

Biofuel production and refining development at KCMC Copra Mill



Kiribati – Italy Cooperation Programme utilising Renewable Energy addressing the economy and climate change challenges.

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Table of Acronyms

CCA	Chevalier College Abemama
CO ₂	Carbon Dioxide
CROP	Council of Regional Organisations of the Pacific
EEZ	Exclusive Economic Zone
EPU	Energy Planning Unit
KCMCL	Kiribati Copra Mili Company Limited
MCIC	Ministry of Commerce Industry Cooperative
CNO	Coconut Oil
FFA	Free Fatty Acid
EU	European Union
GEF	Global Environment Fund
MELAD	Ministry of Environment Lands and Agriculture
MFED	Ministry of Finance and Economic development
MPWU	Ministry of Public Works and Utilities
PIGGAREP	Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project
SIDS	Small Island Developing States
TA	Technical Assistance

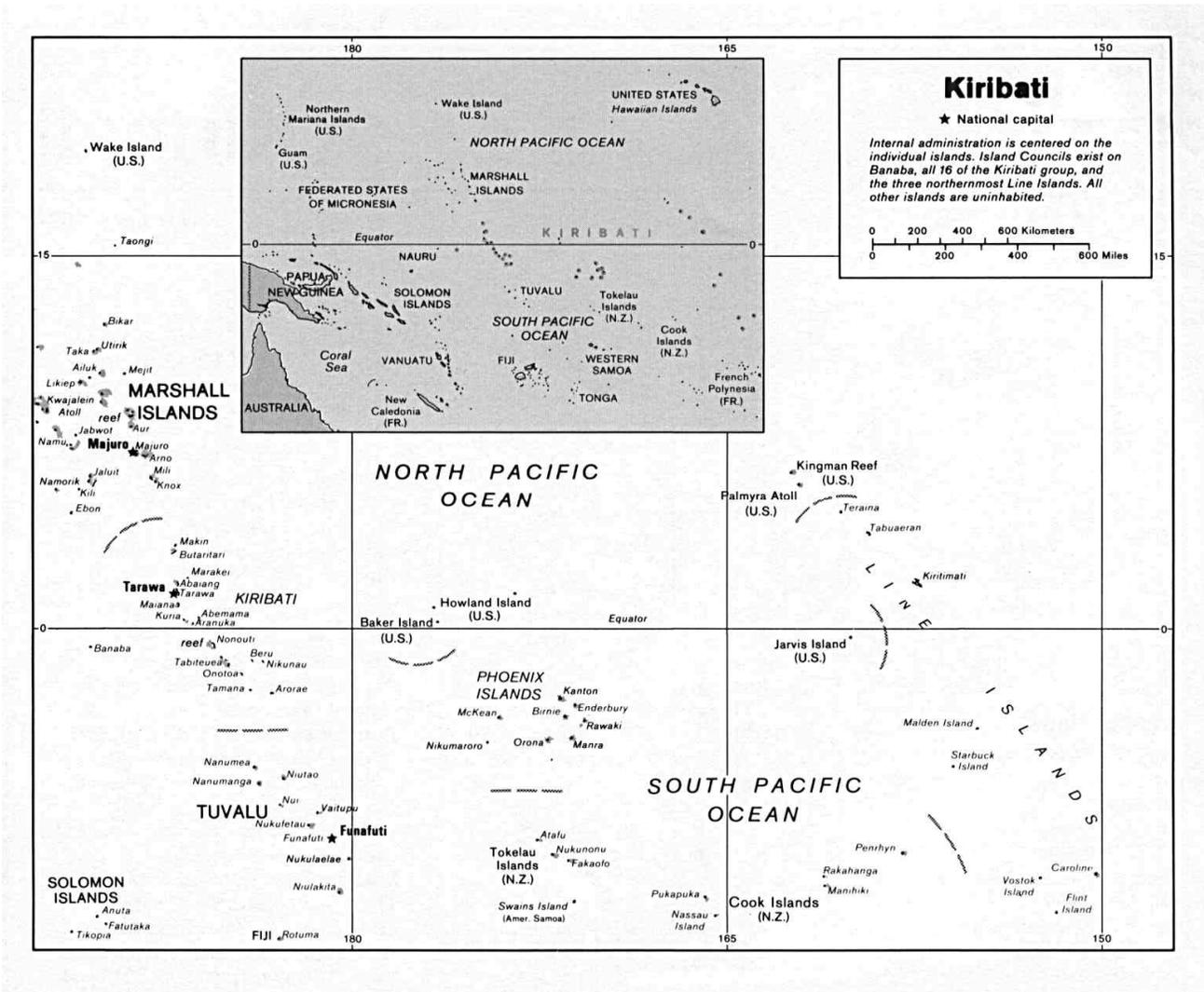


Figure 1: Map of Kiribati and its immediate neighbors (Source: google maps)

1. Background

Although there is substantial evidence of the environmental remuneration of using coconut oil as fuel, it is the local cost of petroleum fuel that is the real driver behind these developments in the Pacific Island economies. Electric utilities generally suffer greatly from depending on imported diesel for power generation and are seeking new ways to hedge these risks. The cost of electricity in the islands is a significant disadvantage for business investment, which makes it harder for the island to develop the economics of scale necessary to avoid very high energy costs. The economics of most of Pacific Island communities are depressed as it is, and the economics of energy are a massive burden that weighs them down as they try to improve their standards of living and quality of life.

Coconut industry in Kiribati is viewed by Government as an important means to promote its overarching goal of equitable distribution of prosperity and has made appropriate policy commitments to boost copra production and thus the income of the farmers. To improve income from the copra, the oil mill has been established to add value to the commodity producing crude oil and copra meal for export and coconut oil based products for import substitution in products like soaps, cooking oil, perfumed body oil etc for the. In recognition of the need to boost production, Agriculture operational plans and strategies puts as one of its emphasis, increasing coconut production.

