7.3.1.5 Solar

Unit characteristics were developed for the potential installation of a stationary photovoltaic solar project. The plant would include panels, panel mounts collection systems, inverters and interconnection to the grid. Panels were assumed to be stationary mounted and constructed of polycrystalline silicon. While siting was not investigated, solar installations typically have minimal environmental impact during construction and operation. The collection of irradiance data to support expectations of energy production should be studied prior to moving forward with a solar project of this type.

7.3.1.6 Wind

Unit characteristics were developed for the potential installation of a wind project. The plant would include approximately ten wind turbines (2 MW each), collection systems, and interconnection to the grid. While siting was not investigated, the location of wind turbines is critical to optimize energy production. The collection of wind data to support expectations of energy production should be studied prior to moving forward with a wind project of this type.

7.3.1.7 Ocean Thermal Energy Conversion

Unit characteristics were developed for the potential installation of an ocean thermal energy conversion project. This project would utilize the cold temperature of ocean water at depth to support operation of an organic rankine power cycle. Large pipes would be routed from an on-shore facility out into the ocean and down several hundred meters. The cold ocean water would be used to condense the operating fluid of a closed cycle, which would then be expanded over a turbine to generate power. This type of project would require significant effort from an environmental assessment standpoint due to the reef that surrounds Guam. Siting should be near the load center to minimize costs of the land based interconnection costs.

7.3.1.8 Sea Water Air Conditioning

Unit characteristics were developed for the potential installation of a sea water air conditioning project. This project is essentially a demand side management project, which would displace the electrical load currently being provided by air conditioning units operating on electricity. Large pipes would be routed from an on-shore facility out into the ocean and down several hundred meters. The cold ocean water would be used to support operation of water to water heat exchangers in an on-shore facility. The chilled water produced would then be piped to buildings requiring air conditioning. This type of project would require significant effort from an environmental assessment standpoint due to the reef that surrounds Guam. Siting should be near the load center to minimize costs of the land based interconnection costs.

7.3.1.9 Geothermal

Unit characteristics were developed for the potential installation of a geothermal project. This project was assumed to be a binary type geothermal project, which uses hot water or steam from deep beneath the earth's surface to vaporize the working fluid of a organic rankine power cycle on the surface. Wells are drilled to access the hot water or steam and return the used fluids back beneath the earth's surface. It is our understanding that Guam has limited geothermal resources available. Therefore additional investigations would be required prior to moving forward with this project to confirm the resource and site the plant.

7.3.1.10 Municipal Solid Waste

Unit characteristics were developed for the potential installation of a municipal solid waste (MSW) project. This project was assumed to utilize MSW as the fuel source for a boiler /STG combination. A tipping fee would be required to obtain the MSW, which would likely be required to offset the economics of landfill operators currently in operation on Guam. The project could limit the amount of solid waste being landfilled on the Guam, but would require significant environmental and political investigations prior to moving forward.

8 Demand Side Management

8.1 Introduction

At the request of GPA, R. W. Beck, Inc., an SAIC Company ("R. W. Beck"), was retained to perform an evaluation of the cost-effectiveness of residential and commercial demand-side management ("DSM") program measures for potential implementation by GPA.

This DSM study was conducted in a manner to provide a practical investigation of DSM program potential for GPA, evaluating the cost of the program measure commensurate with the size and scope of GPA's electric system. The analysis was conducted in two phases: (i) a technical screening assessment, and (ii) an economic screening analysis.

The technical screening assessment involved a review of potential DSM options. DSM measures previously examined for GPA during prior IRP efforts for technical potential were combined with R. W. Beck's existing database of DSM measures deployed in other projects, and the entire set of measures were evaluated for technical potential using updated engineering estimates of energy and peak demand savings.

Technical potential (energy and demand savings) estimates were prepared using weather patterns specific to GPA, and were vetted to make sure that savings estimates were reasonable compared to approximate Guam baselines. A wide array of technical options was considered for both the residential and commercial sector, including measures previously abandoned, to ensure updated engineering intelligence pertaining to certain measures was evaluated objectively. DSM measures were also qualitatively evaluated for implementation in the GPA service area, and factors such as scalability, viability on an island terrain and in a tropical climate, and adoption potential were considered. Consistent with the scope of services for this study, the two measures in each sector (residential and commercial) that were deemed most promising from a technical perspective were considered for further evaluation during the economic screening analysis.

The economic analysis was performed using a cost-benefit evaluation model developed by R. W. Beck in partnership with EPRI (the "EPRI Model"). R. W. Beck developed this concise spreadsheet tool to assist utilities with the assessment of the costs and benefits associated with electric system improvements and efficiencies ("Programs"), including capital improvement projects, distributed generation and storage, and other energy efficiency incentives or efforts that reduce demand and energy consumption. The key components of avoided cost (or benefits) that are analyzed in this tool are: Avoided or Delayed Generation or Purchased Power Capacity Additions (demand savings), Avoided Costs of Energy Production, Avoided Transmission and Distribution cost (including avoided capital expenditures), System Loss savings, Avoided ongoing Operation and Maintenance ("O&M") costs associated with Transmission and Distribution system improvements (if any) and the value of potential power market sales of resources that are free to serve the external market in place of the energy generation that has been avoided as a result of the Program. The central Program Cost components are generally treated as exogenous (or external estimates entered by the user) and include the ability to model specific incentives with customer adoption projections or generic Projects with an all-in cost. Benefit-Cost ratios are then developed based on all input and analyses. Not all elements of avoided cost are applicable for a given utility Program, and R. W. Beck has taken care to specify benefits and costs according to the measure in question. Table 8-1 below summarizes the measures that were evaluated for economic potential by sector.

Table 8-1
DSM Measures Evaluated for Economic Potential

Residential	Commercial
2.5 Ton Central A/C – New Unit	60 Ton Chiller, 8 x 5 Operation
CFL Lighting (25 Watts)	CFL Lighting (25 Watts)

In performing this economic screening analysis, industry-standard techniques and formulae were applied to the evaluation of the DSM measures. The GPA Smart Grid Business Case model and the GPA IRP data warehouse were used as the main sources of information on marginal resource characteristics and energy and demand rates. The economic screening analysis was performed from the perspective of GPA (e.g., marginal power supply costs of GPA were compared to DSM measure costs).

Per the scope of services for this study, detailed projections of DSM program saturations, potential customer penetration rates, and utility incentive programs were not developed. Instead, the economic screening was performed based on a conservative estimate of adoption per DSM measure based on projected GPA customer counts by sector, beginning in calendar year 2013 with no incremental increases during the study period. Importantly, the economic analysis did not assume any level of incentive on the part of GPA for a given measure.
Cost-effectiveness evaluations were performed for three different perspectives on DSM program implementation, as follows[14].

Utility Cost Test ("UCT") – A measure of whether the benefits of avoided utility costs are greater than the costs incurred by a utility to implement the DSM program.

Rate Impact Measure ("RIM") Test – A measure of 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.

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

[14] The EPRI model result is identical to the Total Resource Cost Test described below. Additional ratios were developed from the constituent components of avoided cost and measure cost as tracked in the EPRI model.

Summary results of the economic screening are presented below in Table 8-2. The table provides present value benefit to cost ratios computed over the period 2013-2022 for each DSM measure for each of the cost-effectiveness tests described above.

GPA established that a DSM measure must pass both the UCT and the RIM Test before it would promote a DSM measure as part of its IRP filing. A benefit to cost ratio of greater than 1.0 for the UCT and the RIM Test indicates that GPA could promote and develop a given DSM program such that the program would reduce GPA's operating costs at a level greater than the cost of the program and that net benefits derived from the program would not cause an increase in the retail rates charged to GPA customers. .

None of the DSM measures evaluated for economic potential were found to pass both the UCT and RIM Test criteria. As such, GPA is not including any projections of DSM impacts in its IRP filing. However, GPA may choose to implement DSM programs for reasons that are different than the economic conditions considered. For instance, GPA may choose to ignore adverse retail rate impacts and implement DSM programs based on the TRC Test results. Furthermore, to the extent GPA desires to explore increased incentive levels in the future, the results shown herein will be impacted. Refer to Section 3 of this report for a more detailed tabular summary of the cost-effectiveness screening as well as some important assumptions underpinning the results.

Table 8-2
Summary Results of DSM Cost-Effectiveness

	B/C Ratio		
Residential Measures	**UCT**	**RIM**	**TRC**
2.5 Ton Central A/C - New Unit	10.619	0.914	0.357
CFL Lighting (25 Watts)	2.234	0.691	1.916
Commercial Measures			
60 Ton Chiller, 8 x 5 Operation	83.637	0.988	1.447
Commercial CFL Lighting (25 Watts)	3.805	0.792	3.264

In addition to the results presented in this report, Appendix A provides detailed results tables from the EPRI model summarizing the ultimate economic screening analysis results for each of the four measures.

8.2 Introduction and Description of Study

This report has been prepared for the use of GPA for the specific purposes identified in this report and is solely for the information of and assistance to GPA and should not be relied upon for any other purpose or by any other party unless authorized by R. W. Beck.

The projections presented in this report were developed on the basis of the assumptions and circumstances described herein. In preparing this report, we have made certain assumptions with respect to conditions that may exist or events that may occur in the future. While we believe the use of such assumptions to be reasonable for the purposes stated herein, we offer no other assurances with respect thereto, and it should be anticipated that some future conditions may vary significantly from those assumed herein due to unanticipated events and circumstances. To the extent that future conditions differ from those assumed in the analysis, actual results and outcomes may vary from those projected.

The conclusions, observations, and recommendations contained herein attributed to R. W. Beck constitute the opinion of R. W. Beck. To the extent that statements, information, and opinions provided by GPA or others have been used in the preparation of this report, R. W. Beck has relied upon the same to be accurate and for which no assurances are intended and no representations or warranties are made. R. W. Beck makes no certification and gives no assurances except as explicitly set forth in this report. This report summarizes our work up to the date of this report; changed conditions which occur or become known after such date could affect the results presented in the report to the extent of such changes.

8.3 Approach and Methodology

8.3.1 Technical Screening Assessment

The first step in the study process included a technical screening assessment. The technical screening assessment involved a review of potential DSM options. DSM Measures previously examined for GPA during prior IRP efforts for technical potential were combined with R. W. Beck's existing database of DSM measures deployed in other projects, and the entire set of measures were evaluated for technical potential using updated engineering estimates of energy and peak demand savings.

Technical potential (energy and demand savings) estimates were prepared using weather patterns specific to GPA, and were vetted to make sure that savings estimates were reasonable compared to approximate Guam baselines. A wide array of technical options was considered for both the residential and commercial sector, including measures previously abandoned, to ensure updated engineering intelligence pertaining to certain measures was evaluated objectively. DSM measures were also qualitatively evaluated for implementation in the GPA service area, and factors such as scalability, viability on an island terrain and in a tropical climate, and adoption potential were considered. Consistent with the scope of services for this study, the two measures in each sector (residential and commercial) that were deemed most promising from a technical perspective were considered for further evaluation during the economic screening analysis.

8.3.2 Economic Screening Analysis

The economic analysis was performed using a cost-benefit evaluation model developed by R. W. Beck in partnership with EPRI (the "EPRI Model"). R. W. Beck developed this concise spreadsheet tool to assist utilities with the assessment of the costs and benefits associated with electric system improvements and efficiencies (“Programs”), including capital improvement projects, distributed generation and storage, and other energy efficiency incentives or efforts that reduce demand and energy consumption. The key components of avoided cost (or benefits) that are analyzed in this tool are: Avoided or Delayed Generation or Purchased Power Capacity Additions (demand savings), Avoided Costs of Energy Production, Avoided Transmission and Distribution cost (including avoided capital expenditures), System Loss savings, Avoided ongoing O&M costs associated with Transmission and Distribution system improvements (if any) and the value of potential power market sales of resources that are free to serve the external market in place of the energy generation that has been avoided as a result of the Program. The central Program Cost components are generally treated as exogenous (or external estimates entered by the user) and include the ability to model specific incentives with customer adoption projections or generic Projects with an all-in cost. Benefit-Cost ratios are then developed based on all inputs and analyses. Not all elements of avoided cost are applicable for a given Program, and R. W. Beck has taken care to specify benefits and costs according to the measure in question.

8.3.3 DSM Measure Assumptions

Table 8-3 provides a general description of each DSM measure that was deemed most desirable in the technical screening and for which an economic evaluation was conducted. Per the scope of services for this study, detailed projections of DSM program saturations, potential customer penetration rates, and utility incentive programs were not developed. Instead, the economic screening was performed based on a conservative estimate of adoption per DSM measure based on projected GPA customer counts by sector, beginning in calendar year 2013 with no incremental increases during the study period. Importantly, the economic analysis did not assume any level of incentive on the part of GPA for a given measure. By modeling the DSM measure installations at the first year of the study, the DSM measures were modeled to have the greatest possible net present benefits. As required (e.g. lighting measures), new DSM measure installations were modeled to occur at the end of the useful life of the measure to maintain the persistence of the DSM demand and energy reductions over the study period.

Table 8-3
DSM Measure Descriptions

DSM Measure	General Description
Residential Measures:	
2.5 Ton Central A/C – new unit	Install a new 2.5 Ton Central A/C unit with an estimated SEER of 14.5 to replace units that have an estimated SEER of 7.0.
CFL Lighting (25 Watts)	Replace a 100 Watt incandescent light bulb with a CFL.
Commercial Measures:	
60 Ton Chiller, 8 x 5 operation	Replace existing chiller on a commercial scale with a brand new 60 ton chiller that dispatches on an 8 hours per day, 5 days per week schedule for locations where such dispatch is appropriate.
Commercial CFL Lighting (25 Watts)	Replace traditional 100 Watt commercial lighting with CFLs at a commercial scale.

8.3.4 GPA Cost Assumptions

Evaluation of DSM program measures requires a comparison of the DSM measure costs against avoidable utility operating and capital costs. In general, the modeled utility cost and system characteristics include the following:

- Avoided capital costs for future GPA generation facilities;
- Avoided O&M costs for future GPA generation facilities;
- Avoided GPA transmission costs;
- GPA transmission and distribution losses;
- GPA financing costs and assumptions;
- Projections of average base (non-fuel) retail rates for GPA customers; and
- Projections of average and marginal GPA fuel costs.

These assumptions were developed from a number of sources, including the current GPA IRP analyses, the GPA Smart Grid Business Case model, and available projections of GPA's future customer base, energy requirements, and peak demand. Appendix A contains a complete pro forma summarizing the results of the four measures that were evaluated economically, and delineates the results of R. W. Beck's analysis of all system characteristics above. The elements of avoided cost that are applicable (i.e., result in tangible savings) differ by Program. For example, a Program that results in a very small reduction in peak demand will not be sufficient to cause a delay in the next incremental capacity addition for a given utility. Refer to Appendix A for detailed line item costs and benefits that have been estimated for each measure.

8.3.5 DSM Benefit-Cost Tests

For this study, industry standardized formulae were adopted for computing DSM measure costs and benefits[15]. We have relied upon three of the standard tests for this study: the Utility Cost Test ("UCT"), the Rate Impact Measure ("RIM") Test, and the Total Resource Cost ("TRC") Test. In general terms, the equations that define the three standard tests can be described as follows.

Utility Cost Test:

Benefits	=	Avoided Energy Supply Costs (net generation level decreases × marginal energy costs)
	+	Avoided Capital Supply Costs (net generation level decreases × incremental capital costs)
	+	Avoided O&M Supply Costs (net gen. or distribution level decreases × marginal O&M costs)
	+	Participation Charges
Costs	=	Increased Energy Supply Costs (net generation level increases × marginal energy costs)
	+	Increased Capital Supply Costs (net generation level increases × incremental capital costs)
	+	Increased O&M Supply Costs (net gen. or distribution level increases × marginal O&M costs)
	+	Utility program costs (administrative costs)
	+	Incentives (utility incentives, rebates, etc.)

Rate Impact Measure ("RIM") Test:

Benefits	=	Avoided Energy Supply Costs (net generation level decreases × marginal energy costs)
	+	Avoided Capital Supply Costs (net generation level decreases × incremental capital costs)
	+	Avoided O&M Supply Costs (net gen. or distribution level decreases × marginal O&M costs)
	+	Revenue Gains (net meter level increases × retail rates)
	+	Participation Charges
Costs	=	Increased Energy Supply Costs (net generation level increases × marginal energy costs)
	+	Increased Capital Supply Costs (net generation level increases × incremental capital costs)
	+	Increased O&M Supply Costs (net gen. or distribution. level increases × marginal O&M costs)
	+	Revenue Losses (net meter level decreases × retail rates)
	+	Utility program costs (administrative costs)
	+	Incentives (utility incentives, rebates, etc.)

Total Resource Cost ("TRC") Test:

Benefits	=	Avoided Energy Supply Costs (net generation level decreases × marginal energy costs)
	+	Avoided Capital Supply Costs (net generation level decreases × incremental capital costs)
	+	Avoided O&M Supply Costs (net gen. or distrib. level decreases × marginal O&M costs)
	+	Avoided Participant Costs (avoided capital, O&M, etc.)
	+	Tax Credits
Costs	=	Increased Energy Supply Costs (net generation level increases × marginal energy costs)
	+	Increased Capital Supply Costs (net generation level increases × incremental capital costs)
	+	Increased O&M Supply Costs (net gen. or distrib. level increases × marginal O&M costs)
	+	Incremental Participant Costs (capital costs, O&M, etc.)
	+	Utility DSM Program A&G Costs

The computations reflect all of the incurred incremental costs and avoided incremental costs (benefits) that were used to evaluate the DSM measures, as applicable to the measure in question.

[15] The EPRI model result is identical to the Total Resource Cost Test described below. Additional ratios were developed from the constituent components of avoided cost and measure cost as tracked in the EPRI model.

