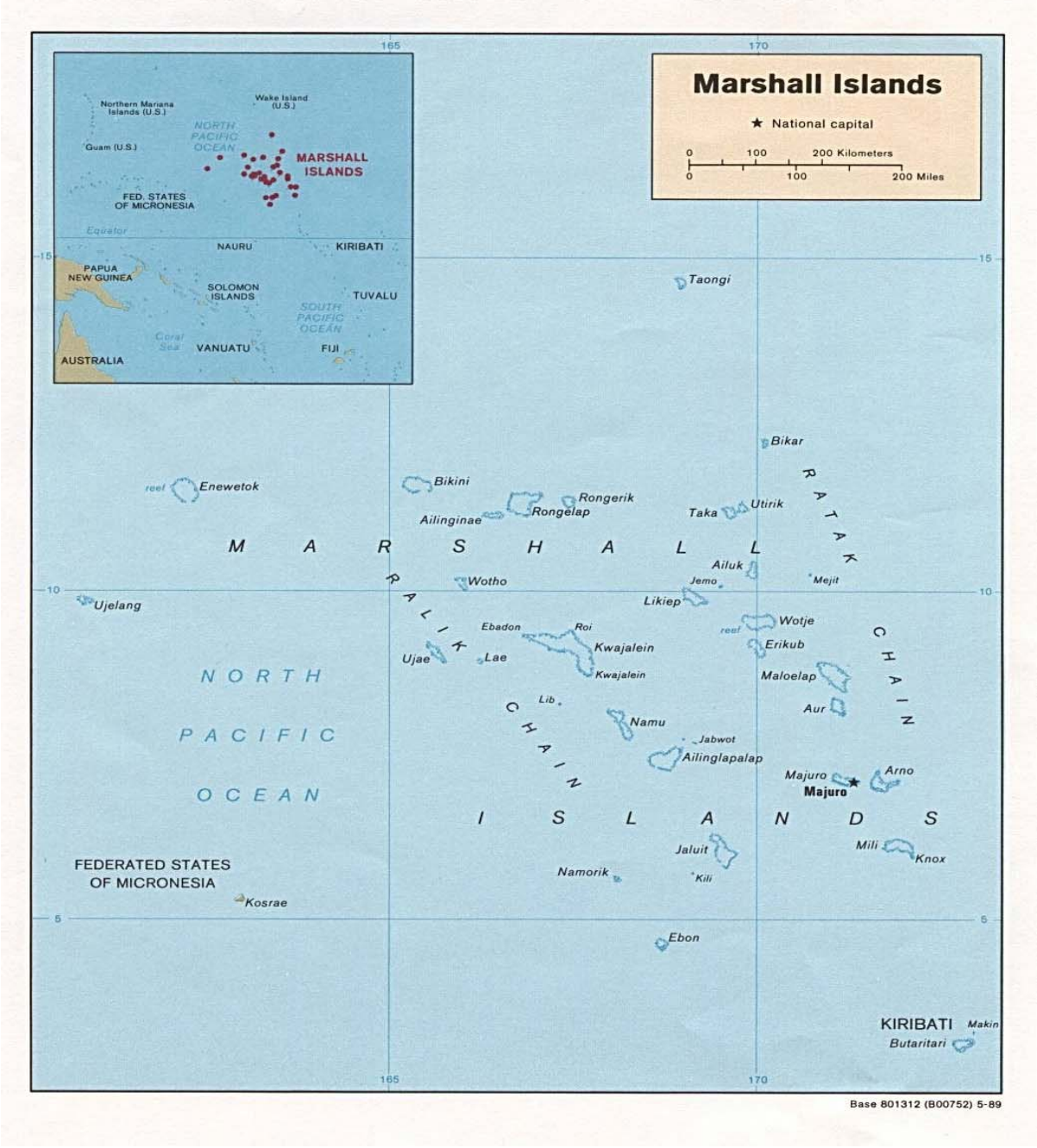
ADMIRE

Acting for the Development of Marshall Islands Renewable Energy



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I. Introduction

The Republic of the Marshall Islands (RMI) is one of the few unique "atoll nations" in the world. It consists of over 20 atolls scattered in the central part of the vast Pacific Ocean located approximately halfway between Japan and Hawaii. The islands are dispersed over 1.9 million square kilometers with the combined total land area of only 181 square kilometers. The recent census shows that the population is approximately 52,000 with two-third of the residents in the two district centers, Majuro, the capital, and Kwajalein, and the other one-third living in the "outer islands." Similar to most Small Island States, the Marshall Islands encounters constraints imposed by its small size, geographical distance from major international markets, natural disasters and limited resources base as the RMI aims toward achieving a self-sustaining economy, notwithstanding the process of reconciling traditional ways with many aspects of foreign influence, requirements of a modern democracy and a market economy.

Located in the Central Pacific between 4 and 14 degree north and between 160 and 173 degree east, the RMI consists of two nearly parallel strings of atolls lying from the northwest to the southeast: Ratak (sunrise) group and the Ralik (sunset) group. The atoll chains are so isolated that the closest two major international centers, Honolulu and Tokyo, are more than 5,000 kilometers away. The republic comprises a total of 26 scattered atolls or 1,225 low-lying islets. The typical atoll will have about 80 – 100 islets and anywhere from 3 – 4 modest sized communities, ranging from 100 – 400 people. While the land area is small, some of these atolls enclose enormous lagoons. The Kwajalein Atoll lagoon, which is about 2,300 square kilometers, is the largest atoll in the world. The climate is characteristic of tropical islands all year long. The temperature is hot, reaching an average of 81 degree Fahrenheit with an average rainfall of about 12 inches per month.

