



Palau Energy Conservation Strategy (PECS)

Strategies and Action Plans to Reduce Energy Consumption by Government

Provided to the Government of Palau through the
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FINAL REPORT

Philippe McCracken
Herbert Wade
Peter Johnston

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Preface

Executive Order 234 of 2005 mandated the Executive Branch of the Palau Government to reduce electricity and fuel use for government. The Palau Energy Conservation Strategy (PECS) provides strategies and practical action plans to support the Government in its effort to reduce its energy consumption as specified in the Executive Order. The mandated baseline against which to compare changes in governmental energy use is the average electricity and fuel consumption for 2004 and 2005. One person from each ministry has been appointed as an Energy Conservation Officer, and is responsible for energy-related matters within their ministry.

This final version of the proposed PECS incorporates changes resulting from Steering Committee inputs during the second and final PECS workshop held in Koror on August 2nd, 2007.

1. Introduction

- 1.1. Palau is the westernmost Micronesian country, 800 km east of the southern Philippines. Eighty percent of its approximately 21,000 inhabitants live in or around the largest urban center, Koror. Nearly all households and businesses in Palau are connected to the public electricity grid, resulting in an electrification rate that is close to 100%.
- 1.2. The government-owned Palau Public Utilities Corporation (PPUC) operates and maintains a national electricity grid that covers all islands except for the distant Southwest Islands that have photovoltaic (PV) power. The current national rate for electricity is US\$0.24 – \$0.26/kWh for government and business customers, the unit rate increases for high levels of monthly energy use (see Annex 9). An additional charge can be imposed for high kW demand based on the peak demand per month, but no government customers have been charged under this tariff schedule. PPUC electricity is generated solely by diesel generators with government diesel fuel prices slightly above \$0.63/liter in July 2007. Infrastructure (water and sewage pumps, sewage plants and the lighting for the Japan-Palau Friendship Bridge) accounted for 40% of government electrical consumption in 2004/2005; the remaining 60% was used mainly within offices.
- 1.3. Although there is some national government fuel use for sea transport, inter-island shipping is by private or state government-owned ships. The national government direct transport fuel use is primarily for road transportation.
- 1.4. Palau's Compact of Free Association with the USA, the main source of external assistance, expires in 2009. Although a renegotiation may be possible and discussions are underway, it is expected that Government revenue will decrease after 2009, possibly substantially. Consequently, Government is looking for practical ways to cut costs in its operations including reducing its energy consumption.
- 1.5. Palau has an Energy Office, located within the Bureau of Public Works of the Ministry of Resources and Development, consisting of one full-time position – that of Director – to deal with energy policy, renewable energy development and government energy use as well as other matters relating to the use and production of energy in Palau. The Director of the Energy Office reports directly to the Minister of Resources and Development. Financial and other resources available from Government are insufficient for effectively carrying out all the Energy Office's duties and external support is utilized when available.
- 1.6. Executive Order (EO) 132, promulgated in 1994, mandated a reduction in government energy use but did not specify the amount or its timing. It also mandated that one person per ministry be appointed as Energy Conservation Officer (ECO) to be responsible for implementing those energy conservation measures initiated in each ministry by the Energy Program Manager. However, there were no penalties for lack of implementation and though persons were assigned as ECOs in recent years they were not active until 2005 when Executive Order 234 re-emphasized the need for energy savings within government. Although Executive Orders are only applicable to the Executive branch of the Government, that branch accounts for about 90% of national government employees and about the same percentage of Government energy use.

- 1.7. Executive Order 234 of 2005 mandates a reduction in government electrical consumption and vehicle fuel cost by 10% for the Executive Branch. A three-person Energy Audit Team was established whose responsibility is to ensure compliance with the Executive Order. There are no provisions for additional funding or staff; these are new duties added to those of existing staff. The baseline from which to compare the results of any energy reduction activity is specified as the electricity and fuel consumption for the two-year period ending in August 2005. In December 2005, all Energy Conservation Officers submitted monthly electricity and fuel consumption reports, covering the period from January to November 2005, to the Energy Office. Although they were tasked to submit monthly consumption reports to the Energy Office starting in January 2006, this has not been done.

2. Overall Concept of the PECS

Recognizing the financial and manpower constraints likely to be faced by the Government of Palau (GoP) at the end of the current Compact period, the PECS does not rely on an expectation of a major infusion of new funds or large staffing increases. In brief, the PECS aims to accomplish the following:

- 2.1 A reduction of energy use by 10% within the Executive Branch, based on an agreed upon baseline, and if possible the extension of this goal to Palau's Judiciary and Legislature.
- 2.2 The use of both 'carrots' (e.g. awards, recognition) and 'sticks' (e.g. tougher Executive Orders, regulations, standards, building energy codes, etc.) to encourage compliance and discourage waste.
- 2.3 A simple reporting, monitoring and implementation system that relies primarily on existing staff (ECOs and Energy Audit Team) to monitor and report to the President through the Energy Office on Government energy use and to manage the implementation of improvements.
- 2.4 Close cooperation with funding agencies and regional organizations whose support could strengthen the Energy Office and may ease implementation.
- 2.5 A program of accurate and timely information to key decision makers to explain the rationale of the PECS, the benefits of implementing it, and the costs to Government and the nation of a 'business-as-usual' approach of continued growth in energy consumption.
- 2.6 Modest strengthening of the GoP's Energy Office.
- 2.7 Improved cooperation between the GoP and the PPUC regarding planning and energy efficiency improvements for Government and subsequently for Palau overall.

3. Strategies and Action Plans

A Steering Committee composed of stakeholder representatives was formed in February 2007 to guide the development and implementation of the PECS (Annex 1). In order to effectively reduce GoP energy consumption, the proposed strategies were developed, revised, and finalized following the actions of the Steering Committee at workshops held in March and August, 2007.

The summaries are graded from one (●) to five (●●●●●), with ● being the lowest and ●●●●● the highest within the three categories. For example, an ‘ease of implementation’ of ●●●●● means the measure is very easy to implement, an initial cost of ● means it is quite inexpensive, and savings of ●●● suggest good but not exceptional savings. N/A means ‘not applicable’

3.1. Strategy: Periodic training of ECOs in energy auditing, monitoring and reporting procedures

Summary description	Summary of costs and savings
Periodic training of ECOs ECOs have been given initial classroom and on-site training in energy auditing procedures by a Palau-based company that has relevant experience. There is to be a short refresher training every 6 months.	Ease of implementation ● ● ● Cost ● ● Savings ● ● ● ● Initial Priority ● ● ● ● ●

Description: The ECOs have been trained in energy auditing procedures and in the application of energy conservation measures. A basic hands-on training session by an engineering/architectural firm with experience in energy audits of buildings and electrical equipment was given on June 7th, 2007, with an emphasis on lighting, cooling, and office equipment. The training session had a hands-on component at the Ministry of Education’s headquarters building so that the participants could apply what they had learned in class.

In order to keep ECOs up to date with effective energy conservation techniques and technologies, as well as to keep their skills current, it has been agreed by the Steering Committee that the ECOs will be provided retraining/refresher training twice yearly. This may be training presented by outside persons with experience in energy auditing of buildings and electrical equipment involving demonstrations, lectures on successful experiences elsewhere, or training by the Energy Officer in auditing, reporting and other administrative matters. Additionally the monthly meetings of ECOs will typically include informal training and sharing of experiences.

Every year, each ministry is to have designated a month when it will pay special attention to reducing its energy consumption. During this Ministry Energy Conservation Month, the ministry’s ECO is to perform audits of all the ministry’s buildings and monitor the electrical consumption of specific appliances, using special auditing equipment provided by the Energy Office (see strategy 14).

Action Plan: In June 2007, an engineering/architectural firm provided initial training of the ECOs in basic energy auditing as well as energy monitoring and reporting procedures. After the initial classroom training, the ECOs received personalized on-site training by a member of the PECS consulting team. This included walk through audits of the buildings in the ECOs' ministries. Standard audit report forms have been proposed and provided to the Energy Office.

Retraining of the ECOs is to be provided in December and June of each year.

The monthly meetings of ECOs are to be held on the second week of each month so that the Energy Office has time to compile and analyze the previous month's total energy consumption for all ministries. The meetings should be limited to two hours unless a training session is included.

Estimated cost: \$750 - \$1,000/year for twice yearly refresher training.