8.4 Results

GPA has established that a DSM measure must pass both the UCT and the RIM Test before GPA would promote a DSM measure as part of its IRP filing. A benefit to cost ratio of greater than 1.0 for the UCT and RIM Test indicates that GPA could promote and develop a given DSM program such that the program would reduce GPA's operating costs at a level greater than GPA's cost of implementing the program and that the program would not cause an increase in the retail rates charged by GPA. A summary of net benefits (or costs) and the benefit to cost ratio are provided for each evaluated DSM measure in Table 3-1 below.

None of the DSM measures evaluated for economic potential were found to pass both the UCT and RIM Test criteria. As such, GPA is not including any projections of DSM impacts in its IRP filing. However, GPA may choose to implement DSM programs for reasons that are different than the economic conditions considered by GPA. For instance, GPA may choose to ignore adverse retail rate impacts and implement DSM programs based on the TRC Test results. Furthermore, to the extent GPA desires to explore increased incentive levels in the future, the results shown herein will be impacted. Finally, it is our understanding that GPA will continue to implement its existing electric utility facility maintenance and efficiency programs, and that GPA will continue to offer public information programs on energy conservation.

Table 8-4
Summary Results of DSM Cost-Effectiveness

	NPV ($000)			B/C Ratio		
Residential Measures [1], [3]	**UCT**	**RIM [4]**	**TRC**	**UCT**	**RIM**	**TRC**
2.5 Ton Central A/C - New Unit	$1,908	($198)	($3,793)	10.619	0.914	0.357
CFL Lighting (25 Watts)	$245	($198)	$212	2.234	0.691	1.916
Commercial Measures [2], [3]						
60 Ton Chiller, 8 x 5 Operation	$16,391	($198)	$5,125	83.637	0.988	1.447
Commercial CFL Lighting (25 Watts)	$556	($198)	$523	3.805	0.792	3.264

Footnotes

[1] Based on 1,000 customer adoptions/bulbs, and marginal cost and resource information derived from Guam's Integrated Resource Plan assumptions and Guam's Smart Grid Business Case.
[2] Chiller assumes adoption by 250 commercial customers who on average dispatch the chiller on an 8 hours a day 5 days per week schedule. Commercial CFL evaluated based on 1,000 bulbs being distributed.
[3] Engineering estimates for energy and demand savings utilized to develop B/C ratios based on Guam-specific weather patterns and technical measure modeling performed by SAIC. Adoption estimates based on conservative assumptions as a percentage of projected Guam customer counts by sector. The top 2 technical measures by sector were evaluated economically.
[4] Due to a lack of Guam incentives, and the assumption of marginal resource costs to capture both avoided costs and revenue loss, the NPV of the RIM Test from strictly a dollar differential perspective is driven solely by estimated Guam A&G costs in each case, or approximately $26,000 per year. B/C ratios differ by measure for the RIM test due to the varying contribution of A&G costs to the overall B/C picture.

9 Key Results

This section discusses the key results from GPA's analysis of candidate generation expansion plans under several hundred scenarios considering:

- Generation unit life extension recapitalization;
- Generation unit retirements singly or in groups;
- Fuel diversification and associated infrastructure requirements;
- Scenarios for projected loads;
- Operation under projected fuel prices;
- Reserve margin requirements;
- Candidate generation units for future energy supply;
- Demand-Side Management;
- Phase I and II Renewable Energy Acquisitions;
- Environmental compliance and GPA's Environmental Strategic Plan;
- Cost and operations models for existing generation assets; and,
- Optimization of system technical losses as advised by GPA's FY 2010 Long-Range Transmission Plan.

Appendix K contains the results for Strategist simulations under the several hundred scenarios analyzed.

9.1 Key Results

The most important result of GPA's analysis is that a move from residual fuel oil is the least cost generation expansion plan. The primary drivers of this result include:

- Costs for environmental compliance with several new U.S. EPA regulations especially with the Reciprocal Internal Combustion Engine Maximum Available Control Technology (RICE MACT) rule
- Expectation of lower delivered natural gas prices including amortized capex costs for building the necessary delivery, storage, and distribution infrastructure.

Table 9-1 shows the potential net present value savings of the top three generation expansion scenario plans. These plans indicate net present value savings greater than one billion dollars for a GPA conversion from residual fuel oil to liquefied natural gas. Tables 9-2 through 9-4 illustrate the capex requirements for these three expansion plans.

Table E-1, Potential Savings of Diversifying to LNG

CASE	Retirement Units	PV Utility Costs ($000)	Present Value Variance (Savings) from Base Case ($000)
1	None	6,451,778	BASE CASE
2	Marbo, Dededo Diesel, Cabras 1&2	5,258,080	(1,193,698)
3	Marbo, Dededo Diesel, Tanguisson 1&2	5,311,525	(1,140,253)
4	Marbo, Dededo Diesel, Cabras 1&2, Tanguisson 1&2	5,241,317	(1,210,462)
5	Marbo, Dededo Diesel, Dededo CT 1&2, Yigo, Macheche	5,348,209	(1,103,570)
6	Marbo, Dededo Diesel, Dededo CT 1&2, Yigo	5,354,665	(1,097,114)
7	Marbo, Dededo Diesel, Dededo CT 1&2	5,360,709	(1,091,069)
8	Marbo, Dededo Diesel	5,388,596	(1,063,182)

		Present Value Variance (Savings) from Base Case ($000)	
CASE	Retirement Units	Initial Screening Assumptions[1]	Test Assumptions[2]
1	None	BASE CASE	BASE CASE
2	Marbo, Dededo Diesel, Cabras 1&2	(1,193,698)	(1,204,930)
3	Marbo, Dededo Diesel, Tanguisson 1&2	(1,140,253)	(1,146,924)
4	Marbo, Dededo Diesel, Cabras 1&2, Tanguisson 1&2	(1,210,462)	(1,201,425)
5	Marbo, Dededo Diesel, Dededo CT 1&2, Yigo, Macheche	(1,103,570)	
6	Marbo, Dededo Diesel, Dededo CT 1&2, Yigo	(1,097,114)	
7	Marbo, Dededo Diesel, Dededo CT 1&2	(1,091,069)	
8	Marbo, Dededo Diesel	(1,063,182)	

[1] Initial screening assumptions include additional operation costs for intermittent renewable options (solar and wind) and the availability of geothermal potential.

[2] Testing assumptions evaluate results based on removal of initial screening assumptions.

Avoided Compliance Costs due to Retirement or Fuel Conversion by Scenario ($000)

		Avoided Compliance Costs[1] ($000)		
Case	Retirement Units	Retirement	Fuel Conversion	Total
2	Cabras 1&2 Retirement	161,300	300,000	461,300
3	Cabras 1&2 and Tango Retirement	221,300	240,000	461,300
4	Tanguisson Retirement	61,300	400,000	461,300

[1] Avoided compliance costs assumes that GPA would be allowed to defer compliance of RICE MACT for Slow Speed Diesel units and BOILER MACT (MATS) for Steam units until LNG is available in 2018.

Table 9-2, Recommended Capital Requirements (thru 2020) – Tanguisson Retirement

Complete / Commission By FY	Description	Project Period	IWPS Capacity Impact (MW)	Life Extension ($000)	Fuel Conversion / New Construction ($000)	EPA Compliance ($000)	Total CAPEX ($000)
2013	Retire Marbo CT and Dededo CT		- 26 MW	$ -	$ -	$ -	$ -
2014	Life Extension & Environmental Compliance for *Peaking Units* [1]	2013 - 2014	-	$ 24,220	$ -	$ 7,150	$ 31,370
2015	Environmental Compliance for *Baseload Plant* [2]	2013 - 2015	-		$ -	$ 13,002	$ 13,002
2018	Life Extension of Baseload Plants (Excluding Cabras 1&2 & Tanguisson)	2014 - 2019	-	$ 9,680	$ -	$ -	$ 9,680
2017	Solar PV	2014 - 2017	+ 20 MW (2x10MW)		$ 90,000		$ 90,000
	Wind	2014 - 2017	+ 20 MW		$ 93,000		$ 93,000
2018	LNG Import Terminal & Gasification Facility[3]	2013 - 2018	-		$ 212,000		$ 212,000
	TEMES CT Repower as *Combined Cycl* e[4] & LNG Conversion	2014 - 2018	+ 20 MW (capacity increase)		$ 81,000		$ 81,000
	New Combined Cycle[4] Units (2 Each)	2014 - 2018	+ 60 MW		$ 128,400		$ 128,400
	Cabras 3 LNG Conversion	2014 - 2018	-		$ 13,560		$ 13,560
	Cabras 4 LNG Conversion	2014 - 2018	-		$ 13,560		$ 13,560
	MEC 8 LNG Conversion	2014 - 2018	-		$ 13,711		$ 13,711
	MEC 9 LNG Conversion	2014 - 2018	-		$ 13,711		$ 13,711
	Retire Tanguisson 1 & 2		- 53 MW (-2x26.5MW)				$ -
			TOTAL:	$ 33,900	$ 658,942	$ 20,152	$ 712,994
			LNG Related Costs:		$ 475,942		
			Renewable Costs:		$ 183,000		

NOTES:

1 Peaking Units are the following diesel fueled combustion turbine and diesel engine units which are primarily used for peak hours or during maintenance of baseload units: Dededo CT 1&2, Macheche CT, Yigo CT, Marbo CT, Dededo Diesel Units 1-4, Tenjo Diesel Units 1-6, Talofofo Diesel Units 1-2, Manenggon Diesel Units 1-2 and Piti 7 (TEMES).

2 Baseload Plants refer to the high sulfur fuel oil fueled plants which primarily dispatched first due to fuel costs. These plants include Cabras 1&2, Cabras 3&4, Piti 8&9 (MEC), and Tanguisson 1&2.

3 This is the total construction cost of the facility, however GPA will evaluate other contracting options to minimize cost impact.

4 Combined Cycle reference is a Combustion Turbine (CT) which ties in a Heat Recovery Steam Generator (HRSG) to its exhaust. The HRSG used in this reference is an additional 20 MW which increases plant efficiency since no additional fuel is used for power generated through the HRSG.

Table 9-3, Recommended Capital Requirements (thru 2020) – Cabras 1&2 Retirement

Complete / Commission By FY	Description	Project Period	IWPS Capacity Impact (MW)	Life Extension ($000)	Fuel Conversion / New Construction ($000)	EPA Compliance ($000)	Total CAPEX ($000)
2013	Retire Marbo CT and Dededo CT		- 26 MW	$ -	$ -	$ -	$ -
2014	Life Extension & Environmental Compliance for *Peaking Units* [1]	2013 - 2014	-	$ 24,220	$ -	$ 7,150	$ 31,370
2015	Environmental Compliance for *Baseload Plant* [2]	2013 - 2015	-		$ -	$ 13,002	$ 13,002
2018	Life Extension of Baseload Plants (Excluding Cabras 1&2)	2014 - 2019	-	$ 6,340	$ -	$ -	$ 6,340
2017	Solar PV	2014 - 2017	+ 20 MW (2x10MW)		$ 90,000		$ 90,000
	Wind	2014 - 2017	+ 20 MW		$ 93,000		$ 93,000
2018	LNG Import Terminal & Gasification Facility[3]	2013 - 2018	-		$ 212,000		$ 212,000
	TEMES CT Repower as *Combined Cycl* e[4] & LNG Conversion	2014 - 2018	+ 20 MW (capacity increase)		$ 81,000		$ 81,000
	New Combined Cycle[4] Unit	2014 - 2018	+ 60 MW		$ 128,400		$ 128,400
	Cabras 3 LNG Conversion	2014 - 2018	-		$ 13,560		$ 13,560
	Cabras 4 LNG Conversion	2014 - 2018	-		$ 13,560		$ 13,560
	MEC 8 LNG Conversion	2014 - 2018	-		$ 13,711		$ 13,711
	MEC 9 LNG Conversion	2014 - 2018	-		$ 13,711		$ 13,711
	Retire Cabras 1 & 2		- 132 MW (-2x66MW)				$ -
2019	Tanguisson 1 LNG Conversion[5]	2014-2018	-		$ 16,817		$ 16,817
	Tanguisson 2 LNG Conversion[5]	2014-2018	-		$ 16,817		$ 16,817
			TOTAL:	$ 30,560	$ 692,576	$ 20,152	$ 743,288
				LNG Related Costs:	$ 509,576		
				Renewable Costs:	$ 183,000		

NOTES:

1 Peaking Units are the following diesel fueled combustion turbine and diesel engine units which are primarily used for peak hours or during maintenance of baseload units: Dededo CT 1&2, Macheche CT, Yigo CT, Marbo CT, Dededo Diesel Units 1-4, Tenjo Diesel Units 1-6, Talofofo Diesel Units 1-2, Manenggon Diesel Units 1-2 and Piti 7 (TEMES).

2 Baseload Plants refer to the high sulfur fuel oil fueled plants which primarily dispatched first due to fuel costs. These plants include Cabras 1&2, Cabras 3&4, Piti 8&9 (MEC), and Tanguisson 1&2.

3 This is the total construction cost of the facility, however GPA will evaluate other contracting options to minimize cost impact.

4 Combined Cycle reference is a Combustion Turbine (CT) which ties in a Heat Recovery Steam Generator (HRSG) to its exhaust. The HRSG used in this reference is an additional 20 MW which increases plant efficiency since no additional fuel is used for power generated through the HRSG.

5 Tanguisson Units would either need to convert or retire since it would the only remaining plant on RFO requiring GPA to maintain fuel storage and inventory for three fuels.

Table 9-4, Recommended Capital Requirements (thru 2020) – Cabras 1&2 and Tanguisson Retirement

Complete / Commission By FY	Description	Project Period	IWPS Capacity Impact (MW)	Life Extension ($000)	Fuel Conversion / New Construction ($000)	EPA Compliance ($000)	Total CAPEX ($000)
2013	Retire Marbo CT and Dededo CT		- 26 MW	$ -	$ -	$ -	$ -
2014	Life Extension & Environmental Compliance for *Peaking Units* [1]	2013 - 2014	-	$ 24,220	$ -	$ 7,150	$ 31,370
2015	Environmental Compliance for *Baseload Plant* [2]	2013 - 2015	-		$ -	$ 13,002	$ 13,002
2018	Life Extension of Baseload Plants (Excluding Cabras 1&2 & Tanguisson)	2014 - 2019	-	$ 2,680	$ -	$ -	$ 2,680
2017	Solar PV	2014 - 2017	+ 20 MW (2x10MW)		$ 90,000		$ 90,000
	Wind	2014 - 2017	+ 20 MW		$ 93,000		$ 93,000
2018	LNG Import Terminal & Gasification Facility[3]	2013 - 2018	-		$ 212,000		$ 212,000
	TEMES CT Repower as *Combined Cycl* e[4] & LNG Conversion	2014 - 2018	+ 20 MW (capacity increase)		$ 81,000		$ 81,000
	New Combined Cycle[4] Units (2 Each)	2014 - 2018	+ 120 MW (2x 60MW)		$ 256,800		$ 256,800
	Cabras 3 LNG Conversion	2014 - 2018	-		$ 13,560		$ 13,560
	Cabras 4 LNG Conversion	2014 - 2018	-		$ 13,560		$ 13,560
	MEC 8 LNG Conversion	2014 - 2018	-		$ 13,711		$ 13,711
	MEC 9 LNG Conversion	2014 - 2018	-		$ 13,711		$ 13,711
	Retire Cabras 1 & 2		- 132 MW (-2x66MW)				$ -
	Retire Tanguisson 1 & 2		- 53 MW (-2x26.5MW)				$ -
			TOTAL:	$ 26,900	$ 787,342	$ 20,152	$ 834,394
			LNG Related Costs:		$ 604,342		
			Renewable Costs:		$ 183,000		

NOTES:

1 Peaking Units are the following diesel fueled combustion turbine and diesel engine units which are primarily used for peak hours or during maintenance of baseload units: Dededo CT 1&2, Macheche CT, Yigo CT, Marbo CT, Dededo Diesel Units 1-4, Tenjo Diesel Units 1-6, Talofofo Diesel Units 1-2, Manenggon Diesel Units 1-2 and Piti 7 (TEMES).

2 Baseload Plants refer to the high sulfur fuel oil fueled plants which primarily dispatched first due to fuel costs. These plants include Cabras 1&2, Cabras 3&4, Piti 8&9 (MEC), and Tanguisson 1&2.

3 This is the total construction cost of the facility, however GPA will evaluate other contracting options to minimize cost impact.

4 Combined Cycle reference is a Combustion Turbine (CT) which ties in a Heat Recovery Steam Generator (HRSG) to its exhaust. The HRSG used in this reference is an additional 20 MW which increases plant efficiency since no additional fuel is used for power generated through the HRSG.

9.2 New Generation Plant Siting

This study recommends siting the new combined cycle combustion turbine power plant in northern Guam for the following reasons:

- The 2010 Long Range Transmission Plan advocates siting new baseload generation[16] in northern Guam because it results in about 1% reduction in line losses or correspondingly, about a 1% reduction in fuel expenses;

[16] The 2010 Long Range Transmission Plan analyzed a scenario for siting a 60 MW power plant at Harmon substation.

- Siting new generation in coastal areas puts them at risk for tsunami, typhoon elevated ocean surges, and rising ocean levels attributed to global warming. Siting new units in northern Guam in elevated areas effectively removes most of these risks;
- The retirement of Dededo Diesel Power Plant and Marbo CT opens up potential brownfield sites for new generation that may ameliorate environmental permitting for the new plant; and
- A pipeline to northern Guam supports a business model for the commercial supply of gas for cooking, transportation, and may open up other business and residential use for natural gas

9.3 LNG/Natural Gas Redundant Storage Facility Considerations

GPA does not have to duplicate the bulk storage capacity of its main onshore storage and regasification facility. GPA needs to select a strategy to mitigate risks for main storage facility failure or inaccessibility. GPA should consider spatial diversity strategies for gas storage among but not limited to the following strategies:

- A second LNG or compressed natural gas storage facility at the existing Bulk Fuel Storage Facility or within the Orote-Cabras-Piti Area;
- A second LNG or compressed natural gas storage facility sited in northern Guam that may use LNG or compressed gas isotainers;
- Ship and land-based LNG storage facilities.

