Guam Power Authority
PO Box 2977
Hagåtña, GUAM 96932

Guam Power Authority

Integrated Resource Plan

FY 2008

August 8, 2008

EXECUTIVE SUMMARY

The Authority's Integrated Resource Plan (IRP), in order to increase the well-being of customers and stakeholders, aims to provide:

- Lowest cost power in the long run for customers;
- Fuel Diversity; and
- Electric power supply in an environmentally responsible manner

Integrated Resource Planning is an exercise in strategic as well as capital planning. It is an ongoing activity that does not end with the submission of a report. The business situation is dynamic and uncertain. It is especially when rapid change is anticipated that continued planning and analysis becomes even more critical. Additionally, the IRP must be folded with other long-range and medium-range studies into a cost-of-service study.

The Strategic Issues behind this Integrated Resource Planning effort include:

- Fuel diversity that considers fuel supply risk, renewable energy, reduced environmental and greenhouse gas footprints, and energy conservation or Demand-Side Management (DSM);
- Supporting the electric power service requirements for the impending Department of Defense (DOD) build-up and its economic consequences; and
- Acquisition of new electric energy supply and its implication on human resource requirements and the Authority business model;

The primary recommendations of this IRP include:

- Award wind or other renewable energy projects by December 2009;
- Bring Liquefied Natural Gas (LNG) as a substitute fuel for Diesel Fuel Oil by 2012;
- Plan and permit for an additional gas-fired plant or non-petroleum-fired plant as a hedge for the uncertainty in the scope of the DOD buildup and related economic activity — Guam Power Authority (GPA) should construct this plant based upon high load growth triggers and work with the DOD to mitigate rate impacts to other customers; and,
- Find a business partner to develop the Guam Sea Water Air Conditioning (GSWAC) Project.

Other recommendations of this IRP include:

- Ensure that all generation plants meet the performance standards agreed with the Guam Public Utilities Commission (Guam PUC);
- Examine life extension of its existing plants in a comprehensive and integrated manner;
- Continue to evaluate renewable and energy efficiency technologies in order to obtain the lowest energy prices for its customers;
- Work collaboratively with the Guam PUC and stakeholders to improve the Authority's financial position relative to obtaining funding for these projects;
- Continue to investigate Geothermal, Ocean Thermal Energy Conversion (OTEC), Integrated Gasification Combined Cycle (IGCC), and other technologies;
- Work with Guam Waterworks Authority (GWA) on an interruptible load arrangement in order to hedge against the risk of higher than baseline load growth;
- Work with the Guam PUC to establish the rules of engagement and rates for net metering;
- Work with the Guam PUC on implementing economically and socially viable Demand-Side Management (DSM) Programs; and
- Add to its web site Enercom's packaged set of Internet energy tools called Energy Depot®[1] as part of an initial small DSM project and customer outreach.

Bringing LNG as a substitute fuel for diesel requires the Authority to:

- Work with the Department of Defense to support the paradigm change at the Japan Bank for International Cooperation's (JBIC) pledge for infrastructure funding for the DOD marine move from supplying electric energy to supplying LNG;
- Renegotiate the Taiwan Electrical and Mechanical Engineering Services (TEMES) Energy Conversion Agreement to include converting its plant to use natural or synthetic gas and combine cycle operation; and
- Examine supplying natural gas for industrial, commercial, and residential use as a utility under the Consolidated Commission on Utilities (CCU) and the Guam PUC.

Table 1 shows the capital requirements for the primary recommendations of this IRP. Note that the CLNG Project is contingent upon accelerated load growth.

[1] Online Energy Audits & Information. Accessed at http://www.hometownconnections.com/utility/enercom.html on May 27, 2008

Table 1, Recommended Capital Requirements (thru 2018)

Project	Description	Construction Schedule	Commission Year	Capital Requirement ($ 000)
WIND	Wind Farm - 20x2MW	18 Months	2011	97,076
WIND	Wind Farm - 20x2MW	18 Months	2012	97,076
TEML	TEMES Conversion to LNG - 40MW		2012	8,633
GSWAC	Guam Sea Water Air-conditioning	60 months	2013	100,000
CLNG	CC w/ LNG / LM6000	43 Months	2013 to 2021 Depending on Load Growth	334,000
SSD	Reciprocating Engine (Slow Speed Diesel) - 2x20MW	30 Months	2017	70,980
WIND	Wind Farm - 20x2MW	18 Months	2018	97,076
TOTAL				**804,841**

TABLE OF CONTENTS

1 Situation Analysis

1.1 Introduction

Guam Power Authority (GPA) is a public corporation and an enterprise fund of the Government of Guam. The Guam Power Authority Act of 1968 established GPA in May 1968. Guam Code 12 Chapter 8 sets the legal definitions, empowerments and limitations for the Authority.

The Consolidated Commission on Utilities (CCU), a five member elected board of directors, administers GPA. The directors are elected for staggered four-year terms. Additionally, the Authority is regulated by the Guam Public Utilities Commission (Guam PUC).

The Authority serves about 46,000 customers and has an annual budget of approximately $350 million dollars. GPA's highest peak system demand is 281.5 MW.

The Authority is a full service electric utility. It generates and wheels electric energy from power plant to individual users. GPA has an installed generation capacity of 552 MW gross including 181 MW from Independent Power Producers (IPPs). GPA has organized 210 MW of its baseload capacity under two Performance Management Contracts (PMCs). These contracts provide private management using public employees to operate and maintain the plants. These contracts contain performance-based incentives for reducing plant operating costs. Furthermore, the Authority has installed 663 miles of transmission and distribution lines and operates 29 substations throughout the island.

The Authority is budgeted for 592 Full-Time Employees (FTE's) but has 509 full time employees as of May 5, 2008. Additionally, GPA has an apprenticeship program recognized and licensed by the U.S. Bureau of Labor.

1.2 Historical Period since the Last Integrated Resource Plan

In its Fiscal Year 1999 Integrated Resource Plan, the Guam Power Authority foresaw limited near term-economic growth. Looking back since then, historical system peak demand fell, for the most part within the lower band between the Authority's low growth scenario and medium growth scenarios. Several systemic shocks such as the gulf war, SARs, major typhoons, and rising fuel prices occurred during this period adversely affecting the Guam economy. As a result, the demand for electric power contracted or remained flat relative to FY 1998.

1.2.1 Looking Forward

The Authority must plan for an economic boom driven by resurgence in tourism and the proposed massive build up of the United States military infrastructure. This IRP forms a significant part of the Authority's Business Plan. Most importantly, this Business Plan looks at near term strategic management decisions such as:

- The expectation of future loads, sales and revenues;
- New Public-Private Partnerships; and
- Near-term addition of generation plant to serve future loads including fuel diversity, generation retirement or life extension, financing, and demand-side management.

1.3 Load Forecast

GPA believes that Guam is leaving a period of flat economic growth. Guam is entering a period of high economic growth. The leading indicator of this view is the anticipated build-up of military infrastructure and presence as recorded in the Department of Defense Quadrennial report, anticipated load projections from the United States Navy, as well as speculative future projects and deployments beyond the timeframe of the quadrennial reports.

1.4 Energy Conversion Agreements

In FY 1997, GPA committed to Energy Conversion Agreements (ECA) with Hawaiian Electric Industries, Inc. (HEI), Marianas Electric Company (MEC), and Taiwan Electric and Mechanical Engineering Services (TEMES). HEI took over the Authority's Tanguisson Power Plant. MEC constructed the Piti 8&9 slow speed diesel plant. TEMES constructed Piti 7, a 40 MW combustion turbine. Ownership of the Tanguisson plant ECA has changed from HEI to Mirant and from Mirant to Pruvient. MEC ownership has changed from Tomen Bank and Enron to Osaka Gas and Arclight, and finally solely to Osaka Gas. TEMES ownership remains the same. These contracts are for twenty-year terms. Table 1-1 indicates nominal generation capacities, and the effective and termination dates for the ECA contracts.

GPA is in an era of "contracted competition." GPA must measure its generation system performance against the performance and cost achieved by the ECA contractors.

1.5 Performance Management Contracts

The Guam Power Authority staff came up with the idea of using PMCs to improve baseload plant reliability and efficiency. GPA staff recognized that GPA did not have sufficient plant management, technical, and plant operation acumen resident at GPA to run its baseload facilities well. Keeping many of these skill sets full-time at the Authority is economically prohibitive. Additionally, GPA already had difficulty recruiting to fill technical and professional positions. Also, GovGuam procurement does not support an operations environment well. GovGuam procurement issues often result in prolonged unit outages. Furthermore, the Authority recognized the need for better, consistent training of its plant staff. Finally, staff foresaw that performance-based compensation would best drive exemplary performance and better protect the ratepayer from poor performance.

Table 1-1, ECA Summary

Plant	IPP	Plant Capacity (MW)	Contract Effective Date	Contract Termination Date
Piti Unit 7 (Combustion Turbine)	TEMES	40	December 1997	December 2017
Piti Unit 8&9 (Slow Speed Diesel)	MEC	88	January 1999	January 2019
Tanguisson Unit 1&2* (Steam)	Pruvient[2]	53	August 1997	August 2017

Using these salient points, GPA staff engaged management about the opportunity to use a contracted management team to manage, maintain, and operate its baseload plants. The Authority worked with two consultants[3] to flesh out the details of applying staff concepts and entered into a collaborative development of a PMC for Cabras 1&2 with the Guam Public Utilities Commission. All Authority baseload plants are now under the management of PMCs. These contracts have resulted in increased plant efficiencies and availabilities.

1.6 Near-Term Generation Addition

The Authority must make prudent decisions for near-term generation additions in light of its expectation for increasing electric demand. DOD's proposed buildup of facilities and the movement of marine units from Okinawa will drive increasing electric demand in the next eight years. This is in contrast to growth driven by tourism expansion in the nineties. However, uncertainties in DOD planning and approval of funding by a new Congress and presidential administration provide an element of risk.

1.6.1 Long Term Generation Reliability

GPA is in the midst of a transformation towards long-term generation system reliability. Beyond FY 2007, GPA contends that it will improve and maintain generation plant reliability to place among the top quartile of units as part of its strategic vision. The Authority will embark on a program for continuous measurable improvement in

[2] Contract has been reassigned two times. HEI (Hawaii Electric Industries Inc.) was the first IPP then Mirant.

[3] Larry R. Noyes of New Energy Associates in Atlanta, Georgia and Dave L. Rogers of Information2Energy.

generation reliability to meet or exceed unit availability levels stipulated in its ECAs by fiscal year 2010.

1.6.2 Environmental Constraints

GPA faces major environmental constraints on adding baseload capacity. In the short-term, Cabras-Piti complex is the only developed site for baseload expansion. Expansion on this site is limited by air-emission permitting as well as ocean discharge permitting. Currently, the Orote Basin is designated a non-attainment area for SO_2. However, the Section 325 waiver granted to GPA works in its favor. This waiver allows GPA to use higher sulfur content fuel when the wind blows offshore.

The Authority submitted a petition for re-designation of the Cabras-Piti area during 1996 based on air quality modeling and ambient air monitoring. However, GovGuam and GPA did not follow through. Hence, the re-designation did not occur.

If GPA chooses to pursue re-designation after a 10-year hiatus, it will face a number of potential obstacles[4]:

- Although United States Environmental Protection Agency Region 9 (USEPA IX) retains some individuals familiar with the 1996 petition (including USEPA's lead attorney), some others will need to be familiarized with the project;
- USEPA IX policies and regulatory focus may have changed;
- USEPA will likely want to see additional ambient air quality monitoring data;
- USEPA will likely want to see evidence that fuel switching has been taking place as required;
- USEPA will likely also expect to see activities by Guam Environmental Protection Agency (GEPA) that GPA will not directly control, including SIP (State Implementation Plan) revision, updated regulations and new permit conditions on the Cabras-Piti power plants;
- USEPA will likely also expect to see GEPA create a sulfur dioxide maintenance plan; and
- Staff and administration at GEPA has changed.

It is also likely that unexpected issues will arise. This is not surprising when dealing with a 10-year-old petition as well as local and federal regulators. Furthermore, limits on thermal discharge into the ocean will likely require cooling towers for new plants. However, the Section 325 exemption available to GPA can be a powerful tool to manage those challenges.

---

[4] McNurney, John M. [JMcNurney@RWBeck.com] email

1.6.3 Generation Mix and Load Shape

The Authority has all its generation in oil-fired units. This presents a strategic problem that has arisen over the last few years. While it is a prudent choice in the past because oil was inexpensive, it is no longer the case.

Peaking unit technologies are relatively inexpensive and quick to install but expensive to operate. Therefore they are ideally operated only during system peak demand periods or as reserve units in the absence of reliable baseload capacity. Efficient baseload units require much longer permitting and construction lead times. However, they possess much higher capital requirements for installation but are less expensive to operate. Intermediate units have unit characteristics between peaking and baseload. Table 1-2 describes the characteristics of these unit operating modes and technologies.

GPA's current generation mix has substantial number of diesel-fired peaking plants stemming from the need to add capacity in the early 1990s. In the last few years, the Authority has not relied heavily on diesel-fired generation to produce electric energy.

Guam's year-round tropical climate and tourism-based economy results in a relatively flat load cycle with high load factor. Such characteristics tend to favor baseload technology additions since operation near the peak is the norm. As an example, Figure 1-1 shows the GPA average demand hourly load shape for the period April 29 – 30, 2008. Note that GPA requires peaking capacity for only four hours for about 15 to 19 MW incremental peak.

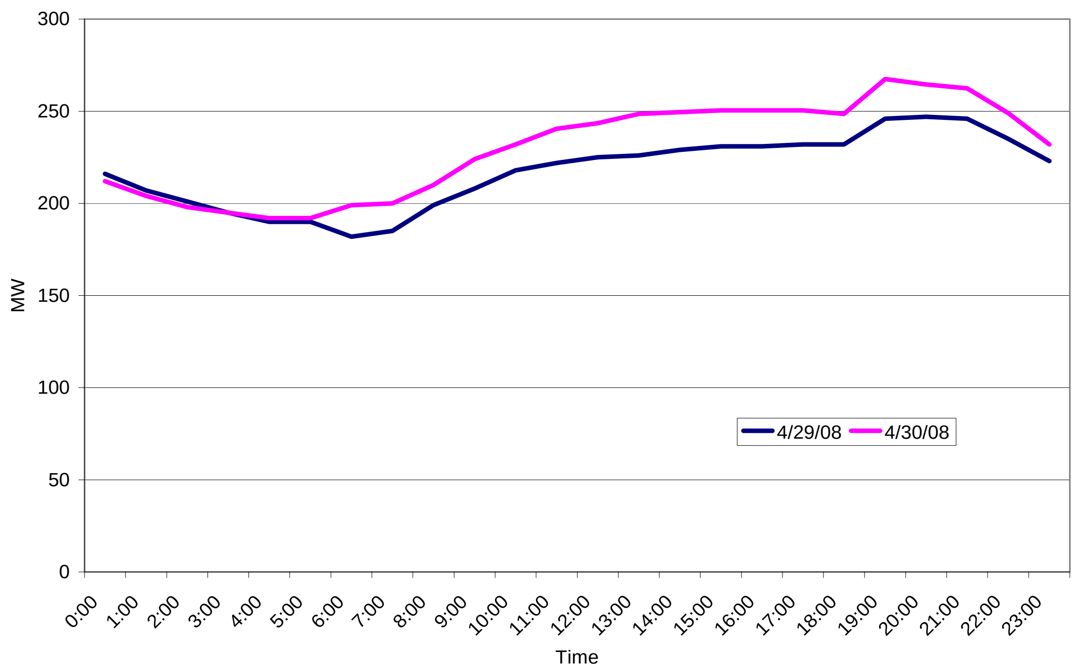

Figure 1-1, GPA Average Hourly Generation Requirements

Table 1-2, Duty Cycles and Capacity Factors[5]

Generating Unit Duty Cycle	Capacity Factor (%)		Generic Characteristics		
	Nominal	Range	Cost	Performance	Other
Baseload	65	50-85	High capital cost; low fuel cost; low maintenance cost	High Availability; high efficiency	Long Construction Lead Times
Intermediate	30	20 – 50	Intermediate-to-high capital cost; intermediate fuel cost	Increased output flexibility	Generally long construction lead times
Peaking	10	1-20	Low capital cost; high fuel cost; high maintenance cost	Increased output flexibility; quick starting	Short construction lead time

1.7 Fuel Issues

Fuel is a complicated issue. It now comprises over two-thirds of residential electric power rates. The issue is a global issue and affects all fuel types. Fuel issues include:

- Fuel price volatility;
- Risk of Fuel supply disruption;
- Fuel diversity;
- Environmental policies;
- Fuel hedging; and
- Prudent Fuel Use.

For the Guam Power Authority, fuel diversity will involve putting infrastructure in place to support other fuel types. This includes procurement, delivery, storage, and on-island transport. Figure 1-2 shows historical fuel prices for Diesel Fuel Oil No. 2, High-Sulfur Fuel Oil (HSFO), and Low-Sulfur Fuel Oil (LSFO).