3.2. Strategy: Monthly monitoring and reporting of energy consumption by ECOs

Summary description	Summary of costs and savings
Monthly monitoring and reporting by the ECOs Monthly reporting allows the Energy Office to track changes in ministries' energy consumption as they occur. The Energy Office then reports an analysis of the results directly to the President's Office emphasizing problem areas.	Ease of implementation ●●●● Cost ● Savings ●●●● Initial Priority ●●●●●

Description: The ECOs for each ministry are to report their ministry's electrical and fuel consumption to the Energy Office every month. Monthly reporting will allow the Energy Office to track progress and changes more rapidly than if reporting were to be done over longer periods of time and will allow identification and the timely introduction of measures to reduce inefficiencies. Upon receipt of the reports, the Energy Office is to analyze each ministry's energy use and provide a summary report of overall government energy consumption to the President's Office with reporting emphasizing problem areas. That office would then be responsible for taking action if energy reduction efforts were found to be wanting in any ministry.

Action Plan: Reporting of monthly electricity and fuel consumption to the Energy Office is to be completed before the end of the first week of the following month in a standardized format to be provided by the Energy Office. PPUC electricity bills for a month are available during the first week of the following month. Fuel invoices for transportation are obtained at the time of purchase and can be summed by the ECO over the month. The Energy Office is then responsible for compiling the information provided to it by all ministries, and comparing that month's consumption with the baseline and with that of previous months. If a ministry is found to be failing in its obligation to reduce its energy use, a report noting the problem is to be prepared by the Energy Office and submitted to the President's Office.

Estimated cost: No additional budget requirements are expected.

3.3. Strategy: Performance awards and bonuses for ECOs

Summary description	Summary of costs and savings
Awards for top three Energy Conservation Officers (ECOs) Awards to be given to the three ECOs whose ministries have achieved the largest or most significant energy reduction, and public recognition to the top three ministries or bureaus.	Ease of implementation ●●●●● Cost ● Savings N/A Initial Priority ●●●●

Description: Providing performance awards and formal recognition on a regular basis is expected to serve as incentives for Ministries, bureaus, and individual Energy Conservation Officers to reduce energy consumption. Monthly recognition for the three top-performing ECOs are to be publicized in the local media, and a yearly award ceremony for the top three overall ECOs would be organized. The three ministries with the most effective energy saving programs would also be publicly recognized so as to encourage participation of all employees in energy conservation measures. A five-member body for judging the contestants and bestowing the award is to be composed of representatives from the OERC (within the Office of the President), the Energy Office, PPUC, the Ministry of Finance, and the private sector.

Action Plan: The panel of judges to be established under the PECS will select the three annual award winners, and organize the annual ceremony. The award is to be given to the three ministries and ministerial ECOs that have accomplished the highest percentage reduction in electricity or fuel use for that year. The award would be a public presentation of a certificate of recognition; one would be given to the ministry and be accepted by the minister, and one would be given to its ECO.

The yearly ceremony will coincide with the annual Earth Day celebrations at the end of April.

Approximately one month will be required to establish the panel of judges after the PECS is formally accepted for implementation and prepare judging criteria. The monthly recognition would be presented during the ECOs' monthly meetings.

Estimated cost: \$400 for year-end ceremony.

3.4. Strategy: Preferential purchasing of energy efficient vehicles and equipment

Summary description	Summary of costs and savings
Require the purchase of fuel efficient vehicles and high efficiency electrical equipment Purchase vehicles with diesel or hybrid engines having the minimum displacement suitable to their type of use and purchase only energy efficient electrical equipment.	Ease of implementation ●● Cost ●● Savings ●●●● Initial Priority ●●●●●

Description: Where available, U.S. Energy Star (or equivalent) certified electrical products are to be purchased over alternatives that consume more energy. Unless special exemptions are justified and approved, all government vehicles that are purchased should have diesel or hybrid engines with an engine displacement of less than 2.5 liters, a manual transmission, and two-wheel drive.

Upgrading lighting systems presents one of the simplest and quickest energy reduction initiatives. Incandescent bulbs and ballast-type transformers for fluorescent tubes will be replaced by high-efficiency compact fluorescent lights (CFLs) and electronic ballasts. An Executive Order or other regulatory mechanism as appropriate will be issued requiring their upgrading and the EO will be supported by additional funding for the upgrades.

Action Plan: A document detailing proposed electrical equipment purchasing procedures has been prepared by the consulting team and provided to the Energy Office. The procedures are largely based on the US Energy Star certification but also make an allowance for energy efficiency standards used for products from other countries. The Director of the Bureau of Property and Supply is to be the final arbiter of any application for exemption to the appliance purchasing regulations.

Similarly, vehicle procurement procedures have been prepared and provided to the Energy Office for formal government approval. They include regulations on the type and size of a vehicle's engine, its type of transmission, and its drivetrain. Any application for exemption to one or more of the purchasing criteria will be reviewed by a Vehicle Purchase Board, composed of the Director of the Energy Office, the Director of the Bureau of Property and Supply, and someone appointed by the President.

An inspection of lighting systems in those government facilities that have not yet been audited is required to ascertain the number of incandescent bulbs and transformer-type ballasts to be replaced. This is being undertaken by the ECOs as they perform their walk-through audits. Once the proposed new Executive Order is signed and funding is secured, at least two months would be required for the purchase and installation of the high efficiency lights.

Estimated cost: No added budget is likely to be needed for developing the purchasing guidelines. The typical cost in mid 2007 for an acceptable-quality CFL is \$2 per unit for a 60W incandescent equivalent, and an electronic ballast is approximately \$20 per light. Bulk purchases of CFLs and ballasts by the government could reduce these costs. The cost of replacing all lights will be unknown until inspections are carried out at government facilities.

3.5. Strategy: Regular maintenance of government vehicles and equipment

Summary description	Summary of costs and savings
Regular maintenance schedules	Ease of implementation ●●
Perform scheduled maintenance of vehicles and equipment to maximize their efficiency.	Cost ●●●
	Savings ●●●
	Initial Priority ●●●

Description: The energy efficiency of vehicles and electrical equipment decreases without regular maintenance. A regular maintenance program is therefore required to maintain energy efficiency. An added benefit of regular preventative maintenance is longer equipment life and delaying the cost of replacement or major repairs. Government pumping and delivery systems for potable water and waste water also require regular maintenance if energy efficiency is to be retained.

Action Plan: The Bureau of Property and Supply in the Ministry of Finance will be responsible for verifying that the maintenance schedule for vehicles and pumps is being followed. The PECS consulting team found that hiring a private company to maintain Government air-conditioners would not be cost-effective; therefore requiring each ministry to maintain their own air-conditioners is the approach proposed though the quality of air-conditioner maintenance may not be as evenly maintained across Government ministries as would be the case with contracted maintenance.

A draft maintenance schedule for vehicles has been provided to Government for consideration and adoption. Maintenance on pumps, boilers, and other large energy consumers is to follow the manufacturer's recommended servicing schedule.

Estimated cost: Depends on frequency and complexity of maintenance.

3.6. Strategy: Add an energy efficiency specialist position within the Energy Office

Summary description	Summary of costs and savings
Increase Energy Office Staff by One Person Additional staff to specifically monitor energy reduction measures of ministries, to adjust programs as needed and to prepare project proposals to obtain assistance for energy efficiency improvements.	Ease of implementation ●● Cost ●●● Savings ●●● Initial Priority ●●●●●

Description: The Energy Office has only one full-time position, that of Director. This lack of human resources hinders the Office's ability to develop energy efficiency initiatives and to properly monitor progress in their implementation. Furthermore, an energy conservation officer would allow the Energy Office to spearhead new energy conservation initiatives and secure finance to fund energy efficiency projects both for Government and the private sector. The cost of a new staff member would be more than offset by the expected 10% savings in the government's electricity bill which exceeds \$4.2 million per year. (This is based on the average of 2004 and 2005 electricity consumption at August 2007 rates plus the estimated electricity bill for the Capitol Complex in 2007, which is based on six months of data.)

Action Plan: One of the activities under the EU's REP-5 program provides an Energy Planner for Palau for two years. The PECS consulting team has provided the GoP with suggestions for energy efficiency that can be added to the Energy Planner's ToR. The recruitment process is currently under way, and the Planner is expected to be recruited before the end of 2007.