9.4 Renewables

The availability of solar and wind technologies prior to the conversion allows savings on fuel consumption as early as 2017. In addition a geothermal resource by 2019 is also selected as a competitive resource to gas and oil fired units. These modeled resources may also represent other renewable technologies with the same operating and cost assumptions. Figure 9-1 illustrates the how selected renewables would impact the Guam Renewable Porfortlio Standards.

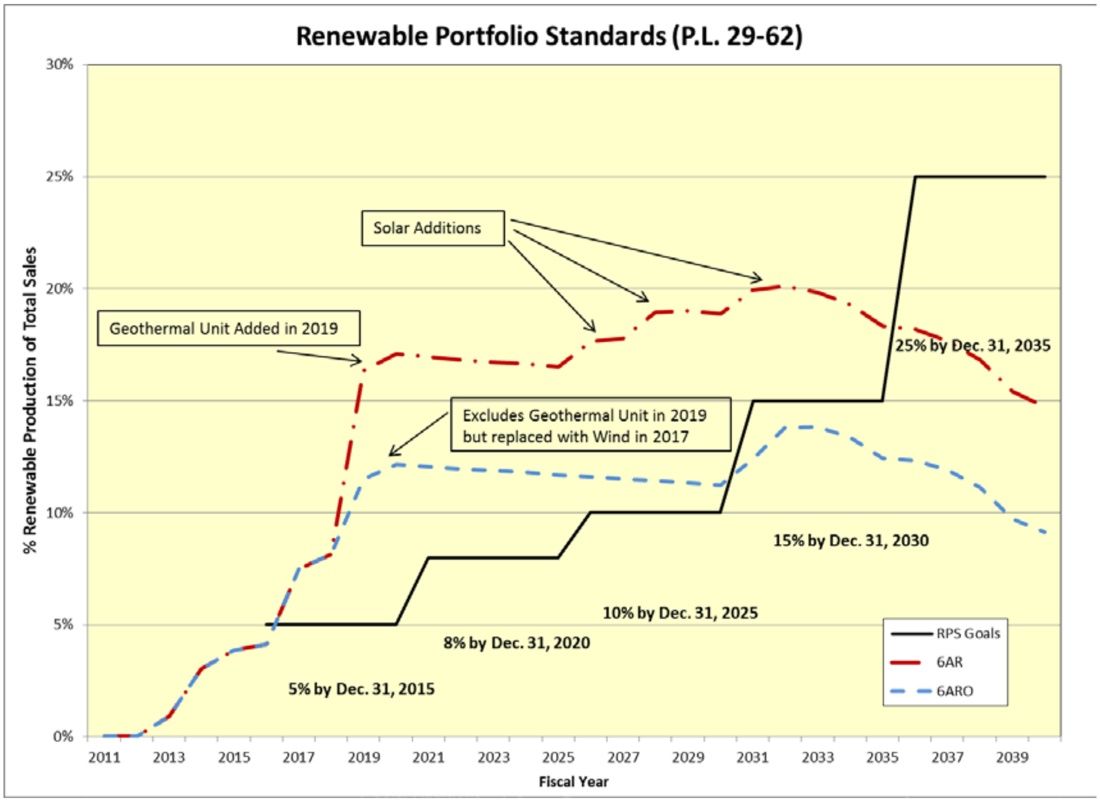


Figure 9-1: Case 2 Results and Renewable Portfolio Standards

10 Recommendations

The primary recommendations of this IRP include:

- Obtain an agreement between the United States (USEPA) and Guam Environmental Protection Agencies to suspend compliance with the RICE MACT for Cabras 3&4 and MEC 8&9 until GPA completes transition to LNG;

- Procure an additional 40 MW of renewable energy resources under the Phase II Renewable Energy Acquisition Program, if cost-competitive with other available technologies, as early as 2017 to reduce present value costs;

- Develop the necessary infrastructure and contracts to engender the transition from residual fuel oil to Liquefied Natural Gas (LNG) by 2018 or sooner;

- Retire Marbo CT and Dededo Diesels 1-4 by FY 2014;

- Firm up the decision by the end of FY 2014 to retire the Cabras 1 & 2 and/or Tanguisson 1&2 units in 2018 concurrent with the availability of LNG;

- Based upon baseload retirement decisions, construct a new 60 to 120 MW gas-fired combined cycle power plant, preferably in northern Guam to reduce technical line losses, online concurrent with the availability of LNG in 2018;

- If GPA makes the decision not to retire Cabras 1&2 or Tanguisson 1&2, complete conversion of these units to burn natural gas concurrent with the availability of LNG in 2018;

- Complete repowering Piti 7 GE Frame 6B combustion turbine generator (CTG) into a combined cycle burning natural gas concurrent with the availability of LNG in 2018;

- Complete conversion of the Cabras 3 & 4 and MEC Piti 8 & 9 units to burn natural gas concurrent with the availability of LNG in 2018;

- If economically and technically feasible, build a 10 MW Geothermal unit to come online in 2019; and

- Work towards compliance with all new environmental standards and regulations.

Other recommendations of this IRP include:

- Ensure that all generation plants meet the performance standards agreed with the Guam Public Utilities Commission (Guam PUC);

- Implement automated economic dispatch and unit commitment to optimize fuel use;

- Work collaboratively with the Guam PUC and stakeholders to improve GPA's financial position relative to obtaining funding for these projects;

- Continue to investigate geothermal potential for Guam;

- Continue to investigate other resource options including Ocean Thermal Energy Conversion (OTEC), Sea Water Air Conditioning (SWAC) and other technologies;

- 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 as none of the projects evaluated by R.W. Beck pass the Rate Impact Measure (RIM) Test;

- Examine supplying natural gas for industrial, commercial, and residential use as a utility under the Consolidated Commission on Utilities (CCU) and the Guam PUC;

- Finalize the disposition of assets currently under Independent Power Producers including the possible retirement of Tanguisson power plant and the transition of these power plants to operation under Performance Management Contracts (PMC) or Independent Power Producers (IPP);

- Consider a business model using competitive bidding where GPA generates immediate cash from the sale of assets currently held under expiring Energy Conversion Agreements to Independent Power Producers while simultaneously awarding long-term power purchase agreements to these IPPs; and

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

11 Next Steps

In order to comply with local legislation and regulatory requirements, GPA 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.

11.1 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.

11.2 Acquisition Process

It is GPA's intention to acquire all LNG infrastructure and supply, 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. GPA 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.[17] Significant interest in wind exists. DOD has conducted wind studies at specific locations on its properties, and wishes to work collaboratively with GPA. DOD has commissioned and completed wind studies designed to determine optimal sites for wind monitoring towers. In our conversations with DOD[18], DOD 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, GPA'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.

[17] 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
[18] These discussions occurred several meetings with NAVFAC Marianas over several years..

Upon the Guam PUC's approval of the IRP and authorization to proceed, GPA will embark on a LNG Infrastructure and supply and new power acquisition process. GPA has developed a preliminary schedule for new renewable power acquisition in Figure 11-1.

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.

		Duration		MONTHS																													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31 - 56	57
1	**RFP Preparation & Outreach**	**3**	**mo**																																
	1.1 Develop RFP Document	*1*	*mo*																																
	1.2 PUC Review & Approval	*1.5*	*mo*																																
	1.3 Outreach	*1*	*mo*																																
2	**Initiate and Execute RFP Process**	**11**	**mo**																																
	2.1 Questions & Answer Period	*2*	*mo*																																
	2.2 Proposal Development	*4*	*mo*																																
	2.3 Proposal Submittal & Evaluation	*2.5*	*mo*																																
	2.4 Negotiations	*1*	*mo*																																
	2.5 PUC Contract Review & Approval	*1.5*	*mo*																																
3	**Permit & Construction**[1]	**43**	**mo**																																
	3.1 FERC Permitting	*15*	*mo*																																
	3.2 Front End Engineering and Design (FEED)	*6*	*mo*																																
	3.3 Design and Construction	*43*	*mo*																																
4	**Start-up**	**1**	**mo**																																

Total Duration - 57 Months

[1] This refers to the construction of the LNG import terminal and gasification system based on the schedule provided in the R.W. Beck 2011 LNG Study.

Figure 11-1, LNG Infrastructure Resource Acquisition & Construction Proposed Schedule

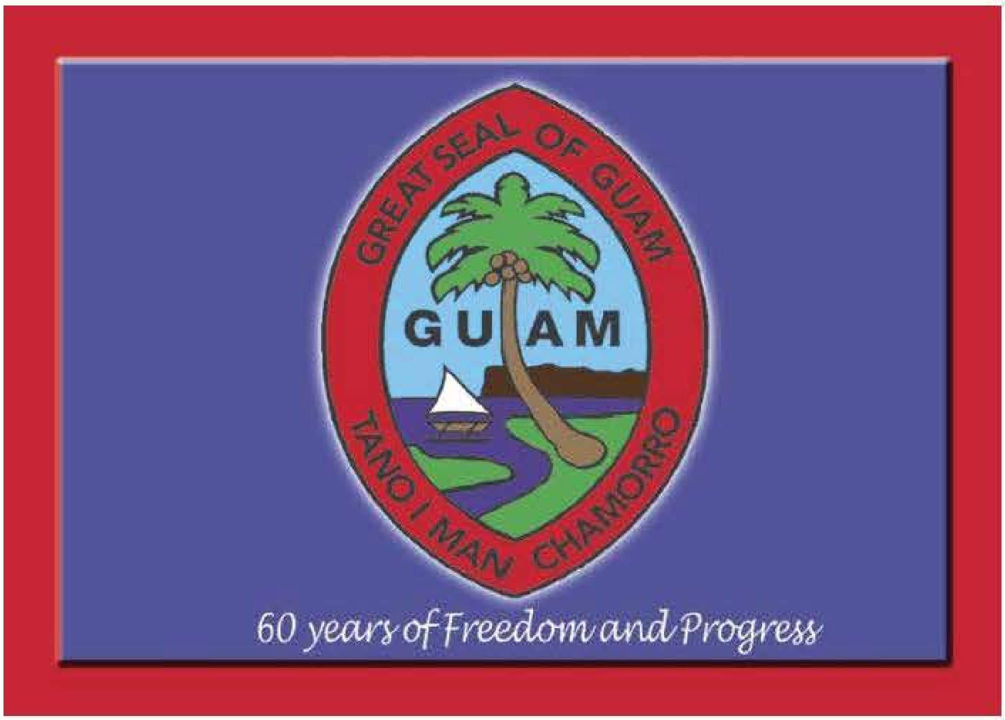
APPENDICES

A Load Forecast

Prepared For

Guam Power Authority

The GPA Sales and Load Forecasting Process Documentation



Prepared by

P L Mangilao Energy, LLC

September 30, 2012

I: Overview: The GPA Sales and Load Forecasting Process Documentation

In 2005 the Guam Power Authority (GPA) engaged PL Mangilao Energy, LLC (Mangilao), to develop a comprehensive ability to forecast sales, loads, fuels prices, and the range of environmental factors that influence GPA's short- and long-term planning environment. The tools and techniques that have been prepared during the development of this forecasting business process reside within GPA's Strategic Planning and Operations Research Department (SPORD). Within SPORD, Mr. Francis Iriarte has served as both the project manager and as the coordinator of the transfer of the tools and techniques implemented by Mangilao, insuring that over time, and at a pace appropriate to GPA's growth, SPORD conducts the day-to-day function of forecasting. This documentation is intended to facilitate that transfer of ownership and to support GPA in its current planning activities. In the meantime, Mangilao continues to serve as an adjunct to staff, preparing forecast products in consultation with SPORD.

Chapter II, titled "The Economic Outlook For Guam," contains Mangilao's latest outlook for Guam.

Chapter III, titled "The GPA Sales and Load Forecasting Process: the Models and How They Work," describes the regularly scheduled procedures that are necessary to obtain good forecast results.

Appendix A, titled "Running the GPA Sales and Load Forecasting Model,"

Appendix B, titled "Variable Names Used In the GPA Sales and Load Forecasting Models,"

Appendix C, titled "Current Estimated Equations In the GPA Sales and Load Forecasting Model,"

Appendix D, titled "The GPA Sales and Load Forecasting Model Driver,"

II: The Economic Outlook For Guam

In supporting GPA's sales and load forecasting for use in their 2012/13 Fiscal Year Budget, five-year financial planning and their financial and regulatory reporting, PL Mangilao Energy, LLC has worked to prepare a Baseline sales and load forecast that is founded upon a conservative view of Guam's economic prospects. Guam – and the US – is enduring a protracted period of slow growth as the Great Recession draws to a close. The greatest financial risk facing GPA is believed to be a continuation of this slow growth. To capture this perspective on risk, Mangilao has relied upon the Moodys Analytics (formerly Economy.com) outlook for Guam, supplemented with GPA's knowledge and experience of the local economy.

Many rumors and some information circulates regarding the prospect for a large military build-up on Guam. Guam also has the opportunity to greatly expand its tourism and hospitality industry over time. These future opportunities are not considered in the Moodys outlook, or in the outlooks prepared by most Mainland analysts. Of course, these positive risks must be considered in GPA's long-term capital planning, and Mangilao has found it necessary to prepare scenarios reflecting these risks for use in GPA's Integrated Resource Planning analysis (the Baseline Budget and Financial Planning Forecast does not include these speculative opportunities). This Budget forecast does not include the construction of any new hotel towers, and the only military construction that is included are the projects for which funds have been obligated.

Over the years we have found that the Mainland analysts preparing economic forecasts for Guam are not familiar with the economy of the Pacific Islands, which remain remote and mysterious to analysts living in Boston, Philadelphia or Washington, DC. The forecasts of Guam's economy prepared by Moodys Analytics or any of the other mainland forecasters make statistical extrapolations of recent historical data. Not having done fieldwork on Guam, these forecasts do not take into account the impact of an impending military buildup or tourism growth. On top of their unfamiliarity with the island economy, they are further handicapped by the poor quality of locally produced economic data (relating to income, employment and the price level) that results from decades of inadequate funding. In contrast, Mangilao began its work for GPA in 2005 with four person weeks of fieldwork on Guam followed by a focused effort to develop a thorough knowledge of Guam's economic statistics and to build relationships with the people who are responsible for preparing those statistics. Most recently, in August 2011 Mangilao spent another three person weeks on Guam updating its field work and interviewing several dozen of the island's thought leaders and subject experts. This present outlook for GPA electricity sales is based upon this seven year effort.

People who are not involved in forecasting every day often underestimate the difficulties associated with long range forecasting. 20 years is a very long time in human terms (almost three dog-years). The easiest way to think about it is to imagine all of the things that have changed in your neighborhood or your town over the past 20 years. No matter where your neighborhood is located, the list will be extensive. In fact, sometimes it's simpler to just list the relatively fewer things that have not changed. Not only is twenty years a very long time horizon, we must also be sensitive to the fact that all forecasts are wrong. As one comedian said on an HBO special, "We are peripheral visionaries – we can see far into the future, but only around the edges."

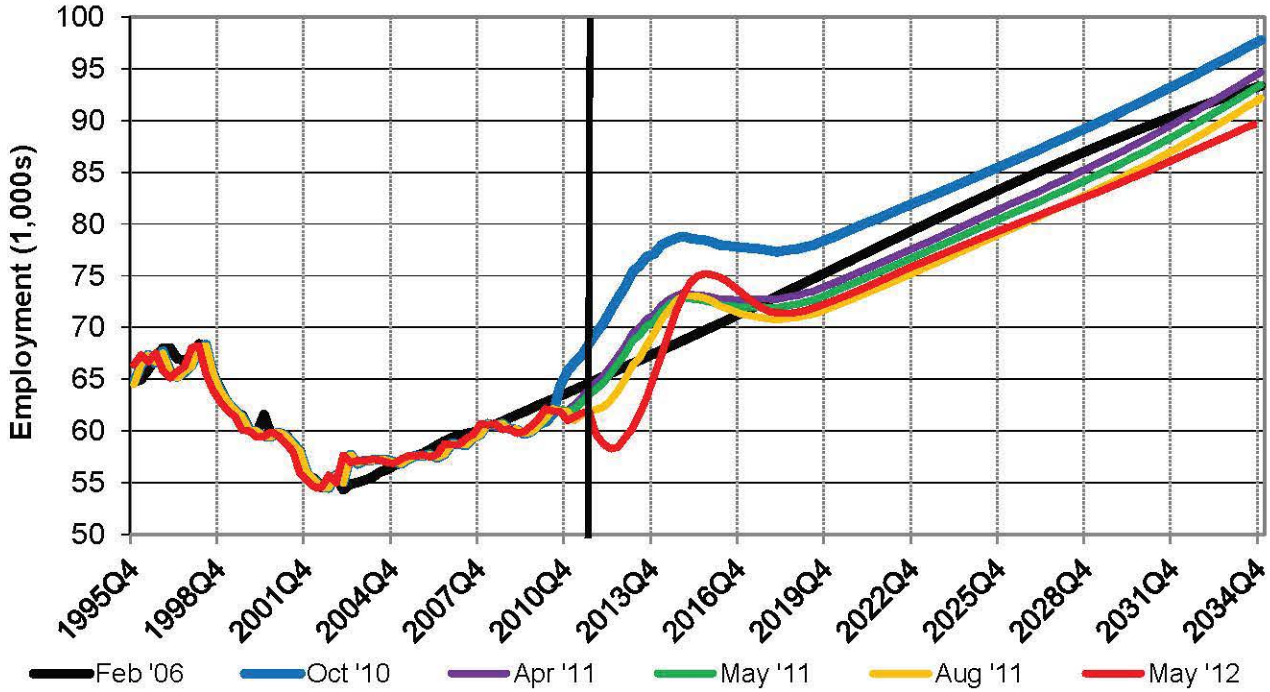
Mangilao has worked to educate Mainland analysts, especially at Moodys Analytics and IHS-Global Insight, as to the local data and resources that are available as they work to understand Guam. Before we launched this effort, in May 2005, the outlook for Guam that Moodys was publishing called for a dismal 0.5% employment growth over the next 20 years, with no prospects for growth in a stagnant tourism market and no prospects for new investment in a military backwater. At the time we noted that this was not an isolated opinion; it was typical of all Mainland forecast vendors.