[5] 1993 EPRI Technology Assessment Guide Volume 1: Electricity Supply. Table 2-1

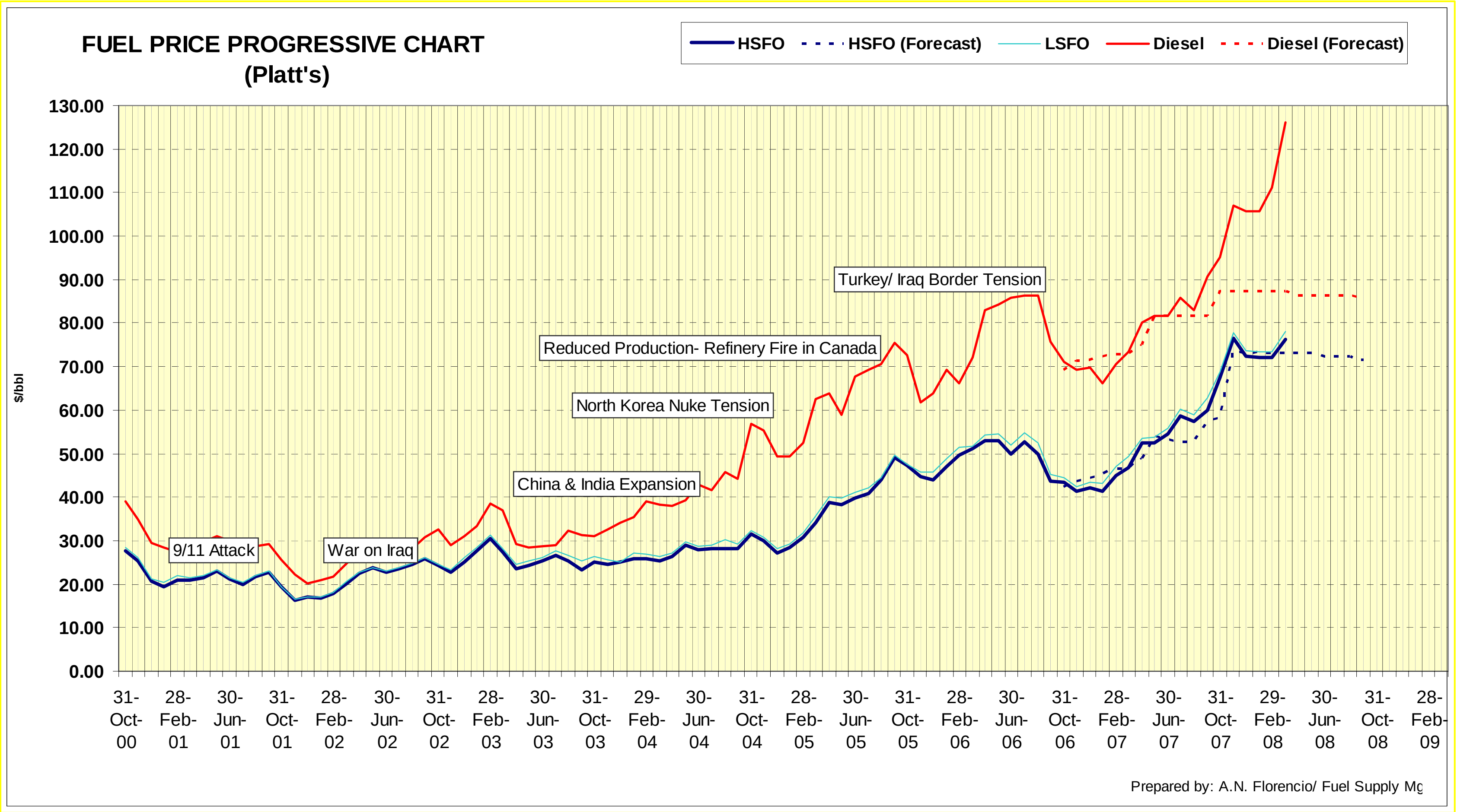

Figure 1-2, Historical Fuel Prices for Diesel No. 2, HSFO, and LSFO

1.7.1 Comprehensive Fuel Management Planning Requirement

GPA's Board of Directors has directed management to plan for fuel purchases. This directive has the following challenges:

- The availability of Major Baseloads impact fuel use dramatically;
- Generator failures are stochastic;
- Fuel Purchase Minimums must reflect expected unit dispatch but contain market and Fuel Management costs; and
- Fuel Purchase Maximum must reflect agreed upon contingencies.

The fuel purchase planning process must revisit the generation expansion plan. It must investigate fuel use under the assumption of expected or target operation modes as well as operation modes under various unit failure contingencies. GPA must plan for a bandwidth of operation and provide acceptable minimum and maximum fuel purchase limits.

This planning process must include a fuel purchase planning framework to provide the following:

- Fuel Purchase Minimums to satisfy expected use and inventory requirements; and
- Flexibility to accommodate baseload failures.

1.7.2 Change in Purchasing Practices Driven by Increased Baseload Reliability

With improvements to baseload reliability, GPA relies less on diesel fuel for energy production. Figure 1-3 shows the GPA's consumption by fuel type for FY 1991 through FY 2006. Figure 1-4 shows GPA production fuel expense by type for FY 1991 through FY 2006. Figure 1-5 shows the fuel savings to customers as a result of increased operational efficiencies.

The cost difference between Residual Fuel Oil (RFO) No. 6 and Diesel Fuel Oil (DFO) No. 2 on a per unit basis is a major system cost issue. Historically, DFO No. 2 is 1.5 times more expensive than HSFO No. 6.

The increase in diesel fuel use from FY 1992 until FY 1996 is due to fast track units serving loads. The drop in this fuel use from 1996 to 1999 is due to the operation of the Cabras 3&4. Despite the high unavailability of its own baseload units, the decline in diesel fuel use from FY 2000 to FY 2001 is due to the energy production from Independent Power Producers (IPP). The dip in fuel use from both RFO and diesel in FY 2002 is due to loss of loads because of typhoons. Recent historical decrease in the use of DFO No. 2 from FY 2003 stems from increased energy production from baseload units under the PMCs. Note that better baseload availabilities and better attention to economic dispatch have reduced both RFO and diesel consumption.

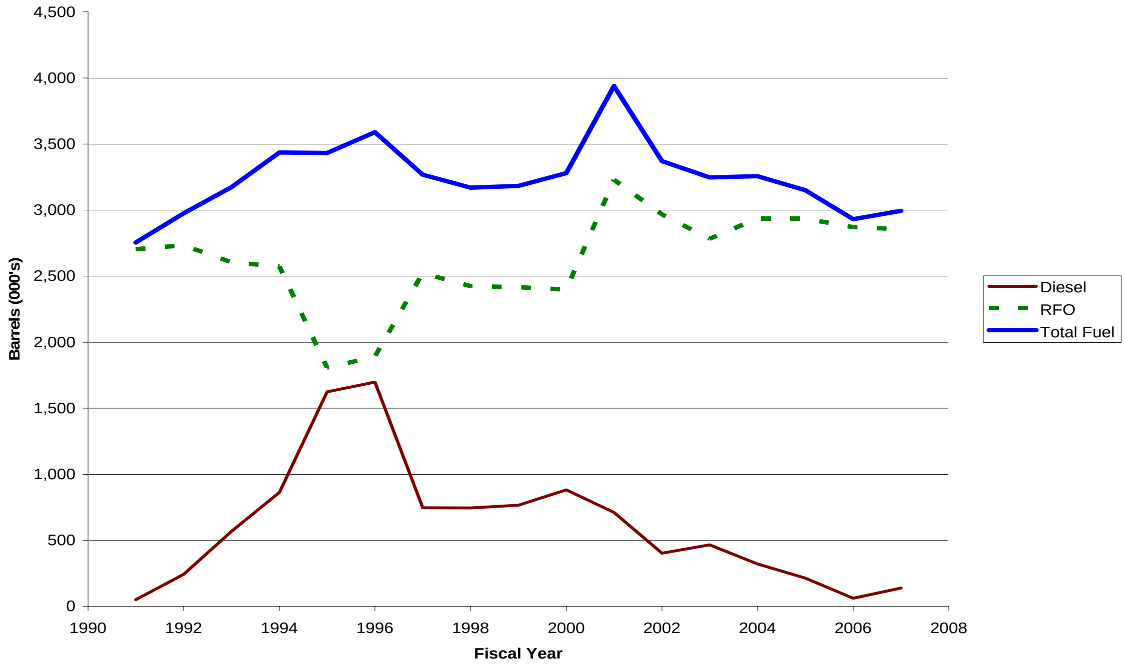

Figure 1-3, Production Fuel Consumption (000 Barrels) For FY 1991 Through FY 2007

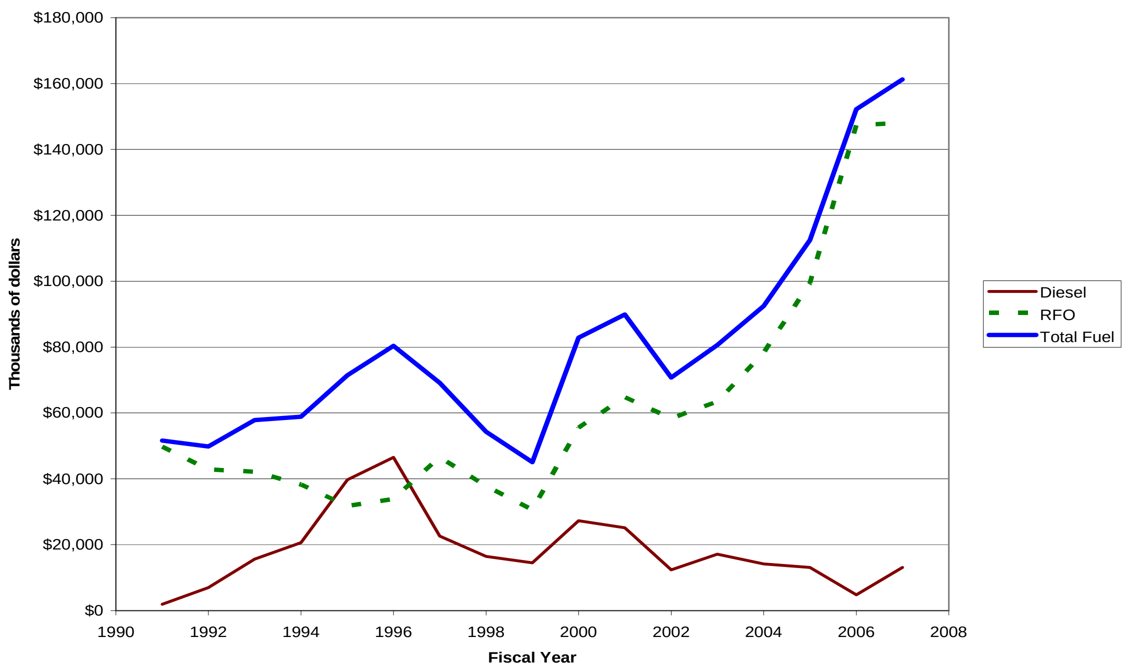

Figure 1-4, Production Fuel Expense ($000) For FY 1991 Through FY 2007

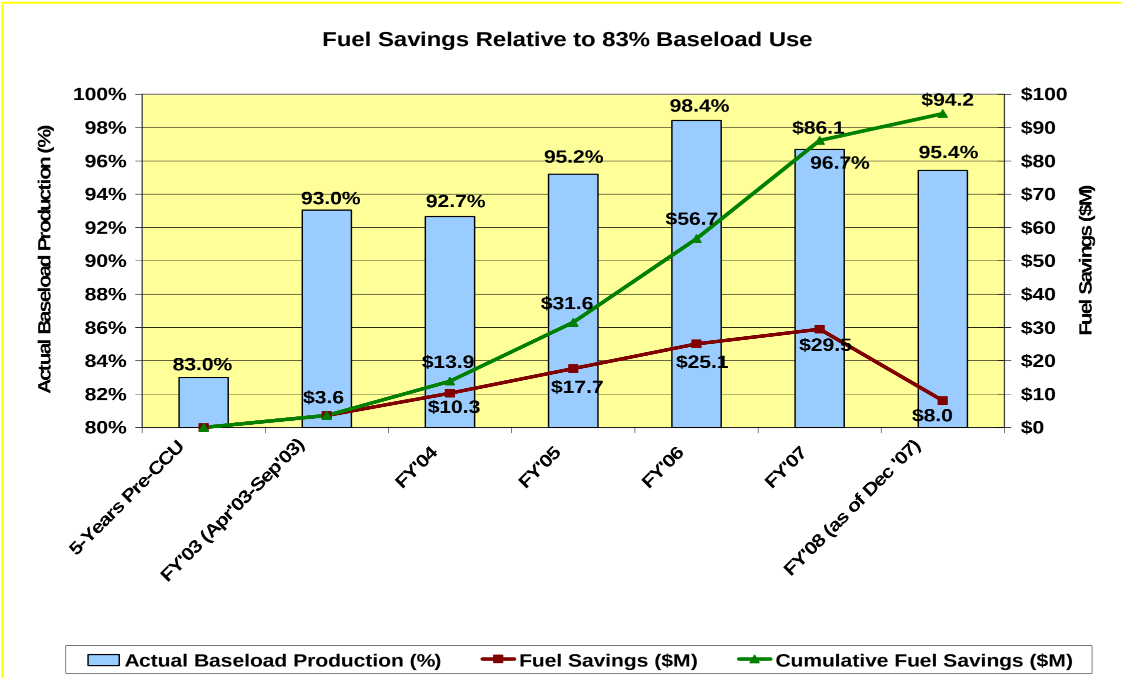

Figure 1-5, Fuel Savings Due to Increased Efficiency in Operations

1.8 Generation Retirement

GPA must prudently plan for generation unit retirements. Keeping units as back-up for poor operations is expensive. GPA must consider N-M scenarios, where N represent the number units installed and M represent the number of units on outage. Keeping assets because of equipment failures for large values of M is very expensive. However, GPA must also weigh the cost of unserved energy as part of the planning process.

1.8.1 Manpower Utilization Issues

Any retirement plan for generation must account for disposition of personnel. Thus, any generation retirement plan must assess the extent to which required personnel reductions may take place by retirement or retraining for reassignment within GPA and the Government of Guam.

1.8.2 Operational Value of Diesel-fired Assets

GPA must consider the operational value of units as strategic reserve by quantifying it in terms of net present value (NPV). Additionally, the introduction of non-firm capacity renewable energy will require quick-start generation as a backup. The Authority would not need to add this backup capability. It already exists.

1.9 Risk

There are several risks that the Authority has exposure to in creating and executing upon the recommendations of the IRP. These include planning risk, financial risk, and regulatory risk. The Authority must institutionalize uncertainty and risk management throughout all its planning: operational, financial, medium-range, and long-range.

1.9.1 Planning Risk

Long-term electric power supply planning must consider risk. As part of the planning process, the utility needs to forecast loads, sales, economic variables, and revenues. Additionally, it must forecast the capital, fixed, and variable costs for various power supply candidates. The longer the forecast, the greater the risk for divergence from what may actually transpire.

In order to plan well, the Authority needs to consider scenario planning. "Scenario planning, which considers adaptive behavior under alternative futures, is uniquely suited for identifying and categorizing unknown utility risks."[6]

The magnitude and timing of DOD load growth is still very much uncertain. It may be prudent for the Authority to work with Guam Waterworks Authority (GWA) on an interruptible load arrangement in order to hedge against the risk of higher than baseline load growth;

In addition to forecast risk, the run-up of fuel prices and tightening of supply, especially in the last quarter of calendar year 2007, to $126/BBL for crude oil is of great concern and threatens the affordability of electricity on Guam. It is also having an enormous financial impact as free cash flows are being diverted to fuel inventory. This run-up on fuel price is pushing the drive to fuel diversity and the introduction of renewable energy.

1.9.2 Financial Risk

There are three finance issues affecting resource planning:

- Short-Term Debt;
- GPA's Growing Long Term Bond Debt; and
- Bond and Credit Rating.

[6] Karyl B. Leggio, David L. Bodde, and Marilyn L. Taylor. "Managing Enterprise Risk: What the Electric Industry Experience Implies for Contemporary Business." Oxford, U.K.: Elsevier Ltd. 2006. page 14.

1.9.2.1 Short Term Debt

The Guam Legislature granted GPA the authority to obtain Tax Exempt Commercial Paper (TECP). Commercial paper is unsecured capital market financing based on the financial strength of the organization. The paper has varying terms between 30 - 270 days. Interest is payable upon expiration of the notes. TECP benefits include the following:

- Lower Interest Rates;
- Flexible Terms; and
- Flexible Drawdown.

GPA and its regulators must consider the need to preserve GPA's access to such financing. TECP is short-term debt. It has the probability of being rolled-over, but contains an element of risk. TECP should be used prudently. GPA's continued drawdown of its letters of credit to their maximum limits with out a cycle of full payment within the year has negatively affected its relations with lending institutions. GPA cannot allow this to occur with TECP.

Recently GPA’s attempts to obtain TECP financing have failed due to market and credit issues.

1.9.2.2 GPA Long Term Debt Outlook

GPA has undergone an accelerated and massive capital improvement driven by the high load growth and economic boom of the late 1980s and 1990s. Table 1-3 shows the growth in GPA assets and long-term bond debt.

GPA's access and the terms of access to the municipal bond market is an important resource advantage over alternative financing provided by other means. GPA must prudently manage its financial position in order to maintain access to the investor-grade municipal bond market. Furthermore, GPA has improved its bond rating from non-investment grade (junk) to its current rating: Standard & Poor's (S&P) – BB+, Stable, Moody’s and Fitch – Ba1, Positive Outlook.

Table 1-3, GPA Total Assets and Total Bond Commitments

Year	Total Assets (000's)	Total Bond Debt (000's)
FY07	$ 756,114	$ 381,595
FY06	$ 779,963	$ 386,888
FY05	$ 769,855	$ 391,901
FY04	$ 781,395	$ 396,648
FY03	$ 810,326	$ 401,141

1.9.3 Regulatory Risk

Federal and local legislation regarding environmental and utility policy may have a large impact upon the choice of competing planning portfolios. Of concern is the institution of greenhouse gas legislation such as a carbon cap and trade program and renewable portfolio standards. The concerns are well founded and fundamentally affect the economics of the addition of coal-fired generation. On a global and domestic scale, carbon legislation and cap & trade programs are:

- Currently in place in the EU, Japan, Australia, etc;
- China is working on implementation;
- Mainland has a voluntary credit mechanism trading today;
- EEI and other major trade groups have announced their support of the upcoming legislation;
- Most trade groups and major utilities are activity involved in the shaping of the legislation;
- Expected to be passed in 2010 and in effect in 2012.

