

KOSRAE UTILITIES AUTHORITY

# STRATEGIC PLAN

**FY2006 to FY2011**



*Planning Today for the Energy of Tomorrow  
October 2005*

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## INTRODUCTION

The Strategic Plan covers the time period from FY2006 through FY2010. The purpose of the Strategic Plan is to provide KUA staff and Board with goals and action plans for the next five years in order to provide electrical service to the customers and citizens of the State of Kosrae. The purpose also is to provide a document for the Government and citizens of Kosrae, as well as other interested parties, with information about the present status of KUA and guidelines for future activities.

The major challenge for the next five years will be to cope with and implement programs to reduce the cost of electric power and energy. This effort may require the modification of existing equipment; possible installation of new equipment; new technologies; exploration of and perhaps installation of alternative energy systems; reduction in distribution system losses; changes in operations; increased efforts in benchmarking and performance measurements and negotiations with diesel fuel suppliers for lower cost fuel.

Several power line extensions will be necessary over the duration of the Strategic Plan as well as maintenance, additions and programs that have already been initiated. It is not anticipated that KUA's electrical loads will increase over the next five years since there has been a trend of level to decreasing electrical loads over recent years. The reason for electrical load reductions has been attributed to a declining economy as well as increasing cost of electrical energy, mostly resulting from higher cost diesel fuel for the KUA engine-generators.

Retaining, attracting and training personnel are also major elements of the Strategic Plan. Having a capable and well trained and motivated work force is very important to providing the service of electrical power to Kosrae. KUA, during the past five years, has had a goal to hire as many personnel as possible from the local population to manage, operate and staff KUA rather hiring technical and managerial personnel from off island. The Strategic Plan will include efforts to continue that effort.

The financial strength of KUA is a major element of the Strategic Plan because of the importance of the electric service that KUA provides to the entire State of Kosrae. Electrical energy is a vital necessity for the health, safety, welfare, economics and enjoyment of the citizens of Kosrae. Therefore, the Strategic Plan will focus on policies that are necessary to bring revenues into alignment with expenses. The Strategic Plan also includes policies to assure capital formation necessary to finance future expansion of the electrical system and to replace worn

out capital assets such as power generation equipment, vehicles, office computer systems, etc.

Financially KUA's major challenges will be the ability to set and collect tariffs sufficient to cover cash expenses. Secondly it will also be a challenge to determine the appropriate level of revenue necessary to pay capital investment costs including depreciation costs and investments for replacement of capital assets such as trucks, transformers, poles, etc. New capital assets will also be required for such investments as power line extensions and modifications to the power plant. Enterprise business practices and the FSM Infrastructure Plan recommend that the full cost of depreciation be included in the electric rate tariffs. However, due to the difficult economic conditions in Kosrae at the present time, and as a result of comparing the financial practices of similar public entities that receive much of their capital funding from grants, the Strategic Plan recommends consideration be given to rate tariffs that do not include the full amount of depreciation. These issues are part of the Strategic Plan. Collection of the tariff billings will also be a challenge. KUA has been very successful with the use of "Cash-Power" meters for improving collections and accounts that are in arrears. The Strategic Plan will explore the continuation of "Cash-Power" meters and possibly other opportunities.

The ability of Kosrae citizens to pay for their electrical services continues to be a serious problem since unemployment is high and wages in Kosrae are low. Therefore economic development in Kosrae is a very important activity and assistance with economic development in Kosrae is included in the Strategic Plan.

During the work sessions that were conducted as a prelude to the development of the Strategic Plan, there were many inquiries about possible services other than electric utility services that may appropriately fit within the structure of KUA. Suggestions included propane fuel service; district air conditioning service, sharing of a possible Broadband Communication system that may be part of KUA's future Distribution system upgrade with Kosrae internet users; reactivating the central refrigeration system at the KUA Plant site; and other services including water utility service in selected areas of Kosrae. The Strategic Plan considers exploring those new services.

Other issues that are included in the Strategic Plan address KUA's commitment to good Customer Relations, Responsiveness to customers, Environmental issues, Partnerships, and others including a commitment to help in the development of an excellent quality of life for the residents of Kosrae.

The Strategic Plan is divided into several sections. The first section lists the Vision, Mission and Values of KUA. The next section discusses the present status and current realities of Kosrae Utilities Authority. The third section lists fifteen broad “OBJECTIVES” of KUA in the development and implementation of the Strategic Plan. This section also includes the Strategy of how KUA plans to achieve each of the Objectives. The fourth section is a narrative and the background for each of the Objectives/Strategies and a listing of the major goals and activities that are planned. The final and fifth section is the Action Plan section. The Action Plans are the Staff developed specific actions that KUA will implement to achieve the Objectives. The Action Plans, and there are generally at least three Action plans for each objective – one each for the Production Division, the Distribution Division and a combined Action Plan sheet for the Administration/Planning and Engineering Divisions (including Customer Service) – have listed a Strategic Goal, a the major Action that is necessary to accomplish the Strategic Goal and a list of Sub-Activities with start dates, end dates, responsible party and expected outcome. There are also several Appendices attached that provide background information of various concepts, especially alternative energy concepts, included in the Strategic Plan that will require additional investigation in the future to carry out some elements of the Action Plans.

## **STATUS OF KOSRAE UTILITIES AUTHORITY**

### **KOSRAE UTILITIES AUTHORITY**

The Kosrae Utilities Authority (KUA) was established by the State of Kosrae to provide utilities to the State of Kosrae. It was created by the State Legislature and signed into law by the Governor in 1993. At present, KUA provides electricity to approximately 1700 residential, commercial, industrial and government customers for a population of approximately 8,000 throughout the 42-square-mile island state of Kosrae.

### **GOVERNANCE**

KUA is governed by a five-member board. The Board is appointed to three-year terms by the Governor. The Board has responsibility for all aspects of the Kosrae Utilities Authority. However, since it is an authority created by the State KUA Board members and management maintain a close working relationship with the State Government and present proposed changes in tariffs to the Governor and State Legislature prior to implementation.

### **MANAGEMENT**

KUA is managed by a general manager, hired by the Board, to oversee the planning, development, operation and finances of KUA. Fred Skilling is the General Manager. He has served in that responsibility for four years and served as Assistant General Manager for five years before becoming General Manager. Mr. Skilling was a State Senator before becoming the Assistant General Manager.

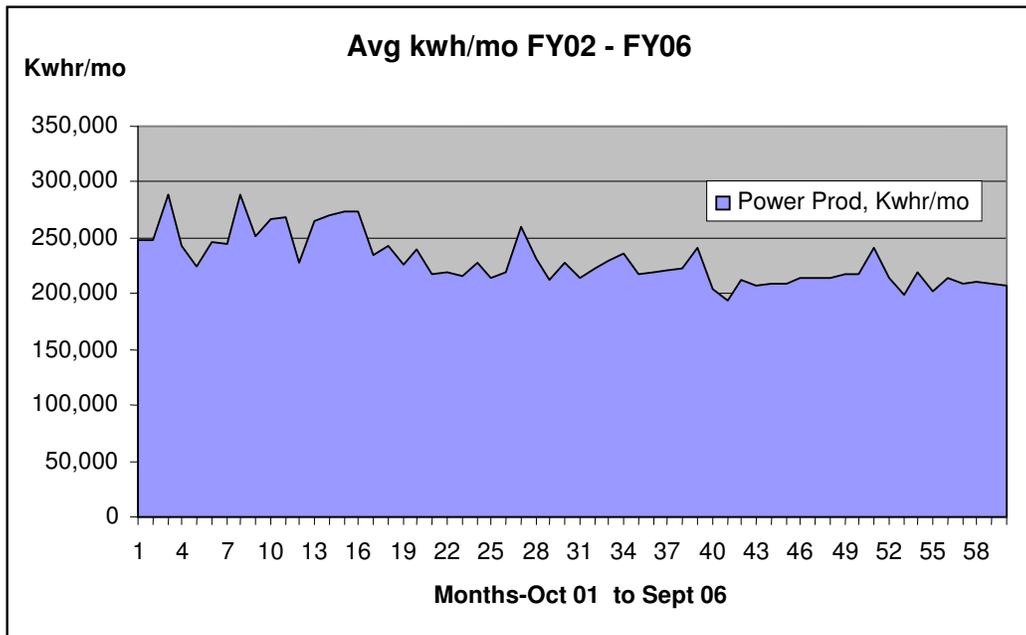
### **POWER PRODUCTION FACILITIES**

**GENERATORS** KUA has a power production facility in Tofol that consists of five (5) Caterpillar engine generators ranging in size from 460 kW to 1.65kw. with combined capacity of 4,580 kW. There is also a 650 kW portable generator that is available for remotely locating during emergencies. The peak load is 1,200 kW during the day and 700 kW at night. Electrical loads have been declining for the past 4 years. Average monthly energy generation is approximately 775,000kWh. Fuel efficiency ranges from 12 – 15 kw/hr per gallon of #2 diesel oil.



KUA Diesel Engine-Generator Unit # 7, installed 1997

**ELECTRICAL POWER PRODUCTION – KWHR/MO**



KUA has a substation located at the power plant with two 2,500 kW step up transformers to provide power to the 13,800 kW distribution power lines. The substation was constructed in 1976 and is of standard over head pole and cross beam structure design. A new substation upgrade is being designed which is anticipated to be a low profile pad mounted type facility, scheduled for completion in F2006.

**FUEL** The Power Production Division has four oil storage tanks capable of holding XXXXXX gallons of # 2 diesel fuel. This is sufficient to operate the plant for XXX days.

**DISTRIBUTION FACILITES**

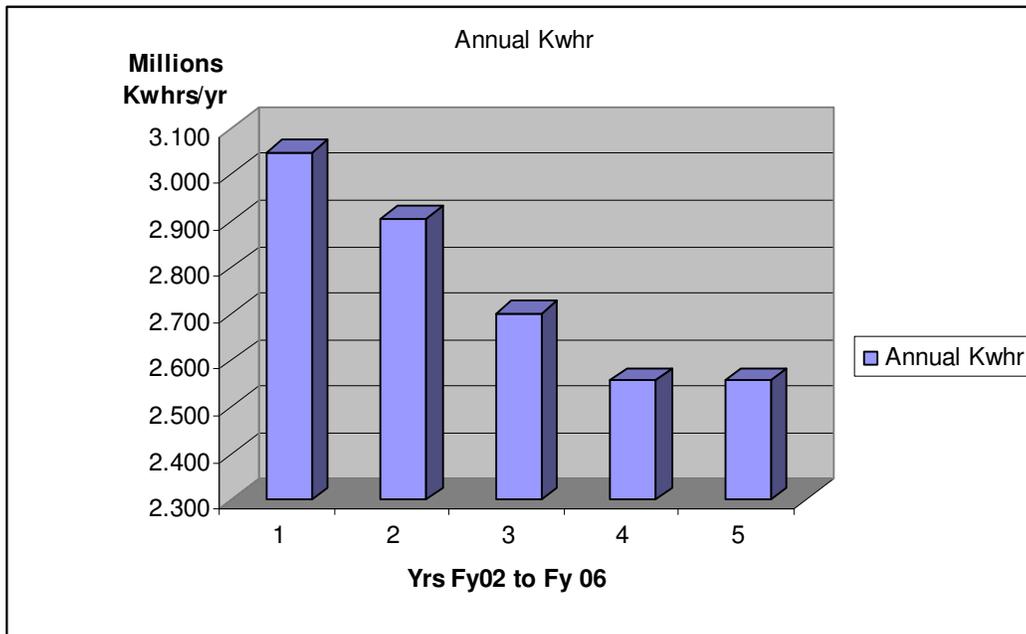
KUA has approximately 30 miles of 13,800 volt distribution lines. There are three circuits extending in a radial manner from the power plant in Tofol that distribute the electricity to the 1700 customers of Kosrae. The Lelu circuit is approximately four (4) miles long; the Tafansac circuit is approximately 9 miles long and the Malem / Utwe circuit is 15 miles long. The circuit to Tafansac was rebuilt in 2001/2002 and the circuits in Lelu and to Malem/Utwe are scheduled to be rebuilt in FY2006/2007. The circuit to Tafansac is a relatively large conductor line (336 MCM, AAA) installed mostly on fiberglass poles. The line was financed with the assistance of the U.S. Federal Emergency Management Administration and the U.S. Dept. of Interior as part of an effort to prepare the Pacific Island utilities for

the threat of typhoons. The larger size conductor not only can carry a large amount of power but it has the strength to withstand battering from gale force winds and tree limbs and debris associated with heavy winds. Funds have been made available from U.S. FEMA and U.S.DOI for the rebuilding of the power line from Tofol to Utwe with a similar circuit in a program of “power line hardening’ for typhoon preparedness. Funds have also been made available from the U.S. Dept. of the Interior for rebuilding the old and deteriorated 13.8 kV distribution power lines in the community of Lelu.

### BUDGET

KUA has 33 employees working in the Power Production, Distribution, Customer Service, Planning and Engineering and Administration Divisions. The annual budget revenue for FY2005 is estimated to be \$1.65 million. Operational expenses are estimated to be \$1.85 million, and the non-cash cost of capital expense (depreciation) is expected to be \$470,000. Cash loss of \$190,000 and an income statement loss of \$660,000 are anticipated for FY2005.

**ANNUAL KWHR SALES FY2002 THRU EST. OF FY2006**



### TARIFFS

The base electric rate tariff is approximately 18 cents per kwhr for residential customers and 20 cents per kwhr for commercial and government customers. Included in the base rate of 20 cents per kwhr is 8 cents per kwhr for fuel, an amount that equates to the cost of diesel fuel at \$1.00 per gallon which is used to generate the electricity. In addition to the base electric rate, a Fuel Adjustment Charge is added for the price of diesel fuel above \$1.00 per gallon. The FAC increases by one cent per kwhr for each 12.5 cents per increase in the cost of diesel fuel above \$1.00 per gallon. The cost of diesel fuel at present (Sept. 2005) is \$2.30 per gallon therefore the FAC is 10.4 cents per kwhr. KUA does not have a power “demand” rate typical in most utilities.