Since that time, Mangilao has introduced the Guam analysts at Moodys and IHS-Global Insight to the economists and businessmen responsible for originating this data – Mr. Gary Hiles at Guam Department of Labor, Mr. Albert Perez at Guam Department of Commerce and Mr. Nick Captain at Captain Realty and many others. The analysts have eagerly followed up with these valuable local sources of real and accurate information, making contact by telephone and email. In Moody's October 2010 Guam write-up the analyst quoted all three sources, and was expecting 10% employment growth on Guam in 2011, slowing to 2.8% growth in the period 2014 through 2016.

As can be seen in the chart immediately below, expectations for Guam have been revised downward in the May 2012 forecast (red line). The current expectation is that growth is about to be interrupted by an approximately 3% decline in local employment that will last until late 2013, resulting from the DoD restrictions on spending as part of the federal government's austere response to the Great Recession.

Revisions to Moodys Employment Outlook

February 2006 – May 2012



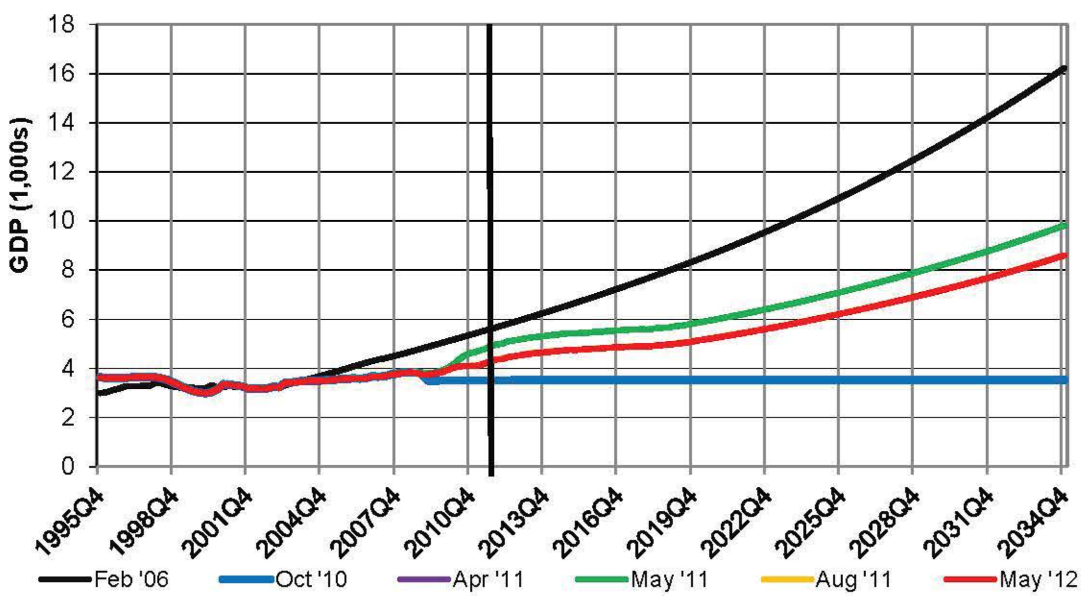
All of the Moodys forecasts from their February 2006 employment outlook through their current May 2012 employment outlook share the point of view that beyond the short term the economy will return to a 2.8% growth path. There has been no recognition of a large number of infrastructure construction projects that are in the various capital budgets for Guam, federal, local and civilian, beyond the projects for which funds are currently obligated. In the October 2010 forecast the outlook for infrastructure development was terrifically optimistic, reflective of the plans then in place. As time has passed and the economy has entered recession, those plans for infrastructure development have been marked down dramatically.

Another key feature of the Moodys outlook is that when the budgeted capital expenditures run out the capital spending is also assumed to run out, since it can no longer be documented. Someone more familiar with Guam's key strategic role in US military force projection might assume otherwise. There is also an assumption that only one new, large tourist hotel will be built in the next twenty years. Someone more familiar with Guam might also question that assumption. But especially if you are just looking at the data, the saw tooth pattern between 2004 and 2011 emphasized how uncertain capital spending can be, as smaller projects were started and finished while larger projects were pushed out further into the future.

Moodys has also reduced their outlook for Guam Gross Domestic Product. In the following chart, the 2006 Guam GDP outlook (black line), combined with their employment outlook, implied a growth in Guam productivity roughly comparable to what was expected for the Mainland. Based upon recent Guam GDP published history, however, their expectations have been revised severely downward, implying very slow growth – possibly negative real growth – in Guam household disposable income. Mangilao believes this is an understandable error caused by inconsistencies in the preparation of Guam's historic GDP, employment and consumer price index data.

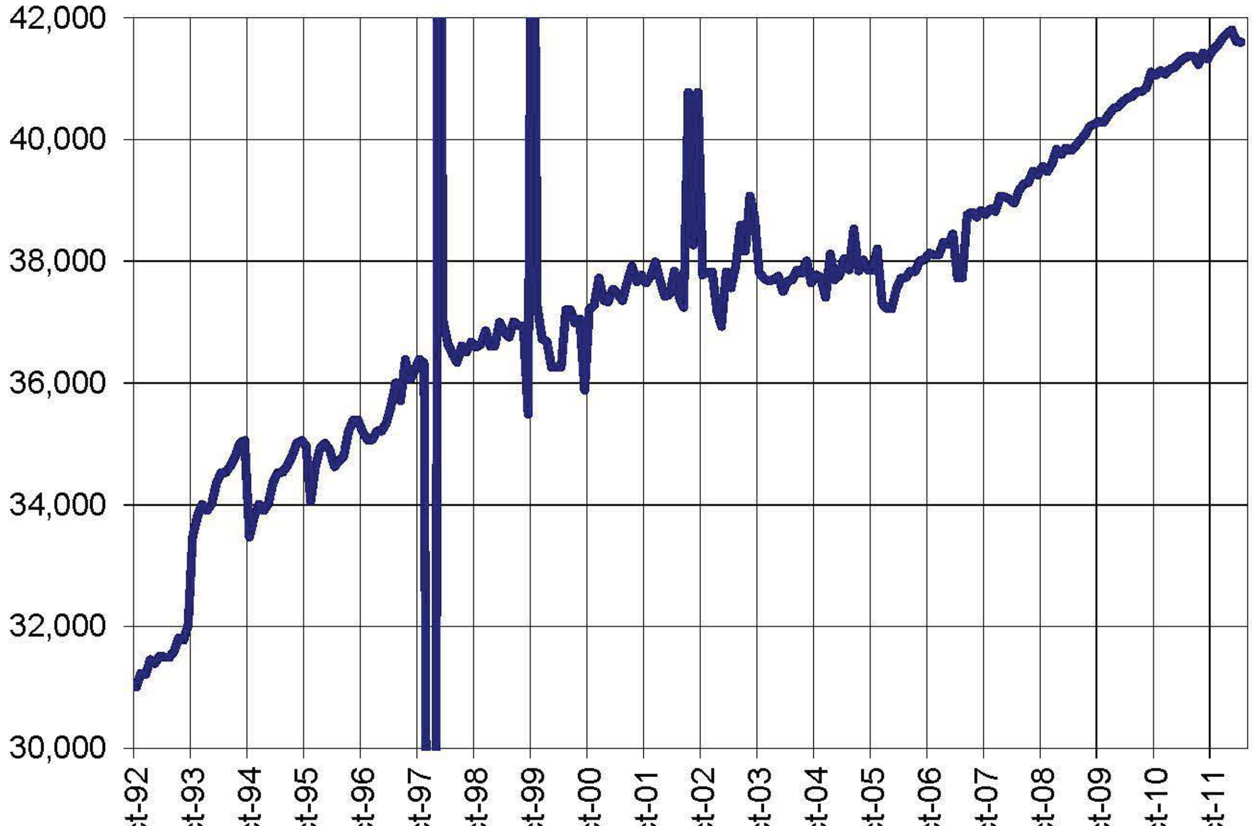
Revisions to Moodys Guam GDP Outlook

February 2006 – May 2012



The chart below, illustrating the growth in GPA's residential customers, shows how residential customers track local employment. Up until the second half of 2007 it wasn't clear whether Guam was growing or not. A number of informed people were becoming increasingly convinced that a boom in infrastructure spending was coming, but the argument required a lot of interpretation, a lot of judgment, and information most people find hard to understand. After 2007 both employment and customers began trending upward. But the growth has come in fits and starts, and it is possible the Great Recession is causing a stutter step that will cause yet another period of waiting for growth to resume.

GPA Historical Residential Customer Growth



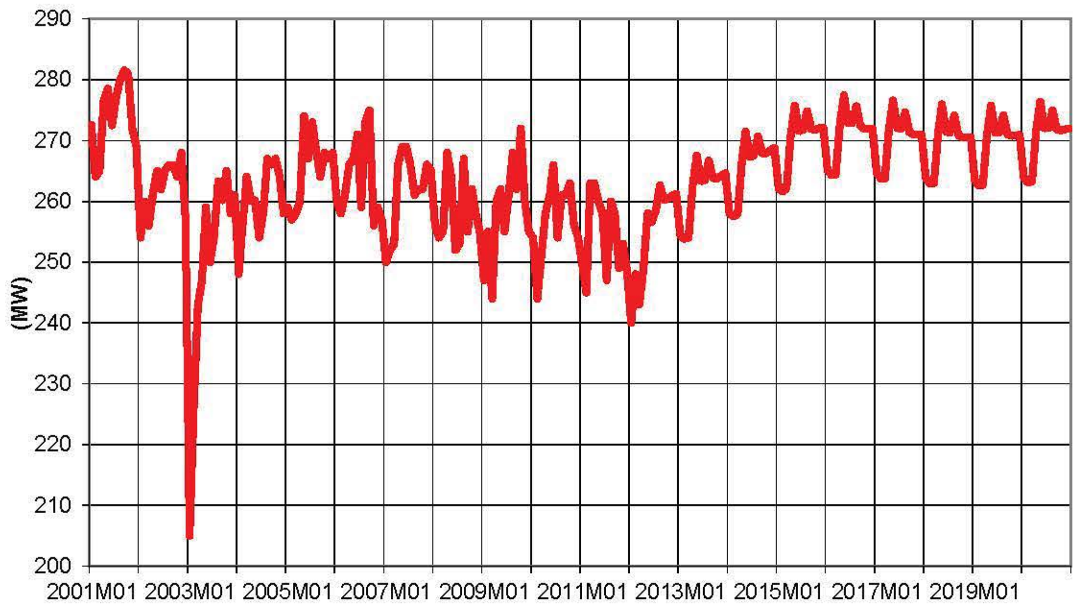
The Baseline Scenario

In preparing the Baseline Economic Scenario for this report we relied upon an economic forecast for Guam that was prepared by Moodys Analytics in May 2012. As noted above, their outlook for Guam, and the outlook of most Mainland analysts, has changed dramatically over the past few years. The forecast currently calls for 1.86% growth in total civilian non-agricultural employment on Guam over the period 2011 to 2021. In this forecast, employment grows from 61,850 jobs at the end of 2011 to 74,390 jobs at the end of 2021. Over the next five years, 2011 to 2016, the employment is expected to grow 3.65% annually, but this slows as soon as currently budgeted capital spending projects wind down. This contrasts with 2006, when the expectation for long-term growth in employment was 1.85%.

In private discussions, Moody's Analytics has indicated that they believe that most of the expected growth will occur in the sectors most closely related to military activities and growth in the tourist trade. They also believe that fewer jobs will be created in local government, utilities and goods producing activities, with the result that over time these sectors will become less important in the local economy on a percentage basis. In other words, they do not break out tourism or infrastructure development separately in their forecasting, but they believe that the lion's share of their predicted growth will occur in these two sectors.

The Baseline outlook for GPA's total load is that it grow from 272 MW in 2010 to 276 MW in 2015, and then remain essentially unchanged through 2020. Over the period 2005 through 2010 total power demand grew -0.15% annually. We expect that from 2010 through 2015 demand will grow +0.27% annually, and from 2015 through 2020 it will grow at +0.05% annually.

GPA Monthly Total Peak Hour Demand



We expect that GPA's total sales will grow from 1.618 tWh in 2011 to 1.589 tWh in 2015 and 1.613 tWh in 2020. Over the period 2005 through 2010 total energy sales grew -0.08% annually. We expect that from 2011 through 2015 total sales will grow +0.74% annually, and from 2015 through 2020 total sales will grow at +0.30% annually.

B. The Alternative Economic Scenarios

In addition to the rather pedestrian expectations for economic growth held by the Mainland analysts, Mangilao believes that Guam is faced with two potentially significant sources of economic growth – the development of new military and infrastructure projects and tourism. We began our analysis by constructing four important additional scenarios for economic growth and development that must be reconciled with the Moodys Economy.com forecast before one gets a clear picture of the real opportunities on the island.

We think of these opportunities as a two by two matrix, made up of a Low Tourism and a High Tourism case, coupled with a Low Infrastructure and a High Infrastructure case. Our opinion is that the Low Tourism and High Tourism cases have relative probabilities of 60% and 40%, respectively. We think that the same is true of the Low Infrastructure and High Infrastructure cases. Beginning in late 2011 the decision was taken to design the Low Tourism/Low Infrastructure case as an "EPA Scenario," in which it is assumed the Low Tourism and Low Infrastructure assumptions are augmented with the assumption that EPA's intent to delay further infrastructure spending on Guam for five years while enhanced environmental infrastructure is completed.

Table 1 illustrates the interaction between these cases to build the last four of our five scenarios. Across the top of the table are the Low Tourism and High Tourism cases, with probabilities of 60% and 40%, respectively. On the left side of the table are the Low Infrastructure and High Infrastructure cases, with probabilities of 60% and 40%, respectively.

Table 1

Four Scenarios For Economic Growth On Guam

		Low Tourism	High Tourism
		60%	40%
Low Infrastructure	60%	36%	24%
High Infrastructure	40%	24%	16%

The Low Tourism-Low Infrastructure case is believed to have a probability of 36% [60% times 60%]. Similarly, the High Tourism-Low Infrastructure case is assigned a probability of 24%. The Low Tourism-High Infrastructure case also has a probability of 24%. Finally, the High Tourism-High Infrastructure case is given a probability of 16%.

B.1 The Low Tourism Case

The Low Tourism case assumes that tourist visitation, as collected and reported by the Guam Visitors Bureau and the Guam Hotel and Restaurant

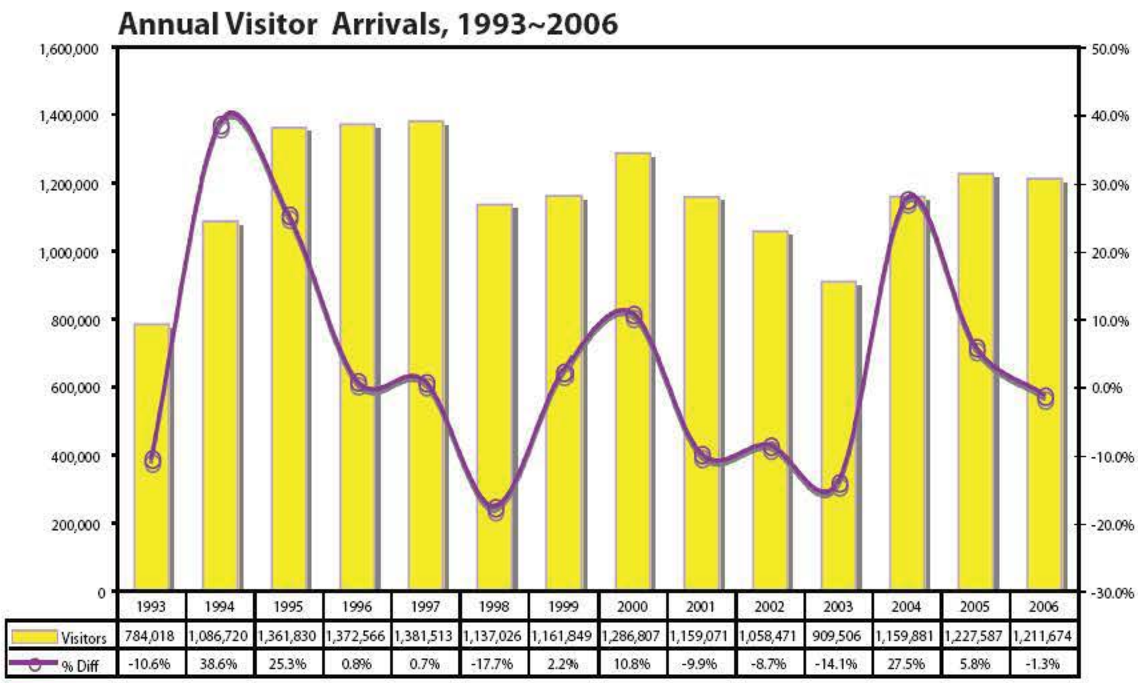
Association, will grow at an average annual compounded growth rate of 1% over the time horizon of the forecast.