2 Strategic Issues

The Strategic Issues behind this Integrated Resource Planning (IRP) effort include:

- Fuel Diversity, fuel supply risk, and renewable energy;
- Supporting the electric power service requirements for the impending Department of Defense (DOD) build-up and its economic consequences; and
- Acquisition of new electric energy supply and its implication on human resource requirements and the Authority business model.

Fuel diversity is the top driving force behind this IRP effort. The rising cost of fuel oil impacts the affordability of electric energy and saps free cash flows from operations and capital investments into fuel inventory. Fuel price volatility is an increasing strategic issue with petroleum. Additionally, having a non-diversified fuel base places the Authority's customers at a higher risk for supply disruption. Furthermore, local dollars for fuel oils are almost entirely spent outside the local economy. This money does not multiply itself among the community. Renewable sources of energy may allow for some of these dollars to trickle into the local economy. Finally, as an island people, the results of greenhouse gases contributing to climate change are clearly evident in the shrinking coastlines of Guam and our island neighbors.

Tourism growth triggered the economic boom of the nineties. The Authority grew from a 156 MW to a 281.5 MW peaking utility in less than a decade. The engine for next decade of economic growth on Guam will be the DOD build-up and its economic consequences in the civilian community.

Acquisition of new diversified electric energy supply has implication on human resource requirements. The Authority is not familiar with many of these new technologies. The Authority must consider whether new electric supply assets will depend entirely on external labor sources or whether Guam needs to grow the labor pool necessary to support these human resource needs. Furthermore, the Authority's business models include its own generation with internal staffing, independent power producers with external staffing, and performance management contracts with mixed staffing. Additionally, there are private sector advantages in execution and tax credit eligibility. Public sector advantages include Federal Emergency Management Agency (FEMA) and government grant eligibility and lower costs of money. Using the business model to provide the greatest value for customers is a strategic concern.

3 Scope of Work

This study is part of a regular cycle in the process of overall utility and strategic planning. In this phase, GPA will investigate the following issues related to critical near-term and potential long range strategic decisions:

- The Need For Generation Capacity (Next Unit Addition);
- Retirement Of All Generation Units Singly And In Combination;
- Benefits and Costs of GPA's Demand-Side Management Program;
- Projected Effect of Implementing a Deep Sea Water Cooling Distribution System in Tumon Bay;
- Implementation of Renewable Portfolio Standards Policy; and
- An Optimized Near and Long-Term Generation Expansion Plan.

4 IRP Process

GPA combines an analytical process approach and a stakeholder approach in developing this IRP.

4.1 Analytical Process

GPA used the following steps below to develop this IRP.

- Review planning environment;
- Develop inputs and assumptions;
- Develop load and resource balance to identify annual capacity/energy positions;
- Define candidate resource list, including demand-side management and supply resources;
- Use the capacity expansion optimization tool STRATEGIST to determine the optimal portfolio that eliminates annual capacity deficits according to capacity reserve margin requirements;
- Use planning scenario results to help determine a diversified resource mix that is robust across the range of alternative futures;
- Create risk analysis portfolios based on alternative strategies for managing portfolio risks that can be differentiated; and
- Select a preferred portfolio using evaluation criteria: *Cost, risk, system reliability, emission.*

4.1.1 Review Planning Environment

GPA considers fuel diversification and renewable portfolio standards in this IRP including conventional and renewable candidate resources. Research efforts included fuel accessibility, price and storage. GPA focuses intensely on wind power primarily because of availability of data on capital and operational costs and maturity of technology. However, in the implementation of the recommendations GPA will consider wind power as a proxy for all renewables.

4.1.2 Develop Inputs & Assumptions

GPA uses a software application to determine optimal expansion plan based on lowest system costs. With that, critical information is inputted such as operational costs (fixed and variable costs, production efficiencies, etc.), anticipated load requirements, seasonal use, and availability/maintenance scheduling, to name a few. For new resources, construction timelines and capital/construction cost assumptions are applied.

In addition to this GPA must consider impacts of changes in capital costs, anticipated legislation (Carbon Cap & Trade or Renewable Production Tax Credits), uncertainties in Guam growth and uncertainties in fuel. Assumptions are typically made and new scenarios are developed in order to consider them.

4.1.3 Develop Load & Resource Balance

As the sole power utility on Guam, GPA must ensure power is available to its customers. System availability and reliability is a factor in determining when to bring in the next resource. System reserve margins ensure that the system is capable to serve its customers when a unit or several units are not operational due to maintenance or forced outages. R.W. Beck consultants recommended that a 50-60% reserve margin is appropriate for Guam.

4.1.4 Define Candidate List

The selection of potential resources can have a serious affect on an island grid. Units sized inappropriately will affect system reliability and may put the system at risk for system blackouts. Additional considerations include land requirements, local and federal regulation restrictions (environmental impact), accessibility to fuel resources, and fuel diversification. These are supply-side options.

GPA must also consider options for the customer-side. These are typically referred to Demand-Side Management (DSM) programs. They may be in the form of rebate program that promotes energy efficient appliances or displacing electricity use by an alternate source such as ocean water cooling for large hotel air conditioning systems.

4.1.5 Determine Optimal Portfolio

In order to determine an optimal portfolio a modeling software for resource expansion optimization is used. This software analyzes planning scenario costs which include load requirements, operational costs, and financing/bond requirements to determine the most economical plan for a study period. GPA licensed STRATEGIST to perform this task.

4.1.6 Determine Diversified Resource Mix

The STRATEGIST software will determine the most economical plans without constraints for fuel diversity. GPA should consider fuel diversification in addition to the most economic plans. However, GPA believes that the most economic plans will have substantial diversification.

4.1.7 Create Risk Analysis

Fuel market uncertainties and typhoons are risks that Guam is exposed to. Although fuel prices can be adjusted and analyzed through the expansion tool software, damages to wind turbines after a super typhoon and loss of production capacity and additional repair costs are not easily analyzed. Optimal plans identified through software modeling are further evaluated against such risks.

4.1.8 Select Preferred Portfolio

After all the models have been run and the risk analysis has been completed a preferred portfolio can now be selected that incorporates a least cost optimal plan and has considered risk factors.

4.2 Stakeholder Process

GPA uses a stakeholder process in an effort to involve the community in the development of the IRP. This process allowed GPA to provide the community progress in the plan and also initiated dialogue on assumptions and risk considerations being used for new resource candidates, fuel forecasts and availability, and local and federal regulations.

GPA selected representatives from different areas in the community and held four public meetings that presented progress information on the current state of GPA, anticipations of the IRP, information used in the IRP, and the modeling results. The meetings initiated in October 2007 and the last meeting was held in April 2008.

4.2.1 The Stakeholders

GPA initiated the stakeholder process by selecting and inviting people from the community which represent the following areas:

- Department of Defense (DOD);
- Hotel Industry (Guam Hotel & Restaurant Association);
- Construction Industry (Guam Contractors Association);
- Financial Institution (Bank of Guam);
- Legislature;
- Government Agencies (Guam Energy Office, Guam Chamber of Commerce, Port Authority of Guam, Civilian Military Task Force/DPW, EPA);
- Environmental;

- Other (Residential Customers);
- Public Utilities Commission of Guam (Guam PUC); and
- Consolidated Commission on Utilities (CCU).

4.2.2 Meetings

GPA completed four public meetings during the development of the IRP. The initial meeting provided an overview of the Authority and objective of the IRP as well as preliminary data acquired. The next meeting discussed the key assumptions being used. The third meeting provided preliminary results. Finally, the fourth and final meeting provided the updated assumptions and results.

GPA has tried to incorporate or address concerns generated during these work sessions by initiating additional research on other fuels and technologies as well as updating forecasts. All presentations, handouts and audio files were made available to the public on the GPA website at: www. guampowerauthority.com.

5 Future Electric Requirements of Guam

GPA contracted P.L. Mangilao Energy in FY 2006 to develop and update an econometric model to forecast GPA's sales and load. At the onset of this contract, there were four scenarios of probable load growth: No significant growth, Rapid tourism growth, Rapid infrastructure growth, and Rapid tourism and rapid infrastructure growth[7]. This was during the early discussion period of the Okinawa military base relocation and consideration of the Naval and Air Force base expansions. During the last several months however, it has become more evident that Department of Defense (DOD) growth will occur and that the baseline scenario should reflect this as infrastructure impact. Thus, the scenarios evaluated for this integrated resource plan are:

- Normal – "Business as Usual" (No DOD Buildup);
- Baseline – Moderate Tourism Growth and DOD Buildup; and
- High – Rapid Tourism and Rapid Infrastructure Growth.

These scenarios are based on local research on construction, labor, tourism, and anticipated DOD growth. The levels of growth due to DOD buildup present significant construction and employment opportunities. Ultimately, this affects Guam's economic outlook. Potential infrastructure spending due to primarily DOD contracts, amount to $8 billion as early as 2013 and totaling $16 billion by 2025 for a rapid infrastructure scenario. Growth in infrastructure will impact the GPA electrical system due to energy requirements necessary to support new load and the capability of the system to meet energy demand.[8]

5.1 The Econometric Model

There are several variables that go into an econometric model. Economic forecasts for Guam and Japan by Moody's are used to provide the basis for tourism and construction assumptions for Guam. Additional information that will affect construction activities, such as DOD buildup, is provided through the Department of Defense Quadrennial Report and meetings with DOD representatives. Historical weather and peak load data is also used to develop patterns for energy use (sales).

GPA uses the latest E-view program version to run its forecasting model. This is a Windows-based forecasting package developed by QMS (Quantitative Micro Software). Figure 5-1 identifies the variables used in the GPA model.

[7] GPA Peak Demand and Sales Forecast Documentation**,** PL Mangilao Energy, LLC, September 23, 2007.
[8] Forecasting GPA's Long Range Sales and Load, 2007 GPA Pacific Power Association Conference Paper

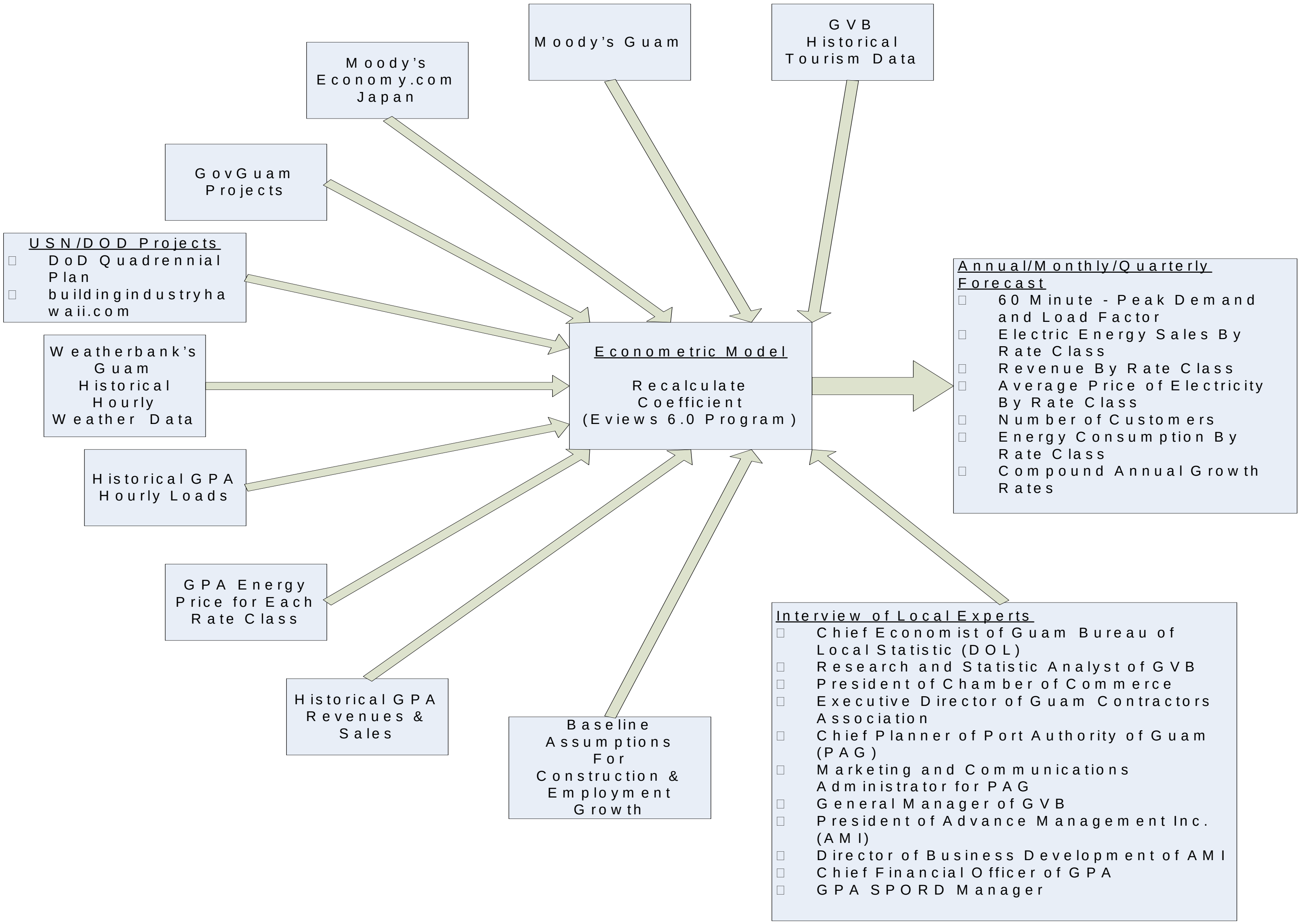

Figure 5-1, Econometric Model Input/Output Flow Diagram

5.2 Summary of Load Forecast Scenarios

The Normal ("Business as Usual") scenario does not consider significant tourism growth or appreciable DOD buildup. It does not consider the Okinawa base relocation.

The Baseline scenario is based on the Moody's forecast for Guam and Japan. It incorporates a 5.4% employment growth and anticipates a peak of 366 MW by 2017.

The High scenario considers a more expansive DOD buildup, inclusive of basing of aircraft carriers and attack submarines.

5.2.1 Forecast Assumptions

P.L. Mangilao made several assumptions in the forecast as shown in Table 5-1. These are based on their experiences and prior research over several decades forecasting in the electric power industry. This data is used for all scenarios.

Table 5-1, Forecast Assumptions

Assumptions	Assumed Value
Number of jobs created indirectly for every new infrastructure job	0.6
Construction employment effects are transitory	
Number of permanent operating or maintenance job is created for every $1 (2005 $) in construction spending:	1
A/E Firm's Average Overhead Rate:	30%
Guam Average Hourly Earnings In Construction (2005 $):	$11.50
Mainland Average Hourly Earnings In Construction (2005 $):	$37.00
Construction Expenditure per Construction Job (2005 $):	$189,150
% of Materials & Supplies in Construction Expenditure:	67%
% Labor Costs in Construction Expenditure:	33%
% of I-94 Labor:	50%
% of Mainland Labor:	50%
I-94 Workers, % of wages spent locally:	30%
Mainland Workers, % of wages spent locally:	50%
Indirect Employment Multiplier	0.60

In addition to the forecast assumptions, proposed construction projects for GovGuam and DOD were also considered. The projects are listed in Table 5-2 and the annual construction expenditures are graphed in Figure 5-2.