The National Energy Policy Vision, that was adopted by the government in 2003, states that "Renewable energy is the most appropriate long-term alternative source to replace imported petroleum products for electricity production in the Marshall Islands; solar photovoltaic (PV) is already technically and financially attractive for relatively small remote island demands when properly planned, operated and maintained."

According to the 1999 Census of the Marshall Islands over two – thousand homes on the outer islands use kerosene for both lighting and cooking. The price for kerosene on the outer islands is above $2 per gallon. The use of flammable fuels within buildings poses several serious safety issues as most homes on the outer islands are constructed of wood or local materials. Use of solar systems should be cheaper for the average household and reduce some of the dangers of using petroleum products and open flame lighting in small wooden or thatch dwellings. The monthly fee for the use of the solar systems will be in the range $8 - $12 per month.

II. Objectives of the RMI Renewable Energy Program

(Reworked from Durrand pages 16 – 17)

There are five major objective areas to be addressed by the RMI renewable Energy Program. These are briefly described as:

- The first is to improve the quality of life for all people living in the outer islands.
- The second is to deal with some significant and serious environmental issues, by thinking globally but acting locally.
- The third, by providing light, particularly in the schools and medical dispensaries, vital government services can be accessed more easily.
- The fourth objective of the program is to help create an environment where people have the opportunity to supplement or increase their household incomes.
- The fifth objective is to have a program that is sustainable in terms of operation and maintenance.

Gender/Quality of Life

Thumbs up for Solar Power in the Marshall Islands

Many of the benefits of solar systems apply to all members of the household, regardless of gender or age. However, women benefit particularly from lighting whilst preparing food, dealing with the night fishing catch and tending to sick children at night. Men benefit particularly from lighting when preparing to go fishing at night and when getting ready to go off to work on their land early in the morning. In addition, children will have light to either complete their homework from school or read with the entire family.

Environmental issues

Solar energy is environmentally better in the outer islands than either diesel or petrol generators, because it produces no noise, emissions of fumes or greenhouse gases. Solar systems produce almost no visual impact in the outer islands (it is often difficult to see them – even from a short distance). The transport of liquid fuels to the outer islands carries high risks of leakage into water supplies and marine fisheries, and will remain a major problem for Marshall Islands in the future. The practical difficulties of transporting fuel to the outer islands include transfers by small boat, and carrying or floating oil drums to shore

before rolling them up the beach and placing them in open storage areas, where they heat up in the sun. Also a gallon of diesel or gas costs $5 per gallon and this is very expensive given the very limited incomes of households on the outer islands.

Health and Education

Social equity is necessary if there is to be any meaningful reduction in poverty. Skewed distribution of services, particularly in health and education, dilutes the impact of most economic growth. By focusing resources into these service areas, opportunities to make gains in education and good health can be better realized, poverty can be reduced and the quality of life improved. For example, most homes on the outer islands use kerosene lanterns that produce a small amount of poor quality light this makes it very difficult for people to read and for children to do any homework.

For example, when it rains on the outer islands the window shutters often have to be closed but, these shutters provide the only light for the classroom. Then without light, teachers end up sending the children home. Communities can use the schools for public functions in the evenings, students can continue to study or complete homework. Solar powered dispensaries can mean that vaccines or other drugs, not previously available to outer island communities, except on rare occasions, can be maintained and provided, as the situation requires. This could save lives and improve overall health care.

Employment and income generation

The MEC will directly employ two resident technicians in each equipped atoll picked from individuals in the Community. They will be trained during the solar installation campaign and backed up by senior technicians from the Marshalls Energy Company (MEC) who will make quarterly visits to the outer islands.

Solar systems provide better lighting for the handicraft making which can be expanded during night hours. It will also assist men with the preparation of their fishing gears during the night and/or early morning fishing trips.

Powering diesel generators with locally produced copra oil would not only provide a job to two island technicians but also generate extra income to the local copra producers and would open opportunities for other locally manufactured copra by-products such as soap.

Sustainability

Through the implementation arrangement worked out in conjunction with the Marshalls Energy Company (MEC), the future sustainability of the project is excellent. Customer service, monthly fee collection, maintenance and system upgrades will be handled by an organization that has an outstanding reputation amongst the utility operations in the Pacific Region. By having an organization and people who are experts in the field operate and manage the entire system, sustainability is more now than with any other similar project ever attempted in the RMI.

III. Why Alternative Energy? : A Priority of the People

The government of RMI recognizes that the provision of a cost-effective and a sustainable source of electricity to its outer islands is a key to the improvement of the standard of living of its people. Providing good public services such as clean water, power and telecommunications to people on the outer islands is also viewed as a major tool to reduce urban drift from the outer islands into the urban centers of Majuro and Ebeye and its impact on the nation's welfare. The RMI government, in its commitment to the global effort to reduce GHG emission while ensuring sustainable development for its people believes that for the remote and scattered outer islands populations, stand alone solar systems represent the best technical and economic solution to supply electricity on the outer islands.