Figure 1 is a chart prepared by the Guam Visitors Bureau depicting annual visitation to Guam since 1993. As can be seen, the rate of growth in visitation over the past decade is very sensitive to the choice of when the decade began and when it ended. For example, depending upon whether one considers the period 1993-2005, 1994-2005 or 1995-2005, the average annual compound growth rate for visitation is –1.0%, 1.1% or 3.8% respectively. We take 1% growth as an arbitrary middle ground to characterize the historical experience.

Figure 1

(Source: Guam Visitors Bureau)

Pre-Recession Visitors to Guam, 1993-2006



The assumption of 1% growth in visitation is then combined with the additional assumptions listed in Table 2 to construct the Low Tourism case. The case is constructed so that new hotel rooms are built when the annual occupancy rate becomes very high, in excess of 90%, and then only enough rooms are constructed to bring the occupancy rate back down below 90%. Several reviewers have pointed out that in real life the industry would go through capital spending cycles in which it periodically overbuilt (boom/bust cycles or business cycles), but those cycles are not really modelable. We simply assume that the industry continues to build at a steady, prudent level just sufficient to serve growth in tourism. We do believe, however, that boom/bust cycles are more typical of the tourism/hospitality industry.

Table 2

Low Tourism Case Assumptions

Assumptions	Assumed Value	Calculated Value
Build When Average Occupancy Exceeds:	90%	
Average Length of Stay:	3.45 days	
Time Required to Build New Hotel Tower:	3 years	
Number Of sf/Room, Inclusive Of Common Area:	26,670 sf	
Construction Cost/sf, 2005 $:	$ 275.00 per sf	
Permanent Hotel Employment (employees/room):	1	
A/E Firms' 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 $):		$ 485,000
% of Materials & Supplies in Construction Expenditure:	67%	
% of 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%	
Employment Multiplier:	0.60	

The key assumptions in Table 2 are the length of stay, total square footage per room and construction costs per square foot. Notice that we are making the very conservative assumption that for every job created in the hotel industry, only 0.6 new jobs are created in the local economy outside the hotels – restaurants, services to tourists, retailing, services to the hotels, etc. These key assumptions not only determine the outcome of the case, they also serve as levers so that one can do what-if analyses on questions like "what happens if the average length of stay is extended?"

Based upon these assumptions, Mangilao has prepared a Low Tourism Case forecast of employment growth on Guam that is attributable simply to 1% growth in visitation. When we first prepared this scenario, we argued that the scenario would begin with the rehabilitation of an existing tower in late 2007 or 2008. That has transpired, and we are now waiting for a favorable turn in foreign exchange rates. As shown in Figure 2, total employment from tourism growth inclusive of temporary construction employment, directly created new permanent jobs and indirectly created new permanent jobs reaches 1,565 jobs by the end of 2027. During this same period, the number of hotel rooms expands from 7,780 to 8,674 in 2027.

How likely is the Low Tourism case? We think that it is pretty likely. We believe that the Low Tourism case has a 60% probability (relative to 40% for High Tourism).

Figure 2

Low Tourism Case

B.2 The High Tourism Case

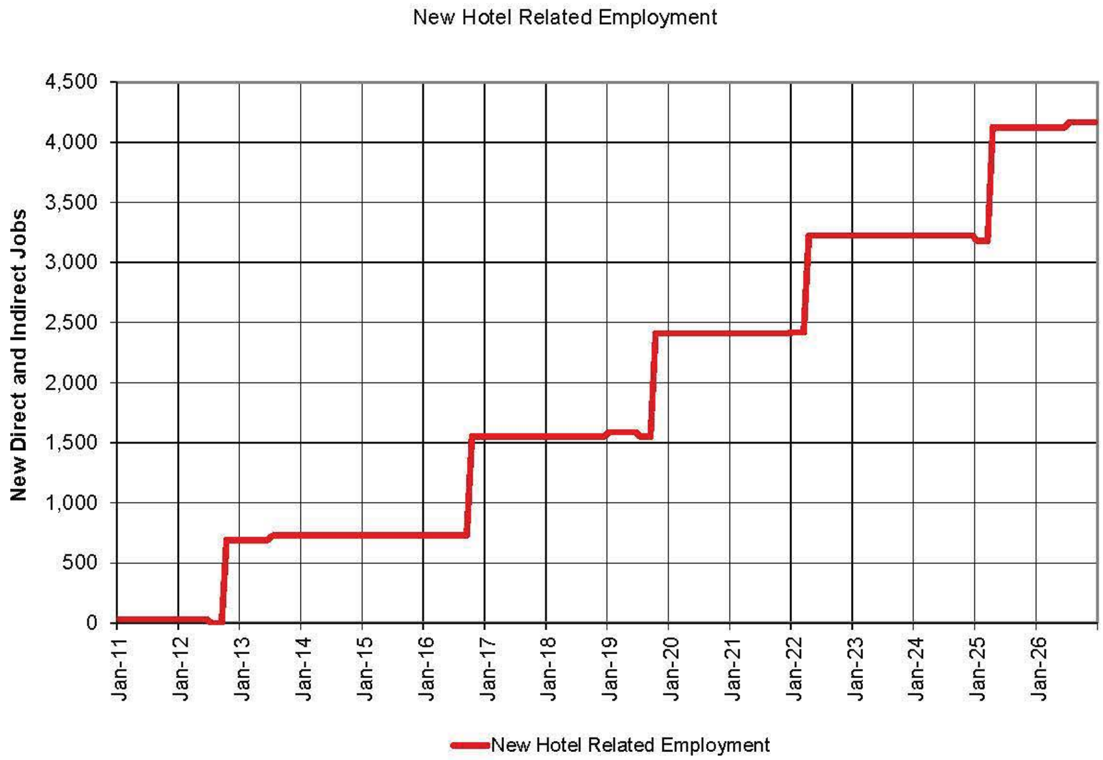
The High Tourism case observes that if one goes back in history to before the recent doldrums began, there was a small body of writing in the Tourism and Hospitality literature that argued that there was a strong relationship between reductions in the Y/$ exchange rate, growth in Japanese Real Personal Income, and growth in Guam tourist visitation. We have replicated this work using monthly data over the brief period 2000 to 2005 using linear regression analysis. Beginning in 2012, however, we have added the additional enhancement of looking at visitation from Japan, South Korea and Taiwan separately as well as a fourth category of "Other" or "Not Elsewhere Classified."

Using Japanese visitation as an example, the results of our analysis indicate that as the Yen depreciates against the dollar, a one Yen decrease in the Y/$ exchange rate leads to an increase in monthly visitation to Guam of 905 visitors. An increase in real personal income per capita of Y100,000 (measured in real 1995 Yen) leads to an increase in monthly visitation to Guam of 27,292 visitors. Of course, this estimated relationship presumes that Guam will maintain its market share as a destination for Japanese tourism. Mangilao then used these estimated relationships to forecast visitation to Guam using the Moodys Economy.com forecast for the Japanese economy. A copy of this forecast is appended to this chapter as Appendix B.

Based upon these estimated relationships combined with the Moodys Economy.com outlook for the Japanese, South Korean and Taiwanese economies and the assumptions listed in Table 2, Mangilao anticipates that between 2007 and 2027 the number of tourist quality hotel rooms on the island will increase from their current level of 7,780 rooms to a total of 10,136 rooms, an increase of 30%. During this same period (as shown in Figure 3) we expect the development of new hotel properties will lead to the creation of 4,166 new jobs, including temporary construction jobs, permanent jobs in the new hotels, and jobs created indirectly on the island as a result of new hotel development.

Figure 3

High Tourism Case



The High Tourism case is expected to have a likelihood of 40%. It is a very probable outcome, and it very definitely could occur.

B.3 The Low Infrastructure Case

In the case of Military and Infrastructure construction spending, it appears that none of the spending that is in the pipeline for Guam has been incorporated into the available economic forecasts. This should be considered normal. It is simply not practical for these forecasters to do field work on the opposite side of the world to any great degree. As a result, their work tends to be statistical, and their forecasts tend to extrapolate existing trends. In the case of Guam, we think that is an unfortunate oversight.

Mangilao believes there are two reasonable scenarios for Military and Infrastructure construction spending, and both of these scenarios involve economic activity that is over and above what is contained in the Moody's Economy.com forecast (or any other forecast that we have seen). In our Low Infrastructure case we have tabulated all of the construction projects that have been recently let, for which bidding has begun, that seem absolutely necessary, or that are included in the current Department Of Defense Quadrennial Plan and similar or related documents. For each project we have verified the proposed cost estimate, and we have derived a reasonable construction-spending curve for the total of all of the projects. A complete tabulation of these projects is included below as Table 3.

Table 3

Low Infrastructure Case

Identified Military/Infrastructure Construction Projects

	Estimated Cost	Estimated Project Start	Estimated Project Completion	Estimated Permanent Employment
Xray Wharf Upgrade by Sun Woo Corp	$ 2,000,000	2006	2006	2
Romeo Sierra Wharves Upgrade by Reliable Builders	$ 3,000,000	2006	2006	3
Dredging Naval Harbor	$ 8,000,000	2006	2006	8
Naval Waterworks and Wastewater Projects	$ 103,600,000	2008	2008	104
Naval Power System Hardening and Recapitalize	$ 400,000,000	2007	2017	400
Alpha Bravo Wharves Project	$ 55,000,000	2006	2007	500
Liguan Terrace Elementary School	$ 30,000,000	2006	2008	30
Astumbo Middle School	$ 30,000,000	2006	2008	30
Ukudu High School	$ 30,000,000	2006	2008	30
Adacao Elementary School	$ 30,000,000	2008	2010	30
New DoDEA Elementary/Middle School	$ 40,600,000	2006	2008	41
New DoDEA High School	$ 40,600,000	2006	2008	41
Housing construction and renovation at Naval Station	$ 512,000,000	2006	2025	300
Munitions storage facilities at AAFB	$ 15,000,000	2006	2006	50
Guam Army National Guard Facility Phase IV	$ 4,900,000	2006	2006	50
Replace AAFB Canine Facility	$ 3,500,000	2006	2007	25
GPA Underground Lines Upgrade	$ 200,000,000	2006	2013	200
GTA Modernization Investment	$ 100,000,000	2006	2010	100
Water System Upgrade	$ 360,000,000	2007	2009	360
P-780A, Upgrade NW Field, Ph I	$ 12,000,000	2007	2009	100
P-780B, Upgrade NW Field, Ph II	$ 12,000,000	2007	2009	100
Global Hawk Complex	$ 52,000,000	2007	2009	100
P-502, Kilo Wharf Extension, Ph I	$ 101,800,000	2008	2008	100
P-494, Harden Electrical System, Dist/Subs	$ 50,000,000	2007	2009	50
Naval Hospital Replacement	$ 145,000,000	2008	2011	500
8,000 Marines from Okinawa	$ 6,600,000,000	2008	2012	8000
P-502A, Kilo Wharf Extension, Ph II	$ 25,000,000	2008	2008	100
Future Naval Construction	$ 3,168,000,000	2010	2025	500

The total amount of all projects in the Low Infrastructure Case inventory is an incredible $12.1 billion. Spending takes place at a varying rate that exceeds $200 million annually. This is a very large injection into the Guam economy relative to its size, with a huge impact.

We have then used information gathered during our field work relating to the cost structure of Guam's construction industry to translate this construction spending curve into an estimate of temporary construction jobs that will be created, permanent jobs that will be directly created to operate the new infrastructure, and permanent jobs that will be created indirectly through the multiplier or percolator effect. We have made the conservative assumption that every job created directly through these infrastructure programs leads to another job being created in the island economy.

We believe that total new employment inclusive of directly and indirectly created follow on civilian jobs will amount to 12,358 by 2027.

Of course, there is some uncertainty about when exactly these construction monies will be spent. In many cases we have had to assume a project length, and in all cases we have assumed that construction expenditures are equal in all years of the project. For example, the Governor of Guam has indicated that funds will be obtained and spend to upgrade the island's water system. We do not speculate on how these funds will be spent or by whom. We do assume that $300 million will be spent (the announced amount) in equal annual amounts over a construction period that will last three years, with spending beginning in 2008. Construction employment, direct follow-on employment and indirectly created follow-on employment are then calculated based upon our understanding of impact multipliers, as they appear to operate on Guam.

Given this approach, it is very easy to accommodate any announced change in construction plans or any new information that becomes available on construction spending or the cost structure of construction on Guam. It is a simple matter to modify the spending assumptions in the model to adapt the scenario to changing opinions and perspectives.

We believe that the Low Infrastructure case has a likelihood of 60%.

B.4 The High Infrastructure Case

Corresponding to the Low Infrastructure case we have the High Infrastructure case. The High Infrastructure case looks just like the Low Infrastructure case in the early years, but the aggressive infrastructure development program continues into the second decade of the forecast. This continuation of infrastructure development is assumed to occur because of an increasing military presence on Guam in response to developing national defense interests in Asia. We have attempted to tabulate all of these possible projects, totaling more than $16 billion, in Table 4.

Of course, many of these projects are speculative, but in this type of scenario, looking this far into the future, the exact definition of the projects is not terribly important. The essence of the scenario is simply that the strategic interest of the US will require a large and expanding military presence on Guam indefinitely far into the future.

Table 4

High Infrastructure Case

Identified Military/Infrastructure Construction Projects

	Estimated Cost	Estimated Project Start	Estimated Project Completion	Estimated Permanent Employment
Xray Wharf Upgrade by Sun Woo Corp	$ 2,000,000	2006	2006	2
Romeo Sierra Wharves Upgrade by Reliable Builders	$ 3,000,000	2006	2006	3
Dredging Naval Harbor	$ 8,000,000	2006	2006	8
Naval Waterworks and Wastewater Projects	$ 103,600,000	2008	2008	104
Naval Power System Hardening and Recapitalize	$ 400,000,000	2007	2017	400
Alpha Bravo Wharves Project	$ 55,000,000	2006	2007	500
Liguan Terrace Elementary School	$ 30,000,000	2006	2008	30
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Ukudu High School	$ 30,000,000	2006	2008	30
Adacao Elementary School	$ 30,000,000	2008	2010	30
New DoDEA Elementary/Middle School	$ 40,600,000	2006	2008	41
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Housing construction and renovation at Naval Station	$ 512,000,000	2006	2025	300
Munitions storage facilities at AAFB	$ 15,000,000	2006	2006	50
Guam Army National Guard Facility Phase IV	$ 4,900,000	2006	2006	50
Replace AAFB Canine Facility	$ 3,500,000	2006	2007	25
GPA Underground Lines Upgrade	$ 200,000,000	2006	2013	200
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P-502, Kilo Wharf Extension, Ph I	$ 101,800,000	2008	2008	100
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8,000 Marines from Okinawa	$ 6,600,000,000	2008	2012	8000
P-502A, Kilo Wharf Extension, Ph II	$ 25,000,000	2008	2008	100
Future Naval Construction	$ 3,168,000,000	2010	2025	500
High Growth Scenario				
Aircraft Carrier Group	$ 3,150,000,000	2010	2015	6000
Submarine 1	$ 189,000,000	2010	2014	360
Submarine 2	$ 189,000,000	2015	2019	360
Submarine 3	$ 189,000,000	2020	2024	360
Submarine 4	$ 189,000,000	2025	2029	360

Of course, $16 billion is a huge amount of spending to take place on an island that is 8 miles wide and 30 miles long, and one would expect a huge economic impact. **In this high growth scenario, 13,100 civilian jobs are added to the island economy by 2027**. Even this could be an understatement, however. It is entirely possible that during the second decade of the forecast the US may find increasing local resistance to its military presence in Asia (just as is being seen now in Okinawa and Korea), requiring that it concentrate even more forces on Guam.

The High Infrastructure case is expected to have a likelihood of 34%, or 1:3. It is not particularly improbable, but it very definitely could occur. It is equal to the odds of rolling either a one or a two on a single dice.

B.5 Summarizing the Four Scenarios

These four cases interact to form the five scenarios, which can be characterized as follows:

The Budget Scenario or Baseline Scenario, using the Moodys Analytics forecast, is a slow growth case. It is likely to be more reflective of the island's recent past then it's near term future.

Scenario I, the Low Tourism-Low Infrastructure Scenario or the "EPA Scenario" with a probability of 36%, involves moderate long-term economic growth driven primarily by military spending an infrastructure development. This scenario is roughly equivalent to the Moodys Economy.com forecast.

Scenario II, the High Tourism-Low Infrastructure Scenario leads to 7, 780 new hotel rooms and 10,136 new Guam jobs related to hotel development. An additional 13,100 new Guam jobs will be related to infrastructure development.

Scenario III, the Low Tourism-High Infrastructure Scenario, both with a probability of 24%, are high growth scenarios that quickly cause the recent period of lagging growth to be forgotten. Finally,

Scenario IV, the High Tourism-High Infrastructure Scenario with a probability of 16%, is a boomtown scenario with extremely rapid growth.

Scenario I, the EPA Delay or Low Tourism-Low Infrastructure Case, is the slowest growth case that Mangilao believes to be reasonable. In this case, and in all of these cases, between 2012 and 2027 there will be roughly 13923 jobs created outside of the Tourism and Infrastructure sectors. About 1,565 jobs will be created through slow growth in the tourism industry, and about

12,358 civilian infrastructure/military related jobs will be over the same period.

In Scenario II, the High Tourism-Low Infrastructure Case, the rapid recovery of tourism leads to more rapid growth in the hospitality industry, and 4,166 new jobs are created. The infrastructure/military development creates 12,358 new civilian jobs. In this scenario, 16,524 new civilian jobs are created in total.

Scenario III involves Low Tourism-High Infrastructure assumptions, with 1,565 jobs created in the hospitality industry and 13,100 jobs are created in infrastructure. This scenario involves rapid growth, with a total of 14,665 civilian non-agricultural jobs created.