Estimated cost: As the Energy Planner is expected to be financed by the EU, no additional budget allocations are required by the GoP for the initial two years.

3.7. Strategy: Incorporate energy monitoring and reporting within the Capitol Complex maintenance contract.

Summary description	Summary of costs and savings
Capitol Complex Maintenance Expand scope of work for Capitol Complex maintenance contractor to include energy monitoring, reporting, and reduction.	Ease of implementation ●● Cost ●●● Savings ●●●●● Initial Priority ●●●●●

Description: With the completion of the Capitol Complex, government energy use has risen dramatically. Although energy services are centralized, there is no centralized authority for managing the Complex so it is impractical for the ECOs to monitor energy use at the Complex, attempt energy reduction initiatives, and provide the necessary coordination among the various ministries. Only a centralized energy management program is likely to be effective. Therefore the PECS Steering Committee recommends that the company hired to oversee maintenance of the Capitol Complex should also be responsible for monitoring and reporting its energy consumption and for implementing simple energy conservation measures (e.g. turning off lights that are not being used, maintaining the proper set points for the air conditioning, etc.). As energy consumption at the Capitol affects all branches of government, the Capitol Complex maintenance contractor should report directly to the Energy Office for energy related matters, which would then provide the President's Office with reports on energy use and proposals for investments in energy reduction initiatives at the Capitol Complex.

Action Plan: Due to a lack of funds, the CIP Office has cancelled the issuing of a maintenance contract, and no indication has been given as to when funding will be available. However, the need for maintenance of the Capitol's electrical equipment and the monitoring of its energy use grows more pressing as the equipment gets older.

Estimated cost: Some modest additional funding will probably be required beyond what would already be budgeted for a maintenance contract, as additional work would be required by the contractor.

3.8. Strategy: Establish criteria for prioritizing energy reduction initiatives

Summary description	Summary of costs and savings
Establish and implement a methodology to prioritize energy reduction initiatives within Government The projects with the best financial return will have priority in implementation. Simple payback time will be a key criterion used for prioritization, but absolute and relative cost savings will also be considered.	Ease of implementation ●●●●● Cost ● Savings ●●● Initial Priority ●●●

Description: To determine which energy reduction measures should be undertaken, a method of prioritizing them is to be established. The criteria will be based on a combination of:

- simple payback time,
- life-cycle cost savings,
- availability of funding from donors,
- cost savings relative to baseline,
- visibility to the general public,
- time required for completion of measure,
- ease of implementation, and
- likelihood of cost savings to remain over the long term.

Each of the criteria is to be weighted, thus the measure with the highest priority will be the one that obtains the highest overall score. A weight of 0.35 is to be used for simple payback, 0.2 for life-cycle cost savings, 0.1 for relative cost savings, 0.1 for the likelihood of cost savings to remain over the long term, 0.1 for the time required to complete the project, 0.1 for ease of implementation, and 0.05 for the visibility to the general public. Availability of funding will obviously be a consideration but cannot be a fixed weighting factor as it will have a varying effect on the ability of the Government to implement energy savings measures since a variety of funding sources may be available for different types of activities (See Annex 6 for sample calculations).

Action Plan: This prioritization process is to be used by ministries to prioritize energy efficiency measures from their budgets as well as by the Energy Office in prioritizing overall government initiatives for energy efficiency improvements.

Estimated cost: No additional budget allowances are expected

3.9. Strategy: Periodically adjust the energy consumption baseline.

Summary description	Summary of costs and savings
Revise Baseline Periodically To remain up to date, the two-year energy consumption baseline should be changed to a one-year baseline and revised as necessary.	Ease of implementation ●●● Cost ●● Savings N/A Initial Priority ●●●●●

Description: The Steering Committee decided that the two-year baseline against which to compare energy reduction measures as mandated by Executive Order 234 should be replaced by a one-year baseline, beginning in April 2007 and ending in March 2008. This is because the 2004 - 2005 baseline does not include the electricity use at the Capitol, nor the additional fuel used by Government vehicles to commute to the Capitol. Having the baseline start in April 2007, when the consumption of the Capitol has more or less stabilized, would allow meaningful comparisons to be made with current energy use. The April – March baseline should be updated by the Energy Office when Government consumption changes considerably following the addition or removal of a large building electrical consumer (e.g. the Capitol Complex, a large water pumping station, etc.), using data supplied by the ECOs.

Estimated cost: No additional budget lines are expected to be required

3.10. Strategy: Establish an equitable method to allocate ministerial costs of electricity in the Capitol Complex

Summary description	Summary of costs and savings
Determine and Implement a Method to Equitably Divide the Monthly Capitol Complex Electric Bill Among Ministries The electric bill is to be allocated based on a combination of ministry office space and ministry office personnel.	Ease of implementation ●● Cost ●● Savings ●●●● Initial Priority ●●●●

Description: The Capitol Complex is billed by PPUC as a single customer. However, there are numerous ministries housed in the Complex that occupy different amounts of office space and have a different number of personnel. Energy usage by the legislative, judicial, and executive buildings, as well as that of the central air conditioning system, is recorded by separate government-owned meters. Currently money has been appropriated by the OEK (Palau's National Congress) for paying the Capitol Complex bill for all branches of Government. However, once that money has been spent, the expected method of allocating electricity bills will be to divide the bill for the entire Complex by the number of ministries housed there, regardless of the amount of office space used or the level of the ministry's staffing at the complex. This places an unfair burden on the ministries with few staff at the Complex. It also reduces incentives for any one ministry to reduce its energy use since the benefits are shared by all. An equitable method to divide the electric bill could include:

- The percentage of common loads (e.g. air conditioning, nighttime lights, lights in common areas, etc.) paid for by a ministry would be equal to the percentage of the total office space occupied by that ministry in the Complex. An energy audit has revealed the energy use of the common loads.
- Once the amount to be paid by each ministry for common loads has been calculated, the remainder of the PPUC bill would be borne by each ministry in proportion to the number of personnel it has working at the Capitol Complex relative to the total personnel at the Complex.

Action Plan: A survey of the wiring within the Complex done as part of the PECS audit has shown that individual metering of ministries is not practical. Therefore an allocation of energy cost based on office area and number of personnel will be used. The Energy Office, based on data and recommendations by the ministry ECOs and the Capitol Complex maintenance company, will be responsible for annually updating the proportion of the Capitol Complex bill to be paid by each ministry as the office space allocation and the number of on-site personnel change. For the initial apportionment of the PPUC bill, it may take four to six weeks to ascertain the number of people permanently at the Capitol in each ministry, the number of people at the Capitol part-time, and the office space allocated to each ministry. Therefore the change to the proposed methodology would take place in January 2007. The Energy Office will be the arbiter of disputes regarding the allocation of Capitol Complex energy costs.

Estimated cost: No additional budget lines are expected to be needed.

3.11. Strategy: Information campaign for OEK and government employees

Summary description	Summary of costs and savings
Information campaign Information campaign aimed at encouraging employees to adopt energy-saving practices	Ease of implementation ● ● ● Cost ● ● Savings ● ● ● Initial Priority ● ● ●

Description: An information campaign aimed at educating decision makers and public servants about energy-saving and energy-wasting behavior is to be undertaken since significant savings can be achieved if government employees simply become aware of wasteful practices and undertake simple measures to reduce waste. Energy savings suggestions will be solicited from employees and recognition given at the monthly ECO meeting to the employee that suggests the most cost-effective approach for reducing energy use in his/her ministry. For savings that require additional government expenditure, a high level approach is necessary and part of the information campaign should be targeted specifically at ministers and members of the OEK. The campaign is to be organized and implemented by the Energy Planner, to be provided to the Energy Office by the EU REP-5 program.

Action Plan: Promotional leaflets, posters, booklets etc. are to be developed and distributed. Much can be directly copied from US DOE materials and publications from Guam and CNMI. Also, energy-saving tips and energy consumption facts could be disseminated via monthly ministerial emails or memos. The emails or memos would also provide government-wide recognition of the employees who come up with the most cost-effective energy reduction schemes. A workshop is to be organized to educate the OEK about the importance of energy efficiency and conservation and the costs to Palau of inaction.

Estimated cost: \$1,000/year, \$500 for the OEK workshop.