Pacific island nations share a heavy dependence on imported petroleum (which accounts for 45% of primary energy consumption on average, with a range of 34-99%, World Bank report, 1992a). Although they are low energy consumers in global terms, their energy costs are high relative to their small economies. The World Bank Pacific Regional Energy Assessment report (1992a) showed the tremendous impact of petroleum imports on the economy. The ratio of petroleum imports to total exports is ranging from a low of 10% for Papua New Guinea to a high of over 400% for the Marshall Islands, Palau, and Tuvalu. This constitutes a dangerous dependency situation, and in cases of a major disruption in the fuel supply due to global shortages, rising prices, conflicts or other causes, the consequences would be dramatic. (Leplus, pg 15).

Why Alternative Energy? : The Cost of Kerosene and Batteries for Households on the Outer Islands

(From Worrall, pg 95 – 96)

In developing countries it is often considered that an affordable level of expenditure on electricity for households is 5% of their incomes. Levels in excess of 6% for low-income households are generally regarded as not affordable. For the communities surveyed during the 1994 ADB Outer Island Electrification Study, 5% of the average weighted income of the basic category suggests, that on this basis of ability to pay, households would be able to pay between $6.1 and $7.2 per month for lighting from a solar system which compares with their expected savings in kerosene and battery costs of $13.30 per month. Accordingly it appears that poor households are paying about 10% of their monthly income on electricity substitutes.

The initial 1994 ADB survey results indicated that households use a lantern for approximately 3 to 4 hours of lighting per night, and leave the lantern turned down to provide a night light for a further 6 to 8 hours per night. At a normal kerosene lantern consumption of 0.1-liters/hour/kerosene lantern, the lantern would use 12 litres or 3 US gallons per month. This is very similar to consumption of kerosene for lighting in pacific rural areas. The preliminary result of the survey indicated that these householders consume about 1 US gallon of kerosene per month per lantern for lighting. This is inconsistent with their claimed lantern use (which is reasonable and expected) and is discarded as either a survey error or a consistent understatement.

Households purchase kerosene at the local island store at a cost of between US$3.00 and US$3.50 per gallon. For the purposes of the current analysis we have adopted a cost of US$3.25 per gallon (exclusive of duties). Kerosene lanterns are estimated to cost, in the outer atolls, around US$15.00 (exclusive of duty) and replacement wicks US$0.85. Kerosene lanterns are estimated to have an average life of 5 years. Assuming a 10% discount rate this amounts to $0.33 per month. The cost of wicks and other lantern parts is estimated at US$5.00 per annum, or $0.42 per month. The monthly cost of a kerosene lantern is as follows:

Lantern capital costs	$0.33
Operating cost	$0.42
Fuel cost	$9.72
Total cost	$10.50

In the case of pressure lanterns the capital cost is approximately $50 (exclusive of duty) and mantles $2.50 each. Pressure lanterns are assumed to have a life of five years. Assuming a 10% discount rate, this amounts to a capital cost of $1.10 per month. The cost of mantles and other lantern parts is estimated of $24 per annum or $2.00 per month. Therefore the monthly costs of a pressure lantern is as follows:

Capital costs	$1.10
Operating cost	$2.00
Fuel cost	$22.75
Total cost	$25.85

In addition each household uses a large flashlight inside the house and for moving about outside in the dark. These flashlights on average take 4 size D batteries and last for approximately one week. The island price (net of duties) is approximately $0.70 per battery or $11.20 per month. However in terms of substitution with photovoltaic or an internal combustion reticulated system, it is estimated that an internal lighting system would displace approximately 25% of battery usage. The balance of torch usage outside the house and for fishing would continue. Therefore the benefit (avoided cost) to be ascribed to the photovoltaic or IC system would be $2.80 per month.

Many households also have battery operated radios and/or cassette players. These are estimated to use on average 6 size C batteries a week at an average outer atoll cost (exclusive of taxes) of $0.60 per battery. Because there is still some requirement for use of portable radios, it is estimated that a photovoltaic or IC reticulated power system would displace only 75% of the battery usage. Therefore the benefit (avoided cost) be provided by the photovoltaic or IC reticulated system is estimated at $10.80 per month.

The above kerosene and battery use benefits are summarised below in Table 10.2. This table demonstrates the amount, being spent by households on kerosene and batteries, available to meet the cost of the photovoltaic option. These are the major costs incurred by households. At higher levels of household income, expenditure on energy represents a much lower proportion of monthly income.

Table :Benefits (Avoided Costs) Based on Electricity Substitutes

	Kerosene/ Pressure Lanterns No	Kerosene/ Pressure Lantern (1) $	Flashlight (2) $	Radio (3) $	Total $
1 room House	1	10.50	2.80	-	13.30
2 room House	2	21.00	2.80	10.80	34.60
House w/ small washing machine	3	31.50	2.80	10.80	45.10
House w/ VCR/TV	3	31.50	2.80	10.80	45.10
House w/ refridge/freezer	4	57.35	2.80	10.80	70.95
Church/Hall (5)	2	21.00	2.80	25.00	48.80
Primary school	2	21.00	2.80	-	23.80
Store/dispensary	2	21.00	2.80	10.80	34.60

Notes:

1. Based on total avoided costs of $10.50 per month per lantern for kerosene lantern, and in the case of a house with a refer/freezer, one pressure lantern at an avoided cost of $25.85 per month per lantern.
2. Assumes a saving of $2.80 or 25% of the monthly battery cost.
3. Assumes a saving of $10.80 or 75% of the monthly battery cost.
4. In the case of church and primary school assumed that use of kerosene lanterns over a month was equivalent to a 2-room house.
5. An allowance of $25.00 per month for batteries or generator to operate an electric organ or PA system.