Table 5-2, Construction Projects

Project Description	Estimated Cost	Estimated Project Start	Estimated Project Completion
X-ray Wharf Upgrade by Sun Woo Corp	$ 2,000,000	2006	2006
Romeo Sierra Wharves Upgrade by Reliable Builders	$ 3,000,000	2006	2006
Dredging Naval Harbor	$ 8,000,000	2006	2006
Naval Waterworks and Wastewater Projects	$ 103,600,000	2008	2008
Naval Power System Hardening and Recapitalize	$ 400,000,000	2007	2017
Alpha Bravo Wharves Project	$ 55,000,000	2006	2007
Liguan Terrace Elementary School	$ 30,000,000	2006	2008
Astumbo Middle School	$ 30,000,000	2006	2008
Ukudu High School	$ 30,000,000	2006	2008
Adacao Elementary School	$ 30,000,000	2008	2010
New DoDEA Elementary/Middle School	$ 40,600,000	2006	2008
New DoDEA High School	$ 40,600,000	2006	2008
Housing construction and renovation at Naval Station	$ 512,000,000	2006	2025
Munitions storage facilities at AAFB	$ 15,000,000	2006	2006
Guam Army National Guard Facility Phase IV	$ 4,900,000	2006	2006
Replace AAFB Canine Facility	$ 3,500,000	2006	2007
GPA Underground Lines Upgrade	$ 200,000,000	2006	2013
GTA Modernization Investment	$ 100,000,000	2006	2010
Water System Upgrade	$ 360,000,000	2007	2009
P-780A, Upgrade NW Field, Ph I	$ 12,000,000	2007	2009
P-780B, Upgrade NW Field, Ph II	$ 12,000,000	2007	2009
Global Hawk Complex	$ 52,000,000	2007	2009
P-502, Kilo Wharf Extension, Ph I	$ 101,800,000	2008	2008
P-494, Harden Electrical System, Dist/Subs	$ 50,000,000	2007	2009
Naval Hospital Replacement	$ 145,000,000	2008	2011
8,000 Marines from Okinawa	$ 6,600,000,000	2008	2012
P-502A, Kilo Wharf Extension, Ph II	$ 25,000,000	2008	2008
Future Naval Construction	$ 3,168,000,000	2010	2025
High Growth Scenario:			
Aircraft Carrier Group	$ 3,150,000,000	2010	2015
Submarine 1	$ 189,000,000	2010	2014
Submarine 2	$ 189,000,000	2015	2019
Submarine 3	$ 189,000,000	2020	2024
Submarine 4	$ 189,000,000	2025	2029
Total	$16,040,000,000		

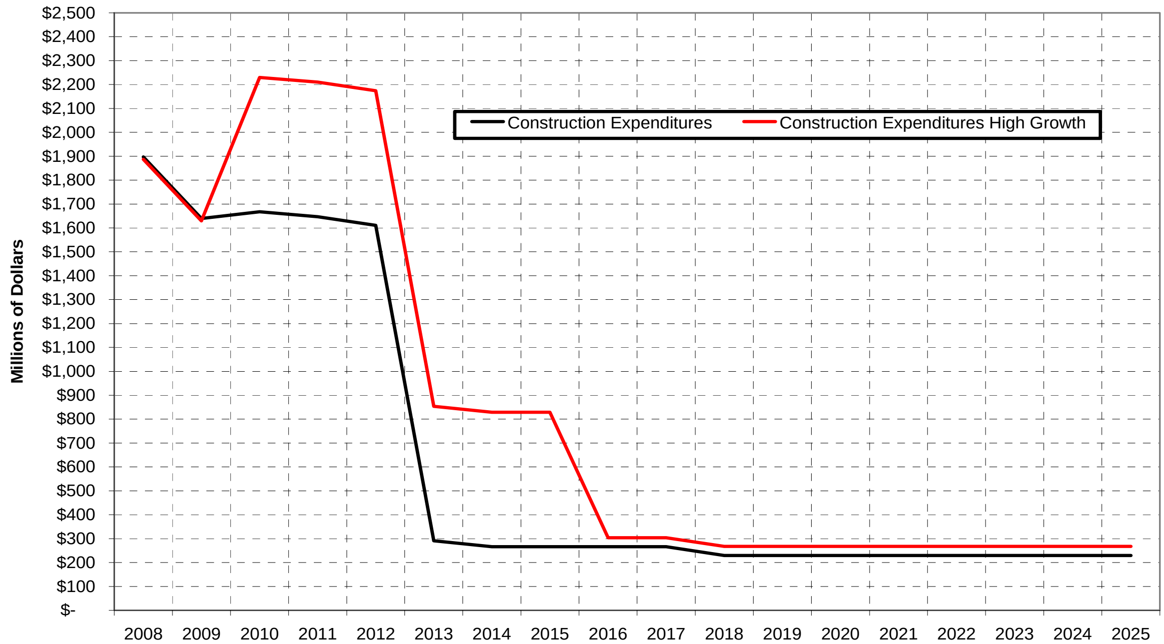

Figure 5-2, Total Construction Expenditures

5.2.2 Energy and Peak Demand Forecast

Figure 5-3 charts the forecast results for GPA energy sales. All three scenarios show significant growth rates with the High scenario taking off as early as 2008.

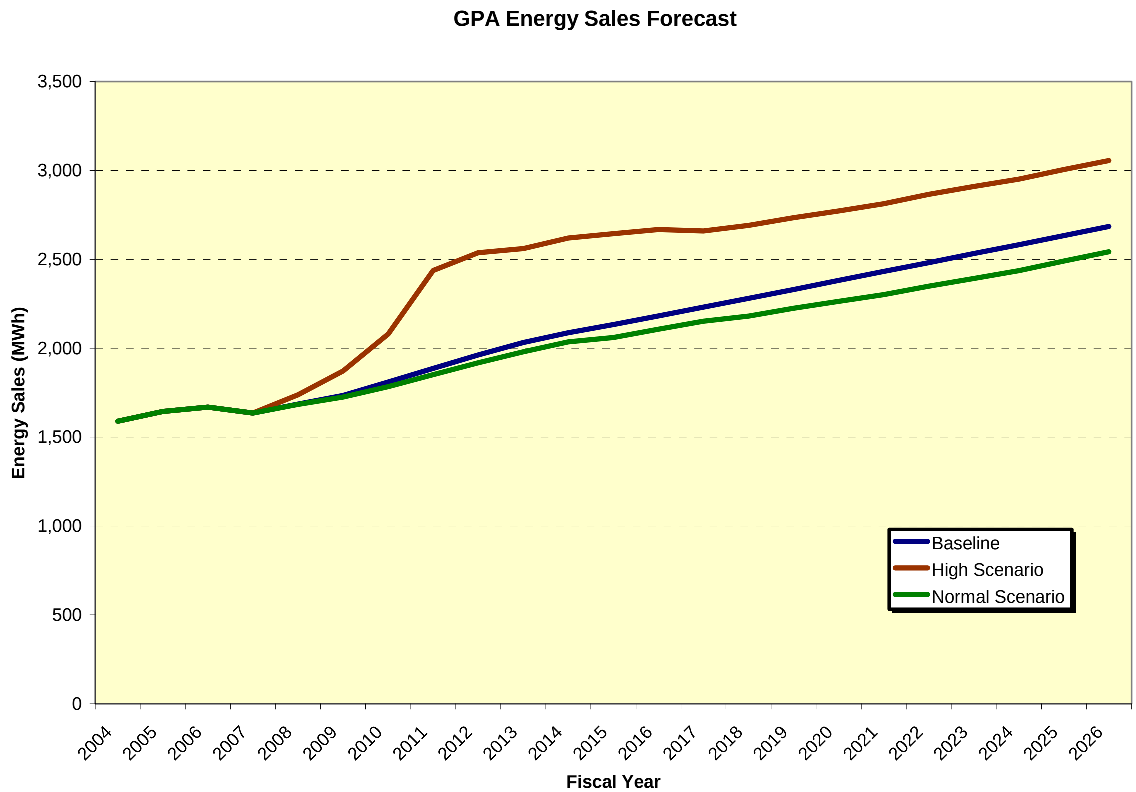

Figure 5-3, Energy Forecast

Figure 5-4 graphs the peak demand forecast. Based on a 60% reserve margin, the Baseline scenario shows new capacity is required in 2017. This is 5 years earlier than the scenario with minimum growth. Although GPA's currently installed capacity is sufficient to support a baseline scenario growth for the next several years GPA would need to start initiating the acquisition of the next unit due to procurement, engineering and construction schedules.

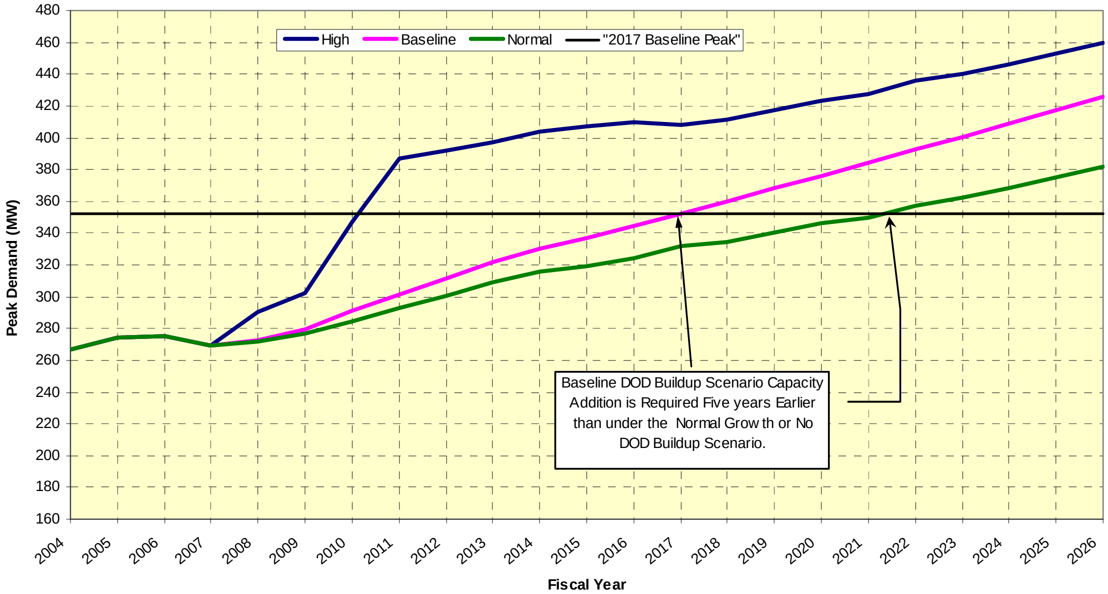

Figure 5-4, Peak Demand Forecast

6 Future Fuel Costs & Choices for GPA

GPA contracted P.L. Mangilao Energy in 2008 to develop the fuel price forecasts for Residual Fuel Oil (RFO), Diesel Oil (Diesel), Coal, and Liquefied Natural Gas (LNG). P.L. Mangilao Energy's fuel price forecast for RFO and Diesel are based on the forecasts of Singapore prices consistent with Strategic Energy and Economic Research's (SEER's) most recent "Global Petroleum SEER Monthly".[9] Similarly, the forecast for LNG is consistent with SEER's most recent outlook for natural gas, "Natural Gas SEER Monthly". The forecast for thermal coal is developed by JD Energy. These three forecasting organizations have been working closely together for more than a decade and their forecasts of energy prices are constructed to be rigorously consistent.

Figure 6-1 shows the forecast for high and low sulfur fuel oils, diesel, coal and LNG in heat energy unit price based on the long-term baseline scenario developed P.L. Mangilao Energy back in early 2008. However, current market conditions indicate higher than forecast prices for the near-term Prices are expected to rise even higher due to the weakening of the US dollar and the growing geopolitical tensions.

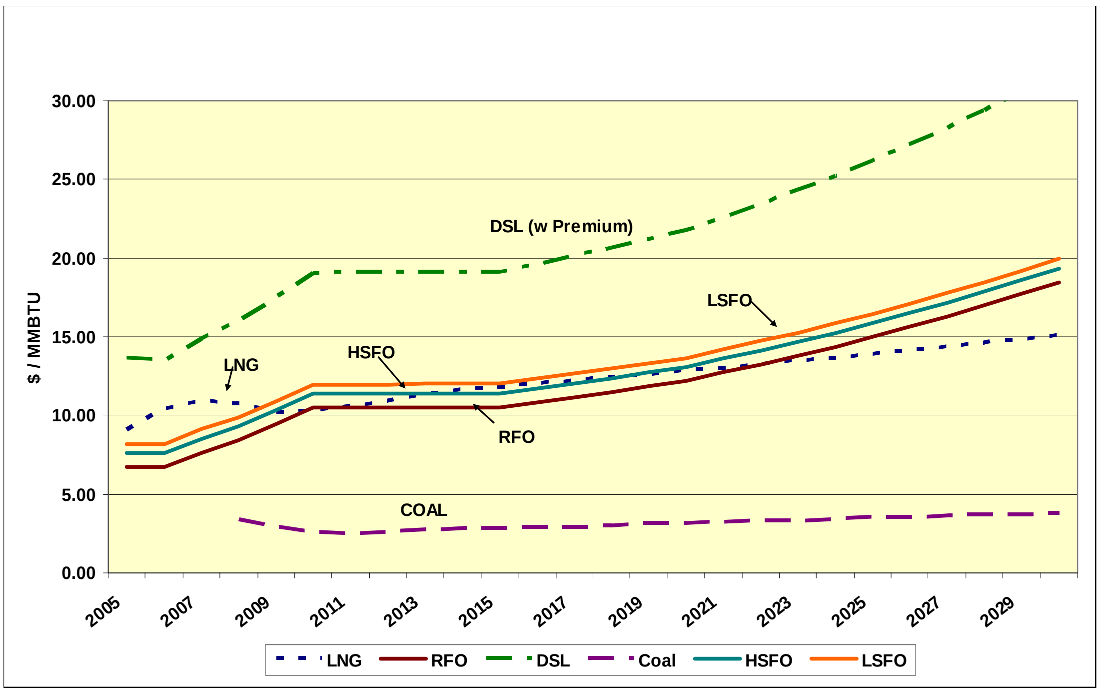

Figure 6-1, Forecast for Petroleum Products, Coal and LNG ($/MMBTU)

[9] GPA Peak Demand and Sales Forecast Documentation, PL Mangilao Energy, LLC, September 23, 2007.

The heat energy unit price forecasts are based on 5.7 million BTUs per barrel for Diesel, 6.0 million BTUs per barrel for High and Low Sulfur Fuel Oil.

The forecast fuel price for diesel is the SEER's forecast Singapore price for Gasoil plus the average markup in GPA's Diesel supply contracts, $14.2 per barrel. The forecasts for both High and Low Sulfur Fuel Oil recognizes that the price GPA pays is pegged to Singapore price for 180 cst Residual prices. An added markup of $5.30 per barrel is the markup over 180 cst Residual in GPA's supply contract and a special additional markup for the Low Sulfur variety of $3.49 per barrel is also from GPA's supply contract.

6.1 Price Forecast for Fuel Oil

P.L. Mangilao Energy developed three scenarios for the fuel oil price forecasts; a Low, a Base, and a High case. Prices given in the scenarios are shown for the following:

- West Texas Intermediate (WTI) in nominal or current year $/barrel;
- US Refiner's Acquisition Cost of Crude (a benchmark price in energy markets);
- Prices for RFO and No. 2 Fuel Oil CIF Singapore; and
- Prices for RFO and No. 2 Fuel oil CIF Guam.

The price of petroleum products in Asia, including Singapore and Guam is shape by the global market forces, such as product balances and shipping costs. Diesel Oil is historically 1.5 times more expensive than RFO, and shipping "clean" products such as Diesel fuel costs more. However, refinery economics do not vary significantly over the long term, and the outlook and forecasts over the next two decades result to eventual minimal differences between the RFO and Diesel forecasts prices.

6.1.1 Base Case

Table 6-1 illustrates P.L. Mangilao's base case outlook for petroleum products that will be purchased by GPA. This scenario shows approximately a 2% increase in worldwide oil production capacity, and by the end of 2008, the strong growth in oil productive capacity is expected to cause sharp downward pressures on oil and natural gas prices.

Table 6-1, Fuel Oil Forecast (Base Case)

	Current Year $ per BBL					
	US RAC Imported Crude	Singapore Resid 180	Singapore Gasoil	Guam Resid	Guam Gasoil	WTI
2005	$46.53	$39.58	$62.09	$40.45	$63.35	$54.91
2006	$58.88	$39.41	$61.37	$40.31	$62.67	$66.05
2007	$60.94	$44.99	$69.22	$45.92	$70.55	$71.95
2008	$62.44	$49.63	$75.59	$50.55	$76.93	$71.92
2009	$65.53	$55.62	$84.01	$56.56	$85.38	$71.57
2010	$68.75	$61.87	$92.81	$62.84	$94.21	$71.98
2011	$68.88	$61.99	$92.99	$62.98	$94.42	$72.26
2012	$68.97	$62.08	$93.11	$63.09	$94.58	$72.56
2013	$69.03	$62.13	$93.19	$63.17	$94.70	$72.73
2014	$69.05	$62.14	$93.21	$63.21	$94.76	$72.75
2015	$69.02	$62.12	$93.18	$63.21	$94.76	$72.67
2016	$71.08	$63.98	$95.96	$65.10	$97.59	$72.47
2017	$73.21	$65.89	$98.83	$67.04	$100.49	$74.45
2018	$75.40	$67.86	$101.78	$69.04	$103.49	$77.53
2019	$77.64	$69.88	$104.82	$71.09	$106.57	$80.74
2020	$79.96	$71.96	$107.95	$73.20	$109.74	$84.09
2021	$83.39	$75.05	$112.57	$76.32	$114.41	$87.73
2022	$86.93	$78.24	$117.36	$79.54	$119.24	$91.47
2023	$90.61	$81.55	$122.32	$82.88	$124.25	$95.25
2024	$94.41	$84.97	$127.45	$86.34	$129.43	$99.11
2025	$98.35	$88.51	$132.77	$89.91	$134.79	$103.02
2026	$102.64	$92.38	$138.57	$93.82	$140.65	$107.21
2027	$107.10	$96.39	$144.58	$97.86	$146.71	$111.73
2028	$111.71	$100.54	$150.80	$102.05	$152.98	$116.50
2029	$116.48	$104.83	$157.25	$106.38	$159.48	$121.79
2030	$121.42	$109.28	$163.92	$110.87	$166.21	$126.71

6.1.2 High Price Case

P.L. Mangilao's high price case outlook is similar to the high price case contained in the US DOE/EIA 2007 Annual Energy Outlook. This can be found on US DOE's website - www.eia.doe.gov/oiaf/archive/aeo07/aeohighprice.html.

This takes into consideration global market uncertainties that can drive up the price of petroleum products, such as supply disruptions and strong demand growth. Table 6-2 illustrates the high case outlook for petroleum products delivered to Guam.