3.12. Strategy: Monitor energy reduction efforts of the energy offices of Guam and Saipan

Summary description	Summary of costs and savings
Discussions with Guam and Saipan energy offices Learning from Guam and Saipan's experiences with government energy-reduction programs can benefit Palau by applying their successes and avoiding their failures with the potential of reducing the cost and improving the quality of Palau programs.	Ease of implementation ● ● ● ● ● Cost ● ● Savings ● ● Initial Priority ● ●

Description: Guam and Saipan have undertaken energy reduction and demand-side management projects in the past and both currently have government energy use control measures in effect. Palau would benefit from learning from their experience and applying lessons learned. Links between the programs should be developed for exchanging information among the energy offices, as well as possibly coordinating the training of energy personnel.

Action Plan: Issues to be considered in discussions could include past experiences with government energy reduction initiatives, ongoing government energy reduction projects, obstacles and challenges in reducing energy use, availability of external funding for Demand-Side Management and Clean Development Mechanism projects, effectively involving the power utility in energy conservation efforts and other activities of mutual interest. An informal exchange of information should occur throughout the year to keep up to date on projects and government energy management activities in Guam and the CNMI. Energy conservation and efficiency should be included as a topic at high-level meetings between Palau, Guam, and the CNMI.

Estimated cost: An additional \$5,000 per year is expected to cover the necessary travel costs.

3.13. Strategy: Designate a ministry or government building as a showcase for government energy efficiency

Summary description	Summary of costs and savings
Showcase ministry/building One ministry would be the recipient of additional funding for extra energy efficiency efforts each year.	Ease of implementation ● Cost ●●●● Savings ●●●●● Initial Priority ●●●●●

Description: Once each year, a ministry or government building will be designated by the Energy Office as a showcase for energy efficiency projects. This ministry or building will benefit from additional expenditures for energy audits and energy reduction activities based on those audits.

Action Plan: The selection of the ministry to be the energy efficiency focus for the next year would be made by the President's Office based on Energy Office recommendations and analysis of the benefit-cost ratio. Criteria to be used for the selection may include the potential for cost effective energy reduction actions, the ministry's prior performance in energy reduction programs, project visibility, and the possibility of replication of the energy reduction programs by other ministries. The Public Works/EQPB building is proposed as an initial showcase building. Approximately three weeks are estimated to be required to identify and designate a building to be showcased.

With PIEPSAP support, the Bureau of Public Works/EQPB building in Koror was audited in August 2007. The audit concluded that savings of about \$340 per month can be achieved by an initial investment of about \$9,600, a payback period of 28 months. However, funds still need to be secured to implement the recommendations.

Estimated cost: To be determined but approximately \$15,000/year

3.14. Strategy: Maintain an adequate inventory of basic energy auditing equipment

Summary description	Summary of costs and savings
Audit Tools Inventory An inventory of auditing equipment should be purchased and maintained	Ease of implementation ● ● Cost ● ● ● Savings ● ● ● Initial Priority ● ● ● ● ●

Description: In order to perform useful energy audits of government buildings, adequate energy auditing equipment should be purchased as deemed appropriate by the consultants and the Energy Office in consultation with the engineering/architectural firm that trains the Energy Conservation Officers. This equipment is to be kept at the Energy Office, and be lent to the ECOs during their ministry's Energy Conservation Month. It will include energy meters, thermometers, infrared thermometers, illuminometers, clamp-on ammeters, etc.

Action Plan: The contents of the basic kits for detailed energy audits for government facilities have been determined. SOPAC has provided funds for the purchase of the auditing equipment, which has been ordered and delivered.

Actual cost: \$1,200

3.15. Strategy: Audit the Koror-Airai potable water system

Summary description	Summary of costs and savings
Koror-Airai water system audit An inventory of auditing equipment should be purchased and maintained	Ease of implementation ● ● ● ● ● Cost ● ● ● ● Savings ● ● ● ● ● Initial Priority ● ● ● ● ●

Description: Currently, residential customers can choose to pay a flat rate of \$10 for their water and not be metered. Commercial customers must have meters at their water connections, and pay a rate of \$0.85 per 1000 US gallons. As water and sewage pumps account for 32% of the GoP's electricity use, reducing their consumption and recovering the cost of treating and pumping potable water and sewage should be made a priority. The amount of electricity used to pump potable water is expected to increase, as there are plans to install a water treatment facility on the Tabecheding River in the state of Ngatpang that will service Koror and Airai.

Action Plan: An audit of the potable water distribution system should be carried out, as some of the pipes may be in need of replacement. The pumps should be audited as well, and a cost-benefit analysis should be performed to determine which pumps should be replaced immediately with new, high-efficiency ones.

Water meters should be installed on all customers' water connections and flat-rate billing should be discontinued. A tariff study should be undertaken in order to determine what tariff structure is appropriate for full cost recovery.

Estimated cost: Depends on the number of unmetered customers and the complexity of the pumping system.

4. Conclusion

These PECS strategies were discussed and finalized following the second PECS workshop held on August 2nd, 2007, in Koror. They serve to focus efforts in energy reduction by the Government of Palau, once they are formally approved.

Annex 1: Membership of the PECS Steering Committee and Task Force

Membership of the PECS Steering Committee:

Organization:	Person:	Position:
Office of the President	Kione Isechal	Special Adviser, also PPUC board chair
Ministry of Education	Edwel Ongrung	Admin Service Manager
Ministry of Finance	Darren Fritz	Budget Analyst
Palau Public Utilities Corporation	Ken Sugiyama	GIS Engineer
Ministry of Resources and Development	Gregorio Decherong	Director of Energy
OERC	Olai Polloi	Climate Change Coordinator
Belau Tourism Association	Cliff Terry	President, TRB Architects, Koror
Shell & Mobil	Frank Kyota	Shell Area Manager

Membership of the PECS Task Force (the Energy Conservation Officers):

Ministry:	Person:	Position:
Ministry of Justice	Florence Salvador	Auto mechanic
Ministry of Education	Edwel Ongrung	Admin Service Manager
Ministry of Health	Joseph Severino	Maintenance manager
Ministry of State	Salvador Tellames	Director, Bureau of Domestic Affairs
Ministry of Finance	Darren Fritz	Budget Analyst
Ministry of Commerce and Trade	Nelson August	Statistician
Ministry of Community & Cultural Affairs	Tobias Marbou	Acting Director, Bureau of Community Services
Ministry of Resources & Development	Gregorio Decherong	Director, Energy Office

Annex 2: Baseline for Government Electricity Use

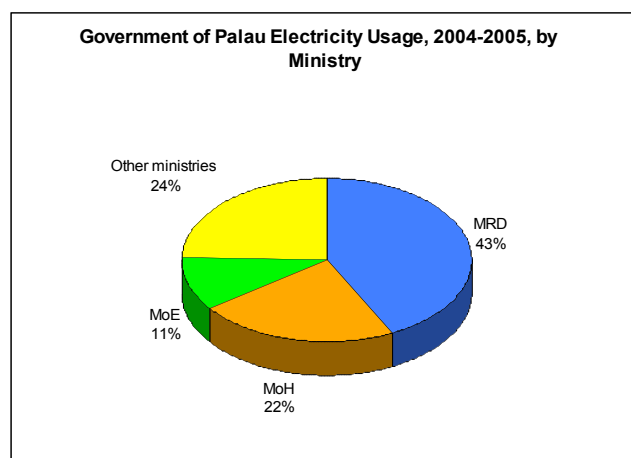


Figure A2-1: Distribution of 2004-2005 GoP Electricity Use, by Ministry
(Source: PPUC, early 2007)

As shown in Figure A2-1, (with details in Table A2-1 below), the largest consumer of electricity during the baseline period was the Ministry of Resources and Development (MRD), with 44% of the total. The PPUC data show that 40% of the Government's electricity use was for potable water and wastewater pumping, and that the hospital (Ministry of Health, MoH) accounted for 20% of the baseline consumption. The Ministry of Education (MoE), including public schools, accounted for 10% of the total. However, the baseline, as specified by Executive Order 234, is calculated for 2004-2005. Therefore it does not reflect the added demands imposed by the new Capitol Complex, which, based on January to June 2007 bills provided by PPUC, is expected to increase the baseline by 20%. Based on August 2007 electricity rates, the annual cost of baseline power consumption is \$3.5 million. The addition of the Capitol is expected to increase this to \$4.2 million annually. A 10% reduction in electricity consumption using the 2004-2005 baseline, adjusted for the Capitol Complex, would therefore reduce the Government's bill by \$420,000 per year.