With its given location and distances from export markets and limited port infrastructure, Kiribati continues to face the export challenges: high costs in oil export operations, high freight, and expensive packaging used etc. With these export and marketing issues for crude oil and the ever increasing price of fuel, total utilization of oil for the domestic market is the most logical approach. Current world wide moves towards use of vegetable oil as substitute of fossil fuel presents a viable alternative for Kiribati. There are on-going efforts towards this direction recommending production for domestic consumption, bio-fuel/bio-diesel and once on the agenda of the KCMCL was the power generation using 100% coconut oil as fuel for electricity production.

The Kiribati Copra Mill Co. Ltd was first established in 2001 and became commercially operation in the last quarter of 2003. The Company is 100% government owned established with the main objectives of adding value to the raw copra for both the export and domestic markets. The Company owns a copra oil milling plant that has the capacity to crush the entire copra production in Kiribati (8500 – 12000MT/annum), a soap processing plant and a small oil refinery unit. Current areas of business activities therefore include coconut oil production with copra cake as by-product, toilet and laundry soap processing, perfumed body oil production, and pet bottling. About 90% of the oil produced is currently exported with balance sold in the domestic market as crude oil and soap and body oil processing for the domestic market. About 85% of copra cake produced is also exported with balance sold in the domestic market.

2. Motivation

Copra, like fish for Kiribati is 'gold', the main cash earner of the majority of the population in Kiribati and revenue earner for the country. The export of copra, the traditional coconut product was justified on the grounds of the lack of suitable alternative technologies, skills and capital for domestic value adding. The proposed coconut bio fuel has wide economic development implications through rural income distribution, energy security and foreign exchange savings.

Pacific Island economics suffer from a diesel dependency syndrome. The development path in industry, transport, and household energy consumption has seen a dramatic expansion towards using fossil fuels, especially diesel. To meet the cost of import of these fossil fuels and associated combustion technologies, the society not only allocates an ever growing proportion of its hard earned foreign exchange, but also finds itself under heavy pressure to meet the growing demand for foreign exchange by destructive environmental practices such as intensive logging of native forests. Besides, the current energy consumption path seeds long term environmental problems for the beautiful Island Nations through pollution, global carbon emissions and destruction of forest carbon-sinks and biodiversity.