Table 6-2, Fuel Oil Forecast (High Case)

	Current Year $ per BBL					
	US RAC Imported Crude	Singapore Resid 180	Singapore Gasoil	Guam Resid	Guam Gasoil	WTI
2005	$46.53	$39.58	$62.09	$40.45	$63.35	$54.91
2006	$58.88	$52.99	$79.49	$53.89	$80.79	$66.05
2007	$60.94	$56.81	$85.21	$57.73	$86.54	$71.95
2008	$64.48	$59.34	$89.01	$60.26	$90.34	$72.17
2009	$69.73	$63.42	$95.14	$64.37	$96.50	$74.84
2010	$75.19	$67.67	$101.51	$68.64	$102.91	$78.42
2011	$79.48	$71.53	$107.30	$72.52	$108.73	$82.55
2012	$83.93	$75.54	$113.31	$76.56	$114.78	$86.48
2013	$88.56	$79.70	$119.55	$80.75	$121.06	$91.12
2014	$93.36	$84.03	$126.04	$85.10	$127.59	$96.54
2015	$98.35	$88.52	$132.78	$89.61	$134.36	$102.01
2016	$103.32	$92.99	$139.49	$94.12	$141.11	$107.64
2017	$108.48	$97.63	$146.45	$98.78	$148.11	$112.74
2018	$113.83	$102.45	$153.67	$103.63	$155.38	$117.97
2019	$119.38	$107.44	$161.17	$108.65	$162.91	$123.57
2020	$125.14	$112.63	$168.94	$113.87	$170.73	$129.27
2021	$129.84	$116.85	$175.28	$118.12	$177.12	$134.19
2022	$134.69	$121.22	$181.84	$122.53	$183.72	$138.64
2023	$139.71	$125.74	$188.61	$127.07	$190.54	$143.88
2024	$144.89	$130.40	$195.61	$131.77	$197.58	$149.30
2025	$150.25	$135.22	$202.84	$136.63	$204.86	$154.92
2026	$155.94	$140.34	$210.51	$141.78	$212.59	$160.72
2027	$161.81	$145.63	$218.45	$147.11	$220.58	$166.71
2028	$167.89	$151.10	$226.65	$152.61	$228.83	$172.90
2029	$174.16	$156.75	$235.12	$158.30	$237.36	$179.30
2030	$180.65	$162.59	$243.88	$164.17	$246.17	$185.94

6.1.3 Low Price Case

On the other hand, excess oil productive capacity can lead to sharp drops in oil prices. This would be the most likely case if the world economy can return to reasonable political stability and moderate economic growth. Table 6-3 shows the Low Price Case scenario constructed by SEER.

Table 6-3, Fuel Oil Forecast (Low Case)

	Current Year $ per BBL					
	US RAC Imported Crude	Singapore Resid 180	Singapore Gasoil	Guam Resid	Guam Gasoil	WTI
2005	$46.53	$39.58	$62.09	$40.45	$63.35	$54.91
2006	$58.88	$52.99	$79.49	$53.89	$80.79	$66.05
2007	$60.94	$54.06	$82.26	$54.98	$83.59	$71.95
2008	$61.19	$54.55	$82.61	$55.47	$83.94	$69.13
2009	$62.98	$56.42	$85.03	$57.36	$86.39	$69.28
2010	$64.83	$58.35	$87.52	$59.31	$88.92	$69.67
2011	$63.91	$57.52	$86.28	$58.51	$87.71	$68.38
2012	$62.91	$56.62	$84.93	$57.64	$86.40	$62.17
2013	$61.82	$55.64	$83.45	$56.68	$84.96	$63.15
2014	$60.63	$54.57	$81.85	$55.64	$83.40	$62.95
2015	$59.35	$53.41	$80.12	$54.51	$81.70	$63.61
2016	$61.34	$55.21	$82.81	$56.33	$84.43	$65.09
2017	$63.40	$57.06	$85.59	$58.21	$87.25	$67.24
2018	$65.52	$58.97	$88.46	$60.15	$90.16	$69.46
2019	$67.71	$60.94	$91.41	$62.15	$93.16	$71.74
2020	$69.97	$62.97	$94.46	$64.21	$96.25	$74.10
2021	$72.57	$65.31	$97.96	$66.58	$99.80	$76.80
2022	$75.25	$67.72	$101.58	$69.03	$103.47	$79.59
2023	$78.02	$70.22	$105.33	$71.55	$107.25	$82.47
2024	$80.88	$72.79	$109.19	$74.16	$111.17	$85.44
2025	$83.84	$75.45	$113.18	$76.86	$115.21	$88.51
2026	$86.89	$78.20	$117.31	$79.64	$119.38	$91.69
2027	$90.05	$81.04	$121.56	$82.52	$123.69	$94.96
2028	$93.31	$83.98	$125.96	$85.49	$128.14	$98.34
2029	$96.67	$87.00	$130.51	$88.55	$132.74	$101.83
2030	$100.15	$90.13	$135.20	$91.72	$137.49	$105.43

6.2 Price Forecast for LNG

P.L. Mangilao presented three cases for LNG price forecast, Base Case, High Case, and Low Case. This forecast is based on the Indonesia market (Tangguh) for LNG. It is considered the most likely source of LNG for Guam. Prices shown are for the commodity cost of LNG purchased at Tangguh, the cost of transport to Guam, the cost of regasification, and the delivered cost.

P.L. Mangilao points out that there are several challenges regarding the use of LNG as a substitute for Diesel and RFO. These are major challenges that GPA must seriously consider. The smallest sized LNG tankers require the corresponding required storage facilities be available on Guam. Increased costs are associated with purchasing a partial tanker load. Regasification requires a minimum throughput to be economic. To overcome these challenges, it was assumed that other applications for natural gas would be developed so that the overhead cost of storage and regasification could be spread over larger volumes.

The Tangguh LNG prices are shown in Tables 6-4, 6-5 and 6-6, the differences in the data being the adjustments for transportation costs and regasification of LNG.

6.2.1 Base Case Forecast

Table 6-4 is the base case outlook for LNG Prices for Guam. The delivered price of LNG is expected to gradually decrease over the forecast time horizon, from $10.91/mmbtu in 2007 (CIF Guam) to $13.90/mmbtu in 2025.

Table 6-4, LNG Forecast (Base Case)

Nominal $ per MMBTU

	Tangguh Indonesia	Transport	Regas	Guam Delivered Price
2005	5.15	1.30	2.65	9.09
2006	6.37	1.34	2.73	10.44
2007	6.74	1.37	2.80	10.91
2008	6.58	1.37	2.80	10.75
2009	5.95	1.41	2.87	10.22
2010	5.92	1.44	2.94	10.30
2011	6.13	1.48	3.01	10.62
2012	6.34	1.51	3.09	10.94
2013	6.57	1.55	3.16	11.28
2014	6.80	1.59	3.24	11.63
2015	6.86	1.63	3.32	11.82
2016	6.93	1.67	3.41	12.01
2017	7.00	1.71	3.49	12.20
2018	7.07	1.76	3.58	12.40
2019	7.13	1.80	3.67	12.60
2020	7.20	1.85	3.76	12.81
2021	7.27	1.89	3.85	13.02
2022	7.34	1.94	3.95	13.23
2023	7.42	1.99	4.05	13.45
2024	7.49	2.04	4.15	13.67
2025	7.56	2.09	4.25	13.90
2026	7.63	2.14	4.36	14.13
2027	7.71	2.19	4.47	14.37
2028	7.78	2.25	4.58	14.61
2029	7.86	2.30	4.70	14.86
2030	7.93	2.36	4.81	15.11

6.2.2 High Price Case

Table 6-5 shows the High Price Case forecast for LNG delivered to Guam, where LNG is expected to reach $16.43/mmBTU in 2025.

Table 6-5, LNG Forecast (High Case)

Nominal $ per MMBTU

	Tangguh Indonesia	Transport	Regas	Guam Delivered Price
2005	5.15	1.30	2.65	9.09
2006	6.37	1.34	2.73	10.44
2007	6.74	1.37	2.80	10.91
2008	7.16	1.37	2.80	11.33
2009	7.14	1.41	2.87	11.41
2010	7.46	1.44	2.94	11.84
2011	7.59	1.48	3.01	12.08
2012	7.80	1.51	3.09	12.40
2013	7.84	1.55	3.16	12.56
2014	7.78	1.59	3.24	12.61
2015	7.91	1.63	3.32	12.87
2016	8.17	1.67	3.41	13.25
2017	8.42	1.71	3.49	13.62
2018	8.67	1.76	3.58	14.01
2019	8.89	1.80	3.67	14.35
2020	9.11	1.85	3.76	14.71
2021	8.89	1.89	3.85	14.63
2022	9.15	1.94	3.95	15.04
2023	9.45	1.99	4.05	15.49
2024	9.76	2.04	4.15	15.95
2025	10.08	2.09	4.25	16.43
2026	10.41	2.14	4.36	16.92
2027	10.76	2.19	4.47	17.42
2028	11.11	2.25	4.58	17.94
2029	11.47	2.30	4.70	18.47
2030	11.85	2.36	4.81	19.02

6.2.3 Low Price Case

Table 6-6 shows the Low Price Case forecast for LNG delivered to Guam, where LNG is expected to reach $13.49/mmBTU in 2025.

Table 6-6, LNG Forecast (Low Case)

Nominal $ per MMBTU

	Tangguh Indonesia	Transport	Regas	Guam Delivered Price
2005	5.15	1.30	2.65	9.09
2006	6.37	1.34	2.73	10.44
2007	6.74	1.37	2.80	10.91
2008	6.14	1.37	2.80	10.31
2009	5.77	1.41	2.87	10.05
2010	5.60	1.44	2.94	9.97
2011	5.79	1.48	3.01	10.28
2012	6.00	1.51	3.09	10.60
2013	6.21	1.55	3.16	10.92
2014	6.43	1.59	3.24	11.26
2015	6.49	1.63	3.32	11.44
2016	6.55	1.67	3.41	11.63
2017	6.62	1.71	3.49	11.82
2018	6.68	1.76	3.58	12.02
2019	6.74	1.80	3.67	12.21
2020	6.81	1.85	3.76	12.42
2021	6.88	1.89	3.85	12.62
2022	6.94	1.94	3.95	12.83
2023	7.01	1.99	4.05	13.05
2024	7.08	2.04	4.15	13.27
2025	7.15	2.09	4.25	13.49
2026	7.22	2.14	4.36	13.72
2027	7.29	2.19	4.47	13.95
2028	7.36	2.25	4.58	14.19
2029	7.43	2.30	4.70	14.43
2030	6.17	2.36	4.81	13.35

6.3 Delivered Cost of Coal

Similarly, P.L. Mangilao developed two cases for the coal price forecast. This forecast is based on the assumption that coal will be delivered to Guam will most likely come from local Pacific Basin producers in Indonesia or Australia. The price adjustments are made to include transportation costs to Guam.

6.3.1 Base Case Forecast

Table 6-7 presents P.L. Mangilao's base case forecasts for Indonesian Coal delivered to Guam. It was assumed that Indonesian Coal would have had an average delivered price of $67.80.ton (CIF Guam) in 2008. It is expected to reach $69.50/ton in 2025.

Table 6-7, Coal Forecast (Base Case)

	Delivered Prices			
	2006$/t		Nominal $/t	
	Australia	Indonesia	Australia	Indonesia
2008	95.20	66.20	97.50	67.80
2009	79.20	55.80	83.14	58.58
2010	69.30	49.20	74.57	52.94
2011	63.40	45.50	69.92	50.18
2012	65.70	46.70	74.27	52.79
2013	66.90	47.40	77.52	54.92
2014	66.20	46.80	78.62	55.58
2015	65.90	46.80	80.22	56.97
2016	65.50	46.40	81.73	57.90
2017	65.10	46.20	83.26	59.09
2018	64.80	45.90	84.95	60.17
2019	64.40	45.60	86.54	61.28
2020	64.40	45.60	88.70	62.81
2021	64.00	45.50	90.35	64.24
2022	63.70	45.20	92.18	65.41
2023	63.30	44.90	93.89	66.60
2024	62.90	44.60	95.63	67.81
2025	62.90	44.60	98.02	69.50
2026	62.50	44.40	99.83	70.92
2027	62.10	44.10	101.67	72.20
2028	61.70	43.90	103.54	73.67
2029	61.40	43.60	105.62	75.00
2030	61.20	43.40	107.90	76.52

6.3.2 High Price Case

Table 6-8 presents P.L. Mangilao's High Price Case forecast for Indonesian Coal delivered to Guam. Indonesian Coal was expected to reach $93.94/ton in 2025.

Table 6-8, Coal Forecast (High Case)

	Delivered Prices			
	2006$/t		Nominal $/t	
	Australia	Indonesia	Australia	Indonesia
2008	95.20	66.20	97.50	67.80
2009	79.20	55.80	83.14	58.58
2010	85.00	60.28	91.46	64.86
2011	85.00	60.28	93.74	66.49
2012	85.00	60.28	96.09	68.15
2013	85.00	60.28	98.49	69.85
2014	85.00	60.28	100.95	71.60
2015	85.00	60.28	103.48	73.39
2016	85.00	60.28	106.06	75.22
2017	85.00	60.28	108.72	77.10
2018	85.00	60.28	111.43	79.03
2019	85.00	60.28	114.22	81.01
2020	85.00	60.28	117.07	83.03
2021	85.00	60.28	120.00	85.11
2022	85.00	60.28	123.00	87.24
2023	85.00	60.28	126.08	89.42
2024	85.00	60.28	129.23	91.65
2025	85.00	60.28	132.46	93.94
2026	85.00	60.28	135.77	96.29
2027	85.00	60.28	139.16	98.70
2028	85.00	60.28	142.64	101.17
2029	85.00	60.28	146.21	103.70
2030	85.00	60.28	149.87	106.29

7 Supply Side Options

The supply side options are identified to support an island grid system, provide fuel diversification, or support renewable energy standards.

7.1 Generation Resource Candidates

R.W. Beck, a subcontractor to local engineering firm Winzler & Kelly, support the research and development of this integrated research plan. R.W. Beck consultants researched viable and mature options for the GPA system which includes unit size, technology type, construction schedule, capital and operating costs, operating parameters (fuel efficiency, operating capacity, etc.), environmental issues (emissions, siting concerns, etc), fuel availability and price trends, and the availability and reliability of each technology.

The research results include six (6) options:

- Small Coal-Fired Power Plant – a pulverized coal (PC) boiler or circulating fluidized bed (CFB) boiler powering steam turbines;
- Small Combined-Cycle Power Plant W/ Liquefied Natural Gas (LNG) Facility – Combustion Turbines fueled by LNG;
- Wind Farm – On-shore, ridgeline configuration wind turbines, off- shore a possibility;
- Re-power Piti Power Plant - Retro-fitting Piti 7 Combustion Turbine (CT) into a Combined-Cycle plant by adding an Heat Recover Steam Generator (HRSG) and a Steam Turbine (ST);
- Biomass Power Generation Facility – Steam turbine generator plant fueled by biofuels and municipal solid waste; and
- Reciprocating Engine – Low or medium speed water cooled diesel units utilizing efficient reciprocating engine.

7.1.1 Capital & Operating Costs

A summary of costs are provided in Table 7-1.

Table 7-1, New Supply Side Options, Construction & Operation Costs[10]

Plant Description / Technology	Nominal Capacity MW	Primary Fuel	Capital Cost $000	Capital Cost $/kW	FOM $000	VOM $000	VOM $/MWH
Steam / PC/CFB	60	Coal	300,250	5,004	$ 4,928	$ 2,061	4.61
CC w/ LNG / LM6000	60	LNG	334,000	5,567	$ 4,004	$ 1,212	2.56
Wind / 10x2MW On-shore	40	Wind	97,076	2,427	NA	NA	19
Retrofit / Piti 7 CC	60	No. 2	71,601	NA	$ 2,464	$ 2,206	4.61
Biomass / Stoker/CFB	10	MSW	85,608	8,561	$ 4,107	$ 5,690	76.88
Recip / 2x20MW S/MSD	40	No. 6	70,980	1,775	$ 2,135	$ 1,669	5.64

7.1.2 Construction Schedules

GPA and R.W. Beck believe that overlapping of Permitting and Engineering work can occur most especially with low environmental risk options. Other options such as a coal plant would presumably require permitting to be completed before additional investments is put into plant construction.

A summary of permitting and construction timelines is provided in Table 7-2.

Table 7-2, New Supply Side Options, Construction Timelines[11]

Plant Description	Technology	Months		
		Permitting	Start of Eng to CO	Total Duration
Steam	PC/CFB	30	36	66
CC w/ LNG	LM6000	30	28	43
Wind	10x2MW Onshore	15	9	18
Retrofit	Piti 7 CC	24	18	30
Biomass	Stoker/CFB	30	30	45
Recip. Engine	2x20MW S/MSD	24	18	30

[10] Letter to GPA on Development of Resource Option Characteristics, R.W. Beck, November 16, 2007.
[11] Ibid.

7.2 Fuel Conversion Options

In addition to new power facilities, GPA researched fuel conversion of existing diesel fired-units to natural gas fuel. Natural gas can potentially provide GPA fuel diversification at a much lower cost than new supply options. GPA assumes that the fuel will be received as a gas (after regasification process) for fuel that has been shipped in liquefied form from Indonesia or Australia. The following was capital cost conversion for existing GPA facilities:

Table 7-3, Fuel Conversion Project Costs for Existing GPA Facilities

Existing Diesel-Fired Plants	LNG Conversion Costs ($000)*
Tenjo Plant	$39,608
TEMES CT	$8,633
Cabras 1&2 Plant	$17,667
Tanguisson Plant	$22,821
Macheche CT	$10,407
Dededo CT 1&2 Plant	$21,800
Yigo CT Plant	$14,020

Conversion costs include pipeline costs from the Cabras fuel farm area which is a potential area for gas storage.

7.3 Additional Options

During the course of the IRP development, GPA met with several companies that proposed, work with or supplied renewable energy alternatives. Several of these companies also participated in the stakeholder meetings and provided GPA with some information that are modeled in Strategist as options to the baseline models performed. The results are discussed later in the IRP. The companies and the power generation technologies discussed are:

- **Solar Thermal Plant,** *NAAVONO Energy USA, Inc* - Utilizes a liquid medium running parallel through parabolic solar trough which is heated vaporization to drive turbine;

- **Biogas (Methane) Extraction,** *Ship Supply, Logistic/Provisions* - Plant fueled with captured methane from decomposing waste at the Ordot dump;

- **Ocean Thermal Energy Conversion (OTEC),** *OCEES* - Using warm surface water to vaporize system fluid (ammonia) to drive turbine to produce electricity and cold deep water cools fluid to cycle the process; and

- **LNG + H2 Motor Generator,** *h2ondemand* - Fuel blend of natural gas and hydrogen with Deutz Hydrogen motors.

