. At one time during 1993, Shell had indicated that it might downsize its storage capacity to possibly 1 million barrels. However, Shell recently leased considrable tankage to a U.S. oil marketing company for storage of products (primarily diesel and jet fuel) for transhipment to East Asian markets. It has been suggested that this relationship has been positive for both companies. In February 1994, Shell Guam advised that it plans to close its storage facilities beginning in early 1995. This will remove 3.9 million barrels. Shell Guam and the GEO have indicated that if the U.S. federal government ever intends on developing SPRs in the Pacific Islands or utilizing Guam as a key forward military base (for refueling) then it would be wise to takeover the storage facilities now and thereby avoid capital (construction and land) costs.

Most of the remaining commercial petroleum storage facilities are located on the north rim of Apra Harbor near the oil tanker terminal facilities. These tanks, managed or owned by Mobil, Exxon, or BHPPA, provide at least 800,000 barrels of petroleum storage capacity. In addition to the commercial storage capacity, the Guam Power Authority (GPA) has over 600,000 barrels of storage capacity for fuel oil and diesel oil at its disposal.

Included in this amount are the auxiliary day tank storage facilities at the Cabras, Tanguisson, Piti, and Dededo plants as well as the two large 268,000 barrel fuel oil storage tanks operated by IPEDCO on Cabras Island. Also, the Department of Defense has large storage facilities for military fuels. This capacity has been reported to be 4.1 million barrels, and these facilities occupy one percent of Guam's total land area.[31] Department of Defense-owned storage capacity is not included in

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[31] *Increasing Oil Spill Management Capacity in the American Flag Pacific Islands*, Pacific Basin Development Council, April 1992, p. 40. Note: not all of the military storage is used or useable.

Figure 5.13 Guam Petroleum Product Usage, 1982 and 1992

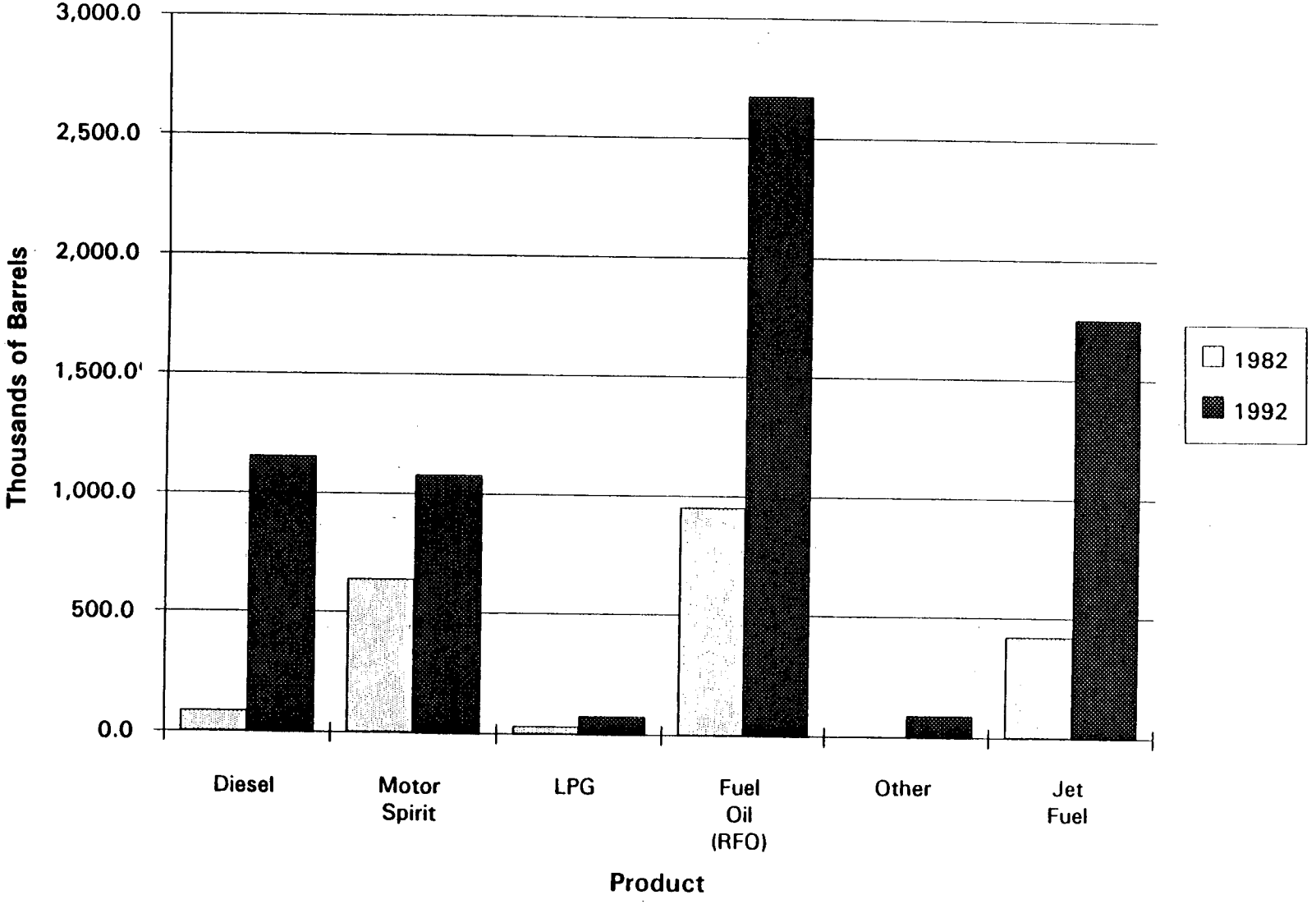


Figure 5.14 Guam Petroleum Product Usage, 1982

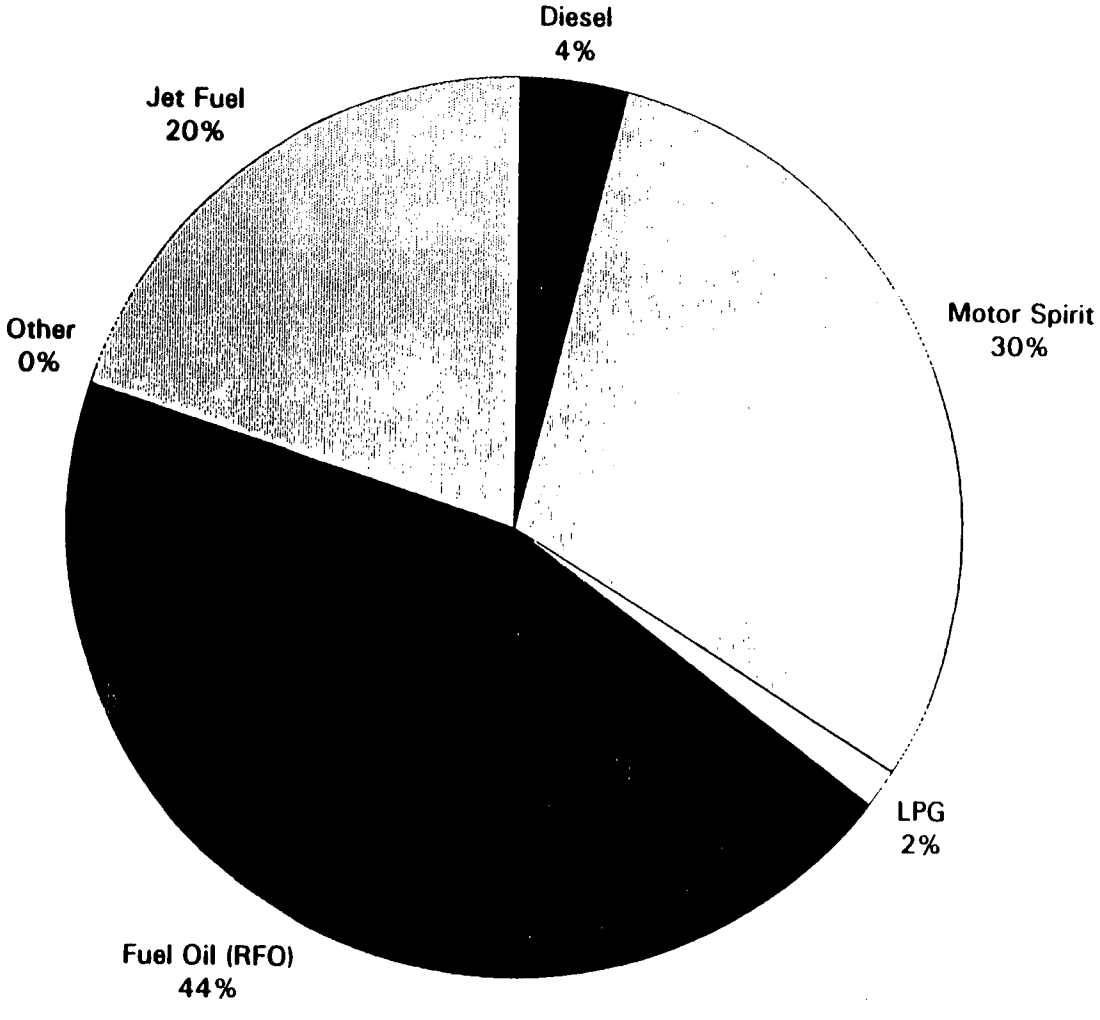
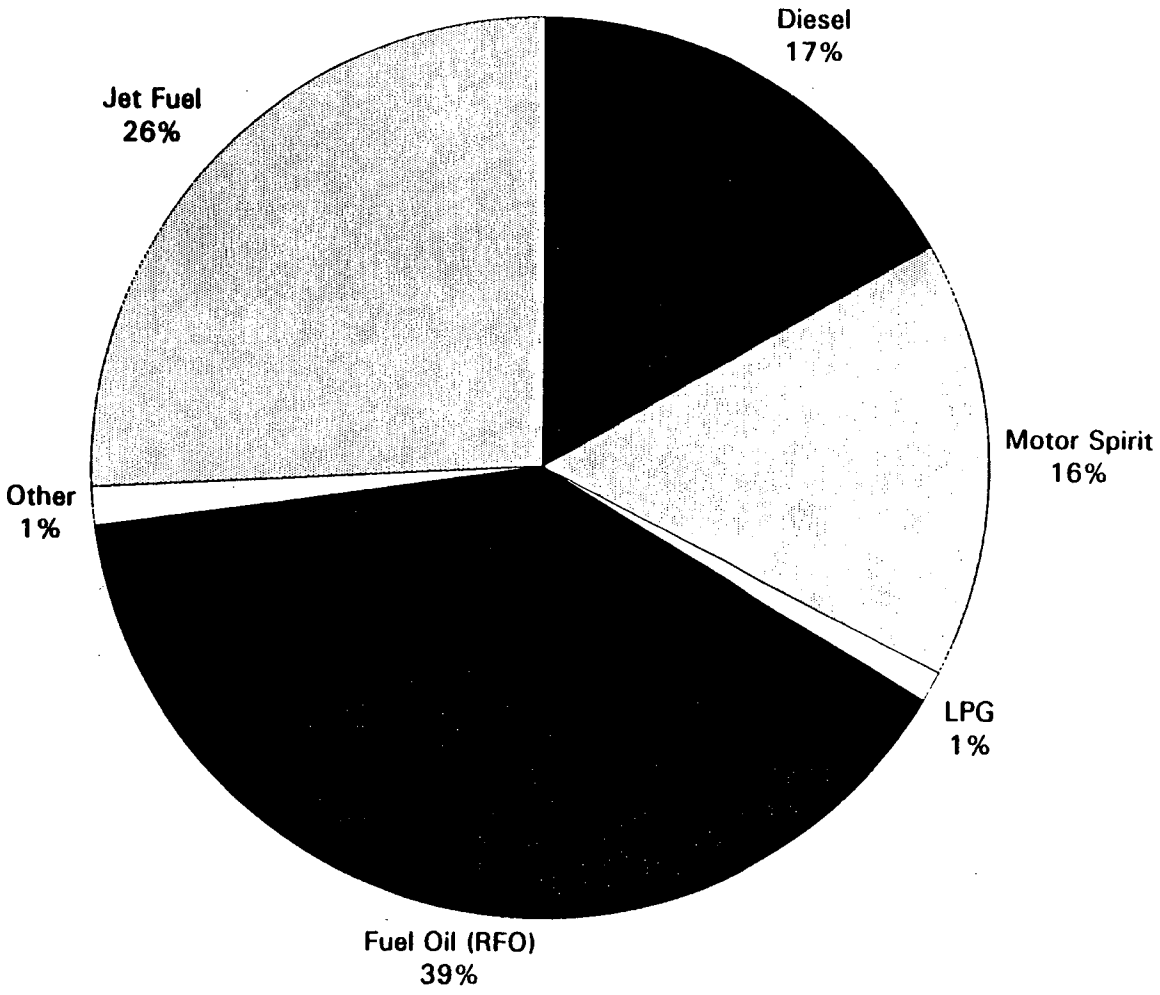


Figure 5.15 Guam Petroleum Product Usage, 1992



any of the calculations or aggregate capacities discussed in this section. The storage figures shown have not been discounted for the storage leased for supply to Asia.

Competition among the oil companies is increasing, as evidenced by the fact that Mobil recently won two regional fuel supply contracts in the CNMI and Palau from its Guam-based competitors.[32] This competitive attitude can also be seen in the reluctance of some oil companies to provide detailed information about their operations. Data collected from the Guam Energy Office and during interviews with representatives of the oil companies operating on Guam pertain to only about 90 percent of the storage capacity on Guam. No data on storage capacity broken down by product have been provided by Exxon.

An estimate can be made regarding the amount of storage capacity that is available for each petroleum product on Guam. In Figure 5.16, almost a half million barrels of Guam's petroleum storage are not specified due to incomplete information from Exxon (no data) and BHPPA (aggregate storage data because volumes of storage for each product were being changed--storage facilities have been upgraded and expanded). However, assuming the current information available from the other oil companies on their Guam-based storage capacity is typical, this known product distribution information can be applied to the unspecified Exxon and BHPPA storage capacity to derive a rough estimate of the total product storage capacity on Guam. This estimate is presented in Figure 5.17.

Fuel storage in terms of days can also be calculated based on information gathered from communications with some of the oil suppliers, assuming that the inventories (as a percentage of storage capacity of these suppliers) are typical. The results of these calculations are shown in Table 5.4 and indicate an average inventory of petroleum products kept on Guam at any particular time. Due to insufficient data, however, accurate calculations of the minimum inventory of products on Guam could not be made.

The calculations used to generate the numbers in Table 5.4 assume that all fuel stored on Guam will be used on Guam and that none will be shipped to other northern Pacific markets. This means that the numbers in the Table 5.4 will be slightly less if some of Guam's fuel is sent to another island, and it should be emphasized that Guam is the transshipment point for nearly all of Micronesia.[33] Also, it is worth noting that although Guam has the most storage capacity of any Pacific island (except for Hawaii), typically less than 20 percent of this storage capacity is utilized. Guam's market of less than 19,000 barrels per day does not require the oil suppliers to operate their storage facilities at anywhere near capacity.

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[32]"Mobil nets CUC fuel contract," *Pacific Daily News*, Focus on the Commonwealth & Micronesia section, April 9, 1993, p. 3.

[33]The Federated States of Micronesia, the Republic of the Marshall Islands, CNMI and Palau receive petroleum products via Guam. The Micronesian nations of Kiribati and Nauru are supplied either from Fiji or Australia.

Figure 5.16 Guam Petroleum Product Storage, 1992

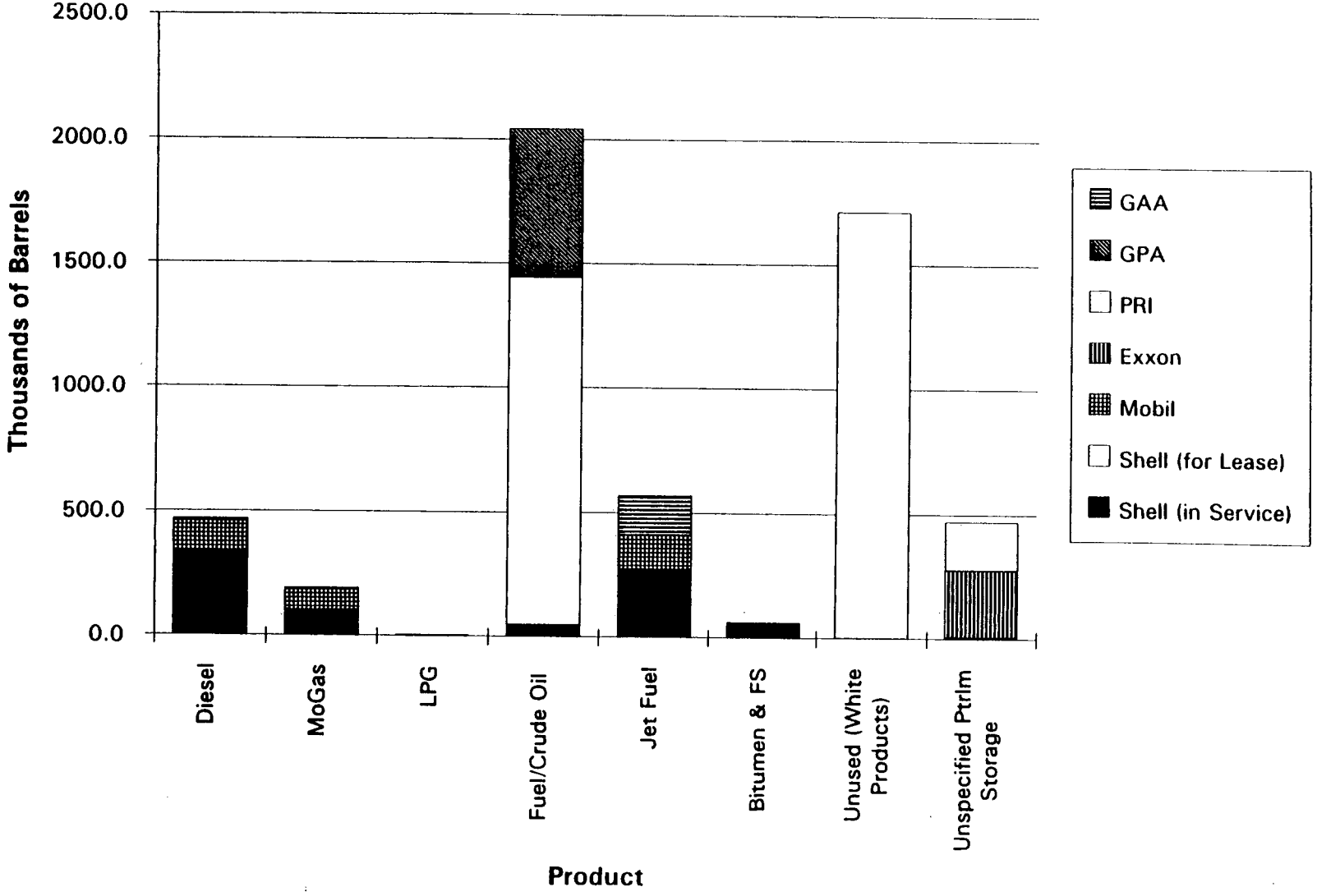

Figure 5.17 Guam's Fuel Storage Product Distribution Estimation

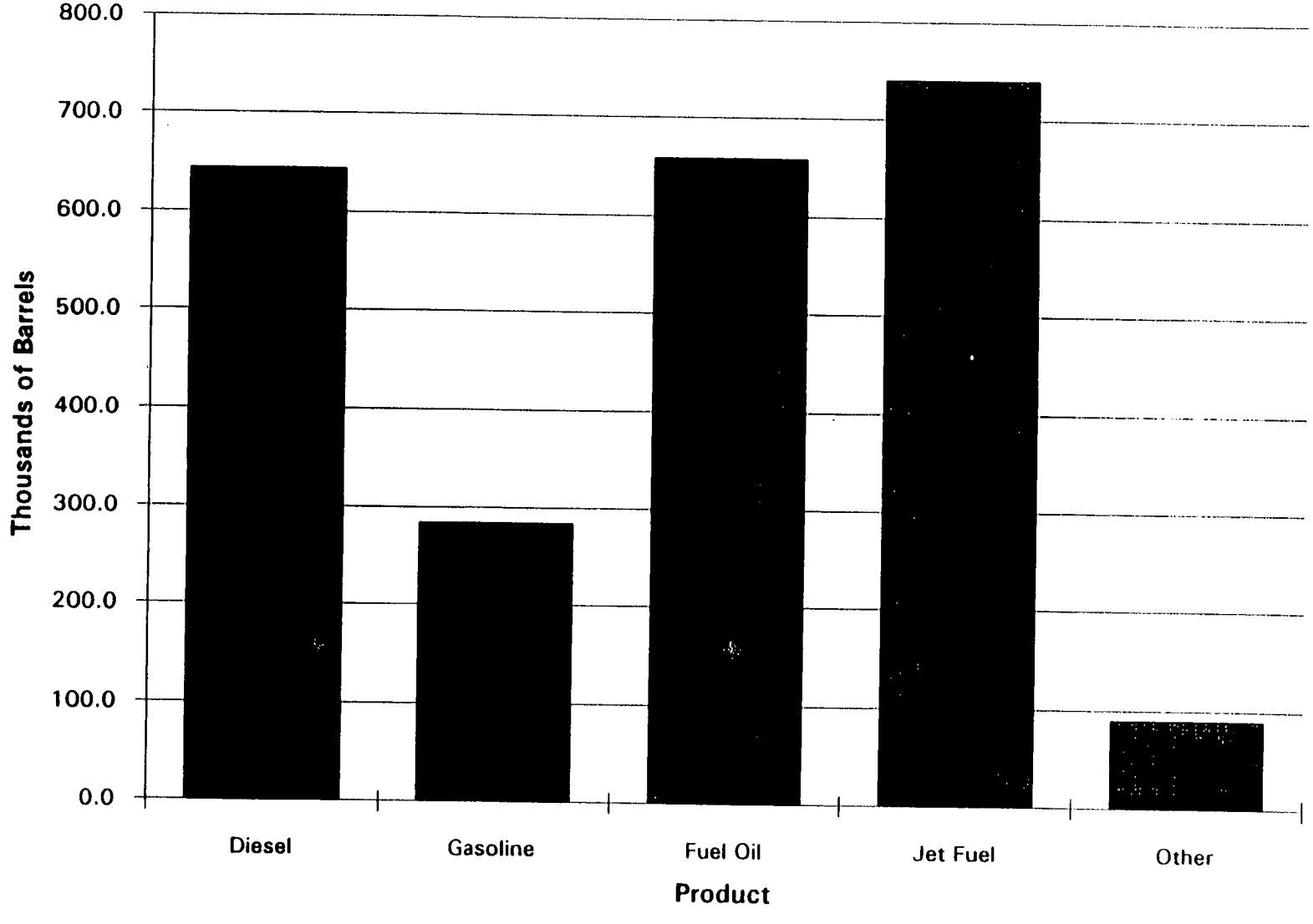

Table 5.4. Estimated Guam Petroleum Product Storage

Product	Maximum Theoretical Inventory in Days* (All Tanks)	Maximum Inventory in Days** (In-Service Tanks Only)	Estimated Average Inventory in Days***
ADO	203	203	80
MoGas	96	96	41
Fuel Oil	281	90	24
Jet Fuel	511	154	65
Total	294	129	51

* Assumes all tanks on Guam are 100 percent full.
** Assumes only those tanks on Guam that are currently in service are 100 percent full.
***Assumes only those tanks on Guam that are currently in service are kept at the "average stock level" supplied by the oil companies.

In 1991, 104 tankers (which averages one tanker visit per every three and one-half days) called on Guam. Mobil and Shell both use medium-range (MR) tankers, while Exxon uses general purpose tankers and the tankers employed by BHPPA typically have a 50,000 to 70,000 barrel capacity. All tankers deliver products from Singapore, with a typical voyage time to Guam of approximately nine to ten days. Commercial vessels also bring in lubricants and other products.

Guam has four oil transfer facilities, two of which belong to the U.S. Navy and two are used by private companies. A network of pipes allows fuel off-loaded at either of the commercial facilities to be transferred to military storage or to the other commercial dock's facilities. One of the two main commercial berths for fuel tankers is the Cabras Island berth (or Golf Pier), which is used by BHPPA and Mobil. This berth is fitted with four tanker discharge pipelines, two 12-inch diameter lines for ADO and jet fuel, one 10-inch diameter line for unleaded gasoline, and a smaller 8-inch line for regular gasoline.[34] This pier can receive MR tankers with a capacity of approximately 260,000 barrels, a maximum length of 650 feet, and a maximum draft of 38 feet.

Shell, Exxon and GPA use the old GORCO facility (Berth F-1), which has four pipelines that run the 6.5 miles from the dock to the storage tanks (see Figure 5.18). Two of these lines have a 24-inch diameter and are dedicated to ADO and fuel oil. The two smaller 16-inch diameter lines service gasoline and jet fuel. There are two 10,000 barrel-displacement tanks owned by Shell at this dock. These tanks have sufficient capacity to allow a line switch between two different grades of fuels (e.g.,

[34]March 1993 communications with G. Tavanavanua.

Jet A-1, JP-5, DPK). This has been a frequent operation under the military storage contracts. These displacement tanks and the four dedicated lines provide a very flexible product receiving and delivery system. There is no line heating, but these lines can handle crude oil or products with pour points up to 90°F.[35] The F-1 facility can handle tankers with up to 135,000 deadweight tons and with a draft of 53 feet. The maximum length of a vessel that can be accommodated is 435 feet from the manifold to the bow. This is the only dock to receive LPG.

Most of the onshore distribution of petroleum products is done in bulk, except for lubricants and other specialty products which are marketed in packages. There are a total of 39 service stations on Guam serving the retail market. Almost half (17) of these stations are run by Mobil, while Exxon has 11 stations, and Shell and BHPPA have seven and four sites, respectively.

Aircraft refueling at the international airport terminal is operated by Lockheed. All companies bridge jet fuel from their own bulk fuel installations to the airport refueling terminal, where the fuel is stored in two 80,000 barrel vertical tanks. A hydrant system connects to the tarmac, where aircraft are refueled by refueling carts. Small aircraft are refueled by trucks. Airport storage will be increased with the current airport expansion.

Future Developments

A simple forecast of future petroleum imports to Guam cannot be easily made since the historical data on Guam's oil imports are incomplete and inconsistent. However, a reasonable projection of Guam's petroleum imports may be estimated using data from other sectors.

The Guam Power Authority (GPA) has recently updated its system load forecast.[36] The economic scenario that underlies this forecast is one of rapid growth during the next five years resulting from continued hotel and condominium construction and increased levels of tourism. After the five years of rapid growth, a period of steady expansion and consolidation will follow, with increasing levels of tourism and continued hotel development at moderate levels for the subsequent decade. The basis for this projected growth is the construction and completion of all the hotel developments that are now being built or have been approved for construction by Guam's Territorial Land Use Commission (TLUC) as well as those hotel developments that have been publicly announced. No new large unannounced hotel developments are assumed, but construction of one new 400-room hotel per year after 1998 was projected. Furthermore, only two-thirds of the condominiums under current consideration were assumed to be built by the year 2000. It was also estimated that all of these new developments will receive their energy requirements from the GPA (and not their own on-site power units) which is predicated on a further assumption that the GPA will be able to maintain highly reliable power delivery during this period of rapid growth.[37]

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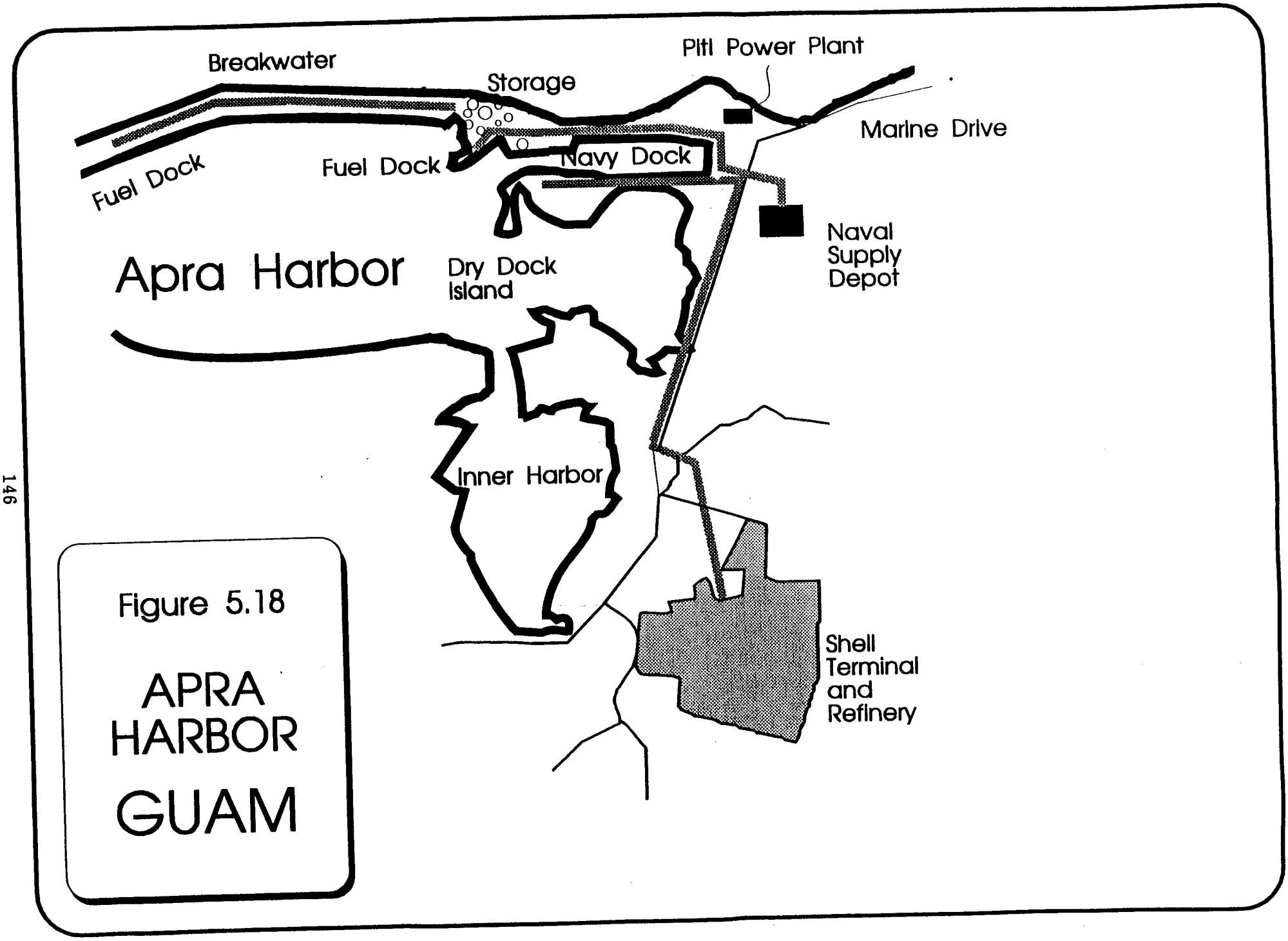
[35]*Shell Guam Storage Facilities*, Shell marketing booklet

[36]*1992 Updated System Load Forecast: Guam Power Authority*, R.W. Beck and Associates, May 1992.

[37]Currently, power outages are a frequent occurrence on Guam. Refer to "Power outage yesterday was intentional," *Pacific Daily News*, April 7, 1993, p. 6.


Breakwater
Storage
Piti Power Plant
Marine Drive
Fuel Dock
Fuel Dock
Navy Dock
Naval
Supply
Depot
Apra Harbor
Dry Dock
Island
Inner Harbor
Shell
Terminal
and
Refinery
Figure 5.18
APRA
HARBOR
GUAM

From this analysis, the GPA predicted that its sales of electricity will increase at an average annual rate of 7.5 percent until 1995 and then increase 4.9 annually between 1996 to 2000. After the turn of the century, the growth in power sales will slow to 2.3 percent. As the GPA currently imports about 43 percent of Guam's petroleum, it is reasonable to assume that the GPA's purchase of petroleum will increase at a rate similar to its electricity sales.

In addition to the GPA forecast, estimates of future sales (to non-GPA customers) by oil suppliers on Guam were gained through communications with these companies. Estimates of the growth rate of petroleum product sales on Guam range from 4.0 to 5.5 percent per year.

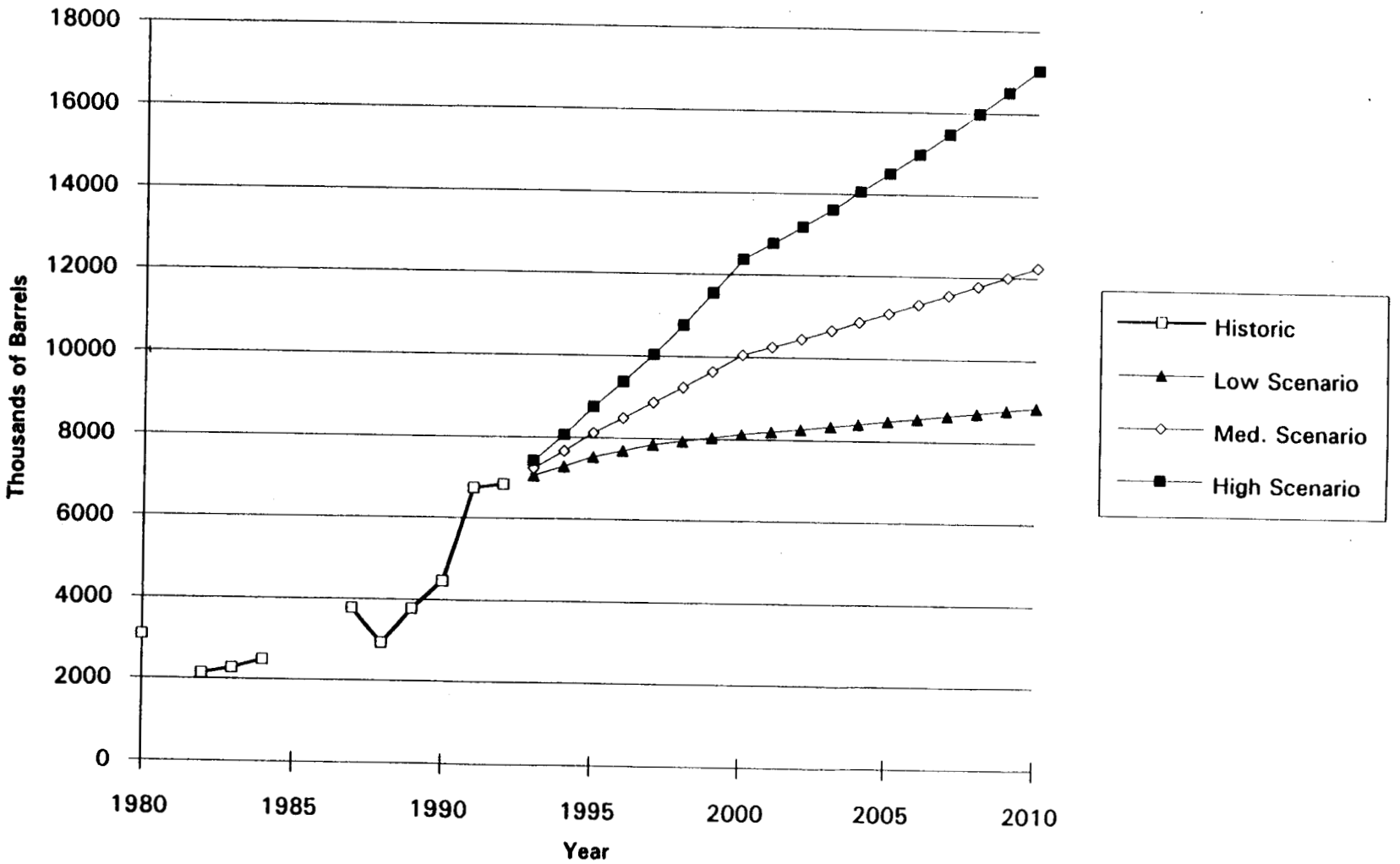
Using these assumptions, the amount of Guam's petroleum imports can be estimated to rise to 10 million barrels per year by the year 2000 at an average annual growth rate of 4.9 percent per year. However, by varying the assumptions of the economic growth of Guam, this estimated volume of oil imports in the year 2000 can fluctuate by plus or minus 2 million barrels of oil (see Figure 5.19). The GPA's low-growth case scenario assumes that only those hotels currently under construction or those that have already been approved by the Territorial Land Use Commission will be built and that no further hotels will be added. Also, this low-growth scenario assumes that only one-third of the listed condominiums are completed. Alternatively, the high-growth case scenario assumes that all hotel developments that are approved, under construction, announced and speculated will be completed and that at least one 400-room hotel per year (not yet associated with any announced or speculated project) will be added in Guam after 1998. When these assumptions are factored into the GPA's expected electricity sales, the resulting growth rate of Guam's petroleum imports then comes to 2 percent per annum in the low-growth case scenario (resulting in Guam's importation of 8 million barrels in the year 2000) and 7.5 percent per year in the high-growth case scenario (which results in 12 million barrels of oil being imported in the year 2000).

The Oil Spill Pollution Act of 1990

Regulations that are to be promulgated under the Oil Spill Pollution Act of 1990 have the potential to significantly affect the Guam petroleum sector. This legislation was largely a congressional response to the Exxon Valdez spill in Alaska. It focuses heavily on defining the financial responsibilities of the owners/operators of oil tankers and shore facilities (tanks and tank farms). This law places the burden of establishing and maintaining adequate containment and cleanup capabilities on these owners/operators. It also requires that these owners/operators obtain certification of financial responsibility to prove they could cover potential liabilities from the cleanup of a spill and from the losses resulting from a spill, including environmental damage and losses of income (both cash and subsistence) for those who depend on the resources damaged by the spill.