The yearly electricity bills in Table A2-1 were calculated using the tariff structure presented in Annex 7, based on the PPUC meter data provided for 2004, 2005, and the first four months of 2007 (except the Capitol, where data were available for the first 6 months of 2007). There is a drop in the consumption of almost all ministries and branches in 2007 relative to the baseline (care must be taken in making comparisons, since data were only available for the first four months of 2007). The Legislative and Judicial branches were strongly affected by the move to the Capitol, while other departments, like the ministries of health and education, were not. As such, a more recent baseline, such as the April 2007 – March 2008 baseline proposed in strategy 9, should be used, as it provides a more accurate basis for comparison.

Table A2-1: 2004-2005 GoP Electricity Use by Ministry

Category	2004 consumption [kWh]	2005 consumption [kWh]	Baseline [kWh]	% of Total	2007 consumption (est.) [kWh]
Big users (>3 GWh/year)					
Ministry of Resources and Development	5,742,122	5,896,485	5,819,304	42.6	5,829,210
Ministry of Health	3,044,717	3,078,597	3,061,657	22.4	2,794,449
Capitol Complex	--	--	--	--	2,635,360
Medium users (>500 MWh/year)					
Ministry of Education	1,460,945	1,404,360	1,432,653	10.5	1,389,512
Ministry of Commerce and Trade	849,906	761,045	805,476	5.9	792,589
Ministry of Community & Cultural Affairs	593,415	547,723	570,569	4.2	470,469
Small users (<500 MWh/year)					
Ministry of Finance	400,330	373,761	387,046	2.8	258,204
Ministry of Justice	334,269	378,609	356,439	2.6	420,009
Judicial Branch	326,953	306,142	316,548	2.3	176,520
Executive Branch	272,720	251,013	261,867	1.9	155,592
Legislative Branch	239,081	230,944	235,013	1.7	14,760
Ministry of State	230,003	223,588	226,796	1.7	185,025
ROP Component Units	195,819	161,793	178,806	1.3	155,841
TOTAL	13,690,280	13,614,060	13,652,171		15,277,540

Note: The estimated 2007 consumption for the Capitol is based on January – June 2007 data. The estimated 2007 consumption of all other branches is based on January – April 2007 data

Annex 3: Revised Baseline for Government Fuel Use

Table A3-1 and Figure A3-1 show 2004-2005 government fuel expenditures and their distribution within governmental departments. Data were obtained from the Ministry of Finance's Bureau of National Treasury in March 2007.

Table A3-1: GoP Fuel Expenditures by Ministry for Baseline Period of 204-2005

Organization	2004	2005	% change	Baseline: 2004-05 Ave.	% of baseline Expenditure
Ministry of Resources & Development	\$179,353.82	\$165,802.56	-7.6	\$172,578.19	24.6
Ministry of Justice	\$106,555.33	\$231,266.35	117.0	\$168,910.84	24.1
Ministry of Education	\$92,376.46	\$101,936.43	10.3	\$97,156.45	13.9
Ministry of Health	\$63,329.54	\$56,854.13	-10.2	\$60,091.83	8.6
Office of the President	\$42,170.99	\$43,340.03	2.8	\$42,755.51	6.1
Boards, Commissions, Authorities & Other Agencies	\$46,475.25	\$36,316.81	-21.9	\$41,396.03	5.9
Ministry of Finance	\$36,969.71	\$44,602.50	20.6	\$40,786.11	5.8
OEK	\$26,832.45	\$31,817.86	18.6	\$29,325.16	4.2
Ministry of Commerce & Trade	\$20,586.06	\$25,560.01	24.2	\$23,073.04	3.3
Ministry of Community & Cultural Affairs	\$7,958.96	\$13,399.94	68.4	\$10,679.45	1.5
Ministry of State	\$4,727.91	\$12,090.91	155.7	\$8,409.41	1.1
Office of Vice President	\$5,608.45	\$5,975.58	6.5	\$5,792.02	0.8
TOTAL	\$632,944.93	\$768,963.11	21.5	\$700,954.02	100

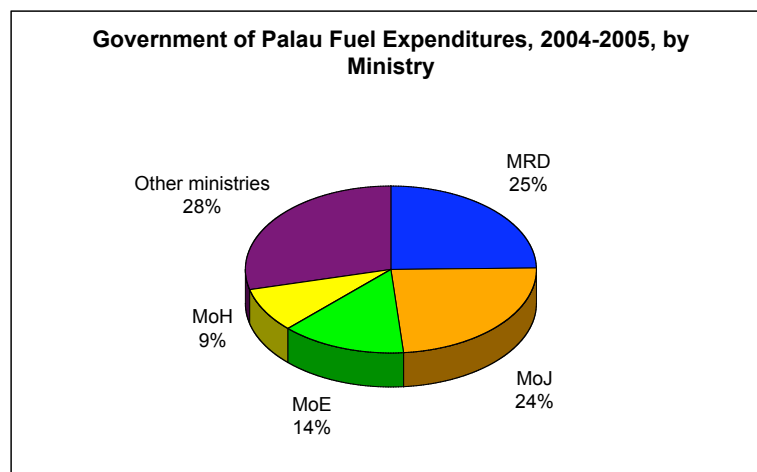


Figure A3-1: Distribution of Baseline Fuel Expenditures, by Ministry

Figure A3-1 shows that the Ministries of Health (MoH), Education (MoE), Justice (MoJ which includes the police), and Resources and Development (MRD) accounted for a total of nearly 65% of the Government's fuel expenditures. The baseline cost for 2004-2005 is \$700,000 per year, but as Table A3-1 and A3-2 show, the expenditures varied widely during 2004 through 2005. Several caveats must be noted in the fuel use data:

- The data provided by the Ministry of Finance were only for fuel expenditures, not fuel consumption. Without accurate information regarding past fuel prices at the pump, an accurate baseline of fuel consumption by volume is impossible.
- Some of the data provided by the Ministry of Finance included bills for vehicle repairs. Due to the sheer number of the bills, it is not practical to verify each bill to separate which ones are for fuel and which ones are for repairs. In the future, the ECOs from each ministry should keep track of fuel consumption by both expenditure and volume purchased. Costs of repairs should not be counted as a fuel cost.
- Data provided by the Ministry of Finance reflect what was charged to government accounts in 2004-2005, not what was paid in 2004-2005, and as such are a good indication of actual consumption for those two years.

According to the Supply Office of the Ministry of Finance, road vehicles account for most of the Government's fuel consumption. In March 2007, (Table A3-2), there were 515 vehicles operated by the Government of Palau. Of these nearly half (47%) were used by the Ministry of Resources and Development (including Public Works) and the Ministry of Justice (including police). Including the Ministries of Education and Health, four ministries account for 69% of the total. 63% of all vehicles excluding construction equipment are large and can be expected to be heavy users of fuel per mile traveled.