Why Alternative Energy? : The Secretariat of the Pacific Community Solar Report on Namdrik Atoll (2000)

The results from the 1994 ADB survey were reconfirmed in 2000, as part of the PREFACE feasibility study for RMI sponsored by the Secretariat of the Pacific Community (SPC) the average consumption of kerosene per household was 14 litres at a cost of $14/month. Monthly consumption of disposable D cell batteries was 13 units/month at a cost of $8/month. Part of the kerosene consumption is due to the 60 kerosene stoves available on Namdrik atoll, but most of them are just used randomly. A significant part of D cell batteries is for torches for walking at night and night fishing but it is estimated that these expenses have been reduced up to 2/3, due to the equivalent service provided by the solar systems.

In conclusion, the $12 monthly fee presently collected from solar clients is not an extra expense but an alternative to the former kerosene and batteries expenses for house and yard lighting. Households did not have a good picture of such balance as buying one liter of fuel or 2 disposable batteries at a time is less impressive than paying the $12 monthly bill.

The Namdrik project is a rehabilitation of a former project funded by France and poorly managed in the early 90's. The same PV panels are used, two 40 Wp modules, giving up to 0.3 kWh/day. The Solar Home Systems which will now be installed in the other outer islands within the ADMIRE Solar PV component, will be two 75 Wp modules array at least, providing more than 0.5 kWh/day to the client.

Why Alternative Energy? : Keeping Faith with International Commitments and Agreements

The United Nations Conference on Environment and Development, held in Rio de Janeiro, in 1992 called for the achievement of a sustainable energy future for all. The Global Conference on the Sustainable Development of Small Island Developing States, held in Barbados had translated Agenda 21 into specific policies, actions and measures to be taken at the national, regional and international levels to enable small island developing states to achieve sustainable development, minimizing the stress on their fragile ecosystems. Concerned about the energy sector in particular, Barbados Programme of Action for the Sustainable Development of Small Island Developing States, also called to gather and disseminate information, and promote regional cooperation and technical exchanges among small island developing states on energy-sector issues, including new and renewable sources of energy (ESCAP, 2002). A regional consensus, affirmed at the 2002 Regional Energy Meeting in the Cook Islands and finalized through Rarotonga Declaration agreed on a shared visions: 'Available, reliable, affordable, and environmentally sound energy for sustainable development for all Pacific islanders' (CROP EWG, 2002). (Leplus, pg 9).

- Earth Summit in Rio de Janeiro (1992)
- The Kyoto Protocol (1997)
- The Millennium Development Goals (2000)
- The World Summit for Sustainable Development (2002)
- The International Conference for Renewable Energies (2004)

Solar Power and New Water Catchment on Namdrik Atoll

The Marshall Islands and Solar Power

"*An analysis of the performance of solar power installations in other countries of the Pacific strongly indicates that they must be operated by a utility responsible for operation, maintenance and collection of fees/payments…. Village owned, government owned schemes and individually owned solar units have not worked generally because of inadequate maintenance….*"

Marshall Islands – Outer Islands Electrification Feasibility Study (1994)- PG 6

IV. Lessons Learned: The Development of the RMI Solar Electrification Program

(From Worrall, pg 43- 48)

The Ministry of Resources and Development began working on this project with the revitalization of the Energy Office in 2001. One of the first tasks of the Energy Office was to work with SPC on the Namdrik Atoll Solar Energy Rehabilitation Project. At the same time the Minister of Resources and Development involved the Economic Policy, Planning and Statistics Office (EPPSO) by requesting assistance to examine information about solar programs in the Pacific Region. The main point of reference was a review of the Asian Development Bank's report on the Electrification of the Outer Islands (Republic of the Marshall Islands – 1994). The most significant finding was the recommendation that existing utility companies must be involved in this process if the goal of more wide spread solar electrification is to be realized.

After the scrutinizing of various management approaches utilized throughout the Pacific region and fully comprehending the strengths and weaknesses of the approaches used, the Energy Office, with approval from the Cabinet, has decided to turn over the installation, operation and maintenance of the Outer Island Electrification Project to the Marshalls Energy Company (MEC). Without any doubt, the success of MEC has been borne of its diligent and well established management and accounting systems. Furthermore MEC has a customer-oriented approach that enables people to see that their payments are translated into a service. In addition MEC has several trained technicians and electricians required to oversee substantial technical elements of this project.

Initially, the community benefiting from the solar systems must be informed through ongoing consultations with R&D and MEC regarding all aspects of planning, installation, payments, etc. The Ministry of R&D must ensure that the outer island communities understand why MEC, and not the local government is carrying out such projects. Without the community's involvement and commitment, the solar project will not achieve sustainability.

The Marshalls Energy Company (MEC)

MEC is responsible for the electricity sector [except in Kwajalein], sale of LPG and managing bulk fuel storage facilities. MEC's distributed power is available to Majuro, with smaller facilities on Jaluit and Wotje. Electric power in Ebeye, the other major urban center, is supplied by Kwajalein Joint Utilities Resources (KAJUR). The Majuro power station was enlarged in 1998 by construction of a new additional 12.8 MW plant, funded by

a commercial loan of $11m. MEC currently has 132 employees dispursed throughout its operation centers, of which only four are non - Marshallese.