On the mainland U.S., oil companies have responded to this law by forming the Marine Spill Response Corporation (MSRC). By banding together to manage catastrophic spills and to meet the other demands of this bill, these companies are able to lower the costs facing individual companies that try to comply with this legislation. Although the charter of the MSRC had explicitly excluded all of the U.S. Pacific islands except Hawaii, benefits of the corporation have now been extended to include Guam and the other U.S. Pacific islands. In addition, the Hawaii-based Clean Island Council provides backup for oil spills in the islands region.

Figure 5.19 Guam Oil Demand



Guam also has its own oil spill response plan and has founded the APRA Harbor Spill Coop, which has already had successful exercises with the full cooperation of all parties involved, including representatives from the oil companies. At this time, it is still uncertain as to the fuel price impacts of the total costs of the equipment and the training required by regulations issued to enforce compliance with the Oil Spill Pollution Act of 1990. However, the key is that the oil companies have made considerable investments in and provided the required oil spill response equipment and training.

In addition to the potential problems associated with the containment and cleanup capacity requirements of this legislation, the financial responsibility requirements of this law could present an even greater challenge. The owners/operators of tanker vessels and the shore facilities need to be able to prove that they can cover the potential liability from a spill. On Guam, where the certification of the local cleanup and containment capability is still uncertain, it could be very difficult for an insurance company or a "guarantor" to estimate the amount of liability it will have to cover. It has been suggested that some of the vessels serving this region may not be able to get insurance or that the price will be so high that the owners/operators may decide not to serve the area. The Oil Spill Pollution Act of 1990 states that unless the owners/operators can be certified to be able to cover the potential liability of an oil spill, they may not continue to operate. Again however, the oil companies and oil spill co-op in conjunction with the Coast Guard and U.S. Navy have made arrangements to respond to spills, even if certain litigation issues remain somewhat unclear.

Electricity

The Guam Power Authority (GPA) is a nonprofit autonomous government utility that supplies electrical energy to approximately 36,000 customers on the island of Guam. The utility was created by the Guam legislature in 1968, with actual operations commencing in early 1969. The GPA is governed by a five-member board of directors, which is appointed by the governor of Guam and confirmed by the legislature. The directors serve five-year staggered terms.

In 1984, under the terms of the refinancing of a $36 million loan to the GPA by the Federal Financing Bank, the Public Utilities Commission (PUC) of Guam was formed. This seven-member commission maintains regulatory oversight of the rates of the GPA. The commission's procedures parallel those of similar commissions in the United States. The PUC also has authority to review all contracts that the GPA might engage in, including increases in rates and charges.

The Island-Wide Power System (IWPS) for Guam refers to the power generation, transmission, and distribution facilities operated by both the U.S. Navy and the GPA. Per the Power Pool Agreement of 1972, Guam's power is supplied through a joint effort of the Navy and the GPA. Since this agreement was implemented, the costs of operating and maintaining the IWPS, together with a return on the parties' investments in this pool, are shared based on the power actually delivered.

In 1988, a memorandum of understanding was signed by the Navy and the GPA in which both parties agreed to nullify the Power Pool Agreement and to subsequently transfer all of the Navy's generation, transmission, and distribution assets to the GPA. This new arrangement granted the GPA full responsibility and control over the IWPS with the Navy becoming a transmission-level customer of the GPA.

The history of the modern power generation facilities on Guam starts in 1944, shortly after the liberation of the island from Japanese forces, when the United States Navy began providing electric power to both the military and civilian residences. When Guam was granted territorial status in 1950, the distribution of power was transferred to the Public Utilities Agency of Guam, and separate circuits were established to serve the military and civilian loads. In 1967, it became apparent to the government of Guam that the United States federal government would no longer appropriate monies to enlarge the naval power generation and transmission facilities. The rapidly expanding civilian power requirement forced the government of Guam to create the Guam Power Authority, and in 1969, GPA operations began when the responsibility for distributing the Navy-generated power was transferred from the Public Utilities Agency to the GPA.

The GPA immediately began investing in power generation equipment by constructing the 25 megawatt Tanguisson No.2 Unit alongside the existing Navy-owned 22 megawatt Tanguisson No.1 Unit. During the early 1970s, the GPA also installed eight diesel units to serve primarily as backup units. Once the GPA Revenue Bond Act became law in 1974, the GPA began to raise funds through the sale of bonds and was able to complete the financing of Cabras No.1 Unit and most of Cabras No.2 Unit, two 63 megawatt units that came on line in 1975 and 1976, respectively.

In 1976, Guam was struck by Supertyphoon Pamela, which devastated the island and led to the deterioration of the GPA's financial position to the point where revenue bond financing was no longer possible. The GPA requested assistance from the U.S. Department of the Interior for the continuation of its capital improvement program. After lengthy negotiations, the Department of the Interior guaranteed a $36 million loan from the Federal Financing Bank pursuant to U.S. Public Laws 94-395 and 98-454, enacted by the United States Congress. Under the terms of this financing agreement, the Department of the Interior pays approximately half of the 14 percent interest rate on this loan,[38] which for fiscal year 1993 alone has been estimated to be a subsidy equal to $1.26 million.[39]

In 1992, the peak load on the IWPS was 240.1 megawatts, and a recent load forecast projects that this will increase by more than 7 percent per year, resulting in a peak load in the year 2000 of 373.4 megawatts.[40] The IWPS plans to increase generating capacity by an additional 155 megawatts this decade, including a 16 megawatt unit to be installed by the Navy and 139 megawatts of GPA capacity to be added prior to 1999[41] (refer to Figure 5.20). The GPA's recent addition of a new 23 megawatt unit has raised the system's installed generating capacity to its current level of 373 megawatts, with installed capacity scheduled to reach 400 MW in 18 to 24 months. This rapid growth in capacity should relax the strained system which had existed prior to 1993. Evidence of the system's limitations were frequent brownouts. GPA has also had to make major adjustments, repaits and restoration caused by recent typhoons and earthquakes. All of these have added substantial costs to

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[38]*Guam Power Authority Annual Report 1989*, Note 4 of Guam Power Authority Notes to the Financial Statement.

[39]*A Report on the State of the Islands: June 1992*, United States Department of the Interior, p. 49.

[40]*1992 Updated System Load Forecast: Guam Power Authority*, R.W. Beck and Associates, May 27 1992, p. 16.

[41]*A Report on the State of the Islands: June 1992*, United States Department of the Interior, p. 49.

In 1991, 32 percent of the total IWPS sales of 1.267 million megawatt hours were to the military. Civilian residential and commercial sales accounted for 28 and 30 percent, respectively, of the total IWPS electrical consumption, and the local government of Guam used the remaining 10 percent of this power. Within the commercial sector, recent analyses show that the largest single segment (92,700 megawatt hours) of the commercial sales is to hotels and tourist facilities at hotel sites. Generation losses are now below 13 percent, and the IWPS fuel utilization rate was calculated in 1992 to be 0.09535 gallons/kwh sold. The financial statistics for 1992 show the GPA operating with a net annual income of $3.22 million.[43] Data from the GPA (see Table 5.5) indicate that the percentage of the GPA's operating expenses represented by fuel cost was 41 percent in 1992.

[43]"Impact of Economic Growth on the Planning and Management of Infrastructure Systems on Guam," presentation by John Benavente, General Manager, GPA, December 6, 1991.

Figure 5.20 Guam's Projected Peak Power Demand

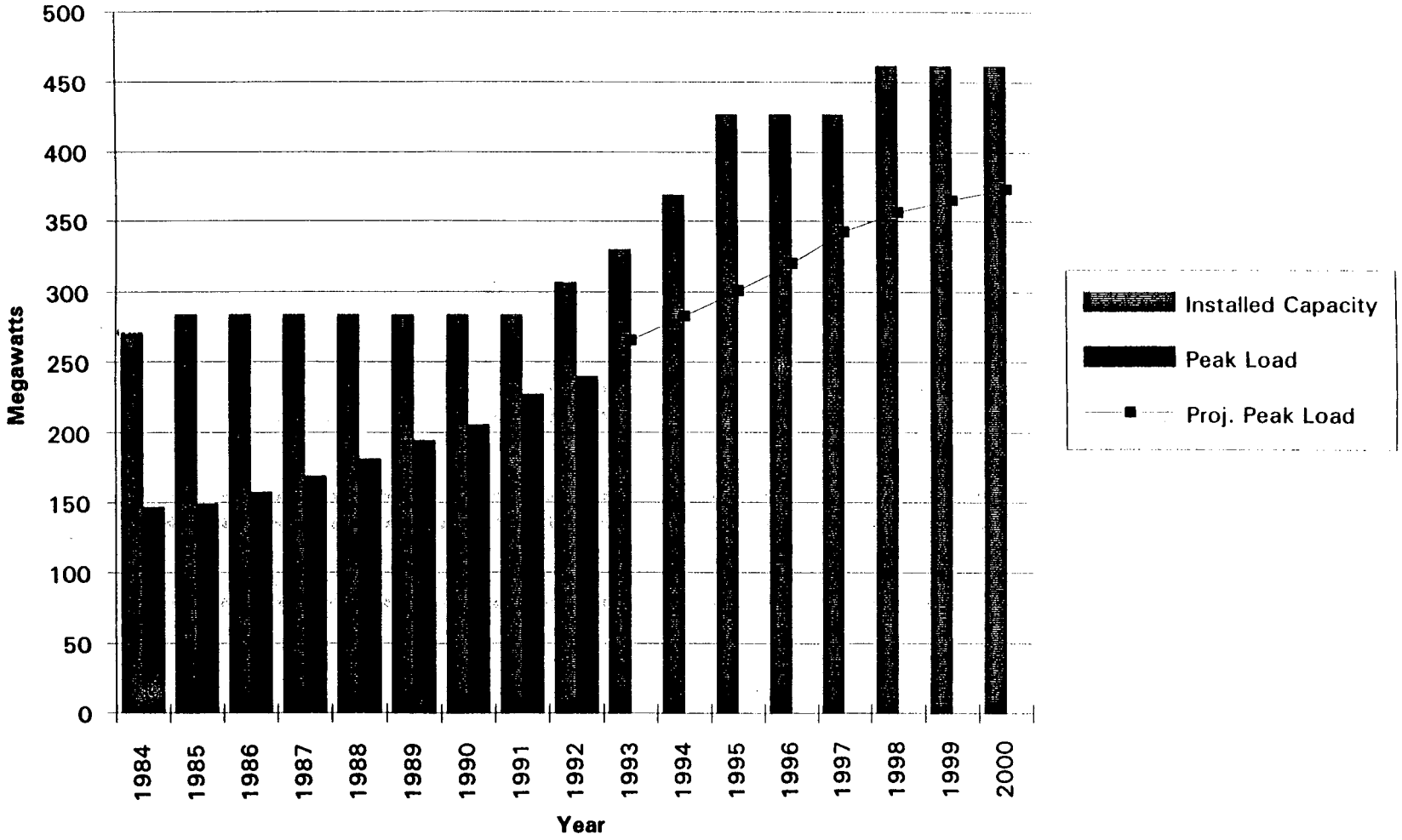

Table 5.5. Selected Guam Power Sector Indicators

1992 Selected Data			FY 1992 IWPS Fuel Consumption (barrels)		
Peak Load MW	Installed Capacity MW	Fuel Efficiency (kwh-sold/gal)	Residual Fuel Oil #6	Diesel Fuel Oil #2	Low Sulphur Fuel Oil
240.1	307	10.49	2,718,961	243,893	13,548

Guam 1991 Electrical Consumption (MWh)

	Sector				
Total Consumption	Military	Government	Residential	Commercial (all loads)	Commercial* (Hotels only)
1,267,070	404,675	132,429	354,015	375,951	82,225
Percentage	32%	10%	28%	30%	6%

* Estimate

1992 GPA Financial Highlights

GPA Operating Revenues	$94,533,484
GPA Fuel Cost	$37,506,563
Other GPA Expenses	$53,805,859
GPA Net Income	$ 3,221,062

1992 GPA Assets & Debt

Total Utility Plant	$155,083,950
Other Assets	$ 77,096,666
Total Assets	$232,180,616
Long-term debt	$72,253,416

UNIQUE VULNERABILITY TO OIL SUPPLY DISRUPTIONS

There are a number of characteristics of Guam and its energy sector which show a unique vulnerability to oil supply disruptions when compared to rest of the United States. First, Guam is totally dependent on imported petroleum. The Guam Power Authority (GPA) decided in 1991 not to build a coal-fired power plant because of the cost and the amount of land required for storage and handling of coal. In addition, the length of time required to build a coal plant (including permitting) was considered too long given the pressing need to immediately increase generation capacity. Second, Guam is supplied from Singapore and not from the United States, yet it is vulnerable to any sanctions imposed against the United States and must adhere to all directives from the USDOE. Third, there are insufficient data to quantitatively assess the economic effects of an oil supply disruption or oil price increase on Guam. In addition, Guam's economy has been growing dramatically over the last decade and is now driven by tourism and services and retailing in the private sector rather than Federal (including military) expenditures. This rapid transformation has resulted in an economy which is very sensitive to fluctuations in the Japanese economy because Japan is the overwhelming source of tourists and investment capital. However, this linkage has not been quantitatively defined. Lack of a means to measure such effects is a major vulnerability because there is no guide for the future. Fourth, Guam is highly vulnerable to tropical typhoons, which are the most frequent threats to the oil supply. Fifth, a severe supply and price disruption could devastate the small open Guam economy. Sixth, Guam is the transshipment point for petroleum products to the CNMI, Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands; because of this role, Guam has to consider not only its own energy security but also the supply to these other islands.

Data on the impacts of past oil crises on Guam were unavailable because data have been collected only for the last several years. However, in order to provide a reasonable basis for assessment, the effects of the 1973/74 and 1979/80 oil crises on Fiji, Tonga and Vanuatu were analyzed based on a study of these economies which utilized a social accounting matrix (SAM) model. While the independent island nations have economies which are not as monetized as the U.S. Pacific islands, there are a number of similarities including the openness of the economies, concentration of economic activity in but a few sectors (Fiji and Vanuatu have comparatively large tourism sectors), dependence on oil imports for commercial energy, relatively large public sectors, dependence on imported manufactures, machinery, medicine and food. All of the Pacific islands are "price-takers" subject to external events which they are unable to control. Although there are differences between the economies of the U.S. Pacific islands and those of independent island nations (e.g., per capita income is much higher in the U.S. Pacific islands), the results of the 1973/74 and 1979/80 analyses provide order of magnitude indications as to how the U.S. Pacific islands could be impacted by oil price shocks. The order of magnitude indications were corroborated by the data which were available as well as by comments by government and private sector officials including on-island banks. Thus, estimates on the economic impacts of oil price shocks have been made using the best available information.

Oil crises in 1973, 1979 to 1980, and in 1990 did not result in any supply disruptions. Guam complied with all USDOE directives on supply allocations during the 1973 and 1979/1980 crises. Because of past successes in dealing with oil crises, the four oil companies which supply Guam believe that they will be able to provide petroleum products during crisis periods.

Vulnerability to Natural Disasters

Since 1948, Guam has had 130 typhoons either directly hit or pass within 200 miles. Typhoon Omar (with sustained winds of 125 miles per hour and gusts of up to 155 miles per hour) struck on August 28, 1992. Damage was substantial because of accompanying storm surges, the longevity of the typhoon in the Guam area, and because of the course of the storm. Damage from the storm was valued at over $250 million to military installations, $50 million to government of Guam facilities, $100 million to the private sector, and over $25 million to the tourism industry. Nearly 1000 homes were destroyed, 1300 homes suffered major damage, and 3500 homes received minor damage. Omar was followed by three additional typhoons between September and December 1992. However, it is essential to note that typhoons have never led to a fuel shortage.

However, one of the key effects of Omar and the subsequent typhoons was the decline in tourist arrivals: over 90,000 tourists were expected in September 1992, but as a result of Omar, arrivals totalled only 50,000. This 45 percent reduction in the number of tourists resulted in a loss of on-island tourist spending of $76 million, a fall of $1 million in Gross Receipt Tax and Hotel Occupancy Taxes, and a loss of 1500 jobs. The effects of the typhoons combined with a major slowdown in the Japanese economy have caused the Guam economy to enter a recession-like period for the first time in over a decade.

During Guam's earthquake in August 1993 that measured 8.2 on the Richter scale, Apra Harbor's main dock sustained considerable damage, including large cracks in the dock itself and to some of the pilings. Even though there was damage to some power facilities including transmission lines and cracks in the floor of one of Guam's power plants, partial electricity services were quickly restored and there was no damage to the fuel docks or storage facilities. Guam was exempted from the Jones Act following the earthquake.

Vulnerability to Global Oil Supply Disruptions

The availability of an energy supply on Guam depends on the delivery of petroleum products to Apra Harbor from Singapore. The voyage by medium-range tanker between Singapore and Guam takes nine to ten days and skirts Indonesia and the Philippines. This supply route has proven reliable in the past.

As noted in previous sections, Apra Harbor has four secure off-loading points for petroleum products. Two of these off-loading points are owned by the military. Apra Harbor is an excellent facility, able to handle a range of ships and commodities.

Economic Effects of Energy Supply Disruptions

It is extremely difficult to quantitatively assess the economic effects of oil supply disruptions on the small open Guam economy because of a lack of historical and applicable data. However, the experiences of other islands could indicate some of the likely economic effects.

Under a moderate (less than 2 MMBD) supply disruption which is centered on Latin American, African or Middle Eastern producers, the effects would be minimal. There would be no reason to anticipate that the supply would be sufficiently restricted to result in major price increases.

Instead, it is likely that Guam would experience modest inflation based on price rises for imports in their country of origin. Direct effects on tourist arrivals would also probably be minimal because the main market, Japan, would not be significantly affected.

However, if there is a major supply disruption centered on Asian oil producers, the economic effects would be devastating. Oil price rises would be severe, reflecting shortages on the Singapore market. The short-term consequences of the 1979 oil price rise led to inflation rates of 7.5 percent in Japan, 11 percent in Australia, 15 percent in Fiji and nearly 30 percent in Tonga and Vanuatu. Guam's inflation between 1979 and 1981 nearly doubled to over 20 percent. Applying the 1979 experience to Guam, a doubling in Guam's inflation rate should be anticipated. The effect of an oil price doubling on GPA's operations would also be severe. In 1990, fuel cost accounted for 44 percent of total operating expenses. This oil price doubling would require tariff increases or subsidies to pay for a 44 percent increase in operating expenses.

While the direct effects of a major supply disruption may not appear severe at first glance, it is the secondary impacts which would trigger considerable dislocations. As an example of secondary impacts, Guam and the CNMI experienced a downturn in tourism immediately following the onset of the 1991 Gulf War because tourists were frightened to fly to a U.S. territory. The Iraqi president had threatened to attack U.S. territory and economic interests throughout the world, and there had been several reports of uncovered terrorist activity by Iraqis in Asia which heightened concern. By the end of 1991, tourism began to recover and early 1992 tourist arrivals were at record levels. As noted above, in August 1992, Typhoon Omar struck and was followed by several other typhoons. The result was a drop of nearly 45 percent in the level of tourist arrivals, a loss of 1,500 jobs, and lost taxes, all of which have been greatly compounded by the continuing downturn in the Japanese economy.

This experience could be used to infer the effects of a major oil supply disruption. A major oil supply disruption caused by political upheaval in Asia could result in greatly reduced levels of tourism if people are afraid to travel anywhere in the Asia-Pacific region. If the effects of the political upheaval result in sharp reductions in tourism such as were caused by Typhoon Omar and the recent downturn in the Japanese economy, then Guam would clearly experience major dislocations, including high unemployment and reduced tax revenues. Thus, it is not simply the oil supply disruption which affects Guam, but also the cause of the supply disruption: if there is political upheaval in a major Asian nation, people in other nations will be reluctant to expose themselves to a perceived danger and would probably not travel in Asia and the Pacific region.

Another secondary effect of a major oil supply disruption is that it would most likely lead to economic downturns in the regional economies because of their trade relationships. As an example, the 1973/74 oil price rise led to global recession, including a severe downturn in Australia which greatly impacted the level of Australian tourism to Fiji. In other words, a severe oil supply disruption creates secondary effects which are not felt for several months yet may continue for several years.

In Table 5.6 estimates of economic effects of an oil price shock are provided for Guam. The first row shows projections of the rates of price increases for petroleum under low price, base price and high price scenarios. The most recent value for imported petroleum products is also in this row. The value of the oil imported into Guam in the years 1995 and 2000 is estimated by assuming that the 1990 demand escalates by either a low, medium or high growth rate every per year and then multiplying this demand by the projected price of oil in the respective year. The projected price is

obtained by using the three price scenarios. The table shows that the value of petroleum imports doubles for Guam by the year 2000.

Although gross island product (GIP) is not measured in Guam, the government of Guam does estimate the total island wage income, which in 1990 was estimated to be $1,858.8 million. Economic expansion at 9 percent per annum would theoretically raise this value to $2,860.0 million in 1995 and $4,400.5 in the year 2000. As described in Chapter 3, oil shocks have been thought to cause a GIP to decline by anywhere from 2.5 to 4.7 percent. Table 5.6 shows the resulting GIP based on these approximations. In order to assess the likely effects on employment, the estimated economic growth rate of 9 percent has been applied to private sector employment and extrapolated to the years 1995 and 2000 while public sector employment was held constant. The employment on the island after an oil shock that results in a loss of 5 percent or 10 percent of the private sector jobs is also shown for the years 1995 and 2000.

Loss of government revenue is one of the key effects of an economic slowdown resulting from an oil price shock. It has previously been mentioned that Fiji experienced a 4.8 percent loss of tax revenue during an oil price shock. In order to estimate the magnitude of this loss, 1990 government budget data was used and the effects of a 4.8 percent decline on the deficit was computed. For 1995 and 2000, the local government revenue was calculated assuming an annual growth of 9 percent per annum. This also assumes that direct taxes will increase in proportion to economic growth.

The most important question regarding the economic effects of an oil supply disruption is whether Guam would experience more severe problems than the rest of the United States. Although the United States would experience inflation and recession, Guam's small open economy would be totally exposed to global market forces: all medicine and nearly all food is imported, and the economy is nearly totally dependent on off-island trade and international tourism. In simple terms, the rest of the United States does not have to rely on ocean transport and other nations for essential goods and services. In sum, there would be no territory of the United States more severely affected by a major Asian oil supply disruption than Guam. (Note: this analysis also applies to CNMI and Palau).

Options for Accessing Oil Supplies in Emergencies

An analysis of the global oil industry and specifically current and projected oil flows in the Asia-Pacific region provides several scenarios which would prove very difficult for the U.S. Pacific islands including Guam. These scenarios are: 1) major political turmoil in the Middle East and in Asia, resulting in a net loss of at least 4.5 MMBD for a six month period; and 2) global catastrophe, e.g., a major war, or regionalized/localized conflicts which effectively result in the closure of major oil producing regions such as the Persian Gulf. In both cases, Singapore refiners would have their supplies reduced by at least 25 percent, with the actual reduction probably reaching as high as 50 percent. The result would be a loss of petroleum supplies from Singapore to the Pacific islands of at least 25 percent and possibly even exceeding 50 percent. The short-term effects would be considerable because of a doubling or tripling of prices on the now oil-short Singapore market. In addition, if there is political turmoil in Asia, then the tourism industry would be greatly affected both by higher fuel prices and the reluctance of people to travel.

Table 5.6 Economic Impacts of an Oil Price Shock - Guam

		$ Millions					
		Base Year	1995			2000	
Value of Petroleum Imports		(1991) $140.6	Demand Growth Scenarios-1995			Demand Growth Scenarios-2000	
			Low	Medium	High	Low	Medium	High
Oil Price Increases			2.0%	4.9%	7.5%	2.0%	4.9%	7.5%
2.0% per year			$164	$178	$191	$199	$249	$303
3.9% per year			$176	$192	$206	$235	$295	$358
6.6% per year			$195	$212	$228	$297	$371	$451
		(1990)					
GIP-base	($ millions)	$1,858.8		$2,860.0			$4,400.5	
decline of 2.5%	($ millions)	$1,812.3		$2,788.5			$4,290.5	
decline of 3.0%	($ millions)	$1,803.1		$2,774.2			$4,268.5	
decline of 4.7%	($ millions)	$1,771.5		$2,725.6			$4,193.7	
		(1992)					
Employment		66,489		82,869			115,967	
decline of 5%		66,498		79,797			111,240	
decline of 10%		64,125		76,724			106,512	
Local Government Revenues	($ millions)	(1991) $539.2		$761.1			$1,171.1	
4.8% Loss of Direct Taxes	($ millions)	$25.9		$36.5			$56.2	
Resulting Budget Surplus (Deficit)	($ millions)	$102.6						

Notes:

1. Value of petroleum imports calculated by multiplying estimated average annual demand growth by estimated petroleum price increases.
2. Estimates for gross island product, employment and government revenues, utilize average annual increases of 9.0 percent.

Other oil disruption scenarios, including moderate loss of production in certain West African and Latin American regions, would have limited impact on supply in the Pacific Islands. Prices would increase but the effects would probably be only temporary because of the expectation that the market would be able to adjust (e.g., oil prices first skyrocketed and then returned to near-normal levels following the Iraqi invasion of Kuwait).

Local oil supply disruptions could be caused by typhoon damage to docking and storage facilities. However, the Guam facilities have survived severe storms relatively unscathed. Thus, unless a typhoon much stronger than any storm over the last five decades directly hits the oil facilities, it is doubtful that a local event would cause a major disruption.

Given these impacts of possible disruption scenarios, there are several options to increase energy security in Guam. These include developing a strategic petroleum reserve (SPR) on the island, increasing the volume of on-island stocks, access to the U.S. SPR, developing alternative supply arrangements, and reducing demand. These are discussed below. In addition, the relationship between the oil companies and the Guam government and the capability and willingness of these parties to work together under crisis conditions are also addressed.

However, it must be stressed that the U.S. Pacific islands have not had an interruption in the supply of petroleum products since the end of World War II. Prices for petroleum products in the islands have jumped sharply during oil crises (e.g., 1973/74 and 1979/80), but the supply of petroleum has been continuous.

Increasing Commercial Stocks

Increasing on-island inventories is another option to improve energy security. The other Pacific islands use a minimum inventory measure of six weeks or 40 days, but a larger inventory could be maintained in order to provide a margin of safety against a major supply disruption. Price increases for the additional inventory would probably approximate a $2 per barrel per year maintenance charge plus the cost of the petroleum products. Distributed over the volume of total imports, these costs do not add substantially to the price of petroleum products because stocks already average 51 days on Guam. In other words, Guam should be able to meet this minimum inventory level without additional construction cost.

Building Regional Petroleum Reserve (RPR)

A petroleum reserve on Guam as well as a joint SPR shared with other island entities has been considered. Ninety days worth of supply for Guam, the CNMI, and Palau would be approximately 2 million barrels, and a storage facility for this amount would cost about $120 to build and stock and about $4 million per year to maintain. However, there is already 129 days of storage capacity available on Guam and a further 165 days of "mothballed" (out of service) storage capacity. Given the existing storage capacities and the cost of SPR establishment running at $60 per barrel excluding land prices ($30 per barrel for construction and $30 barrel for product), it appears difficult to justify building any SPR facility on Guam.

Alternative Supply Options

Papua New Guinea (PNG) is currently producing 135 MBD of crude which is being refined in Australia. As with other oil-exporting nations, PNG would like to receive the highest value for the exploitation of its national resources. However, if market prices are paid for PNG crude, then it might be possible to initiate discussions on some type of guaranteed supply arrangement between PNG and all of the Pacific islands. The supply agreement would have to stipulate that in the event of an oil crisis (and, crises would have to be well-defined), PNG would guarantee access to supply, which could presumably continue to be refined in Australia. PNG may be willing to consider this arrangement if all of the Pacific islands (independent nations and territories) jointly make the proposal. However, PNG may also wish to consider some type of reciprocal arrangement whereby its access to certain goods or services would be guaranteed. This could include preferential status for trade, official lending, or other assistance mechanisms provided by the United States. It should also be noted that the PNG crude is of very high quality and would be a very good match to the configuration of the now-closed GORCO refinery on Guam.

Other neighboring nations such as the Philippines and Japan might also be able to offer alternatives to supply from Singapore. Both nations have major refining facilities which could be utilized to process crudes provided via alternative suppliers. Some additional assessment of this option may be warranted.

Access to Military Stocks

Although there are military fuel storage installations located in Guam, it is doubtful that during periods of major political upheaval in Asia and the Middle East the military's fuel supplies could be transferred to civilian populations except in cases when the health and safety of civilians were at risk.

Guam could also consider expanding its role as a transhipment point and supplier for the tuna fleets operating in the North Pacific Micronesian area. This could result in additional throughput of 1000,000 to 150,000 barrels per month, or roughly twice current levels. Additional throughput would also increase stocks and thus energy security. As mentioned earlier, an oil marketing company is using some of Shell's storage for transshipment to East-Asian markets. This also will increase energy security

Guaranteed Access to the U.S. SPR

In May 1992, a bill was introduced to the U.S. Congress, which guaranteed access to the U.S. SPR for a percentage of oil demand requirements of the U.S. Pacific islands including Guam. What would not be guaranteed would be the transport.

Under the proposal, the price paid for the petroleum would be an average of the bids submitted by the oil companies trying to acquire supply, or, in other words, the price would be the market rate. Thus, the islands would be paying at the same rate but would be guaranteed supply. Also under the proposal, the U.S. Pacific islands would have priority status at SPR docking facilities. However, the islands would be responsible for processing and chartering tankers. Oil companies could be contracted to process products and provide ships.

No additional establishment or maintenance costs would be required. Although future prices for SPR petroleum during crisis situations could be substantial, this option ensures some degree of access to the U.S. Pacific islands. In order for this option to be implemented, Guam will have to coordinate its efforts with the other U.S. Pacific islands and develop strategies to process products and access tankers during crisis periods.

Energy Emergency Planning

Guam has no energy emergency plans of its own, but does employ the Hawaii's plan as a guide. The GPA and other government departments do have natural disaster response plans. An energy emergency plan would assist Guam decision-makers in allocating fuel supplies during an energy emergency.

Demand Management

A demand management plan can effectively stretch out scarce supplies, thereby reducing the negative impacts of a supply disruption. Demand management can be a valuable component of a response strategy. In the event of an oil crisis, energy conservation and rationing programs, such as odd-even days for driving would presumably go into effect. Guam has adopted Hawaii's energy emergency plan as an interim measure and is considering developing its own. However, the data which are required to develop and implement a comprehensive program are lacking in Guam.

LONG-TERM ENERGY VULNERABILITY RESPONSE OPTIONS

Medium to long-term response measures to Guam's energy vulnerability include developing alternative energy sources and integrated resource planning. However, it has already been noted that alternative energy options are limited in Guam. Until the economics of OTEC or DWOR greatly improve, it appears that Guam will remain tied to fossil fuels. Small coal units could be an option for Guam. LNG or restarting the refinery are other options, albeit probably very expensive. There is also some potential for waste-to-energy facilities, especially involving municipal solid waste. Furthermore, more use can be made of solar water heating and lighting technologies.

Alternative Energy Resources

Guam possesses a number of indigenous energy resources, including solar, biomass, and hydroelectric potential, OTEC and wind. In addition, coal, while not indigenous, could be imported from several Pacific Rim sources such as Australia and the United States and would thus improve Guam's energy security by providing diversity to the current energy supply mix. Unfortunately, only coal and OTEC are energy sources which have the potential to significantly contribute to baseload power, and both of these have considerable constraints on their commercial use. These alternative energy resources are discussed below.

Solar

Solar insolation measurements (5 kwh/m^2 per day) on Guam indicate a resource suitable for a range of solar technologies. There is substantial potential to increase the use of solar power for hot water heating, which currently accounts for 26 percent of electricity demand in the residential end use sector (the residential total for October 1991-September 1992 was 414 GWh). Water heating required

9 GWh (2 percent) in the commercial end use sector (commercial total was 490 GWh). Solar hot water heaters are economically competitive with electric and gas heaters. The only potential problem in using this technology is the need to secure the device against typhoon damage.

There are also opportunities for the use of photovoltaic external lighting technologies (24 GWh in the commercial end use sector), which the GEO is promoting. However, widespread use of photovoltaics, including as a baseload energy source, could prove difficult because of the amount of land required. It has been reported that it would be difficult to obtain 20 acre sites for photovoltaic installations. Finally, the cost and performance of large-scale photovoltaic systems indicate that tying into the existing power grid would be a preferred choice.

Biomass

Guam is currently considering the development of a municipal solid waste-to-energy facility with an installed capacity of between 4 and 12 MW. There is sufficient waste (at least 200 tons per day, with some estimates indicating an islandwide resource of more than 300 tons per day) for the facility, the development of which is being primarily driven by the need to reduce the rate of land filling. GEO and the Bureau of Planning are facilitating this effort.

Additional proposals to establish energy crops and/or utilize the abundant tangantangan (*Leucaena leucophala*) vegetation have been made but do not appear commercially viable either because of economics or land availability (at least 4,000 acres would be required). However, if a municipal solid waste facility is developed, the waste resource could be complemented by tangantangan.

Hydroelectricity

Over the years, the U.S. Army Corps of Engineers has studied a number of potential hydroelectric sites. The studies have concluded that the resource is limited and would be very expensive to develop. However, GEO is reviving interest in hydro and assessments have been proposed on the viability of low-head hydro potential at several sites. This renewal of interest is based on potential for an energy source as well as for a potable water resource. Although the low-head hydro resource is limited, it may be sufficient to justify the development of a small number of sites, which will be assessed over the next several months.

OTEC/DWOR

Guam has the required bathymetry (water depth of 1000 meters) within 3000 meters from shore which along with a temperature difference of at least 68° F between water at the surface and at 1000 meters depth constitute the major parameters necessary for OTEC. In addition, the preferred site for an OTEC facility is Cabras Island, which is the current location of the GPA's largest generating plant. Although the cost of an OTEC facility remains too high for commercial application, capital costs have declined considerably over the last decade because of technological advances and now approximate $6 to $10 million per net installed megawatt (roughly the cost of oil at $36 to $44 per barrel). OTEC is still at least a decade away from commercial application.

GEO is considering a DWOR facility for Faian Point on the east-central coast. GEO believes that the DWOR could have the potential to provide potable water and cold, clean and nutrient-rich water for the establishment of aquaculture and high-value agriculture(e.g., fresh, exotic flowers) industries. Hawaii is currently assessing the viability of DWOR for use in air-conditioning in areas with high densities of hotels and office buildings. Preliminary results indicate that DWOR could be viable. Assessment of the DWOR resource is considered a priority of the GEO.

Wind

Although Guam is a regular victim of typhoons, its wind resource is limited. However, there may be some sites on the windward coast which could have the consistent wind speeds necessary for wind power. In the near future, wind will not have a major impact on Guam's energy supply.

Coal

Coal was being considered as an alternative energy source by the GPA as recently as 1990/91. The combined effect of the GPA's rapid load growth during the 1980s and the need to retire older oil-fired boilers resulted in a very serious evaluation of the coal option. Although there were a number of factors favoring the use of coal, including the range of potential supply sources such as Australia, Indonesia, China, and the United States, several disadvantages led the GPA to continue its reliance on oil. The disadvantages included the storage and handling of coal in a very limited port area. While the decision against coal has already been made and new diesel and oil-fired boilers are being constructed, it is quite possible that the GPA will consider coal as an energy source towards the end of the decade. However, it should be noted that Guam is exempt from the sulfur emissions requirements in the U.S. Clean Air Act. Given this exemption and the fact that the Asia-Pacific region will be awash with high-sulfur fuel oil into the next decade, coal is clearly a longer term option.

OTHER MEASURES FOR IMPROVING ENERGY SECURITY

In addition to options for accessing oil supplies during energy emergency and long-term response options, consideration should also be given to improving overall management of the energy sector. Specifically, data collection on energy supplies and end uses, formalizing and expanding the dialog with oil companies, and integrated resources planning are activities which could provide substantial short- and long-term benefits at very little cost. These are discussed below.

Data Collection

As illustrated in Table 5.6, the amount of money that Guam will spend on oil will increase by over 70 percent by the end of the decade. This warrants a systematic evaluation of whether or not this money is being spent wisely. Concurrent with this growth in fuel cost is the GPA's plan to expand its generation capacity by some 50 percent to approximately 460 megawatts by the year 2000. Taken together, it is clear that the energy sector will be one of the most, if not the most expensive sector in Guam's economy. Hence, there is an urgent need to collect volume, value, cost build-up (e.g., f.o.b., c.i.f. and shipping charges), and inventory data on imported petroleum products. Data from the GPA need to be integrated with the petroleum data to establish a method of regularly assessing the role of energy in the local economy. Such an assessment ought to include the evaluation of the needs and costs of any economic development strategies.

Oil Company Relations with Government

Regardless of whether a local or regional SPR is established or if demand management plays the lead role in the next oil crisis, major oil companies will manage the bulk of the supply and distribution networks necessary to maintain Guam's access to oil. Relations between the oil companies and the government of Guam are generally very good. Although Shell was especially cooperative supplying data, some of the other oil companies do not regularly provide all product supply and cost information. This is interesting because similar information is routinely provided to South Pacific governments. Moreover, these data are essential to planning for and managing an energy emergency. If unwilling to voluntarily provide information, the oil companies should be directed to furnish volume, value and storage data. In addition, it is suggested that consideration be given to establishing a minimum inventory level on Guam. Both of these issues will require cooperation between the oil companies and Guam's government.