Finally, Scenario IV, the High Tourism-High Infrastructure Case, involves 4,166 new jobs in hospitality and 13,100 new jobs in infrastructure/military, leading to 17,266 new civilian non-agricultural jobs being created over the forecast period.

In this last scenario, Guam's growth occurs with such rapidity that over the 20-year time horizon of the forecast the island is transformed to such an extent that it would be almost unrecognizable to a Guamanian of today – very similar to the way that Central Florida evolved so dramatically over the period 1964 to 1984 with the growth of the government complex on Cape Kennedy and the Disney World tourism complex near Orlando. Over that 20-year period entirely new government and corporate landowners replaced the traditional family landowners. The traditional landowners exchanged their real estate for cash, the money was spent easily by the next generation, and the families have disappeared from local life. This scenario involves big winners and big losers, and a fundamental transformation of the island's demographics. It would be very unlikely that the island's traditional stakeholders would be able to maintain their current status as the island's political and cultural leaders, or to preserve their traditional culture.

We have tried to summarize the results of these scenarios in Table 5. Table 5 presents the scenario matrix presented originally above in Table 1, along with the scenario outcome, measured in terms of jobs created. In Table 5, the new jobs created in each scenario are listed immediately next to the scenario name, and the cumulative impact is presented below in the matrix. For example, in the Low Tourism Case 1,565 new jobs are created in the hospitality industry, and 13,923 new jobs are created in the Low Tourism-

Low Infrastructure Scenario (1,465 hospitality jobs + 12,358 infrastructure jobs).

Table 5

Job Creation By Scenario

		Low Tourism	High Tourism
		1565	4166
Low Infrastructure	12358	13923	16524
High Infrastructure	13100	14665	17266

It will be recalled that we have assigned probabilities to each of these four scenarios – the Low Tourism-Low Infrastructure Scenario has a probability of 36%, the Low Tourism-High Infrastructure and the High Tourism-Low Infrastructure Scenarios each have a probability of 24%, and the High Tourism-High Infrastructure Scenario has a probability of 16%.

III: The GPA Sales and Load Forecasting Process: the Models and How They Work

PL Mangilao Energy, LLC (Mangilao) has constructed a turnkey electricity sales and peak demand forecasting system for GPA. This chapter describes the methodological approach that was used in building this forecasting system. The chapter is accompanied by four appendices: Appendix A provides the written procedures used in maintaining the model and in preparing a forecast; Appendix B is a data base dictionary for the variables used in the model; Appendix C reports the statistical results obtained in the most recent re-estimation of the model; and, Appendix D contains the EViews model driver used in "running" the model.

Modeling Philosophy

One of the most vitally important planning tools for electric utilities is the integrated end-use/econometric model and forecasting system. Its advanced precision assists the utility in the production of forecasts that will withstand the scrutiny of regulators and senior executives alike, as well as maintain its credibility over time. In addition, such tools can be helpful in attaining the most important result, which is the prevention of imbalances between energy demand and availability.

Mangilao has designed, built, tested, and estimated an electricity sales and peak demand forecast system (the "GPA Forecast System"). The system incorporates the features of Mangilao's basic modeling philosophy. This philosophy recognizes that the ideal econometric features of a model whose purpose is forecasting can often be quite different from the ideal features of a model intended for research purposes.

Modeling Philosophy and Quality Control

In developing customized models, Mangilao's initial emphasis is conceptual. Mangilao utilizes a rational expectations approach to forecasting electricity demand. Simply put, behavior is forecast as a function of the expected principal determinants of that behavior rather than as a function of past behavior.

Focus On Reducing Forecast Risk

Mangilao's modeling philosophy primarily focuses on forecasting, in contrast to hypothesis testing. The goal is to assist GPA in managing financial risk by minimizing the risk associated with the forecast. Electric utilities face substantial financial risk and potential loss associated with the peak load and sales forecasting activity because of the long lead times and enormous costs of plant expansions. Forecast risk management focuses upon reducing the forecast variance as far as possible.

The procedures that are commonly used in econometric modeling or statistical analysis are only adequate to insure the "unbiasedness" of forecasts. While unbiasedness is a necessary condition, it is not sufficient for minimizing forecast risk, as forecast "efficiency" is not addressed. Unbiasedness of the forecast simply means that the probability of positive and negative errors are equal. Efficiency means that the forecast provides the smallest possible forecast variance and makes a statement about the size of the forecast errors: they will be as small as possible given our knowledge of the economic structure, engineering practice and the normal "noise" in the data.

There are several techniques that combine to form a philosophically consistent approach to reducing forecast variance. The most important are:

- Diagnostic use of summary statistics;
- Discriminating use of categorical variables; and
- Correction for serial correlation.

Summary statistics are not used as decision rules for selecting an equation, but instead they are used as diagnostic tools in searching for the smallest possible standard error of regressions. Reducing the standard error of the regression generally reduces the standard error of the forecast and improves the ability of the model to provide "reasonable" forecasts.

Mangilao also uses categorical variables (also called "dummy" or binary variables) sparingly. Indiscriminate use of these variables reduces degrees of freedom, reduces precision of the estimates and, more significantly, implies that the equation is misspecified.

Treatment of serially correlated residuals is frequently ignored by forecasters, or treated incorrectly. Correcting for serial correlation through the use of something as simple as appropriate differencing or through the use of the Cochran-Orcutt or Hildreth-Lu procedures often serves to reduce the standard error of the regression dramatically and will provide more efficient forecasts.

Model Specification

In its modeling work, Mangilao uses a well-defined set of criteria for judging model and data base usefulness. Of central interest is the theoretical and empirical specification of the model as a whole and of the individual equations in each model component. Estimated coefficients and elasticities must pass rigorous reasonability checks based upon past experience with similar models. A wealth of information can be drawn from previous studies (conducted by Mangilao and others) and the continuity and consistency of results present in those studies.

In general, energy sales and peak load models are estimated using raw data (i.e., actual values) rather than in a transformed specification using logarithms. The reason for this is to avoid imposing the highly restrictive constraint of constant elasticities upon the model, particularly upon price and income. Instead, elasticities are evaluated at the means of the data and provide higher quality information to planners and policy makers or in-the preparation of scenario analyses or sensitivity studies.

Mangilao also avoids forecasting either sales for a customer class or system load on a per customer basis. As can be shown mathematically, doing so artificially constrains the elasticity of demand with respect to customer growth to the value 1.0. Again, this is a fundamental difference between modeling to forecast versus modeling to test hypotheses. Usage per customer is always a valuable diagnostic, and it is always reviewed. It is not an appropriate functional form for model estimation, however.

Avoiding Lagged Dependent Variables

Econometric specifications prepared by other modelers frequently incorporate a lagged dependent variable to capture these expectational considerations. This is improper. The lagged dependent variable serves as a proxy variable, capturing adjustments in appliance and capital stocks and their utilization rates. The problem is that the use of the lagged dependent variable biases the estimated coefficients (i.e., the forecast values are not equal to the expected value of the outcome). Use of the lagged dependent variable essentially defines a trend model, as the lagged dependent variable becomes the strongest influence in the forecast and is not independent of random disturbances.

The biased estimates arise because the assumption of adaptive expectations constrains long-run behavior to be the same as it was in the short run. It is faulty logic to assume that consumers do not adjust their rates of utilization of fixed appliance stocks to changes in prices and income. Given an appliance stock, there is no reason – other than autoregression – to expect current consumption decisions to be based on a prior period's consumption. If prior period consumption is used as an explanatory argument, price and income elasticities are biased and the model will not properly capture current period adjustments to small changes in current income and price. These current period effects are then swamped by prior period consumption.

Consequently, lagged dependent or adaptive models do not serve well as causal models. As forecasting tools, they are not good at identifying turning points. They only reflect last period's activity; they tend to overstate consumption in economic downturns and understate it in periods of economic expansion. In addition, the presence of the lagged dependent variable tends to render the model inappropriate for policy or impact analysis because of the resulting biased elasticities.

Models consisting of equations that make use of lagged dependent variables tend not to yield good forecast results. The most important problem is that such models are not really causal models, and thus are generally ineffective at predicting turning points. The models are likely to overstate energy consumption during economic downturns and understate it during economic expansions. In addition, the use of lagged dependent variables in equations is liable to render the model inappropriate for policy or impact analysis because of the resulting biased elasticities.

The use of lagged dependent variables amounts to placing a ruler on the most recent realized observations and making the case that the future will be pretty much like the past exclusively because the lagged dependent variable parameter often scores well in tests of parameter significance. For these reasons, an important part of Mangilao's modeling philosophy is the sparing use of lagged dependent variables.

Focus On Forecast Accuracy

While these technical concerns are crucial to performance, the acid test of any model is the quality of forecasts produced. Careful attention must be paid to the implications of model structure and estimated elasticities on overall forecast performance. This is accomplished via a comparative analysis of historical and model backcast values, as well as an analysis of forecast sensitivity to changes in economic and non-economic phenomena.

Most important of all, however, model and data base assessment must rely upon the knowledge and skill of the analyst. It is imperative that those doing the modeling have the experience to examine a forecast and react on both technical and intuitive levels, diagnosing problem areas well before the stage at which their articulation becomes necessary. To our knowledge, no firm in the nation has a more diverse background in forecasting generally, or in the construction of hybrid utility forecasting models in particular, than Mangilao.

That the Mangilao recommended methodology is a hybrid end use econometric model does not imply we regard other approaches as being without value or that any modeling and forecast system should be perceived as the replacement for other modeling and forecast methodologies. Rather, each approach should be viewed as complimentary in providing information to decision-makers. Each model is an information system that provides additional and different detail about the characteristics of consumers and how they should be expected to respond to given endogenous and erogenous events. The ability of an end-use econometric model to accommodate alternative policy simulation makes it a particularly useful tool in the planning process.

Mangilao does not view model development as a "Black Box" exercise. Mangilao believes it is vital to view the project as a joint effort, with GPA SPORD involved with the project from start to finish in some elective fashion. We feel this way because:

- GPA SPORD possesses familiarity with aspects of your specific operations that Mangilao personnel can never achieve.
- This familiarity includes knowledge of GPA's available data, previous forecast efforts, the ultimate uses to be made of the resulting forecast, and the nature of the service territory generally.
- GPA SPORD will eventually be responsible for running the model.

Close interaction between Mangilao and GPA SPORD staff during the ongoing model operations and maintenance continues to enhance the model and the forecast.

Building the Most Efficient Forecast

The most important difference between the Mangilao approach and others is that we look at different measures of success in equation estimation. The usual approach is to focus on techniques of estimation best suited for research purposes – usually a single equation model tailored to yield good hypothesis tests on its parameters. This means that the builder of such a model is likely to have searched for explanatory variables that yield high t-statistics, a high priority in variable selection for models of this type.

In contrast, Mangilao and GPA believe that identifying regressors that perform well in t-tests of parameter significance is only one of several objectives that a modeler should try to attain, instead of the most important one. Mangilao takes the view that an over-emphasis upon high t-statistics does not necessarily lead to the attainment of the very most important criterion that a forecasting model must meet—a low forecast standard error.

The standard error of the forecast is almost never discussed, because it is very difficult to measure directly. We are not aware of any software program that calculates the standard error of the forecast, because it is so awkward to calculate. Mangilao uses a more intuitive approach. The standard error of the forecast is a function of three things:

- The standard error of the regression;
- The number of variables included in the model; and,
- The distance from the mean of the historical values.

Nothing can be done about the distance from the means of the historical values, other than to realize that the further out one tries to go, the larger the standard error of the forecast will be, getting larger at a steadily increasing rate. The inclusion of variables in the model must follow a Principal of Parsimony, requiring that each included variable must really "pay it's own way" since it will serve to increase the standard error of the forecast. Finally, the modeler must keep a close eye on specifying the model so as to keep the standard error of the regression as small as practicable, since that is really the lever that most easily controls the standard error of the forecast.

As a result, Mangilao puts a high priority upon attaining a relatively small standard error of regression when selecting equations in the process of model building. This is generally accomplished through three main methods:

- Diagnostic use of summary statistics,
- Correct modeling of seasonal patterns,
- Correction for serial correlation.

Mangilao does not use summary statistics as decision rules for selecting an equation, but instead as diagnostic tools in searching for the smallest possible standard error of regression. Reducing the standard error of the regression generally reduces the standard error of the forecast, and improves the ability of the model to provide "reasonable" forecasts. This process requires a great deal of judgment and experimentation, since including almost any new variable will raise the standard error of the regression. The forecaster must judgmentally balance the benefit of having one more explanatory factor against the cost of a larger standard error of regression.

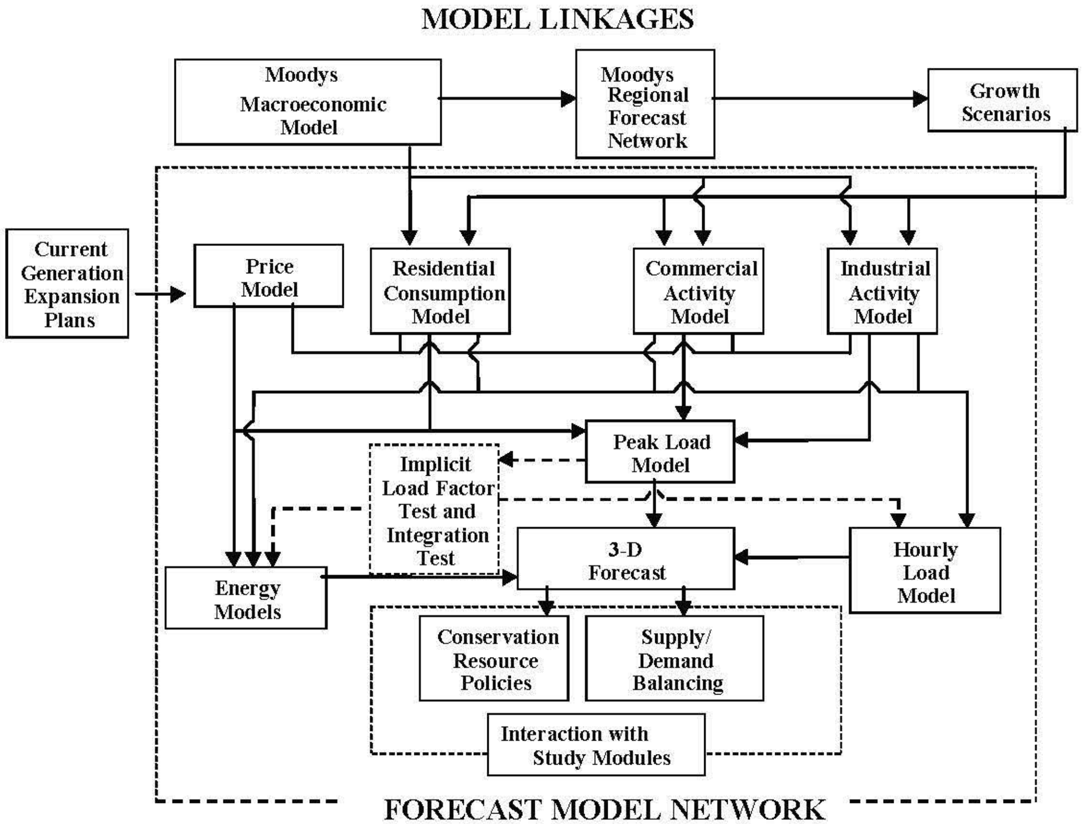
Forecasters too frequently either ignore or treat incorrectly the problem of serially correlated residuals. Correcting for serial correlation through the use of something as simple as appropriate differencing or through the use of a Cochrane-Orcutt or Hildreth-Lu procedure often serves to reduce the standard error of the regression—and hence the standard error of the forecast – providing dramatically more efficient forecasts.

Of course, Mangilao employed other criteria as well in judging candidate equations in the construction of the GPA Forecast System. Of central interest was the theoretical and empirical specification of the model as a whole. Estimated coefficients are also required to pass rigorous tests of reasonability drawn from Mangilao's past experience with other models.

Model Architecture

The figure immediately below illustrates the sub-models and linkages that characterize the GPA integrated econometric/end-use electric energy and load forecasting system. This modeling effort uses a regional economic activity sub-model to produce utility service area growth scenarios that in turn drive the customer demographics, sectoral energy consumption and peak demand sub-models. Great flexibility exists in the actual construction of the forecasting system, and Mangilao has utilized the approach with more than 60 utility clients.

Schematic of the GPA Load and Sales Forecast Modeling Network



The forecast model system is internally consistent. Consistency between and within models in the forecast system means that:

- Forecast variables have the same definitions, i.e., are the same variables when used in different sub-models of the system;
- Data inputs use the same measurements; and
- Underlying theoretical and policy assumptions are the same.

Although the forecast model system is designed to operate from the forecasts of Moodys Economy.com Macroeconomic and Regional Forecast subscription services, GPA has the option of using alternative forecasts.

Number Of Customers

The customer forecast is very important to the sales forecast. Growth in the sales can be thought of as having two components. First, customer growth provides for a broadening of the system, providing demand for electricity at more delivery points. Second, factors such as household demographics, real household incomes and the real all-in price of electricity determine the customer's usage, or the deepening of the relationship with the individual customer. The two concepts – number of customers and usage – combine to deliver sales growth. The foundation of the forecast is number of customers.

In working with a large number of utilities, Mangilao has found that employment is often a much better predictor of customers than population. Population is estimated as an annual number and is then interpolated to a quarterly periodicity. Guam employment data, on the other hand, is prepared as a quarterly series, and is almost a census of the working population. Employment growth is also more closely tied to net new connects – when the job market is good, the rate of household formation increases and vice versa. At the same time, there's no hard rule, and sometimes other techniques work quite well.