A successful domestic coconut bio fuel energy program involves an efficient grass-root level production technology of the fuel and appropriate combustion or use technologies. On both counts, the coconut oil produced by hot press method will be chemically treated to bring the world standard of coconut bio fuel. Or another technology is for extraction of coconut oil by cold press expelling and cleaning the oil to the 1 micron particle level to use on diesel engine.

The Company commenced on trial and error phase in late 2005 to produce and use bio fuel using coconut oil and diesel at ratio of 1 (cno) to 4 (diesel) to run its vehicles and coconut oil and kerosene at **65% (cno) and 35%** (kerosene) ratio to run its boiler. Trial and error testing of the fuels continued into 2006 but had stopped due to realization of needs to apply proper technology in the production of bio fuel for effective utilization. As a result of trials however, the Company was assured of the coconut oil potential for use as fuel. Results of analysis of KCMCL bio fuel confirmed th need to tackle quality of oil as fuel and therefore production as well as application ceased and work resumed on identifying appropriate plant, equipment and technical assistant.

Kiribati Copra Mill Company Ltd (KCMCL) decision is based on a number of reasons:

i) the high costs in the export operations of oil to overseas markets: Kiribati is located far from the world markets of oil and faces highest costs in terms of freight compared to neighboring exporting countries; oil packaging is an additional cost to the export of oil as the port facility and capacity is yet to facilitate bulk shipment of the oil. Flexi bag holding about 21 MT is currently used to pack the oil for the

export markets; relative additional costs are created to move full containers from production site to wharf and then onto barge for transfer onto vessel.

- ii) the demand for alternative energy sources and available production technologies: Kiribati is perhaps
- iii) the environment benefits for small island states like Kiribati;
- iv) the need to combat the price fluctuation in the world oil market price;
- v) the need to combat the ever increasing fuel price

- vi) expansion and value adding for increased financial returns.

Following success stories on the production and use of the coconut bio fuel in the neighbouring countries of Vanuatu, Fiji and Marshall Islands, and world wide, the company decided to embark on the project setting up its own task force to undertake a technical study and put up recommendations to the Board with the view to commence as soon as practicable within 2008.

3. Aims of the Project

The production of bio fuel will contribute to the new policy direction of Government to address the international and national issue of climate change, the national issue of the increasing fuel price, facilitation of private sector development, industries development and the expansion aspirations of the Company into value adding of producing bio fuel for the benefit of society at large.

Government provides significant budget support to the copra industry in terms of copra subsidy. Government also subsidizes imported fuel. The opportunities exist in the renewable energy area for Kiribati to pursue and coconut oil, beside the solar and wind energy sources, plays an important role. Export of copra is not sufficient and value adding through oil milling for coconut oil production is one intervention in the direction of return maximization that Government undertook. Through recent developments in the field of renewable energy – the bio fuel production technologies, KCMCL’s aim to produce fuel standard coconut oil for the transport sector and contribute to addressing national issues over imported fuel costs and supply, and to provide for other industrial use. At the same time the bio fuel program will address high cost issues currently faced by copra industry within Kiribati and to the international markets. Specifically to facilitate the aims, the interventions with details in the table below are specified.

Type of Intervention	Details
Bio Fuel Production and quality control	<ul style="list-style-type: none"> ▪ Installation of a 1000-5000 liter per 8hr plant and outlet accessories ▪ Appropriate quality control and monitoring lab at the KCMCL site in Betio. ▪ A TA will be recruited to establish the lab for quality monitoring and control
Capacity Building	<ul style="list-style-type: none"> ▪ Enrichment programs through training and development, exposure and attachment with similar set ups in the region and elsewhere, membership in appropriate international organizations and attendance of relevance technical conferences and meetings.
Educational and Awareness Enhancement	<ul style="list-style-type: none"> ▪ Promotion and Awareness programs on the benefits of bio fuel production and application/usage. ▪ Consultation workshop with key stakeholders of bio fuel potential users in Tarawa.