Having noted that the oil companies should provide more information and other services, it should also be stated that one of the least-cost yet most effective measures to ensure petroleum supply is to establish an attractive operational and investment environment for major oil companies on Guam. This does not mean surrendering control but it does require monitoring and constant interaction. Although relations are generally good between the oil companies and Guam's government, the quality of the interactions could be improved.

Integrated Resource Planning

Considerable attention should be given to integrated resource planning including least-cost assessments of technologies and developing strategies to more efficiently plan and manage energy use. Demand-side management techniques are but one step in a process in developing a broad-based program aimed at energy conservation, energy efficiency, and cost reduction. Savings can be substantial. Traditionally, investments in the supply side have payback periods from seven years and up, while investing in energy efficiency technologies provides payback in one to four years.

Only when energy use is effectively managed can renewable energy technologies provide for baseload demands. Until then, renewables will have only limited potential to affect dependency on oil.

Substantial sums have been allocated to the energy sector over the past several years with mixed results. There is a major need to develop plans and management structures for the energy sector which reflect both the short- and long-term issues, and most importantly provide some consistency in direction for the sector. Moreover, management and planning for the sector require immediate attention.

The energy sector in Guam consists of three primary players: the oil companies, the GPA and the government energy office. Although responsibilities for each have been specified, there does not seem to be any overall coordination of the sector. There are no legislative mandates for the energy office in Guam. Consideration should be given to a dialog to determine whether or not an energy office should exist, how it should be funded, what the staff levels and functions should be. The results of this dialog would also enable the role of the GPA and the oil companies to be more clearly defined in the local energy sector.

It is strongly recommended that Guam initiate a review of its energy sector with the USDOE invited to participate in this review. A well-managed review would provide the basis to establish the integrated resource planning process which encompasses demand-side management activities, least-cost assessments of technologies and energy sources, and energy security options. The fiscal and economic consequences of a future oil price shock may initiate such an evaluation, but it is clearly preferable to have finished such an assessment and have taken any possible preventative measures prior to the damage being done.

Summary of Energy Emergency Response Options

Table 5.7 summarizes various energy emergency response options including accessing oil supplies, long-term alternatives, and other measures which could facilitate improved management of the energy sector. As stated above, securing oil supplies during energy emergencies requires considerable planning and/or investment. One option would be to access the U.S. SPR, which would require no additional capital and up-front fuel costs. Premiums would presumably have to be paid in the event of an energy emergency for both fuel and transport, and possibly for refining. The major disadvantage to this option is that supplies may have to be sourced from the U.S. Gulf Coast via the Panama Canal. The other low-cost supply option is to access military stocks. However, supplies would be limited to the level required to preserve safety and sustain life, which means that the economy would remain totally exposed to a potential loss of supply. Building a regional petroleum reserve would be unnecessary given Guam's extra storage capacity. However, fuel stocks would have to be purchased and facility maintained. Increasing commercial stocks is a lower cost option which warrants further discussion with the oil industry. Commercial inventories currently average 51 days, which should be sufficient for most emergencies.

Alternative energy sources will have limited impact on energy security during this decade. Fluidized-bed coal plants with capacities as low as 25 MW, have been determined as technologically and financially viable. Thus, some consideration may be give to evaluating this option in future years.

The other response measures including energy emergency planning, demand side management, improved data collection and analysis, expanding dialogue with the oil industry, and integrated resource planning are all focused on improving management of the energy sector in a cost-effective manner. These measures may warrant implementation.

Table 5.7 Summary of Energy Emergency Response Options

	Response Action	Advantage	Disadvantage	Cost
Options for Accessing Oil in Emergencies				
Building Regional Petroleum Reserves (RPR)	develop 1 to 3 months extra storage	on-island or closer than U.S. SPR	cost	$30/barrel to build, $2/barrel per year to maintain, plus land costs and fuel costs; however, additional capacity is unnecessary
Increasing Commercial Stocks	develop 1 to 3 months extra storage	on-island	cost	same as RPR
Guaranteed Access to the U.S. SPR	develop refining and transport arrangements with oil companies or other island governments	least cost	distance	unknown/to be determined with oil companies
Access to Military Stocks	arrange level of supplies with military	limited on-island costs	supply limited to minimum to prevent loss of life	unknown
Energy Emergency Planning	develop energy emergency plans	low cost, complements any supply options	doesn't ensure emergency supplies	unknown but assume less than $50,000
Demand Management	develop demand side management program	cost-effective, valuable for energy conservation even without energy emergency	doesn't ensure energy supplies	assume $200-300,000
Long-term Responses: Baseload Power from Alternative Fuels				
OTEC	build baseload OTEC plant	local renewable energy source	very high cost, experimental technology	upwards to $40 million per installed MW

Biomass/Biogas	build biomass/biogas plant	use local resource	small volume, high cost	unknown but assume costs are similar to higher than coal per installed MW
Coal	build coal-fired plant	available energy resource	high cost for handling and storage	Unknown: roughly $3 million per installed MW, plus unknown costs for port handling and storage facilities
Other Measures for Improving Energy Security				
Data Collection	collect energy supply and end use statistics	low cost, useful for overall sector planning/ management	limited impact on energy emergency	unknown but assume less than $50,000 per year
Oil Company Relations	establish working group with oil companies, which focuses on long-term investments/solutions to energy supply	limited direct cost	potential tax concessions	unknown
Integrated Resource Planning	develop energy supply and demand scenarios which assess options for efficient resource allocations within energy sector	cost-effective, valuable for energy conservation even without energy emergency	requires constant monitoring and revision	unknown but assume roughly $200-300,000

Six

THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

INTRODUCTION

The Commonwealth of the Northern Mariana Islands (CNMI) is situated in the western part of the Pacific Ocean, 3,226 miles west of Honolulu and 1,272 miles south of Japan. The CNMI consists of 14 islands extending in a general north-south direction for 388 nautical miles from Farallon de Pajaros in the north to Rota in the south with a total dry-land area of 176.5 square miles. Only four of the fourteen islands are inhabited. Saipan, the largest island (46.5 square miles), is the most densely populated, with a large nonresident work force, and is the urbanized commercial and government center. The islands of Tinian (39.2 square miles) and Rota (32.8 square miles) are largely rural.

The islands of the CNMI are of volcanic origin enveloped in a limestone crust. On Saipan, limestone underlies 83 percent of the island and, generally, the soil is less than 30 inches deep. Because of Saipan's complex geology and a mountain range that extends across three-quarters of the island on a north-south axis, there are many narrow, rugged valleys, but only two perennial streams, draining from west to east near the central part of the island.

The climate of the islands is tropical and thus warm and humid throughout the year with little variation in temperature. The mean annual temperature is 83° Fahrenheit, and the annual rainfall averages about 83.5 inches. The season of the most serious tropical storms is from August to December. Although typhoons do not occur every year, storms with winds as high as 115 miles per hour, and gusts up to 160 miles per hour, are not unusual.

The population of the CNMI has increased 159 percent in the period between the 1980 and 1990 censuses. The 1990 census count of the total population in the CNMI was 43,385, an increase of 26,605 over the 1980 census count of 16,780. Seventy percent of this increase is accounted for by the large influx of alien nonresident workers who have arrived over the past decade to run the growing industries in the Commonwealth.

Forty-six percent of the population of the CNMI are U.S. citizens. Most of these people (or 39 percent of the total population) are of Chamorro, Carolinian, or mixed Chamorro/Carolinian ethnicity. People with citizenship in Asian countries make up 43 percent of the population, while Micronesians and other non-U.S. Pacific islanders constitute 11 percent of the CNMI's population.[1]

The 1990 census did not include the daily visitor or tourist count which was estimated to average about 4,000 persons per day. Although these people are transients, they inflate the islands' population by almost 10 percent and represent a large consuming group that makes demands on the CNMI public facilities and infrastructure.

By the year 2000, the CNMI Office of Budget and Planning has estimated that the daily population of the CNMI could range from 68,700 to 95,600. These projections represent an increase over the estimated daily 1990 population ranging from 45 to 100 percent.

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[1]Racial classifications used here are taken from the U.S. Department of Commerce, Bureau of the Census, *The 1990 Census of Population and Housing for the CNMI.*

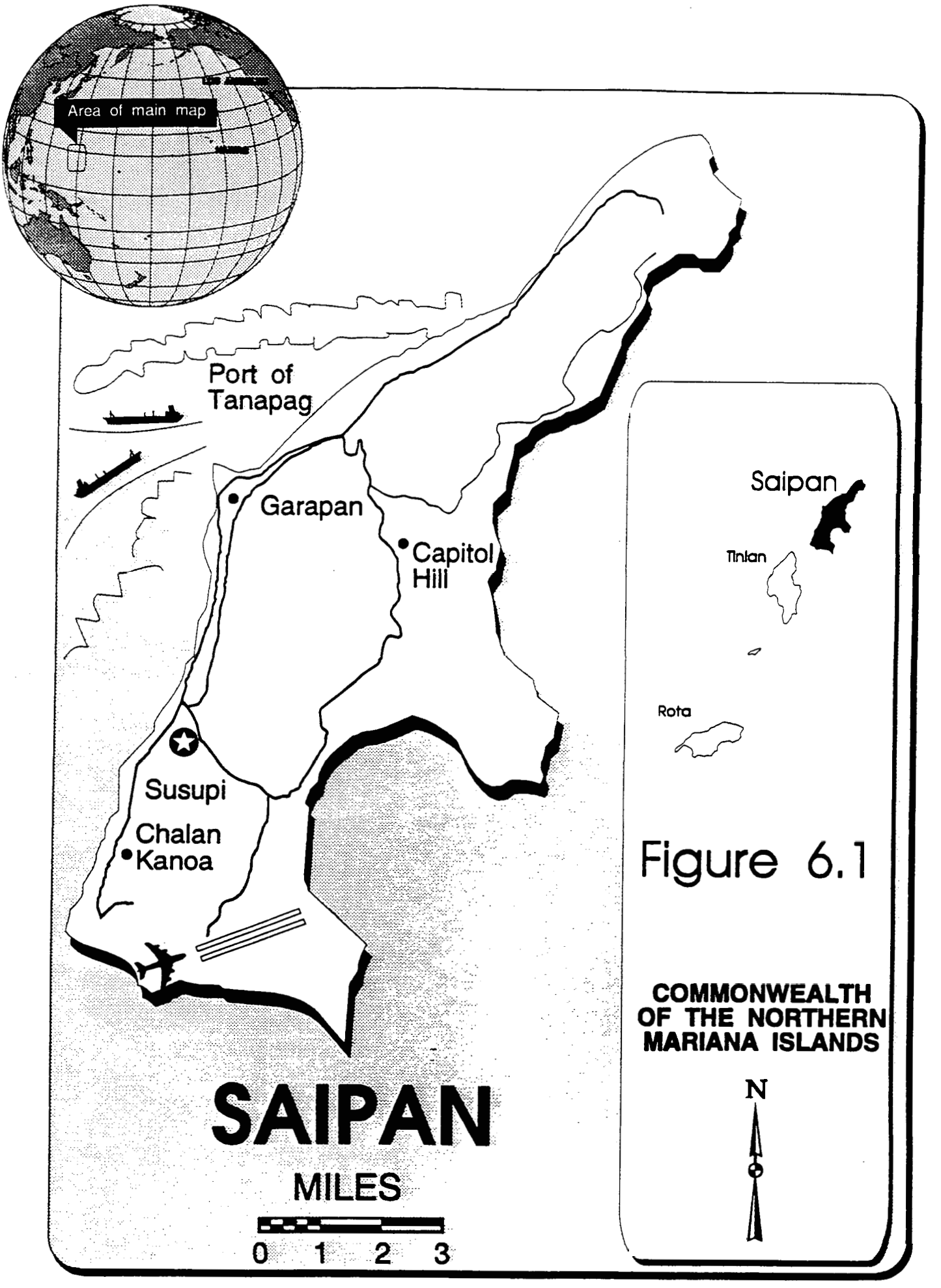
Area of main map
Port of Tanapag
Garapan
Capitol Hill
Susupi
Chalan Kanoa
SAIPAN
MILES
0 1 2 3
Saipan
Tinian
Rota
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS
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Figure 6.1

ECONOMIC OVERVIEW

The Commonwealth economy can be characterized as service oriented and almost totally dependent upon imports. The largest sector, tourism, is dominated by Japanese hotel investment with Japan as the primary visitor market. Manufacturing activities are rather insignificant with the exception of the garment industry, which is almost entirely dependent upon foreign workers and the distant U.S. market, which allows the importation of some CNMI manufactured goods into the United States under Headnote 3(a) of the U.S. Customs Schedule. While there is a dynamic and growing private sector, which increasingly contributes to internally generated government revenue, the CNMI government remains the largest single employer and is supported by U.S. federal assistance, albeit, at a declining rate[2] (see Figure 6.2).

Economic growth in the CNMI has been uneven, with the island of Saipan, which has 90 percent of the population and 26 percent of the land area, receiving the lion's share of development. The other islands with significant populations (Rota and Tinian) have had little development and have not participated in the Commonwealth's economic boom to any notable extent.

The Commonwealth's economic future will depend on its ability to capitalize on its popularity with Japanese tourists and its special status as a U.S. Commonwealth. This commonwealth status offers both advantageous customs treatment under the U.S. tariff regulations and the designation of the CNMI as a unique U.S. location relatively near the rapidly growing Pacific Rim economies. However, the severely strained local infrastructure (roads, water, power, and sewers) and the limited amount of land for future development are serious constraints on the CNMI economy.

GDP and Income

Because of the lack of a current and complete statistical data base, it is difficult to provide a precise "current picture" of the CNMI economy. Analysis of existing available information demonstrates the dynamic nature (particularly in the tourism sector) and other key aspects of the local economy such as the dominance of government in employment and wage generation for CNMI residents, the limited size of the labor force, and the dependence on imports. By making the best use of the information available, a rough sketch of the CNMI economy can be made.

Using trends in the gross domestic product (GDP) as an indicator of the general economic climate, the economy of the CNMI appears to be extremely robust (see Figure 6.3). Between 1980 and 1991, GDP has increased at an average annual rate of 26.9 percent (in current dollars). In the four years from 1987 to 1991, GDP increased fivefold. It has been stated that there is probably no area under the American flag that has experienced such unprecedented economic growth during the 1980s as Saipan. It should be noted that prior to 1978 the economy of the entire CNMI was very limited, so that any growth would be impressive. Nevertheless, Saipan experienced a construction and investment boom as a result of many factors, the most important of which is the stability and confidence engendered in the area as a result of its U.S. Commonwealth status. As a direct result of

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[2]*Economic Development Strategy: A Prospectus for Guiding Growth*, Office of Planning and Budget, Executive Office of the Governor, Saipan, Second Revised Edition, 1993, p. 26.

Figure 6.2 CNMI Government Revenue Services

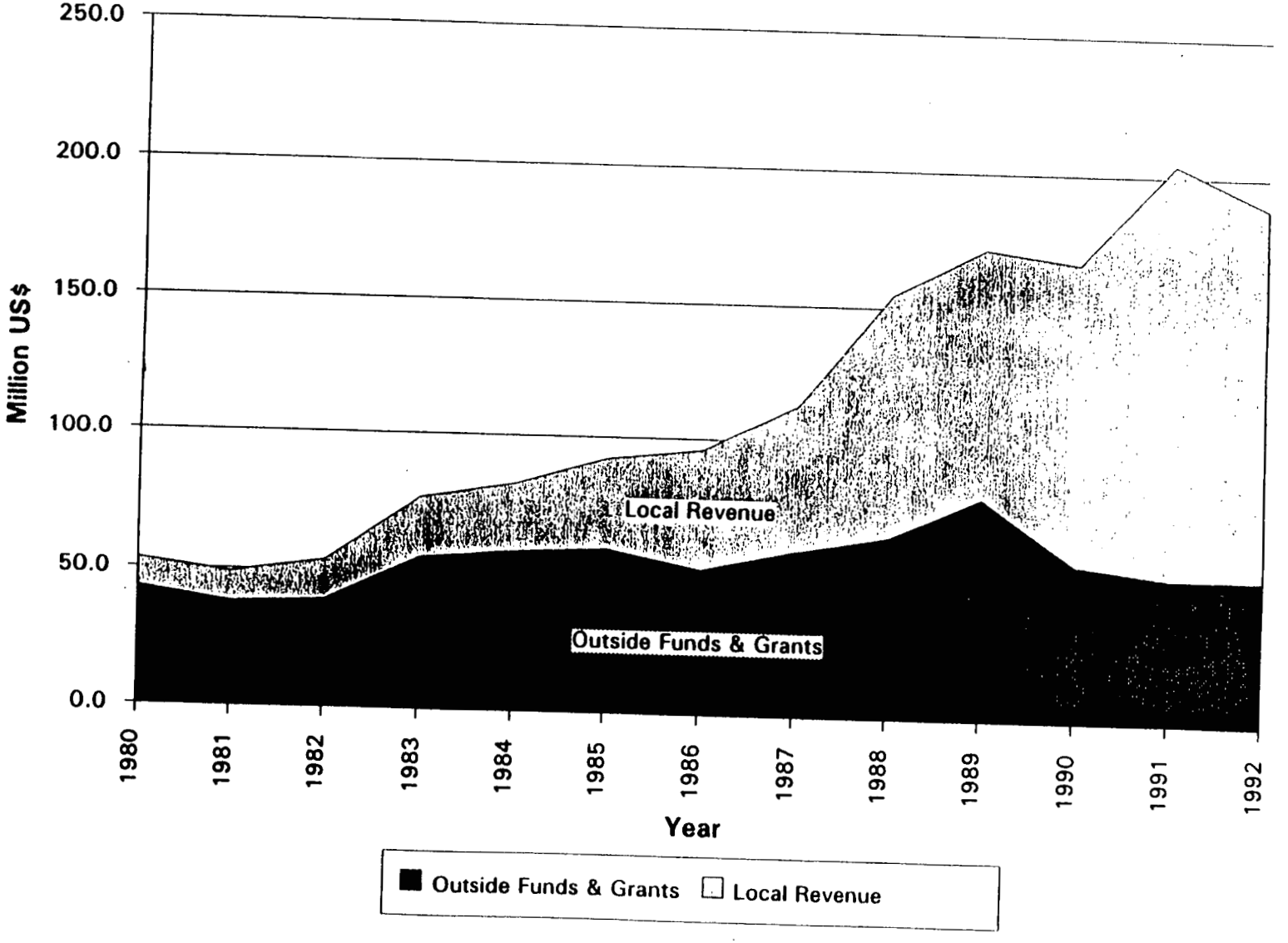
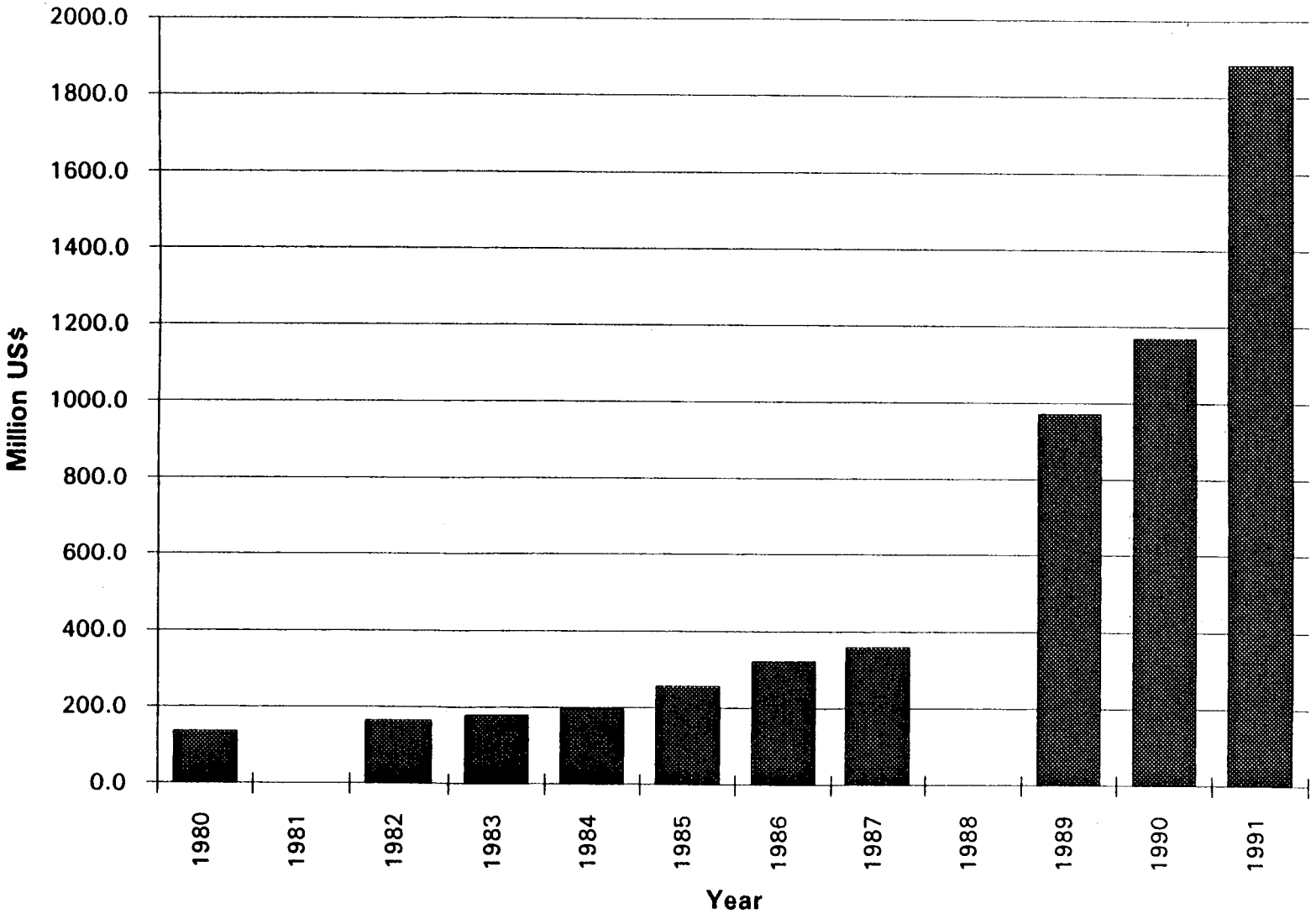


Figure 6.3 CNMI Gross Domestic Product



this status, a substantial injection of federal assistance in the forms of grant funds and federal programs has been made available to the CNMI.

During the period of the Trust Territory government, it was the policy of the U.S. government (the administering authority) to prohibit foreign investment in the area. One of the objectives of this policy was to postpone any decisions pertaining to such investment until the islands in the Trust Territory achieved self-government and could thus weigh the merits of the investments themselves. In 1978, the Northern Mariana Islands obtained self-governing status by virtue of the Commonwealth Covenant and abandoned these restrictions on foreign investment, particularly in tourist-related enterprises. Under the terms of this covenant, local political stability was assured by an affiliation with the United States and the people (meeting necessary conditions) in these islands eventually became U.S. citizens. Also in the same year, air service to Japan was initiated.

Those three milestones reached in 1978 (the relaxing of investment laws, association with the United States, and air service to Japan) are considered to be responsible for the "take-off" of the Commonwealth economy. A fourth factor was the move by the United States government in 1986 at the Plaza Accords in New York to devalue the dollar relative to the yen which had the effect of making United States real estate and other assets extremely attractive to Japanese investors. Japanese capital flooded into the Commonwealth, and from 1986 to 1991, there were over 27,000 land transactions recorded in the CNMI.

In 1990, total wage and salary income in the CNMI equaled $265.9 million, which represented an increase of 22.6 percent over that in 1989 and an increase of 160 percent over that in 1988 (see Figure 6.4). In 1990, 76 percent of the wages paid were within the private sector, while 18 percent were paid to Commonwealth government employees, with the rest paid to federal and other government employees. Of the 25,965 people reported in the labor force in 1989, 76 percent of these workers earned less than $10,000 per year. The most recent estimate of per capita income in the CNMI was $7,199 for the year 1991.[3]

Data from the 1990 census[4] show another aspect of income distribution in the labor force (taken here to mean all people over age 15) that is illustrated in Figure 6.5. The average income of working age Filipinos (who comprise about 40 percent of the labor force when defined as above) is almost one-third that of thegPÅigenous Marianas islanders, who have an average income of about $16,700 per year. A similar situation exists with the Chinese, who make up about 8 percent of the labor force, as their average income is only one-fourth of the average income of indigenous workers. On the top end of the scale, 12 percent of the labor pool (composed of Americans, Japanese, and Koreans) bring home on average three-quarters more income than the local Marianas islanders.

Employment

It is generally acknowledged that the present economy of the CNMI cannot be sustained entirely by the indigenous Chamorro/Carolinian population. Using data from the 1990 census, the CNMI Office of Planning and Budget has estimated that the total indigenous labor force (all healthy

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[3]*Economic Development Strategy: A Prospectus for Guiding Growth*, Office of Planning and Budget, Executive Office of the Governor, Saipan, Second Revised Edition, 1993, p. 139.

[4]Ibid., p. 141.

Figure 6.4 Total CNMI Wage and Salary Income

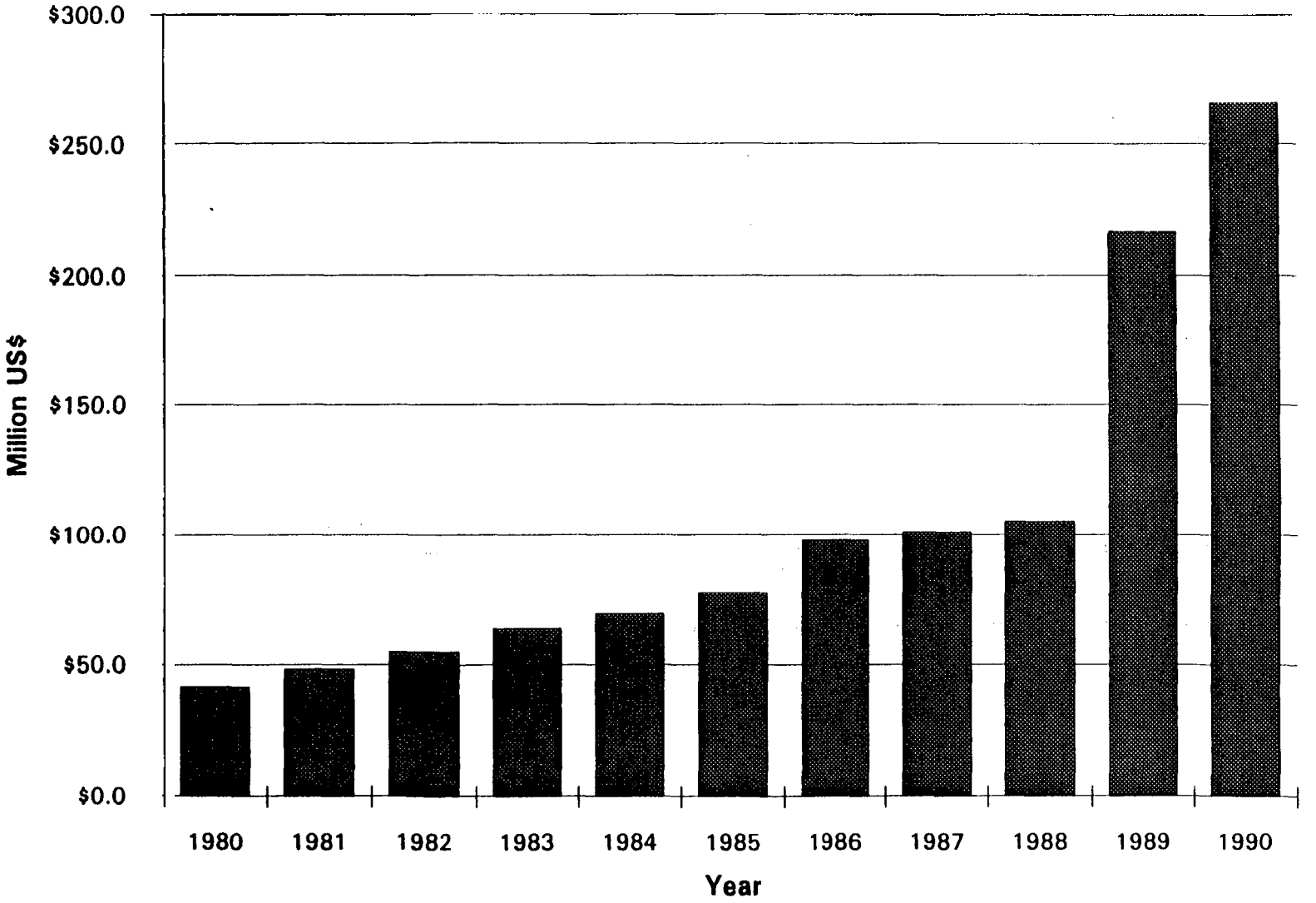
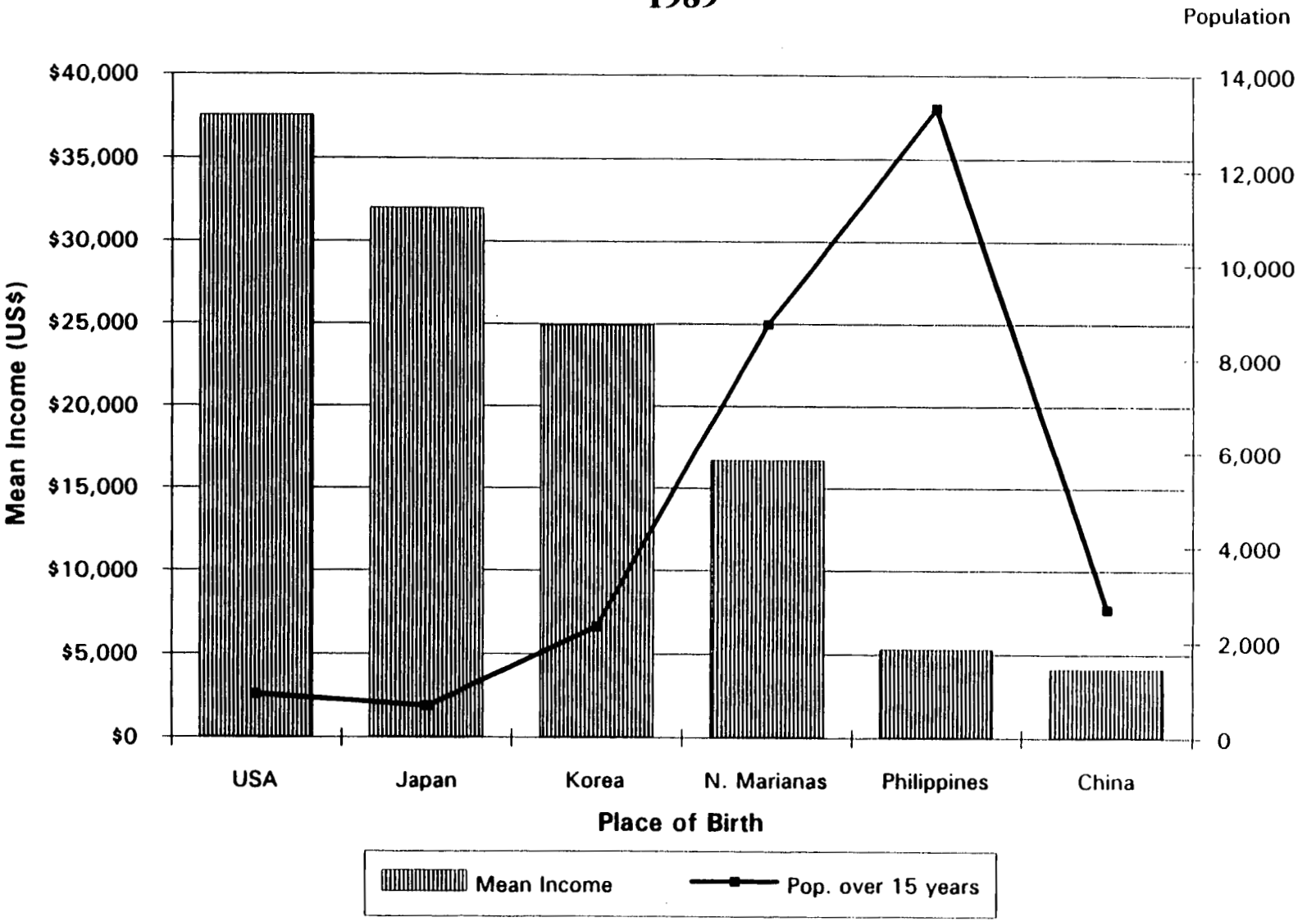


Figure 6.5 Average Income for CNMI Labor Force* by Place of Birth, 1989



* Labor force defined here as population age 15 or over, regardless of citizenship.

employed and unemployed males and females, including housewives, between the ages of 15 and 64) is 7,476.[5] However the total employed labor force in the CNMI is over three times greater than this number at 25,965. Since the number of indigenous people actually employed is only 4,777, then 82 percent of the working labor force in the CNMI is made up of nonresident laborers.

The large numbers of guest workers that have been imported into the Commonwealth are primarily (70 percent) from the Philippines, but also come from other Asian countries, including the People's Republic of China. It is becoming increasingly apparent, even to the CNMI Office of Planning and Budget, that these nonresident workers will be necessary for the economy to function at present levels, and indeed, even more imported workers will be required if the economic base is to continue to expand.

Simply stated, the CNMI's rapidly developing economy has been financed in large measure by off-island sources and is operated (as indicated in Figure 6.6) to an increasingly greater extent by foreign workers.

The three major sectors employing workers are the construction, garment manufacturing, and public administration sectors (see Figure 6.7). These three sectors employ 60 percent of the CNMI labor force and each have approximately 20 percent of this labor pool. The remaining 40 percent of the CNMI work force is employed in tourism-related enterprises in hotel, restaurant, retail, and recreational jobs.

The Alien Labor Act of 1986 states that nonresidents cannot be employed in such private sector positions as retail clerks or cashiers, secretaries, bookkeepers, accounting clerks, messengers, receptionists, and taxi, bus, or surface tour boat drivers. The rationale behind this law is that the listed positions are considered to be entry-level positions within the economy and opportunities for local people to first enter the world of business should be reserved for CNMI residents, who, theoretically, after gaining practical on-the-job experience, will eventually advance to higher more responsible managerial positions. However, as shown in Figure 6.8, despite this law, throughout all of the CNMI private industries nonresident labor accounts for on average 82 percent of all jobs filled. The only exception to this is the public administration sector where only 20 percent of the employees were not born in the CNMI.

Prices

The Commonwealth has no control over monetary policy as it is subject to "cost-push" increases in prices from its major supplying countries, namely the United States and Japan. Imports from the United States account for nearly 60 percent of the value of the goods imported into the CNMI so that the U.S. inflation rate thus affects the CNMI economy via these commodities. The same is true to a somewhat lesser extent for commodities imported from Japan. The price structure of items procured from Japanese sources is also influenced by a weak dollar in relation to the yen. In addition to imported inflation, the increasing shipping cost for imports also adds to the prices paid by the CNMI consumers.

The consumer price index (CPI) of the CNMI was first estimated in 1972 and again in 1977 by consumer expenditure surveys that profiled the spending patterns of representative CNMI

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[5]Ibid., p. 140.