Next to hydro-power, wind power is the most mature of large renewable technologies to date. GPA uses wind power as a proxy for other renewable options.

However, GPA has initiated research on large solar photovoltaic plant, integrated gasification combined cycle (IGCC) plant, and geothermal plants as additional supply side renewable options.

The IGCC option is a coal conversion to synthetic gas process which is typically connected to a combined cycle plant for power production in industrial plants. Initial research has found they are high in capital costs, there is not reference plant design yet, there are few vendors or engineers for this technology, and it is hard to get favorable contract terms or risk sharing.

GPA has also initiated discussions of geothermal potential for Guam with a company in California but has not been able to complete research on this.

8 Demand Side Management

8.1 Introduction

Demand Side Management (DSM) activities and programs modify the shape and magnitude of customer loads in a way that is mutually beneficial to the customer and the Authority.

GPA filed a 20-year resource DSM plan with the PUC in 1993. The plan indicated a reduction of 27 MW in net capacity by 2000, and 39 MW by 2010, corresponding to estimated energy savings of 47,000 MWH and 118,000 MWH respectively, if the four most cost-effective programs were implemented. In August 1994, these four programs were initiated:

- Commercial Lighting;
- Commercial Air Conditioning;
- Residential Air Conditioning; and
- Residential Water Heating.[12]

However, personnel movement in FY 2000 required GPA to rebuild its DSM portfolio and reorganize the organization to be able to support the DSM program. Implementation was thus cut short.

For FY 2008, GPA decided to re-consider the implementation of DSM programs as a supplement for this period's IRP. A large-scale option and several small scale options were evaluated.

Guam Seawater Air Conditioning (GSWAC) is being considered as a major DSM program. Makai and Market Street Energy performed a technical and economic assessment of the major components of Guam Seawater Air Conditioning (GSWAC) system to determine operational performance, probable costs, economic and business advantages, risks and potential challenges.

For the small-scale options, a study was performed by R.W. Beck to evaluate the cost-effectiveness of residential and commercial DSM programs for potential implementation by GPA. Projections were based on the assumptions and circumstances described in the R.W. Beck Report.

[12] Demand Side Management Study, R.W. Beck, March 2008.

8.2 DSM Resource Alternatives

8.2.1 Large-Scale DSM Program

GSWAC explores the potential for using deep, cold seawater for air conditioning hotels and other buildings on Tumon Bay. Deep seawater at 42.5°F is brought to shore via an intake pipeline located three miles offshore at a depth of 2200'. Through a heat exchanger, the seawater will come in contact with a fresh water loop and bring down the temperature of fresh water. The cooled fresh water is then delivered to the customers.

8.2.2 Small-Scale DSM Programs

For the small-scale options, twenty-four DSM programs were suggested to GPA, and four were considered eligible for potential application:

- Energy Efficient Lighting Retrofit – Retrofit existing (60W) incandescent and fluorescent lamps with compact fluorescent and high-efficiency fluorescent lamps. Utility promotion through public information programs;

- Solar Photovoltaic – Install a 5-kW solar photovoltaic electric generation system in residential dwellings;

- Solar Thermal Water Heating – Install 40-gallon solar thermal water heating system in residential dwellings to replace electric water heating system; and

- Energy audit – Dwelling and business energy efficiency and infrared heat detection audits conducted by the utility.

Customers implement low-cost recommendations, providing 10% reduction in typical energy use.

8.3 Peak and Energy Impacts

8.3.1 Large-Scale DSM Program

The implementation of GSWAC as a large-scale DSM option will yield approximately 92 GWH energy savings per year. GSWAC uses one-sixth ($1/6^{th}$) the power of conventional air conditioning, with a capacity factor of over 70%.

8.3.2 Small-Scale DSM Programs

The impacts resulting from the small scale DSM programs are described in Table 8-1 as annual energy savings and peak reductions.

Table 8-1, Energy Savings from Small-Scale DSM Programs

	PENETRATION	MEASURE LIFE	ENERGY REDUCTION	NON-COINCIDENT DEMAND REDUCTION	PEAK DEMAND REDUCTION	COINCIDENT FACTOR	LOAD FACTOR
	# customers	years	kWh/year	kW	kW		
RESIDENTIAL PROGRAMS:							
Energy Efficient Lighting Retrofit	200	5	135,000	92.00	46.00	0.50	16.8%
Solar Photovoltaic (5 kW)	10	20	130,000	50.00	40.00	0.80	29.7%
Solar Thermal Water Heating	500	15	1,350	2.25	0.34	0.15	6.8%
Residential Energy Audit	1000	7	670,000	169.96	50.99	0.30	45.0%
COMMERCIAL PROGRAMS:							
Energy Efficient Lighting Retrofit	500	5	150,000	35.00	28.00	0.80	48.9%
Solar Photovoltaic (10 kW)	10	20	260,000	100.00	80.00	0.80	29.7%
Solar Thermal	200	15	540	0.90	0.27	0.30	6.8%
Residential Energy Audit	200	5	330,000	66.09	26.44	0.40	57.0%

8.4 Costs

8.4.1 Large-Scale DSM Program

The estimated capital cost for GSWAC ranges from $73 million to slightly over $100 million, depending on pipeline location and chilled water distribution. The best option costs approximately $100 million.

8.4.2 Small-Scale DSM Programs

Customers typically pay more for the DSM technology than the standard technology. DSM Program Measure or Program Costs include Equipment Costs per customer, Utility Program Costs and Tax Credits or Non-Utility Rebates. Included in the Equipment Costs per customer are installation and maintenance invested by participating customers. Table 8.2 provides the fixed DSM expense and variable incentives, in 2006 real dollars.

Table 8-2, DSM Program Costs

	PENETRATION	MEASURE LIFE	EQUIPMENT Costs/customer		TAX CREDITS & REBATES	UTILITY COSTS
	# unit	years	$/unit (Installed)	$/year (O&M)	$ per Customer	$ per Unit
RESIDENTIAL PROGRAMS:						
Energy Efficient Lighting Retrofit	200	5	3.0	-		5.0
Solar Photovoltaic (5 kW)	10	20	9,000.0	900.0	(5,000.0)	200.0
Solar Thermal Water Heating	500	15	3,500.0	5.0	(1,050.0)	40.0
Residential Energy Audit	1000	7	190.0	-		90.0
COMMERCIAL PROGRAMS:						
Energy Efficient Lighting Retrofit	500	5	2.0	-		50.0
Solar Photovoltaic (10 kW)	10	20	9,000.0	1,800.0	(5,000.0)	200.0
Solar Thermal	200	15	3,500.0	2.0	(1,050.0)	40.0
Residential Energy Audit	200	5	420.0	-	-	150.0

The costs do not include incentive payments. The incentive payments are one-time payments to GPA customers who have purchased and installed eligible DSM technologies.

8.5 Economic Evaluation

8.5.1 Large-Scale DSM Program

The Economic Evaluation of GSWAC utilized simple payback method, a levelized cost comparison with conventional air conditioning (AC).

Five GSWAC scenarios differing in onshore pipe routing, pipe path and system size were considered, all showing less costs compared with conventional air conditioning. The analysis showed that GSWAC levelized costs ranged from $1,100/ton/year to $1,300/ton/year, much lower than conventional AC's levelized cost of $2,020/ton/year.

A business plan was created for the best option among the five scenarios. Results showed that the project would cost approximately $100 million.

Economic Evaluation of the GSWAC program was completed by including it in the Strategist assumptions as an alternative for Demand Side Management.

8.5.2 Small-Scale DSM Programs

For the other DSM options, technical screening assessment was done by R.W. Beck. Each measure or program was rated for suitability to implementation, and ranked independently for residential and commercial classes and for utility facilities and services. The options that indicated at least an average potential for implementation were considered for further evaluation via the Economic Screening Analysis. To determine the economic viability of the eligible alternatives, several evaluations were completed:

- Utility Cost Test – measures whether the benefits of avoided utility costs are greater than the costs incurred to implement the DSM program;

- Rate Impact Measure (RIM) Test – measures whether utility ratepayers that do not participate in a DSM program would see an increase in retail rates as a result of other customers participating in a utility-sponsored DSM Program; and

- Total Resource Cost (TRC) Test – measures whether combined benefits of the utility and customers participating in the DSM program are greater than the combined costs to implement the DSM Program.

The results of the test are summarized in Table 8.3 Test Results.

Table 8-3, Test Results

BENEFIT/COST RATIO BY TEST METHOD			
RESIDENTIAL PROGRAMS:			
	Utility Cost	RIM	TRC
Energy Efficient Lighting Retrofit	29.353	0.730	4.193
Solar Photovoltaic (5 kW)	40.418	0.744	0.205
Solar Thermal Water Heating	21.508	0.679	0.416
Residential Energy Audit	2.094	0.592	0.722
COMMERCIAL PROGRAMS:			
	Utility Cost	RIM	TRC
Energy Efficient Lighting Retrofit	13.833	0.889	1.258
Solar Photovoltaic (10 kW)	40.418	0.888	0.258
Solar Thermal	21.508	0.809	0.416
Residential Energy Audit	2.636	0.568	0.694

A Benefit-to-Cost Ratio (Benefit/Cost Ratio) of greater than 1.0 for the Utility Cost and RIM Test indicated that the program would reduce GPA's operating costs at a level greater than GPA's cost of implementing the program. Additionally, the program would not cause an increase in the retail rates charged by GPA.

GPA has established that the DSM Programs passing both criteria for both Utility Cost Test and RIM Test are eligible for implementation. As can be seen in Table 8-3, none of the DSM measures evaluated were found to pass both tests. As such, GPA is not including any projections of the impacts of small-scale DSM programs in its IRP filing.

9 Policy Issues and External Factors

Since the last completed IRP in 1999, federal and local legislation have emerged regarding reduction in green-house gas emissions and establishing renewable portfolio standards. In the Integrated Resource Planning Process, the Authority examined several pieces of federal and local legislation.

The Public Utility Regulatory Policies Act of 1978 (PURPA) resulted as a response from U.S. Congress to address the energy crisis in 1973. This legislation was drafted to encourage energy conservation and use of renewable energy among other things. It opened up a market for power by requiring utilities to purchase power from non-utility electric power producers at an "avoided cost" rate. The Energy Policy Act of 2005 (EPAct of 2005) amended PURPA by introducing standards that that would specifically address conservation and promotion of renewable energy. These standards included (1) Net Metering, (2) Fuel Diversity, (3) Fossil Fuel Generation Efficiency, (4) Smart Metering, and (5) Interconnection. Electric utilities are required to consider each standard and make a determination whether or not it is appropriate to implement. Implementation is, however, discretionary.

Locally, bills have been introduced citing PURPA and EPAct of 2005. Two have passed into law. Public Law 27-132 requires the Authority to allow net metering to customers. This has not been implemented pending rate setup. Public Law 29-62 promotes renewable energy and requires the authority to meet renewable portfolio standards as early as 2015. The Authority supports both these laws.

There have also been some bills, citing PURPA, which would have some detrimental consequences for the Authority if passed. These bills try to establish retail access without performing the work necessary to protect the interests of customers and utilities. Retail competition for electric supply (also called retail access or retail choice) is defined as allowing retail customers of an electric utility the option to choose a supplier for generation service. Authority managements and several consultants retained by GPA have testified against these bills. The electric energy price increases due to increasing fuel prices motivate these efforts as they are wrongly seen as a quick way without much effort out of a difficult situation despite the evidence otherwise.

In testimony before the 29th Guam Legislature[13], Dr. Kenneth Rose summarized the following about the state of retail access:

- 20 states have retail access for either all customers or for only larger customers.
- However, 35 states have repealed, delayed, suspended, limited retail access to just large customers, or are now no longer considering retail access.

[13] Before The Guam Legislature: Proposed Bill No. 122 Testimony of Kenneth Rose, Ph.D. on Behalf of Guam Power Authority. January 9, 2008

- States that had not passed a restructuring law dropped further consideration after the California power crisis, the Enron collapse, revelations of market price manipulation, disclosures of accounting improprieties and data misreporting, the August 2003 blackout, and significant price increases in restructured states.

Rose explicated on a number of implementation issues that need to be considered before enacting retail competition, none of which these bills have considered:

- A “stranded cost” policy – Who pays for utility costs that are no longer paid for by customers that left the utility?;

- Rates have to be “unbundled” – that is, separate charges for generation, distribution/ transmission, and other services need to be determined; and

- “Cherry Picking” by alternative suppliers impose costs on remaining customers and a policy is needed to determine under what conditions customers can return to utility generation service.

Furthermore, Rose, who had been an early supporter of retail access, summarized his experiences about the unintended consequences of retail access. Rose posited that the United States experience in open retail access is different from what was expected when the laws were being passed. These expectations and experiences include:

- It was expected that prices would decrease for all customer groups – but prices are increasing faster in restructured states than in states that remain regulated.

- The cost to serve retail customers “full requirements” service is higher than expected and more complex.

- In additional to energy (generation), there are congestion charges, capacity costs, ancillary service requirements, transmission charges, transmission organization administrative charges, and costs of market risks faced by suppliers such as the loss of customers or a change in demand.

As the only power utility on Guam, GPA supplies local federal facilities, including military bases, their energy requirements. Federal facilities must provide 20% of their electric energy use from renewable sources by 2020. GPA’s strategic vision for future supplying the energy needs of the impending military buildup on Guam includes establishing renewable portfolio standard goals that address the federal renewable energy mandates.

The Authority believes that federal legislation regarding greenhouse gases and carbon legislation in particular are simply a matter of time rather than speculation. All three presidential candidates – Obama, Clinton, and McCain - are in support of such legislation. Therefore, the Authority must ensure that its baseline planning scenario includes structures that account for this impending legislation. The Authority must also actively consider renewable energy as the focal point of this IRP. Guam law and Federal mandates for renewable energy demand it.

10 Capital Requirements

Table 10-1 and Table 10-2 list the capital requirements of the recommended expansion plan for the Base and High Scenarios respectively. Because the magnitude of this plan is very large, the Authority may need to partner up with the federal and private sectors.

Table 10-3 lists the Recommended Capital Requirements that incorporates both scenarios in which the Authority should prepare for in the event of accelerated load growth. The Authority will consider rate impacts and creative financing in its RFP for Renewable Energy and in its FY 2008/2009 Load Research and Cost of Service Study.

Table 10-1, Capital Requirements for Base Scenario (thru 2018)

Project	Description	Construction Schedule	Commission Year	Capital Requirement ($ 000)
WIND	Wind Farm - 20x2MW	18 Months	2011	97,076
WIND	Wind Farm - 20x2MW	18 Months	2012	97,076
TEML	TEMES Conversion to LNG - 40MW		2012	8,633
GSWAC	Guam Sea Water Air-conditioning	60 months	2013	100,000
SSD	Reciprocating Engine (Slow Speed Diesel) - 2x20MW	30 Months	2017	70,980
WIND	Wind Farm - 20x2MW	18 Months	2018	97,076

Table 10-2, Capital Requirements for High Scenario (thru 2018)

Project	Description	Construction Schedule	Commission Year	Capital Requirement ($ 000)
RETR	Retrofit / Piti 7 CC	30 Months	2010	71,601
WIND	Wind Farm - 20x2MW	18 Months	2011	97,076
WIND	Wind Farm - 20x2MW	18 Months	2012	97,076
GSWAC	Guam Sea Water Air-conditioning	60 months	2013	100,000
CLNG	CC w/ LNG / LM6000	43 Months	2013	334,000
WIND	Wind Farm - 20x2MW	18 Months	2013	97,076
SSD	Reciprocating Engine (Slow Speed Diesel) - 2x20MW	30 Months	2016	70,980

Table 10-3, Recommended Capital Requirements (thru 2018)

Project	Description	Construction Schedule	Commission Year	Capital Requirement ($ 000)
WIND	Wind Farm - 20x2MW	18 Months	2011	97,076
WIND	Wind Farm - 20x2MW	18 Months	2012	97,076
TEML	TEMES Conversion to LNG - 40MW		2012	8,633
GSWAC	Guam Sea Water Air-conditioning	60 months	2013	100,000
CLNG	CC w/ LNG / LM6000	43 Months	2013 to 2021 Depending on Load Growth	334,000
SSD	Reciprocating Engine (Slow Speed Diesel) - 2x20MW	30 Months	2017	70,980
WIND	Wind Farm - 20x2MW	18 Months	2018	97,076
TOTAL				**804,841**

11 Key Results

This section discusses the various investigations and findings completed for this IRP:

- Deferment of Base Load Unit and Intermediate Unit Retirements;
- Base Case Analysis; and
- Robustness analysis of supply-side options:
  - Effectiveness of supply-side options as a function of Capital Costs;
  - Effectiveness of Wind Farm as a function of Capital Costs, Capacity Factor, Carbon Cap & Trade and Production Tax Credits.

The Authority analyzed other emerging technologies including:

- Solar Thermal Power Conversion;
- Ocean Thermal Energy Conversion;
- Municipal Solid Waste Conversion;
- Initial Look at Integrated Gasification Combined-Cycle Plant Technology; and
- Initial Look at Geothermal Energy Technology.

11.1 Deferment of Base Load and Intermediate Unit Retirements

GPA evaluated the year-by-year deferment of Baseload and Intermediate unit retirements. The proto-base case was then modified according to the new retirement years resulting from the analysis. All subsequent analysis used this modified base case.