4. Technical Description

4.1 Background and Justification

World coconut oil production is approximately 3.5 million tons and represents 3% of the world production of edible oils. In Kiribati, the coconut is the most important crop. For more than a century, the income derived from copra sustains the rural economies on the atolls where smallholders produce practically all copra. Copra and CNO are also the most important export commodities currently generating US\$3.7 million in annual export earning last year. The dispersed nature of the islands puts shipping in the center of the copra industry and irregular shipping schedules frequently constrains market access for the rural copra producer. In recent years unfavourable world market prices for copra and CNO have required substantial government subsidies to keep the copra industry alive.

Kiribati annual production averages 8,500 - 12,000 tons per annum. At oil extraction ratio of 0.55kg of coconut oil per kg of copra, this translates into a coconut oil production potential of 6,050 tons per year. The following table outlines the annual copra quantity in the Gilbert and Line Islands from 2004 to 2007 landed in Tarawa (excludes quantity remaining in the Islands):

Copra Production	2004	2005	2006	2007
Gilbert Group	11073	4540	5064	11073
Line Group	1619	2240	940	1867
Annual Production	12692	6780	6004	12940
Copra Crushed	4582	3889	5676	6778
Oil Extraction rate 55%	2520	2139	3122	3728

KCMCL copra crushing plant is originally designed to process the entire copra production in Kiribati. As depicted from the table above, the quantity of copra crushed each year ranges from 3889 m/t to 6778 m/t. This indicates that the mill is yet to reach its full crushing capacity. With bio fuel production, KCMCL would be in a position to transform some of its crude oil to bio fuel at the early stages of the project without disruption to its oil export activities.

KCMCL mill is designed to crush about 8500 – 12,000 MT copra in a year but is currently operating at 70% of its designed specs. The oil is extracted from copra by mechanical extraction through screw presses. Extraction rate depends on the quality of copra as well as efficiency of the

press. At the moment the mill is operating at around 55-60% extraction rate. Because the KCMCL screw presses and filters do not produce good clean oil, hence crude CNO for bio-fuel has to undergo further refinement in the refinery plant.

The quality of the final products depends on the initial quality of raw materials, good harvesting and transport conditions from fields to mill, and the efficiency of processing operation, purification and storage of end products. KCMCL does not have proper bio-fuel plant setup and had made use of its own existing 2MT capacity oil refinery plant (for cooking oil, body oil manufacturing) and own crude CNO to produce refined coconut oil for bio-fuel. This involves a simple refining steps similar to cooking oil process before it can be blended with diesel or kerosene to make up bio-fuel.

The refining process for bio-fuel follows washing of CNO with water to degum and remove minute contaminants in the crude oil. Caustic, at times, is added to lower the Free Fatty Acid (FFA) content of CNO. The mixture is left to separate the two phases and water with contaminants are removed by downward displacement. Washed oil is heated up to 100°C under constant vacuum to remove moisture. Refinery filter press with filter clothes greater than 5microns is used to ensure further removal of unwashed soap and smaller particles the cloth are specifically designed for. KCMCL used the filtered CNO and mix with either kerosene or diesel for its bio-fuel use.

Following the analysis on KCMCL refined oil by a German vegetable oil fuel standard a (DIN 51 056) a few issues are apparent for addressing. The analysis found KCMCL oil flash point 38°C lower than standard and of 200°C and this only implies storage safety measures. The acidity level (neutralisation number, TAN) was significantly high with 11.98mg KOH/g and needs to be lowered to the 2mg KOH/g standard. The moisture content was found to be 0.136% higher than the standard of 0.075%. Particulate contamination was found to be 6mg/L higher than the 25mg/L standard. The latter three are major concerns and can contribute a lot to the efficiency of the oil for bio-fuel.