MEC imports diesel fuel for supply to its power stations. MEC owns a 6 – million gallon tank farm which allows it to sell fuel to the RMI government and foreign fishing vessels. This operation is regarded as one of MEC's most profitable activities. MEC also imports liquified petroleum gas (LPG) into the RMI in bulk containers for resale in standard smaller range bottles to the public, private sector & fishing boats. (Durrand pg 58)

MEC Power Stations and Tank Farm near the Delap dock on Majuro

Government subsidies to MEC ceased in 1993, when MEC began to operate profitably. In 1999, MEC's financial balance by activities was positive, benefits from power generation and to a less extent fuelling of vessels and LPG sales were more than covering the losses from the other branches (distribution, administration and the Jaluit power plant).

MEC functions independently of the government operations and as such operates it own accounting procedures and systems. These systems are fully audited annually by International Auditing companies. (Durrand, pg 58).

MEC is also a founding member of the Pacific Power Association (PPA) based in Fiji. The PPA is an Association formed by nearly all the power utility companies from the Pacific Island nations along with industry suppliers and manufacturers from the rest of the world. This association pulls together the vast array of knowledge and expertise spread throughout the Pacific and allows these small island states to collectively support each other.

Lessons Learned: Institutional Issues from Solar Electrification Projects Across the Pacific Region

Throughout the many reports written examining solar power in the pacific, many lessons learned were observed and elaborated. The RMI considered these lessons and reflected on the past experiences of solar projects on the outer islands and began to develop new approaches in solar program development.

- ***User maintenance rarely works***
  Many problems with solar equipment are subtle and require training and experience to determine the problem.
  RMI Solution:
  With specific project related donor equipment installed in very remote locations, there is always a problem with maintenance and spare parts.
  The involvement of MEC has meant that there is now a source of locally available qualified staff to develop an ongoing training and maintenance regime along with spare parts inventory (that is based here) in the Marshall Islands. In the past experts would come and install systems then leave, never to return. This often meant that people who had never seen a solar system before, were often left to try and keep the system running with no knowledge of the limitations and workings of the system and to do so with whatever materials they could afford or fashion to get the systems to work.

- ***Fee Connection and management should be from outside the immediate community.***
  When fees are collected by a local community organization, collection discipline is lax and funds are often used for other community projects instead of being set aside for solar equipment repairs.
  RMI Solution:
  Communities in many of the Pacific Islands still hold dear to custom and hierarchical values. This value of respect for the elders and the traditional rights associated with seniority compounds the problems associated with who should pay and who believes that they are not required to pay. Therefore it is hard for an individual to demand an elder or someone of higher status to pay for services.
  These island communities are usually small and supportive of all in the community. If payments are collected and no rigid controls are in effect, then collected payments will disappear to what may be considered a more worthy cause. This usually results in the decision to not collect any fees at all.

MEC Office Namdrik Atoll

To resolve this issue, MEC has the resources to send in a 'non-island' local to enforce the company's policies towards payment or disconnection of service. All monthly service fees are sent to MEC's Majuro office where payment records will be maintained on an atoll-by-atoll basis. All money received will be deposited into the particular atolls accounts to build up spares inventory and allowing for materials for expansion of services etc.

- ***Frequent visits by trained maintenance personnel is very important***

  Frequent maintenance checks help ensure that the battery electrolyte levels have not fallen below minimums, that shading has not become a problem, that connections are clean and tight and that the user has not added more lights or otherwise modified the solar system in a detrimental manner.

  RMI Solution:

  During the installation period of the solar equipment, talented individuals will be selected for additional training with the aim of taking over the role as 'on-island' maintenance staff to run the operation. These staff will be responsible for the day-to-day maintenance of all the installed systems. In addition they will be required to attend, at regular intervals, training sessions at MEC's training facilities in Majuro. The 'on-island' technicians will be in contact with the Majuro based electricians via single side band radio to discuss any issues that develop. The Majuro electricians will also be doing inspection trips around the islands on a regular basis.

- ***Spare parts stocks must be readily available***

  While this represents a substantial investment as well as increased inventory control problems, weeks or months of delay between needing a spare part and receiving it from overseas suppliers is unacceptable.

  RMI Solution:

  MEC currently stores all the spare parts for the existing solar program and has development plans to increase the size of their current facilities to included a dedicated Renewable Energies storage and training facility. The 'hook-up' fee that each customer pays for the installation is deposited into a specific Atoll account.

These funds are to be used to provide an inventory of spares specifically for that atoll's needs in addition to any surplus installation materials.

- ***Field technicians should have ready access to technical assistance and should have access to a continuing training program***.
  Giving a local resident a one or two week crash course in solar equipment maintenance is clearly not adequate nor is a system where the technician is expected to call for help only when he is already in deep trouble. Regular visits by a senior technician to provide on-the-job training and to check the technician's work for problems is important both to the field technician and to the success of the project.
  RMI Solution:
  MEC has qualified Marshallese and expatriate electricians on its staff. Several were involved in the existing solar installation programs and have been to several solar specific courses at facilities around the Pacific. These staff will be involved in the installation of equipment at future locations as well as training of the 'on-island' technicians. Follow up sessions by these staff members will be conducted on the outer islands at regular intervals, in addition to maintaining regular radio contact, with the technicians. MEC is also planning to expand it existing facilities to include a new training facility that will include identical systems to those used in the outer islands. This will enable the electricians to replicate problems found on the outer islands and develop solutions. During training sessions, the technicians will be able to physically show the electricians potential problems on these units as well.