Table A3-2: Road Vehicle Fleet by Ministry, Early 2007

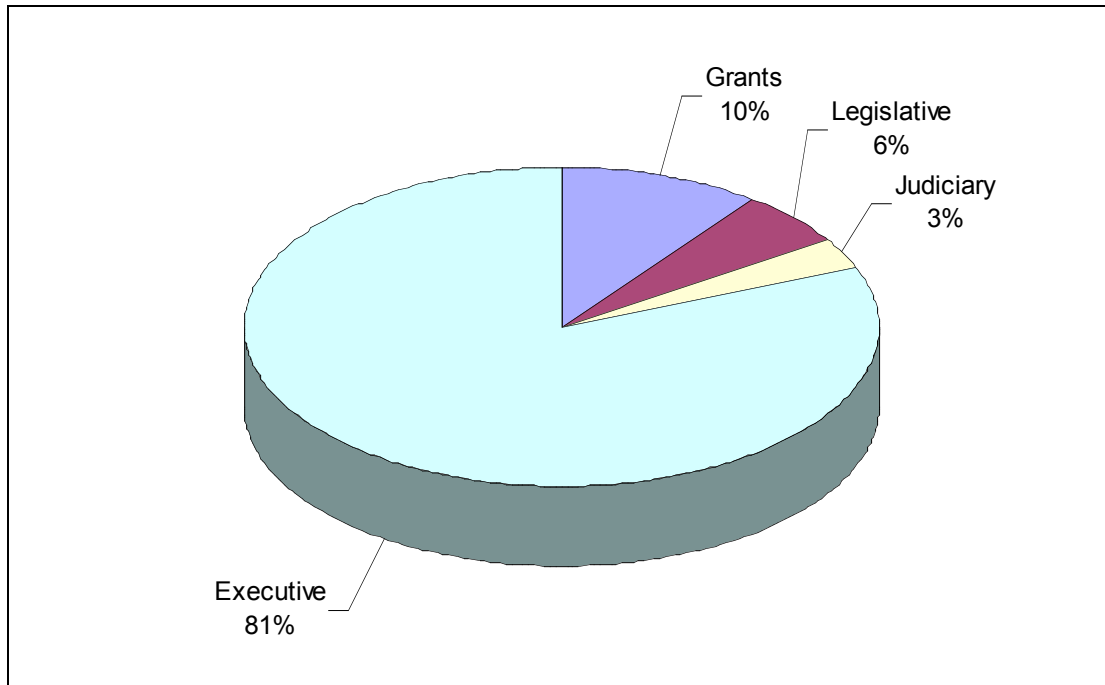
Ministry	cars	vans	SUV's	pickup trucks	larger trucks	buses	constr. equip.	motor-cycles	Total	% by Ministry
Ministry of Res. & Development	5	2	31	67	2	0	41	0	148	28
Ministry of Justice	27	9	26	10	4	0	0	20	96	19
Ministry of Education	1	5	10	16	0	22	1	0	55	11
Ministry of Health	10	6	21	19	0	1	1	0	58	11
Ministry of Finance	16	4	12	6	0	1	0	4	43	8
Miscellaneous	8	3	16	5	1	0	0	0	33	6
Ministry of Com. & Trade	6	0	8	5	2	0	0	0	21	4
OEK	5	1	10	2	0	0	0	0	18	3
Ministry of Comm. & Cultural Affairs	3	1	5	1	0	0	0	0	10	2
Judicial Branch	1	0	3	6	0	1	0	0	11	2
President's Office	4	0	4	2	0	0	0	0	10	2
Ministry of State	3	3	0	0	0	0	0	0	6	1
Vice President's Office	1	0	2	1	1	0	1	0	6	1
TOTAL	90	34	148	140	10	25	44	24	515	100
Percentage by vehicle type	18	7	28	27	2	5	8	5	100	-

Notes:

- 1) Percentages are rounded to nearest one percent so totals may not add up to 100.
- 2) "Miscellaneous" includes agencies not directly within the Government hierarchy, such as the Environmental Quality Protection Board, the Palau Visitor's Authority, the Palau National Olympic Committee, and others.
- 3) Details are shown in spreadsheet 'GoP Vehicle List.xls' of 5 April 2007.
- 4) At least 6 vehicles (one van, three SUV's, two pickups, and one bus), and no doubt many more, are diesel-fuelled.

Annex 4: Distribution of Government Employees by Branch of Government

According to the Ministry of Finance, there were exactly 2,000 employees of the Government of Palau on 17 March 2007. Of these 91% were in the Executive branch (including grant-funded workers, who are all based in the Executive), 6% in the Legislative Branch and 3% in the Judiciary Branch.



Note: Details are available from the spreadsheet 'Gov't Employees Number.xls' of 5 April 2007

Annex 5: Recommended Methodology for Allocating Electricity Costs Among Ministries at the Capitol Complex

The method currently proposed by the Ministry of Finance for allocating costs among ministries at the Capitol Complex is to divide the PPUC bill equally among the various governmental agencies working at the Capitol, regardless of the agencies' allocated office space or number of personnel based at the Complex. This is not an approach that provides incentives for energy conservation as it does not allocate the substantial energy costs equitably among resident ministries.

The following methodology is proposed to more equitably divide the Capitol Complex's PPUC bill among the ministries and agencies resident in the Complex. The recommended apportionment of the bill is based on the square footage of office space allocated to each ministry and the number of staff each ministry has at the Capitol. An energy audit is required to determine the electrical loads in the common areas (hallways, lobbies, restrooms, nighttime lighting, grounds, etc.), the total floor space, and the office space in each of the three Capitol Complex buildings. Once this is done, assuming that the methodology is accepted, the following steps will be used to divide the Capitol Complex's PPUC bill.

Step 1: Personnel, office space, and meter readings

The number of personnel in each governmental branch and the floor space occupied by each branch will be compiled and verified. The energy consumption for the month for each building will be read from the four government-owned meters in the chiller room.

Step 2: Allocation of chiller consumption to each building

The governmental agencies in the three buildings are responsible for paying for the Complex's air-conditioning. The chillers' energy consumption will be divided among the three buildings based on the percentage of floor space occupied by each building (e.g. if the Legislative Building has 30% of the Complex's floor space, then it is responsible for 30% of the chiller load).

Step 3: Allocation of common area and chiller loads to each governmental branch

Once the chiller consumption has been apportioned to each building, the electrical consumption for common areas in each building and for the chillers can be distributed among the branches, based on the percentage of office space that each branch has in their respective building (e.g. if the Ministry of Finance occupies 20% of the office space in the Executive Building, it is responsible for 20% of that building's common electrical consumption).

Step 4: Allocation of specific loads to each branch

The difference between the meter reading for a particular building and the common area consumption for that building (as determined by the energy audit) will be distributed among the various governmental

branches based on the percentage of staff each branch has working in the building. For example, if a ministry has 40% of the staff in the Executive Building, then it is responsible for 40% of the branch-specific load for that building. As these staff numbers will vary over time, the baseline will be the number of staff based at the Complex as of 1 June 2007, to be adjusted quarterly.

Step 5: Allocation of PPUC bill to each branch

Once the electricity consumption for the Complex has been allocated to each branch of government, the portion of the PPUC bill that each branch must pay can be calculated. It will be based on the percentage of energy used by a branch relative to the total consumption measured by the government-owned meters in the chiller room. (Requiring each branch to pay for a percentage of the actual bill instead of a percentage of the energy metered for each building is preferable because: a) the PPUC meter reading may not be identical to the sum of the four Government meters, and b) the Government can be delinquent in paying its bills, so interest accrues and must be paid.)

Sample Electricity Use Calculations

The following types of calculations will be carried out by the Energy Office for all ministries working in the Executive Building, but can be used for the other two Complex buildings as well. *Note that all numbers below are hypothetical and illustrative only; the actual numbers may be substantially different.* The calculations will be adjusted when actual data are available.

Step 1: Personnel, office space, and meter readings

Table A5-1: Illustrative Allocation of Staff & Space at Capitol Complex

Ministry	Personnel at Capitol	Office space at Capitol (ft ²)
Resources and Development	13	2500
Health	4	1000
Education	7	2000
Justice	9	2500
Commerce and Trade	5	1000
Community and Cultural Affairs	2	750
State	2	1000
Finance	24	3000
TOTAL	66	13,750

Assume for the illustrative calculations that, following an initial energy audit, electrical loads in common areas (hallways, lobbies, restrooms, grounds, etc.) are found to be 30,000 kWh/month, and that the floor space at the Executive Building is found to be 40% of the Capitol Complex floor space.

Furthermore, assume that the consumption of all three Capitol Complex buildings and the chillers is 240,000 kWh for the month (as read from the government-owned meters in the chiller room) distributed as follows:

Chillers:	72,000 kWh	30%
Executive Building:	96,000 kWh	40%
Legislative Building:	36,000 kWh	15%
Judiciary Building:	36,000 kWh	15%
<hr/>		
TOTAL:	240,000 kWh	100%

Step 2: Allocation of chiller consumption to each building

Since 40% of the floor space at the Complex is in the Executive Building, then 40% of the cost of running the chillers should be paid by the bureaus in the Executive Building. Thus, they are responsible for $72,000 \text{ kWh} \times 40\% = 28,800 \text{ kWh}$ for the chillers.