## **MISSION**

**Kosrae Utilities Authority provides safe, reliable, high quality electric and other utility services at rates that provide good value for the benefit received to all customers, and promotes a good quality of life in Kosrae**

## **VISION**

**Kosrae Utilities Authority is committed to serve the residents of Kosrae by providing utility services that meet the needs of the customers and to do so in an efficient, fair, quality and friendly manner.**

# **VALUES AND PRINCIPLES**

Kosrae Utilities Authority values and guiding principles for achieving the vision will include the following:

## **Common Good**

KUA decisions and actions will be carried out with a commitment to be for the common good of KUA customers and residents of the State of Kosrae.

## **Customer Satisfaction**

KUA will provide the best possible service for the customers with the resources available.

## **Outstanding Employees**

KUA will strive to empower a diverse workforce committed to excellence, professionalism, integrity, and quality work.

## **Effective Management**

KUA will embrace a management philosophy that promotes customer satisfaction, fosters teamwork, incorporates factual information, focuses on results and requires accountability at all levels.

## **Balanced Decisions**

KUA will integrate ethical social, environmental, technological and economic considerations in decision making.

# VALUES AND PRINCIPLES

(Continued)

## **Productive Partnerships**

KAU will collaborate with customers, government and private organizations and vendors to work toward common goals.

## **Customer Involvement**

KUA will provide opportunities for customer input into the decisions and actions of KUA.

## **Shared Capabilities**

KUA will share safety and conservation technical expertise with KUA customers and the Kosrae public and such other resources that may be shared without causing a burden on the customers of KUA.

## **Innovative Technologies**

KUA will incorporate cost effective technologies and work practices in KUA's products and services.

## **Fair Financial Return**

KUA will operate financially accountable to the customers and maintain electric rates as low as possible that provide a fair financial return for services rendered to assure that KUA is financially stable.

# **CURRENT REALITIES**

In planning strategy for the future of KUA, the following current realities will impact the future of KUA and have been taken under consideration in the Strategic Plan:

## **Financial**

1. Fuel costs are very high
2. The Fuel Adjustment Charge has increased from two cents to eight and a half cents (8.5) per kwhr in the last eight months
3. Recent base rate increases have been implemented to recover costs.
4. Economic conditions of the service area are not good.
5. Customers are unhappy with rising electric costs.
6. Large accounts payable by government accounts are outstanding.
7. Cash Power meters are installed on more than 60 percent of residential customers.
8. Cash Power meters very well received and have solved non-payment problems.
9. KUA is financially just breaking even; cash flow is even with recent base rate increases.
10. Depreciation costs are not being covered by rates since end of Compact I contract with the United States.
11. Financial reserves are reasonably strong and well managed.
12. Return on reserves is low due to low interest rates in the market.
13. Earnings from operations for replacement of aging vehicles, transformers, line replacement, meters and power plant & administration capital projects are not adequate.
14. Maintenance costs are increasing due to inflation in supplying vendor countries.
15. New material and equipment costs are increasing substantially.

## **Operations: Production**

1. KUA has good maintenance and operation personnel.
2. Staffing level is minimal but presently adequate.
3. Reliability of the Power Plant is very good.
4. No major problems have occurred with the power plant due to improper operations or maintenance.
5. The newest engine is eight years old; newer engines are more efficient.
6. Engine efficiency is 33.5 % vs. theoretical 38.5 %.
7. Metering is insufficient at plant to correctly identify production losses.

## **Operations: Distribution**

1. Distribution division has good, trained personnel.
2. Staffing level is minimal but presently adequate
3. Distribution Personnel are able to plan and construct KUA's power lines effectively and efficiently.
4. Reliability of distribution system is reasonably good.
5. Restoration of power after storm event outages is reasonably good.
6. Vegetation clearance from power lines has been reasonably good.
7. Losses from plant to customer are 7.5% vs. desired 5.5%.
8. Right of Way and easements are difficult to obtain.
9. Vegetation grows rapidly in ROW requiring frequent tree trimming.
10. Climate is salty sea mist, rain and high humidity.
11. Transformers are installed for airport industries that no longer exist resulting in unnecessary "no load" losses by the transformers.
12. Vehicle fleet is aging.

## **Planning: Engineering**

1. Electric loads and sales are declining.
2. Limited assistance is available in engineering activities.
3. KUA has good computer spreadsheet model for long range financial plans.

## **Personnel**

1. Training personnel is difficult due to remote location and expensive due to off-island travel requirements.
2. Availability of skilled work force is poor.
3. Majority of workforce has been with KUA for many years and are stable, trained fairly well and have a good understanding of the business.
4. Safety practices and awareness of staff is adequate but could be improved.
5. Wages are reasonable for Kosrae but are lower than Pacific Island Utilities.

## **Customer Relations**

1. Office personnel work well with customers
2. Government and customers occasionally complain of lack of information from KUA and about KUA issues, particularly finances.
3. KUA publishes an annual report, makes a status report to the Governors Office annually and has an audit completed annually that is made available to the public.
4. The Cash Power meters have substantially increased the Customer Service personnel work load.

## **Administration**

1. Management and supervisory personnel have many years of experience and have proven ability to operate, maintain and manage KUA effectively.
2. Management is very good in assuring that power supply is reliable, meters are read, bills are rendered regularly, billing is collected, budgets are competently prepared and followed, reports are prepared timely and accurately.
3. Management assures that accounting is performed on a timely and accurate basis, audits are performed, appropriate controls are in place and financial resources are securely and conservatively managed.
4. Staffing level is minimal but adequate at present.
5. Due to retirements, Staff is not trained sufficiently to be as effective as desired in providing energy advisory and energy audit services.
6. Accounting, purchasing & financial Staffing is effective and efficient.
7. Office equipment systems are in need of replacement and upgrading as well as some software systems such as customer billing.

## **Environmental**

1. KUA depends on diesel fuel for 100% of electric power production.
2. Greenhouse gases are increasing and Kyoto Accord is not being met.
3. Particulate and NOx from diesel engines are above world standards but not significant in remotely located Kosrae to pose a health hazard to Kosrae.
4. KUA has a program to dispose of waste oil properly.
5. All equipment with traces of PolyChlorinated Byphenol (PCB) have been properly contained or disposed.

# **OBJECTIVES AND STRATEGIES**

The Objectives and Strategies of KUA are the general listing of the results desired and the principles methods by which KUA plans to follow to accomplish the Objectives. The Strategies for KUA over the time frame of the Strategic Plan are the guidelines by which the mission, vision and objectives will be achieved. The following list of Objectives with the accompanying Strategies will be the issues that KUA will concentrate its efforts upon in order to achieve the Objectives. There are Action Plans included in the final section of this Strategic Plan that will address each of the Objectives and Strategic goal. The Action Plans relate to specific actions that each of the major departments of KUA, - the Power Production, Distribution, and Administration/Planning/Engineering Departments – will carry out to achieve the specific Objective of KUA.

## **OBJECTIVE - SAFETY**

**Operate an electric system that is safe for customers, the public and KUA employees.**

## **STRATEGY**

The delivery of electrical service to the customers of KUA by its very nature has serious elements of danger in the production electricity, the delivery of electricity, and construction of facilities for delivery of electricity. Therefore safety must be one of the first priorities for KUA. In order for KUA to reach the objectives of Safety, the strategy must be that Safety be the primary focus of all employees' actions, plans, policies and decisions at all times. To assure a continued focus on safety, management, supervisors and all employees must consider safety as the number one goal in all activities. A comprehensive and continued training program, along with frequent and regular training meetings, will be undertaken. All accidents, near-accidents and safety hazards will be analyzed so that training can be developed to prevent future incidents. Annually a review will be made of the history of safety at KUA, issues will be analyzed and continuing programs and/or corrective measures will be taken for the succeeding year's safety programs.

## **OBJECTIVE - EFFICIENCY**

**Reduce the cost of electricity to the customers of KUA.**

### **STRATEGY**

Efficiency improvement will include all aspects of KUA systems. It will include analyzing and improving operations and maintenance and upgrading of existing equipment and facilities involved in the production, delivery, customer and administrative functions; replacement of outdated and inefficient equipment where warranted; analysis of all purchases and purchasing policies, especially as related to fuel since fuel is the main cause of the high cost of electrical energy; review and adjustments of distribution system technical features; and analysis and updating of personnel practices in operations, maintenance, engineering, administration and customer service. KUA will search for opportunities to improve the performance of existing equipment and rigorously search for alternative methods to provide electricity or the necessary energy resources required by KUA customers. Over the next five years KUA will explore hydroelectric, wind, wave, tidal, biomass, solar, combined cycle, fuel cell, propane, natural gas, cogeneration, waste heat recovery, and any other system, technology or fuel that may help improve efficiency and lower the cost of energy for KUA customers and Kosrae citizens. KUA will explore partnerships that may help improve efficiency, reduce risks or otherwise help reduce the cost of electric service to KUA customers.

## **OBJECTIVE – RELIABILITY**

**Provide reliable, high quality electric service.**

### **STRATEGY**

The highest degree of reliability of electrical service is necessary in today's homes, businesses and governmental functions. To achieve that high level of reliability, KUA will assure that all mechanical and electrical systems are

designed, installed, operated and maintained properly. Design of the system and specifications for and purchase of quality equipment and systems will be done with a concern for reliability. Outages will be minimized by trimming vegetation from around the power lines and keeping the right-of-ways clear of possible interference. Policies and practices will be developed and adopted so that when outages do occur, crews are trained to quickly locate, restore and repair the problem. Post-outage analysis will be conducted to determine the cause of outages, and action will be taken to reduce the possibility of repeat outages. New equipment for System Control and Data Acquisition will be purchased to help increase reliability for the electrical production and distribution systems. Similar efforts will be undertaken in other aspects of KUA operations such as meter reading, billing, customer service, accounting, engineering and other administrative functions to assure the highest possible level of reliability in all aspects of KUA's service.

## **OBJECTIVE – CUSTOMER RELATIONS**

**Be known for excellence in customer relations.**

### **STRATEGY**

Relationship with KUA customers is a vital element in the delivery of good service. KUA will work to instill in all representatives of the utility the importance of providing good service in a courteous manner. Regular training programs will be provided to keep customer relations a major focus of each KUA representative. Surveys will be conducted periodically to assess customer satisfaction and assessment of results and if necessary, training programs conducted to address customer and public satisfaction concerns. Management will seek ways to keep the Public and State Officials informed of the status of KUA at least on a quarterly basis and/or when major events occur. Increased emphasis will be placed on providing assistance to KUA customer's use of energy and their efforts to conserve and efficiently and effectively use energy.

## **OBJECTIVE – RESPONSIVENESS**

**Be responsive to customers, public government’s requests for service, construction of new facilities and for their requests for information about KUA activities, plans, policies and finances**

### **STRATEGY**

Responsiveness to customer’s requests for service, attentive response to system necessary operational and maintenance needs and responsiveness to the public’s requests for information is vital to the smooth functioning of an electric utility. KUA will review existing practices and policies regarding responsive attention to customer’s requests for service and extensions and make appropriate adjustments to assure timely and well communicated responses to customers requests to the extent that resources allow. KUA will develop and follow appropriate schedules for various operational activities and maintenance functions necessary to provide good service to KUA customers.

Being responsive to customers inquires and requests for information are an important function of a publicly owned entity such as KUA. The Board, Management, supervisors and all employees will work to provide information to customers and public and government entities in an accurate, timely and meaningful manner. Inquiries will be made of customers, public, businesses and government regarding their needs and expectations of information about KUA’s activities, plans, policies and finances. Using the inquiries as a basis, KUA will provide the appropriate information and develop such information that is legal to provide and appropriate to serve the request.

## **OBJECTIVE – FINANCIAL**

**Make KUA a financially self-sustaining organization with a good financial foundation.**

## **STRATEGY**

KUA must be able to maintain a good financial condition in order to be able to provide safe, reliable and economical power for Kosrae into the future. A thorough review of the financial requirements of KUA will be made to assess the present condition of KUA, and plans will be developed to assure a good financial condition into the future. Present revenues are on the edge of not being sufficient to recover actual cash expenses. Although rates have been raised twice in the past year, and a series of more increases is planned, revenues still are insufficient to recapture the cost of capital (depreciation) that was originally invested in the facilities. In enterprise funds, it is usually necessary to capture depreciation expenses in order to replace equipment and facilities as they wear out and also to provide capital for system expansion and improvement. KUA will analyze the necessity of capturing the full amount of the capital investment in previous projects in light of continuing opportunities to obtain funding through future capital grants. The necessity of full capital recovery in each year may be reduced if KUA can maintain a good financial record sufficient to issue bonds, provided KUA can assure the lending markets that rate tariffs will be sufficient to meet minimum requirements necessary to pay off bond debt and provide reserves. KUA will also analyze the need to collect full recovery of past capital investments, giving consideration to bond market requirements, as a prerequisite to setting revenue requirement policies and tariffs. KUA will review collection procedures and assure that they are appropriate and adequate to collect for services rendered. Several large outstanding bills continue to exist in KUA's accounts receivable, and KUA will analyze those receivables and determine if collection of the long overdue bills is possible. If not, the Board must decide what action will be taken.

Because KUA is a creation of the State of Kosrae and received a large amount of its original assets from the State without compensation, KUA will review its financial obligations to the State. The KUA Board will review this as a policy matter and determine if compensation is appropriate and if KUA is financially able to provide such compensation. Also, most business ventures in Kosrae

provide some return on assets to their owners. KUA will, through Board review of this policy, analyze whether some return on investment is appropriate and also if KUA has sufficient revenues to make such payments. KUA, like all businesses, will not be able to make a return on investment to the State if revenues are insufficient to fund current operations and capital recovery and/or expansion.