The Total All-In End-Use Price of Electricity

As will be discussed extensively, a key factor in determining a customer's electricity usage is the real price of electricity, inclusive of all taxes, surcharges, distribution, transmission and generation expenses and the cost of fuel. All electricity demand and sales forecasts with which we are familiar begin with the assumption that electricity and electric power are normal goods, or that as the real price goes up consumers consume less electricity, other things being equal.

In calculating real prices (or real incomes) on Guam, Mangilao has used the Guam Consumer Price Index (CPI) published quarterly by the Government of Guam Bureau of Statistics and Plans. Mangilao is of the opinion that the CPI can be greatly improved, probably by improving the survey instrument used in its compilation. Some features of the CPI and its sub-indices are extremely hard to explain, and may be misleading. As a result, when historical data are converted from nominal values to real, errors or noise are introduced to the transformed data. These errors in converting from nominal real cause all statistical analysis to be somewhat impaired.

Mangilao spent significant time reviewing the use of the Guam CPI. While we believe it is deficient, economic theory requires the use of real prices, since there is little evidence that customers respond to nominal prices (there is little evidence of "money illusion"). We examined the use of the US CPI or the CPI for Honolulu, and we feel those choices would be inferior to using the Guam CPI. The Guam CPI behaves differently simply because of its great distance from the rest of the US, Guam's greater reliance upon imported goods and services and its proximity to Asia. Our conclusion is that the Guam CPI should be improved, but it is the best available measure of the prices paid by Guam's consumers.

Earlier versions of the GPA modeling system simply assumed that the total all-in price of electricity would increase with general inflation. This was an appropriate simplifying assumption during the early development of the sales and load forecasting models. It is a truism of commodity price forecasting that over an extended period such as 15 to 20 years, it is very unusual for a commodity price to increase much more or much less than the general rate of inflation, although there can be big differences in the short run. An often-quoted example is the value of gold – over the past several hundred years, the price of an ounce of gold has usually been equivalent to the cost of an expensive men's suit of clothes.

In December 2010 Mangilao prepared a spreadsheet based forecasting model for end use electricity prices that explicitly takes into account the difference in the rate of increase in fuel costs in comparison to other commodities. The retail-pricing model divides the price of electricity to a customer class into two components, the non-fuels component and the fuels component. The non-fuels component of the price is assumed to escalate with the rate of general inflation, as measured by the Guam CPI. The fuels component of price is assume to escalate with the weighted average cost of fuel delivered to GPA.

Electricity Sales By Revenue Class

The GPA forecast system produces projections of electricity sales according to a structure defined by explanatory variables selected according to economic theory. Electricity demand is derived from demand for the services of a stock of capital goods that use electricity as a primary energy input.

Many energy sales models, both econometric and engineering, tend to be very aggregative. In Mangilao's view aggregate modeling fails to explicitly recognize or allow the evaluation of the differences in demand response to varying uses of electricity as an input fuel across different mixes and types of customers. Furthermore, the uses of electricity (e.g., the composition of capital stocks and their utilization rates) vary significantly across types of customers within each class.

These characteristics of demand derived from variations in stocks and their utilization rates can be explicitly captured by further disaggregating each class into sub-classes defined principally by their major capital stocks or end-users. This approach to modeling both increases the sensitivity of a forecast model and also provides greater information, Specifically, detailed modeling that is end-use oriented enhances the evaluation of conservation programs, particularly those associated with major electricity end-uses such as heating, air conditioning and water heating.

Mangilao consistently applies this highly disaggregated approach to modeling electric energy demand. Demand specifications of these types, based upon prior empirical work conducted by Mangilao, are described and interpreted below. We should note that these specifications, while theoretically correct, might not exactly characterize the relationships to be found for any individual utility. They do, however, clearly indicate the Mangilao approach to modeling, both theoretically and empirically,

Residential Electricity Sales

A general issue that arises in demand forecasting and analysis is the difference between the short run and long run effects of changes in the economic environment. For example, if a worker becomes unemployed and household income falls, the family unit may wish to save money by reducing consumption of "luxury" services provided by certain household durables. Thus, the family might turn off the air conditioner more readily and would, most certainly, be less likely to buy additional electricity-using durables. A rise in the price of electricity relative to a competing fuel such as propane might elicit a similar response.

In the long run, however, the consumer has the ability to alter electricity consumption in another way-by altering the nature of the family's physical stock of durable goods. Heat pumps and better insulation, or perhaps even more efficient air conditioners can be installed. With regard to transitory changes in income, the short run impact may be significant while the long run impact is not. With regard to permanent income changes and/or relative price changes, however, the long run impact can be assumed to be greater than the short run because of the stock effect adding to the utilization effect.

Mangilao captures the short and long term effects separately in two ways, First, the direct introduction of lags on the independent variables segregates analytically the gradual adjustment over time of consumers to changes in factors such as price and income. Second, by including the stock of appliances directly in the demand equations, we separate the utilization from the stock effect.

The demand for electricity by residential consumers is derived from the demand for services provided by a stock of electricity-consuming household appliances. In the long run, the demand for electricity is equivalent to a demand for increments to the capital stock, which is determined by income and the prices of appliances and alternative fuels. The choice of utilization rates for fixed electrically driven capital stock is determined by the price of electricity. As noted above, the intensity of use of some appliances responds to differences in weather conditions and this characteristic allows direct modeling of the impact of weather on residential electricity sales.

Assuming the availability of adequately detailed electric appliance data, the residential model of electricity demand per customer can be generalized as follows:

Residential Sales = f(real income; real price of electricity; real price of competing fuels; individual measures of air conditioning, space heating and water heater stocks, each weighted by weather conditions and adjusted for energy efficiency standards; aggregate measure of non-weather-sensitive appliance stocks, adjusted for energy efficiency standards; if available, a vector of conservation measures, i.e., insulation, weather stripping, thermostat setting, etc.; and a vector of binary variables unique to the service area).

Energy demand is sometimes forecast on a per customer basis in order to focus on variations in individual use. In this way, price and income elasticities and conservation measures may be more readily evaluated. Doing so, however, artificially constrains the elasticity of sales with respect to customers to a value of 1.0. Lag structures on the price and income terms are used in all equations to capture both short and long term price effects and permanent income effects. The model also contains two sets of identities to aggregate total residential sales. One set (if required) sums sales across each sub-group described above as the product of use per customer and number of customers. The second set sums sub-group sales totals to total residential kilowatt-hour sales.

Commercial Electricity Sales

The commercial sector is not nearly as homogenous as the residential sector and the available data is not as detailed as found in the industrial sector. The commercial sector does possess, however, a stock of electricity-consuming equipment whose rate of utilization is expected to respond to changes in prices, incomes, and employment. The number of commercial customers is expected to increase in response to an increase in population and income levels. Both are major determinants in the expansion of the market for goods and services provided by the commercial sector. As the number of commercial customers increase, total employment in the commercial sector would also tend to increase.

The approach taken in modeling commercial sales is analogous to the residential sector: the demand for electricity is derived from the demand for output of goods and services produced by the commercial sector. Electricity is an input to the processes used to produce these goods and services. Consequently, the greater the demand for output, the greater is the utilization of the stock of capital goods to produce output and the greater the demand for electricity as an input.

For some utilities, the commercial sector is relatively small and there is little benefit derived from disaggregating commercial sales into customer sub-classes. However, even when the commercial sector is small, disaggregation allows explicit treatment of an important characteristic: the subsets of commercial customers face different marginal electricity prices based on average use per customer. Given the differential in marginal electricity prices, there is no reason to expect similar price elasticities to exist between the customer subsets. The elasticities on other variables could also be expected to differ between the groups, given the differences in employment, income, appliance stock, etc. Mangilao's approach is to work at the disaggregate level to the extent possible given data availability. In general, the commercial demand for electricity can be specified by the following structure. The exact number of "j" commercial sub-groups modeled would depend upon the ability to meaningfully disaggregate the commercial sales data.

```
Commercial sales_j = f(real income or sales tax revenues as
     proxies for demand for goods and services by the
     commercial sector; the real price of electricity; the
     real price of competing fuels; employment in trade and
     services as proxy for the general stock of
     electricity-consuming capital goods and production
     processes, or square footage as proxy for general
     stocks, particularly lighting; the saturation of
     electric heating and air conditioning or employment as
     a proxy weighted by weather; a vector of conservation
     measures or thermal efficiency factors weighted by
     changes in square footage; and a vector of binary
     variables unique to the service area).
```

The intensity of use, or rate at which fixed stocks of electricity consuming capital goods or appliances are used, determines electricity consumption. This rate is by the real price of electricity, weather conditions, and the level of activity in the local economy, as measured by employment and real GDP per employee.

Mangilao has found that GPA's sales are very sensitive to the real all-in price of electricity, just as economic theory suggests. The table below reports the estimated price elasticities calculated deterministically based upon August 2006 data.

These are estimates at a point in time (not estimated using simulation techniques), so they are only comparable to other estimates of short-run price elasticities. They are not necessarily comparable to long-run elasticities derived from simulation techniques.

Mangilao has compared these estimated elasticities to estimates we have prepared in other jurisdictions, and they are similar. They were also discussed at the Fall 2008 meeting of the EEI Load Forecasting Committee, with other committee members reporting that they had obtained similar results for their jurisdictions.

Estimated Short-Run Price Elasticities

Sales By Revenue Class, Calculated 09/23/06

Estimated Price Elasticitities	
	Elasticity
Residential	-0.21
Small General Non Demand	-0.18
Small General Demand	-0.21
Large General	0.00
Private Outdoor Lighting	-0.68
Govt Small Non Demand	-0.52
Govt Small Demand	-0.15
Govmt Large	0.00
Agency Street Light	-0.06
Navy	-0.09

A substantial share of electricity consumption is sensitive to weather. This dependence is represented in the sales equations by the inclusion of weather variables, which includes direct modeling of the impact of weather changes on energy consumption. Such inclusion also allows the analyst to evaluate expected electricity sales over the forecast horizon by inserting hypothetical normal weather and deviations from normal weather into the equations.

An additional modeling challenge is that Guam is subject to frequent and severe typhoons that disrupt the utility's operations in ways not seen on the mainland. It is necessary to include categorical or dummy variables for the typhoons Chataan, Paka and Pongsona because in the aftermath of the storms there were fewer customers connected to the system.

Given these theoretical and structural attributes, the modeling methodology can be characterized as a "hybrid" econometric application, incorporating economic and non-economic relationships that explicitly embody end-use characteristics by specifying individual end-use applications and capital good stocks as determinants of energy demand.

Public Use Electricity Sales

Energy sales for public use consists of a diverse group of customers, these may consist of public authority (e.g., municipal pumping and local government buildings) and street lighting. On the assumption that public use sales can be disaggregated into these two groups, Mangilao models and forecasts public authority sales separately from street lighting. Public authority sales can be specified and modeled as a function of the real price of electricity to these customers, real personal income, population, employment, and weather. Income, population, and employment serve as alternative measures of the level of public services provided by public authorities.

As the production of public services increases, energy consumption rises because it is derived from changes in production. For example, as population increases, a relatively greater quantity of public services is required. As incomes rise, local tax revenues increase and both the quantity and quality of public services also increases. Weather conditions serve to capture that portion of energy consumption that is weather determined, principally air conditioning usage.

Street lighting sales are specified as a function of population or number of households (serving as proxies for the stock of street lighting) and real price of electricity used in street lighting. Seasonal categorical variables are also significant demand determinants, specified to reflect the differentials in daylight hours over the year.

The need to model and forecast aggregate public use sales, where complete disaggregation of the data between the public authority and street lighting classes of sales is not feasible, is unlikely to significantly change the generalized model structure hypothesized above.

Public Authority Sales = f(real price of electricity; real personal income; population; employment; and weather conditions)

Street Lighting Sales = f(the real price of electricity; population; households; and a vector of seasonal categorical variables)

Peak Demand

Forecasts of peak loads are important inputs into a utility's planning for future capacity requirements. The peak load model component of the GPA model examines and forecasts GPA's seasonal megawatt peak loads. We now model Navy and civilian demand separately, allowing for a more nuanced view of peak loads. The total GPA load is the sum of the maximum Navy and civilian loads.

The modeling approach taken is an econometric specification, directly incorporating both the economic and non-economic determinants of peak electricity demand. Actual monthly peaks are modeled as being causally determined by changes in service area employment, the real price of electricity, and categorical typhoon and monthly dummy variables.

This hybrid model differs from pure engineering models in at least four ways. First, it is a dynamic behavioral forecast model of the demand for peak load imposed by consumers on system capacity. In contrast, engineering models tend to be static cross-sectional models of the absolute technical characteristics associated with the electric demand of individual devices or buildings and structures. Consequently, these models analyze the relationship of changes in technology to peak demand for a given array of technologies and load management strategies. They evaluate how demand is formed technically but do not focus on why demand is formed. Demand is formed by the behavioral responses of consumers and not solely by the existence of technology. Hence, the engineering model is somewhat limited as a forecast tool because it lacks behavioral sensitivity.

The second difference is that being behavioral, the specification indirectly incorporates the structural determinants of peak demand. The principal explanatory variable is not the level of energy sales, but a vector of those variables that directly determine peak demand, recognizing that energy and power represent different commodities to consumers. Peak loads represent demand for a fixed stock of generating capacity that, in turn, is related to the power requirements of a fixed stock of electricity-consuming capital goods held by consumers.

Aggregate power requirements imposed on the system are determined by nearly instantaneous weather conditions and a vector of economic characteristics and customer demographics. Sales represent demand for a flow of energy related to the intensity of use of consumer-held stocks. Intensity or rate of use of these stocks is dependent in part on cumulative changes in weather conditions and economic characteristics, such as prices, income, employment, output of goods and services, etc. Since consumer behavior associated with peak load and energy demands is related to somewhat different demand determinants, each is modeled independently of the other for forecast purposes.

A systematic relationship is often hypothesized for modeling purposes between the overall volume of sales and peak demands, but there are substantial difficulties associated with this assumption. First, the price of electricity would be sensitive to the market penetration of new technologies. As electricity prices change, the elasticity of demand for peak load may shift relative to the demand during "shoulder" periods. Second, "peak demand" forecasts must be tempered by absolute changes in the patterns of seasonal weather extremes. Third, changes in technologies embodied in appliance stocks, their composition and saturations may change the relationship between sales and peaks, especially when the focus narrows to summer, winter and seasonal "shoulder" periods. Changes and shifts of these types are not explicitly evaluated when peak demand is explained solely in terms of the total volume of electricity sales. Finally, if power demand is not related explicitly to economic activity independent of sales, the opportunities for evaluating the impact of alternative policy considerations are more limited.

Independence of the energy and peak load models is important not only for the reasons noted above, but also because the forecast peak values can then be used as a "check" upon forecast values provided by the energy sales model via the computation of implicit load factors. At the same time, the differing impacts of conservation upon peak loads and sales are separated and independently evaluated. For example, price and income are not only important determinants of peak load and energy demand, but also convey additional information about conservation.

Marginal increases in price and decreases in income tend to promote conservation even in the absence of specific conservation technologies or load management strategies. To the extent price and income elasticities are expected to differ between peak and energy demands, this important characteristic is not distinguishable when the two demands are not modeled separately (e.g., when demand for peak loads is expressed as a function of energy sales).

Third, the Mangilao approach to peak load modeling is more useful in studies of end-uses since it explicitly includes specific end-use capital stocks as determinants of demand. Demand specifications that incorporate capital stocks not only have enhanced analytical and forecast sensitivity but also directly accommodate the inclusion of technologies embodied in new stocks as temporal stock adjustments occur. For example, the increased energy efficiencies evaluated by the Federal government's Appliance Efficiency Standards Program are easily incorporated into the stochastic equations. Mangilao has successfully applied this type of end-use demand modeling methodology in the construction of many utility forecast systems.

The fourth difference is that the preferred Mangilao modeling approach captures and reflects the relative uniqueness and differences from service area to service area in prices, income distribution, housing and population density, adjustment rates to demand in response to various stimuli, etc.

The relative advantages of hybrid econometric end-use forecasting are numerous. One is that causes and effects are clearly defined and incorporated into the system of equations given the theoretical and formal basis of the specifications. Another is that an econometric end-use model lends itself to rigorous testing, as its outputs, in the form of forecasts, are reproducible. This follows from the quantitative structure of the equations where relevant explanatory variables are represented by numerical values rather than qualitative summaries of trends and expectations.

The formal and explicit nature of the model allows evaluation by independent parties, as all assumptions underlying a system of equations are explicit. Similarly, the forecast assumptions associated with the explanatory variables are also explicitly stated. Another relative advantage is that all econometric equations are unified in the sense that the relationships between the dependent and independent variables are considered concurrently.