Deferment of existing unit retirements show significant utility costs savings differences from the base case. The implementation of this strategic initiative must ensure that such savings not be exceeded by the operating and refurbishment costs associated with extending the operating life of the units. Table 11-1 illustrates the new retirement years determined the most viable.

Table 11-1, Optimal Retirement Year Results

Unit	Type	Optimal Retirement Year
Cabras 1	Baseload	2026
Cabras 2	Baseload	2027
Cabras 3	Baseload	2035
Cabras 4	Baseload	2036
MEC 8 (Piti 8)	Baseload	2038
MEC 9 (Piti 9)	Baseload	2039
Tanguisson 1	Intermediate	2028
Tanguisson 2	Intermediate	2029

11.2 Optimal Resource Plan Analysis

The Authority used the software application, STRATEGIST, to investigate optimal resource expansion plans. The investigative scenarios assumed a planning period starting at year 2006 up to year 2035.

The investigative scenarios included a Normal, Baseline and High demand and energy forecast, a high low fuel forecast, and other variations of key assumptions,

Table 11-2 presents the results of the Optimal Resource Plan Analysis. To illustrate the additional costs associated with the increase in Load Forecast, the differences between the High and Normal scenarios and the Baseline and Normal scenarios were obtained. Details on the selection of the Wind option were noted to see how it is affected by load growth.

Table 11-2, Results of the Optimal Resource Plan Analysis

SCENARIO	Net Present Value Utility Costs ($000)	Difference from NORMAL Scenario Utility Costs ($ 000)	WIND DETAILS		
			Wind Farm before 2017?	No. of Wind Farms	Year Installed
NORMAL	$5,401,374.00	$0.00	-	0	-
BASE	$5,717,896.50	$316,522.50	**YES**	2	2011, 2012
HIGH	$6,672,279.50	$1,270,905.50	**YES**	3	2011, 2012, 2013

Table 11-3 enumerates the different supply-side options selected for the three scenarios. Wind, Slow Speed Diesel and LNG Conversion are the preferred alternatives for all scenarios, with the addition of TEMES LNG conversion for the Normal and Baseline Scenarios, and the Retro-fit option for the High Scenario.

Table 11-3, Comparison of Selected Options

YEAR	NORMAL	BASELINE	HIGH
2006			
2007			
2008			
2009			
2010			RETR
2011		WIND	WIND
2012		WIND TEML	WIND
2013			CLNG WIND
2014			
2015			
2016			SSD
2017	WIND TEML	SSD	
2018	WIND	WIND	
2019	WIND		
2020	WIND	WIND	SSD WIND
2021	CLNG	CLNG	WIND
2022			CLNG
2023	SSD CLNG	SSD CLNG	CLNG
2024	SSD	CLNG	CLNG
2025			
2026	CLNG	SSD CLNG	SSD CLNG
2027	SSD CLNG	SSD	SSD
2028	SSD	SSD	SSD
2029		CLNG	SSD
2030	SSD		SSD
2031		WIND	
2032		SSD	
2033			
2034	SSD		SSD
2035			

All supply-side options coming in before 2017 are added as a substitute to high oil-fired generation and not because of the need for capacity additions.

11.3 Robustness Analysis

The Authority evaluated the affect of varying the key assumptions to the above optimal resource expansion plans in order to substantiate the effectiveness of each option under a wide range of conditions. The Authority defines this set of investigations as robustness analysis. If an expansion plan is more robust than another, it means that it inherently has less risk associated with it.

11.3.1 Effectiveness of Supply-side Options as a Function of Capital Costs

The Authority investigated scenarios where capital costs for various candidate resources were increased and decreased by 10, 20 and 30%. Results for each scenario were compared to determine how decreasing capital costs affect the selection. Tables 11-4 and 11-5 summarize the results.

For the SSD option, decreases in Capital Cost make the option more viable; that is, more SSD options are selected as it gets more affordable. When capital cost is decreased 30%, a total of 8 SSD options are selected as compared to only 6 using the original cost. For the CLNG option, the decrease in Capital Cost has no effect on the selection of CLNG units. Results show that the number of CLNG units selected does not change even up to a 30% decrease in capital cost. Decreasing the capital cost has likewise no effect on both the Coal option and Retrofit option. Even when capital cost has been decreased by 30%, these two candidates are still not competitive enough to be chosen.

The Authority increased capital costs for Wind and SSD candidate resources by 10, 20 and 30% as part of it robustness analysis. For SSD, increasing capital cost does not affect the selection of SSD units. However, a 30% increase in capital cost decreases the selected number of Wind Farms. Table 11-5 presents the results.

Table 11-4, Effect of Decreasing Capital Cost to Alternative Option Selection

	No. of Units Selected				
CAPITAL COST ADJUSTMENT	**WIND**	**SSD**	**CLNG**	**CFB**	**RETR**
-30%	5	8	5	0	0
-20%	5	6	5	0	0
-10%	5	6	5	0	0
Base Case	5	6	5	0	0

Table 11-5, Effect of Increasing Capital Cost to Alternative Option Selection

	No. of Units Selected	
CAPITAL COST ADJUSTMENT	**WIND**	**SSD**
Base Case	5	6
10%	5	6
20%	5	6
30%	4	6

11.3.2 Effectiveness of Wind Farm

11.3.2.1 As a Function of Capital Cost

Results from the previous section show that the wind farm is a robust decision.

Additional analysis was done with the results from the test described in the previous section by inspecting Wind Farm selection prior to year 2017. Wind Farms are brought online prior to 2017 as a substitute for diesel-fired energy production. Table 11-6 indicates that regardless of an increase or decrease in capital cost of up to 30%, Wind Farms are always selected prior to 2017.

Table 11-6, Effect of Capital Cost to Wind Farm Selection

CAPITAL COST ADJUSTMENT	**No. of Wind Farms coming in before 2017:**	**Total Wind Farms for study period:**
-30%	2	5
-20%	2	5
-10%	2	5
Base Case	2	5
10%	2	5
20%	2	5
30%	2	4

11.3.2.2 As a Function of Capacity Factor, Carbon Cap & Trade and Production Tax Credits

The Capacity Factor assumed for Wind Farms for the study period is 30%, with considerations for the seasonality and strength of wind on the island. To test the robustness of any decision to employ Wind Farms, The Authority investigated several scenarios where the Capacity Factor of the Wind Option ranged from 15% to 35% in 5% increments. GPA compared the number of Wind Farms brought in before 2017 for each scenario to determine how changing the Capacity Factor affected the Wind Option.

Additionally, because of uncertainties in the Federal Legislation regarding, the Authority evaluated various scenarios for Carbon Cap & Trade (CT) and Production Tax Credits (PTC) to observe effects on Wind resource selection. These were tested along with different capacity factors in four scenarios:

- Scenario with CT and PTC for CF of 15% to 35%;
- Scenario with CT but no PTC for CF of 15% to 35%;
- Scenario with PTC but no CT for CF of 15% to 35%; and
- Scenario with no CT and no PTC for CF of 15% to 35%.

Results indicate that CT and PTC do not materially affect Wind Farm selection. If there is CT but no PTC, a 15% capacity factor will decrease the number of Wind Farms selected before 2017. For the scenario with PTC but no CT, Capacity Factors, no Wind Farms come in before 2017 for a CF of 15%. For the scenario where there is no PTC and no CT, the number of wind farms decrease at a CF of 20%, and at a CF of 15%, no Wind Farms come in before 2017. Table 11-7 shows the results for this analysis.

Table 11-7, Effect of Capacity Factor, Carbon Cap & Trade and Production Tax Credits To Wind Farm Viability

ANALYSIS CRITERIA	**Capacity (Wind Farm):**	**40 MW**	**40 MW**	**40 MW**	**40 MW**
	With Carbon Cap & Trade?	**Yes**	**-**	**-**	**Yes**
	With PTC?	**Yes**	**-**	**Yes**	**-**
RESULTS	CAPACITY FACTOR (%)	Wind Farms Selected Prior to 2017:			
	15	2	0	0	1
	20	2	1	2	2
	25	2	2	2	2
	30	2	2	2	2
	35	2	2	2	2

11.4 Other Investigations

Several proponents of emerging renewable sources of energy have provided GPA with information regarding their technologies. Using the data given by the suppliers, each new option was modeled into the base case and assessed as another supply-side candidate.

11.4.1 Solar Thermal Power Conversion

GPA recently received data regarding Solar Thermal Power Conversion. The Baseline scenario was modified to include a 25 MW Solar Thermal Power Conversion and executed in STRATEGIST. Results show that addition of this technology improves the Net Present Value Utility Cost for the study period, and a Solar Thermal Power Conversion plant is brought in at year 2016. Table 11-8 below illustrates the results.

11.4.2 Ocean Thermal Energy Conversion (OTEC)

The Authority investigated an OTEC option. After modifying the base case scenario to include OTEC technology, the Authority ran its simulations to determine whether OTEC would displace other supply candidates. Ocean Engineering and Energy Systems (OCEES) provided information on capital and operating costs.

Initial investigations showed that a 20 MW OTEC plant would need a subsidy of over $100 million in order to be competitive. GPA did not consider other uses of this technology such as potable water production, plant cooling, mariculture, or bottled gourmet water.

11.4.3 Municipal Solid Waste Conversion

The Authority investigated a Biomass or Municipal Solid Waste-to-Energy plant option. After modifying the base case scenario to include this technology, the Authority ran its simulations to determine whether it would displace other supply candidates.

Results indicate that this technology would require a subsidy of over $120 million in order to be economically viable for electric power production. This capital may be raised in the form of tipping fees or other such fees associated with Solid Waste management.

11.4.4 Integrated Gasification Combined Cycle Plant

The Integrated Gasification Combined Cycle Plant (IGCC) option refers to the conversion of coal to synthetic gas. The synthetic gas would fuel a gas-fired combined cycle plant. The IGCC technology allows for carbon capture, which is a significant advantage to coal plant.

Some challenges remain with this technology. The fuel price is tied to relatively inexpensive coal but, IGCC plants have very high capital costs. To date, there are very few vendors and engineers developing IGCC, and it is hard to get favorable contract terms. Apart from this, the reliable sequestration of carbon is still under development.

Table 11-8, Inclusion of Solar Thermal Power Conversion as a Supply-side Option

Year	Units
2006	
2007	
2008	
2009	
2010	
2011	WIND
2012	WIND, TEML
2013	WIND
2014	
2015	
2016	SOLAR
2017	
2018	
2019	SSD
2020	WIND
2021	WIND
2022	CLNG
2023	SSD, CLNG
2024	SSD
2025	
2026	CLNG
2027	
2028	SSD
2029	CLNG
2030	
2031	
2032	
2033	SSD
2034	
2035	

11.4.5 Geothermal Energy

GPA has initiated a conversation with Bottle Rock Power (BRP), and an exchange regarding the possibilities for electricity production via geothermal sources is ongoing. BRP believes there is geothermal potential on Guam.

BRP's principal asset is a 55-MW geothermal power plant at The Geysers Geothermal Field in northern California, and they expect the facility to produce approximately 200,000 MWH of electricity annually, to be sold to Pacific Gas & Electric Company.

11.5 Fuel Diversity Outlook

GPA is currently using mostly Residual Fuel Oil (RFO) for electricity production. A small percentage of energy production comes from Diesel Fuel Oil (DFO).

Through this IRP, GPA hopes to reduce the use of petroleum-based fuels through the implementation of Renewable Energy options (WIND), conversion to Liquefied Natural Gas and the use of the DSM program, GSWAC.

Figure 11-1 illustrates the Fuel Diversity Outlook for the study period.

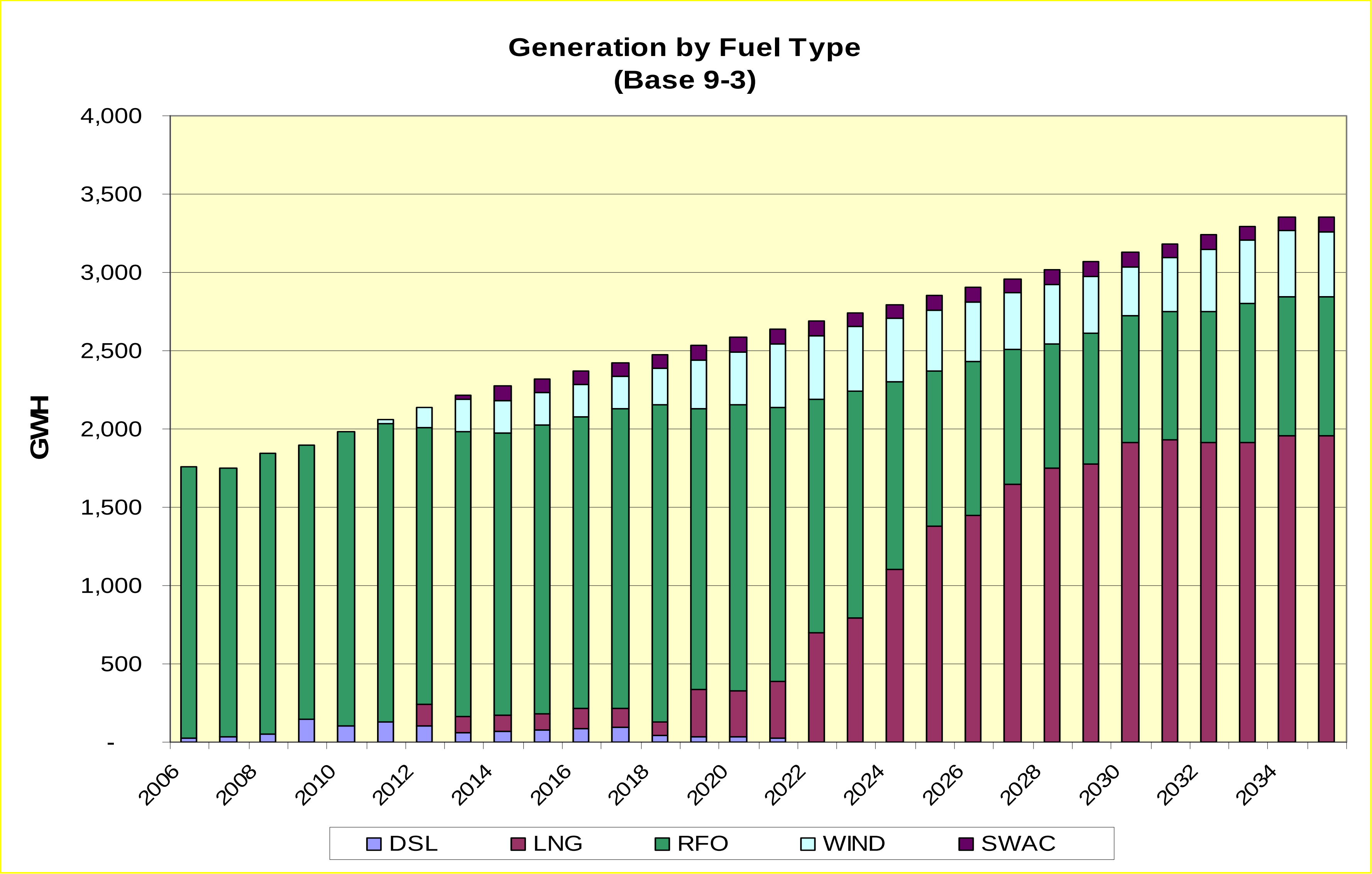

Figure 11-1, Fuel Diversity Outlook

12 Recommendations

The Integrated Resource Plan (IRP) report identifies three main alternative futures and an optimal resource plan for each.[14] The IRP report defines these three alternative futures as normal, baseline, and high. In the near-term GPA will base its decisions upon the baseline scenario which assumes significant DOD impacts. However, GPA planning and execution on its expansion plan must consider the high growth scenario. This is only prudent as the DOD has not completed its studies and there is great uncertainty surrounding the results presented to the Authority. Thus, GPA must recognize that DOD impacts could be more significant than those contained in the baseline scenario. Therefore, prudent management dictates that the Authority maintain vigilance and flexibility to respond accordingly. Under the normal and baseline scenarios GPA has sufficient capacity to meet customer demand. However, fuel diversification and the economic displacement of oil-fired generation presents the near-term resource challenge.

First, this IRP recommends that the Authority begin the procurement process to integrate renewable energy as quickly as practical following the renewable resource acquisition process outlined in Section 13. The Authority needs to act expeditiously to meet its aggressive target of awarding wind or other renewable energy projects by December 2009.

Second, this IRP recommends that the Authority begin the process to bring LNG as a substitute fuel for diesel fuel oil by 2012. This will include:

- Working with the Department of Defense to change the paradigm concerning the Japan Bank for International Cooperation's (JBIC) pledge to support the infrastructure requirements for the DOD marine move from one of supplying electric energy to one supplying LNG;

- Renegotiation of the Taiwan Electrical and Mechanical Engineering Services (TEMES) Energy Conversion Agreement to include a conversion of the plant to use natural or synthetic gas and combine cycle operation; and

- Examination of supplying natural gas for industrial, commercial, and residential use as a utility under the Consolidated Utility Commission and the Guam Public Utility Commission.

Third, the Authority should plan and permit for an additional gas-fired plant or non-petroleum-fired plant as a matter of prudency regarding the uncertainty in the scope of the DOD buildup and related economic activity. GPA should construct this plant based upon load growth triggers.

Fourth, the Authority must ensure that all its plants meet or exceed the equivalent availability and other performance standards agreed with the PUC.

Fifth, the Authority must examine fully life extension of its existing plants.

[14] Portions of this section capitalize on our discussions with Larry R. Gawlik and may borrow liberally from the May 7, 2008 PUC Staff Update: Integrated Resource Planning (IRP) Process

Sixth, the Authority must continue to evaluate renewable and energy efficiency technologies in order to obtain the lowest energy prices for its customers.