## **OBJECTIVE – FAIRNESS AND EQUITY**

**Have fair, equitable and adequate rate tariffs and extension policies.**

## **STRATEGY**

Developing fair and equitable pricing for KUA services, line extensions and other services is necessary to assure that each customer pays his or her fair share and is not a burden to others being served by KUA. Although it is difficult to assure perfect equity, KUA will annually analyze rate tariffs and extension policies and prices to assure that they are fair and equitable within the guidelines that the Board of directors establishes. During the development stage of KUA, power line extension policies have required each customer to pay for the extension of the line to their property. This policy will be examined to determine if the policy is still appropriate or if any other line extension policy is financially feasible at this time. Public input and discussion will be invited to review this policy. Rates now are based on sales of energy but electric service has two components – energy and power. Power is measured in Kilowatts and is the capacity to provide energy and energy is measured in Kilowatt hours and is the provision of power over a period of time. Some customers require large amounts of power but only for a short period of time, requiring KUA to build power plants and electric distribution lines and transformers sufficiently large to serve that power. But when that power is only used for a brief period of time, rate tariffs that charge only for energy do not recover enough revenue to pay for the cost of the equipment necessary to provide that power. Therefore, other customers subsidize such customers. It is therefore appropriate at some time in the development of an electric utility to consider the installation of electric meters that collect information and provide billing for both power and energy elements of service. These meters are called demand meters and they are usually necessary for larger

businesses, industries and occasionally government complexes. Residential customers usually use electricity in such a uniform manner that rate tariffs can be developed that reflect their fair share of energy and power without the use of demand meters. KUA will analyze and determine the need for demand meters and demand rate tariffs.

## **OBJECTIVE – CUSTOMER ASSISTANCE**

**Help customers be energy efficient and have policies and programs of equitable assistance.**

### **STRATEGY**

KUA's primary function is the delivery of electrical energy to the customers. However, KUA is in a unique position to have personnel qualified to be trained to assist customers in the efficient use of the electrical energy that they purchase. The strategy for customer assistance will be to assure that the customer receives the power necessary to meet health, welfare, business and personal needs, but to educate the customer on efficient use of electric energy and seek methods, programs and policies that will help customers minimize the need for electric energy to the greatest extent they determine is appropriate. This will include making energy audits available and reviewing and considering providing services and equipment that would save energy. KUA will work with the State of Kosrae to encourage setting appropriate efficiency standards for appliances and developing standards for insulation and weatherization for buildings determined appropriate. KUA will develop information and programs to encourage the use of passive systems to reduce energy usage and encourage use of ceiling fans to assist in cooling and other programs and methods to help reduce customers' use of electrical energy. KUA will seek grants to help pay for customers' energy efficient products and programs.

## **OBJECTIVE – NEW SERVICES AND FACILITIES**

**Provide timely extensions of service to customers at lowest reliable cost and conduct a fiscally sound construction and extension of service program to meet the future needs of Kosrae.**

### **STRATEGY**

KUA will work to develop plans, financial resources and schedules to extend power lines to areas in need of electrical service. KUA will seek grants and assistance where possible to help finance the extensions, thereby reducing the financial burden on KUA customers. KUA will establish a methodology to prioritize installation of line extensions where funds and schedules are in conflict. The schedules and costs will be communicated to customers and appropriate parties and updates issued if schedules or costs change.

## **OBJECTIVE – ENVIRONMENTALLY PROACTIVE**

**Be a strong proponent of good stewardship of the environment locally and globally.**

### **STRATEGY**

KUA recognizes the fragile nature of the environment in Kosrae and the environment in general and will maintain an awareness and commitment to be good stewards of the environment. KUA will seek new power production systems that will give consideration to reducing greenhouse gases, improve efficiencies and reduce pollutants. KUA will seek systems that further the concept of a sustainable environment but will appropriately balance the ideal with that which is financially justifiable and affordable in the Kosrae community of customers. KUA will review its power plant operation for environmental risks,

and take appropriate action to minimize risks. Transformers, oil storage tanks, power plant and vehicle fluids, and other possible environmental contaminants will be monitored. Policies and procedures will be reviewed to assure that any environmental contaminants from these sources will be properly contained.

## **OBJECTIVE – ECONOMIC DEVELOPMENT**

**Be available as a partner with the Kosrae state government in economic development for the common good of all citizens of Kosrae.**

### **STRATEGY**

KUA's future financial stability and success depends substantially on the financial health of Kosrae. Therefore, KUA will work with State of Kosrae officials for economic development. KUA will consider special, temporary incentive rates for businesses and industries to encourage location of new companies in Kosrae that will provide added employment for Kosrae citizens. KUA will consider adjustments to extension policies that would aid in encouraging new industries to locate in Kosrae. KUA will explore new business functions that may interrelate with KUA's primary purpose, if such new business functions are determined to be an appropriate function of KUA. The new functions may include the provision of water and wastewater utility services for selected areas of KUA; providing district cooling for buildings near the KUA power plant; reactivation of the central refrigeration facility located at the KUA power plant site; providing bottled propane for Kosrae; installation and maintenance of solar hot water heaters to help reduce customers' dependence on electric hot water heating; sharing high speed communications systems; and other similar interrelated energy or ancillary services of KUA.

## **OBJECTIVE – SHARING**

**Be ready and available to engage in additional services that may be appropriate and desired by customers, citizens and government and make existing equipment and personnel expertise resources of KUA available provided it does not burden KUA customers.**

## **STRATEGY**

KUA will analyze the opportunities to share computer servers, communication systems, specialized vehicles and equipment, test equipment and mechanical systems without creating a burden on the customers of KUA. KUA will also analyze and make available, if possible and appropriate, technical personnel if the personnel can be shared without interfering with KUA's primary business of providing good service to KUA customers. KUA will explore opportunities to share its capability to be of service to Kosrae in business areas additional to electric utility service when asked to provide such services. Such services may be water and/or wastewater services; propane fuel service; broadband over power line service; etc.

## **OBJECTIVE – PARTNERSHIPS**

**Develop good relationships with partners such as governments – local, state and national- vendors, DOI, grant agencies, neighboring utilities and others who impact KUA services**

## **STRATEGY**

KUA will develop good working relationships with various partners involved in the provision of service to KUA customers. KUA will seek working alliances with the many product and service vendors who do business with KUA; U.S. Governmental agencies such as DOI, RUS, FEMA, etc. involved in services, grants and loans to KUA; Pacific Rim nations interested in providing support for Kosrae; organizations who have interests in providing aid, grants, loans, or services to KUA and Kosrae; neighboring Utilities and such organizations as the Pacific Power Association, South Pacific Secretariat, European Union, etc. that have interests in supporting KUA, and local businesses, governmental entities, organizational groups and other parties that have mutual interests in KUA service issues and improving the quality of life of Kosrae.

## **OBJECTIVE –EXCELLENCE & PROFESSIONALISM**

**Be known for excellence and professionalism of personnel who are well-trained employees and serve as a resource for assisting others in Kosrae and the FSM region.**

### **STRATEGY**

KUA will develop programs and policies that will seek to attract high quality personnel to KUA's workforce and will provide training to assure that the work force is well trained in all aspects of their work responsibilities, supervisory, managerial, and policy development, and interpersonal relationship skills. KUA will develop policies that will assure equal opportunity to diverse elements of the Kosrae population for employment, training and promotion. KUA will continue to assure that all members of the KUA staff and Board exhibit a sense of motivation in their respective responsibilities, solid knowledge of their respective work activities, professionalism in their work and interrelationships, and a desire for continued learning to improve their skills. The KUA Board will develop educational and developmental programs to help educate new board members on the complexities of the electric utility business. The Board will review and conduct training sessions to assure that they are meeting their responsibilities according to Kosrae state law and in a professional manner. Deliberations and actions on KUA issues will be open to public input and review, unless the matters are legally defined as items that must be reviewed in closed session.

## **OBJECTIVE – QUALITY OF LIFE**

The KUA organization will work as a team member with all other parties in Kosrae toward assurance of a high quality of life for the citizens and residents of the state.

## **STRATEGY**

KUA will work to improve the quality of life in Kosrae. KUA will strive to conduct its business affairs in a manner that will add to the quality of life. KUA will strive to avoid actions, plans, construction of facilities and operations of the electrical system that might detract from quality of life for the public in general and for individual residences and customers specifically. In cases where quality of life for a specific party might be impaired by a construction project or operation of the electric system, KUA will use caution in considering such actions and proceed only when the service is necessary for the common good of all Kosrae citizens and KUA.

# **STRATEGIC PLAN**

## **ACTION PLANS**

### **SAFETY**

1. Safety will be the primary focus of all KUA employees' actions, plans, policies and decisions at all times.
2. Each Dept. will have a Safety plan, conduct regular staff and crew safety meetings and review safety issues that arise during the course of work.
3. Management and supervisors will quarterly have training programs on safety related issues that apply to the work of the various crews and staff.
4. Accidents, near-accidents and safety hazards will be analyzed so that training can be developed to prevent future incidents.
5. Annually a review will be made of the history of safety at KUA, issues will be analyzed and continuing programs and/or corrective measures will be taken for the succeeding year's safety programs.
6. KUA will benchmark their safety record and programs with other Pacific Island Unities and take corrective training measures when KUA lags other utilities.
7. The goal is for no lost time accidents and no injuries or accidents to customers or public resulting from KUA facilities and actions.

# **EFFICIENCY**

## **Power Production**

1. KUA will search for opportunities to reduce the cost of fuel.
  - a. Consider partnerships with the Micronesian Petroleum Corp. to purchase annual requirements of fuel in an effort to reduce the price; purchasing fuel directly from wholesale suppliers and contracting with MPC to unload, store and deliver the fuel.
  - b. Explore feasibility and acceptability of partnership with MPC whereby KUA with its better financial capability purchases all fuels for Kosrae and MPC delivers the fuel to the users; KUA may offer to provide the billing and collection services for fuel also.
  - c. Work with other Pacific Island Utilities in securing better pricing for fuel, either through combined bulk purchases; exercising political and/or legal pressures on the regions suppliers; or other programs to reduce the cost of primary fuel energy.
2. KUA will review existing engine generator efficiencies to achieve efficiency of 15.4 kWh per gallon by FY2008.
  - a. Review all operational procedures to determine if altering operations can improve engine efficiency and take action accordingly.
  - b. Review maintenance on all engines to determine if additional or change in maintenance can improve engine and take action accordingly.
  - c. Work with Caterpillar Engineers and service technicians to determine if additional efficiencies can be achieved by making modifications to the equipment and take action accordingly.
3. KUA will explore the economics and feasibility of installing a new more efficient diesel engine, which may be smaller than Units #6 or #7 and would run at "base" load efficient loading with additional power coming from running #6 or #7 at lower loads than at present.

4. KUA will explore capturing the waste heat from the diesel engines and make additional power or make chilled water for distribution to surrounding customers for use in air conditioning their buildings.
  - a. KUA will continue its attempt to obtain a grant from the United States Rural Utility Services for a grant to build a waste heat to central chilled water system in an effort to increase efficiency of the KUA power production system to the 60% range from the present 35%.
    - i. The concept waste heat recovery system will use an absorption chiller to capture jacket water and oil cooler waste heat and/or also use an adsorption chiller to capture the exhaust heat.
    - ii. Preliminary engineering study may first explore use of a fuel cell system now in final testing stages by the U.S. Dept. Of Energy that uses diesel oil directly to produce electricity and in addition provides high temperature waste heat for use with an adsorption system, predictably at an efficiency rate, when including chilled water, in excess of 75%.
    - iii. The concept goal of chilled water system will be provide approx. 40 degree F. chilled water, deliver the chilled water to each building and convert existing window a/c units to chilled water radiator type room air conditioners or to assist building owners in installing central a/c units with air ducts to each room and automated controls to regulate flows to each room.
    - iv. The chilled water cooling system concept is to extend the chilled water pipes from the power plant through the Government Administrative complex, the education campus, to the Legislative and nearby government offices to the Hospital with another line tapped off extending to business locations near the post office.

- 5 KUA will explore several alternative energy concepts in an effort to reduce the cost of producing electrical power for Kosrae. The various alternative energy concepts that will be explored are listed below with additional information of the concept included in the Appendix:
- a. Wave Power – Possibly two or three types.
    - i. Linear Tube hydraulic motor/generator
    - ii. Coastal wave air chamber type driving a turbine generator.
    - iii. Ocean wave buoy air chamber type driving a turbine.
  - b. Tidal Power – Possibly at two locations using hydraulic turbines.
    - i. Causeway
    - ii. Mangrove tidal basin behind the Nautilus Resort.
  - c. Wind Power – Possibly two types of locations.
    - i. A site along east side of Kosrae.
    - ii. A site high on one of Kosrae’s mountains.
  - d. Ocean Current power using one or two 250 kw “underwater windmill” type turbines mounted on a pipe pillar in 100 – 150 ft deep water in a high current area.
  - e. Hydroelectric dam and/or run of river hydraulic turbine possibly on rivers or streams in the southern part of Kosrae.
  - f. Biomass using waste vegetation from Kosrae to either:
    - i. Burn dried vegetation, produce steam for a micro steam turbine installation ;
    - ii. Utilize anaerobic digester to produce methane gas to use in an internal combustion engine, either gas engine or diesel engine type.
  - g. Solar using Photo Voltaic panels
  - h. Fuel Cell systems using either propane or diesel fuel.
  - j. Mini combined cycle plants to obtain maximum efficiency.

## Operations

1. KUA management, supervisors and operational personnel will examine their various functions and analyze how each of their processes may be streamlined, eliminated without reducing service to the customer, outsourced at a lower cost, or seek methods of reducing the cost of performing each work function.
2. KUA will continue to work with other Pacific Island Utilities in the ongoing benchmarking program designed to help each utility set efficiency standards and improve performance.
3. The Engineer, Supervisors and the distribution crews will explore methods to reduce the energy loss in the distribution system from the power plant to the customer. Areas of considerations will be:
  - a. Determine if installation of capacitors can reduce losses.
  - b. Analyze transformer sizing to assure that large transformers are not being only partially loaded. Change out underutilized large transformers with smaller transformers to reduce “no-load” losses.
4. KUA will analyze all aspects of the metering, reading, billing and collection of bills to assure that all energy being delivered to the customers meter is properly billed and collected.
  - a. Conduct a complete review of all meters and connections to the power lines to assure that no unauthorized use is occurring.
  - b. Review the meter testing program to assure that all meters are checked on a regular basis to assure that they are working properly.
  - c. Review meter reading procedures to assure that all meters are being read correctly; that the readings are being entered and billed correctly and that the collections are being made for the billings.
  - d. Review the need for a new billing system and take action accordingly.