Generally however, characteristically, the following issues will be present in the coconut oil and in addition to specific issues of KCMCL coconut oil the bio fuel processing plant should be capable of addressing them.

(i) **Water in the oil:** If the starting material (copra) is not properly dried the coconut oil produced has a high amount of water. Effects of this will be 'difficult ignition'. An obvious solution will be 'heating of the as-produced oil, properly dried copra i.e. low moisture content.

(ii) **Viscosity:** The kinematic viscosity of coconut is many times higher than the diesel fuel at room temperature. The viscosity decreases exponentially as the temperature increases. Effects are 'inefficient combustion', 'pump' and 'injector' failure. Solution-wise, 'pre-heating and/or blending' is necessary.

(iii) **Iodine value:** Oils react with water and air to form polymers (plastics) at high temperature. This tendency is defined by the Iodine value of the oil. Coconut oil has the smallest Iodine value among all the vegetable oils which makes it a better fuel. However, effects will relate to 'injection system problems and obvious solution will be 'start and stop with diesel fuel'

(iv) **Soap build-up:** Plant oils react with the lubricant oil in the engine and will have effects of 'soap formation in the engine sump' and solution will be to 'use coconut oil both as fuel and lube oil'.

(v) **High boiling point:** Coconut, oil has much higher boiling point. The engine temperatures have to be very high 500-600C to ensure complete combustion. The effects will be in 'the cylinder head and piston and this can be addressed by blending 'CNO with diesel or kerosene'.

(vi) **High cloud point/wax formation:** Cloud point is temperature at which the oil starts to solidify. This property is related to the presence of fatty acids in the oil. Coconut oil has a cloud point of about 24 degrees C while diesel solidifies at 9 degrees C. Thus 'solid particles will form and float in the oil form waxes. If the temperature drops to around 24 degrees C, the oil solidifies and blocks the fuel lines hence catastrophic failure. To address the problem, 'removal of FFA and solid triglycerides is necessary'; a dual fuel system is another option.

A number of systems are available in the international market some of which have been used in the Pacific Region including Vanuatu, Marshall Islands, Samoa (more recently), Philippines and others. KCMCL through the support of PIGGAREP undertook a technical study visit to both Vanuatu and Marshall Islands in search of an appropriate type of equipment to address the oil quality issues faced during initial trial periods of production and application in the mill and to do consultations with major users of fuel in the two countries.

For KCMCL to set up a coconut oil processing plant to convert the coconut oil into coconut bio fuel, the plant must be capable of removing the following;

- Impurities below 5 micron
- Moisture below 0.075%
- Degumming phosphorous content below 20ppm
- Removal of FFA

KCMCL Bio Fuel task force that undertook a technical visit to Vanuatu and Marshall Islands has made a proposal for a specific system that addresses the bio fuel issues identified. The system will comprise of a physical process of filtering using a mixing tank, a Centrifuge, a special storage tank that avoids developing of moisture (breathing effect) a pump and meter at KCMCL in Betio where a crushing mill is already operating. For Kiritimati, a new smaller oil milling plant with bio fuel production capability will be ideal for the Line and Phoenix Group. Technologies reflecting this need are available and a proper feasibility study on bio fuel for Kiritimati is a component of the bio fuel production and development of KCMCL to be undertaken.