Seventh, the Authority must work collaboratively with the Guam PUC and stakeholders to improve the Authority's financial position relative to obtaining funding for these projects.

Eighth, the Authority must continue to investigate geothermal, Ocean Thermal Energy Conversion (OTEC), Integrated Gasification Combined Cycle (IGCC), and other technologies since they will probably play a large role as these technologies become commercially available for Guam.

Ninth, the Authority must find a business partner to develop the Guam Sea Water Air Conditioning Project.

Tenth, the Authority must work with the Guam PUC to establish the rules of engagement for and rates for net metering.

Eleventh, the Authority must work with the Guam PUC on implementing small scale Demand-Side Management Programs. None of the projects evaluated by R.W. Beck pass the Rate Impact Measure (RIM) Test. Thus, they will impact customer rates. GPA will add to its web site Enercom's packaged set of Internet energy tools called Energy Depot®[15] as part of an initial small DSM project and customer outreach. The Authority will encourage the Guam Waterworks to add Enercom's Water Depot product to its web site.

Twelfth, the Authority must work with Guam Waterworks Authority (GWA) on an interruptible load arrangement in order to hedge against the risk of higher than baseline load growth.

[15] Online Energy Audits & Information. Accessed at http://www.hometownconnections.com/utility/enercom.html on May 27, 2008

13 Next Steps

In order to comply with local legislation and regulatory requirements, the Authority must take several steps in pursuit of new power production facilities construction and contracts for new demand side management programs.

A proven approach currently used in a number of states in the US Mainland is making the private sector compete for the development of a power plant. The process starts with the development of an Integrated Resource Plan (IRP) which shall serve as a “road map” to new generation acquisition. Objectives, targets and schedules shall also be defined at this point. Once this has been achieved, the next steps are:

- Submission to the Public Utilities Commission (Guam PUC) for review and approval;
- Development of Requests for Proposals (RFPs) to initiate the competitive process for resource development. This shall be an open and competitive process, wherein the best responsive offer is considered; and
- Awarding of Contracts for resource to chosen developers. May include the building and operation of plants, as well as fuel supply and management.

13.1 Role of the Public Utilities Commission

Before the development of the RFPs, the Guam PUC must review and approve the IRP. In addition, the procurement, rate filings, bond petitions or other processes will require oversight by the Guam PUC.

The Guam PUC, like many other commissions in the mainland, performs functions such as:

- Set rates for cost recovery;
- Evaluate utility’s adequacy to serve the public;
- Examine environmental & location impacts for new resource siting;
- Set reserve margins to ensure sufficient power is available;
- May require utilities to evaluate different options for meeting and shaping projected future demand for electricity through an IRP process; and
- Enforce laws (Renewable Portfolio Standards).

With that, it is anticipated that Guam PUC will conduct a thorough review of the document to ensure it meets the objectives as set forth in prior issued Guam PUC orders regarding the development of this IRP document. This may include public hearings and review of the document by its technical consultant(s). GPA shall not commence new resource or demand side program acquisition without the Guam PUC's acceptance of the document and an authorization to proceed in the form of a Guam PUC order.

13.2 Acquisition Process

It is the authority's intention to acquire all new power resources (supply side) and demand-side programs (customer side) through an open invitation for bid procurement process.

There are several challenges regarding renewable resource acquisition. One of those challenges is that some resource development firms are unfamiliar with Guam and, and may lack knowledge or understanding of Guam's power needs. Another challenge is that Guam's power requirements may be viewed as small as compared to other public utilities. Thus, the process will include an outreach strategy. The Authority will develop information packages, provide a webpage and publish advertisements to promote interest for potential vendors to participate in any upcoming procurement solicitations. This will allow potential bidders to familiarize themselves with Guam prior to the formal announcement of any procurement invitations.

The renewable resource of choice in the near-term is wind.[16] Significant interest in wind exists. DOD has shared the fact that it is conducting wind studies at specific locations on its properties, and wishes to work collaboratively with the Authority. DOD has commissioned and completed wind studies designed to determine optimal sites for wind monitoring towers. In our conversations with DOD[17], it believes – and GPA concurs - that adequate wind monitoring data is critical to the siting and ultimate design of wind turbine installations on Guam. Having such information prior to procurement of these resources lowers risk and increases the likelihood of larger and more participants in the procurement process. Therefore, the Authority's immediate conduct of wind studies is critical.

The reduction of risk from the developer's perspective is a paramount concern since:

- Most established renewable resource development firms are busy;
- Most established renewable resource development firms are not familiar with Guam;
- GPA's requirements may be viewed as "small"; and
- Lack of understanding of Guam power issues.

Upon the Guam PUC's approval of the IRP and authorization to proceed, the Authority will embark on a new power acquisition process. GPA has developed a preliminary schedule for new renewable power acquisition in Figure 13-1. GPA believes the IRP-driven competitive

[16] Portions of this section capitalize on our discussions with Larry R. Gawlik and may borrow liberally from the May 7, 2008 Guam PUC Staff Update: Integrated Resource Planning (IRP) Process

[17] These discussions occurred during the weekly Joint Guam Program Office (JGPO) and Guam Utilities teleconference. Additionally, CMDR Matthew Suess and DOD's Jack Brown have been instrumental in this dialog.

acquisition process will create a more competitive generation environment and most importantly provide least cost energy for our customers. GPA intends to use the competitive RFP process for acquisition of proposals for the turn-key development of one or more wind farms. The Authority will heavily borrow from the "White Creek" development model described in Stakeholder Meeting No. 3. This business model combines the advantages of a public/private undertaking[18].

Moving towards fuel diversity, the introduction of LNG into the fuel mix coupled with the conversion of the TEMES CT plant to use this fuel will provide an economic displacement of diesel fuel oil as system demand increases.

The challenge regarding the introduction of LNG as a replacement for diesel fuel includes:

- Changing the paradigm concerning the Japan Bank for International Cooperation's (JBIC) pledge to support the infrastructure requirements for the DOD marine move from one of supplying electric energy to one supplying LNG;
- Renegotiation of the Taiwan Electrical and Mechanical Engineering Services (TEMES) Energy Conversion Agreement to include a conversion of the plant to use natural or synthetic gas; and
- Examination of supplying natural gas for industrial, commercial, and residential use as a utility under the Consolidated Utility Commission and the Guam Public Utility Commission.

[18] Session 3—IRP Stakeholder Meeting—STRATEGIES FOR ACQUIRING NEW RESOURCES (http://www.guampowerauthority.com/operations/strategicplanning/GPAIRP.html) White Creek public/private development model.

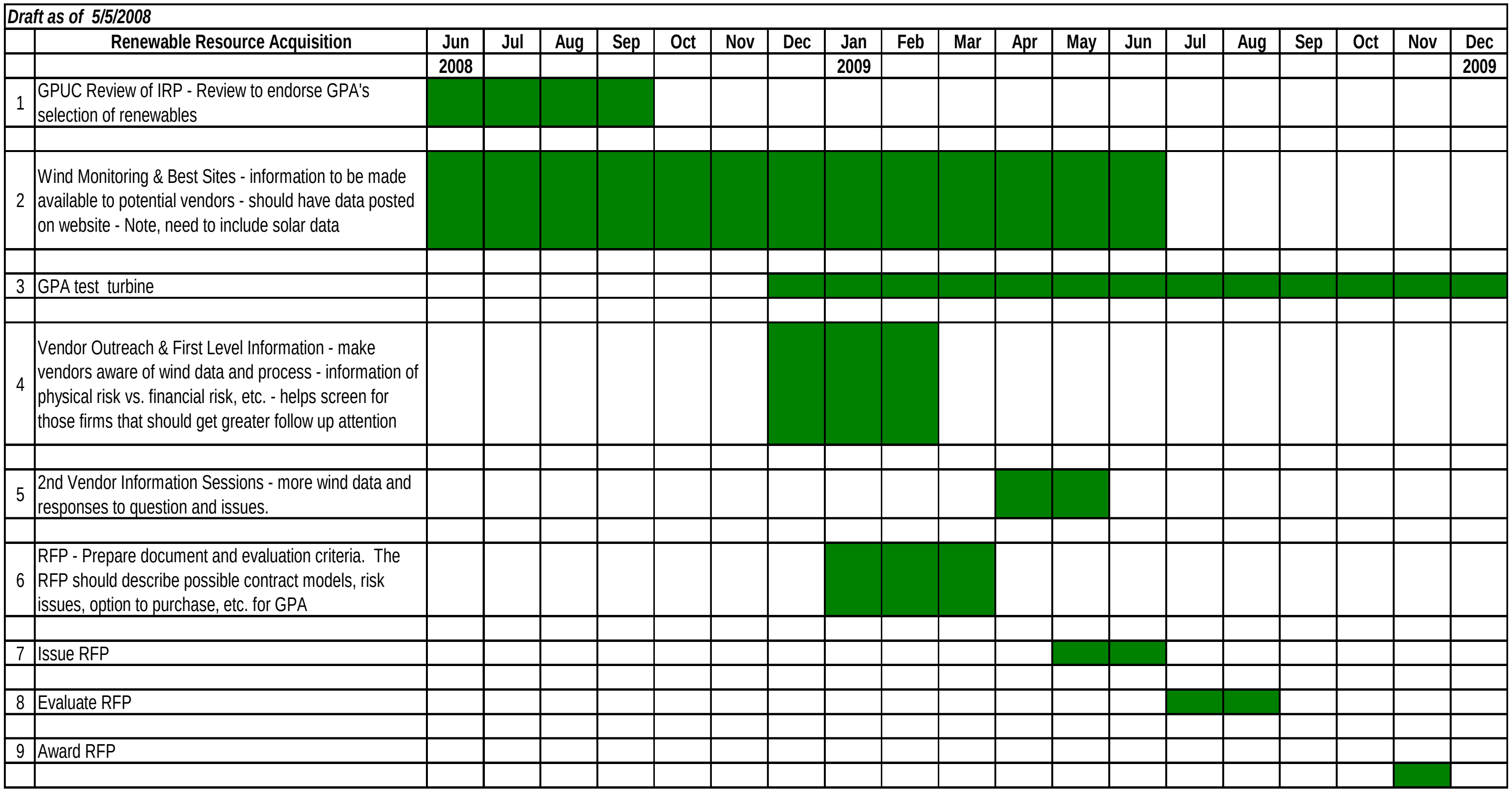

Figure 13-1, Renewable Resource Acquisition Proposed Schedule

APPENDICES

A Generation Resource Handbook

B Renewable Portfolio Standards

C Load Forecast

D Fuel Forecast

E Supply Side Options

F Demand Side Options

G Guam Environmental Assessment

H Energy Policy Act of 2005 Implications

I Vertical Axis Turbine Viability

J Description of Analysis Tools

K Bibliography

Bibliography

"Table 2-1" in 1993 EPRI Technology Assessment Guide, Volume 1: Electricity Supply

Chaudhuri, Partha S., Murphy, Michael, and Burns, Robert E. Commissioner Primer Carbon Dioxide Capture and Storage, The National Regulatory Research Institute, March 2006.

Leggio, Karyl B., Bodde, David L., and Taylor, Marilyn L. Managing Enterprise Risk: What the Electric Industry Experience Implies for Contemporary Business, Oxford, U.K.: Elsevier Ltd. 2006. Page 14.

Vudrinen, Asko Planning of Optimal Power Systems, Vammala, Finland: Vammalan Kirjapaio Oy, 2007.

Wood, Allen J. and Wollenberg, Bruce F. Power Generation Operation and Control Second Edition, New York, NY: John Wiley&Sons, Inc. 1996.

Li, Wenyuan PhD. IEEE Fellow Risk Assessment of Power Systems: Models, methods and Applications, Hoboken, NJ: IEEE Press. 2005.

Burns, Robert Summary of H.R.6 – Energy Policy Act of 2005 Title XII: Electricity, The National Regulatory Research Institute, August 2005.

Weber, Christoph Uncertainty in the Electric Power Industry: Methods and Models for Decision Support, New York, NY: Springer Science+Business Media, Inc., 2005.

McGarvey, Joe, et al. What Generation Mix Suits Your State? Tools for Comparing Fourteen Technologies Across Nine Criteria, The National Regulatory Research Institute, February 14, 2007.

PL Mangilao Energy, LLC. GPA Peak Demand and Sales Forecast Documentation. September 23, 2007.

Cruz Jr., John J., P.E. and Iriarte, Francis J.,P.E. "Forecasting GPA's Long Range Sales and Load" in 2007 GPA Pacific Power Association Conference Paper.

PL Mangilao Energy, LLC. GPA Peak Demand and Sales Forecast Documentation. September 23, 2007.

R.W. Beck. Letter to GPA on Development of Resource Option Characteristics. November 16, 2007.

R.W. Beck. Demand Side Management Study. March 2008.

Georgetown Consulting Group. "Guam PUC Staff Update: Integrated Resource Planning (IRP) Process." May 7, 2008.

L Acknowledgements

Acknowledgements

Guam Power Authority would like to thank the following for their participation, support and important contributions in the completion of this Integrated Resource Plan:

IRP Stakeholders and their representatives, for their participation and contributions during the Stakeholder Meetings:

- **Public Utilities Commission of Guam**
  Jeffrey Johnson, Chairman

- **Consolidated Commission on Utilities**
  Simon A. Sanchez II, Chairman
  Benigno Palomo, Vice Chairman-GPA
  Eloy P. Hara, Vice Chairman-GWA
  Gloria Nelson, Secretary
  Joana "Margaret" Castro Blas, Commissioner

- 29th Guam Legislature
  Senator James V. Espaldon
  Vicente Lizama, Staff Assistant

- Bank of Guam (Financial Institution)
  Joseph P. Bradley, Senior VP/ Trust& Economic & Market Statistics Officer

- Community Representative (Environmental)
  Joanne Brown, Guam Soil & Water Conservation Liaison – UOG

- Department of Public Works / Civilian Military Task Force
  Larry P. Perez, Director / Chairman
  Dominic Muna, Solid Waste Management Superintendent
  Mario Garcia, Planner, Highway Division - Federal Highway
  Maria Duarte, Management Analyst IV, Solid Waste Management Division

- Guam Chamber of Commerce
  Stephen C. Ruder, Chairman of the Board
  Jennifer O'Mallan, Staff Assistant

- Guam Contractors Association
  James Martinez, Executive Director

- Guam Energy Office
  Jlawrence M. Cruz, Director
  Noel Cruz, Engineer II

- Guam Environmental Protection Agency
  Lorilee T. Crisostomo, Administrator
  Michael J. Gawel, Planner IV
  Edwin Aranza, Planner III
  Raymond Calvo, Planner II
  Peter Q. Cruz, Environmental Health Spec. Supervisor

- Guam Hotel & Restaurant Association
  Mary P. Torre, President

- Naval Facilities Marianas
  Captain Paul T. Fuligni, Commanding Officer
  Commander Matthew Suess, Operations Officer
  Jack Brown, Utilities & Energy Conservation Manager

- Port Authority of Guam
  Kenneth T. Tagawa, General Manager
  Joaquin P. Cruz, Deputy General Manager
  Herman Paulino, Program Coordinator IV

Engineering & Technical Services Consultants who shared their expertise on subject matters essential to the IRP:

P.L. Mangilao Energy, LLC & Consultants
Kemm C. Farney, Ph D, PL Mangilao, LLC
Peter C. Mayer, PhD, PL Mangilao, LLC
Dave L. Rogers, PL Mangilao, LLC
John Dean, President, JD Energy, Inc.
Michael Lynch, President and Director of Global Petroleum Service, Strategic Energy & Economic Research Inc. (SEER)
Ronald Denhardt, CEO and Vice President, Natural Gas and Power, Strategic Energy & Economic Research Inc. (SEER)
James T. Jensen, Senior Consultant, International Gas, Strategic Energy & Economic Research Inc. (SEER)

Winzler & Kelly / R.W. Beck & Consultants

Angelo Muzzin, Principal and Senior Director – R.W. Beck, Inc.
Youssef Hegazy, Ph.D., Executive Consultant – R.W. Beck, Inc.
Kenneth Rose, Ph.D., Independent Consultant
John M. McNurney, Principal and Senior Director, Environmental Services – R.W. Beck, Inc.
Lanny P. Waguespack, Barnes & Click, a Division of R. W. Beck, Inc.

Guam Economic Development and Commerce Authority for their generosity in providing a facility for a portion of our IRP stakeholder meetings:

Anthony Blaz, Acting Administrator
Christina Garcia, Acting Deputy Administrator
Eleanor Umagat - Lujan, Executive Assistant
Francisco Santos, Computer Specialist

University of Guam for the use of the Anthony Leon Guerrero Multi-Purpose Room for a portion of the stakeholder meetings:

Dr. Jeff D. T. Barcinas, Vice President, University and Community Engagement, University of Guam
Roberta S.N. Flores, Administrative Assistant
Bruce Best, Research Associate, University of Guam

All stakeholder meeting attendees including:

Guam Congresswoman Office Representative
Office of Senator Lujan Representative
Village Mayors
Local and Off-island Vendors, Engineers, Consultants & Contractors
GPA Independent Power Producers

GPA's Strategic Planning and Operations Research Division (SPORD):

John J. Cruz, Jr., P.E., Manager
Bea Davis, Administrative Assistant, Executive Office/SPORD
Jennifer G. Sablan, Special Projects Engineer
Lorraine O. Shinohara, P.E., Special Projects Engineer
Maria Paz A. Tison, Special Projects Engineer
Rodney C. Cruz, Special Projects Engineer
Roel A. Cahinhinan, P.E., Special Projects Engineer
Francis J. Iriarte, P.E., Special Projects Engineer