## **CUSTOMER'S EFFICIENT USE OF ENERGY**

1. KUA will encourage and develop programs to help customers purchase energy efficient appliances and equipment.
  2. KUA will work with the State of Kosrae to encourage the development of energy efficiency standards for appliances such as refrigerators, Air conditioners, Freezers, etc. that are sold or delivered to Kosrae.
  3. KUA will work with the State of Kosrae to encourage the development of energy efficient standards for building construction, especially building construction for buildings that plan to include air conditioning.
  4. Encourage businesses, industries, government offices and residents to use ceiling fans to assist in cooling office and work spaces.
  5. Encourage customers to use central cooling systems to improve efficiencies, if more than one room is to be air conditioned.
  6. Encourage customers to install automatic control systems to open and close room/space vents on central air conditioner systems so as to discontinue air conditioning unused offices and spaces.
  7. Encourage customers to install automatic thermostat control devices on air conditioning systems that will cycle air conditioners on and off and adjust temperatures based on preset settings and to operate the air conditioners only when offices or work spaces are being used.
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## **RELIABILITY**

1. KUA will assure that all mechanical and electrical systems are designed, installed, operated and maintained properly in the power plant and on the electric distribution system to assure a high level of reliability.
  2. The system will be designed and specifications used to purchase quality equipment to assure reliability in the KUA electrical system.
  3. Trimming vegetation from around the power lines and keeping the right-of-ways clear of possible interference will be emphasized to help improve reliability.
  4. Policies and practices will be developed and adopted so that when outages do occur, crews are trained to quickly locate, restore and repair the problem. Post-outage analysis will be conducted to determine the cause of outages, and action will be taken to reduce the possibility of repeat outages.
  5. Outage restoration will strive for a response to site problem within 30 minutes and restoration of power within one hour.
  6. New equipment for a System Control and Data Acquisition system will be purchased to help increase reliability for the electrical production and distribution systems
  5. KUA will review other areas of service such as meter reading, billing, customer service, accounting, engineering and other administrative functions to assure the highest possible level of reliability in all aspects of KUA's service.
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## **CUSTOMER RELATIONS**

1. KUA will work to instill in all representatives of the utility the importance of providing good service in a courteous manner.
  2. Regular training programs will be provided to keep customer relations a major focus of each KUA representative.
  3. Management will seek ways to keep the Public and State Officials informed of the status of KUA at least on a quarterly basis and/or when major events occur. Increased emphasis will be placed on providing assistance to KUA customer's use of energy and their efforts to conserve and efficiently and effectively use energy.
  4. KUA will work to instill in all representatives of the utility the importance of providing good service in a courteous manner.
  5. Surveys will be conducted periodically to assess customer satisfaction and assessment of results and if necessary, training programs conducted to address customer and public satisfaction concerns
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## **RESPONSIVENESS**

1. KUA will review existing practices and policies regarding responsive attention to customer's requests for service and extensions.
2. KUA will make appropriate adjustments to assure timely and well communicated responses to customer's requests, recognizing that extensions require financial resources and policies assuring fairness to all customers when considering all extension projects.
3. KUA will develop and follow appropriate schedules for various operational activities and maintenance functions necessary to provide good service to KUA customers.

4. The Board, Management, supervisors and all employees will work to provide information to customers and public and government entities in an accurate, timely and meaningful manner.
  5. Inquiries will be made of customers, public, businesses and government regarding their needs and expectations of information about KUA's activities, plans, policies and finances and using these inquiries as a basis, KUA will provide the appropriate information and develop information that is legal to provide and appropriate to serve the request.
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## **FINANCIAL**

1. A thorough review of the financial requirements of KUA will be made to assess the present condition of KUA, and plans will be developed to assure a good financial condition into the future.
2. A long range pro forma, for which the format is already available, will be refined to chart the future financial obligations and resources of KUA using the estimated costs of the final programs and projects proposed in this Strategic Plan.
3. KUA will analyze the necessity of capturing the full amount of the capital investment in previous projects in light of continuing opportunities to obtain funding through future capital grants.
4. KUA will utilize recommendations by RUS and investment banking firms to guide their decision regarding the amount of depreciation expense to include in the rate tariffs. A sufficient level of depreciation and/or funds necessary to meet future principle and interest costs plus normal bond provision requirements of additional cash flow coverage will guide KUA management and Board in determining the appropriate capital recovery funds to include in the rate tariffs.
5. KUA will work diligently to maintain a good financial record and set and collect rate tariffs so that KUA can assure lending markets that

KUA has the commitment and capability to have sufficient revenue to meet minimum requirements necessary to pay off bond debt and provide reserves.

6. KUA will review its present collection procedures and assure that they are appropriate and adequate to collect for the services rendered.
  7. KUA will analyze large outstanding receivables and determine if collection of the long overdue bills is possible. Special attention will be given to the defunct Pacific Tuna, Inc. account and efforts will be explored to resolve this outstanding account, including an accounting and legal review of the options available.
  8. KUA, being a creation of the State of Kosrae, and having originally received a large amount of its original assets from the State without compensation, will review its financial obligations to the State for repayment of the original assets or a return on investment to the State on those assets. The KUA Board will review this as a policy matter and determine if compensation is appropriate and if KUA is financially able to provide such compensation within the time period of this Strategic Plan. KUA will assure that appropriate cash inflows are available before repayments of capital or a return on invested capital or similar compensation is provided.
  9. KUA will seek grants from various sources for capital expansions and special programs for KUA customers, such as energy conservation, audits, financial assistance programs, etc. KUA will seek grants from the U.S. Dept. of Interior; the U.S. Rural Utility Service; the U.S. Federal Emergency Management Agency; the various entities and agencies associated with the European Union that provide assistance to Pacific Island communities; the Asian Development Bank; various foundations in the U.S. and elsewhere that target assistance to the Pacific Islands and developing countries.
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## **FAIRNESS AND EQUITY**

1. KUA will annually analyze rate tariffs and power and service line extension policies and prices to assure that they are fair and equitable within the guidelines that the Board of directors establish.
  2. KUA will examine the present policy of requiring developers, including individual home/business owners, to pay for the extension of power lines. This policy will be examined to determine if the policy is still appropriate or if any other line extension policy is financially feasible at this time. Any change of this policy shall consider fairness to existing customers. Public input will be invited during the review of this policy.
  3. KUA will analyze and determine the if power demand type of billing meters and demand rate tariffs are appropriate.
  4. KUA will review it's pay scales for employees by 2007 to determine if their compensation is commensurate with the work that they perform and equitable with similar positions in Kosrae and other Pacific Island Utilities.
  5. KUA will review Right Of Way acquisition policies and determine if it is necessary or appropriate to alter the present policies or reaffirm the existing ROW acquisition policies.
  6. KUA will review design issues relating to distribution lines, guy wires, service drop lines, etc. that encroach on private property and determine if the present policies for such activities is equitable.
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## **CUSTOMER ASSISTANCE**

1. KUA will increase it's efforts to provide energy usage and energy conservation information.
  2. Provide training programs to train either KUA or contract personnel to perform energy audits and provide the energy audits at actual cost.
  3. Develop expertise on residential, business and industrial energy use and provide assistance to customers on a cost basis for their complex energy decisions.
  4. KUA will develop information and programs to encourage the use of passive systems to reduce energy usage and encourage use of ceiling fans to assist in cooling and other programs and methods to help reduce customers' use of electrical energy.
  5. KUA will share its qualified personnel with KUA customers to assist them with the efficient use of the electrical energy
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## **NEW SERVICES AND FACILITIES**

### **Power Production**

1. Overhaul #2 engine top end FY2006
2. Upgrade Radiator on #7 engine FY2006
3. Upgrade Power Plant Substation FY2006
4. Relocate Exhaust on #6 engine FY2006
5. Perform Major Overhaul of #7 engine FY2007
6. Review necessity of Replacing #5 Cat D398 with a Cat 3512 PY2007
7. Maintenance on Switch Gear & Relays FY2007
8. Install Fire Hydrants at Power Plant FY2007
9. Install Emergency Lights FY2007
10. Install Waste Heat recovery-Absorption/Adsorption Chiller FY2007
11. Perform Major Overhaul of #8 Engine FY2008
12. Enclose front wall on Power Plant FY2008

### **Distribution**

1. Okat to Melo line extension FY2005
2. Utwe to Walung line extension FY2006
3. Rebuild line Tofol to Utwe -FEMA Hardening Project FY2006
4. Malem Inner Road line extension FY2007
5. Lelu Distribution line upgrades FY2007
6. Tafunsak Distribution line upgrades FY2007  
(3 phase to end of road)
7. Okat to Walung line extension FY2008
8. Cross Island Road Power line FY2008

### **Customer Service**

1. New billing system FY2006
2. Install 400 Cash Power meters FY2006
3. New meter calibration equipment FY2006
4. Provide Surge Protector Equipment for customers FY2006
5. Install 400 Cash power meters FY2007
6. Install Cash Power meters on three phase customers FY2007

## **Administration**

1. Office Facility Remodeling/Expansion FY2006
2. Replace several office machines FY2006
3. Replace misc. utility vehicles FY2006 thru FY2010
4. Develop Disaster Preparedness and Restoration Plan FY2006-FY2007

## **Engineering/Planning**

1. Finalize and monitor 5-year strategic plan FY2006
  2. Conduct studies for renewable energy systems FY2006 thru FY2010
  3. Develop feasibility study regarding propane service FY2006
  4. Conduct feasibility study about Broad Band Service over power lines FY2006
  5. Conduct feasibility and engineering studies regarding Waste Heat Recovery Central Chiller Air Conditioner system. FY2006 – FY2007
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## **ENVIRONMENTALLY PROACTIVE**

1. KUA will maintain an awareness and commitment to be good stewards of the environment.
  2. KUA will seek new power production systems that will give consideration to reduction of greenhouse gases, improve efficiencies and reduce pollutants.
  3. KUA will seek systems that further the concept of a sustainable environment but will appropriately balance the ideal with that which is financially justifiable and affordable in the Kosrae community of customers
  4. KUA will review its power plant operation for environmental risks and take appropriate action to minimize risks.
  5. Transformers, oil storage tanks, power plant and vehicle fluids, and other possible environmental contaminants will be monitored.
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## **ECONOMIC DEVELOPMENT**

1. KUA will work with State of Kosrae officials for economic development in Kosrae.
  2. KUA will consider special, temporary incentive rates for businesses and industries to encourage location of new companies in Kosrae that will offer employment for Kosrae citizens.
  3. KUA will consider adjustments to extension policies that would encourage new industries to locate in Kosrae.
  4. KUA will explore new business functions that may relate with KUA's primary purpose, if such new business functions are determined to be an appropriate function of KUA.
  5. KUA will continue be willing to provide water and wastewater utility services for selected areas of KUA but will defer to the State of Kosrae for directives regarding providing such service.
  6. KUA will explore the feasibility, desirability and grant funding to provide district cooling for buildings near the KUA power plant using a central chiller plant powered either by a waste heat recovery system at the power plant or by mechanical electric drive chiller.
  7. KUA will explore the reactivation of the central refrigeration facility located at the KUA power plant site.
  8. KUA will consider the feasibility and desire of Kosrae citizens of providing bottled propane fuel for Kosrae.
  9. KUA will consider the feasibility and desire of Kosrae citizens and business for KUA to install and maintain solar hot water heaters that can help reduce customers' dependence on electric hot water heating.
  10. KUA will consider the feasibility and desire of Kosrae for KUA to share high speed internet and communication systems over a "Broad Band Over Power Line" system.
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## **SHARING**

1. KUA, due to the nature of its business, occasionally has equipment, personnel, and training capability that may be helpful to other KUA governmental entities; therefore, KUA will offer use of such equipment and capabilities when possible. KUA's first responsibility is to the KUA customers but KUA will be open to share selected capabilities when possible without provided it does not create a burden on KUA's customers.
2. KUA will analyze opportunities to share computer servers, communication systems, specialized vehicles and equipment, test equipment and various mechanical systems without creating a burden on KUA customers.
3. KUA will also analyze and make available, if possible and appropriate, technical personnel if the personnel can be shared without interfering with KUA's primary business of providing good service to KUA customers.
4. KUA will explore opportunities to share its capability to be of service to Kosrae in business areas other than the electric utility service business when asked to provide such services by the citizens and the State of Kosrae.

## **PARTNERSHIPS**

1. KUA will develop good working relationships with various partners involved in the providing of service and assistance to KUA customers.
2. KUA will continue to seek good working alliances with the many product and service vendors who do business with KUA.
3. KUA will work closely with U.S. Governmental agencies such as DOI, RUS, FEMA and others involved in services, grants and loans to KUA.

4. KUA will continue working on developing good working relationships with Pacific Rim nations interested in providing support for Kosrae.
  5. KUA will search out organizations who have interests in providing services, loans, grants, or aid to KUA and Kosrae
  6. KUA will work with neighboring utilities and such organizations as the Pacific Power Association, South Pacific Secretariat, European Union, etc. that have interests in supporting KUA and Kosrae.
  7. KUA will continue to work on developing good working relationships with local businesses, governmental entities, organizational groups and other parties that have mutual interests in KUA service issues and improving the quality of life of Kosrae.
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## **EXCELLENCE & PROFESSIONALISM**

1. KUA will develop programs and policies that will seek to attract high quality personnel to KUA's workforce.
2. KUA will provide training to assure that the KUA work force is well trained in all aspects of their work responsibilities, supervisory, managerial, policy development, and interpersonal relationship skills.
3. KUA will develop policies that will assure equal opportunity to diverse elements of the Kosrae population for employment, training and promotion.
4. KUA will continue to assure that all members of the KUA staff and Board exhibit a sense of motivation in their respective responsibilities, solid knowledge of their respective work activities, professionalism in their work and interrelationships, and a desire for continued learning to improve their skills.