V. Funding and Budget Requirements for the RMI Solar Program

Funding programs are required to complete the installation of basic PV lighting systems to the remaining outer islands. Estimates based upon completed works to date have been calculated for the remaining atoll communities to arrive at the following estimated costs shown in the table below. The RMI Government continues to allocate funds for this project but with the limited resources and prior commitments, it will be impossible to to meet goals previously set to achieve basic lighting/power services to every home within the RMI. External assistance must be sourced to achieve these goals.

OUTER ISLANDS ELECTRIFICATION PROJECT

LIST OF POTENTIAL OUTER ISLANDS HOUSEHOLDS FOR PV

Atolls/Islands	No. of Households (Pop. 99)	Est. Mat'l Costs ($2,500 per sys)	Est Installed Costs ($4,500 per sys)
Ailinglaplap	236	*$590,000*	**$1,062,000.00**
Arno	244	*$610,000*	**$1,098,000.00**
Kwajalein (Ebadon, Santo)	103	*$270,000*	**$463,500.00**
Jaluit (not Jabor)	146	*$365,000*	**$657,000.00**
Mili	136	*$340,000*	**$612,000.00**
Ebon	122	*$305,000*	**$549,000.00**
Namu	127	*$317,000*	**$571,500.00**
Maloelap	138	*$345,000*	**$621,000.00**
Sub - Total	**Total H 1252**	***$3,142,000***	**$5,634,000.00**
Ailuk	88	*$220,000*	**$396,000.00**
Likiep	82	*$205,000*	**$369,000.00**
Aur	86	*$215,000*	**$387,000.00**
Utrik	65	*$162,000*	**$292,500.00**
Sub - Total	**Total H 321**	***$802,000***	**$1,444,500.00**
Lib	15	*$37,500*	**$67,500.00**
Jabat	15	*$37,500*	**$67,500.00**
Wotho	18	*$45,000*	**$81,000.00**
Wotje (Wodmej)	27	*$67,000*	**$121,500.00**
Majuro (Aenkan)	14	*$35,000*	**$63,000.00**
Sub - Total	**Total H 89**	***$222,000***	**$400,500.00**
Ujae	67	*$167,500*	**$301,500.00**
Lae	32	*$64,000*	**$144,000.00**
Sub - Total	**Total H 99**	***$231,500***	**$445,500.00**
GRAND TOTAL	**1761 Households**	***$4,397,500***	**$7,924,500**

NOTE: Bold Est Installed Cost column <u>includes</u> Material purchase costs

Typical Basic Solar Lighting System

Two 75-80Wp solar panels mounted on an adjustable pole structure supplying power to a control box mounted on the pole. Inside the control box will be the charging controller supplying the collected power to storage batteries. The stored charge is then supplied via a voltage regulator to the house via small circuit breakers and switches to supply up to 4 fluorescent tube lights located around the residence, both indoors and outdoors. In addition a small LED night light is often supplied as well as a multi-voltage power outlet, ranging from 3 - 12Volts, for the connection of small radios and or inverters.

VI. THE MARSHALL ISLANDS AND BIOFUEL/COPRA OIL

The coconut tree is a vital component of island ecosystems, a staple food and often the only local source of income for many rural communities in the Pacific region. Its products and by-products, including copra, have played and will continue to play a fundamental role in the islands' economies. The last decades have seen world copra and coconut oil prices fluctuate widely, but decline in real terms. This difficult situation, in which coconut growers world-wide find themselves today, is aggravated by the fact that the Marshall Islands are widely scattered and insulated. This can lead to the decline of major cash income, particularly in the rural and remote areas, and to the continuing heavy reliance on petroleum products, which hampers the region's socio-economic development. (Leplus, pg1)

The coconut tree, called the "Tree of Life", is a vital component of island ecosystems and often the only local source of cash income for many rural communities in the Pacific region. Removing and drying the coconut kernel to make "copra" has been the primary source of income for people in the Marshall Islands for generations, and still plays a fundamental role in their economies and in income distribution to the most rural families, which often depend on copra sales for school fees, taxes and to purchase basic necessities. (Leplus, pg 17).

As atoll communities have solar lighting systems installed, there is an increasing awareness that many households desire to have even better amenities available. This desire for appliances such as washing machines, televisions, VCRs, refrigeration and freezer storage is strong though financially unobtainable for many. Most will however obtain a TV and VCR through a relative from one of the major centers and with the aid of power inverters, run these items from the solar lighting system. This has prompted the rise in the capacity of the basic supplied system from 80Wp to 150Wp to make this more achievable.

Making Copra and Using Solar in the Marshall Islands

However with the people producing copra to generate income, MEC sees the potential for developing this process further. MEC is looking to source/develop a series of mini copra driers, mills and presses to process the copra into oil. This oil then can be used as an alternative to diesel fuel in small generators. MEC aims to develop a range of small generators ranging in size from 5kW up to 50kW that can run on this fuel source. The various system sizes would then be available to individuals and/or

communities or co-operatives as a complete system. The Coconut oil generators would need to be used in conjunction with solar lighting systems. The intention is for the generators to power high load appliances such as washing machines and other major appliances such as freezers. These items do not require a 24hr power supply; they could be run for several hours in the morning then again in the evening for several more hours. This leaves the solar lighting system solely for powering lights and light load appliances during the day and night time.

The potential advantages of being able to produce coconut oil on the outer islands create numerous possibilities for the isolated subsistence farmer. The production schedules would no longer be restricted to the shelf life of dried copra. The farmer could convert all his copra to oil and sell this to other communities or to the major mill in Majuro. Having freezer storage capability in the outer islands allows for a greater range of food preservation and storage. This and other benefits will increase the number of people wanting to travel and stay in the outer islands longer and more frequently.

