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Developing a Nation

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World Bank Sustainable Energy Project

Short Term Consultancy – Colin Dyer
12 – 22 February 2008

REPORT

Primary Purpose: Investigation in Coconut Oil Production and Conversion to Fuel for Power Generation

Background

The World Bank Sustainable Energy programme is about to be launched in five Pacific nations. This project has a number of phases including the use of coconut oil (CNO) as a fuel to power generators for the production of rural electricity. It is anticipated that applications of this technology could be applied in the generation of urban electricity for Out-stations and urban centres and also to drive small generators that can supply electricity in rural and remote applications and communities.

Solomon Islands is one of the nations involved and committed to this program. However infrastructure and the uses of these appropriate technologies are not widespread and little is known of latest developments, successes and failures of this type of application, especially from those using and producing such technologies. There is a vast amount of theoretical knowledge, but little practical “hands on” understanding.

The main purpose of the consultancy, was to view the applications and interact with those people and organisations that are using this technology and technologies that are related to it and to see how this could be integrated into the project in the Solomon Islands

Day One – Port Moresby

After arrival in POM I spent time with Mr. Matt Carr (PNG Sustainable Energy Ltd). The purpose of this interaction was to become familiar with the local conditions in sustainable energy and plan the following days that would be spent travelling and working together. Mr. Carr was able to update me on the current challenges and difficulties that he was facing in the production of CNO using a mill that were sourced from Project Support Services (PSS), Lae. It seemed that the mill was designed for the extraction of oil from various seeds and not particular to coconut. This meant that the machine often jammed causing substantial time and energy losses.

Recently Carr had machined up to 3 millimetres off the main shaft of the press which seemed to have eliminated the jamming. However, efficiency rates of the machine were now in question and trials were continuing.



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Days Two to Four, Buka

Matt Carr and I travelled to Buka to meet with Mr. Matthias Horn of Buka Metal Fabricators (BMF). Mathias is a local identity and well regarded in the conversion of coconuts to oil and using the oil in vehicles and machines. To date BMF have produced 170,000 litres of CNO which they have sold or used in motor vehicles. He owns a Toyota Land Cruiser, a Toyota Hilux and two 10 ton trucks, plus 2 village based diesel electricity generators– all of which run on 100% CNO.

Oil production happens in a nearby village which is the traditional home of Mrs. Horn. We visited this place and viewed the oil production and the operating generators. So consistent is the power generation in this village that community industry has expanded to include a store with refrigerated goods, steel fabrication, timber finishing and furniture making.

Mr Horn had two different types of coconut mills in operation. They have an Indian Tiny Tech and a Chinese 105 mill that had come from PSS. Both units were operating and much discussion was had over the strengths and weaknesses of the two types. The resulting oil was used in a number of areas over and above as a fuel oil for diesel engines. Some oil was used as the core ingredient in soap manufacture and some is mixed with perfume and packaged for massage, body and hair oil.

Mill statistics were expressed as follows:

- | | |
|--------------------------|------------------------|
| ➤ Tiny Tech Mill | 50 -60 litres per hour |
| ➤ Chinese 105 | 80 litres per hour |
| ➤ Copra to oil yield | 50% |
| ➤ Hours worked per day | 8 per person per day |
| ➤ Manpower required | 4 per unit |
| ➤ Plate filters required | 2 minimum |
| ➤ Holding tanks required | 4 x 100Litres Min |

Much discussion took place over the use and applications of CNO in the engines that were owned and operated by Mr. Horn. As a mechanical engineer, Horn has a wide knowledge of engines and the technologies involved. Furthermore, the Bougainville Crisis and continuing transport and infrastructure difficulties had driven him to research widely to achieve the results required in his situation. He has vast practical experience in the field and has considerable understanding of many of the logistical, cultural and technical issues involved.

Key points expressed by Horn in regard to standing engines and vehicles running on 100% CNO were:

- Good copra must always be used in oil production
- Copra must be dried well before extraction takes place
- All oil must be clean and filtered
- Settling over an extended period provided the most efficient filtering system
- 'Indirect' Injection systems are almost always universally acceptable to CNO use



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- ‘Direct’ Injection can be problematic but can work well with fuel system modifications
- All oil for engines should be preheated
- Unburnt fuel is a major challenge in operations and so some operational changes are essential



Days Five to Seven, Kaviang

After leaving Matt Carr in Port Moresby, I travelled on to Kaviang to meet with Hugh Walton of the National Fisheries Authority (NFA).