Figure 6.6 Nonresident Work Permits, CNMI

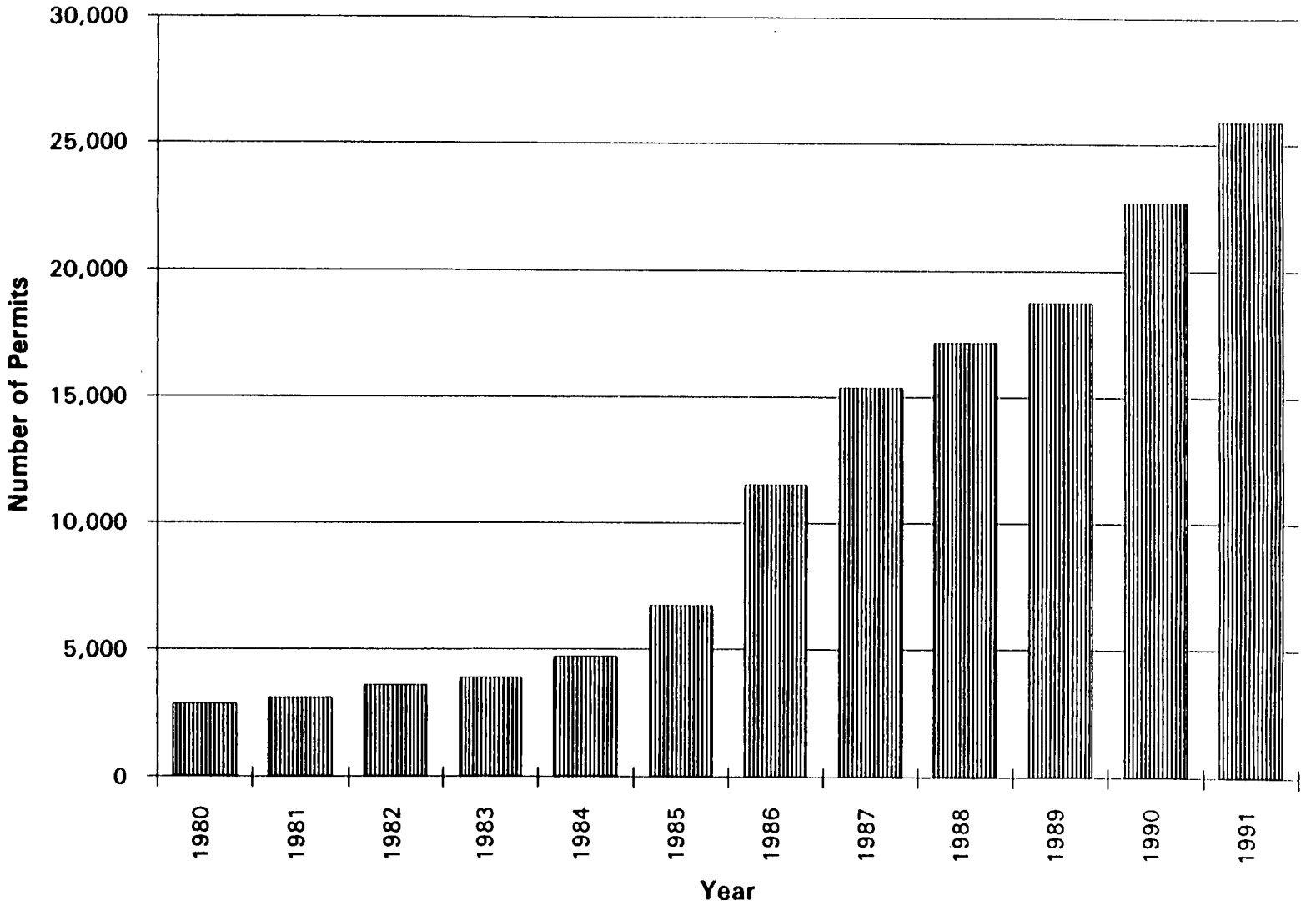


Figure 6.7 CNMI Employment by Sector, 1990

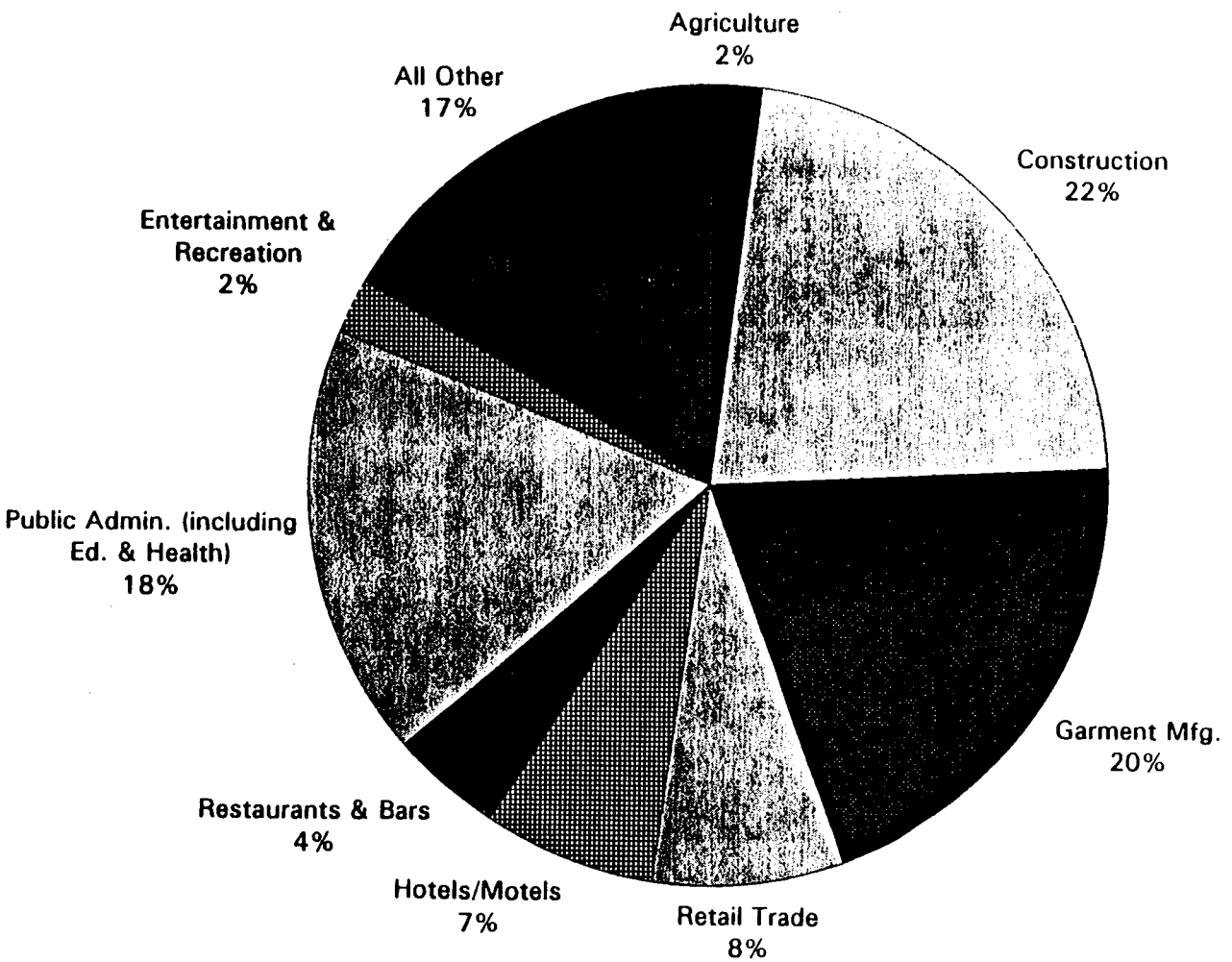
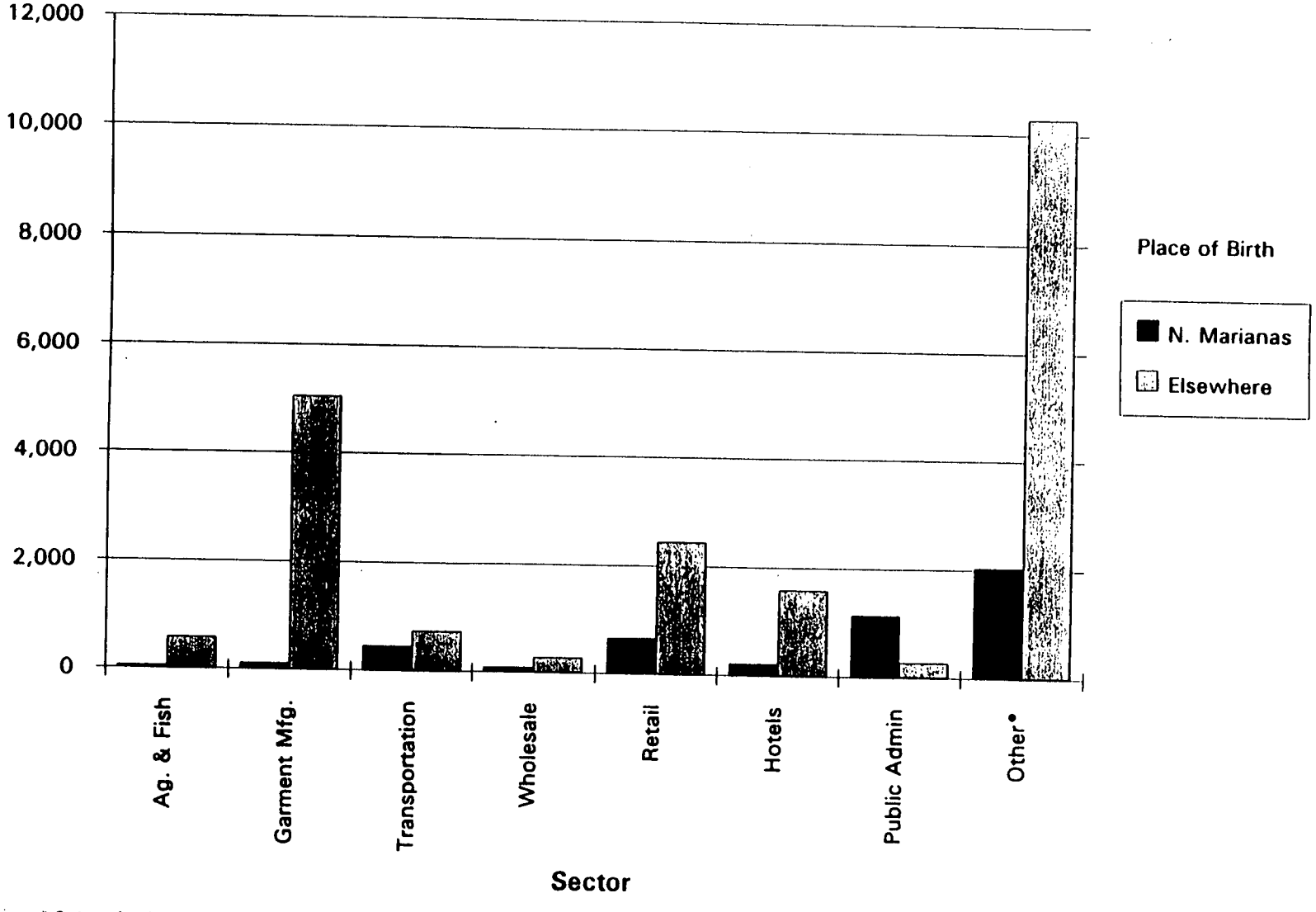


Figure 6.8 CNMI Employment Characteristics by Sector



*Other includes construction, education, health services, entertainment, recreation, domestic help, etc.

consumers. Although the CPI data were collected regularly every quarter since 1978, with only a few exceptions, the CPI was not computed or officially published. According to the CNMI Department of Commerce and Labor, these data contained numerous inconsistencies due to nonadherence to the original methodology and procedural guidelines. Furthermore, there were also calculation errors due to inappropriate use of the item weights.[6]

The CNMI government has recently completed a careful review and evaluation of the existing CNMI consumer price survey data files and a systematic field verification of the CPI data for the years since 1988. New weights have been established and a corrected computational procedure was written in order to produce an accurate series of the CPI based on the results of a survey done in 1977. Hence, even though the CNMI CPI is based on 1977 prices (i.e. 1977 = 100), an accurate series of this index is only available from 1988 onward.

Inflation rates calculated from these CPI data show that inflation rates in the CNMI have been, until recently, roughly within two percentage points of U.S. inflation rates (see Figure 6.9). However, in 1992, the CNMI CPI jumped to 11 percent, caused by increases in what the CNMI Department of Commerce and Labor calls the Health and Recreation Index. This index, which includes the prices of items such as alcoholic beverages (weighted at 53 percent), newspapers (21 percent), and dental fees (18 percent), shot up over a third in 1992 and accounted for 70 percent of the CNMI CPI's increase in the last year.

Trade and Business Growth

The value of imports into the CNMI reached $392.4 million in 1991. This is a 14.7 percent increase over the value of imports recorded the previous year. Petroleum products accounted for the item with the largest value at $81.8 million, followed by construction materials at $58 million, passenger transportation equipment at $57.9 million, and food at $47 million, with the remaining balance consisting of a wide variety of miscellaneous items (see Figure 6.10).

Items imported from Guam ($157.4 million) and the United States ($71.6 million) accounted for 58 percent of all the imports. Seventeen percent of the imported commodities (worth $65 million) originated in Japan, while the remaining 25 percent (including the petroleum which is sourced out of Singapore) valued at $98.4 million originated elsewhere.

It should be noted that all of these amounts represent values of taxable commodities used within the private sector. Items imported by the government (nontaxable) are not included in these figures.

The only products of any significance which are exported from the CNMI are garments, which are shipped entirely to the United States. In 1991, the invoice value of exported garments reached $255 million, which is about 60 percent of the total value of CNMI's imports for the same year (see Figure 6.11). There are also small quantities of agricultural and fishery products exported to Guam, but the value and quantity of these exports are so low that they are not recorded.

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[6]*Commonwealth of the Northern Mariana Islands Consumer Price Index (CPI)*, Vol.1, No. 1, Central Statistics Division, Department of Commerce and Labor, CNMI, p. 1.

Figure 6.9 Inflation Rates in the USA, Japan, and CNMI

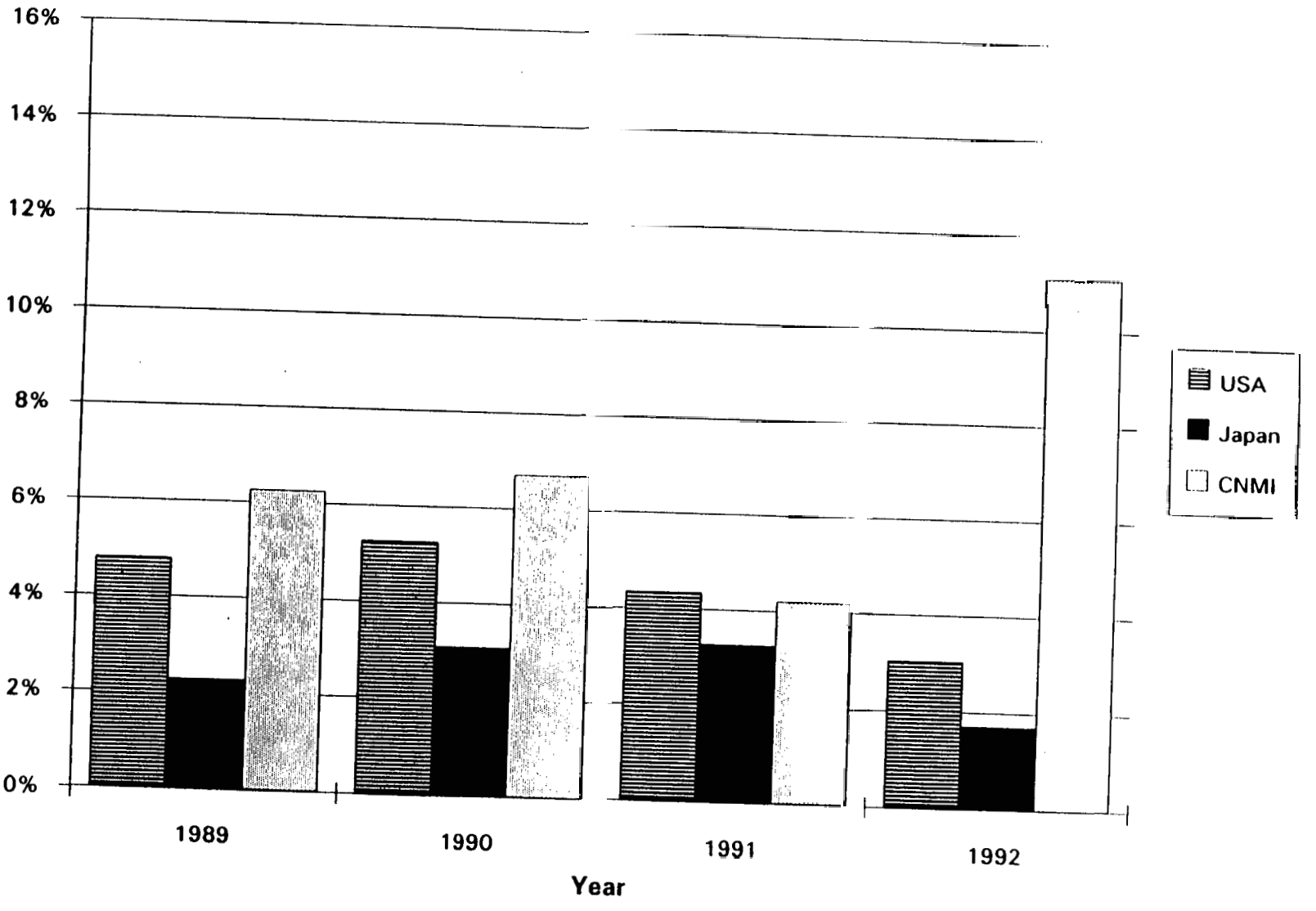
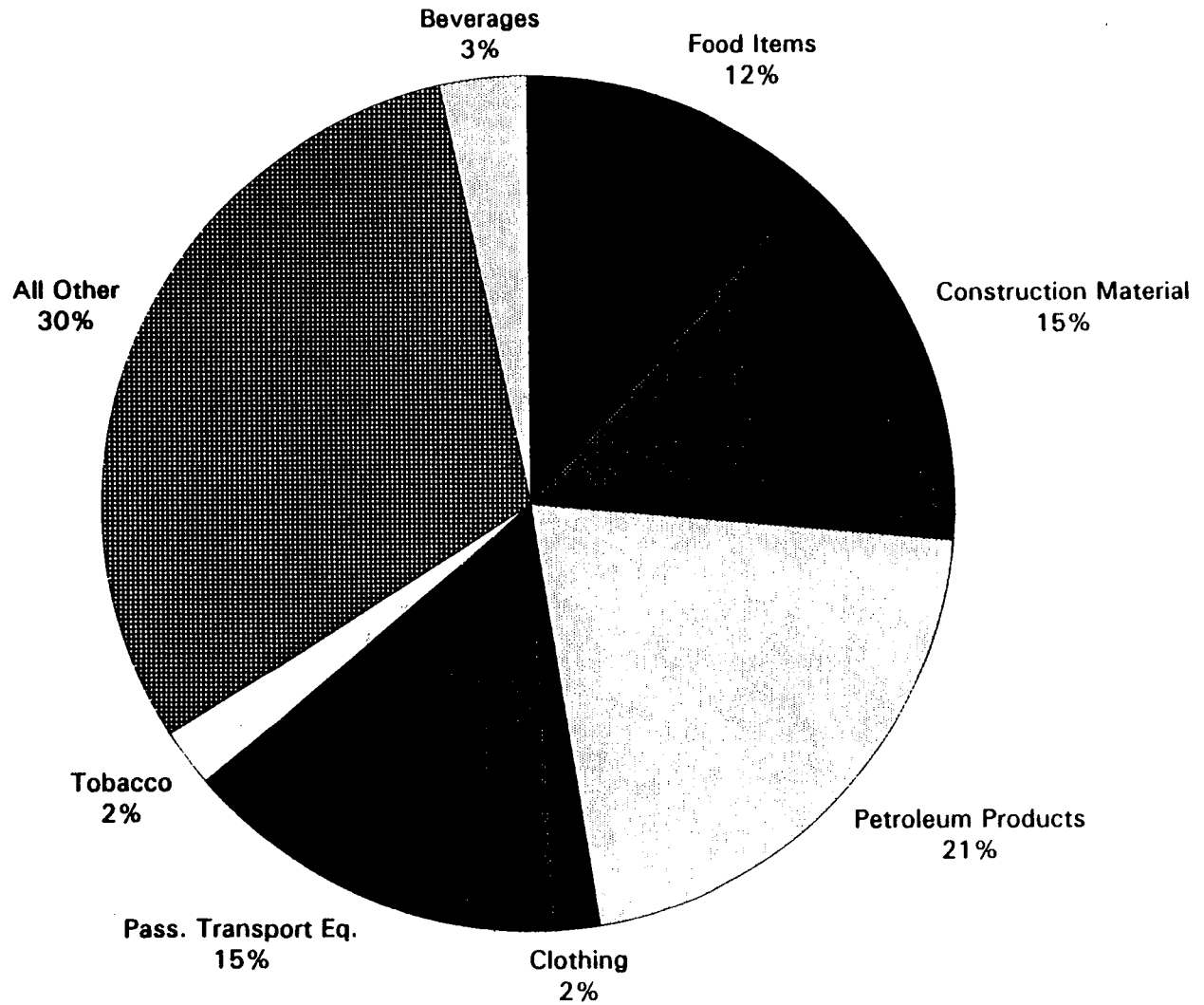
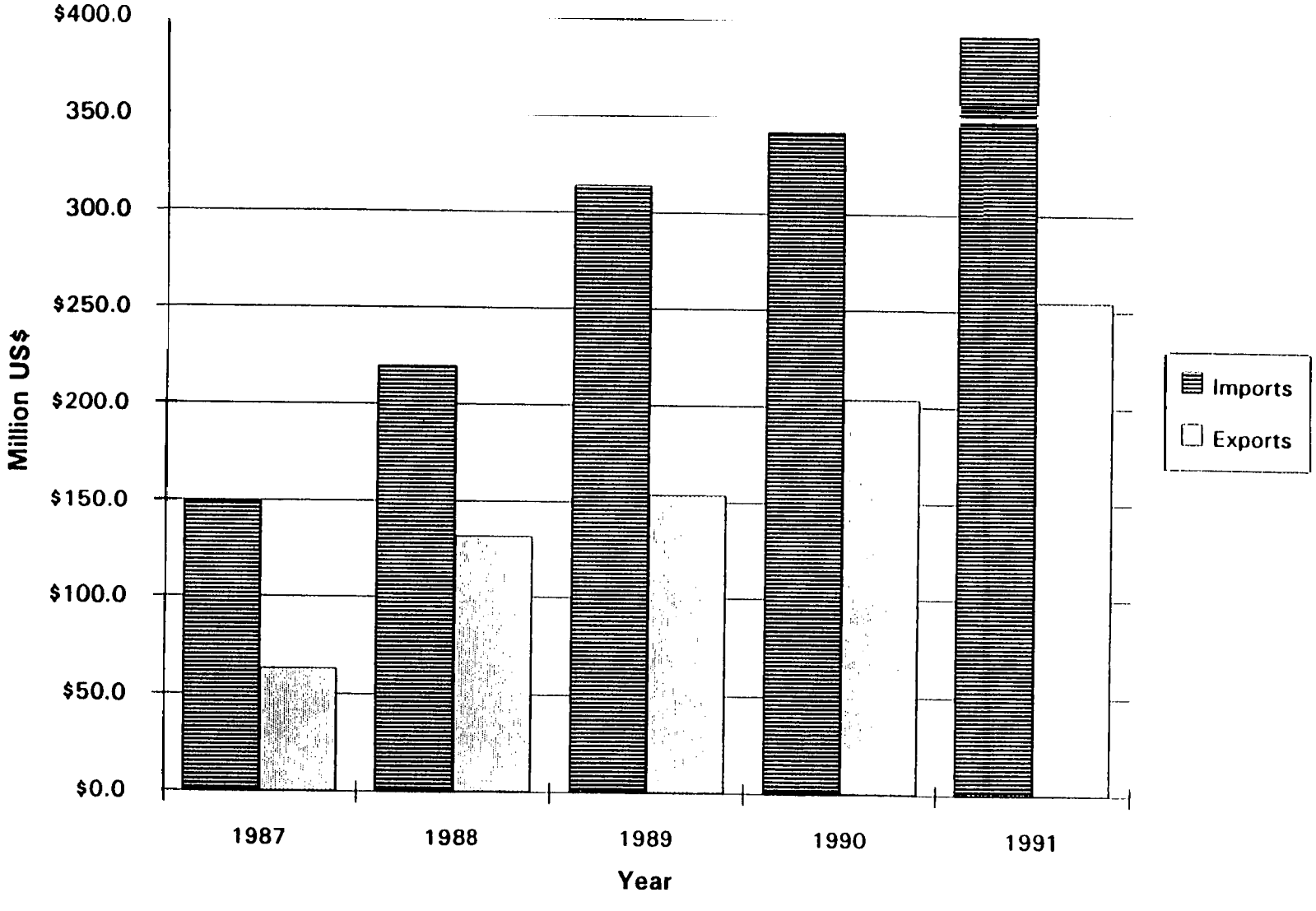


Figure 6.10 CNMI 1991 Imports, Percentage of Total Value Imported



* Excludes items imported by the CNMI government

Figure 6.11 CNMI Imports vs. Exports



In the period from 1985 to 1991, gross business revenues in the CNMI increased five-fold from approximately $250 million to nearly $1.4 billion (see Figure 6.12). This growth represented an average increase of 32 percent per annum over this six-year period.

As indicated in Figure 6.13, most of the economic sectors in the CNMI have seen their gross revenues grow at fairly uniform (and fast) rates averaging between 33 and 37 percent per year since 1987. Exceptions to this have been the garment manufacturing industry, which has experienced an increase of revenues at an average annual rate of 80 percent, and the CNMI retail sector, which has recorded growth in revenues at an incredible average annual rate of 114 percent since 1987.

Key Sectors

Tourism

According to estimates made by the Marianas Visitors Bureau,[7] tourists spent over $444 million in the CNMI during 1991. This amount is 13 percent greater than the value of all the taxable commodities imported into the Commonwealth that same year. In 1992, the estimate of tourist expenditures exceeded $500 million.

Since the inception of the Commonwealth's tourism industry, the CNMI has relied heavily on Japan as its primary visitor market. But in 1992, while there were ongoing recessions in Japan and in the United States that caused a worldwide slowdown in tourism, the CNMI enjoyed a 15 percent gain in visitor arrivals. Even during 1991, when the difficult global economic conditions were coupled with the effects of the Persian Gulf War, the CNMI experienced a small 2 percent increase in visitor arrivals. The CNMI's close proximity to other emerging markets has been its reported key to continued growth while other tourist destinations have seen a drop in business. The Marianas Visitors Bureau has long recognized the need to diversify the CNMI tourism base and has put much effort into reaching out to new Asian markets.

These efforts have included aggressive promotion in new markets both inside and outside Japan. Despite the Japanese recession, Japanese visitors to the CNMI increased 12 percent in 1992. New direct air routes from Korea, Taiwan, and Hong Kong together with strengthened marketing efforts have contributed to a dramatic increase in visitor arrivals from these countries. The CNMI Budget and Planning Office believes that current and expected travel patterns in the Asia-Pacific region indicate that tourism will continue to be a viable base upon which the CNMI can maintain its economic growth through the end of this century.

The CNMI tourism success story has not been without cost. The rapid growth of this industry has placed a heavy burden on the Commonwealth's utilities, roads, and transportation facilities. Infrastructure is one of the leading constraints to tourism growth in the near term. Problems related to water, power, and sewers are particularly serious. Currently, utility service hours are constrained, power outages are frequent, water quality does not meet the U.S. Environmental Protection Agency Safe Drinking Water Act Primary and Secondary Standards, and degradation related to sewage disposal and other forms of water pollution has already occurred and may become worse.

[7]March 25, 1993 communications with J.S. Chong, Research Manager, Marianas Visitors Bureau.

Figure 6.12 CNMI Gross Business Revenue

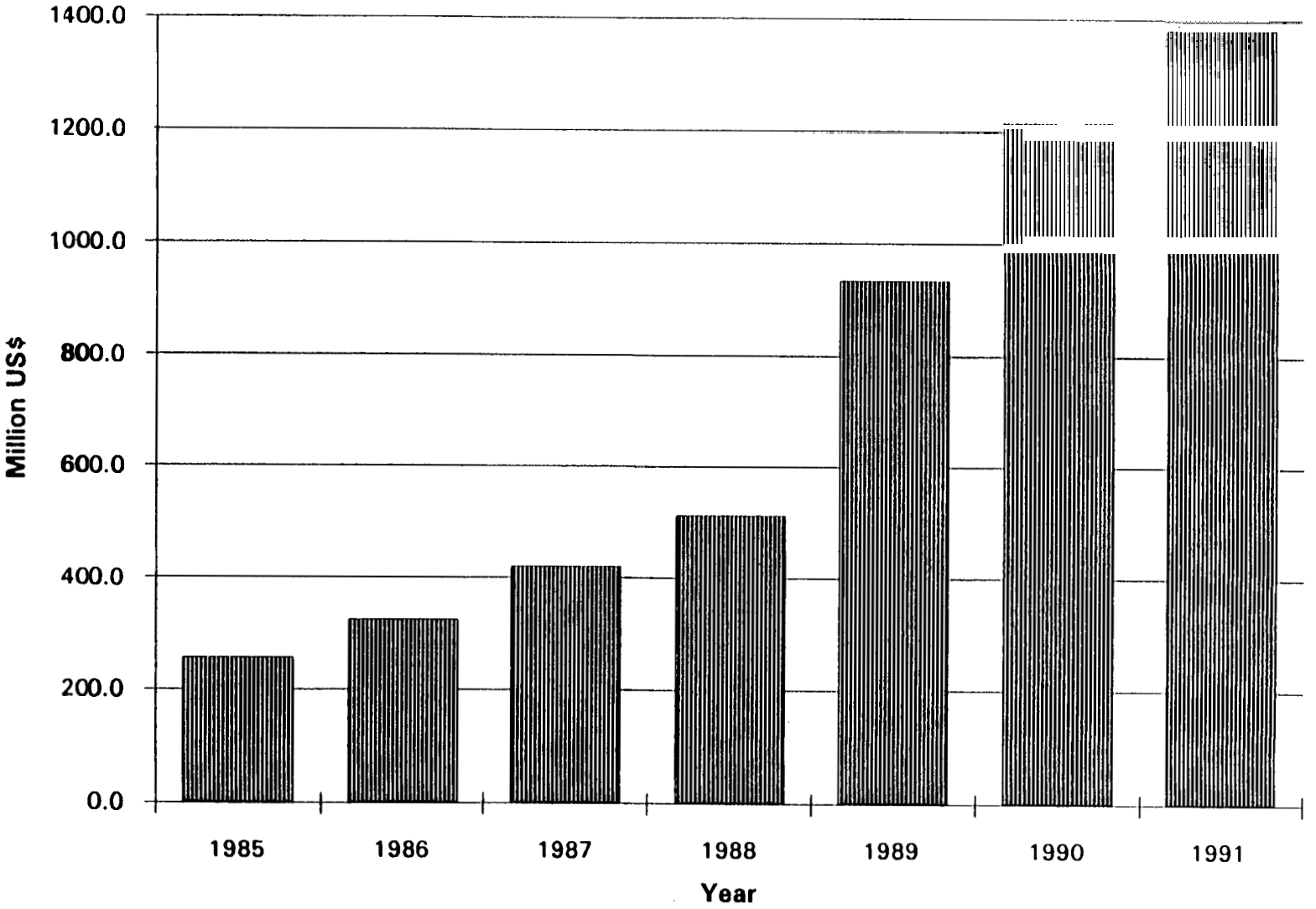
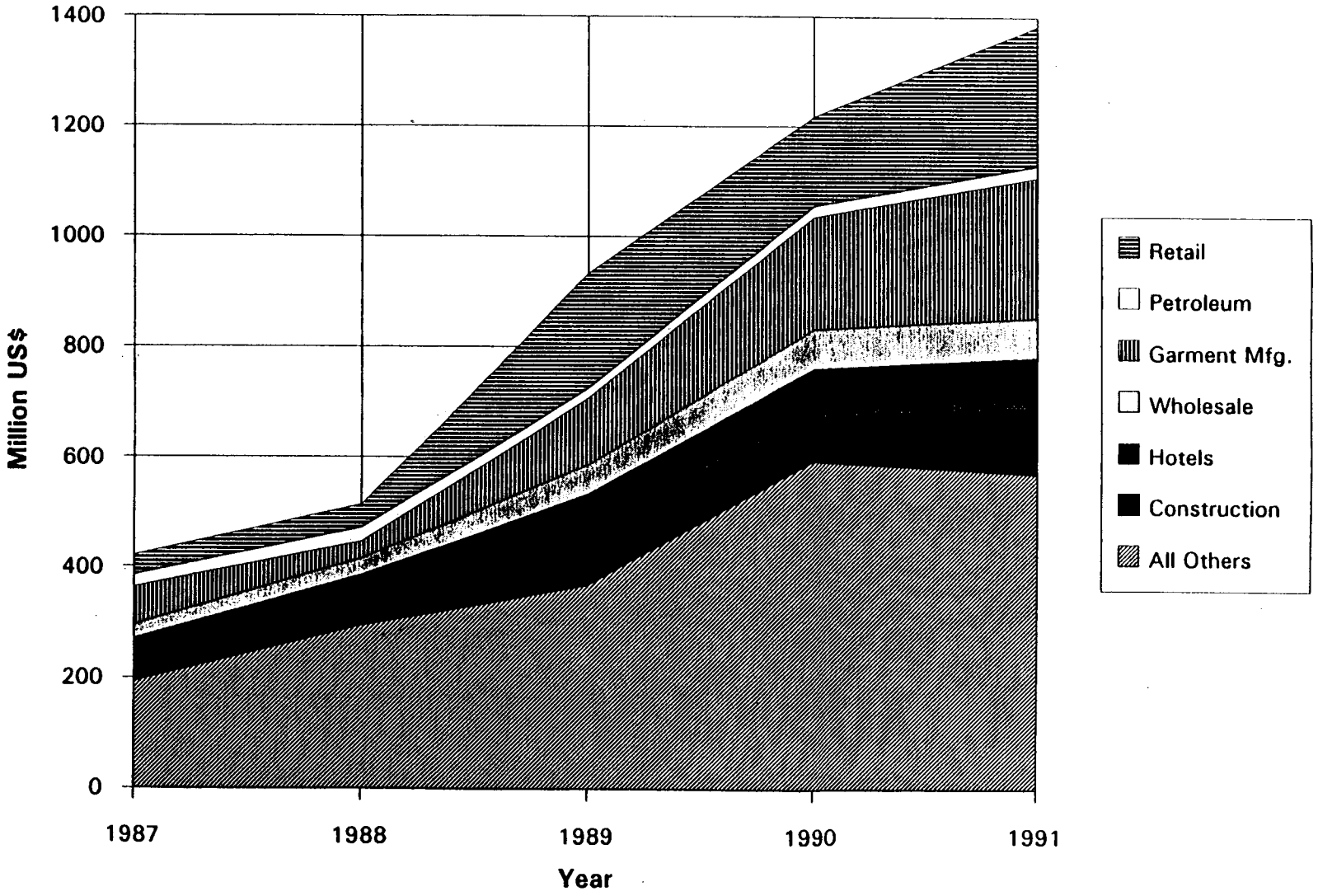


Figure 6.13 CNMI Gross Business Revenue by Sector



Construction

Growth projections for the tourism sector have important implications for every segment of the CNMI economy, including the construction industry. The low case projection from the Marianas Visitors Bureau of a 10 percent average annual increase in tourist arrivals implies that the CNMI will need at least 6,000 more hotel rooms before the end of the century.[8]

Throughout the 1980s, the CNMI construction industry grew from a small number of independent contractors to dozens of construction companies by 1990, including representatives of some of the largest Japanese construction firms. One economic indicator that reflects this boom is the sevenfold increase in the value of imported construction materials that has occurred since 1983. However, the local contractor's association has recently expressed concern that some major construction projects are being delayed due to the lack of utilities at the sites.

Additionally, there has been some negative publicity about the confusion in the foreign investor community over the legal status of their investments which has reportedly been blamed for an increase in the postponement of construction projects. At issue is Article XII of the Commonwealth Constitution which states that land ownership is limited to persons of CNMI descent. Therefore, the most common means for a foreigner to acquire land is through a long-term lease. Recently, the Supreme Court of the Commonwealth ruled in a particular case that the sale (and subsequent leasing) of property on which a hotel was later built was invalid since the purchaser was an agent acting under the control of non-CNMI owners. Outside investment in CNMI real estate is still legal, but future investors will be much more cautious with respect to the chain of titles of a piece of property. This court decision has coincided with the policy of Japanese banks to tighten up on overseas real estate investments together with the general slowdown in the global economy. The combined effect of legal uncertainty over land titles and the contracting Japanese capital market has led to a major reduction in hotel investment and construction.

Even though fewer multimillion dollar projects are now entering the construction phase, local planners in the Office of Budget and Planning tend to view this slowdown as something that can be used to the CNMI's advantage. This lull will afford time for the CNMI to catch up with infrastructure improvements, which, it is believed, will make the Commonwealth an even more attractive place to invest in the long run.

Garment Manufacturing and Other Sectors

It has been generally acknowledged that the garment industry of the CNMI, which takes advantage of Headnote 3(a), is the only real economic link between the Commonwealth's export sector and the U.S. mainland economy. Headnote 3(a) of the U.S. Customs Schedule is an arrangement between the U.S. Department of the Treasury and the U.S. insular possessions designed to encourage light industries and thereby establish the private sector. Headnote (3a) allows manufacturers duty-free treatment for products from the U.S. territories entering the U.S. Customs Territory. Twenty-six licenses have been issued for garment manufacturing in the CNMI, although not all of these are active as some factories are not operating. The total employment of this industry in 1990 was 5,248, or

[8]*Economic Development Strategy: A Prospectus for Guiding Growth*, Office of Planning and Budget, Executive Office of the Governor, Saipan, Second Revised Edition, 1993, p. 37.

about 20 percent of all employment in the CNMI. The 1990 declared export value of its products equaled $203 million, and by 1991 this had risen to $263 million. This industry paid over $48 million in salaries in 1991.

The garment industry on Saipan has had a significant impact on the economy of the CNMI as a result of several factors, namely providing increased revenue in the form of user fees (a form of export tax), employee income taxes, and the multiplier effect of increased personal and business expenditures in the Commonwealth. Additionally, the establishment of this industry is considered to be a major diversification of the CNMI economy.

The industry's existence is not without its critics, who believe that the large numbers of nonresident workers have had adverse effects on the provision of some government services, such as medical care, and to some extent on the infrastructure, particularly the sewer, water, and power systems. Over half (52 percent) of the CNMI garment workers are from the People's Republic of China, while Koreans and Filipinos also make up a large part (38 percent) of this labor force.[9] At this time the garment industry is under an administratively imposed moratorium, which restricts growth in certain areas and places limitations on existing manufactures. Each existing factory has an alien work force frozen at an assigned level, and local legislation requires an annual increase in the percentage of local resident employees.[10]

Critics of this industry also include members of the U.S. House of Representatives. Legislation has been proposed to remove the duty-free treatment of the CNMI garments unless the garment workers receive the prevailing U.S. minimum wage. This bill, if passed, would mean instant death to the Commonwealth garment industry, according to CNMI factory owners.[11] The industry admits that it pays lower wages, but it says it has a higher tax bill than U.S. mainland factories, and it has to pay for labor recruitment, travel, and permit fees as well as provide subsidized housing and food for the workers. The garment industry argues that these costs are often overlooked by those who claim that the Commonwealth factories have an unfair advantage over mainland factories.