Potential Pilot Biofuel/Copra Oil Project

The opportunity exists to develop a pilot project following the outline briefly described above. This could be developed here on Majuro and perfected over time before undergoing full trials on an outer island. MEC could develop the system utilizing any necessary facilities here on Majuro then transfer the equipment to one of the outer islands where MEC operates the smaller power stations for trial in a nearby outer island community.

A couple of small suitable 10kW generators would need to be procured along with several other necessary items, some of which would be standard off the shelf components. Several other items may need special fabrication, some of which may have to be done overseas.
Anticipated timeframe to develop the system is approximately 18 months at an estimated cost of US$150 - $200,000.00.

There has been no feasibility study done to date, but the system can be built and operated. We know the system works in full scale plants such as copra mills and bio fuel power stations. Several people claim to have small diesel vehicles operating on coconut oil also. Our problem will be in obtaining the right equipment to get the right quality of oil for the smallest of engines, then getting that equipment downsized to be in small enough, affordable, packaged systems. We know we can do this and make it work, we just need some additional help and financing.

VII. Battery Exchange Program – The Challenge of Recycling

With the Outer Islands heavy reliance upon battery products, both previously and into the future with the PV systems, MEC is investigating the potential to institute a battery exchange for recycling program. This program will target the batteries being used in the PV systems initially, with the aim of expanding the program to include used car, boat and equipment batteries. (there are 3000 plus vehicles carrying batteries on Majuro alone). The batteries would be collected and returned to a specific, selected, offshore battery manufacturer for recycling in exchange for purchasing new batteries from their company. Ultimately it is hoped that the small disposable batteries used in flashlights and radios could also be included in the exchange or disposal program.

The current disposal methods of throwing the used batteries into landfills or using them as small boat moorings in the lagoon is environmentally unacceptable. Instances of batteries being broken down to collect the lead components for fishing sinker manufacture are common as is the practice of using the heavier model battery plates as outdoor floor tiling. These uses and disposal methods are creating environmental and health issues within the whole nation.

MEC is required to stock “spares” including batteries for the PV solar program so MEC sees it as a logical extension, and requirement, to be responsible for the collection and disposal of the products under MEC’s control. It is therefore desirable to attempt to extend this service to the community as a whole. Funding and technical assistance will be required to expand existing or create new facilities to provide this service and to locate a suitable and willing battery manufacturer to support the program.

VIII. Achievements of the RMI Alternative Energy Program to Date

Below is a brief summary of the accomplishments of the Solar Program in the Marshall Islands. While this is an impressive list of achievement, much, much more work needs to be completed before success can be declared.

1. **Franchise and Lease Agreement between the National Government and MEC for all alternative energy projects on the outer islands (2003)**

2. **Creation of Alternative Energy Division within the Marshalls Energy Company (2003)**

3. **National Energy Policy Adopted (2003)**
   The Government of the Marshall Islands through the *National Economic* & *Social Summit 2001,* highlighted its strategies for achieving economic and social development and these include, *"increased self-reliance, renewed economic growth, enhanced employment opportunities, alleviating poverty through* a *balanced and more equitable distribution* of *income, environmental sustainability and improved health standards, education services, enhanced competitive skills and change of attitudes.* The National Energy Policy for the Marshall Islands is one of the instruments that are put in place to assist the government to achieve the above development goals.

4. **Namrdik Atoll Solar Electrification (2002 – 2003)**
   Consists of 113 units and 105 paying customers (some customers have double systems). MEC took over the project in early 2004.

5. **Mejit Island Solar Electrification Grant (2002)**
   The RMI received a grant from the government of France for $170,000 to assist with the purchase of solar equipment for Mejit Island.

6. **RMI – European Union (2003)**
   Through the newly ratified Cotonu agreement with the European Union, the RMI will invest approximately $400,000 a year (2004 – 2008) from the EU into Outer Island Solar Projects.

7. **Solar Project Selection Criteria (2004)**
   Developed by the Ministry of Resources and Development and approved by Cabinet.
   Criterion 1 – Population and size of the atoll/island
   Criterion 2 – Availability of Funds and number of systems that can be purchased
   Criterion 3 – Community Readiness
   Criterion 4 – Equal Distribution of capital projects and services

8. **Awarded a Grant for Training Outer Island Solar Technicians and Establishment of a Alternative Energy Database (2003)**

The Ministry of Resources and Development received a 50% matching grant from the U.S. Department of the Interior worth a total of $117,000. This grant will be used to help train outer island solar technicians as well as to establish a database, in both MEC and the Ministry of R/D, of alternative energy systems, parts and projects throughout the RMI.

9. Tinak Hybrid Wind/Solar Project (Arno Atoll):

The Association of the South Pacific Area otherwise known as ASPA funded this project. ASPA is a non-profit organization based in Kwaicho city in Osaka, Japan and is also a sister city of Majuro. Although this project was awarded (approximately $76,000) to Tinak Saint Paul Elementary School and maintained by the Catholic Mission, families of the students and other community groups have access to use the apparatus as long as it does not interfere with the school's schedules and activities. The kids have a better education system with more resources needing more power available to them, such as a copier, T.V., etc. In addition to regular lightings and power to the school, the project also records the weather, particularly wind data, which could be helpful when planning for future wind turbine projects in the RMI. Overall, the system is working and very helpful to the school and community on Tinak.