5. KUA Board will develop educational and developmental programs to help educate new board members on the complexities of the electric utility business.
6. KUA Board will review and conduct training sessions to assure that they are meeting their responsibilities according to Kosrae state law and in a professional manner.
7. KUA Board deliberations and actions on KUA issues will be open for public input and review, unless the matters are legally defined as items that must be reviewed in closed session.

## **QUALITY OF LIFE**

1. KUA will work to improve the quality of life in Kosrae.
2. KUA will strive to conduct its business affairs in a manner that will add to the quality of life in Kosrae.
3. KUA will strive to avoid actions, plans, construction of facilities and operations of the electrical system that might detract from quality of life for the public in general and for individual residences and customers specifically.
4. In cases where quality of life for a specific party might be impaired by a construction project or operation of the electric system, KUA will use caution in considering such actions and proceed only when the service is necessary for the common good of all Kosrae citizens and KUA.

# **Federated States Of Micronesia** **Infrastructure Development Plan** **(IDP)**

The FSM developed an Infrastructure Development Plan in 2003. Within the IDP are included several issues for consideration and some recommended actions regarding Kosrae's infrastructure, including the KUA electric system. The KUA Strategic Plan 2006-2011 has been developed with the IDP issues and recommendations included within the elements of the plan. The items addressed in the FSM IDP are listed below and a brief discussion of how they are being incorporated into the KUA Strategic Plan 2006-2011. Most of the IDP items are also included as part of the line item projects within other sections of the Strategic Plan. There are certain items, however, that the Strategic Plan is recommending either further review of the FSM IDP recommendation or an explanation included herein regarding KUA's suggestion that the IDP recommendation be reevaluated by the FSM.

## **FSM INFRASTRUCTURE DEVELOPMENT PLAN PROGRAMS**

*Funding has been targeted for Kosrae in the FSM Infrastructure Development Plan as follows:*

- *Power Plant rehabilitation – FY2007 - \$107,000*
- *Power Plant rehabilitation – FY2009 - \$387,000*
- *Distribution System Improvements \$1,139,000*
- *Office/Systems/Metering \$3,127,000*

### **Strategic Plan Response (1)**

The Power Plant rehabilitation program for FY2007 and FY2009 is included within the Power Production segment of the Strategic Plan.

The Distribution system Improvements in the amount of \$1,139,000 has been incorporated as part of the line extensions for the Cross Island Road and the power line extensions from Utwe to Walung and from Okat to Walung.

The Office/Systems/Metering is included as part of the effort to provide “Cash Power” meters for most of the KUA customers, plus update of a billing system, and other system improvements.

It should be noted that the cost estimates provided at the time the FSM IDP being developed may be different than estimates developed at the time of preparing this Strategic Plan since conditions, priorities and scope of anticipated projects may have changed.

### **FSM Infrastructure Development Plan Goal #2**

- *Manage Government infrastructure within fiscal realities and encourage private sector involvement.*

### **Strategic Plan Response (2)**

KUA is presently being operated within fiscal realities of fuel costs, maintenance and personnel costs and in appropriate time plans to resume collection of funds for capture of capital investment (depreciation) in the KUA facilities when economic conditions is Kosrae improve. Private sector involvement is difficult in KUA due to its small size and remote location from similar utilities. In a study performed by the Asian Development Bank in 2001, it was determined that the KUA system was being operated in a fiscally sound manner and that privatization was not recommended. The management principles and fiscal care of KUA has remained consistent since 2001, therefore major private sector involvement is not contemplated at the present time. KUA will continue to search for was to involve the private sector in subcontracting out elements of peripheral operations and maintenance work plus certain office and engineering functions where such outsourcing will be advantageous to KUA and its customers.

- 
- *Provide quality career education programs for top management.*
  - *Develop ongoing management training programs*
  - *Arrange for within industry management training in collaboration with private sector*

### **Strategic Plan Response (3)**

KUA has included categories within the Strategic Plan for “quality career education programs for top management.” KUA is presently providing a limited amount of such career education via the work with the Pacific Power Assn. and similar organizations.

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- *Establish action plan for continuous review of privatization programs.*
- *Establish incentive programs to encourage and facilitate privatization corporatization.*
- *Arrangements made by Public Utility Corporations for leasing and sale of all equipment by 2008*

#### **Strategic Plan Response (4)**

See response (2) above. KUA recognizes the benefits of private sector involvement and will continue to search for areas where the private sector can provide a service at less cost and with more reliability than KUA's personnel. However, at the present time, the ability to earn a return on investment is very limited with the KUA system. KUA at present is not even able to recover the depreciation on already invested assets due to the very limited economic resources of the citizens, business and government customers of KUA. KUA earns no return on assets invested. Since it appears unlikely that the private sector could significantly increase the efficiency of the power production facility or purchase fuel at a significantly lower cost than KUA (which is the majority of KUA costs) it would appear that privatization of KUA at the present time would result in a higher and not a lower cost of electric service for the customers of KUA and would result only in a very limited change in the reliability of electric service.

- 
- *Establish users fee legislation to promote cost recovery for infrastructure operations*
  - *Establish reliable and effective collection and enforcement procedures.*

#### **Strategic Plan Response (5)**

KUA has established user fee rates to provide for the cost recovery for infrastructure operations. As mentioned in Strategic Plan Response(2) above, KUA has set rates to include all operating costs. Plans had previously been in place to include a "ramp up" of electric rates to include depreciation, however, this Strategic Plan is has included a reprieve schedule for implementation of the

“ramp up” rates for depreciation for a period of 3 years to allow economic development programs within Kosrae to provide better income for Kosrae citizens to be able to pay the full cost of the KUA infrastructure. KUA believes that this reprieve can be implemented without undue negative effect on the KUA financial structure since the electric loads of KUA have been declining and therefore usage on the engines have been lessened so that replacement of the generating units can be extended. Also, infrastructure funds have continued to be made available to KUA via FEMA and the compact, which has reduced the need for utilizing internally generated funds for such capital expenditures as power line extensions and substation replacement.

KUA has implemented a very effective collection program for the collection of the electric billings. The most successful program has been the installation of “Cash Power “ meters on a majority of the residential customers. This program allows customers to pay in advance for service with cash and after entering a code in a read-out device at their home, they can closely monitor their usage and the remaining funds available. The program has been well received and had been very effective in reducing accounts receivable.

- 
- *Create a permanent public utility corporation board of director’s short course developed by COM-FSM by 2005.*
  - *Responsibility for water sector in Kosrae to be transferred to KUA by 2004.*

#### **Strategic Plan Response (6)**

KUA will work with other FSM State Utility systems to assist in the development of the Utility Board of directors Short Course at COM-FSM. KUA has expressed receptiveness to assuming the responsibility of providing water and wastewater services but State of Kosrae has not yet decided to transfer that responsibility to KUA. The Strategic Plan addresses the issue and recommends a review of the transfer of certain segments of the water and wastewater systems as the State may determine is appropriate.

- *All construction and maintenance force account work outsourced by Public Utility Corporations by 2008*

#### **Strategic Plan Response (7)**

The Strategic Plan includes provisions for KUA to continuously review work activity that can be outsourced to the private sector. However, there is a very limited private sector capability in Kosrae for much of the construction and maintenance work performed on the KUA system. Therefore the Strategic Plan recommends that reviews be made on projects but also that the KUA construction and maintenance personnel review all aspects of their work practices to assure efficiency and quality work.

- *Circumferential roads in - - - - - and Kosrae.*
- *Cross-Island roads in Kosrae and Yap completed by 2008*
- *Improvements to all four state hospitals.*
- *New high schools constructed in - - - - and Kosrae.*
- *Upgrade power systems to provide sufficient power to all citizens.*
- *Identify feasible alternative fuel sources for electricity generation.*

#### **Strategic Plan Response (8)**

KUA has included the extension of power lines around the circumferential road and the extension line for the cross-island road in the Strategic Plan. The Strategic Plan also anticipates the construction of a new hospital (and a new high school) in Kosrae and recommends that energy issues be taken into consideration in the design and that consideration be given to using a central chilling plant in coordination with KUA. The Strategic Plan addresses the extension of power lines to serve all Kosrae citizens and businesses. The Plan also has extensive sections on the identifying feasible alternative fuels and cheaper fuel and alternative energy sources. It will be necessary to do additional review, study and analysis to determine alternative energy sources that may be feasible.

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- *Improvement of existing facilities given priority during first five years of IDP before new facilities are constructed.*
- *Establish and prioritize investments in infrastructure development in order to ensure viability and sustainability.*

**Strategic Plan Response (9)**

KUA has included improvements to the various power lines, substation, power plant and support systems early in the Strategic Plan before new projects are included.

KUA has included Objectives (goals) of prioritizing infrastructure development within the Strategic Plan as requested in the FSM IDP. KUA has also set rate tariffs such that KUA is a viable entity with sustainability.

- *New building and other related regulations and codes of good practice strengthened and adopted.*

**Strategic Plan Response (10)**

The Strategic Plan addresses the need for building codes as it relates to energy efficiency. KUA follows U.S. Electric Code standards in the construction of its power facilities and will follow standard building codes for any structures. The Strategic Plan addresses the adherence to standards such as environmental standards and the Plan commits to following such standards.

# APPENDIX A

## COSTS FOR DISTRIBUTION LINE EXTENSIONS

### KOSRAE UTILITIES AUTHORITY

<b>LINE EXTENSION PROJECTS BUDGETARY ESTIMATES</b>
--

**1 CROSS ISLAND ROAD**

LENGTH OF LINE :      APPROXIMATELY      15,000 FT      OR APROX. 3 MILES

TYPE OF CONSTRUCTION      THREE PHASE (WOODEN POLE CONSTRUCTION)

ESTIMATED COST:      **3 MILES X \$105,000**      **\$315,000.00**

<b>TARGET CONSTRUCTION DATE:</b>	<b>FY 2008</b>
----------------------------------	----------------

**2 TAFUNSAK TO WALUNG (RS-4 ROAD)**

LENGTH OF LINE:      APPROXIMATELY      32,000 FT      OR 6 MILES

TYPE OF CONSTRUCTION      THREE PHASE (WOODEN POLE CONSTRUCTION)

ESTIMATED COST      **6 MILES X \$ 105,000.00 =**

<b>\$630,000.00</b>
---------------------

<b>TARGET CONSTRUCTION DATE:</b>	<b>FY 2008</b>
----------------------------------	----------------

**3 TAFUNSAK THREE PHASE INTERCONNECTION**

LENGTH OF LINE :      APPROXIMATELY      2,300 FT      OR 0.43 MILE

TYPE OF CONSRTRUCTION :      THREE PHASE (WOODEN POLE CONSTRUCTION)

ESTIMATED COST:      **.43 mile X \$105,000**      **\$45,150.00**

<b>TARGET CONSTRUCTION DATE:</b>	<b>FY 2007</b>
----------------------------------	----------------

**4 MALEM INTERCONNECTION (INNER ROAD)**

LENGTH OF LINE : APPROXIMATELY 2,600 FT OR 0.5 MILE

TYPE OF CONSTRUCTION SINGLE PHASE (WOODEN POLE CONSTRUCTION)

ESTIMATED COST: 0.5 MILE X \$ 39,000.00 = \$19,500

Est. 

<b>\$20,000</b>
-----------------

<b>TARGET CONSTRUCTION DATE: FY 2007</b>
--

**5 LELU ISLAND DISTRIBUTION UPGRADE**

LENGTH OF LINE: APPROXIMATELY 1.4 MILES FOR THREE PHASE AND 0.85 MILE FOR SINGLE PHASE

TYPE OF CONSTRUCTION : THREE PHASE (FIBERGLASS POLE CONSTRUCTION) SINGLE PHASE (WOODEN POLE CONSTRUCTION)

ESTIMATED COST:  
THREE PH. LINE: 1.4 MILES X \$ 150,000.00 = \$210,000

SINGLE PH. LINE: 1.0 MILE X \$ 39,000.00 = \$39,000

TOTAL \$249,000

Est. 

<b>\$250,000</b>
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<b>TARGET CONSTRUCTION DATE: FY 2007</b>
--

**6 OKAT ROAD UPGRADE (FROM SINGLE PHASE TO THREE PHASE) /INTERCONNECTION TO CROSS ISLAND ROAD (RS-3 ROAD)**

LENGTH OF LINE: APPROXIMATELY 2 MILES

TYPE OF CONSTRUCTION THREE PHASE (WOODEN POLE CONSTRUCTION)

ESTIMATED COST: 1 MILE X \$ 105,000.00 

<b>\$210,000</b>
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<b>TARGET CONSTRUCTION DATE: FY 2008</b>
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The following Appendices are included as background information for the various alternative energy systems and other technologies that KUA plans to investigate in an attempt to lower energy costs and for selecting other services that may be appropriate for KUA to provide.

## **APPENDIX B**

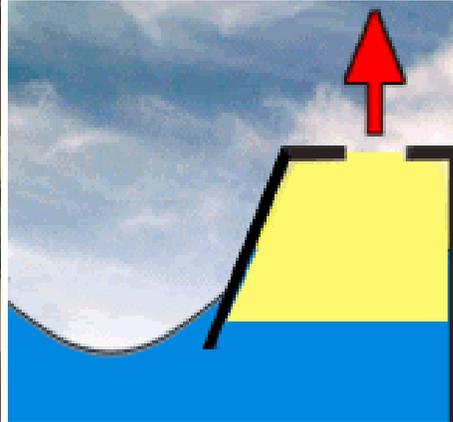
### **Wavegen Coastal Wave Turbine**

A Scottish firm, Wavegen, has developed small power module for incorporating into breakwaters, coastal defenses, land reclamation schemes and harbor walls. It captures the energy of coastal and breaker wave energy in an air chamber. As the waves rise and fall they drive air in and out of the chamber which flows across a turbine that drives an electrical generator.

They presently have a 18.5 kW power modules consisting of a Wells Turbine, valve and noise attenuator. The complete module weigh less than a ton so installation or removal is easily achievable using a small crane. The modules are very simple and rugged: the blades are fixed onto the rotor, have no pinching mechanism, no gearbox and have no contact with seawater.