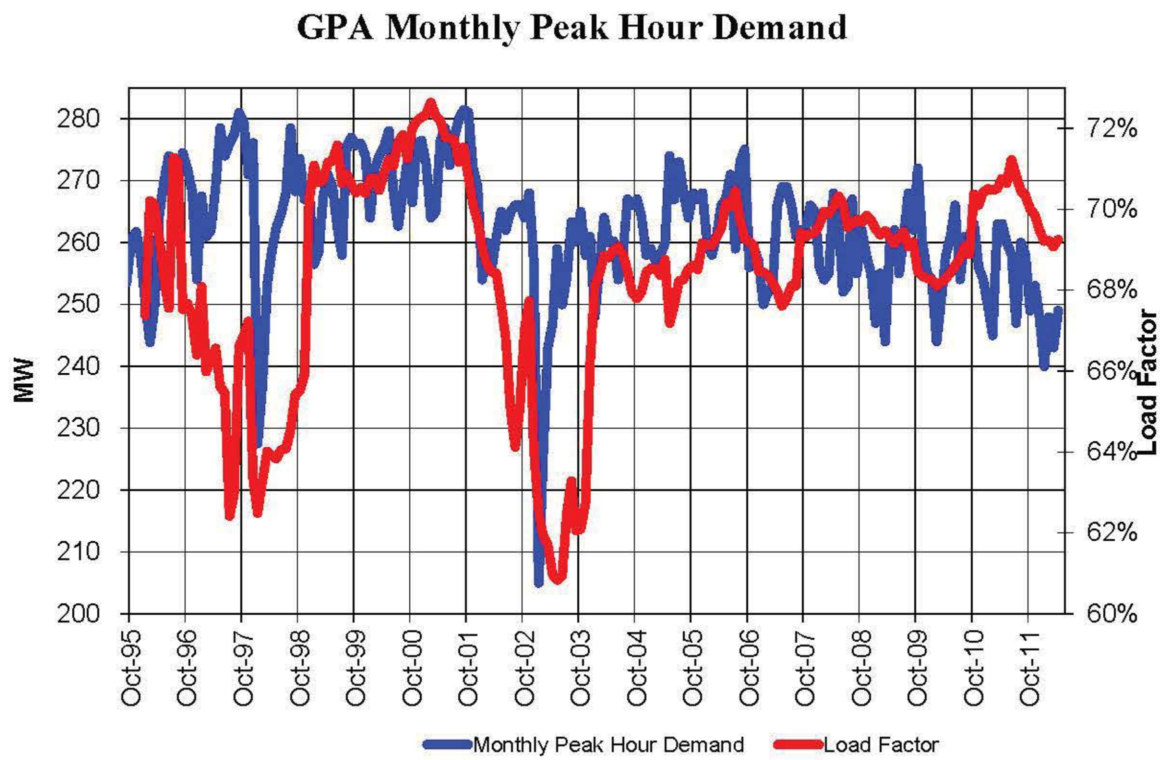
Demand for electricity is assumed to be derived from the demands for services provided by a stock of electricity-consuming capital goods. In the long run, the demand for electricity is equivalent to a demand for stock, which is determined by income and prices of capital goods and alternative fuels. The choice of utilization rates of fixed electromechanical stock is determined by the price of electricity. As noted above, however, the use of some appliances responds to differences in weather conditions and this characteristic allows direct modeling of the impact of weather on demand.

The load forecast model is driven by variables which are commonly divided into two classes: those which influence that portion of the load that is relatively insensitive to temperature and those which influence the temperature sensitive load. Those variables influencing the temperature insensitive load are generally reflective of economic conditions in the service area: real price of electricity, employment and/or income.

Weather sensitive load is driven by the cooling requirements of customers. The key variables explaining cooling loads are indices of cooling requirements (maximum temperature minus a comfort threshold of 75°F). These are used as weights on the number of residential and commercial customers.

The GPA Demand Model

If one looks at GPA's load history, several modeling problems become immediately obvious. First, as shown in the chart below, typhoons play a very important role in GPA's load history.



Appendix A: Running The GPA Sales and Load Forecasting Model

This documentation will assist the user in preparing new forecasts using the GPA Sales and Load Forecast Model developed by PL Mangilao Energy, LLC (Mangilao). If you have difficulties with these procedures, please call Kemm Farney at (desk) 610-356-4677 or (cell) 610-909-7116 for additional support.

One of the most important considerations in forecasting with models is version control. You must have a mechanism for knowing – 6 months or 6 years from now – exactly how this forecast was prepared. You will need to know clearly what was history, what adjustments were made to history (if any), what assumptions were made in preparing the forecast, and where the assumptions were drawn. It is imperative that the forecaster keep extensive and careful notes that record each step in the process. These notes need to be a permanent part of the forecast, kept with the forecast, and used as the first tool creating a new forecast or in "blowing the dust off" an old forecast that suddenly has new interest.

Step 1 – Locate or create the working directory. The first step is to either locate or create the directory where the new forecast will reside. In the first version of the GPA forecast model, it was necessary to create an entirely new working directory. *It is no longer necessary to create a new working directory if a working directory already exists.*

The working directory is entirely dedicated to the forecast, and should not contain unrelated materials. For the purpose of this example, a new directory was created titled:

```
L:\Guam Power Authority\Sales Model
```

If your directory uses a different path, you will need to modify the path names that are used in the model driver program (below). This directory contains (at least) four folders: Weather, Data, Documentation, and Programs. The Weather folder will house all of the weather files. The Data folder will house all the historical data, along with the Moodys economic forecast, the Scenarios, and the forecast flat file produced by the EViews model driver program.

The first step in preparing to use this directory to is make sure that the databases and programs that you begin to work with are the ones that were used to prepare the last good forecast. Failing to use the last good forecast as a starting point may cause old problems to be inadvertently carried forward into the new forecast.

Step 2 – Update the weather data. The second step is to update the hourly historical weather data for the weather station at the Antonio B. Won Pat International Airport (Guam's large commercial airport), collected by the US National Oceanic and Atmospheric Administration (NOAA). This airport is the only choice for data, but it is an appropriate choice, located near the population centers. GPA is currently purchasing this data for GPA from

www.weatherbank.com

Weather Bank is widely regarded by utility forecasters as the least expensive and most accurate of the different weather services. Its service does not offer a lot of bells and whistles, but the data can be delivered in Excel spreadsheets via email and it can be updated as often as the customer asks. Finally, the data is very inexpensive when purchased from this vendor.

The most recent hourly weather data that has been purchased for this project runs through August 31, 2010. It is contained in an Excel spreadsheet that has been prepared for GPA by PL Mangilao that is titled "Guam Weather 101029.xls". This spreadsheet is now larger than 20 mb and must be shared using GPA's ftp site. **A copy of this new spreadsheet must reside in the new directory that was created to contain the forecast.**

Each time updated hourly weather data is received from Weather Bank (only new data is purchased to control expenses), it is appended to this hourly weather file, and the new file is saved with a different date stamp (e.g., "090922" for September 22, 2009) in the file name. The data is appended by cutting it and pasting it to the bottom of the each page in the spreadsheet, being careful to copy the correct data and to carefully avoid missing or duplicate observations.

Save your work every few minutes. This is tedious data entry work, and you do not want to do it over because something happened and you lost your work. **Make certain to include the date stamp in your file name, and to create a new file for this day's work.** If you find problems later, this technique will allow you to determine when the error occurred (and perhaps who did it and why) and it will prevent you from having to redo more work than necessary. Finally, if you are doing a really large amount of data work all at once, add another suffix to your file name, such as a time stamp like 0900, your initials or a scenario identifier, so that you can correct errors without needing to start from scratch. All of this sounds silly, until the time comes when you must throw away a week's worth of work and redo it, just because you found a small error committed last week.

A very important subtask, once the weather data for a calendar year is complete (once December data has been coded) is to update the calculation of the 30-year normal weather at the top of the pages that calculate monthly cooling degree-days (CDDs). These new normal weather values must also be entered into the model driver program, so that the new forecast will incorporate the revisions to normal weather.

This task requires approximately two to three hours to complete, including the time needed for quality control checking. The quality control checking is extremely important; this file is so large, and the results are so sensitive, that it is necessary to be certain that the weather data lines up properly and is entered on the proper page. This large spreadsheet of raw hourly weather data contains all of the weather data available for Guam, even though forecasting currently requires only a few series (such as dry bulb temperature). Having the complete weather data set in raw form means that GPA can quickly and easily extract any desired weather metric that may be required by future studies.

Once the hourly weather file has been updated, the next step is to update the weather file that contains the monthly summary of the hourly observations. These calculated weather metrics are the data that is actually used by the forecasting model and most other analysis. The spreadsheet reads the hourly data from the database and summarizes the data, storing it with a monthly frequency.

This new spreadsheet is titled “Guam Monthly Weather 090922.xls” (the date stamp will change with updating). This spreadsheet contains a great deal of monthly and even daily weather information, including normal weather averages, that are intended to assist the analyst in evaluating and reporting the forecast. Also, this file is where the forecast program reads in historical weather data.

In updating this spreadsheet, it is very important to copy formulas down the page instead of across the page. Formulas must be copied down the page in order for them to continue to reference the correct month (stored as the column title) for that column. Since copying across the page will ruin the data, it is important to check this copying during the quality control review.

Step 3 – Modify the model code to read the new weather data. The third step is to modify the model code so that it uses all of this new weather data. If this step in the process is not completed properly, the updated weather data will not be incorporated into the new forecast.

The best technique is to open the Guam Forecast program in a text-editing package such as Microsoft Notepad, which is found in the Windows Accessories menu. In the top part of the forecast code, there are two command lines labeled:

```
%WEATHER = "Guam Monthly Weather 090922.xls"

%DAILYWEATHER = "Guam Weather 090922.xls"
```

these lines of code tell EViews which files contain the historical weather. Simply update the file name to the latest Guam Monthly Weather file and Guam Weather file.

Finally, if you are early in a new calendar year and your normal weather values have been updated, be sure to update the lines of code in the model driver program that extend the weather series by repeating the monthly weather normals throughout the forecast period.

Don’t forget to save your work frequently. It is a good practice to save your work after each change or set of changes. *It is good practice to go to the top* *of the program and add a comment – comments begin with a single quote mark – indicating who you are, what changes you made to the program, when and why the changes were made.*

This completes the modifications required to read new weather data.

Step 4 – Modify the model code to read the new economic forecast from Moodys Economy.com. The fourth step is to modify the model code so that it uses the newest economic forecast for Guam from Moodys Economy.com. Mangilao is no longer emailed a forecast but instead downloads it from the Economy.com Databuffet service. Within the Databuffet is a basket containing all of the economic variables needed for the GPA forecast. When a new forecast is released, the analyst simply clicks a button to run the basket and retrieve the new forecast in a standardized excel spreadsheet.

While the Databuffet service is simple to use, Mangilao stresses the importance of inspecting the downloaded forecasts. In some cases, just to make certain that they are what Moodys says they are. At Moodys, these tasks are assigned to junior analysts, quality control is a highly controlled expense, and mistakes are frequent. This problem is not limited to Moodys; it occurs frequently with all of the forecasting houses.

With every new forecast the analyst must inspect the data for rebenchmarking of history. Occasionally, government statistics will change the actual history for a data series. This poses a challenge for the GPA model as once the historical data changes the historical relationships in the model also change. This requires a reestimation of the underlying model parameters to make sure the standard error of the regression is at a minimum.

The EViews program has been written to read Moodys forecast in a standardized format. The current Guam forecast in this form is in the spreadsheet file titled "Guam Economics 090920.xls" (this title was assigned to the file by Mangilao so that the economic forecast database names will follow a consistent naming convention). In the past, data deliveries were emailed from Moodys and arrived with various file layouts, or with particular variables multiplied or divided by a scale factor of 1,000. The Databuffet is a simpler more consistent way of receiving the forecast, although not without challenges, as addressed earlier

This new formatted file must reside in the Model Directory. The completion of this task requires less than one hour.

After the updated Moodys Economy.com economic forecast has been formatted and saved to the Model Directory, the EViews model code must be modified to read the new economic forecast instead of the old one.

Open the Guam Forecast program using Notepad. In the top part of the forecast code, there are two commands labeled:

```
%FORECAST = "Guam Economics 090920.XLS"

%SCENARIO = "Scenarios 090927.xls"
```

These lines of code tell EViews which file contains the Guam forecast from Moody's and the different scenario forecasts. Again, simply update the file names to their latest file version.

Notice that the spreadsheet "Scenarios 090927.xls" is also mentioned. This is the spreadsheet that contains PL Mangilao's estimates of the additions to Employment and Real GDP per Employee that will result in Scenarios 2 through 5. If these scenarios are changed, these materials (the spreadsheet and the reference within the code) must also be updated. There is no need to update these materials at this time, since they are current. Once again, we would recommend that for now these changes should be made by Mangilao.

That completes this task. It requires less than 2 person-hours to complete.

Step 5 – Modify the model code to read the new internal sales, load, number of customers and pricing data for GPA. The fifth step is to modify the model code so that it takes advantage of the very latest GPA internal data. It is hard to over-emphasize how important it is to have the very latest internal data, in the most error free form that is possible. Errors in this data add noise to the historical data set that makes it much harder to identify the true statistical relationships. The likely outcome is that the forecast will understate the outlook for sales and load growth.

The current version of this file was updated by GPA and is titled "GPA Data 090922.xls". This file (or its updated version) must reside in the Model Directory. As noted above, it is very worthwhile to update this data file – it is the most important file to update when preparing a new forecast. In fact, without updating this file through the most recent month available it is almost not worth preparing a new forecast.

The analyst will frequently receive the raw data files, and will need to update the database of GPA internal data. The first step is to create a more current version of "GPA Data 10XXXX.xls" using today's date. Data is drawn from three source spreadsheets. Customers, energy sales and revenues by revenue class are taken from the latest version of "REVENUES FY 10 101910.xls". Maximum hourly demand is taken from the latest version of "060110-083110 System Load 101910.xls". Finally, Navy peak demands are taken from "Navy FY10 Billing and KWH 101021.xls". When coding this data, it is usually easiest to code and easiest to proof if one links to the source spreadsheets instead of copying numbers of cutting and pasting. Care must be taken with the following:

- Make sure the data lines up properly with the history that has already been recorded. Data is usually smooth and continuous. Watch for outliers and cut-and-paste or copying-down errors.
- Some of the data, especially the Revenue spreadsheet, read from right-to-left instead of left-to-right. Be careful.
- The front page of the internal database is a set of graphs. Scan them to spot unreasonable or surprising data entries.
- There are two places in the spreadsheet that must be modified. First, there is a block of code for customers, energies and revenues. Second, further down, there is another smaller block for average revenue per kWh, or price. You need to code the starting sell, such as "B8". Getting this wrong will keep the model from solving, giving the error that there is not enough observations.

Great care needs to be taken to ensure that this data represents an accurate depiction of GPA's true accounting history. This accounting history may contain very large accounting adjustments (sufficiently large to show up on a graph). Where large accounting adjustments occur, it may be necessary to include a dummy variable in the model (coded one at the time of the adjustment and zero else) to "whiten" the effects of the adjustment out of the accounting history. Similarly, the historical data may contain large "blips" that reflect the occurrence of a large typhoon or earthquake. Dummy variables may also serve to whiten the disruptive effects of a natural disaster from the accounting data.

Other blips may also occur in the historical data. If they are not accounting adjustments or natural disasters, they may be considered "errors" in the accounting history. In the long run it will be best if we work together to investigate each of these, determining if they can be "corrected". If they cannot be corrected, the modeler has a choice between adding a dummy variable for that time period or interpolating between the two nearest reasonable values in the data. After consideration, it is the opinion of PL Mangilao that the use of dummy variables provides a more auditable solution to this problem, and that will be our recommended approach going forward.

It is also important to insure that the data being used is the latest available. Our experience is that current data is the biggest contributor to forecast accuracy. When new data becomes available, it is almost always worthwhile to stop everything, while that new data is incorporated into the forecast data inputs.

To update the EViews program code, open the Guam Forecast program in Notepad. In the top part of the forecast code, there is a command labeled:

```
%DATA = "GPA Data 090922.xls"
```

This line of code tells EViews which file contains the historical Guam Data. Simply update the file name to the latest version of GPA Data.

Also, the start date of the Forecast period needs to be changed to one month in the future of the last month of historical data. For example, if the historical data ran through July 2009, then the forecast period would start in August 2009. At the top of the EViews program is a command labeled:

```
%STARTFORECAST = "2009:08"
```

This line is telling the program to start the forecasting period in August 2009. To update this simple change the date to reflect one month in the future of the last month of historical data.

Step 6 – Run the model. The sixth step is to run the model. If all of the file paths have been updated and if all of the spreadsheet file names have been updated, the EViews forecasting program should run without errors. In order to run the model, simply use Windows Explorer to find the program file titled "Guam Forecast (Latest Version Date).prg". You may simply double click on this file, and EViews will launch automatically and run the program. You may also first enter EViews, and then enter the command "Run GPAForecast.prg" at the command prompt.

Or, another way to run the program is by first opening eViews and then open the latest updated version of the Budget Forecast program. There is a Run button on the left most part of the tool bar. Simply click the button the program will start to run. This program should run quite quickly and will then create an Excel file that contains all of the forecasting data.

Step 8 – Update forecast reporting spreadsheet. When the EViews forecast program is done running, it will create an Excel file labeled "Forecast (Current Date).xls" that contains the forecast date. This data will need to be pasted into the back of the Guam Forecast Excel file.

First, open the Guam Forecast file in the Documentation directory and scroll to the worksheet labeled "Forecast", which is the right-most worksheet in the Guam Forecast file. Second, open the "Forecast (Current Date).xls" file in the Data directory and copy the entire data in the file. Next, paste the data into the "Forecast" worksheet in the Guam Forecast file into Cell A1.

This newly pasted data will update automatically on the all the Guam Forecast file worksheets.

Appendix B: Variable Names Used In the GPA Sales and Load Forecasting Models

GPA Internal Variables

GSLCUS – government large customers

GSLKWH – government large sales (kWh)

GSLPRI – government large, average revenue per kWh ($/kWh)

GSSLCUS –government street light customers

GSSLKWH – government street light sales (kWh)

GSSLPRI – government street light, average revenue per kWh ($/kWh)

GSSDCUS – small government demand customers (number)

GSSDKWH – small government demand sales (kWh)

GSSDPRI – small government demand, average revenue per kWh ($/kWh)

GSSNDCUS – small government non-demand customers (number)

GSSNDKWH – small government non-demand sales (kWh)

GSSNDPRI – small government non-demand, average revenue per kWh ($/kWh)

LGCUS – large general customers (number)

LGKWH – large demand sales (kWh)

LGPRI – large demand price, average revenue per kWh ($/kWh)

MWGPA – GPA monthly peak hour demand (MW)

NAVYKWH – Navy sales (kWh)

NAVYPRI – Navy, average revenue per kWh ($/kWh)