Other than the garment manufacturing industry and tourism, the remaining activities within the economy are relatively small and are comprised mainly of baking, soft drink bottling, fabrication of cement building blocks, making and retailing souvenirs, tailoring, and a limited amount of metal fabrication. Agriculture has figured prominently in the tiny economies of Rota and Tinian, but to a much smaller extent on Saipan. Currently, only several thousand acres are being farmed, compared to the 40,000 acres under cultivation before World War II. The infestation of the melon fly reduces crop production and effectively prohibits the export of much of the CNMI agricultural produce. However, currently a program funded by both the U.S. government and the Japanese is being implemented to eradicate this pest.

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[9]*The 1990 Census of Population and Housing: Commonwealth of the Northern Mariana Islands*, Table 55.

[10]"89 Garment Industry on Review," *Guam Bu$iness News*, July 1989, p. 25.

[11]D. Phillips, "Guerrero, Tan fret over Payne garment proposal," *Pacific Daily News*, Focus on the Commonwealth & Micronesia section, April 9, 1993, p. 1.

ENERGY SECTOR

Overview

The Executive Director of the Commonwealth Utilities Corporation recently wrote: "The CNMI is totally dependent on fossil fuels for the provision of power, water, and sewer utility service. Any interruption to fuel supply will result in detrimental impacts on the health, safety and welfare of the CNMI."[12] Data from the 1990 census show that 91 percent of the Commonwealth's households are now electrified and over 87 percent of them have at least one motorized vehicle. Petroleum is the energy source that powers the CNMI's transportation sector and generates its electricity.

Although locally available renewable sources of energy have a potential in the long term to provide part of the Commonwealth's energy needs, the evaluation of the contribution that renewables can make is incomplete. Biomass and direct solar hot water heating may offer opportunities to reduce the growth in the consumption of electrical power, but these alternatives cannot realistically be expected to replace petroleum as the primary fuel of the CNMI. This region of the Pacific Ocean also provides favorable conditions for the utilization of an OTEC facility, but only after the technology matures at a future date.

The immediate needs of the CNMI's energy sector center on the reliability and quality of the delivered power to meet the growing demand for electricity. Reduction of power outages has been identified as essential to the economy of the CNMI as its businesses struggle to compete with other regional tourist destinations. The threat of typhoons has also initiated expensive investments, including the installation of some underground electrical distribution systems.

Improvements in the collection and management of energy sector data are clearly warranted. Data on petroleum import and storage levels are not readily accessible to the relevant Commonwealth decision makers which hampers planning efforts. Detailed end use statistics on both electricity and petroleum usage are required for effective conservation efforts and emergency contingency planning.

Supply and Demand for Petroleum Products

In 1991, the reported value of the petroleum imported into the CNMI was $81.8 million, which represented 21 percent of the value of all the imported commodities, and as such, was the highest value single category of imported goods. The volume of oil imported into the CNMI was 1,140 thousand barrels in 1991, and this rose 20 percent to a volume of 1,370 thousand barrels in 1992. The CNMI is completely dependent on imports for all of its petroleum product needs. All petroleum products are shipped to the CNMI by the area's primary suppliers, Shell Oil and Mobil, though a third small oil marketer, a local company, Taga Petroleum, has also operated in the CNMI.[13] Both Mobil and Shell distribute gasoline, ADO and lubricants. Mobil also markets jet fuel and AvGas. All fuel comes from Singapore via Guam, while the lubricants are shipped in directly from both Hong Kong and Guam.

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[12]Ramon S. Guerrero, letter to Pacific Islands Energy Project, East-West Center, March 30, 1993.

[13]*Increasing Oil Spill Management Capacity in the American Flag Pacific Islands*, Pacific Basin Development Council, April 1992, p. 32.

products. These estimates provided by the local petroleum marketers together with the reported 1992 fuel consumption of the Commonwealth Utilities Corporation (CUC) allow a rough accounting to be made of the fuels imported into the CNMI. From Table 6.1 it can be concluded that over half of the fuel brought into the Commonwealth is used for transportation (land, sea, and air), while more than 40 percent of the imported petroleum is used for electricity generation.

Within the transportation sector, further categorization of the estimates of the end uses of these fuels can be made. All of the jet fuel used in transportation is dedicated to aviation, while 98 percent of the gasoline used is devoted to land transportation, with the remaining 2 percent reserved for marine usage. Approximately three-quarters of the diesel used for transportation is consumed by land transport applications and the remaining quarter is used for marine transportation.

Table 6.1 Estimated End Use of Petroleum Products in the CNMI
('000 Barrels)

Product	Transportation	Electricity Generation	Miscellaneous*	Total
Gasoline	243.7	--	--	243.7
Jet Fuel	430.3	--	1.7	432.0
Residual	--	277.9	--	277.9
ADO	34.3	286.7	92.3	413.3
Other**	3.0	--	--	3.0
Total	711.3	564.6	94.0	1,369.9
Percentage	52%	41%	7%	100%

* Miscellaneous usage includes hotels, home cooking, construction, and other commercial establishments.
** Other includes fuels such as LPG and AvGas

Storage and Distribution System

The CNMI storage facilities for petroleum products are outlined in Table 6.2 and in Figure 6.14. The main storage facilities, which account for over 95 percent of the Commonwealth's storage volume, are located on the island of Saipan. Shell owns four vertical cone roof tanks, which provide storage for 75,000 barrels of petroleum products. By tank, the storage capacity is 20,000 barrels for low sulphur ADO, 20,000 barrels for high sulphur fuel oil, 15,000 barrels for premium unleaded gasoline, and 20,000 barrels for regular unleaded gasoline. Mobil's Saipan storage facilities are considerably more extensive with accommodations for 124,000 barrels of products in a total of 11 tanks. By tank capacity, Mobil's storage facilities include 10,000 barrels for premium unleaded gasoline, 22,500 barrels for regular unleaded gasoline (in two tanks), 25,000 barrels for low sulphur

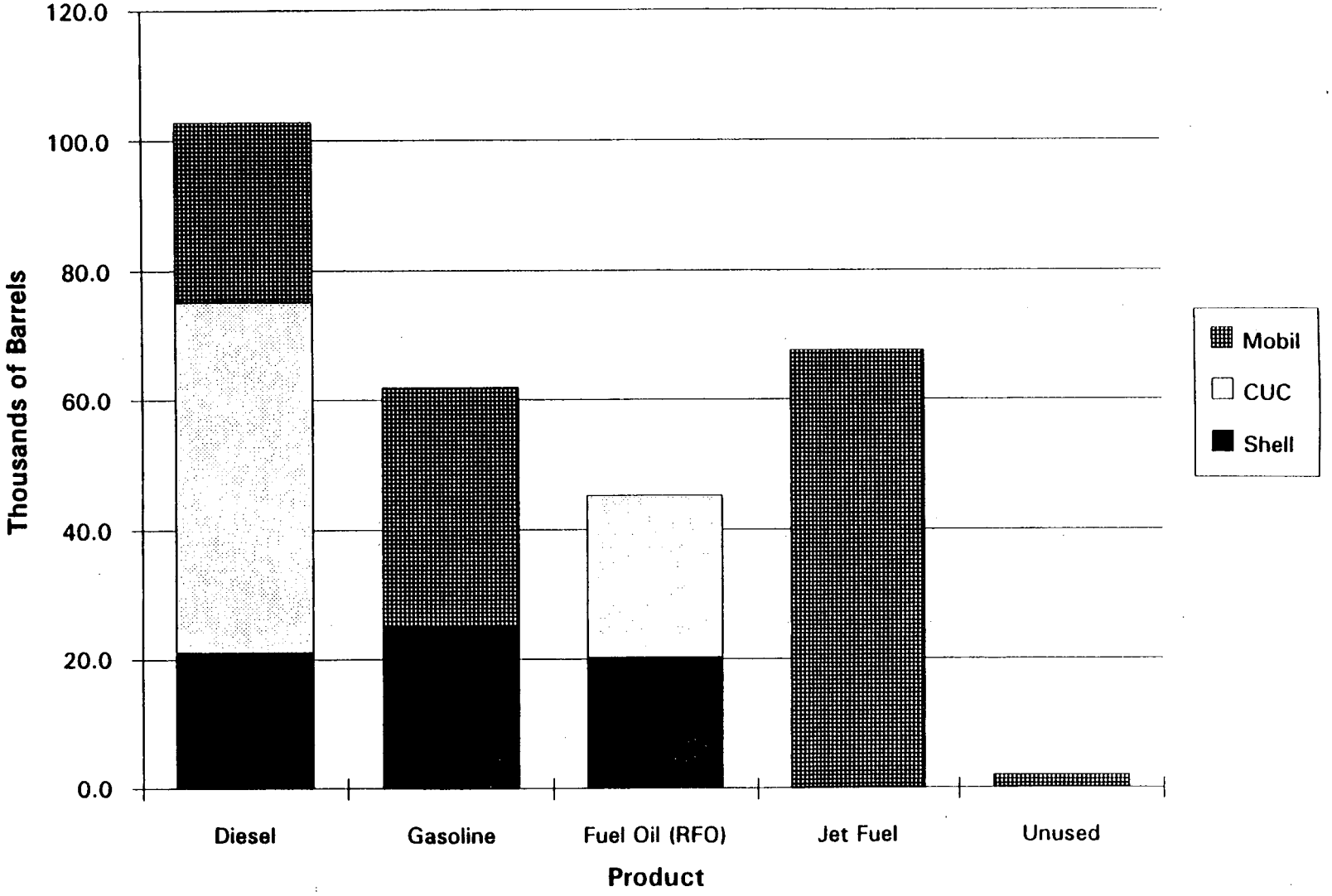
ADO (in two tanks), 65,000 barrels for jet A1 (in four tanks), and a 1,000 barrel slop tank. According to the CUC, the storage capacity it employed in 1992 for the island of Saipan consisted of 47,484 barrels for ADO supplies and 25,018 barrels for residuals.

Rota and Tinian have significantly less petroleum storage capacity than does Saipan. The combined storage capacity available on Rota and Tinian is about 15,700 barrels. Mobil Oil and the Commonwealth Utilities Corporation (CUC) operate these tanks. On Rota, Mobil owns and operates two 1,000 barrel tanks containing regular unleaded gasoline and two 1,000 barrel tanks for low sulphur ADO. The CUC also owns and operates a 5,512 barrel ADO tank on Rota. On Tinian, Mobil owns and operates four tanks—two 1,000 tanks for regular unleaded gasoline, a 700 barrel tank for LSADO, and a 1,000 barrel tank that is normally used as spare storage space but is reported to be presently under repair. Additionally, there are 1,143 barrels of storage on Tinian, owned by Shell Oil but operated by the CUC.

Table 6.2 Major Storage Facilities in the CNMI

Island	Owner/ Operator	Storage Descriptions
Saipan	Shell	20,000 bbls Low Sulphur ADO 20,000 bbls High Sulphur Fuel Oil 15,000 bbls Premium Unleaded Gasoline 20,000 bbls Regular Unleaded Gasoline
	Mobil	10,000 bbls Premium Unleaded Gasoline 22,500 bbls Regular Unleaded Gasoline (2 tanks) 25,000 bbls Low Sulphur ADO (2 tanks) 65,000 bbls Jet A1 (4 tanks) 1,000 bbls Slop Tank
	CUC	47,484 bbls ADO 25,018 bbls RFO
Rota	Mobil	2,000 bbls Regular Unleaded Gasoline (2 tanks) 2,000 bbls Low Sulphur ADO (2 tanks)
	CUC	5,512 bbls ADO
Tinian	Mobil	1,000 bbls Regular Unleaded Gasoline (2 tanks) 700 bbls Low Sulphur ADO 1,000 bbls under repair (spare tank)
	CUC (Shell-owned)	1,143 bbls ADO

Figure 6.14 CNMI Fuel Storage



Both of the CNMI's primary petroleum suppliers have provided information which indicates the average inventories of petroleum products which are typically kept in the commonwealth. Using product consumption rates estimated from 1992 petroleum demand numbers, calculations of the amount of supply (in days) can be made. A maximum theoretical inventory in days is also calculated by assuming no conservation efforts and maximum capacity loading in all storage tanks and then dividing the storage capacity by the daily usage rates to obtain an estimated fuel stock in days. The results of these calculations are presented in Table 6.3.

Table 6.3 Estimated CNMI Petroleum Product Storage in Days

Product	Maximum Theoretical Inventory*	Estimated Average Inventory in Petroleum Company Storage** (Excludes CUC Storage)	Estimated Minimum Inventory in Petroleum Company Storage*** (Excludes CUC Storage)
Gasoline	93	48	17
Jet Fuel	57	36	17
ADO	91	27	12
Residual	59	13	5
Total	75	31	13

* Assumes all tanks in the CNMI are 100 percent full.
** Assumes tanks are kept at the "average stock level" supplied by the oil companies.
*** Assumes tanks are both at "minimum stock levels" specified by the oil companies.

As shown in Table 6.3, the total stored petroleum supply stock can, in theory, last an estimated 75 days without rationing efforts (this number is calculated by applying the aggregated petroleum product usage rate to the total Commonwealth storage supply capacity for petroleum products). However, information provided by the petroleum companies suggests that normally they keep only two-fifths of this amount of oil in the CNMI at any one time. Data from the oil companies also indicate that the minimum amount of petroleum stocks in the CNMI can dip to 13 days if both Mobil's and Shell's tanks reach their minimum stock levels simultaneously.

It would be erroneous to apply the above rates to the islands of Rota and Tinian, as the preceding calculations reflect the total usage by the CNMI which is more characteristic of Saipan, since it constitutes over 95 percent of petroleum demand. Rota's annual consumption of diesel and gasoline is estimated to be 28,400 barrels and 10,400 barrels, respectively. The storage capacity for these products is 7,500 barrels for diesel and 2,000 barrels for gasoline. These numbers suggest that

Rota has the capability to store 97 days of diesel and 70 days of gasoline supplies. Tinian uses 23,000 barrels of diesel and 3,400 barrels of gasoline a year. As it has storage capacity of 1,800 barrels for diesel and 2,000 barrels for gasoline, it can potentially stock a 29-day supply of diesel and a seven-month supply of gasoline.

Petroleum products are delivered to the CNMI by medium-range (MR) tankers (70,000 bbls maximum capacity) and local coastal tankers (LCT) (50,000 bbls maximum capacity). Commercial vessels also deliver lubricants and other specialty packages. Fuels originate in Singapore, while lubricants are supplied by Hong Kong; both are shipped to the CNMI via Guam, with a typical voyage time of nine to ten days for the Singapore-to-Guam leg and then an additional 12 hours to sail to Saipan from Guam. Bunkering facilities on Saipan are very limited and seldom used. Mobil makes monthly deliveries to Saipan and Shell's deliveries arrive every 40 to 45 days.[14] Local coastal tankers are then employed by Mobil and Shell to transfer supplies to Tinian and Rota. The tankers range in size from 8,000 to 50,000 barrels.

Medium-range tanker shipments must be partially off-loaded on Guam before tankers can continue on to Saipan. The shallow waters surrounding Saipan's port facilities are the reason for the partial off-loading. At present, the depth of the harbor ranges from 28 to 30 feet, and this must be considered when larger ships enter the harbor. The actual berthing facility, known as Baker Dock, was recently improved through the joint efforts of Shell and Mobil to ease the delivery process (see Figure 6.15). Concrete bollards and a concrete walkway were added and the No. 23 buoy was moved south to mark the harbor's shallow patch. Two tugs are always available at Baker Dock to assist the arriving tankers, and one remains on standby throughout the stopover to assist in deberthing. Shell has arranged a Mediterranean mooring (tanker backs up to the dock, sets anchors off the bow, and ties off at the stern) for its docking activities. Once docked, each company utilizes six-inch diameter floating hoses to discharge petroleum products to their respective storage tanks.

Off-loading at Rota requires 2,000 feet of six-inch diameter floating hoses to run over the surrounding reef. The hoses are run from the tankers once they are moored using one bollard at the reef as well as the ship's anchor. As these moorings are exposed to the elements, there are frequent disruptions in discharge operations. Floating hoses are not required for discharge of products to Tinian. After berthing alongside the dock, two 300 foot by four-inch diameter pipelines facilitate off-loading.

Once on Saipan, the petroleum products are mainly distributed via tank truck. Bunkering is restricted and now limited to tank truck or barge. Furthermore, the six-inch bunkering pipeline is old and disused. Petroleum products are also distributed to the Commonwealth Utilities Corporation (CUC) via two pipelines. The six-inch diameter steel pipelines run between the tank farm and the CUC power plant, stopping at Baker Dock. One of the lines continues from Baker Dock to the CUC power plant as an eight-inch diameter heated pipe. Mobil recently won the CUC supply contract, which Shell had previously held.

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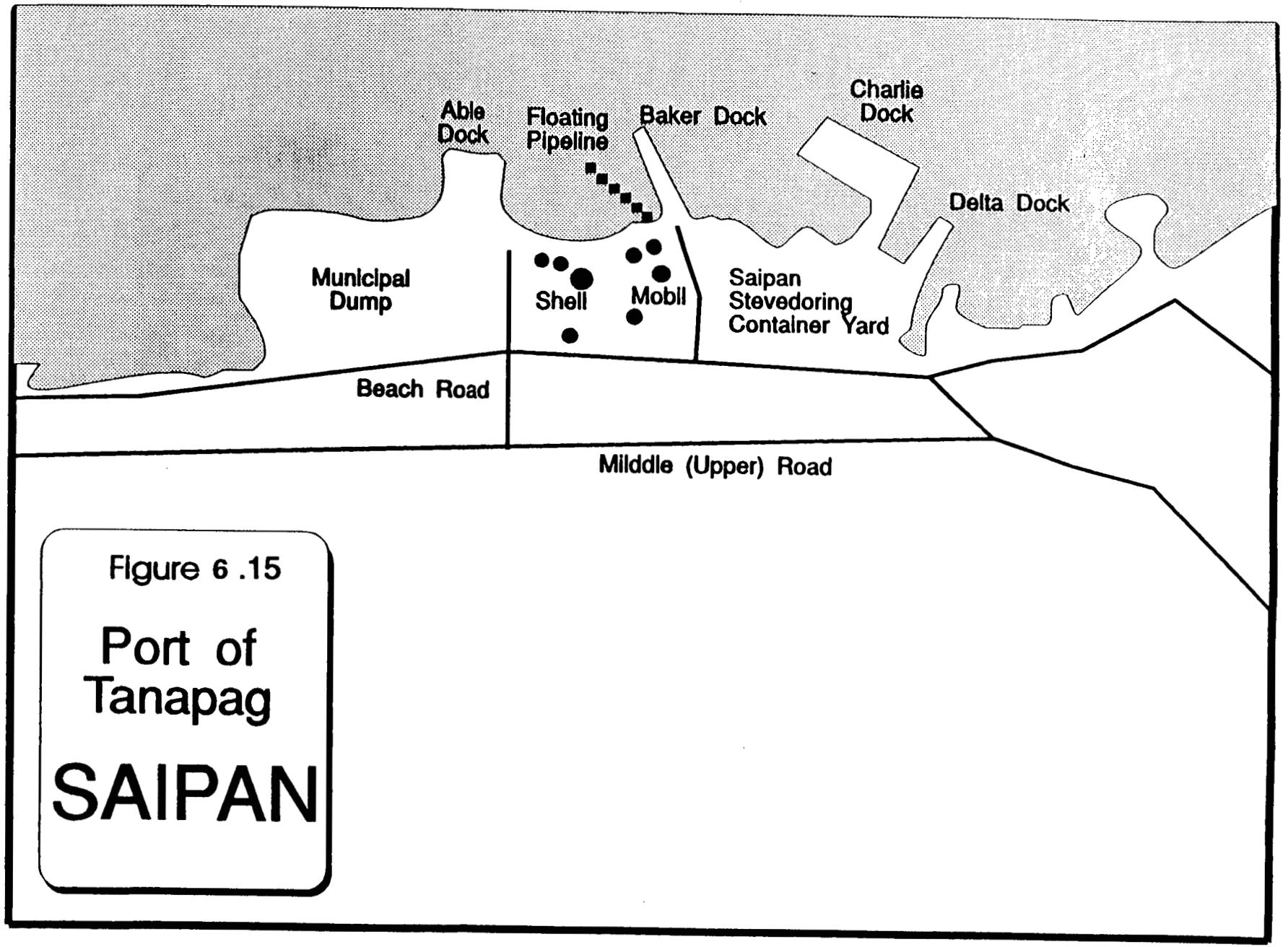
[14]*Increasing Oil Spill Management Capacity in the American Flag Pacific Islands*, Pacific Basin Development Council, April 1992, p. 33.


Able Dock
Floating Pipeline
Baker Dock
Charlie Dock
Delta Dock
Municipal Dump
Shell
Mobil
Saipan Stevedoring Container Yard
Beach Road
Milddle (Upper) Road
Figure 6 .15
Port of Tanapag
SAIPAN

As for aircraft fuel needs, Mobil controls the airport refueling market. Two 1,300 barrel capacity tanks are located at the airport's main terminal and are filled by tank truck deliveries. The tanks are linked by a ten-inch diameter underground hydrant system to the tarmac for the refueling of aircraft.

Retail distribution of gasoline is through gas stations. As of 1987, there were 18 gas stations recorded in the CNMI by the U.S. Economic Census of Outlying Areas.

Future Developments

Key indicators point toward a double-digit annual increase in the amount of petroleum imports over the decade. A recent generation and distribution study for the CUC forecasts over 16 percent per annum growth in the nation's electricity requirements until the year 2000. In the last two years, the CUC has already seen its generation grow by 18 percent per year. Even if the CUC cannot to keep up with this growing demand, it is now common practice for hotels and other businesses to install their own independent power units,[15] which require fuel of their own. A recent report prepared in association with the U.S. Army Corps of Engineers[16] provides a lower estimate of growth for the CUC which is still at least 10 percent per annum.

Despite the overall global economic downturn and its effects on tourism, the CNMI is still experiencing an annual increase of 15 percent in visitor arrivals. This increase affects fuel demand in the transportation sector. Oil company estimates for projected sales in the 1990s exceed 7 percent per annum. Gasoline sales have been forecast to increase by over 17 percent annually until 1997.

By the year 2000, if oil imports increase at an annual rate of 7 percent per year, the CNMI will be importing 2,354 thousand barrels of petroleum. If the annual growth rate for petroleum products is 18 percent, then 5,150 thousand barrels of fuel will be consumed in the year 2000.

New Storage Capacity

Additions and repairs to existing storage capacity are planned to cover the projected increased demand for petroleum fuels. On Tinian, Mobil has a 1,000 barrel vertical tank under repair. In addition, the CUC has plans to build a 1,400 barrel diesel fuel storage facility there. The CUC is rebuilding two 18,000 barrel vertical cone roof tanks and plans to construct three 24,000 barrel tanks to cover its future storage needs on Saipan. Part of the rationale for these new tanks is that the extra storage will enable the CUC to purchase fuel quarterly, rather than monthly as at present. This is expected to save substantial freight costs.[17]

Wharf and Dock Upgrades and Improvements to the Harbor

In addition to the plans for storage capacity, upgrades are also planned for the wharf facilities. The government plans to further the improvements made by Shell and Mobil on Baker Dock, which

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[15] *Pacific Power*, Volume 1, Number 2, January-March 1993, p. 13.
[16] Third Year Review—Operations and Maintenance Improvement Program: OMIP Team's Field Report, Prepared by Louis Berger International, Inc. for the U.S. Department of the Interior and the U.S. Army Corps of Engineers, December 1992, p. 54.
[17] *Pacific Power*, Volume 1, Number 2, January-March 1993, p. 12.

until the improvements had not seen any major post-World War II refurbishment or expansion. The project, estimated to cost between $40 and $50 million, will extend and upgrade the wharf facilities to include accommodations for berthing and discharging of tankers and bunkering facilities.

Approximately 630,000 cubic yards of dredging must be performed to deepen the harbor to allow for adequate and safe accommodations for deep-draught vessels. This would deepen the harbor from 28-30 feet to 38-40 feet. Improvements also include disposal of dredged material, filling of an eight-acre bulkhead wharf, paving, drainage, and the installation of utilities. The planned reconditioning is essential for the continued economic development of the CNMI.[18] Presently, an estimated 85 to 90 percent of all imported products (by weight) enter the CNMI by means of water transport. The planned improvements will aid in meeting the growing freight, commercial, tourism, and recreational demands of the CNMI. Docking for ships will be safer and off-loading will be more convenient. With adequate facilities, ships will no longer have to leave the dock during bad weather (as had happened before, when vessels had to depart prior to off-loading cargo), and numerous vessels can be accommodated at the same time.

Attention will also be paid to the Tinian and Rota harbors. As with the Saipan harbor, improvements and expansion are essential in light of the planned development of both islands. On Tinian, the breakwater has been in dire need of repair since it collapsed in 1991 and now endangers port users at times of severe weather. The need for improvements is even more urgent for the Rota harbor. The present condition of the port facilities is inadequate, and the channel opens directly to the sea, rendering the port useless during severe weather. The inadequacy of the port facilities on these islands (especially Rota) contributes in part to the high cost of living, as these conditions make the delivery of supplies difficult.

The Oil Spill Pollution Act of 1990

As on Guam, regulations that are to be promulgated as a result of the Oil Spill Pollution Act (OPA) of 1990 have a potential to significantly affect the CNMI petroleum sector. This law focused heavily on defining the financial responsibilities of the owners/operators of oil tanks and shore facilities (tanks and tank farms) and places the burden of establishing and maintaining adequate containment and cleanup capability on these owners/operators. It also requires that these owners/operators obtain certification of financial responsibility to prove that they could cover potential liabilities from the cleanup of a spill and from the losses resulting from a spill, including environmental damage and loss of income (both in cash and subsistence) for those who depend on the resources damaged by the spill.

As mentioned in the similar discussion regarding Guam's situation, on the mainland United States oil companies have responded to this law by forming a group called the Marine Spill Response Corporation (MSRC). The charter of the MSRC had excluded all the U.S. Pacific islands but Hawaii which meant that the CNMI might not have received the benefits of this corporation. However, the MRSC is now providing backup for the U.S. Pacific islands including the CNMI. In addition, the Clean Island Council, which is based in Hawaii, will provide support during an oil spill.

In addition to the above, other oil spill response options are available. First, the CNMI and the two oil suppliers could request assistance from the Apra Harbor Oil Spill Cleanup Cooperative.

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[18]Commonwealth Ports Authority 1992 Annual Report, pp. 6-7.

Second, the Marine Safety Office on Guam (MSO), the MSO in Honolulu, and the Pacific Area Strike Team could provide support for a major spill. Finally, it should be noted that the U.S. Coast Guard believes that there are adequate oil spill response equipment on Saipan for small to medium sized spills. Thus, only in the event of a major spill would external resources be required and it would seem that they could be quickly mobilized.

Electricity

The Commonwealth Utilities Corporation (CUC) was established by the CNMI legislature in 1985, partly as the result of negotiations between the United States government and the CNMI government. In 1985, the U.S. government allowed the CNMI government to leverage the Covenant funding through a bond issue and the Grant Pledge Agreement in return for the CNMI government establishing the CUC and placing its power, water, and sewer systems on a full cost recovery basis. The CUC did not actually begin to operate under this new legislation until 1987.

The enabling legislation of 1985 provided that "the Corporation will be financially independent of all appropriations by the Commonwealth legislature by the end of three complete fiscal years from the effective date of this act." Furthermore, this legislation required that within three years the fees collected for a particular utility service needed to be sufficient to cover the cost of operation and delivery of that particular service, including the cost of any associated debt service, or replacement of cost of obsolete or damaged equipment.

Unfortunately, the practical, financial, and political difficulties involved in reaching the objective of full cost recovery for power, water, and sewer services were greatly underestimated by both the CNMI government and the U.S. Department of the Interior. In 1985, adequate financial data were not available to make sound financial decisions regarding utility rates necessary for full cost recovery. In addition, the legislature, without any real understanding of the financial condition of the CUC, eliminated appropriations, but simultaneously put pressure on the CUC to maintain lower utility rates.

Since it began operations, the CUC has not had the detailed budgets for the three utility services necessary to make proper decisions regarding rate increases or subsidies. Even as recently as December 1992, complete financial data on the proper operation and maintenance of the utility systems were still not available to the CNMI decision makers. The accounting software used by the CUC has not operated properly, making it necessary to prepare and maintain manual records, and the auditor has been unable to provide an unqualified audit report for the two years prior to 1992.[19] The three utility system accounts are not kept completely separate, and power revenues are used to support the underfunded water and sewer systems. The key position of comptroller has been vacant for almost two years because of salary limitations imposed by the Commonwealth's personnel system.

The CUC's financial situation requires immediate attention due to serious problems with its budgets and records as well as its cash flow. This was exemplified by the recent difficulties that the CUC encountered in paying its fuel bill. The CUC reportedly avoided a fiscal disaster when its customers came to its aid with prepayments to cover a $4.8 million debt with the CUC's fuel supplier.

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[19]Third Year Review—Operations and Maintenance Improvement Program: OMIP Team's Field Report, Prepared by Louis Berger International, Inc. for the U.S. Department of the Interior and the U.S. Army Corps of Engineers, December 1992, p. 4.

CUC encountered in paying its fuel bill. The CUC reportedly avoided a fiscal disaster when its customers came to its aid with prepayments to cover a $4.8 million debt with the CUC's fuel supplier. Late last year, this supplier declared the CUC in default of its fuel supply contract and announced that the company planned to terminate the agreement unless the bill was paid. It was estimated that an emergency fuel agreement to cover the remaining portion of the existing contract would have cost the CUC 50 percent more for its fuel.[20] This debt crisis arose largely due to the CUC's lenient treatment of its own customers, particularly the low-income customers, who now owe over $2 million. To resolve this crisis, private businesses on Saipan made $1.3 million in prepayments, the CUC generated $1.85 million through a collection drive, and the remainder came from an emergency fund allocation.[21]

The law creating the CUC is seriously deficient because it does not allow the CUC to operate independently and effectively as a business. The law does not allow the CUC to hire, promote and remove employees, or to establish salaries in a manner other than that prescribed by the CNMI's civil service rules. The CUC board of directors also cannot independently appoint its own legal counsel, nor is it responsible for the appointment of its own auditor.

Despite the reports of serious management and financial problems, as well as legislation which has handicapped the best efforts of the senior staff, the CUC has been providing its customers with increasingly reliable electric power. When the CUC became an autonomous agency in 1987, it inherited a dilapidated utility system, including an electric grid on which only 46 percent of the customers were metered. The other power users were charged a flat rate, usually much less than the value of the electricity that they were using. Now, the CUC's metering program is almost completed, as less than 3 percent of the power customers are still billed under the flat rate scheme, and those who are receiving these flat rate bills are paying a rate based on an actual record of the customer's power usage measured with portable service verification equipment. In prior years, frequent electrical outages were experienced due to overloaded circuits, corroded connections, trees falling on the lines, and automobiles striking the poles. Now the outages are relatively infrequent and are caused primarily by automobile accidents.

There is little documentation of the electrical power growth in the CNMI. It is known that huge generators powered the pre-war Japanese sugarcane factories and that the first post-war power plant was built on Navy Hill and later destroyed by fire. The first major power plant of the present generating system was built in 1979 at the Lower Base with three generators, each having a capacity of 7.2 megawatts. A fourth generator was added in 1985. However, only 21 megawatts of the installed 28.2 megawatts could be relied upon for power, since the standard operation and maintenance practices usually had one engine out of service for overhaul or repair. Even if this fourth generator had been available, power demand soon surpassed the supply. By 1987, the CUC declared a moratorium on power hookups. In May 1990, Power Plant II, consisting of two 13 megawatt generators was commissioned at Lower Base. Two more 13 megawatt Mitsubishi engines went on line to service the CUC grid in February 1992.

Power generation has been greatly improved by the installation of these new Mitsubishi engines, together with the rehabilitation of long unused units at both the Lower Base satellite plant and the standby plant in the Puerto Rico area. The net result is that when all the units are in service, the

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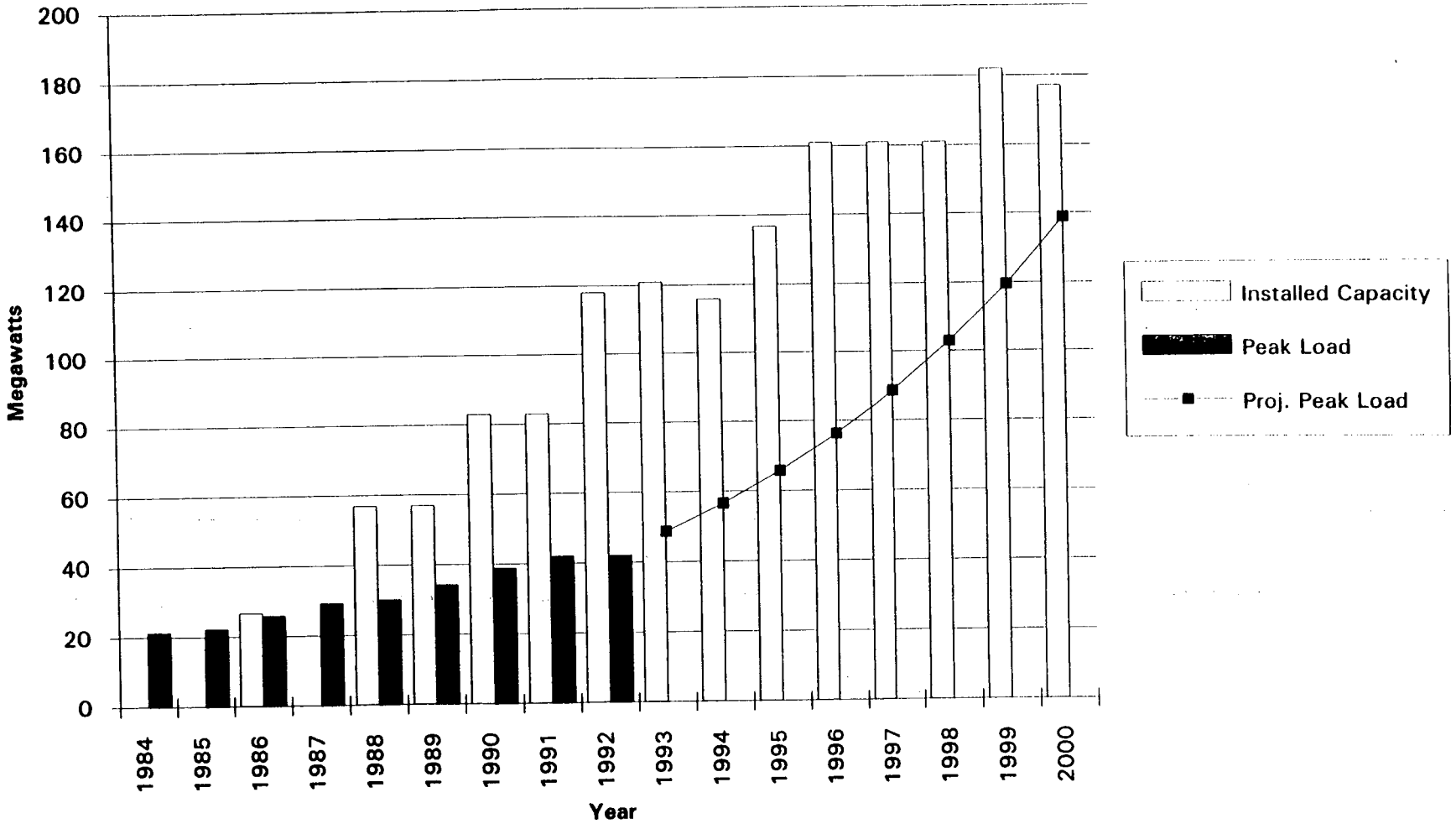
[20] *Guam Bu$iness News*, May 1993, p. 33.

[21] *Pacific Power*, Volume 1, Number 2, January-March 1993, p. 12.

Figure 6.16 CNMI's Projected Peak Power Demand



At the present time, the CUC has a backlog of applications for service amounting to approximately 32 megawatts of new demand.[22] The annual increase in the demand for power has been growing at more than 17 percent over the last two years. Plans are under way to add an additional 26 megawatts of generation capacity, but forecasts of the surging demand indicate that perhaps even more megawatts of generation capacity will be required prior to the end of the decade.

In addition to a huge increase in demand, the CUC has to cope with a large amount of distribution system losses. In fiscal year 1992, the CUC sold only 210.2 thousand megawatt hours of the 276.9 thousand megawatt hours it generated on Saipan, which indicates losses of 24 percent and tends to elevate the Saipan fuel utilization rate of 0.084 gallons/kwh sold.

Statistics available from the CUC's annual report (see Table 6.6) indicate that fuel cost account for 64 percent of the CUC's power divisions operating expenses in 1990. However, new lines that have been constructed and others that have been recently modified or upgraded are now showing losses in the order of 15 to 18 percent.

Table 6.4 Selected CNMI Power Sector Indicators, 1992

				Fuel Consumption (barrels)	
Island	**Peak Load**	**Installed Capacity**	**Fuel Efficiency (kwh-sold/gal)**	**Residual Fuel Oil #6**	**Diesel Fuel Oil #2**
Saipan	42.0 MW	110.04 MW	11.85	263,265	159,212
Tinian	1.8 MW	5.00 MW	10.88	0	19,638
Rota	2.7 MW	5.00 MW	11.89	0	22,717
Total CNMI		120.04 MW	11.81	263,265	201,567

[22]Third Year Review—Operations and Maintenance Improvement Program: OMIP Team's Field Report, Prepared by Louis Berger International, Inc. for the U.S. Department of the Interior and the U.S. Army Corps of Engineers, December, 1992, p. 54.