APPENDIX

Map of the Republic of the Marshall Islands

Table 1: Households by type of fuel used for lighting by atoll/island (1999 Census)

Atoll/Island	# of Households	Electricity	Kerosene	Solar	Others & Not Reported
Alinglaplap	236	8	203	23	2
Ailuk	88	1	67	18	2
Arno	244	17	187	38	2
Aur	86	1	80	5	0
Bikini	0	0	0	0	0
Ebon	122	0	114	8	0
Enewetak	109	46	62	0	1
Jabat	15	0	4	11	0
Jaluit	229	82	145	0	2
Kili	90	90	0	0	0
Kwajalein	1,213	1,089	117	0	7
Lae	32	0	28	4	0
Lib	15	0	15	0	0
Likiep	82	13	62	5	2
Majuro	3,080	2,720	339	8	13
Maloelap	138	18	105	15	0
Mejit	60	0	60	0	0
Mili	136	5	113	18	0
Namdrik	118	0	5	112	1
Namu	127	3	119	3	2
Rongelap	-	0	0	0	0
Ujae	67	1	58	8	0
Utrik	65	1	25	39	0
Wotho	18	0	13	5	0
Wotje	108	7	83	17	0
TOTALS	**6,478**	**4,102**	**2,004**	**337**	**35**

Table 2: Households by type of fuel used for cooking by atoll/island (1999 Census)

Atoll/Island	# of Households	Electricity	Kerosene	Propane	Charcoal	Wood	Solar	Others, None & Not Reported
Alinglaplap	236	0	13	1	47	173	0	2
Ailuk	88	0	5	0	0	80	1	2
Arno	244	6	38	5	1	193	0	1
Aur	86	0	1	0	0	85	0	0
Bikini	0	0	0	0	0	0	0	0
Ebon	122	0	6	0	1	115	0	0
Enewetak	109	2	22	0	8	77	0	0
Jabat	15	0	2	0	0	12	1	0
Jaluit	229	34	53	1	1	138	2	0
Kili	90	89	0	1	0	0	0	0
Kwajalein	1,213	466	720	4	1	13	3	6
Lae	32	0	1	0	0	30	1	0
Lib	15	0	0	1	0	14	0	0
Likiep	82	0	9	2	0	70	0	1
Majuro	3,080	1,105	1,666	87	2	206	0	14
Maloelap	138	0	32	0	8	96	2	0
Mejit	60	0	1	0	0	59	0	0
Mili	136	0	2	2	0	131	1	0
Namdrik	118	0	1	1	0	116	0	0
Namu	127	0	13	0	1	112	0	1
Rongelap	-	0	0	0	0	0	0	0
Ujae	67	0	5	1	0	61	0	0
Utrik	65	0	0	0	0	65	0	0
Wotho	18	0	4	2	0	12	0	0
Wotje	108	0	27	0	2	77	1	1
TOTALS	**6,478**	**1,702**	**2,621**	**108**	**72**	**1,935**	**12**	**28**

Table 3: Population and Median Household Income by atoll/island (1999 Census)
Average Size per Household: 8.7 People; Median Household Income: $6,839.83

Atoll/Island	# of People	# of Households	Median Household Income
Alinglaplap	1,959	236	$838.29
Ailuk	513	88	$637.46
Arno	2,069	244	$1,845.45
Aur	537	86	$2,055.56
Bikini	13	0	0
Ebon	902	122	$983.62
Enewetak	853	109	$10,750
Jabat	95	15	$833.50
Jaluit	1,669	229	$3,272.73
Kili	774	90	$8,114.29
Kwajalein	10,902	1,213	$14,195.31
Lae	322	32	$2,714.29
Lib	147	15	$625.38
Likiep	527	82	$2,133.33
Majuro	23,676	3,080	$9,030.17
Maloelap	856	138	$1,634.62
Mejit	416	60	$2,263.16
Mili	1,032	136	$1,051.28
Namdrik	772	118	$1,409.09
Namu	903	127	$785.03
Rongelap	19	-	0
Ujae	440	67	$683.99
Utrik	433	65	$3,250.00
Wotho	145	18	$2,800.00
Wotje	866	108	$2,875.00
TOTALS	**50,840**	**6,478**	**$6,839.83**

Majuro Weather

Call sign: MAJ (PKMR), Coop ID #: 914460, WBan #: 40710.
Location: **7°05'N / 171°23'E**

The station at Majuro is located on the southeastern end of the Majuro Atoll. This atoll is approximately l60 square miles in area with a lagoon of about l50 square miles. The lagoon is oblong, 22 miles long and about 4 miles wide. Delap Island, on which the station is located, is oriented roughly east-west.

The climate of Majuro is predominately a trade-wind climate with the trade winds prevailing throughout the year. Tropical storms are very rare.

Minor storms of the easterly wave type are quite common from March to April and October to November. The trades are frequently locally interrupted during the summer months by the movement of the zone of intertropical convergence across the area. Rainfall is heavy, with the wettest months being October and November. Precipitation is generally of the shower type, however, continuous rain is not uncommon.

One of the outstanding features of the climate is the extremely consistent temperature regime. The range between the coolest and the warmest months averages less than l degree. The average daily range is less than 9 degrees. Nighttime minima are generally 2-4 degrees warmer than the average daily minimum because lowest temperatures usually occur during heavy showers in the daytime.

Skies at Majuro are quite cloudy. Cumuliform clouds are predominant but altostratus-altocumulus and cirriform clouds are also present most of the time.

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