4.2 Work Package with sub-components, activities, deliverables and milestones for the Biofuel at KCMCL

Sub-components	Description of Activities	Deliverables	Milestones
<ul style="list-style-type: none"> ○ Installation of Biofuel Plant with accessories & quality monitoring and control equipment 	<ul style="list-style-type: none"> ○ Develop tender documents for the procurement of biofuel plants and monitoring equipment – mixing & settling tanks, centrifuge, special storage tank, piping systems, valves, etc., 1-micron filters and bowser; ○ Recruitment of TA to ascertain required lab equipments and costing; ○ Construction of Mini Lab and Biofuel Sales Outlet. 	<ul style="list-style-type: none"> ○ Biofuel plants and monitoring control tender documents finalized & call for tender; ○ Successful tenderer selected; ○ Biofuel plants and monitoring equipment purchased, delivered to site, installed and commissioned; ○ Technical study on lab equipment & accessories successfully done. 	<ul style="list-style-type: none"> ○ Contract awarded; ○ Biofuel plants and monitoring equipment operational; ○ Sale of biofuel commences;
<ul style="list-style-type: none"> ○ Capacity Building 	<ul style="list-style-type: none"> ○ Training schedule and programs for KCMCL staff on operating and maintenance of plants and equipment ○ Training attachments with biofuel institutions overseas ○ Attendance and participation in Biofuel workshops and seminars; 	<ul style="list-style-type: none"> ○ On-the-job training conducted; ○ Operating and Servicing procedures compiled; ○ Training workshop and attachment reports submitted; ○ All plants & equipment in good running condition and operational. 	<ul style="list-style-type: none"> ○ KCMCL staff trained ○ Operating and servicing procedures adopted & used; ○ All plants and equipments operate efficiently.
<ul style="list-style-type: none"> ○ Enhancement of Public awareness 	<ul style="list-style-type: none"> ○ Develop public awareness programs on use of biofuel through media; ○ Designing of bill boards, banners and posters; ○ Demonstration of use of biofuel ○ Workshop consultations 	<ul style="list-style-type: none"> ○ Public awareness campaigns and promotion conducted; ○ Bill boards, banners & posters erected; ○ Biofuel processing and demonstration done; 	<ul style="list-style-type: none"> ○ Public and transport companies aware of existence of biofuel as substitute for fossil fuel; ○ Use of biofuel commences

5. Strategy for international support and identification of possible cofunders

The implementation of the Kiribati Development Plan and related energy action plan and support from the Government is now the primary guideline for the execution of energy-related initiatives in Kiribati. The Italian-Pacific SIDS Cooperation will complement on-going and future bio fuel development projects. With the inauguration of the Global Environment Facility (GEF) funded PIGGAREP in July 2007 plus other initiatives from development partners such as CROP agencies, this project aims at complementing and improving current bio fuel production and development programs of KCMCL for which a number of consultations with donor agencies have commenced.

KCMCL as co-sponsor of such program have also reelected the project in its Business Plan and have already made commitments to make a start. At the beginning of 2008, a technical team from KCMCL was commissioned to undertake a study on existing bio fuel developments in Vanuatu and the Marshall Islands. The technical study aims at on-site inspection of existing bio fuel plants in these countries and to collect information necessary in ascertaining the appropriate type of cleaning system conducive to KCMCL's current bio fuel production needs with a view to commence on production of bio fuel at KCMCL. The sum of US\$10,000 was approved for funding by PIGGAREP as contribution towards the total expenses incurred for the trip.

A number of consultancies on Bio fuel development in Kiribati have been undertaken, a recent one was a consultancy carried out by the European Union to identify potential projects and development programs for possible funding under its Pacific regional program for Renewable Energy. KCMCL raised during the consultation with EU consultant a number of issues relating to revival of bio fuel production in Tarawa and expansion of copra milling capacity at KCMCL and extend operations and copra industry development to Kiritimati Island to specially focus on biofuel processing on the island for the Line & Phinnox Group.

Expression of interest has also been indicated from a Taiwanese buyer of crude coconut oil to provide an oil quality monitoring and control equipment as well as training in Taiwan for KCMCL technical staff as part of long-term oil business cooperation with KCMCL. The aim of the program is to consistently enhance and maintain export quality of oil as well as transferring the technical skills necessary in operating and servicing the equipment.

In addition, opportunities and partnerships will be developed from the Italian-Kiribati cooperation projects to provide an enabling environment for mobilization of resources and bilateral assistance for expansion of this project, especially with future planned use of bio fuel as alternative replacement for imported fossil fuel in Tarawa, Kiritimati and outer islands.