Table 6.5 CNMI Electricity Consumption, 1992 (MWh)

Island	Total Consumption	Sector			
		Govt.	Resident	Comm. (all loads)	Comm. (hotels only)
Saipan	210,200	28,579	64,839	116,781	28,387
% of island total		14%	31%	56%	14%
Tinian	8,977	1,632	3,285	4,060	117
% of island total		18%	37%	45%	1%
Rota	11,349	1,988	4,925	4,436	1,209
% of island total		18%	43%	39%	11%
Total CNMI	230,526	32,200	73,049	125,277	29,712
% of CNMI total	100%	14%	32%	52%	13%

Source: CUC correspondence of March 30 and May 3, 1993.

Table 6.6 CUC Financial Highlights, 1990

1990 CUC Finances		
	Power Division	Total CUC
Operating Revenue	$24,322,712	$25,515,626
Operating Expenses	$20,765,700	$25,632,337
of which, Fuel Costs	$13,387,310	
Other Expenses	$ 7,378,390	$ 1,947,472
Operating Income (Loss)	$ 3,556,472	($116,711)
1990 CUC Assets & Debt		
Electric Plant	$45,535,116	
Other Utility Plant Assets	$23,694,371	
Other Assets	$10,247,905	
Total Assets	$79,477,392	
CUC debt 9/30/90	$50,806,789	

Over half (54 percent) of the CUC electricity is sold to the commercial sector, while residential customers purchase 32 percent, and the government buys the remaining 14 percent. Hotels consume a significant portion of the CUC-generated electricity, accounting for 24 percent of the commercial sector sales, or 13 percent of the entire amount of CUC electricity sold. However, the amount of power sold to the hotels by the CUC (29,711 megawatt hours) does not reflect the entire hotel electrical usage, as it is estimated that only 20 percent of the CNMI's hotels are CUC electrical customers and almost all hotels have their own generation equipment.

As for the islands of Rota and Tinian, the CUC reports that both have over 5 megawatts of installed generation capacity. The peak load recorded on Rota was 2.67 megawatts, and on Tinian, it was 1.8 megawatts. The combined electricity sales of these two islands account for less than 9 percent of the total annual CUC power sales.

Unique Vulnerability to Oil Supply Disruptions

Five characteristics of the CNMI and its energy sector demonstrate its unique vulnerability (compared to rest of the United States) to oil supply disruptions. The first is the CNMI's total dependence on imported petroleum and the fact that it does not have a realistic economic alternative to petroleum. Second, Singapore, rather than any other part of the United States, supplies the CNMI, and it is vulnerable to any sanctions imposed against the United States and must adhere to all directives from the USDOE. Third, there are no useful indicators to assess the economic effects of an oil supply disruption or an oil price increase because the CNMI's economy has been transformed from that of small underdeveloped islands in the 1970s to a standard of living similar to the rest of the United States in the course of 10 to 15 years. Lack of a means to measure these effects is a major vulnerability because there is no guide for the future. Fourth, the CNMI is highly vulnerable to tropical typhoons, which are the most frequent and obvious threats to the oil supply. Fifth, a severe supply and price disruption would devastate the CNMI economy, which is based on imported goods and tourism.

Oil crises in 1973, 1979 to 1980, and in 1990 did not result in any supply disruptions for the CNMI. The CNMI complied with all USDOE directives on supply allocations during the 1973 and 1978 to 1981 crises. The oil companies which supply the CNMI believe that they will be able to meet the basic demand for petroleum products during crisis periods.

Because of the very different level of economic activity in 1993 compared to during the 1973/74 and 1978/79 price increases, it is impossible to utilize the economic effects of these crises as a guide for what could happen if another price increase were to occur today. In other words, the economy has grown so rapidly that it is next to impossible to assess the economic effects of moderate price increases or moderate supply disruptions.

However, in order to provide a reasonable basis for assessment, the effects of the 1973/74 and 1979/80 oil crises on Fiji, Tonga and Vanuatu were analyzed based on a study of these economies which utilized a social accounting matrix (SAM) model. While the independent island nations have economies which are not as monetized as the U.S. Pacific islands, there are a number of similarities including the openness of the economies, concentration of economic activity in but a few sectors (Fiji and Vanuatu have comparatively large tourism sectors), dependence on oil imports for commercial energy, relatively large public sectors, dependence on imported manufactures, machinery, medicine and food. All of the Pacific islands and those of independent island nations (e.g., per capita income is

much higher in the U.S. Pacific islands), the results of the 1973/74 and 1979/80 analyses provide order of magnitude indications as to how the U.S. Pacific islands could be impacted by oil price shocks. The order of magnitude indications were corroborated by the data which were available as well as by comments by government and private sector officials including on-island banks. Thus, estimates on the economic impacts of oil price shocks have been made using the best available information.

Vulnerability to Natural Disasters

Historically, the CNMI experiences 28.4 typhoon alerts per year and experiences four actual typhoons per year. Vulnerability to typhoons requires a different set of planning and supply considerations, including the hardening of storage and distribution facilities as well as the capacity to quickly repair damage to basic services. It also requires the holding of sufficient petroleum stocks to compensate for short-term supply interruptions.

Vulnerability to Oil Supply Disruptions

The energy supply depends on the delivery of petroleum products to Saipan from Singapore via Guam. The voyage by medium-range tanker between Singapore and Guam takes nine to ten days and skirts Indonesia and the Philippines, while the voyage between Guam and Saipan takes 12 hours following a stopover to off-load (usually one to two days). This supply route has proven reliable in the past.

Internally, the distribution of petroleum products from Saipan to the outer islands is dependent on the use of small tankers and barges. Based on some reports, it appears that there have been occasions (e.g., typhoons) when interisland deliveries had to be delayed. The frequency of typhoons requires constant vigilance because the harbors and fuel discharge points on the outer islands cannot accommodate rough weather off-loading. However, storms pass in a matter of a few days, and while devastation may remain, there have been no reports of a prolonged inability to provide fuel to the outer islands.

An example of a typhoon disruption would be when Supertyphoon Kim hit the CNMI on December 3, 1986 with sustained winds of 150 miles per hour (mph) and gusts to 190 mph. Aside from the obvious damage to houses and commercial buildings, over 200 power poles were blown down, there was damage to the power plant and several generators, and the loss of power affected the operations of water supply pumps at wells and booster stations, and sewage treatment facilities were temporarily shut down. In addition, the small oil tanker, the *M.V. Petro Services*, which was carrying 140,000 gallons of gas oil ran aground after attempting to maneuver away from other sinking craft in the Saipan port. Transfer of the gas oil was successfully completed by December 28, 1986. The power distribution system was gradually restored during the next several weeks, with essential service to the wells restored in five days. Hazard mitigation and response measures in the CNMI have improved since Supertyphoon Kim through the combined efforts of the CNMI government and FEMA. Response times and the restoration of essential services are now completed in much less time than was previously required.

The main discharge point for fuels at the port on Saipan is undergoing extensive upgrading. The upgrading will ensure more secure off-loading, including the development of a fuel dock equipped with pipelines to the storage facility versus the current combination of floating hoses and Mediterranean mooring. This should reduce the threat of oil spills. However, it should also be noted

that some of the harbor area on Saipan reportedly contains mines and other ordnance from World War II, much of which have not been located. Thus, any ships which run aground in certain areas could come in contact with explosives.

Response to major oil spills would rely on equipment and support furnished by the Marine Safety Office (MSO) on Guam, the MSO Honolulu, and the Pacific Area Strike Team. The oil companies on Guam have established a Harbor Spill Co-op which would presumably make available its resources. However, even with the oil spill response mechanisms, if there is a major fuel oil spill in the port on Saipan, the result would probably be substantial environmental contamination. For small to medium-sized oil spills, the Coast Guard believes that sufficient resources are available on Saipan.

However, even with an upgraded fuel discharge arrangement, supply and off-loading will continue to be vulnerable to short-term interruptions by typhoons. This potential threat requires that a "safe" level of petroleum stocks be maintained. Typically, stocks are held well in excess of the "safe" level, and generally a minimum of 15 days of supply is maintained. At present, there are no minimum requirements on the level of stocks nor are data collected on stockholdings by the CNMI government. It would be useful to develop an explicit understanding with the oil companies on the level of stocks which needs to be maintained as well as a data collection system to ensure that "safe" stocks are always present.

Economic Effects of Energy Supply Disruptions

As noted above and in previous chapters, it is very difficult to assess the economic effects of oil supply disruptions on the small and very open CNMI economy because of a lack of historical and applicable data. Certain estimates from other locations can be utilized, however, in an effort to indicate several likely economic effects.

Similar to Guam's situation, a moderate (less than 2 MMBD) supply disruption centered on Latin American, African or Middle Eastern producers would result in minimal effects. There would be no reason to anticipate that the supply would be sufficiently restricted to result in major fuel price increases (e.g., doubling). It is most likely that the CNMI would instead experience very modest inflation based on price rises for imports in their country of origin. Similarly, direct effects on tourist arrivals and garment exports probably would also be fairly minimal because the main markets (e.g., Japan for tourist arrivals and the United States for exports) would not be greatly affected.

In the event of a major supply disruption centered on Asian oil producers, the economic effects could be devastating. First, oil price rises would be severe to reflect shortages on the Singapore market. Using the oil crisis of 1979 as a guide, the short-term consequences of the oil price rise led to inflation rates of 7.5 percent in Japan and 11 percent in Australia, while inflation rose to 15 percent in Fiji and nearly 30 percent in Tonga and Vanuatu. Thus the 1979 data indicate that a doubling in the CNMI's inflation rate could be anticipated. Moreover, as Figure 5.5 (Guam vs. U.S. Inflation Rates) shows, inflation rates in the islands remained high for approximately two years, or twice as long as the U.S. inflation rate. The effeet of an oil price doubling on the CUC's operation would also be severe. In 1990, fuel cost accounted for 64 percent of the power division operating expenses. Thus, oil price doubling would require tariff increases or subsidies to pay for a 64 percent increase in operating expenses.

Although the direct effects of a major supply disruption may not seem initially severe, it is the secondary impacts that would be painfully obvious. Guam and the CNMI experienced a downturn in tourism immediately following the outbreak of the Gulf War in 1991 because tourists were afraid to fly to U.S. territory. The Iraqi president had threatened to attack U.S. interests and there were several reports of terrorist activity by Iraqis in Asia which increased concern. By late 1991, tourism began to pick up again and early 1992 tourist arrivals were at record levels.

A major oil supply disruption caused by political upheaval in Asia would result in greatly reduced levels of tourism because people would be afraid to travel in Asia and the Pacific. An impact similar to that caused by Typhoon Omar would clearly lead to major dislocations in the CNMI economy. Thus, it is not only the oil supply disruption which affects the CNMI economy but also the underlying cause of the supply disruption.

A larger albeit secondary effect of a major oil supply disruption is that it would most likely lead to economic downturns in the region's economies. The 1973/74 oil price rise led to a global recession which greatly reduced the levels of visitor arrivals in Fiji and other tourist destinations in the Pacific islands. In other words, a severe oil supply disruption creates secondary effects which are not felt for several months yet may continue for several years.

Table 6.7 provides estimates of the economic effects of an oil price shock on the CNMI. The first row shows projections of the rates of price increases for petroleum under low price, base price and high price scenarios. The most recent value figure for imported petroleum products is also in this row. The value of the oil imported into CNMI in the years 1995 and 2000 is estimated by assuming that the 1990 demand escalates by either a low, medium or high growth rate per year and then multiplying this demand by the projected price of oil in the respective year. The projected price is obtained by using the three price scenarios. The table shows that the value of petroleum imports for the CNMI will double by the year 2000.

In 1990 the GDP was estimated to be $1,175 million. Economic expansion at 10 percent per annum would theoretically raise this value to $1,892 million in 1995 and $3,048 million. in the year 2000.[23] As described in Chapter 3, oil shocks have been thought to cause a GDP to decline by anywhere from 2.5 to 4.7 percent. Table 6.7 shows the resulting GDP based on these approximations. In order to assess the likely effects on employment, the estimated economic growth rate of 10 percent has been applied to private sector employment and extrapolated to the years 1995 and 2000. Public sector employment has been held constant in these calculations. The employment on the island after an oil shock that results in a loss of 5 percent or 10 percent of the private sector jobs is also shown for the years 1995 and 2000. One of the key effects of an economic slowdown resulting from an oil price shock is the loss of local government revenues. It has already been pointed out that Fiji experienced a 4.8 percent loss of tax revenue during an oil price shock. In order to estimate the magnitude of this loss, 1992 government budget data was used and the effects of 4.8 percent decline on the deficit was computed. For 1995 and 2000, the local government revenue was calculated assuming a annual growth rate of 10 percent per annum. This also assumes that direct taxes will increase in proportion to economic growth.

[23] 1990 GDP has been used instead of 1991 because several exceptionally large land sales occurred during 1991 which greatly skewed GDP data.

Table 6.7 Economic Impacts of an Oil Price Shock - CNMI

		$ Millions					
		Base Year	1995			2000	
Value of Petroleum Imports		(1991) $45.9	Demand Growth Scenarios-1995			Demand Growth Scenarios-2000	
			Low	Medium	High	Low	Medium	High
Oil Price Increases			7.0%	12.5%	18.0%	7.0%	12.5%	18.0%
2.0% per year			$73	$85	$98	$113	$169	$248
3.9% per year			$79	$92	$106	$134	$200	$293
6.6% per year			$87	$101	$117	$169	$252	$369
		(1990)					
GIP-base	($ millions)	1,175		1,892			3,048	
decline of 2.5%	($ millions)	1,146		1,845			2,972	
decline of 3.0%	($ millions)	1,140		1,835			2,957	
decline of 4.7%	($ millions)	1,120		1,803			2,905	
		(1990)					
Employment		25,965		39,016			60,036	
decline of 5%		24,896		37,295			57,264	
decline of 10%		23,827		35,574			54,491	
Local Government Revenues	($ millions)	(1992) $134.6		$179.1			$288.5	
4.8% Loss of Direct Taxes	($ millions)	$6.5		$8.6			$13.8	
Resulting Budget Surplus (Deficit)	($ millions)	($3.5)						

Notes:

1. Value of petroleum imports calculated by multiplying estimated average annual demand growth by estimated petroleum price increases.
2. Estimates for gross island product, employment and government revenues, utilize average annual increases of 10.0 percent.

A key question regarding the economic effects of an oil supply disruption is whether the CNMI experiences more severe dislocations than the rest of the United States. Even though the United States would experience inflation and possibly recession, the CNMI's small open economy would be totally exposed to global market forces: nearly all food and all medicine are imported, and the economy is nearly totally dependent on off-island trade and international tourism. In other words, there would be no territory of the United States more severely affected by a major Asian oil supply disruption than the CNMI. (Note: this analysis also applies to Guam and Palau).

Options for Accessing Oil Supplies in Emergencies

An analysis of the global oil industry and specifically current and projected oil flows in the Asia-Pacific region provides several scenarios which would prove very difficult for the U.S. Pacific islands including the CNMI. These scenarios are: 1) major political turmoil in the Middle East and in Asia, resulting in a net loss of at least 4.5 MMBD for a six month period; and 2) global catastrophe, e.g., a major war, or regionalized/localized conflicts which effectively result in the closure of major oil-producing regions such as the Persian Gulf. In both cases, Singapore refiners would have their supplies reduced by at least 25 percent, with the actual reduction probably reaching as high as 50 percent. The result would be a loss of petroleum supplies from Singapore to the Pacific islands of at least 25 percent and possibly even exceeding 50 percent. The short-term effects would be considerable because of a doubling or tripling of prices on the now oil-short Singapore market. In addition, if there is political turmoil in Asia, then the tourism industry would be greatly impacted both by higher fuel prices and the reluctance of people to travel.

Other oil disruption scenarios, including a moderate loss of production in certain West African and Latin American regions, would have limited impact on supply in the Pacific Islands. Prices would increase but the effects would probably be only temporary because of the expectation that the market would be able to adjust (e.g., oil prices first skyrocketed and then returned to near-normal levels following the Iraqi invasion of Kuwait).

Local oil supply disruptions could be caused by typhoon damage to docking and storage facilities on Saipan. However, facilities have survived severe storms relatively unscathed. Thus, unless a typhoon much stronger than any storm over the last five decades directly hits the CNMI oil facilities, it is doubtful that a local event would cause a major disruption.

Given these impacts of possible disruption scenarios, there are several options to increase energy security in the CNMI. These include developing a strategic petroleum reserve (SPR) for the CNMI along with various other islands, increasing the volume of on-island stocks, access to the U.S. SPR, developing alternative supply arrangements, and reducing demand. These are discussed below. In addition, the relationship between the oil companies and the CNMI government and their capability and willingness to work together under crisis conditions are also addressed.

However, it must be stressed that the U.S. Pacific islands have not had an interruption in the supply of petroleum products since the end of World War II. Prices for petroleum products in the islands have jumped sharply during oil crises (e.g., 1973/74 and 1979/80), but the supply of petroleum has been continuous.

Increasing Commercial Stocks

Another option to improve energy security is to increase on-island inventories. The other Pacific islands use a minimum inventory measure of six weeks or 40 days; however, a larger inventory could be maintained in order to provide a margin of safety against a major supply disruption. Price increases for the additional inventory would probably approximate a $2 per barrel per year maintenance charge plus the cost of the petroleum products. Spread over the volume of total imports, this would not add substantially to the cost of petroleum products because stocks already average 31 days in the CNMI. The CNMI would have to add only nine or 10 days worth of inventory, or roughly 30 MB, spread over the entire year's demand of 1,140 MB. This would add only 2 cents per gallon to the price of all fuel consumed in the CNMI.

Building Regional Petroleum Reserves (RPR)

A strategic petroleum reserve servicing Guam, the CNMI, and Palau has been analyzed. A ninety days supply for these three island entities would be approximately 2 million barrels and would cost about $120 million to build and stock and an additional $4 million per year to maintain. However, there are already 129 days of storage capacity available on Guam and a further 165 days of "mothballed" (out of service) storage capacity. Given the existing storage capacities and the cost of SPR establishment running at $60 per barrel (excluding land prices), it appears difficult to justify an SPR facility for the CNMI on Guam. A facility serving only the CNMI would be prohibitively expensive given the need to acquire land plus build and stock the storage reserve.

Alternative Supply Options

As mentioned in the discussion on Guam, Papua New Guinea (PNG) is currently producing 135 MBD of crude which is being refined in Australia. It might be possible to initiate discussions on some type of guaranteed supply arrangement between PNG and all of the Pacific islands. The supply agreement would have to stipulate that in the event of an oil crisis (and, crises would have to be well-defined), PNG would guarantee access to supply which could presumably continue to be refined in Australia. It should also be noted that the PNG crude is of very high quality and would be a very good match to the configuration of the now-closed GORCO refinery on Guam.

Access to Military Stocks

There are no military fuel storage installations located in the CNMI. The closest installations are in Guam. During periods of major political upheaval in Asia and the Middle East, it is doubtful that the military's fuel supplies could be transferred to civilian populations except in cases when the health and safety of civilians were at risk.

Guaranteed Access to the U.S. SPR

In May 1992, a bill was introduced to the U.S. Congress which guarantees access to the U.S. SPR for a percentage of oil demand requirements of the U.S. Pacific islands including the CNMI. However, transport would not be guaranteed.

In this proposal, the price paid for the petroleum would be an average of the bids submitted by the oil companies trying to acquire supply, meaning that the price would be the market rate. The net effect would be that the islands would be paying at the same rate and would be guaranteed supply.

Also in the proposal, the U.S. Pacific islands would have priority status at SPR docking facilities, although the islands would be responsible for processing and chartering tankers. Oil companies could be contracted to process products and provide ships.

This option means no additional establishment or maintenance costs would be required. Although future prices for SPR petroleum during crisis situations could be substantial, this option ensures some degree of access to the U.S. Pacific islands. In order for this option to be implemented, the CNMI will have to coordinate its efforts with the other U.S. Pacific islands and develop strategies to access tankers during crisis periods.

Energy Emergency Planning

There are no energy emergency plans currently operational in the CNMI. The CUC and other government departments have implemented natural disaster response plans. An energy emergency plan would assist CNMI decision-makers in allocating fuel supplies during an energy emergency.

Demand Management

A demand management plan is a tool that can effectively stretch out scarce supplies, thereby reducing the negative impacts of a supply disruption. Demand management can be a valuable component of a response strategy and in the event of an oil crisis, energy conservation and rationing programs, such as odd-even days for driving, would presumably go into effect. However, the data which are required to develop and implement a comprehensive program are lacking in all of the U.S. Pacific islands, including the CNMI.

Long-Term Energy Vulnerability Response Options

Alterative Energy Resources and Options

The small islands of the Northern Marianas have limited indigenous energy resources: there is no hydroelectric potential and geothermal resources are unknown but probably not substantial. However, there are some options which, while not able to provide baseload capacity in the near term, could reduce the demand for baseload capacity. If OTEC becomes an economically feasible option, then the CNMI will be able to utilize this option because it has some of the world's best sites for OTEC. Coal could also become a viable future option. Over the foreseeable future, the CNMI will continue to be dependent on imported petroleum products.

Solar

The CNMI has an excellent solar resource, with insolation measured at an average of 5.2 kwh/m^2 per day. Photovoltaic cells could be cost-competitive options for household lighting and telecommunications on the outer islands. However, the major potential use of this resource is for water heating. The numerous hotels and even the garment industry could greatly expand their use of this resource.

Biomass

Previous studies have suggested that the tangantangan (*Leucaena leucocephala*) vegetation resource could be used for energy production. However, given the small land area and the potential problems accessing land because of the traditional land ownership system, it would seem unlikely that this is a realistic option.

The municipal solid waste (MSW) resource on Saipan is relatively small, approximating only 50 tons per day. Even if complemented by tangantangan, an MSW resource of this size could only power a very small facility. However, a facility may be built in the future because of the need to reduce landfill.

Wind

The wind resource is largely unknown, with measurements available only from the Saipan International Airport (2.5 to 5.7 meters/second). Widespread use of the wind resource is unlikely, given the high frequency of typhoons.

OTEC

When OTEC becomes a competitive technology, the CNMI will be able to utilize its excellent ocean thermal resources for baseload power. Until OTEC establishes commercial viability, this resource will not be utilized.

Coal

A 1983 study assessed the potential for the CNMI and specifically Tinian to serve as a transshipment center for coal between Australia and Japan.[24] The study's findings indicate viability if Japan's coal trade continued to be based on medium-sized (60,000 deadweight tons) colliers. However, Japanese coal ports now typically handle colliers in the 100,000 to 120,000 deadweight ton size and the economics for the transshipment center have been lost.

However, the economical size of fluidized bed coal fired power generation facilities now approximates 25 megawatts. If Guam were to pursue the coal option, then the CNMI could also consider coal because a 25 to 50 megawatt plant would be within its parameters. On its own, the CNMI could not economically develop coal handling and storage facilities.

OTHER MEASURES FOR IMPROVING ENERGY SECURITY

In addition to options for accessing oil supplies during energy emergencies and long-term response options, consideration should also be given to improving overall management of the energy sector. Specifically, data collection on energy supplies and end uses, formalizing and expanding the dialog with oil companies, and integrated resource planning are activities which could provide substantial short- and long-term benefits at very little cost. These are discussed below.

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[24] *Pacific Coal Trade: Economic Opportunities for CNMI, Coal Movement in the Pacific Basin Study*, Pacific Basin Development Council, June 1983.

Data Collection

As shown in Table 6.7, the money that the CNMI will spend on oil will increase by at least three and a half times by the end of the decade. This alone warrants a systematic evaluation of whether or not this money is being spent wisely. The CUC is also planning to expand its generation capacity by some 50 percent to approximately 180 megawatts by the year 2000. Considering both of these factors, it is clear that the energy sector will account for substantial expenditure in the CNMI economy. Therefore an urgent need exists to systematically collect volume, value, cost build-up (e.g., f.o.b., c.i.f. and shipping charges), and inventory data on imported petroleum products. The CUC needs to provide data that can be integrated with the petroleum data in order to establish a regular assessment of the role of energy in the local economy. An assessment such as this ought to include the evaluation of the needs and costs of any economic development strategies.

Oil Company Relations with Government

Even if a local or regional SPR is established or if demand management plays the lead role in the next oil crisis, the major oil companies will still manage the bulk of the supply and distribution networks necessary to maintain the CNMI's access to oil. The relationships between the oil companies and the CNMI are generally very good. However, some of the oil companies do not regularly provide the CNMI government with all product supply and cost information. This is interesting because similar information is routinely provided to South Pacific governments and is essential to planning for and managing an energy emergency. If unwilling to voluntarily provide information, the oil companies should be directed to furnish volume, value and storage data. In addition, it is suggested that consideration be given to establishing a minimum inventory level. However, both of these issues will require cooperation between the oil companies and the CNMI government.

Having noted that the oil companies should provide more information and other services, it needs to be also stated that one of the least-cost yet most effective measures to ensure petroleum supply is to establish an attractive operational and investment environment for major oil companies in the CNMI. This does not imply surrendering control but it does involve constant interaction and monitoring. Although relations are generally good between the oil companies and the CNMI government, it is important that the quality of the interaction be improved.

Integrated Resource Planning

Attention should be given to integrated resource planning including least-cost assessments of technologies and developing strategies to more efficiently plan and manage energy use. The employment of demand-side management techniques are but one step in a process in developing a broad-based program aimed at energy conservation, energy efficiency, and cost reduction. In such programs savings can be substantial. Traditionally, investments in the supply side have payback periods from seven years and up, while investing in energy efficiency technologies provides payback in one to four years.

It is unfortunate that only when energy use is effectively managed that renewable energy technologies can provide for baseload demands. Until then, renewables will have only limited potential to impact dependency on oil.

Although substantial sums have been allocated to the energy sector over the past years, the results have been mixed. There is a major need to develop management structures and plans for the

energy sector which reflect both the short- and long-term issues, and most importantly provide some consistency in direction for the sector. An immediate priority is the management and planning for the sector.

The energy sector in CNMI consists of three primary players: the oil companies, the CUC and the government energy office. The responsibilities for each have been specified, but there does not seem to be any overall coordination of the sector. There are no legislative mandates for the energy office in the CNMI. The time is right for the initiation of a discussion to determine whether or not an energy office should exist, how it should be funded, and what the staff levels and functions should be. The role of the CUC and the oil companies in the local energy sector would be more clearly defined by the results of this dialog.

CNMI should initiate a review of its energy sector with the USDOE invited to participate in this review. A well-managed review would provide the basis to establish the integrated resource planning process which encompasses demand-side management activities, least-cost assessments of technologies and energy sources, and energy security options. The economic and fiscal consequences of a future oil price shock may initiate such an evaluation, but it is clearly preferable to have finished such an assessment and have taken any possible preventative measures prior to the damage being done.

Summary of Energy Emergency Response Options

Table 6.8 summarizes various energy emergency response options including accessing oil supplies, long-term alternatives, and other measures which could facilitate improved management of the energy sector. As indicated in the previous sections, securing oil supplies during energy emergencies requires considerable planning and/or investment. One option would be to access the U.S. SPR, which would require no additional capital and up-front fuel costs. However, premiums would have to be paid in the event of an energy emergency for both fuel and transport, and possibly for refining. The major disadvantage to this option is that supplies may have to be sourced from the U.S. Gulf Coast via the Panama Canal. The other low-cost supply option is to access military stocks but supplies would be limited to the level required to preserve safety and sustain life, which means that the economy would remain totally exposed to a potential loss of supply. Increasing commercial stocks is a lower cost option which warrants further discussion with the oil industry. However, consideration should also be given to developing joint storage arrangements on Guam, where there is excess storage capacity.

Alternative energy sources will have limited impact on energy security during this decade. Fluidized-bed coal plants with capacities as low as 25 MW, have been determined as technologically and financially viable. However, coal may be inviable without longer economics of scale. If Guam were also to switch to coal, then transport and storage costs would be greatly reduced. Thus, some consideration may be given to evaluating this option in future years.

The other response measures including energy emergency planning, demand side management, improved data collection and analysis, expanding dialogue with the oil industry, and integrated resource planning are all focused on improving management of the energy sector in a cost-effective manner. Regardless of energy supply options (e.g., accessing the U.S. SPR, building a regional petroleum reserve), these measures could warrant implementation.

Table 6.8 Summary of Energy Emergency Response Options

	Response Action	Advantage	Disadvantage	Cost
Options for Accessing Oil in Emergencies				
Building Regional Petroleum Reserves (RPR)	develop 1 to 3 months extra storage	on-island or closer than U.S. SPR	cost	$30/barrel to build, $2/barrel per year to maintain, plus land costs and fuel costs
Increasing Commercial Stocks	develop 1 to 3 months extra storage	on-island	cost	same as RPR
Guaranteed Access to the U.S. SPR	develop refining and transport arrangements with oil companies or other island governments	least cost	distance	unknown
Access to Military Stocks	arrange level of supplies with military	limited on-island costs	supply limited to minimum to prevent loss of life	unknown
Energy Emergency Planning	develop energy emergency plans	low cost, complements any supply options	doesn't ensure emergency supplies	unknown but assume less than $50,000
Demand Management	develop demand side management program	cost-effective, valuable for energy conservation even without energy emergency	doesn't ensure energy supplies	assume $200-300,000
Long-term Responses: Baseload Power from Alternative Fuels				
OTEC	build baseload OTEC plant	local renewable energy source	very high cost, experimental technology	upwards to $40 million per installed MW
Biomass/Biogas	build biomass/biogas plant	use local resource	small volume, high cost	unknown but assume costs are similar to higher than coal per installed MW
Coal	build coal-fired plant	fuel available from a number of global supplier	high cost for handling and storage	Unknown: roughly $3 million per installed MW, plus unknown costs for port handling and storage facilities

Other Measures for Improving Energy Security				
Data Collection	collect energy supply and end use statistics	low cost, useful for overall sector planning/ management	limited impact on energy emergency	unknown but assume less than $50,000 per year
Oil Company Relations	establish working group with oil companies, which focuses on long-term investments/solutions to energy supply	limited direct cost	potential tax concessions	unknown
Integrated Resource Planning	develop energy supply and demand scenarios which assess options for efficient resource allocations within energy sector	cost-effective, valuable for energy conservation even without energy emergency	requires constant monitoring and revision	unknown but assume roughly $200-300,000

Seven

PALAU

INTRODUCTION

Palau is located in the western Pacific Ocean, 750 miles north of Indonesia and 550 miles east of the Philippines. The Palau group (also referred to as Belau) lies farthest west among the Caroline Islands. Of the more than 200 islands that make up the Palau group, only eight are permanently inhabited. The land area is 190.7 square miles, with Babeldaob accounting for approximately 75 percent of the total. Babeldaob is the second largest island in Micronesia after Guam.

The Palau islands are an exposed crests of a series of long submarine ridges separating the basin of the Philippine Sea from the Pacific Ocean. Geologic diversity is evidenced by the variegated landscape: high islands of volcanic origin in the central and northern islands (i.e. Babeldaob, Arakabesang, Malakal, and Koror), high raised coral limestone islands in the south central regions (the Rock Islands), and low platform reef and atoll islands in the southwest.

The majority of the land is covered with tropical forest. A high percentage of the soils are well-suited to agriculture, and most of the islands are surrounded by mangrove forests.

The climate is hot and humid, with the annual mean temperature at about 82° Fahrenheit with little seasonal variation. Heavy rainfall occurs throughout the year, notably during December and January. Precipitation averages about 146 inches per year. Although Palau lies outside the main paths of typhoons, such storms do occasionally hit the islands. A 1990 storm severely damaged one of Palau's two main power stations.

The U.S. Bureau of the Census has reported that the 1990 population on Palau was 15,122, representing an increase of 13 percent over the 1980 census count of 13,330. Sixty-nine percent of the population resides in the capital, Koror. Palauans[1] make up 81 percent of the population. Non-U.S. citizens, primarily nationals of Asian countries (two-thirds of which are from the Philippines), comprise 15 percent of the population, and U.S. citizens (either from the mainland or other U.S. Pacific islands) make up about 3 percent of theresidents in Palau. A comparison of the 1990 ethnic breakdown with that reported in earlier censuses is difficult as changes have been made in the tabulation and reporting procedures.

Estimates[2] of the population growth in Palau indicate that by the year 2000, there will be 18,600 people living in Palau. This indicates an increase of 22 percent over the 1990 census count, reflecting an average annual growth rate of 2.1 percent.

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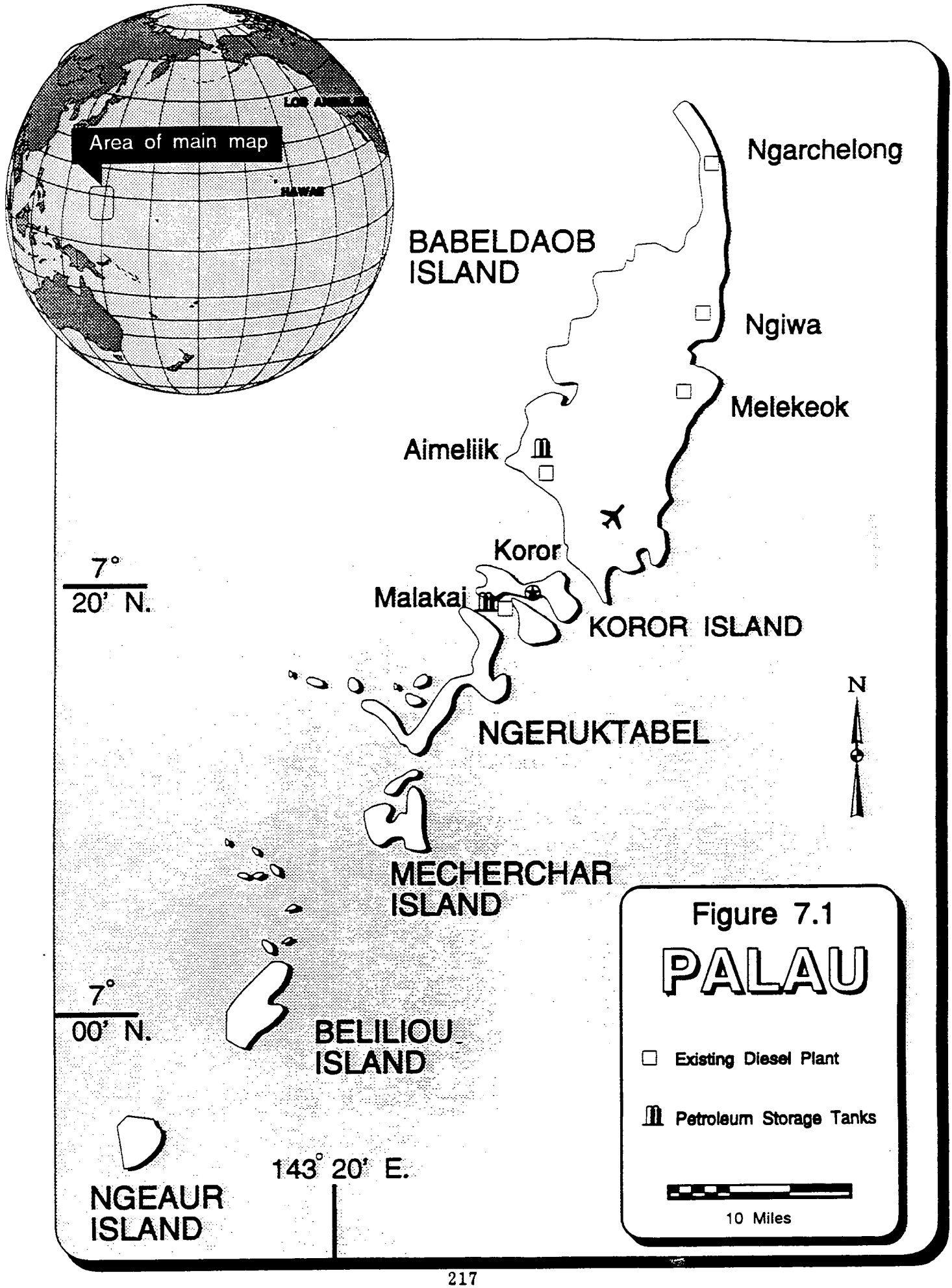
[1]Racial classifications used are taken from the U.S. Department of Commerce, Bureau of the Census, *The 1990 Census of Population and Housing for Palau.*

[2]Estimate was provided by the *Pacific Regional Energy Assessment*, jointly produced by the World Bank, Pacific Energy Development Programme, Asian Development Bank, and Forum Secretariat Energy Division, p. 46.


Area of main map
Ngarchelong
BABELDAOB ISLAND
Ngiwa
Melekeok
Aimeliik
Koror
Malakal
KOROR ISLAND
7° 20' N.
NGERUKTABEL
N
MECHERCHAR ISLAND
7° 00' N.
BELILIOU ISLAND
NGEAUR ISLAND
143° 20' E.
Figure 7.1
PALAU
Existing Diesel Plant
Petroleum Storage Tanks
10 Miles

Political Status

Following World War II, the Marshall, Caroline, and Mariana islands (excluding Guam) were placed under the international trusteeship system and the United Nations Security Council designated the United States as the administering authority. The Trusteeship Agreement of the Trust Territory of the Pacific Islands, which came into force on July 18, 1947, designated the United States as the administering authority, with responsibility to promote the economic, social and educational advancement of the inhabitants. Palau was originally one of the seven districts of the Trust Territory of the Pacific Islands, and in 1978, it opted to become a part of the newly proposed Federated States of Micronesia. Palau later ratified its own constitution, and effective in 1981, this district officially became the Republic of Palau. However, Palau is the only part of the Trust Territory of the Pacific Islands that is still administered by the United States.