According to David Langston, Wavegen's Business Development Manger, the economics of the approach is very favorable. The Turbines are the fifth generation of Wells turbines and incorporate all the learning and cost reduction experience from previous designs and operational experience gained from the an installation at Limpet, England.

Wavegen is currently in discussion with a number of European port authorities interested in installing this technology.



Wavegen's Turbine for an 18.5 kw generator and air chamber technology



WaveGen's Wave Driven Air Turbine Project

# **APPENDIX C**

## **Marine Current Turbines**

Marine current turbines work, in principle, much like submerged windmills, but driven by flowing water rather than air. They can be installed in the sea at places with high tidal current velocities,

resource which is mostly as predictable as the tides that cause them, unlike wind or wave energy which respond to the more random quirks of the weather system. The technology under development by MCT consists of twin axial flow rotors of 15m to 20m in diameter, each driving a generator via a gearbox much like a hydro-electric turbine or a wind turbine. The twin power units of each system are mounted on wing-like extensions either side of a tubular steel monopile some 3m in diameter which is set into a hole drilled into the seabed.

The submerged turbines, which will generally be rated at from 750 to 1500kW per unit (depending on the local flow pattern and peak velocity), will be grouped in arrays or "farms" under the sea, at places with high currents, in much the same way that wind turbines in a wind farm are set out in rows to catch the wind. The main difference is that marine current turbines of a given power rating are smaller, (because water is 800 times denser than air) and they can be packed closer together (because tidal streams are normally bi-directional whereas wind tends to be multi-directional).

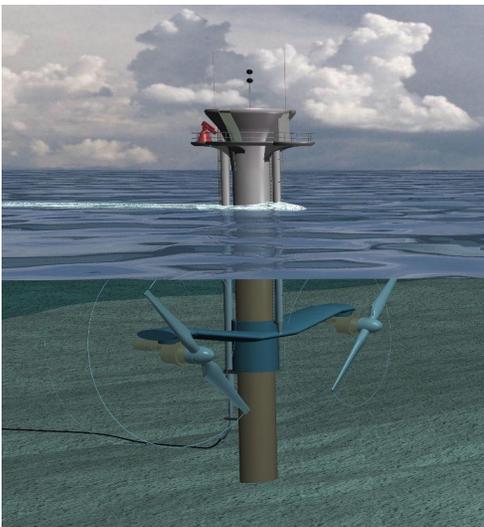
Environmental Impact Analyses completed by independent consultants have confirmed our belief that the technology does not offer any serious threat to fish or marine mammals. The rotors turn slowly (10 to 20 rpm) (a ship's propeller, by comparison, typically runs 10 times as fast and moreover our rotors stay in one place whereas some ships move much faster than sea creatures can swim). The risk of impact from our rotor blades is extremely small bearing in mind that virtually all marine creatures that choose to swim in areas with strong currents have excellent perceptive powers and agility, giving them the ability to successfully avoid collisions with static or slow-moving underwater obstructions.

Another key advantage of MCT's technology as a future large scale generating technique is that it is modular, so small batches of machines can be installed with only a short period between investment in the technology and the time when revenue starts to flow. This is in contrast to large hydro electric schemes, tidal barrages, nuclear power stations or other projects involving major civil engineering, where the lead time between investment and gaining a return can be many years

The technology for placing monopiles at sea is well developed by Seacore Ltd., a specialist offshore engineering company (and MCT's largest shareholder) which is co-operating with MCT in this work. The patented design of our turbine is able to be installed and maintained entirely without the use of costly underwater operations. A unique, patented feature of MCT's technology is that the turbines and accompanying power units can be raised bodily up the support pile clear above sea-level to permit access for maintenance from small service vessels. This is an important feature because underwater intervention using divers or ROVs (Remotely Operated Vehicles) is virtually impossible in locations with such strong currents as are needed for effective power generation. The artist's impression indicates a row of turbines and shows one raised for maintenance from a small workboat.

It is expected that MCT's turbines will generally be installed in batches of about 10 to 20 machines. Many of the potential sites so far investigated are large enough to accommodate many hundreds of turbines. It is worth noting that as a site is developed, the marginal cost of adding more turbines and of maintaining them will decrease, so considerable economies of scale can be gained as the project grows.

The design life for MCT's tidal turbines will exceed 20 years and we believe the main monopile support structure can be designed to survive for many decades (the track record of steel offshore structures, providing they are properly protected, is excellent - many offshore oil and gas structures have lasted upwards of 40 years). The steel pile and other main structural elements in an MCT tidal turbine have cathodic protection and the rotor is constructed from glass and carbon fibre reinforced composite materials which are not significantly effected by contact with seawater.



# **APPENDIX D**

## **Fuel Cells –Propane or Diesel Fueled**

FuelCell Energy Inc. (NasdaqNM:FCEL), a leading manufacturer of ultra-clean electric power generation plants for commercial and industrial applications, has announced it has successfully incorporated design changes to the 250-kilowatt (kW) Direct FuelCell(R) (DFC(R)) power plant resulting in a 25 percent cost reduction as previously announced. This is part of FuelCell Energy's rolling three-year cost-out program that targets a 20-25 percent cost reduction per year.

In addition to reduced capital costs, the DFC300MA power plant -- the new name for the sub-megawatt unit -- is expected to result in lower routine maintenance expenses thanks to its modular three-piece design. This modular architecture, with separate skids for the mechanical balance of plant, electronic balance of plant and the DFC module, is expected to enhance serviceability due to greater accessibility for each component.

"Experience with our fleet of DFC power plants at global customer sites, including feedback specific to existing customer applications, provided us with a rich source of data for driving top-to-bottom improvements," said R. Daniel Brdar, FuelCell Energy's Chief Operating Officer. "We've evaluated every step on an ongoing basis, from initial construction, testing, conditioning, delivery, installation and serviceability that has enabled us to improve the quality and lower costs of our ultra-clean DFC products."

Additional improvements in the DFC300MA power plant include modifying certain subsystems, so parts and materials may be sourced from multiple vendors, and automating the fuel cell conditioning process resulting in higher product quality. The design enhancements to the Company's sub-megawatt DFC power plant will extend to the megawatt (MW) plant design as well.

After final verification, the DFC300MA power plant will begin shipping in the fourth calendar quarter of 2005. The unit is expected to be certified by CSA International, a world-leading certification and testing organization to meet requirements for California and other markets, and also expected to be certified for the emission standards set by the California Air Resources Board's (CARB) stringent distributed generation emissions standards for 2007.

DFC power plants generate electricity without combustion. Their highly efficient electrochemical reactions are thousands of times cleaner than plants burning fossil fuels, and are significantly quieter. These characteristics make fuel cell power appropriate for generating base load electricity where customers face cost, reliability, security or environmental issues with their existing electric power sources -- in settings that include municipal/industrial wastewater treatment facilities, telecommunications/data centers, hotels, universities, manufacturing plants, hospitals, prisons, federal buildings and grid support applications.



**A 250 Kw Fuel Cell in Los Angles**

# **APPENDIX E**

## **Community Broadband**

There is a potential in Kosrae to install broadband over power lines (BPL) to bring high-speed Internet access to any power outlet. Utilities in mainland U.S.A. are conducting tests of the BPL that demonstrate its value to internal utility applications such as monitoring, control and protection of the electric grid.

BPL combines the principles of radio, wireless networking and modems to send data over power lines and also into homes at high speeds. BPL can be used by the utility for such functions as outage management, automated connect-disconnect, load control, automated meter reading, and customer access to a utility's Web site.

A Broadband over Power Line uses a radio system, similar to KUA's existing mobile radio system, to transmit from a base station to receivers-transmitters located on power line poles at various locations around the electric utility system. The radio signals are line of sight. Therefore, relaying transmitters may have to be used to get the radio signal from the base station around the mountain areas to all of Kosrae. The receivers located on the power poles download the Internet or communication signals from the base unit and inject the signal onto the 120-240 volt power line that goes into the customer's home, business or government office. A receiver device is plugged into the wall socket of the home, and the signal is tapped off of the power line and fed into the computer or communication device. The speed of the signal is very fast, much faster than telephone modems. BPL operates on the standard Internet Protocol (IP) signal and it can be hooked up to any computer, communications, and video or data system. The units can be easily installed by line workers and can be accessed across the Internet with an IP address.

The BPL has the ability to provide broadband services to residents in remote areas at a much lower cost than other means.

# **APPENDIX F**

## **Absorption Refrigeration Systems**

One means of extracting energy from the waste heat of the Diesel engine exhausts, radiator and oil cooling systems is with ammonia water absorption refrigeration equipment. The process involves a binary ammonia-water solution, which requires absorption of ammonia vapor from a refrigeration evaporator, and the ammonia-rich solution is regenerated through distillation driven by waste heat input to the distillation reboiler.

Absorption units are well suited for extracting waste heat from the higher temperature exhaust gases of a diesel engine. The Adsorption type units (See Appendix on Adsorption) are better suited for extracting waste heat from radiator and oil cooling systems of a diesel engine. Absorption systems also provide the opportunity to provide refrigeration down to well below freezing temperatures, whereas the Adsorption system is limited to providing temperatures down to approximately 26 to 38 degrees Fahrenheit.

The capital cost of an absorption unit for 250 tons of OoF refrigeration is estimated to be about \$250,000 installed. This would replace about 200-plus tons of existing air conditioning units.

# **APPENDIX G**

## **Adsorption Chillers**

The Adsorption Chiller is simple in design. It uses silica gel, a substance similar to the desiccant crystals used to keep down humidity in a shipping container, and water contained in their respective high vacuum chambers. Operation of the chiller is also simple. It contains only

Water as a refrigerant and a proprietary permanent silica gel (that lasts 30 years) as an adsorbent. The evaporation section cools the chilled water by the refrigerant (water) being evaporated by adsorption of the silica gel in one of two adsorption chambers. The water vapor released from the silica gel by the hot water will be condensed in the condenser section, which is cooled by cooling water such as from a cooling tower. A programmed sequencing controller controls the operation.

The Adsorption system requires a minimum number of skilled operators. Additionally, operation is safe because there is no refrigerant, oil or other chemicals used in the system. Maintenance is simple and inexpensive. No daily maintenance is required.

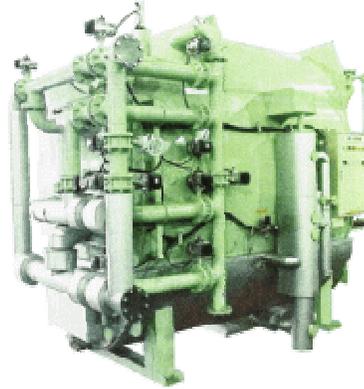
Recommended range for the hot water from the diesel engine radiator and oil cooling system is from 194 to 122 F. Heat from the diesel engine exhaust can be used but the 350 degree plus exhaust heat can not be fully recovered since the ideal input water temperature for the adsorption system is below 200 degrees F. Adsorption systems are best for capturing the higher exhaust temperatures of the diesel engine. Hot water temperatures should not be above 194 degrees F because of the possibility of the water flashing and surging from suction of the pump. Even with hot water temperatures as low as 122 degrees F, the Coefficient of Performance (its measure of efficiency) is reduced, but the chiller can still operate.

# **NISHIYODO ADSORPTION CHILLERS**

## **Waste Heat Adsorption Chiller**

**C E ROGERS**

The *Adsorption Chiller* contains only water as a refrigerant and a proprietary, permanent silica gel (lasts 30 years) as an adsorbent. The evaporator section cools the chilled water by the refrigerant (water) being evaporated by adsorption of the silica gel in one of two adsorbent chambers. It can produce chilled water temperatures of less than 38 F with hot water temperatures ranging from 194 F to as low as 122 F. The hot water regenerates the silica gel in the second of the two adsorbent chambers. The water vapor released from the silica gel by the hot water will be condensed in the condenser section which is cooled by a cooling water, such as, from a cooling tower.



The *Adsorption Chiller* has very low operational costs. The chillers electrical load of just 0.4KW, for the 100 ton model, is for the controls and a two small pumps. One is a vacuum pump for non-condensables and the other is a refrigerant (water) pump that runs only while unloading. Other operational costs such as maintenance are also very low.

## **Highlights**

### **Stable Chilling Capacity**

It remains unaffected not only by fluctuations in temperature, but also by variation of the flow rate. For example, if the flow rate decreases by 50%, the Cooling Capacity holds 93%!

### **Less than 77F Cooling Water is OK**

Unlike standard absorption chillers use, that use Lithium Bromide as an absorbent that will crystallize at 77F the *Adsorption Chiller* has no cooling water temperature limitation, the lower the cooling water temperature the greater the cooling capacity

### **Fast Start Up**

Operating temperature is achieved in just 6 minutes from start up. Compared to standard absorption chillers that take 30 or minutes or more to achieve operating temperature

### Simple Design - Minimal Maintenance

The structure of this adsorption chiller is very simple - the silica gel absorbent, and the refrigerant water contained in high vacuum chamber. It does not require a skilled operator. The maintenance of this machine is very simple: exchanging the butterfly valve seat every 3 years, and changing the oil of the vacuum pump.

### Environmentally Responsible

1. No chemicals are used in this system. No Lithium Bromide mixed with rust inhibitors to be treated as hazardous waste disposal problem. The heat exchanger has an excellent corrosion resistance assuring a high degree of safety and stable operation.
2. Water used as refrigerant, no freons, no Li-Br, no ammonia means : No hazardous leaks, no corrosion, no chemical testing, no replacement, No hazardous waste disposal problems
3. No compressor means: No alignment, no high voltage, no high pressure, no overhaul, no oil change, no surging, no vibration or noise
4. Stable chilled water out-put driven by a wide range (194 to 122oF) of hot water
5. Capacity out-put remains stable as in-put fluctuates. No back up burner required
6. Simple and short start up / stop time
7. 38 F of chilled water is in the standard specification
8. Constant operation - 24 hours / 7 days a week

### **... ABSORPTION CHILLERS, .**

The products have been pioneered by our group company  
Kawasaki Thermal Engineering Co., Ltd.