Step 3: Allocation of common area and chiller loads and to each governmental branch

The common load for the Executive Building is the sum of the building's common area loads as determined by the energy audit (i.e. 30,000 kWh) and the Executive Building's portion of the air-conditioning consumption (i.e. 28,800 kWh). The common load is thus $30,000 \text{ kWh} + 28,800 \text{ kWh} = 58,800 \text{ kWh}$. This load is to be shared by the ministries based on the percentage of office space in the Executive Building that they occupy. Please refer to Table A5-2 to for the illustrative apportionment of the common loads to each ministry.

Step 4: Allocation of specific loads to each branch

After the common loads have been apportioned, the ministry-specific loads can be calculated. The amount of energy directly used by the ministries is the difference between the Executive Building's meter reading (i.e. 96,000 kWh) and the common area loads for the building as determined by the energy audit (i.e. 30,000 kWh) that is 66,000 kWh.

The apportionment of the ministry-specific loads to each ministry is done on the basis of the number of personnel that each ministry has working at the Capitol. Please see Table A5-2 for the apportionment of the ministry-specific loads to each ministry.

Step 5: Allocation of PPUC bill to each branch

Now that all the loads have been allocated to each ministry, the amount to be paid by each ministry to PPUC is the percentage of loads each ministry has relative to the total Capitol Complex load, as read by the government meters (i.e. 240,000 kWh).

Table A5-2:
Illustrative calculations for dividing PPUC bill among the Govt. offices within the Executive Building

Ministry	Personnel	Office space (ft ²)	% Personnel	% Office space	Common load allocation (kWh)	Ministry-specific allocation (kWh)	Total allocation (kWh)	% Allocation of PPUC bill
	[Count]	[Audit]	[# personnel / # workers in Exec. Bldg.]	[Ministry office space / office space in Exec. Bldg.]	[% office space * (common area + chiller loads)]	[% personnel * (Exec. Bldg. load – common area load)]	[Ministry-specific + common]	[Total allocation / total Complex load]
R&D	13	2500	19.7	18.2	10,702	13,002	23,704	9.88
Health	4	1000	6.1	7.3	4,292	4,026	8,318	3.47
Educat.	7	2000	10.6	14.5	8,526	6,996	15,522	6.47
Justice	9	2500	13.6	18.2	10,702	8,976	19,678	8.2
C&T	5	1000	7.6	7.3	4,292	5,016	9,308	3.88
C&CA	2	750	3.0	5.5	3,234	1,980	5,214	2.17
State	2	1000	3.0	7.3	4,292	1,980	6,272	2.610
Finance	24	3000	36.4	21.7	12,760	24,024	36,784	15.33
TOTAL	66	13,750	100	100	58,800	66,000	124,800	52.01

In this hypothetical example, 52% of the total PPUC bill for the month would be paid by bureaus within the Executive branch. Similar calculations can be made for the other two branches. Once the actual numbers are available, a simple spreadsheet will be prepared and the calculations can be done quickly and easily.

Annex 6: Draft Methodology for Prioritizing Energy Conservation Investments

This annex provides a recommended method to prioritize investment in energy reduction initiatives based on the weighted criteria listed in Table A6-1, as endorsed by the PECS Steering Committee.

Table A6-1: Weighted Criteria for Project Prioritization

Criterion	Weight
Simple payback time	0.35
Life-cycle cost savings	0.2
Cost savings relative to baseline	0.1
Time required to completion of project	0.1
Ease of implementation	0.1
Likelihood of cost savings to remain over the long term	0.1
Visibility to the general public	0.05
Total (must add up to 1.00)	1.00

These criteria serve to discriminate between projects that require immediate attention and those that may be deferred until a later date. As an example, two hypothetical projects for the Bureau of Public Works' main office building are compared: replacing all of the inefficient 'fat' T12 fluorescent lights and magnetic ballasts with more efficient 'thin' T8 lights and electronic ballasts, or painting the roof with glossy white paint to reflect heat away from the building and sealing doors and windows against air leaks.

Hypothetical Project 1: Replacing T12 lights with T8 lights

There are currently 30 light fixtures in the Bureau of Public Works' (BPW) main office building, each with two T12 fluorescent lights and a T12 magnetic ballast. Each fixture consumes 72 W, whereas a fixture with T8 lights and ballast would consume 58 W. A local hardware store sells T8 lights for \$5 each, and T8 ballasts for \$22 each. The initial cost to replace all light and ballasts in the BPW office would therefore be 30 ballasts * \$22 per ballast + 30 fixtures * 2 lights per fixture * \$5 = \$960.

Assuming that all lights are on for 9 hours per day (from 7:30 AM to 4:30 PM) for 5 days per week, the energy savings would be 9 hours/day * 5 days/week * 52 weeks/year * (72 W – 58 W) = 32.8 kWh per year per light fixture, or 983 kWh per year for all lights. Assuming an average electricity rate of \$0.25/kWh, the cost savings is 983 kWh/year * \$0.25/kWh = \$246 per year saved.

The simple payback period for replacing all lights would be \$960 initial cost / \$246/year = 4 years.

Assuming a lifetime of 10,000 hours for the lights and ballasts, the lights would last 4.3 years, and would save 4.3 years * \$246/year = \$1,058 in energy costs over the course of their lifetime, assuming that electricity prices remain constant.

The energy cost savings relative to the baseline would be proportional to the relative energy reduction of the light fixtures, i.e. (72 W – 58 W) / 72 W = 19% reduction. Once funding is secured, the purchasing of the lights and ballasts is expected to be quick, since procurement rules allow purchases under \$5,000 to be single-sourced. Once the lights are purchased, only one day would be required for a single person to replace all the lights and ballasts. Installation would be very simple and not require any specialized skills. Government maintenance workers would be expected to install the lights.

As there is no human interaction with the lighting system other than turning the lights on and off, the savings are expected to remain constant throughout the life of the project. However, as the grid voltage in Koror sometimes fluctuates, some ballasts may need to be replaced occasionally.

The visibility to the public is minimal, as the BPW does not have a customer service desk and does not deal with individuals from the public. Furthermore, the fixtures have a covering over the lights that prevents one from seeing what type of light is used.

Hypothetical Project 2: Repainting the roof with glossy white paint and sealing doors and windows against leaks

The roof on the BPW office building is corrugated sheet metal painted dark blue. As such, it absorbs a lot of sunlight and causes the office to be quite warm, requiring air-conditioning to keep it cool. Furthermore, the louvered windows and the exterior doors do not sit well in their frames, allowing cool interior air to escape the building. Even when closed, louvered windows leak cool air. The scope of this project would be twofold: repainting the roof with glossy white paint and sealing windows and doors against air leaks.

Assuming a roof area of 5,000 ft² and 400 ft² covering area per gallon of paint, the amount of paint required is: 5,000 ft² / 400 ft² = 12.5 gal., which will be rounded to 13 gal. The price per gallon of paint is \$30/gal. at a local hardware store, so the price to buy the paint for the roof of the BPW office is 13 gal * \$30/gal = \$390.

Assuming that the price of purchasing silicone gel for sealing gaps between windows and frames, weather stripping and thresholds for doors, and shrink wrap for sealing louvered windows is \$100, the total price of the project is \$490.

A walk-through audit in July 2006 revealed that the BPW has 9 kW_{electric} of installed air-conditioning capacity that is regularly used. The compressors on the air-conditioners run for an estimated 75% of the time the air-conditioners are on (i.e. a duty cycle of 0.75). The daily consumption is therefore 9 kW * 9 hours/day * 0.75 duty cycle = 61 kWh/day. Over the course of an entire year, this amounts to an air-conditioning load of 61 kWh/day * 5 days/week * 52 weeks/year = 15,860 kWh/year. The cost of running the air conditioners (at an average price of \$0.25/kWh) is thus \$3,965/year.

It is not possible to exactly calculate the amount of energy that would be saved over the course of the year by implementing this project without resorting to a detailed audit of the building, but an estimated decrease in energy consumption of 15% is reasonable. This 15% decrease would save \$3,965/year * 15% decrease = \$595/year.

The simple payback time for this project is \$490 initial cost / \$595 yearly savings = 0.82 year, or 10 months.

This project is expected to last at least 7 years before the silicone sealant, shrink wrap, paint, etc. need to be replaced. Over the course of these 7 years, the project is expected to save \$4,200.

The expected cost savings are proportional to the reduction in consumption, therefore a 15% reduction in cost is expected.