A Compact of Free Association between the United States and the Republic of Palau was negotiated and signed in August 1982. Although more than half of the population of Palau favored this Compact agreement, the Compact has never been approved. Palau's constitution has a nuclear-free zone provision, which per the constitution can only be waived by a 75 percent majority vote. As the Compact would allow U.S. nuclear-powered vessels to transit Palauan waters and to make port visits, Palau's courts have repeatedly ruled that a 75 percent approval is required for the Compact to go into effect. Over the past decade, there have been seven unsuccessful votes on the Compact, with majorities in favor of the Compact ranging from 60 to 72 percent.[3]

On November 4, 1992, Palau voters passed a referendum amending the constitutional requirement for 75 percent approval to waive the nuclear-free zone provision and replaced it with a clause allowing approval by a simple majority. Another referendum on the Compact has now been scheduled for November 9, 1993. Under the Compact, Palau would enjoy a special relationship with the United States, particularly in terms of access to U.S. markets. Even though Palau would not be included in the Customs Territory of the United States, most articles exported to the United States from Palau would be exempt from customs duty. The Compact also contains provisions for substantial economic assistance, estimated at up to $30 million dollars per year. This amount does not include the value of a road system to be constructed on the sixth anniversary of the Compact or the $2 million in annual funding for educational and health services. The Compact agreement is based on the assumption that the judicious deployment of these funds will create the conditions necessary for a progressively self-reliant economy.

Economic Overview

The very small and open economy of Palau is supported primarily by United States federal funds. Income, employment, and revenues are determined to a very large extent by the size of Palau government expenditures, which in turn depend on funding from the United States. While only 38 percent of the employed work force is in the public sector, these workers earn 54 percent of Palau's wages and salaries. Palau's trade deficit is supported largely by grants from the U.S. government and also by an increasing flow of foreign investment, particularly from Japan.[4]

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[3]M. Easly, "Controversial Compact Issue on November Ballot," *Pacific Magazine*, November/December 1992, p. 8.

[4]*Palau: An Economic Overview*, Section 4.2, United Nations ESCAP Pacific Operations Center, December 1990.

However, the private sector is expanding, primarily because of growth in the tourism industry. The strength of this recent private sector growth is indicated by increased foreign direct investment, substantial construction activities, and the presence of more foreign workers. The fisheries sector has also grown, with most of the activity centered on exporting fresh tuna (for sashimi) to Japan and Guam as well as supplying the local market which has expanded because of tourism.

The precise level of development and the importance of the various economic sectors in Palau are difficult to assess because of the unavailability of current economic statistics, notably in the areas of trade and domestic production. Yet, it is clear that to accommodate and sustain any future growth, infrastructure needs to be upgraded and extended, and policies and regulations on foreign investment and nonresident workers need to be clarified. It is also apparent that U.S. federal support will continue as the economy's mainstay for the foreseeable future. Relatively higher public sector wages and salaries enable a much higher level of imports than could be otherwise sustained. However, according to a United Nations assessment, Palau's high propensity to import means that funds spent in Palau have a comparatively low impact on economic development.[5]

The ability of Palau's various sectors to reach their economic potential (in particular fisheries and tourism) depends on Palau's ability to attract and select foreign partners who can offer the benefit of investment funds, managerial capabilities, technical skills, and access to international markets. Palau's investment incentives include low business taxes, low import duties on raw material processed for re-export, no real estate tax, labor unions or U.S. quotas on manufactured goods, as well as its proximity to Asian and Japanese markets.

GDP and Income

The last formal estimate of the Palau gross domestic product (GDP) was made in 1983. In current dollar terms, GDP was $31.6 million, representing an increase of 82 percent since 1977 when the GDP was estimated at $17.4 million. This change indicated an average annual growth rate of over 10 percent in the period from 1977 to 1983. Using inflation indicators of neighboring areas (because neither producer or consumer price data are compiled in Palau), growth in the real GDP during this 1977 to 1983 period amounted to about 3.5 percent per annum.

The estimate of 1983 GDP was not derived from information on expenditures on final demand or products originating in each economic sector. Rather, a cost-factor approach was used, the components of which are shown in Table 7.1.

[5]*Palau: An Economic Overview*, Section 4.2, United Nations ESCAP Pacific Operations Center, December 1990.

Table 7.1 Estimate of 1983 Palau GDP by Cost-Factor Component and 1990 Update of this Estimated GDP

Cost-Factor Component	1983	1990
Compensation of Employees	$18.99 million	$30.3 million
Operating Surplus	$11.45 million	--
Consumption of Fixed Capital	$1.10 million	--
Indirect Taxes less Subsidies	$0.03 million	--
GDP at Market Prices	$31.58 million	≈$50 million

In this estimate of 1983 GDP, employee compensation accounted for approximately 60 percent of the total GDP of $31.6 million. An estimate of 1990 GDP was made based on the assumption that this same proportional relationship between the GDP and employee compensation still existed in 1990. As 1989 wages and salaries amounted to $28.3 million and the average annual increase in this number had been about 6 percent since 1983, a rough estimate of 1990 total wages would be $30.3 million, with the 1990 GDP estimated at $50 million.

A second method of estimating the GDP of Palau was based on the large role that the government sector plays in the economy in terms of its recurrent and capital expenditures, which are largely funded through U.S. assistance. In 1983, external assistance (including $1.3 million from Japanese foreign aid) amounted to $19.6 million. In relationship to 1983 GDP, this value represents 62 percent of the $31.6 million. In 1990, the total grants to Palau (again including $3.0 million from Japan) amounted to $31.6 million. Assuming this same proportional relationship between outside assistance and the GDP still existed in 1990, then the 1990 GDP was again roughly estimated to be $50 million. If both the 1983 and 1990 estimates are accurate, then the growth of the Palau GDP in current dollars has averaged 6.8 percent per year.

The $28.3 million in total wages and salaries paid to those in formal employment in calendar year 1989 included $15.31 million disbursed to public sector employees (including those of the Micronesian Occupational College) and $13.03 million paid to private sector employees. According to the 1990 census, the average annual income of the local government employees was $8,047, and for the private sector the average annual wage was $5,057. The 138 federal employees on Palau had an average annual income of $10,847.

Employment

Accord to the 1990 census, there were 5,599 employed persons in Palau (including alien workers). Of these workers, 2,115 (or 38 percent) worked for the local or the federal government,

while the bulk of the other 3,484 workers were in the private sector.[6] Wage and salary employment increased by 8 percent from 1988 to 1989 and appears to have increased 10 percent from 1989 to 1990 when data from the 1990 census is compared with that available from the Social Security Administration.[7] During the period from 1980 to 1989, the estimated average annual growth rate in employment was 3.5 percent. The size of the potential labor force in Palau (persons age 16 or over) in 1990 was estimated to be 10,238, which represents an increase of over 28 percent since 1980. Of the those actually in the labor force, data from the 1990 census indicate that 7.8 percent were unemployed.

Foreign workers make up a large and rapidly increasing portion (34 percent) of the Palau employed labor pool. The increase in foreign workers has been quite swift, growing from approximately 500 in 1984 to the 1,888 recorded in the 1990 census, which indicated that the majority of these workers (60 percent) are from the Philippines. In 1991, the number of alien workers more than doubled to 4,010,[8] according to the Palau Ministry of Commerce and Trade. This increase has been attributed to the large number of fishermen being employed by the two long-line fishing operations based in Palau as well as the rising number of skilled construction workers.

The most recent data available on employment by sector from the 1990 census already appear to be out of date as there are reports from the Palau Ministry of Trade and Commerce of a more recent influx of large numbers of alien workers. Given the volatility of the labor situation in Palau, the 1990 census data (Figure 7.2) can be used as a base upon which current growth may be assessed. In 1990, public sector employees, who work either for the local or federal government, made up 38 percent of the labor force. In the same year, 15 percent of the work force was employed in construction, with 8 percent in either the fishing or agriculture business. The occupations that service the tourist industry (e.g., taxi drivers, entertainers, hotel and restaurant employees) made up 12 percent of the labor force, but this does not represent all the retail and other staff associated with tourism.

Trade and Business Growth

International trade statistics are not formally compiled in Palau. Unofficial data from the customs office indicated total exports valued at about $0.6 million and total imports worth about $24.6 million in 1989. In 1990, the value of total imports was estimated to be $27.5 million. Prior to 1989, most recent data on imports and exports were for 1983 and 1984. Exports increased 20 percent from 1984 to 1989. Palau's records show the f.o.b. value of its imports (which is the value of the cargo at its point of origin) and therefore do not indicate the full cost of imported goods because freight and insurance are not included or reported separately. Both exports and imports are believed to be underreported, but it is apparent that imports greatly exceed exports.

According to these figures there was a deficit of about $24 million in the trade balance in 1989. The principal imported items that year were food and beverages (with a value of $8.5 million) and petroleum products (worth $5.9 million). Currently, the principal export is fish, the value of

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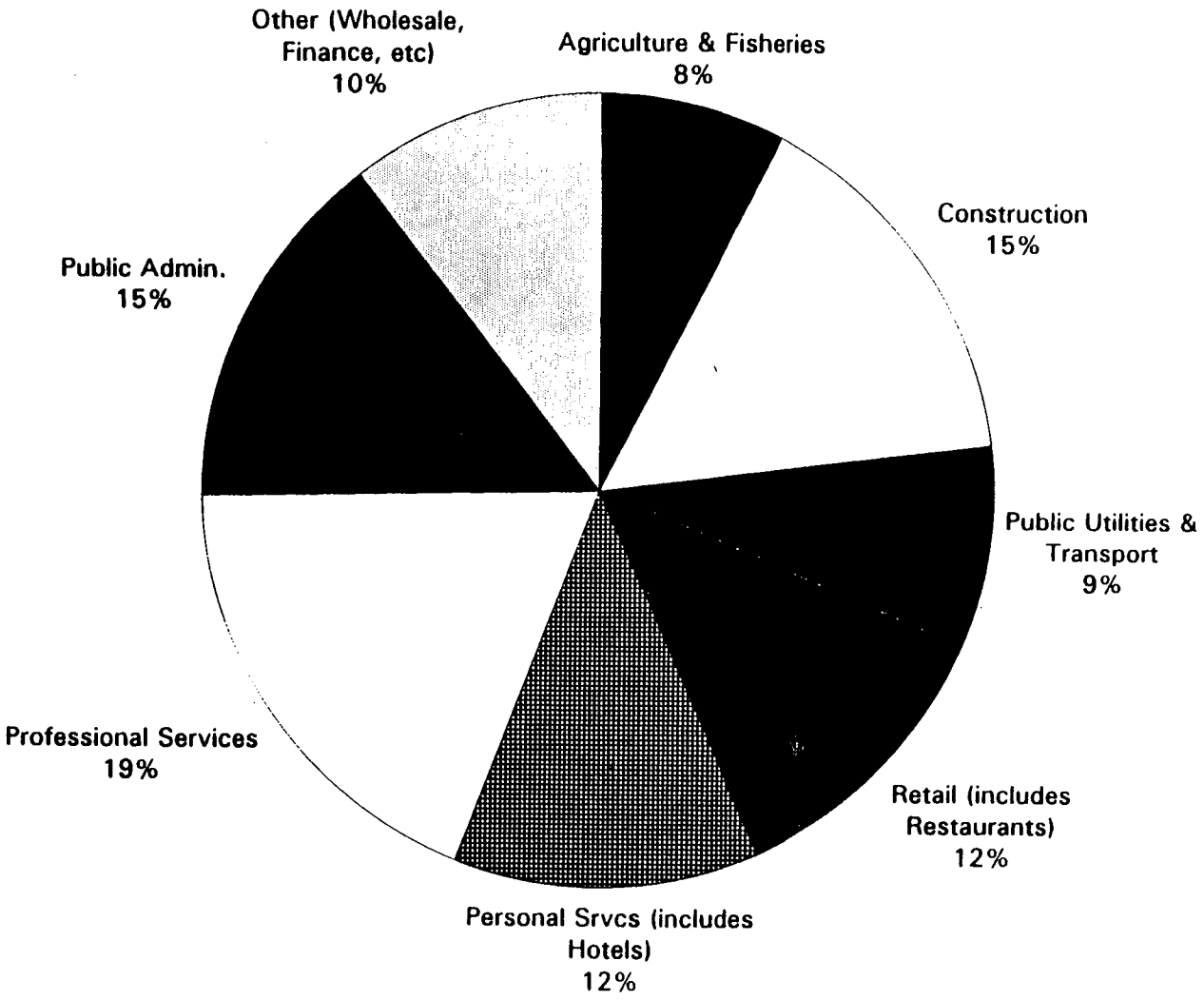
[6] *1990 Census of Population and Housing, Republic of Palau*, Table 76.

[7] Robert L. Lucas, *Performance and Growth Prospects: Republic of the Marshall Islands, Federated States of Micronesia, and the Republic of Palau*, Pacific Islands Development Program, East-West Center, 1991, p. 37.

[8] *1991 Trust Territory of the Pacific Islands*, U.S. Department of State, p. 29.

Figure 7.2 Palau Employment by Sector (1990 Census)



Although reliable data on GDP are unavailable, an indicative base line of private sector activity can be inferred from the value of collected gross revenue taxes and other data. The Business Gross Revenue Tax receipts for fiscal years 1990 and 1991 were $2.9million and $3.3 million, respectively. This tax rate is 4 percent of the total business receipts, which indicates that *reported* business revenues were in the order of $72.0 million and $81.6 million for those two years. The 1992 revenues are expected to have increased by 7 percent, suggesting that the 1992 Palau business receipts will total about $87.5 million. Salary and wage tax receipts also increased 13 percent from 1990 to the beginning of 1992 and are expected to increase another 5.6 percent in 1992.[9]

Palau's Division of Economic Development reports a steadily rising number of business licenses as well as increases in the value of issued construction permits. In 1991, there were 315 new business establishments that were issued permits.[10] Private sector activities stimulated by tourism, such as hotels, restaurants, car rentals, and boat charters, are the fastest growing businesses in recent years.

In 1990, a new foreign investment act was passed which was intended to enable the government to more easily control the type of investments made in the country and to insure greater participation of the Palau people in the economic benefits of these investments. However, an appropriate regulatory framework for this law has not been implemented yet. The law states that applicants must invest at least $500,000 or maintain a work force of at least 20 percent Palauans in order to receive a permit. Certain activities are restricted to those businesses owned by citizens or joint ventures with citizen participation. Each application is to be evaluated in terms of criteria relating to the need for the activity and the benefits that will accrue to the domestic economy, including the degree of local participation in ownership and management, and provisions for training and labor relations. Depending on how regulations define these conditions and criteria as well as specify administrative procedures, this new foreign investment act could be viewed as restrictive by some prospective investors.

Key Sectors

Tourism

Tourism is currently estimated to account for over 600 direct jobs and provide about $12.3 million in visitor expenditures. Palau has over 200 guest rooms meeting international standards of accommodation and caters mainly to the diving special interest segment of the travel market as well as to some general interest travelers, primarily from Japan. Japanese tourists accounted for about 44 percent of Palau's nearly 24,000 visitors in 1991, followed by U.S. tourists, which represented 20 percent of the market. The rest of Palau's visitors come from mainland Asia, the Philippines, Europe, and Australia.

Palau was not immune to the international factors which have dampened the tourist industry worldwide. However, Palau's reputation as being one of the best diving locations in the world has provided a strong appeal to the special interest tourists (i.e. divers). Despite the recent Gulf War and the global recession, Palau's visitor count increased 1 percent in 1991 which is quite a victory for an industry that experienced decreases in many other locations throughout the world.

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[9] *A Report on the State of the Islands*, U.S. Department of the Interior, June 1992, p. 27.

[10] *1991 Trust Territory of the Pacific Islands*, U.S. Department of State, p. 27.

Access to Palau from Japan needs to be improved. Although the international airport was recently upgraded to handle larger aircraft, it cannot accommodate the large wide-body jet aircraft that would enable economical direct flights from Japan. Most Japanese tourists come via Guam, where connections with international flights generally require long waits in the Guam airport transit lounge or overnight accommodations. Much of the proposed investment in Palau is related to tourism, including a new airport. The continued growth of tourism will require upgrading and expansion of Palau's infrastructure.

Fisheries

Data on catch tonnage, types of fish caught, and value of products exported are not available. Current exports of tuna, mainly to the sashimi market in Japan, amount to about 1,200 metric tons, with another 120 tons of reef fish also being exported. Export of the fresh fish is by air to Japan via Guam. However, one company in Palau air freights its fresh tuna via its own DC-8 directly to Japan. In 1989, there were 75 long-line tuna vessels owned by three locally based companies which were licensed to fish in Palau waters. Given the strong demand in Japan for fresh tuna, the locally based long-line fishery is expected to be a growth sector.

The smaller-scale local fishing fleet is also considered significant (though again, no current catch data are available) in contributing to both the market and the subsistence production of fish. Japanese aid is funding the development of rural fishing bases, provisioning them with docking and ice-making facilities. This effort is expected to contribute to a larger amount of locally caught fish supplying the local urban market.

Agriculture

Domestic agricultural production consists of cassava, taro, sweet potato, banana, and coconut. Most production is not marketed and grown for home consumption. Copra is no longer a commercial industry in Palau, with the copra processing plant being closed in 1982. Although no formal statistics are available, marketed production of fruits and vegetables for the urban areas has increased. Much of this increased production is believed to be supplied by Taiwanese and Filipino farmers who enter into partnerships with citizens who provide access to the land. The growing, more affluent urban market, stimulated by rapid growth in tourism, provides good potential for the sustained growth of small-scale commercial farming.

ENERGY SECTOR

Overview

Palau's per capita energy consumption, particularly petroleum, is high by Pacific island standards. Most of the population (88 percent of households) is electrified, and this power is subsidized by the government. Overall, a disproportionately large portion of Palau's financial resources has been directed to the energy sector at an opportunity cost to the other parts of the economy. Imported petroleum products account for over 90 percent of primary energy use and 100 percent of commercial energy use. Commercial energy use grew rapidly during the 1980s due largely to tourism and services, and this trend is expected to continue.

Palau has only limited options to reduce its dependence on oil through local sources of energy or new technologies. Small-scale hydropower may be an option in some of the remote communities on Babeldaob, and photovoltaic systems appear to be a good option for limited electrical needs on

small outlying islands. However, given the status of various alternative energy technologies, their relative economics, the environment in Palau, and the level of existing and planned infrastructure, suggests that Palau will remain dependent on petroleum imports for transport and power for the medium to long term.

Perhaps the most pressing energy issue facing Palau is that there is no overall responsibility for coordinating or overseeing national energy matters within the government. As a result, there are no clearly defined policies, planning is negligible, and the basic data required for informed decision making are not collected.[11]

Supply and Demand for Petroleum Products

In 1989, the value of the petroleum imported into Palau was $5.9 million, which represented 24 percent of the estimated value of all imported goods. This amount is nearly ten times the value of Palau's total domestic exports for that same year. The absence of complete international trade statistics make more current comparisons of the amount spent on petroleum versus the value of other commodities imported or exported impossible, but it is generally believed that situation reflected by these numbers has not significantly changed since 1989. Palau's Customs Office has provided data indicating that 1992 imports of petroleum reached 263,000 barrels with an approximate value of $9.39 million. According to these data, Palau's imports of petroleum products have been increasing at an average annual rate of 12.5 percent per year since 1989, when 175,000 barrels of fuel were imported.

Aside from the Pacific Regional Energy Assessment (PREA),[12] there have been no detailed analyses of energy consumption patterns in Palau since 1982. Estimates made in 1991[13] indicated that imported petroleum products supplied 98 percent of Palau's total energy demand and 100 percent of commercial energy. It is likely that the 98 percent figure is too high, but there are no reasonable nor reliable estimates of domestic use of biomass. Palau's dependence on imported fuels has been attributed to urbanization and the extensive use of commercial energy (electricity, kerosene, and LPG) for cooking. Data from the 1990 census show that 91 percent of all the cooking facilities and kitchens in Palau have electric, gas, or kerosene appliances.[14] The PREA reports show that Palau's petroleum consumption per capita is the highest of the twelve Pacific island countries assessed in 1991. Palau's annual consumption rate of nearly two tons per capita is more that twice that of any other island nation and quadruple that of the neighboring Federated States of Micronesia. The Palau consumption level is more typical of large developed countries such as Australia or Japan than of a developing island nation.

Petroleum products are imported into Palau by Mobil and Shell. Both of these companies market gasoline, ADO, and lubricants. Mobil also provides jet fuel and AvGas. All fuel comes from Singapore via Guam, while some lubricants are shipped from Hong Kong via Guam.

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[11] *Pacific Regional Energy Assessment*, Volume 7, joint World Bank, Pacific Energy Development Programme, Asian Development Bank, and Forum Secretariat Energy Division project, August 31, 1992, p. 4.

[12] *Pacific Regional Energy Assessment*, Volume 7, joint World Bank, Pacific Energy Development Programme, Asian Development Bank, and Forum Secretariat Energy Division project, August 31, 1992.

[13] Ibid.

[14] *1990 Census of Population and Housing, Republic of Palau*, Table 104.

A recent estimate of the end use of petroleum fuels for the year 1990 was made in the PREA.[15] This analysis of petroleum consumption by end use sector was based in part on the sales information on volumes provided by Mobil and Shell, and indicated that 54 percent of the imported fuel was used for transportation, 38 percent was dedicated to electricity generation, and the remaining 8 percent was utilized in households or other government uses. Within the transportation sector, the 1990 analysis indicates that 43 percent of this transport fuel powered land vehicles, 34 percent was used in aviation, and marine uses accounted for the other 23 percent.

The same petroleum marketers were again consulted for a 1992 update of these data. Only rough estimates were provided and the results are summarized in Table 7.2. Even though the amount of petroleum consumed in Palau has risen by over 37 percent since 1990, the proportion of sector end use does not appear to have changed substantially (see Figure 7.3). Palau's 1992 share of fuel use for transport (56 percent) does seem to be growing slightly at the expense of that used in electricity generation (33 percent) which could be accounted for by the growth in the fishing and tourism industries.

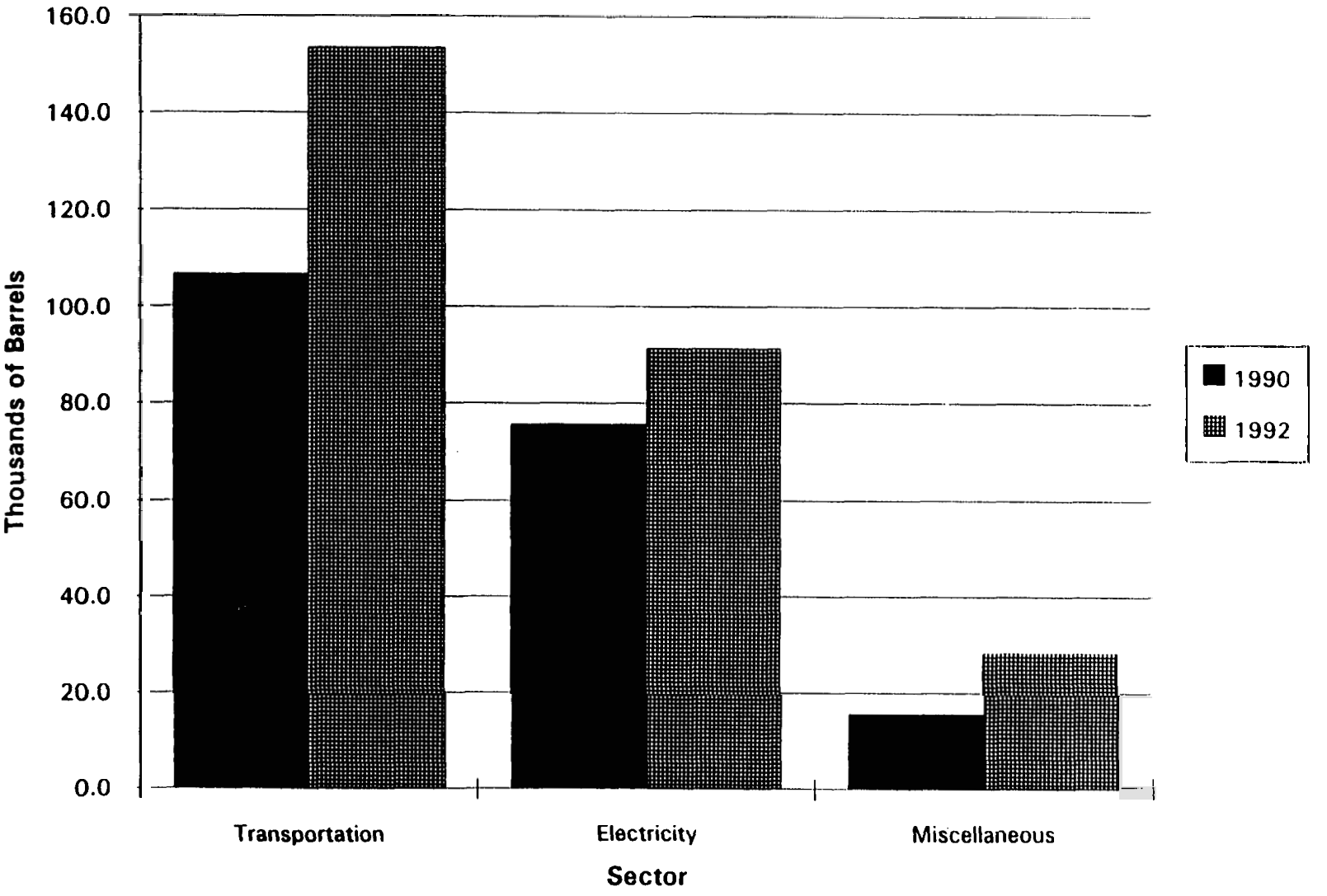
Table 7.2 Estimated End Use of Petroleum Products in Palau, 1992
('000 Barrels)

Product	Transportation	Electricity Generation	Miscellaneous *	Total**
Gasoline	62.0	--	--	62.0
Jet Fuel	30.1	--	2.9	33.0
ADO	61.3	91.3	24.3	177.0
Other***	--	--	1.0	1.0
Total	153.4	91.3	28.2	273.0
Percentage	56%	33%	10%	100%

* Tourism, home cooking, other government uses.
** Note that the total value of fuel used in Palau reported by the petroleum companies is 4 percent higher than the reported petroleum imports from the Palau government.
*** LPG, AvGas, etc.

[15] *Pacific Regional Energy Assessment*, Volume 7, joint World Bank, Pacific Energy Development Programme, Asian Development Bank, and Forum Secretariat Energy Division project, August 31, 1992, p. 6.

Figure 7.3 Palau Fuel Use Estimates by Sector



Further analysis of the information provided about the fuels used in 1992 in the transportation sector reveals that 43 percent of the petroleum dedicated to transportation is still used for land transport. However, a greater part of Palau's transportation fuel (38 percent) is now consumed by marine vessels (which again suggests a growing fishing industry) while aviation only uses 19 percent.

Storage and Distribution

With four fuel depots, Palau has sufficient storage capacity for the foreseeable future. These facilities include:

- A multiproduct facility at Malakal Port owned and operated by Mobil Oil Micronesia;
- the Shell multiproduct depot (formerly owned by Happy World) at Malakal;
- a small Mobil bulk aviation refueling installation at the airport; and
- the large government-owned facility at the Aimeliik power plant.

The facilities contain a total of over 220,000 barrels of storage capacity (refer to Figure 7.4), which based on the current Palau petroleum consumption rate of about 700 barrels per day can theoretically hold a 297-day supply fuel for Palau. However, the actual fuel level typically kept on Palau is probably less than half of this amount.

The Palau storage facilities for the various petroleum company products are outlined in Table 7.3. Mobil has roughly 70,000 barrels of storage capacity on Palau: 36,000 barrels of capacity dedicated to ADO, 13,000 barrels for gasoline split among three tanks, and over 21,000 barrels of jet fuel storage capacity, 700 barrels of which are at the Koror Airport. The Shell facilities can store up to 7,900 barrels of fuel, and currently over 90 percent of this capacity is in service with 4,800 barrels dedicated to ADO and 2,400 now used for gasoline.

The government facilities at Aimeliik are the largest fuel storage installation. Aimeliik has 144,000 barrels of petroleum storage capacity, 72,600 of which are dedicated to ADO. The other 71,400 barrels of storage capacity are currently not used and not needed. These facilities were recently characterized in the PREA as "excessive," "underutilized," and "located at an inconvenient site distant from Koror."

Both of the petroleum suppliers of Palau have provided information which indicates the average inventory of petroleum products which is typically kept in Palau. Using product consumption rates estimated from 1992 petroleum demand numbers, calculations of the amount of supply in days can be made. A maximum theoretical inventory can also be calculated by assuming no conservation efforts and then dividing Palau's total petroleum storage capacity by the daily usage rates in order to obtain an estimated fuel supply in days. The results of these calculations are shown in Table 7.4.

As shown in Table 7.4, if all of the tanks in Palau were filled, nearly ten months fuel supply would be stored. However, the oil companies that provide fuel to Palau report that they usually have only about a two-month supply on hand at any one time. No information is available regarding the average stocks in hand at Aimeliik, but if the in-service tanks there are maintained at the same levels as the oil company tanks in other parts of the island, Palau's average stocks can be estimated to nearly equal a four-month demand of products. However, a 45 day average holding has been indicated as a more realistic estimate.

Figure 7.4 Palau Fuel Storage

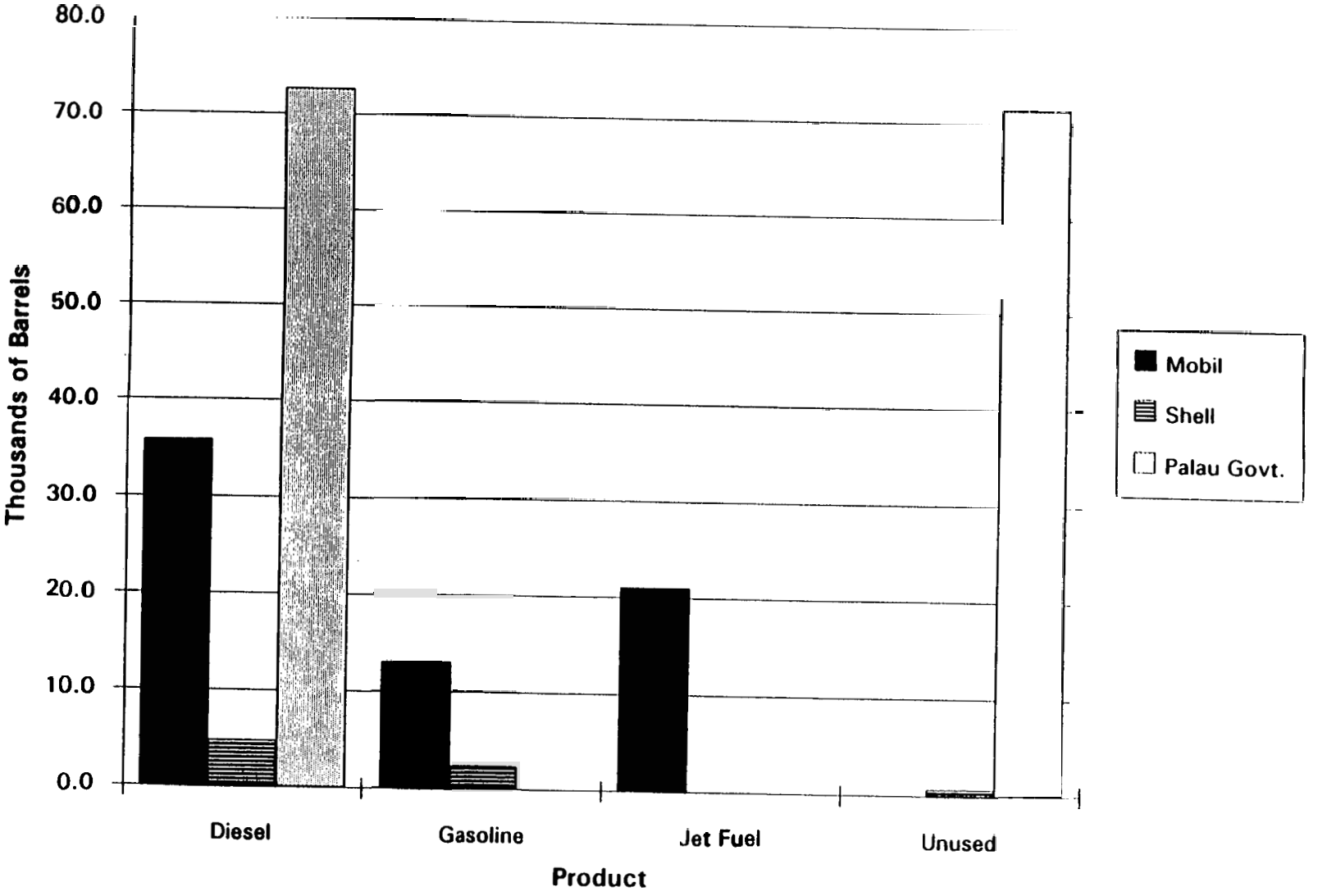


Table 7.3 Major Petroleum Storage Facilities in Palau

Owner	Location	Storage Description
Mobil	Malakal	35,900 barrels ADO 13,000 barrels Gasoline (3 tanks) 20,357 barrels Jet Fuel
Mobil	Koror Airport	714 barrels Jet Fuel
Shell	Malakal	4,800 barrels ADO 2,400 barrels Gasoline (2 tanks) 714 barrels empty
Government	Aimeliik	72,600 barrels ADO (4 tanks) 71,400 barrels unused (4 tanks)

Table 7.4 Estimated Palau Petroleum Product Storage

Product	Maximum Theoretical Inventory in Days (all tanks full)	Average Inventory in Petroleum Company Storage (excludes government storage)*	Minimum Inventory in Petroleum Company Storage (excludes government storage)**	Estimated Average Palau Inventory (all in service tanks in Palau)***
Gasoline	91 days	55 days	25 days	55 days
Jet Fuel	233 days	128 days	35 days	128 days
ADO	234 days	49 days	15 days	138 days
Total	297 days	62 days	21 days	119 days

* Based on "average stock information" supplied by oil companies.
** Based on "minimum stock information" supplied by oil companies.
*** Assumes government storage at Aimeliik maintains the same average stocks (as a percentage of storage capacity) as do the oil company facilities.

Information from the oil companies also indicates that their levels of stored supplies can drop to 21 days if both Shell's and Mobil's stocks are simultaneously at their minimum levels. No

information on the minimum stock level at Aimeliik is available, so this reported minimum supply of 21 days of petroleum fuel stocks does not take into account any of the government storage capacity.

Petroleum products are delivered to Palau by local coastal tankers via Guam. Fuels originate in Singapore and travel to Palau via Guam, with a voyage time of nine to ten days for the Singapore to Guam leg and then an additional two to three days to sail to Palau from Guam. According to the Palau Division of Transportation and Communication,[16] 13 tankers unloaded cargo in Koror in fiscal year 1991 which would indicate a delivery of at least every four weeks.

Malakal Port handles most products except for the diesel supplied to the Aimeliik power station. The 50,000 barrel *Golden Craig*, a 7,000 deadweight ton tanker currently used by Mobil, is the largest vessel handled at the Malakal berth. The maximum draft restriction at this berth is approximately 30 feet, and restrictions imposed by the navigational channel are a major constraint to shipping. At this port, there are two 6-inch diameter pipelines available for fuel discharge. At Aimeliik, the depth of the approach channel to the berth is also a major constraint to navigation, with the maximum draft available of only 26 feet. Three tanker discharge pipelines are available at Aimeliik, two with 6-inch diameters, and one with a 12-inch diameter. Mobil uses the 12-inch pipeline for discharge, and Shell uses one of the 6-inch diameter lines for both discharge and backloading operations. Mobil uses a barge to transfer products from the Malakal bulk storage facility to Aimeliik.

Most of the onshore distribution is handled in bulk, though a small volume in drums is handled by Mobil. Bunkers are handled by pipeline transfers from trucks. One of the two locally registered fishing corporations, the Palau International Traders Incorporated (PITI), has a pipeline dedicated to delivering its required fuel. Mobil hauls jet fuel by road tankers from its Malakal bulk fuel storage facility to its airport storage tanks, and aircraft refueling is handled through a hydrant system.

In 1988, Palau had at least 11 gasoline service stations servicing a country with less than 2,600 vehicles and 40 miles of road. The PREA noted that two more stations have opened since then and that this proliferation of service stations in this small market tends to increase inefficiencies in fuel retailing (as additional stations reduce throughput per site and thus require increased retail margins to be profitable) and raises the retail price to consumers.

Future Developments

Estimating demand for petroleum imports to the year 2000 is difficult due to the general lack of reliable information available from government offices and fuel suppliers on past imported fuel volumes and values--without a source of independent government data, it is impossible to cross-check the numerous inconsistencies that appear in the records that are available. However, the available data indicate that since 1985, Palau's fuel consumption has been increasing at an average annual rate of between 9.5 and 10.8 percent. Over the last two years, the average rate appears to have risen to about 14.5 percent. Gross generation data from the Palau power stations show an average annual increase of 7.3 percent since 1987.

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[16] *1991 Trust Territory of the Pacific Islands*, Department of State, p 167.

Because of projected investments in the tourism industry and increased visitor arrivals, moderate to strong growth in the overall economy is generally expected throughout the decade. It is anticipated that government spending will be maintained at the current levels either through continued U.S. grant assistance as specified under the United Nations Trusteeship, or through the receipt of Compact monies if the Compact is approved. Based on the assumption that no real changes are likely to take place in the U.S. fiscal support of Palau's economy, then Palau's petroleum consumption growth should continue unchanged. A growth rate of between 7 and 12 percent per annum would depend, of course, on the realization of investments in tourism facilities during the decade and on the development of the fishing industry. Such a growth rate would suggest that by the year 2000, Palau could be annually importing between 450,000 and 650,000 barrels of petroleum.