[http://www.khi.co.jp/corp/ksc/eg/products/p\\_01\\_14.html](http://www.khi.co.jp/corp/ksc/eg/products/p_01_14.html)

[www.khi.co.jp](http://www.khi.co.jp)

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## Adsorption Systems

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Adsorption, the binding of molecules or particles to a surface, must be distinguished from *absorption*, the filling of pores in a solid. The binding to the surface is usually weak and reversible. Just about anything including the fluid that dissolves or suspends the material of interest is bound, but compounds with color and those that have taste or odor tend to bind strongly. Compounds that contain chromogenic groups (atomic arrangements that vibrate at frequencies in the visible spectrum) very often are strongly adsorbed on activated carbon. Decolorization can be wonderfully efficient by adsorption and with negligible loss of other materials.

The most common industrial adsorbents are activated carbon, silica gel, and alumina, because they present enormous surface areas per unit weight. Activated carbon is produced by roasting organic material to decompose it to granules of carbon - coconut shell, wood, and bone are common sources. Silica gel is a matrix of hydrated silicon dioxide. Alumina is mined or precipitated aluminum oxide and hydroxide. Although activated carbon is a magnificent material for adsorption, its black color persists and adds a grey tinge if even trace amounts are left after treatment; however filter materials with fine pores remove carbon quite well.

A surface already heavily contaminated by adsorbates is not likely to have much capacity for additional binding. Freshly prepared activated carbon has a clean surface. Charcoal made from roasting wood differs from activated carbon in that its surface is contaminated by other products, but further heating will drive off these compounds to produce a surface with high adsorptive capacity. Although the carbon atoms and linked carbons are most important for adsorption, the mineral structure contributes to shape and to mechanical strength. Spent activated carbon is regenerated by roasting, but the thermal expansion and contraction eventually disintegrate the structure so some carbon is lost or oxidized.

Temperature effects on adsorption are profound, and measurements are usually at a constant temperature. Graphs of the data are called *isotherms*. Most steps using adsorbents have little variation in temperature

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## Adsorption Vs. Absorption ?

Why an Absorption Chiller does not work well in an unstable system.

Why the Adsorption Chiller works with unstable heat recovery.

<u>Comparison</u>	<u>Adsorption Chiller VS</u>	<u>Absorption Chiller hot water fired</u>
<b>Refrigerant</b>	Water	Water
<b>Adsorbent/Absorbent</b>	Silica gel Included	Li-Br \$ 1,200.00 / 30 gal.
<b>Vacuum Pump</b>	Yes (1 Hr/40Hrs)	Yes
<b>Refrigerant Pump (Water)</b>	Runs only when chiller unloads	Continuous
<b>Absorbent Pump</b>	N/A	Magnetic Continuous
<b>Automatic Valves</b>	Butterfly Valves	3 Way Control Valves
<b>Price</b>	Almost the same, but consider	installation cost and life cycle cost.
<b>COP</b>	0.7	0.7
<b>Cooling Tower Size</b>	Heat of rejection equals Cooling	Capacity plus amount Heat input
<b>Corrosion</b>		Strong

<b>Crystallization</b>	No	Yes
	N/A	Low temp. Cooling water Air leakage into the machine Power loss/ failure of dilution Malfunction of system control Failure of a pressure-reducing valve Loss of Heat source
		30 min.
<b>Warm up (Start)</b>		Yes 15 min.
<b>Dilution Cycle (Stop)</b>	0 / 7 min. after long Stop	Inhibitor w/Heavy Metal Check inhibitors' warning label
<b>Inhibitor</b>	N/A	
	No	7 to 9 years
<b>Chiller Life Expectancy</b>		4 to 5 years Hard to dispose of Li-Br because corrosion inhibitor is a heavy
	More than 30 years	\$1,200.00/30 gal. Bucket plus old Li-Br disposal fee
<b>Frequency of Replacement of adsorbent (silica-gel) and absorbent (Li-Br) change-out metal</b>	Not necessary	Should be considered due to corrosion problems
<b>Heat Exchanger replacement</b>	N/A	Needed at 185oF Add to installation cost (Users might notice the machine is being driven by the boiler/heater
<b>Back Up</b>	Not necessary	

<b>Boiler/Heater</b>		rather than the waste heat source)
		Shut down at 180oF or need back up
<b>Required Hot Water</b>	Operates down to 122oF	50% @ 176oF 0% @ 160oF N/A
<b>Temperature</b>	90% @ 176oF 70% @ 160oF 45% @ 122oF	Should be stable
<b>Input Condition</b>	Fluctuation no Problem	Need 3 way-control valve 75oF to 85oF
<b>Cooling Water</b>	The lower the temp the more capacity	\$ 2,000.00 valve + \$ 1,000.00 Control /add to installation cost
<b>Chilled Capacity control</b>	Built-in 7 step unloading	Need 3 way-control valve to by-pass return water extra cost of \$2,000.00 valve + \$1,000.00 Control /add to installation cost
<b>Chilled Water Temp.</b>	37.4oF is available as standard	48oF normal / 41oF for experimental applications
<b>Maintenance</b>	Vacuum pump oil level Butterfly Valves Seat (each 3 years)	Liquid analysis Pumps Controls Back Up Boiler Li-Br exchange Heat Exchanger

		exchange Air Leak (Almost all Absorption Chillers in hospitals and hotels are replaced with centrifugal chillers due to bothersome and expensive maintenance.)
<b>Trouble</b>	Mechanical	Chemical (Many mechanics do not understand chemical phenomenal problem.)
<b>Reliable</b>	Yes	No
<b>Pay back</b>	2 to 3 years	Doubtful



## **APPENDIX H**

### **Electric Drive Mechanical Central Refrigeration Systems**

Refrigeration technology has a long history, but with the evolution of environmental concerns the industry has had to make significant hardware modifications in recent years to accommodate the thermodynamics of the new refrigerants. These units can provide chilled fluids for central refrigeration systems much more efficiently than a series of small electric drive refrigeration systems located on individual refrigerated containers.

Such a system could be located at the KUA power plant and the existing building that at one time housed Kosrae's central chilled storage plant could be remodeled to again serve the purpose of furnishing an economical central chilled storage plant. This system could lower the cost to the many businesses now in Kosrae who own and maintain their own individual refrigerated containers.

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## **APPENDIX I**

### **Biomass Energy Systems**

Biomass is plant or animal matter. Using biomass, or fuels or wastes derived from biomass, as a source of energy entails burning it to yield heat that can then drive engines or generate electricity. The energy in biomass is chemical in nature; it does not suffer from the problem of intermittence that is inherent to wind and solar resources. In this respect, biomass more nearly resembles fossil fuels than it does other renewable energy sources. Indeed, geologists tell us that fossil fuels are simply fossilized biomass.

For most of recorded history, biomass was mankind's principal energy source, mainly in the form of wood used for cooking and heating and as foods to "fuel" human labor and beasts of burden. With the industrial revolution, fossil fuels captured this dominant role. Today biomass still accounts for 15% of worldwide primary energy consumption, but, significantly, the fraction is much higher in developing nations than in developed.

Perhaps the most important factor to remember about biomass' potential role in the energy sector is that, again unlike most renewables, stiff competition will always exist for both the biomass and the requisite land resource to grow it. This is often capsulated in the five "f's" of biomass usage: food, feed, fiber, forage, and fuel. Fuel -- growing biomass to burn it -- will normally be the least valuable on this list. Even among wastes derived from biomass, higher value applications may diminish their use as fuel: manures have value as fertilizers; waste paper can be recycled; cottonseed hulls find their way into oil drilling muds, wood chips into landscape mulches, restaurant greases into pet food.

Although many specialists have envisioned a role for biomass in which it is grown extensively and solely for fuel (energy crops), it is probable that this can only happen with at least some valued dual use or co-product derived from the crop.

Wastes generated by the forest products industry can include logging residues left behind after harvest as well as bark, wood chips, and sawdust generated at mills. In general, the wood wastes generated by modern mills are highly utilized; indeed, forest mills are the largest biomass energy users in the nation today, generating more than half of their large energy requirement on-site. In agricultural areas there is a potential for the cultivation of woody energy crops.

Urban sources of biomass may represent some of the best opportunities for increasing biomass' near-term presence in the energy mix. Wastes that would otherwise be land filled are a particularly good potential fuel source. Methane gas generated and captured at landfills is another important form of urban bioenergy. A final advantage of these wastes is that their supply is surprisingly reliable, much more so than agricultural commodities that fluctuates annually with the vagaries of markets and weather.

*Information from the Texas Renewable Energy Office*

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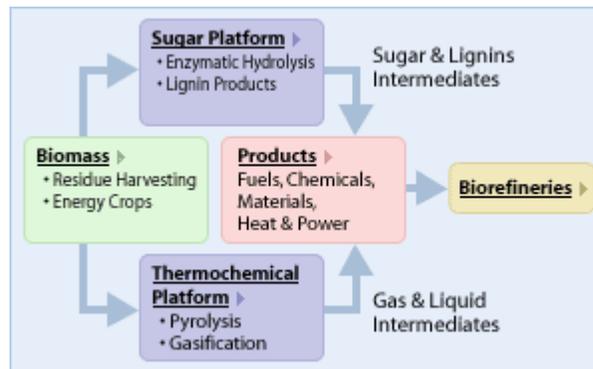
## **Biomass Program**

– U.S. Dept. of Energy

The U.S. Department of Energy (DOE) Biomass Program develops technology for conversion of biomass (plant-derived material) to valuable fuels, chemicals, materials and power, so as to reduce dependence on foreign oil and foster growth of biorefineries. Biomass is one of our most important energy resources. The largest U.S. renewable energy source every year since 2000, it also provides the only renewable alternative for liquid transportation fuel. Biomass use strengthens rural economies, decreases America's dependence on imported oil, avoids use of MTBE or other highly toxic fuel additives, reduces air and water pollution, and

reduces greenhouse gas emissions. Today's biomass uses include ethanol, biodiesel, biomass power, and industrial process energy.

Tomorrow, biorefineries will use advanced technology such as hydrolysis of cellulosic biomass to sugars and lignin and thermochemical conversion of biomass to synthesis gas for fermentation and catalysis of these platform chemicals to produce slates of biopolymers and fuels. To expand the role of biomass in America's future, the DOE Office of the Biomass Program fosters biomass technologies with a balanced portfolio of research and development. While there are various other technologies for biomass conversion, the following graphic shows those that the Biomass Program is concentrating on, as outlined in its Multi-Year Technical Plan ([PDF 62.3 MB](#)) or summary ([PDF 228 KB](#)). [Download Acrobat Reader](#).



## Biogas

### **Tech details of Biogas in Developing Asian Countries**

In many countries, dried manure is used as a cheap fuel in rural and also urban areas. Substantial numbers of trees can be saved because of this (Photo 53), and the ash from manure can be used as a fertilizer. However, this practice contributes significantly to increased air pollution, and much nitrogen goes up in smoke. In zero- grazing and other systems where animals are kept in small spaces, and where water and temperature are not limiting factors, dung can be used far more efficiently when it is processed through biodigesters, the effluent of which can be used as fertilizer. All types of organic material, including animal manure, can be processed through anaerobic digestion in a biodigester, and the technology requires only one large initial investment, after which it runs by itself. Gas, liquid and solid phases are produced. The gas can be used as fuel, and the liquid and solid parts as fertilizer. There are two main types of small-scale biogas digester:

batch fed, which are filled, then digest and then are emptied; and continuous load digesters, which are filled and produce gas and fertilizer continuously.

Despite the merits of biogas technology, biodigesters are widespread only in India (more than 5 million installations) and China (nearly 3 million installations). Recently, an ambitious programme in Nepal has been accelerating the market development of small bio digesters and, in many other countries, some practical experience of disseminating biodigester technology has been gained, often with the support of researchers (Photo 13). However, in most cases, larger-scale dissemination has not taken place, despite the economic, environmental and social benefits of the technology. The main reasons for this slow take-up seem to be that the multiple benefits of biodigesters have to be demonstrated to the end users in order to convince them to invest in the technology, and a market-driven institutional infrastructure needs to be in place to facilitate the large-scale dissemination of the technology.

**Types of digesters.** Among the small-scale and low-cost biodigesters, three basic designs can be distinguished: the floating-drum, also known as the "Indian design"; the fixed-dome, known as the "Chinese design"; and the flexible-bag digester. In general, a well-constructed fixed-dome biodigester has the longest life span, at 20 years or more. The floating-drum digester can have a comparable lifetime, but the recurrent costs are higher as the steel drums have to be replaced every five to ten years as a result of corrosion. The lifetime of the flexible-bag digester is difficult to indicate, as some do not last more than a couple of months, while others function satisfactorily for several years.

The gas pressure in the different designs also varies. Fixed-dome types are characterized by a varying but high pressure, with a maximum of about 1 000 mm of water pressure. The floating-drum design has a stable but lower pressure, at about 100 mm of water pressure; and the gas pressure in flexible-bag digesters is even lower. Users frequently prefer a higher gas pressure, as it is more comfortable to work with owing to the better control of the gas flame that it allows.

**Feedstock.** Many different organic materials can be fed into a biodigester. To allow the bacteria to do their work it is important that the organic matter be accessible to them. This means that pretreatment is sometimes necessary, e.g. through chopping and/or composting of crop wastes. The feedstock that is easiest to use is cattle dung, as it already contains the right bacteria and the vegetable matter has been broken down during its passage through the guts (and teeth) of the cow. Human excrement and manure from chickens and pigs are also useful,

but they do not contain the right bacteria and they need a starter in the form of, for example, slurry from a working biodigester.

Neither the feedstock nor the water used to dilute it before it goes into the digester should contain toxins that would kill bacteria (e.g. antibiotics, detergents and disinfectants). These stop the digestion process completely, a phenomenon that is known as "the digester going sour" because it gives off an unpleasant acidic smell. For example, the dung of cows that have received antibiotics should not be fed into the digester.

Cultural aspects might influence the selection of feedstock. For example, Hindus in India usually accept cow dung for use in biodigesters, while pig dung and human excrement are often not accepted.