Since the initial cost of the project is under \$5,000, the time to purchase the materials once funding is secured is expected to take two weeks. Once the equipment has been purchased, approximately 5 person-days are expected to install everything. Implementation is expected to be quite simple and would not require any specialized skills. Government workers would be expected to install the equipment and paint the roof.

The savings are likely to remain over the long run, as the upgrades do not depend on the behavior and habits of the office workers. Rain will keep the roof clean of dust and dirt, but over time may wear down the paint and reduce its glossiness and thus its ability to reflect sunlight. However, since the color is white, the reduction in glossiness will not dramatically affect the paint's reflective capability.

The change in roof color would be very visible to the public, as the BPW office is next to the main road in Koror. The other upgrades would be hidden from the public, as they would be situated within the building.

Project comparison

A score for each criterion must be assigned to both projects. A grading system from 1-10 is used, with 1 denoting the worst possible score and 10 denoting the best. Since the grading is somewhat qualitative, the score for a project may change depending on the project(s) against which it is compared. Thus it is best to compare as many different projects as possible at one time.

Table A6-2: Project 1 - Lighting upgrade

Criterion	Score	Weight	Final score
Simple payback time	4	0.35	1.4
Life-cycle cost savings	2	0.2	0.4
Cost savings relative to baseline	8	0.1	0.8
Time required to completion of project	8	0.1	0.8
Ease of implementation	10	0.1	1
Likelihood of cost savings to remain over the long term	7	0.1	0.7
Visibility to the general public	0	0.05	0
TOTAL			5.1

Table A6-3: Project 2 - Building envelope upgrade

Criterion	Score	Weight	Final score
Simple payback time	9	0.35	3.15
Life-cycle cost savings	8	0.2	1.6
Cost savings relative to baseline	6	0.1	0.6
Time required to completion of project	7	0.1	0.7
Ease of implementation	8	0.1	0.8
Likelihood of cost savings to remain over the long term	7	0.1	0.7
Visibility to the general public	5	0.05	0.25
TOTAL			7.8

As the preceding tables show, under the hypothetical conditions used, the Building Envelope Upgrade would be the project that should be pursued, due to its considerably higher total score.

Annex 7: PPUC Tariff Schedule

The following table summarizes the current PPUC tariff schedule, as of August 2007, when charges increased by 1 cent per kWh. There are three categories of customers: residential, commercial, and government. The Energy Charge is fixed and incremental, depending on the amount of energy used in one month by a customer. The fuel surcharge varies every quarter, and is the same for all customers, regardless of consumption.

Table A7-1: PPUC Tariff Structure

Customer	Energy Charge		Fuel Surcharge	Total price
Residential	< 500 kWh/mo.	\$0.08/kWh	\$0.14/kWh	\$0.22/kWh
	500-2,000 kWh/mo.	\$0.10/kWh	\$0.14/kWh	\$0.24/kWh
	>2,000 kWh/mo.	\$0.12/kWh	\$0.14/kWh	\$0.26/kWh
Commercial	Up to 2,000 kWh/mo.	\$0.10/kWh	\$0.14/kWh	\$0.24/kWh
	>2,000 kWh/mo.	\$0.12/kWh	\$0.14/kWh	\$0.26/kWh
Government	Up to 2,000 kWh/mo.	\$0.10/kWh	\$0.14/kWh	\$0.24/kWh
	>2,000 kWh/mo.	\$0.12/kWh	\$0.14/kWh	\$0.26/kWh

A different tariff schedule exists for customers with a high maximum demand and with a consumption exceeding 100,000 kWh/month, and is applied at PPUC's discretion. Under this schedule, the customer is charged \$18.60 per kW of maximum demand and \$0.095/kWh of energy consumed. A penalty is applied for customers with poor power factor (below 0.8 lagging). kVA metering is available, and customers are charged 85% of the kW rate to encourage them to increase their power factor.

As of August 2007, no government customers are charged under the high-demand tariff schedule.

The fuel surcharge increases/decreases by \$0.01 for every \$0.127 increase/decrease in the price of one US gallon of fuel. The base price on which the surcharge is calculated is \$0.6336/gal.

The figure below shows the average price of fuel purchased by PPUC for October 2003 to March 2007. Calculations based on the fuel surcharge formula and the current fuel surcharge show that price of fuel is currently around \$2.41/gal.

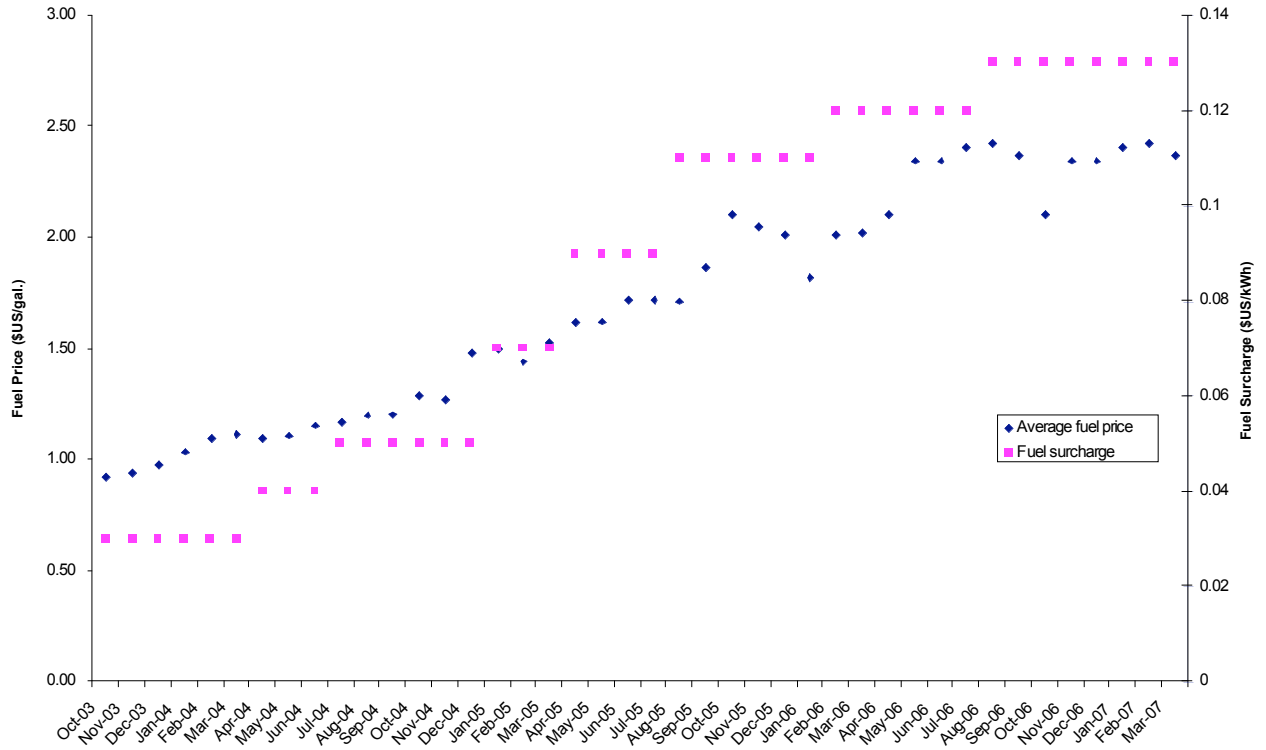


Figure A7-1: Average fuel price purchased by PPUC, and fuel surcharge for –Oct. 2003 – Mar. 2007

Annex 8: Energy Audit Kit

The Energy Audit Kit comprises an inventory of basic energy auditing equipment. The equipment is to be kept at the Energy Office and lent to the ECOs during their ministry's Energy Conservation Month in order to quantify energy consumption or environmental conditions (temperature, lighting).

SOPAC has provided funds for the purchase of the auditing equipment, which has been ordered and delivered to the Energy Office.

Item	Number	Comments
Energy Efficiency Manual	1	For suggesting energy efficiency initiatives and best practices
Infrared thermometers	2	For measuring roof, ceiling, and wall temperatures of government buildings
Clamp-on ammeters with line splitters	3	For measuring the current in 220V appliances or permanently wired appliances
Illuminometer	1	For measuring the light intensity in an office space
Kill-a-Watt meters	10	For measuring the energy consumption of 110V appliances. Also measures power factor, power, Volt-Amperes, current, voltage, and frequency
Alcohol thermometers	5	For measuring temperature at different locations in an office building