6. Economic & social impact

Kiribati is susceptible to fluctuations of commodity prices on the world market. The country at present is 100% dependent on imported fuels. At the same time world market prices dictate the earnings for Kiribati main export product of copra and coconut oil. As a remote and small producer of coconut oil (CNO) and a small consumer of fuel, Kiribati is penalized twice by high transport and transaction costs. This has led to a cross over of diesel supply cost and net earning for CNO.

The production and use of bio fuel as substitute for imported fossil fuel encompasses a number of economic and social impacts. The table below outlines a summary of all positive and negative economic and social impacts associated:

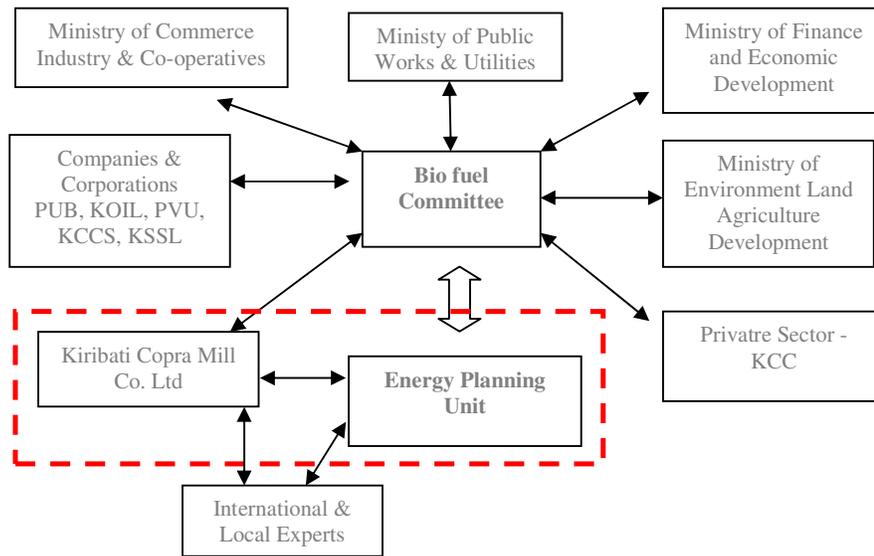
ECONOMIC IMPACTS – pros & cons	SOCIAL IMPACTS – pros & cons
1. Provides cheaper substitute to fossil fuel ie. consumers have a choice to choose between bio fuel and fossil fuel;	1. More cash income for copra farmers on outer islands;
2. Improves Balance of payment by reducing quantity of imported fuel;	2. Improves living conditions on outer islands through increased income earnings;
3. Employment creation – more jobs will be created if bio fuel business goes well;	3. Environmentally friendly in terms of carbon balance and gas emissions;
4. Revenue generation – more income to KCMCL and government through sale of bio fuel and taxes;	4. Reduce fuel supply shortage on outer islands once the bio fuel production extends to outer islands;
5. Sale price of bio fuel is not determined by world commodity price in comparison to imported fuels;	5. Reduction in current fuel price subsidy – this could be used more productively and efficiently in enhancing living conditions on outer islands.
6. High costs of oil exports – freight, insurance, packaging and other fees;	6. Create food shortage and as well lifestyle on outer islands if not complemented by coconut replanting programs;
7. Reduction in export oil revenue for KCMCL if export price of oil is higher than fossil fuel	

The production of bio fuel as substitute for imported fossil fuel is a new business undertaking in Kiribati and many consumers of fuel would have doubts in the application of bio fuel to their cars, trucks and other equipment. The promotion of public awareness on the use of bio fuel plays a very important role in disseminating information to target consumer markets.