### Waste management at different levels

Level	Problem	Solution	How to cope
Government	<ul style="list-style-type: none"> <li>• Water, soil, air pollution</li> <li>• Obstructed sewage systems</li> <li>• Public health</li> </ul>	<ul style="list-style-type: none"> <li>• Purification plants (expensive)</li> <li>• Reallocation of processing units</li> </ul>	<ul style="list-style-type: none"> <li>• Taxes and environment levies (on pigs in Singapore; Chark [FAO, 1998b])</li> <li>• Facilitate education and sensitization activities</li> </ul>
Producer, processor	<ul style="list-style-type: none"> <li>• Health problems</li> <li>• Decreased (farm) output and revenues</li> </ul>	<ul style="list-style-type: none"> <li>• Improved processing methods (blood recuperation, separation of solid and liquid parts, disinfecting)</li> <li>• Efficient utilization of by-products</li> </ul>	<ul style="list-style-type: none"> <li>• Education</li> <li>• Awareness raising</li> <li>• Support from NGOs and other organizations at the community level</li> </ul>
Consumer	<ul style="list-style-type: none"> <li>• Decreased quality of agricultural products</li> <li>• Smell</li> <li>• Decreasing recreation facilities</li> </ul>	<ul style="list-style-type: none"> <li>• Protest to neighbours</li> <li>• Complain at municipality</li> </ul>	<ul style="list-style-type: none"> <li>• Move to other areas</li> <li>• Ignore the problems</li> <li>• Community action</li> </ul>

**Biogas.** The principal uses of biogas are for household energy, such as cooking and lighting (Photo 54), but larger installations can produce sufficient gas to fuel engines, enabling the productive use of energy, e.g. for powering mills and water pumps. The efficiency of biogas production varies enormously. Different sources show ranges between 0.01 and 0.98 m<sup>3</sup>/kg manure. Besides environmental temperature and type of biodigester, efficiency is influenced mainly by the quality of the manure used.

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### **Small-scale biogas plants in India**

In a rural area of South India, the use of biogas instead of kerosene for cookers is promoted. The raw material used is cow dung, which is sufficiently available. The small biogas plants produce enough power per day to supply a family. In this way, the daily fuel demand of one litre of kerosene per family can be replaced.

Per year, the CO<sub>2</sub> emissions are reduced by a ton of CO<sub>2</sub> per biogas plant. The reduction of the flue gas emission and the lower heating costs are additional positive effects for the families. The investment costs amount to 12 dollars per ton of CO<sub>2</sub> saved.

# **APPENDIX J**

## **WAVE ENERGY CONVERTER**

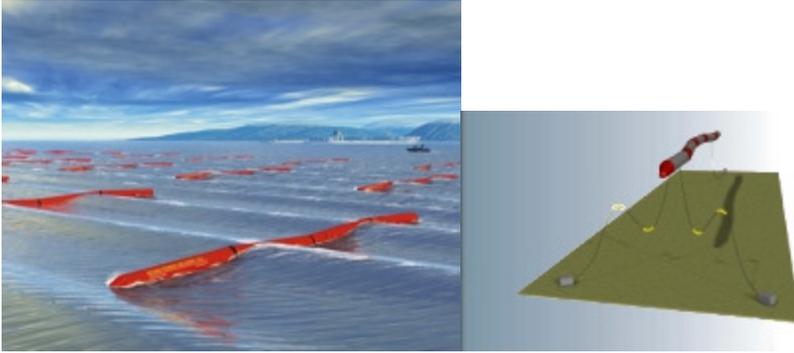
### The Pelamis Wave Energy Converter

The Pelamis is a semi-submerged, articulated structure composed of cylindrical sections linked by hinged joints. The wave-induced motion of these joints is resisted by hydraulic rams, which pump high-pressure oil through hydraulic motors via smoothing accumulators. The hydraulic motors drive electrical generators to produce electricity. Power from all the joints is fed down a single umbilical cable to a junction on the sea bed. Several devices can be connected together and linked to shore through a single seabed cable.

A novel joint configuration is used to induce a tuneable, cross-coupled resonant response, which greatly increases power capture in small seas. Control of the restraint applied to the joints allows this resonant response to be 'turned-up' in small seas where capture efficiency must be maximised or 'turned-down' to limit loads and motions in survival conditions. The machine is held in position by a mooring system, for which a patent has been applied for, comprising of a combination of floats and weights which prevent the mooring cables becoming taut. It maintains enough restraint to keep the Pelamis positioned but allows the machine to swing head on to oncoming waves. Reference is achieved by spanning successive wave crests. The 750kw full-scale prototype is 120m long and 3.5 m in diameter and will contain three Power Conversion Module, each rated at 250kW. Each module contains a complete electro-hydraulic power generation system.

Ideally the Pelamis would be moored in waters approximately 50-60m in depth (often 5-10km from the shore). This would allow access to the great potential of the larger swell waves but it would avoid the costs involved in a longer submarine cable; if the machine was located further out to sea.

Throughout the construction of the full-scale Pelamis, OPD has been working closely with WS Atkins who have independently verified the prototype design according to (DNV) offshore codes and standards.



OPD announces the signing of an order with a Portuguese consortium, led by Enersis, to build the first phase of the world's first commercial wave-farm. The initial phase will consist of three Pelamis P-750 machines located 5km off the Portuguese coast, near Póvoa de Varim. The €8m project will have an installed capacity of 2.25MW, and is expected to meet the average electricity demand of more than 1,500 Portuguese households. Subject to the satisfactory performance of the first stage, an order for a further 30 Pelamis machines (20MW) is anticipated.

# **APPENDIX K**

## **WIND POWER**

Wind power around the world is beginning to become competitive with fossil fuels in Europe, the U.S. and Asia. Systems now being built are of the 1 to 3 mw size and are mounted on towers 250 high. Most wind turbines require a wind speed of approximately 15 miles per hour to be effective. Two problems exist with attempting wind power in Kosrae; 1) Lack of sustained winds sufficient to drive the wind turbine; and 2) The lack of equipment such as cranes and other heavy equipment to install a very large tower required for even the 750 kw size turbines. In the U.S. and Europe, windmills are usually installed in wind farms consisting of dozens to a hundred or more wind turbines. The resulting number helps hold the cost of purchasing and installation down to a level that results in an energy cost in the 6 to 8 cents per kWhr range.

### **Wind Power – Small systems**

The small wind power systems are usually for individual businesses or homes. They are normally in the 10 kW size.

#### **Bergey GridTek System Information**

Small wind power units work cooperatively well with utility power. Often you will be getting some power from both the wind turbine and the power company. If there is no wind, the power company supplies all the power needed. As the wind turbine begins to work the power you draw from the power company is reduced ... causing your power meter to slow down. This reduces your utility bills. If the wind turbine is putting out exactly the amount of power your home needs, the power company's meter will stop turning. At this point you are not buying any power from the utility company. If the wind turbine produces more power than you need it is sold to the power company. In California your utility meter will actually turn backwards and the excess energy is effectively "banked" for your use later in the year. No changes in the household wiring are needed. It is very easy to add these systems to an existing home. The most cost-effective

systems do not have batteries and they can not supply power during utility power outages ([Bergey GridTek](#)). Systems that can supply back-up power during outages are available, but at a higher cost. For information on them click here ([Bergey Home.Sure](#)). We recommend the GridTek battery-less system in most situations where your home already has utility service. A typical 10 kW Bergey GridTek home wind energy system will cost \$40,000 - \$60,000 to install, depending on the tower option and various installation factors. Depending on the wind resource they will produce between 8,000 – 18,000 kWh per year. A home sized wind turbine is big: 21 foot blade diameter and a 80-120 foot tall tower. We recommend a minimum property size of 1 acre. Some areas do not have a sufficient wind resource. In general, we recommend a minimum wind resource of DOE Class 2. Here at our web site you can determine whether a Bergey wind system is feasible at your home or business ... and you can even learn how to buy it factory-direct and install it yourself!

## **METEROLOGICAL DATA FOR KOSRAE**

### **NASA Surface meteorology and Solar Energy**

*Latitude **5.5** / Longitude **163.5***

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**RETScreen Model(s) chosen:**

Wind Energy  
Photovoltaic

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**Geometry Information**

Average elevation: **0** meters

Northern boundary

**6**

Western boundary

**163**

Center

Latitude **5.5**  
Longitude **163.5**

Eastern boundary

**164**

Southern boundary

**5**

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<b>Average Temperature (° C) Mult. By 1.8 &amp; add 32 for Degrees F.</b>													
Lat 5 Lon 163	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	28.1	28.1	28.2	28.3	28.5	28.6	28.4	28.7	28.7	28.7	28.7	28.3	28.4

**Air temperature (Definition)**

Units: degrees Celcius

Note: 10 meters above the earth's surface

<b>Average Wind Speed at 50m (m/s)</b>													
Lat 5 Lon 163	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	6.42	6.16	6.03	5.37	4.86	4.22	3.46	3.40	3.59	3.38	4.36	5.39	4.71

*It is recommended that users of these wind data review the SSE Methodology, Section 7. The user may wish to correct for biases as well as local effects within the selected grid region.*

*All height measurements are from the soil, water, or ice/snow surface instead of "effective" surface, which is usually taken to be near the tops of vegetated canopies.*

**Wind speed at 50m (Definition)**

Units: meters per second (m/s) and percent (difference)

Notes:

- 50 meters above the earth's surface
- percent difference minimum and maximum

<b>Average Wind Speed at 10m (m/s)</b>													
Lat 5 Lon 163	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average	5.49	5.27	5.16	4.59	4.16	3.61	2.96	2.91	3.07	2.89	3.73	4.61	4.03

**To convert meters per sec. to Miles per Hour multiply m/s by 2.237**

*It is recommended that users of these wind data review the SSE Methodology, Section 7. The user may wish to correct for biases as well as local effects within the selected grid region.*

*All height measurements are from the soil, water, or ice/snow surface instead of "effective" surface, which is usually taken to be near the tops of vegetated canopies.*

Average Atmospheric Pressure (kPa)													
Lat 5 Lon 163	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10-year Average													100

#### Atmospheric pressure (Definition)

Units: kilopascals (kPa)

Note: 1 kPA = 10 mb = 1000 Pa

Average Daily Radiation on Horizontal Surface (kWh/m <sup>2</sup> /day)												
Lat 5 Lon 163	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10-year Average	4.76	5.40	5.41	5.49	5.09	5.01	5.24	5.61	5.49	5.50	4.87	4.92

#### Average Daily Radiation on Horizontal Surface (Definition)

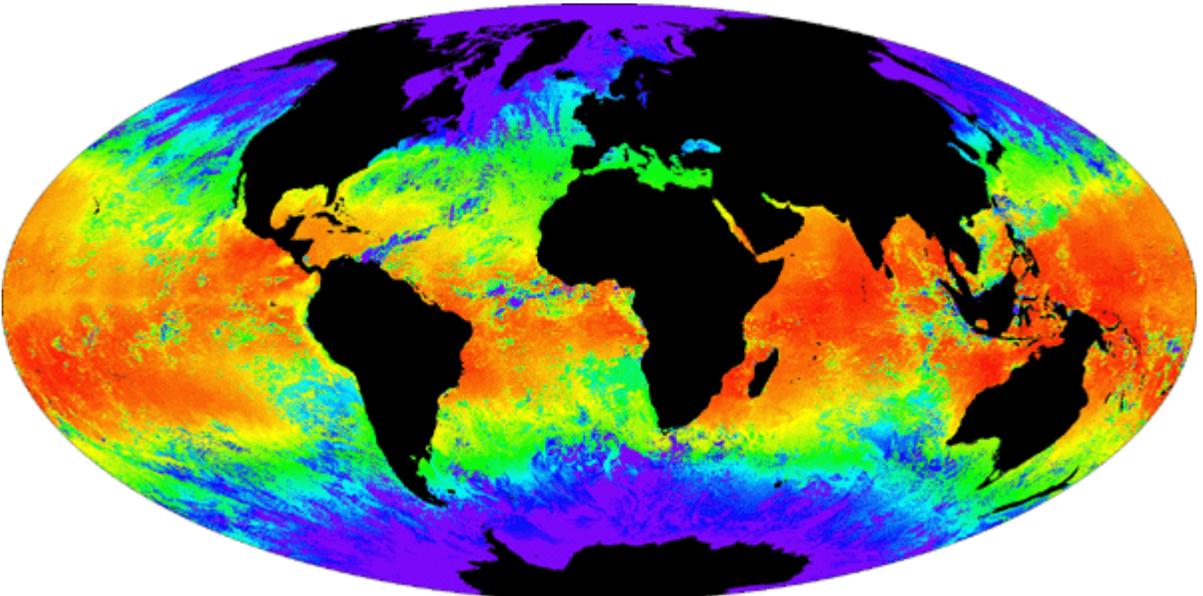
Amount of electromagnetic energy (solar radiation) incident on the surface of the earth.

Units: kWh/m<sup>2</sup>/day

**Note:** Avg. annual radiation is 62.79 kWh/sq.m/day or 584 kWh/100 sq ft/day



**WIND POWER FARM**



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**Wind Speeds Around the world Red = 0-12 mph, blue =15-25mph**

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# **APPENDIX L**

## **SOLAR**

Solar power alternatives unfortunately are not economically feasible at the present time for generating electricity when other alternatives or fossil fuels are available. KUA, with the help of a grant, built a two kW solar voltaic electric power system at the Utwe Marine Conservation site. The system worked well until a tidal wave flooded and damaged the batteries and control systems. The cost of that unit was \$21,000 or \$10,500 per kW of installed capacity. If KUA were to have purchased the unit and had to pay principle and interest on the debt representing the cost of the unit, and with a payout of 15 years with 5% interest, the annual cost would have been about \$2,000. If the unit could produce 100% of its 2000 watt capability for 12 hours each day the cost of energy just for repayment of the debt would be approximately 23 cents per kWh. At present, other alternatives and diesel fuel are more cost effective.

However, solar energy is very viable as a substitute for electric in the heating of water. The Strategic Plan explores possible opportunities for KUA to provide assistance to customers with installation and maintenance of solar hot water heaters as a substitute for using electric heat.