Electricity

According to the PREA, the responsibilities for electrical power generation in Palau are unclear as they are divided between two government ministries as well as the state and national governments. Seven public power systems based on diesel generation provide power in nine of Palau's sixteen states. However, about 98 percent of public electricity production is provided through the grid supplying the states of Koror, Airai, and Aimeliik from the Aimeliik power station, which is controlled by the Bureau of Public Works (BPW) of the Ministry of Resources and Development. The Public Utility Collection Agency is responsible for collecting electricity bills, but the individual states are responsible for the operation, expenses, and revenues of the smaller remote generating units. The BPW is also technically responsible for the maintenance of these generators, but there is no budget for the remote systems. Decisions on repairs and investments are made by Palau's vice president after receiving requests from the state governors. Some power equipment that was donated to Palau has apparently been allocated directly to each state with the maintenance responsibilities being left to the national government.

In February 1992, legislation was passed by both of the houses of the Palau legislature and then signed into law that established a Public Service Corporation for the purpose of supplying reliable electric power which would manage the generation and distribution of this power. This legislation, however, included a provision that kept the ability to approve electricity rate increases in the hands of the legislature. Inasmuch as Palau is still a United Nations Trust Territory, the U.S. Secretary of the Interior has the power of approval over any enacted legislation. Using this authority to eliminate specific sections of any law, the Department of the Interior struck down the section giving the legislature the authority to approve rate increases. However, this same law contained another section that stipulated that if any section of this law were struck out, then the entire statute would become null and void. As a result of the action taken by the Department of Interior and an action taken before the Palau court, the law creating a Public Service Corporation is invalid. Palau's utilities are therefore still a purely government operation and the transition of the urban power sector to a commercialized enterprise, with the attendant long-range policy planning for eventual fiscal autonomy of the utility, has been slowed.

Palau's difficulties in the power sector are not limited to this recent political skirmish between Washington and Koror. The power plant at Aimeliik was constructed as part of a project that has placed the Government of Palau in a serious debt situation. The construction cost of this facility was originally estimated to be $29 million, but this later increased by another $5 million due to additional transmission and distribution equipment that was needed as a consequence of the decision to move this plant from Koror to its Aimeliik site. The justification offered by the promoters of this power plant and storage depot project was the hope of using these storage facilities as a petroleum re-export

terminal, and thereby competing with other terminal locations in Guam and the Philippines. Palau's leaders at the time were led to believe that this enterprise would be self-financing via the sale of fuel to neighboring countries.

To date, the hopes of a profitable re-export business developing on Palau have not materialized. A 1990 economic report stated, "Unfortunately, it will be difficult and very costly for Palau to achieve the status of a re-export center in the foreseeable future due to the high cost associated with the correction and improvement to some physical handicaps associated with the Aimeliik location of the depot facilities.... Aimeliik is not suitable as a re-export terminal due to economic, safety, and technical reasons."[17]

Palau paid for this facility by entering into loan agreements. In 1985, Palau defaulted on its loan payments, and the guarantor banks sued Palau in the U.S. Federal District Court. The court ruled that Palau now owes $45 million (including interest payments) to these banks which equals $3,000 for every man, woman, and child in Palau. The government of Palau appealed this ruling, and the U.S. Court of Appeals ruled in 1991 that the U.S. government has responsibility for Palau's liabilities under the Trusteeship. However, according to the 1989 "Guam Accords" between the United States and Palau, the United States may satisfy creditors in part with funds from the Compact originally meant for fostering increased self-sufficiency in energy production. Hence, in the event of the approval of the Compact of Free Association with the United States, the United States will make available Compact monies to partially repay Palau's creditors.

The rated power generation capacity in the seven public power systems is almost 20 megawatts (Table 7.5). Power for the main grid that provides electricity to Koror, Airai, and Aimeliik states is generated at two widely separated locations: the Aimeliik power plant situated 25 kilometers from Koror on the island of Babeldaob and the Malakal power plant on the island of Malakal. The Aimeliik power station has a rated generating capacity of 12.8 megawatts from four 3.2 Crossly Engine-Brush Generator sets. This station and tank farm were constructed on a turnkey contract and built to a high standard. Since commissioning in 1986, the Aimeliik station and the tank farm were operated by an expatriate crew under a management and operations contract that expired in 1991. Since then, several expatriates were hired by the government on direct contract to supervise Palauan operating crews.

Good preventive maintenance has kept unplanned outages of these engines at a low level. However, there has been a general lack of funds to purchase repair parts which has resulted in the engines having been run well beyond the operating time without overhaul recommended by the manufacturer.[18]

The PREA mission that visited Palau in 1991 reported that although the rated capacity of the Aimeliik machines was 3.2 megawatts per engine, the contractor on site had established an operational procedure which would not allow any of these engines to generate more than 2.3 megawatts due to observed cracks in the foundation of one of the machines and high engine vibration. This procedure effectively derates the Aimeliik power output to 9.2 megawatts.

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[17]*Palau: An Economic Overview*, Section 10.11, United Nations ESCAP Pacific Operations Center, December 1990.

[18]*Third Year Review, Operations and Maintenance Improvement Program*, Louis Berger International, Inc., December 1992, p. 40.

Table 7.5 Selected Palau Power Sector Indicators

	Installed Generation		References
Main Grid	Rating MW	Capacity MW	
Malakal	6.750	5.225	OMIP, 1992, p. 42
Aimeliik	12.800	9.200	PREA, 1992
Total–Main Grid	19.550	14.425	
Rural			
Peleliu	0.800	0.205	Jan. 1990 fax from R. Akitaya
Ngiwal	0.100	0.100	PREA, 1992
Others	1.000	n.a.	Jan. 1990 fax from R. Akitaya
Total–Rural	1.900	0.305	
Grand Total	21.450	14.730	

Note: Peak 1991 grid demand was 7.9 MW
and estimated system fuel efficiency was 11.11 kwh-distributed/gal.

The other station on the grid is the Malakal plant located two kilometers from Koror. This plant has been restricted to stand-by generation since the commissioning of the Aimeliik plant in 1986. This plant was originally installed in the early 1960s, and its critical parts are in an advanced state of disrepair. Of the nine diesel generators at this station, only five are operational, with a total generation capacity of 5.2 megawatts. The facility was damaged by a 1990 typhoon, and some of this damage has not yet been repaired. A recent survey of the station reports that much work must be done if it is to be used to provide power during an overhaul of the Aimeliik units.

In a small utility system, the recommended reserve generation margin can be determined by calculating the "firm capacity" (i.e., total generating capacity of reliable units minus the capacity of the largest unit) which allows for uninterrupted power delivery even during the outage of one unit at the time of peak demand. For the system on Palau, the firm capacity would be defined either as three of the four Aimeliik units generating 6.9 megawatts (operating at a restricted level of 2.3 megawatts each) or 9.6 megawatts (operating at full rated capacity) and between 0 and 5 megawatts from

Malakal, depending on the reliability of the units at this plant. As the 1991 peak load was reported at 7.9 megawatts,[19] the firm capacity of the Palau system is less than the peak demand if the Malakal units cannot be relied upon and Aimeliik's operation is restricted by vibration concerns. Thus, the overhaul and maintenance of Palau's existing generation units is critical to ensuring a reliable supply of power for Palau.

Since 1987, Palau's peak electricity demand has been growing at an average annual rate of 12 percent per annum. If this growth rate continues throughout the decade, then by the year 2000 the peak power demand may exceed 19 megawatts. The existing generation system in Palau can only meet this peak demand if all of its machinery delivers reliable power. Although improved maintenance and facility refurbishment may insure adequate operational margins in the immediate future, it is clear that there is a need to monitor more closely the electrical load growth and develop medium-term forecasts that establish the timing for installation of new generation capacity (see Figure 7.5).

There are 2,755 listed urban electricity consumers (2,406 residential, 269 commercial, and 80 government), but the actual number of consumers is probably greater than reported levels. Many consumers are unmetered, including virtually all government offices and many of the three-phase consumers, whose consumption is reportedly underestimated. As nearly half of the 1990 consumption was unmetered, there are no accurate estimates of electricity use patterns. The PREA has reported that approximately 41 percent of the consumption is residential and 13 percent commercial. However, the remaining 46 percent is unmetered consumption by the government and commercial sectors. Estimates for electrical losses range from 22 to 30 percent (Table 7.6).

Collection of payments from users who are metered appears to be very good. In 1990, 19,100 megawatt hours were billed to consumers who paid about $1.8 million for an average collection of 9.4¢/kwh, which is very close to the average tariff of 9.5¢/kwh. The policy of turning off electricity service within 30 days if charges are not paid appears to be effectively enforced. Data from the PREA (see Table 7.7) also indicate that the percentage of Palau's power sector operating expenses represented by fuel cost is 40 percent.

Other small state-run diesel systems have been installed separately from the main grid in locations including Peleliu, Ngiwal, and Melekeok. The PREA indicates that these systems typically run six to twelve hours per day, are generally poorly maintained, recover less than 30 percent of their operating costs from generated revenues, and deliver unreliable power.

UNIQUE VULNERABILITY TO OIL SUPPLY DISRUPTIONS

There are several characteristics of Palau and its energy sector that give it a unique vulnerability to oil supply disruptions relative to rest of the United States. First, Palau is totally dependent on imported petroleum and does not have any realistic economic alternatives to petroleum. Second, Palau is supplied from Singapore via Guam and not from any other part of the United States. Third, there are no useful indicators to assess the economic effects of an oil supply disruption or oil price increase because the data are lacking. Fourth, Palau is vulnerable to tropical typhoons, which are the most frequent threats to oil supply. Fifth, a severe supply and price disruption would greatly harm the Palau economy which is based on imported goods and tourism.

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[19] *1991 Trust Territory of the Pacific Islands*, U.S. Department of State, p. 41.

Figure 7.5 Palau's Projected Peak Demand

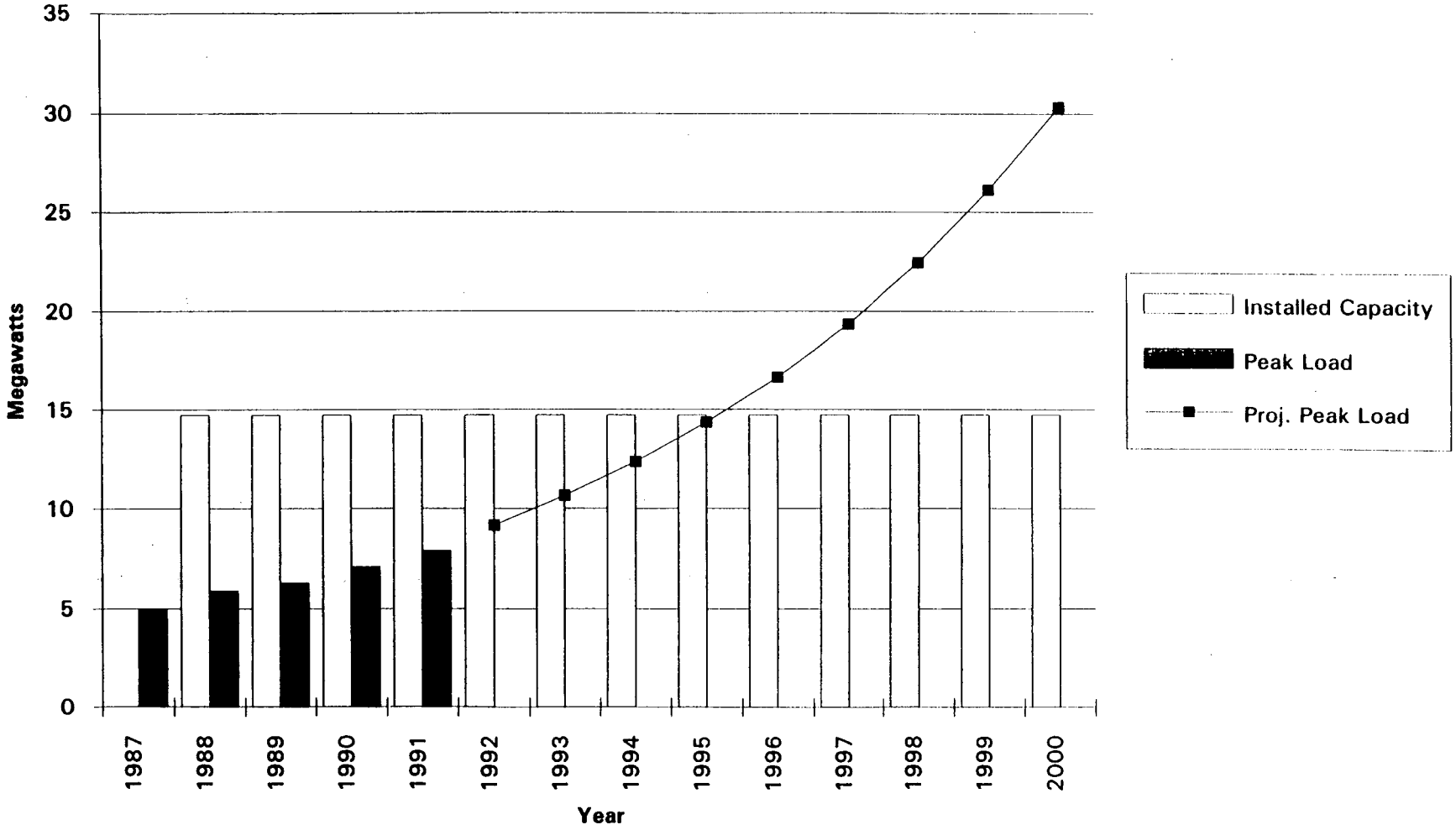

Table 7.6 Palau Power Generation and Consumption,1990
(MWh)

	Gross Generation	Losses	Total Consumption	Sector Consumption		
				Res.	Comm.	Unmetered
Grid	46,200	10,100	36,100	14,500	4,600	17,000
Rural	1,000	300	700	600	100	n.a.
Total	47,200	10,400	36,800	15,100	4,700	17,000
Percent				41%	13%	46%

Table 7.7 Miscellaneous Palau Power Sector Financial Data

1990 Revenue	$2,360,000
1990 Fuel cost	$4,200,800
Other Operating Cost	$6,419,200
Net Operating Loss	($8,260,000)
Fixed Assets (1990)	$15,700,000
Estimated debt (Aimeliik Project)	$45,000,000

As with Guam and the CNMI, there have been no interruptions of the oil supply system. All directives of the U.S. Department of Energy have been followed during previous oil crises. The oil companies supplying Palau believe that they will be able to provide sufficient petroleum products to maintain essential services during crisis periods.

Data on the impacts of past oil crises on Palau were unavailable because data have been collected only for the last several years. However, in order to provide a reasonable basis for assessment, the effects of the 1973/74 and 1979/80 oil crises on Fiji, Tonga and Vanuatu were analyzed based on a study of these economies which utilized a social accounting matrix (SAM) model. While the independent nations have economies which are not as monetized as the U.S. Pacific island, there are a number of similarities including the openness of the economies, concentration of economic activity in but a few sectors (Fiji and Vanuatu have comparatively large public sectors), dependence on

oil imports for commercial energy, relatively large public sectors, dependence on imported manufactures, machinery, medicine and food. All of the Pacific islands are "price-takers" subject to external events which they are unable to control. Although there are differences between the economies of the U.S. Pacific islands and those of independent island nations (e.g., per capita income is much higher in the U.S. Pacific islands), the results of the 1973/74 and 1979/80 analyses provide order of magnitude indications as to how the U.S. Pacific islands could be impacted by oil price shocks. The order of magnitude indications were corroborated by the data which were available as well as by comments by government and private sector officials including on-island banks. Thus, estimates on the economic impacts of oil price shocks have been made using the best available information. This section discusses the effects of energy supply disruptions, including economic effects.

Vulnerability to Oil Supply Disruptions

Palau's energy supply depends on the delivery of petroleum products from Singapore via Guam. The voyage by medium-range tanker between Singapore and Guam takes nine to ten days and skirts Indonesia and the Philippines, while the voyage between Guam and Palau takes approximately two to three days. The Guam-Palau voyage is by local coastal tanker, the *Golden Craig*. This supply route has proven reliable in the past.

Malakal Port handles most products except for the diesel supplied to the Aimeliik power station. The *Golden Craig*, which has a 50,000 barrel capacity and is rated at 7,000 deadweight tons, is the largest vessel handled at the Malakal berth. The maximum draft restriction at this berth is approximately 30 feet, and the restrictions imposed by the navigational channel are a major constraint in shipping. At this port, there are two 6-inch diameter pipelines available for fuel discharge. At Aimeliik, the approach channel to the berth is also a major constraint to navigation as the maximum draft available here is only 26 feet.

Internally, the distribution of petroleum products from Koror to the outer islands is dependent on the use of drums and small interisland vessels. Based on some reports, it appears that there have been occasions (e.g., typhoons) when interisland deliveries had to be delayed. Typhoons are regular occurrences in Palau and can affect off-loading either at the main terminals or at interisland discharge points.

Oil spills in Palau are less of an environmental threat than on Guam and Saipan because fuel oil is no longer used at the power plants. Only light and middle distillates are currently delivered to Palau, although the Aimeliik power station does have the ability to burn fuel oil. However, it should be noted that the Rock Islands, which are only a few miles from the Koror harbor area, have been designated one of the "Eight Wonders of the Aquatic World" by the Costeau Society and National Geographic. Oil spill response equipment is limited in Palau and a spill would require assistance from Guam, the Philippines and Honolulu.

Economic Effects of Energy Supply Disruptions

It is an extremely difficult exercise to assess the economic effects of oil supply disruptions on the small and very open Palau economy due to a lack of historical and applicable data. Estimates from other locations can be utilized, however, in an effort to indicate several likely economic effects.

As with Guam and the CNMI, a moderate (less than 2 MMBD) supply disruption which is centered on Latin American, African or Middle Eastern producers would have minimal effects. It is likely that Palau would experience some inflation based on the price increases of imports. Similarly, direct effects on tourist arrivals and fish exports would also probably be fairly minimal because the main markets (e.g., Japan) would not be greatly effected.

If there is a major supply disruption centered on Asian oil producers, the economic effects could be severe via the same mechanisms affecting Guam and the CNMI. First, oil prices would be expected to rise reflecting the shortages on the Singapore market. The direct effects of a major supply disruption would not be as severe as the secondary effects. A disruption caused by political upheaval in Asia could result in greatly reduced levels of tourism if people are afraid to travel anywhere in the Asia-Pacific region. This would lead to major dislocations in the Palau economy. Thus, it is not simply the oil supply disruption which effects the Palau economy but also the cause of the supply disruption.

The effect of an oil price doubling on Palau's power sector would also be severe. In 1990, fuel cost accounted for 40 percent of the total operating expenses of the electricity utility. Thus, oil price doubling would require tariff increases or greater subsidies to pay for the extra 40 percent increase in operating expenses.

Another secondary effect of a major supply disruption is that it would most likely lead to economic downturns in the regional economies. Similar to the effects experienced in other open economies, a severe oil supply disruption creates secondary effects which are not felt for several months yet may continue for several years.

Palau has a small open economy which depends on imports and trade with Asian nations. The private sector is based on tourism and the Japanese sashimi market--both highly dependent on imported petroleum products for transport and both dependent on a strong economy in the major market, Japan. Because of the nature of its economy, Palau is very vulnerable to fluctuations in the Japanese economy. Assuming that a major oil supply disruption involving Asian producers would negatively affect the Japanese economy, then Palau would be subsequently affected.

Estimates of the economic effects of an oil price shock on Palau are provided in Table 7.8. The first row are projections of the rates of price increases for petroleum under low price, base price and high price scenarios. The most recent value figure for imported petroleum products is also in this row. The value of the oil imported into Palau in the years 1995 and 2000 is estimated first by assuming that the 1992 demand escalates by 8 percent per year until 1995 and then by 6 percent per year until 2000, and then by multiplying the resulting demand by the projected price of oil in the respective year. The projected prices are obtained by using the three price scenarios. The table shows that demand growth and a base case petroleum price increase of 3.9 percent per year results in a doubling in the value of petroleum imports for Palau by the year 2000.

The gross domestic product (GDP) is not measured in Palau, but in 1990 it was estimated to be $50 million. Economic expansion at 10 percent per annum would theoretically raise this value to $80.5 million in 1995, and $129.7 in the year 2000. As described in Chapter 2, oil shocks have been thought to cause a GDP to decline by anywhere from 2.5 to 4.7 percent. Table 7.8 shows the resulting GDP based on these approximations. In order to assess the likely effects on employment, the estimated economic growth rate of 10 percent has been applied to the private sector employment and extrapolated to the years 1995 and 2000. Public sector employment has been held constant. The

Table 7.8 Economic Impacts of an Oil Price Shock - Palau

		$ Millions		
		Base Year	1995	2000
Value of Petroleum Imports		(1992) $9.4	Demand Growth 8% per year 92-95; 6% til 2000	
Oil Price Increases				
2.0% per year			$12	$18
3.9% per year			$13	$21
6.6% per year			$14	$25
		(1990)		
GIP-base	($ millions)	$50.0	$80.5	$129.7
decline of 2.5%	($ millions)	$48.8	$78.5	$126.4
decline of 3.0%	($ millions)	$48.5	$78.1	$125.8
decline of 4.7%	($ millions)	$47.7	$76.7	$123.6
		(1990)		
Employment		5,599	7,726	11,152
decline of 5%		5,425	7,445	10,700
decline of 10%		5,251	7,165	10,248
Local Government Revenues	($ millions)	(1989) $9.0	$15.9	$13.8
4.8% Loss of Direct Taxes	($ millions)	$0.4	$0.8	$1.2
Resulting Budget Surplus (Deficit)	($ millions)	($19.6)		

Notes:

1. Value of petroleum imports calculated by multiplying estimated average annual demand growth by estimated petroleum price increases.
2. Estimates for gross island product, employment and government revenues, utilize average annual increases of 10.0 percent.

employment on the island after an oil shock that results in a loss of 5 percent or 10 percent of the private sector jobs is also shown for the years 1995 and 2000.

One of the major effects of an economic slowdown resulting from an oil price shock is the loss of local government revenues. Fiji experienced a 4.8 percent loss of tax revenue during an oil price shock. In order to estimate the magnitude of this loss in Palau, 1990 Palau government budget data were used and the effects of 4.8 percent decline on the deficit were computed. For 1995 and 2000, the local government revenue was calculated assuming an annual growth of 10 percent per annum. An assumption was also made that direct taxes will increase in proportion to economic growth.

An important question regarding the economic effects of an oil supply disruption is whether Palau experiences more severe dislocations than the rest of the United States. Even though the United States would experience inflation and possibly recession, Palau's small open economy would be totally exposed to global market forces: the economy is nearly totally dependent on off-island trade and international tourism and nearly all food and all medicine are imported. In other words, there would be no territory of the United States more severely affected by a major Asian oil supply disruption than Palau. (Note: this analysis also applies to Guam and the CNMI).

Options for Accessing Oil Supplies in Emergencies

An analysis of the global oil industry and specifically current and projected oil flows in the Asia-Pacific region provides several scenarios which would prove very difficult for the U.S. Pacific islands including Palau. These scenarios are: 1) major political turmoil in the Middle East and in Asia, resulting in a net loss of at least 4.5 MMBD for a six month period; and 2) global catastrophe, e.g., a major war, or regionalized/localized conflicts which effectively result in the closure of major oil-producing regions such as the Persian Gulf. In both cases, Singapore refiners would have their supplies reduced by at least 25 percent, with the actual reduction probably reaching as high as 50 percent. The result would be a loss of petroleum supplies from Singapore to the Pacific islands of at least 25 percent and possibly even exceeding 50 percent. The short-term effects would be considerable because of a doubling or tripling of prices on the now oil-short Singapore market. In addition, if there is political turmoil in Asia, then the tourism industry would be greatly affected both by higher fuel prices and the reluctance of people to travel.

Other oil disruption scenarios, including moderate loss of production in certain West African and Latin American regions, would have limited impact on supply in the Pacific Islands. Prices would increase but the effects would probably be only temporary because of the expectation that the market would be able to adjust (e.g., oil prices first skyrocketed and then returned to near-normal levels following the Iraqi invasion of Kuwait).

Local oil supply disruptions could be caused by typhoon damage to docking and storage facilities in Palau. However, Palau's facilities have survived severe storms relatively unscathed. Thus, unless a typhoon much stronger than any storm over the last five decades directly hits the oil facilities, it is doubtful that a local event would cause a major disruption.

Given these impacts of possible disruption scenarios, there are several options to increase energy security in Palau. These include developing a strategic petroleum reserve (SPR) on various islands, increasing the volume of on-island stocks, access to the U.S. SPR, developing alternative supply arrangements, and reducing demand. These are discussed below. In addition, the relationship

between oil companies and the Palau government and the capability and willingness to work together under crisis conditions are also addressed.

However, it must be stressed that the U.S. Pacific islands have not had an interruption in the supply of petroleum products since the end of World War II. Prices for petroleum products in the islands have jumped sharply during oil crises (e.g., 1973/74 and 1979/80), but the supply of petroleum has been continuous.

Increasing Commercial Stocks

Another option for Palau to improve energy security is to increase on-island inventories. The other Pacific islands typically use a minimum inventory measure of six weeks or 40 days; however, a larger inventory could be maintained in order to provide a margin of safety against a major supply disruption. Price increases for the additional inventory would probably approximate a $2 per barrel per year maintenance charge plus the cost of the petroleum products. Distributing these costs over the volume of total imports is not expected to not add substantially to the cost of petroleum products since stocks already average 119 days in Palau. This means, Palau should be able to meet this minimum inventory level without additional cost.

Building Regional Petroleum Reserves (RPR)

A strategic petroleum reserve servicing Guam, the CNMI, and Palau has been analyzed. A ninety days supply for these three island groups has been estimated to be approximately 2 million barrels and would cost about $120 million to build and stock and an additional $4 million per year to maintain. However, on Guam there are already 129 days of storage capacity available, with an additional 165 days of "mothballed" (out of service) storage capacity. Given the existing storage capacities and the cost of SPR establishment running at $60 per barrel (excluding land prices), it appears difficult to justify an SPR facility for Palau on Guam. A facility serving only Palau is also difficult to justify because of the cost. Although Palau has at least 100 days of "mothballed" storage capacity at Aimeliik, the cost to develop this as an SPR would be very high.

Alternative Supply Options

Papua New Guinea (PNG) currently produces 135 MBD of crude that is refined in Australia. It may be possible to negotiate some type of guaranteed supply arrangement between PNG and all of the Pacific islands. Such a supply agreement needs to stipulate that in the event of an oil crisis (and, the term "crisis" would have to be well-defined), PNG would guarantee access to supply. It should also be noted that the PNG crude is of very high quality and would be a very good match to the configuration of the now-closed GORCO refinery on Guam.

Access to Military Stocks

There are no military fuel storage installations located in Palau. The closest installations are on Guam. During periods of major political upheaval in Asia and the Middle East, it is doubtful that the military's fuel supplies could be transferred to civilian populations except in cases when the health and safety of civilians were at risk.

Guaranteed Access to the U.S. SPR

In May 1992, a bill was introduced to the U.S. Congress which guarantees access to the U.S. SPR for a percentage of oil demand requirements of the U.S. Pacific islands including Palau. What would not be guaranteed would be the transport.

Under the proposal, the price paid for the petroleum from the U.S. SPR would be an average of the bids submitted by the oil companies trying to acquire supply, or, in other words, the price would be the market rate. Thus, the islands would be paying at the same rate but would be guaranteed supply. Also under the proposal, the U.S. Pacific islands would have priority status at SPR docking facilities. However, the islands would be responsible for processing and chartering tankers. Oil companies could be contracted to process products and provide ships.

No additional establishment or maintenance costs would be required for Palau under this proposal. Even though future prices for SPR petroleum during crisis situations could be substantial, this option ensures some degree of access to the U.S. Pacific islands. In order for this option to be implemented, Palau will have to coordinate its efforts with the other U.S. Pacific islands and develop strategies to access tankers during crisis periods.

Energy Emergency Planning

There are no energy emergency plans currently operational in Palau. However, government departments have implemented natural disaster response plans. An energy emergency plan would assist Palau decision-makers in allocating fuel supplies during an energy emergency.

Demand Management

A device that can effectively stretch out scarce supplies is a demand management plan. Such a plan will effectively reduce the negative impacts of a supply disruption. It should be stressed that demand management can be a valuable component of a response strategy. However, the data which are required to develop and implement a comprehensive program are lacking in all of the U.S. Pacific islands including Palau.

LONG-TERM ENERGY VULNERABILITY RESPONSE OPTIONS

Alternative Energy Resources

Palau has a limited range of alternative energy resources, including solar, biomass, wind, and hydropower potential. These resources are discussed below. However, aside from solar resources, none of these appear to have commercial viability. For the foreseeable future, Palau will remain dependent on imported petroleum products from Asia.

Solar

Solar insolation is estimated to range from 4.2 to 5.3 kwh/m^2 per day. This resource is suitable for exploitation at isolated sites and at a cost below that of small diesel systems. There are approximately 100 solar photovoltaic units installed in the southwest islands. These units are being used in residences, health clinics, and for telecommunications equipment. More use of the solar resource is possible, including passive solar water heating in areas connected to the grid.

Biomass

The biomass resource available for energy is unknown. However, vegetation surveys by the U.S. Forest Service (1987) indicate that Babeldaob has over 27,000 hectares of forest, including nearly 22,000 hectares of upland forest. However, commercial access to this resource for energy production could be difficult because of traditional land tenure systems. No economic assessments of the potential of the forest resource for energy have been undertaken.

The potential of municipal solid waste (MSW) as an energy source on Koror has not been assessed. The 1982 USDOE Territorial Energy Assessment described the resource: "This relatively small amount of MSW ..... may not be able to fuel even the smallest practical MSW facility."

Wind

Wind speed has been measured on Koror since 1950, with an annual average of 13 mph. However, wind energy resources appear less viable than photovoltaics.

Hydroelectricity

The 1982 Territorial Energy Assessment estimated a potential hydroelectric resource on Babeldaob of more than 1.2 MW. Follow-up surveys on a dozen sites, ranging in size from 10 to 70 kW, have indicated a resource of approximately 400 kW. Analysis by the PREA mission of these surveys suggests that while the resource has potential for specific village systems, capital and operating costs as well as reliability problems result in an uneconomic option.

Other Measures for Improving Energy Security

In addition to options for accessing oil supplies during energy emergencies and long-term response options, consideration should be given to improving overall management of the energy sector. Specifically, data collection on energy supplies and end uses, formalizing and expanding the dialog with oil companies, and integrated resource planning are activities which could provide substantial short- and long-term benefits at very little cost. These are discussed below.

Data Collection

Table 7.8 shows that the amount of money that Palau will spend on oil will increase by at least 100 percent by the end of the decade. This in itself justifies a systematic evaluation of whether or not this money is being spent wisely. At the same time as fuel costs are expected to escalate, Palau's power sector need to expand its generation capacity by 100 percent to approximately 30 megawatts by the year 2000. Taken together, it is clear that the energy sector will be one of the most, if not the most expensive sector in Palau's economy. Hence, there is an urgent need to systematically collect on a regular basis volume, value, cost build-up (e.g., f.o.b., c.i.f. and shipping charges), and inventory data on imported petroleum products. Power sector data need to be integrated with the petroleum data to establish a method of regularly assessing the role of energy in the local economy. Such an assessment should include an evaluation of the needs and costs of Palau's economic development strategies.

Oil Company Relations with Government

An important fact pertaining to the energy supply in the Pacific is that regardless of whether a local or regional SPR is established or if demand management plays the lead role in the next oil crisis, major oil companies will manage the bulk of the supply and distribution networks necessary to maintain Palau's access to oil. Fortunately the relations between the oil companies and the government of Palau are generally very good. However, some of the oil companies do not provide the government of Palau with all product supply and cost information; which is interesting as this type of information is routinely provided to South Pacific governments. Moreover, such data are essential to planning for and managing an energy emergency. If voluntary information is not forthcoming, the oil companies should be directed to furnish volume, value and storage data. Additionally, consideration may be given to establishing a minimum inventory level. Both of these issues, however, will require cooperation between the oil companies and the governments.

It should also be stated that one of the least-cost yet most effective measures to ensure petroleum supply is the establishment of an attractive operational and investment environment for major oil companies in Palau. Although this does not mean surrendering all control, it does require monitoring and constant interaction with the oil companies. Although relations are generally good between the oil companies and the government of Palau, the quality of the interaction could always be improved.

Integrated Resource Planning

Considerable attention should be given to integrated resource planning including least-cost assessments of technologies and developing strategies to more efficiently plan and manage energy use. Demand-side management techniques are but one step in a process in developing a broad-based program aimed at energy conservation, energy efficiency, and reducing cost. Savings can be substantial. Traditionally, investments in the supply side have payback periods from seven years and up, while investing in energy efficiency technologies provides payback in one to four years.

Renewable energy technologies cannot be expected to provide for baseload demands unless energy use is effectively managed. Until then, renewables will have only limited potential to affect dependency on oil.

Substantial sums have been allocated to the energy sector over the past few years with mixed results. In Palau, there is a major need to develop plans and management structures for the energy sector which reflect both the short- and long-term issues, and most importantly provide some consistency in direction for the sector. Management and planning for the sector require immediate attention.

The energy sector in Palau consists of three primary players, the oil companies, the power sector and the government energy office. Although responsibilities for each have been specified, there does not seem to be any overall coordination of the sector. There are no legislative mandates for the energy office in Palau. A dialog needs to be initiated to determine whether or not an energy office should exist, what the staff levels and functions should be, and how it should be funded. The results of this discussion would also help define the roles of the power sector and the oil companies in the Palau's energy sector.

Palau should initiate a review of its energy sector with the USDOE invited to participate in this review. A well-managed review would provide the basis to establish the integrated resource planning process which encompasses demand-side management activities, least-cost assessments of technologies and energy sources, and energy security options. The fiscal and economic consequences of a future oil price shock may initiate such an evaluation, but it is clearly preferable to have finished such an assessment and have taken any possible preventative measures prior to the damage being done.

Summary of Energy Emergency Response Options

Table 7.9 summarizes various energy emergency response options including accessing oil supplies, long-term alternatives, and other measures which could facilitate improved management of the energy sector. As indicated in the previous sections, securing oil supplies during energy emergencies requires considerable planning and/or investment. One option would be to access the U.S. SPR, which would require no additional capital and up-front fuel costs. Premiums would presumably have to be paid in the event of an energy emergency for both fuel and transport, and possibly for refining. The major disadvantage to this option is that supplies may have to be sourced from the U.S. Gulf Coast via the Panama Canal. The other low-cost supply option is to access military stocks. However, supplies would be limited to the level required to preserve safety and sustain life, which means that the economy would remain totally exposed to a potential loss of supply. Increasing commercial stocks is a relatively low cost option which warrants further discussion with the oil industry.

Alternative energy sources will have limited impact on energy security during this decade. It is doubtful that a small fluidized-bed coal plant could be financially viable.

The other response measures including energy emergency planning, demand side management, improved data collection and analysis, expanding dialogue with the oil industry, and integrated resource planning are all focused on facilitating cost-effective improving management of the energy sector. These measures may warrant implementation.

Palau has considerable excess storage capacity. However, stocking and maintaining a regional petroleum reserve would be expensive.

Table 7.9 Summary of Energy Emergency Response Options

	Response Action	Advantage	Disadvantage	Cost
Options for Accessing Oil in Emergencies				
Building Regional Petroleum Reserves (RPR)	develop 1 to 3 months extra storage	on-island or closer than U.S. SPR	cost	$30/barrel to build, $2/barrel per year to maintain, plus land costs and fuel costs; however, Palau has excess storage capacity
Increasing Commercial Stocks	develop 1 to 3 months extra storage	on-island	cost	same as RPR
Guaranteed Access to the U.S. SPR	develop refining and transport arrangements with oil companies or other island governments	least cost	distance	unknown
Access to Military Stocks	arrange level of supplies with military	limited on-island costs	supply limited to minimum to prevent loss of life	unknown
Energy Emergency Planning	develop energy emergency plans	low cost, complements any supply options	doesn't ensure emergency supplies	unknown but assume less than $50,000
Demand Management	develop demand side management program	cost-effective, valuable for energy conservation even without energy emergency	doesn't ensure energy supplies	assume $200-300,000
Long-term Responses: Baseload Power from Alternative Fuels				
OTEC	build baseload OTEC plant	local renewable energy source	very high cost, experimental technology	upwards to $40 million per installed MW
Biomass/Biogas	build biomass/biogas plant	use local resource	small volume, high cost	unknown but assume costs are similar to higher than coal per installed MW

Coal	build coal-fired plant, probably not viable given small demand	fuel available from a number of global suppliers	high cost for handling and storage	Unknown: roughly $3 million per installed MW, plus unknown costs for port handling and storage facilities
Other Measures for Improving Energy Security				
Data Collection	collect energy supply and end use statistics	low cost, useful for overall sector planning/ management	limited impact on energy emergency	unknown but assume less than $50,000 per year
Oil Company Relations	establish working group with oil companies, which focuses on long-term investments/solutions to energy supply	limited direct cost	potential tax concessions	unknown
Integrated Resource Planning	develop energy supply and demand scenarios which assess options for efficient resource allocations within energy sector	cost-effective, valuable for energy conservation even without energy emergency	requires constant monitoring and revision	unknown but assume roughly $200-300,000

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