At initial stages, bio fuel is expected to face tough challenges from consumers and level of acceptance is likely to be very low. What is imperative at this stage is to raise public awareness on the use of bio fuel through radio promotional campaigns, newspaper advertising and most importantly is public demonstration on the application of bio fuel. During the product demonstration, potential users should be made aware of problems that are likely to incur with the initial use of bio fuel if certain requirements or alternations are not made to their cars, trucks or engines. With potentially lower cost of bio fuel compared to imported fuel coupled with positive results of trial on use of bio fuel, a strong propensity to switch over from use of imported fuel to bio fuel is expected to take effect within a short period of time. To maintain the confidence of bio fuel users, what is important is to ensure that the bio fuel quality level is consistently maintained at all times.

7. Description of the Proponents

The schematic diagram below illustrates the various stakeholders in the bio fuel program of Kiribati for who additional details are provided in the Table immediately below. The Bio fuel committee is a sub committee of the Energy Coordinating Committee specifically established to focus on coconut oil for bio fuel in Kiribati. The Energy Planning Unit closely works with KCMCL on bio fuel development issues. In terms of the Bio fuel project of KCMCL, the Committee will act as a steering committee monitoring the performance to which body the KCMCL in consultation with Energy Planning Unit will report. The assessment on progress as part of its steering responsibilities will be done by the Committee.



Participant	Acronym	Institution	WP /Task	Responsible
Kiribati Copra Mill Co. Ltd	KCMCL	Government Company – bio fuel production and marketing	Bio fuel project coordination of implementation	CEO
Ministry of Public Works & Utilities	MPWU	Energy Planning Unit	Overall policy & facilitator of project implementation	Secretary for MPWU
Ministry of Commerce Industry & Cooperatives	MCIC	Industry Division	Coordination of industry & private sector development policy	Secretary for MCIC
Ministry of Environment Lands Agriculture Development	MELAD	Agriculture Division & Environment Division	Coconut Production (replanting etc) Environment Regulation	Secretary for MELAD
Ministry of Education	MOE	Kiribati Institute of Technology	Education, Training & Promotion	Secretary for ME
Ministry of Finance and Economic Development	MOF	Aid Coordination Unit	Disbursement of funds	Secretary for MFEP
Kiribati Oil Co. Ltd., Kiribati Shipping, Plant & Vehicle Unit, Public Utilities Board, Kiribati Copra Cooperative Society, Kiribati Chamber of Commerce	KOIL, KSSL, PVU, PUB, KCCS, KCC	Government Companies and Corporations	Marketing & technical support	Managers & CEOs

International & National Experts	TA	Private Consultants	Technical and International & Domestic Marketing	CEO, KCMCL Director, EPU
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8. Funding

Table 1: Funding for participants

Participant	Requested Funding (USD)
Adhoc Working Committee	500
Kiribati Copra Mill Co. Ltd	128,500
Ministry of Commerce Industry & Cooperatives	1,500
Biofuel Committee	1,000
International and Expertise/	38,000
Ministry of Finance	500
Total	170,000

Table 2: Cost for categories and participants

Participant	Personnel	Travel & transport	Consum- Able	Durable Equipment	Other Costs	Overhead	TOTAL (USD)
Adhoc Working Committee			500				500
Kiribati Copra Mill Co. Ltd		3,000	1,000	120,000		4,500	128,500
Ministry of Commerce Industry & Cooperatives					1,500		1,500
Bio Fuel Committee			1,000				1,000
International Expertise/Consultancies	30,000	8,000	-	-	-	-	38,000
Ministry of Finance						500	500
TOTAL							170,000

ANNEX 1 – COST ESTIMATES**Budget Summary**

Items	Costs (USD)
Bio fuel production at KCMCL Tarawa:	
• Bio fuel plant & equipment	101,000
• Fuel outlet – tanks, bowser and accessories	12,000
• Shipment and transportation	3,000
• TA for installation and commissioning & training	25,000
• Laboratory for bio fuel quality monitoring and control	15,000
• TA to improve/upgrade lab equipment & accessories	11,000
• Other costs	3,000
GRAND TOTAL ESTIMATE	USD\$170,000