NFA and Reihart Mangels of Emirau Marine Products (EMP) are engaged in a joint venture in the production of CNO for vehicles and as fuel for their standby generators. Basically NFA has provided the set up capital and EMP the manpower and the basic copra. Currently the operation for the oil extraction is in a NFA shed which is producing copra oil on a daily basis. However there have been some technical issues and the operation is still to finalise its production activities and standardise its systems. The joint venture is overseen by Shane Rigby who was unavailable at the time of my visit after being involved in an accident and having to return to Australia for treatment.



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One key factor that was overshadowing the project was the failure of two new coconut mills supplied by PSS. These mills were installed at NFA but blocked and jammed so consistently that they were later removed and rendered useless. Apparently PSS and NFA are now working to machine the extraction shafts down by up to 3mm in an attempt to rectify the problem. This is being undertaken after the experience of Matt Carr and a smaller unit near POM. We await results of this work.

Although NFA were using a Tiny Tech and Chinese 95A expellers, they were using a Chinese hammer mill rather than the Tiny Tech copra cutter to cut the supplied material. This machine cuts the copra so finely that it is blown to an overhead supply hopper for feeding into the expellers. This system was saving a significant amount of labour but may be a contributing factor in the low production percentages.

NFA and EMP had converted a number of engines to run on the CNO. The most interesting unit was the fishing boat Elfride (See pic), which had been operating on the oil produced for over 12 months. Other engines operating on the oil were a 3 ton Toyota Dyna and a Cummins Rotary genset. This rotary genset, which provides the support power for the blast coolers in the marine products packaging plant, has run consistently on the CNO; but only after some minor modification and adjustments.

All engines used by NFA and EMP that were operating on 100% CNO had fuel supply modifications from Wimmera Biodiesel. In every case, these modifications included a heat exchanger and extra filtering systems to ensure that the CNO was clean, water free and at optimum temperature for consistent and complete burning.

Work was being carried out by Shane Rigby on the removal of Free Fatty Acids (FFA's) with the use of caustic soda being mixed in the oil and separated out in a separate holding tank. This was leaving behind a sludge that was of a nature still unknown. Exact details of the process, what was happening and resultant oil quality was not obtained, although some explanations were given at the time. Later discussion with others revealed some contrary opinions and explanations – most of which was beyond my understanding of chemistry. Certainly the resultant oil looked cleaner than the original, but I have little knowledge of its chemical properties and its suitability as a fuel in diesel engines.

Key points to note from Kaviang visit included:

- The NFA/EMP partnership was not yet fully sustainable
- The set up had less holding tanks but they were satisfied that they had enough
- Filtering was taking place after an initial settling period rather than straight after production
- The Wimmera Biodiesel heat exchangers are a competent package – but more expensive than the “home grown” BMF options
- Extensive work had been done on other types of engines with 2 diesel outboard motors also running well on CNO
- Caustic Soda additions to CNO to remove FFA's was a new concept with unconfirmed results or ramifications
- Copra to oil yield was at 40 – 45%. This is low on industry standards



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- Although the Chinese 105 presses were purported to have better output, their reliability and suitability for sustainable CNO production is still not confirmed.



Days Eight – Nine, Lae

After leaving Kaviang and a night layover in Port Moresby, I arrived in Lae. The purpose of this trip was to visit Project Support Services (PSS) a major importer of Chinese agricultural equipment to PNG and the supplier of equipment being used by Matt Carr, NFA and Mathis Horn in Buka. I wanted to be able to view the operational activities of this organisation and to discuss the on going opportunities with the owner – Mr. Greg Denn. Furthermore, the Solomon Island application that I was investigating required continual CNO that was to be used in the generation of electricity. Production amounts were already specified and demand would be unrelenting, so it was important that machinery to be recommended was reliable and tested.

After viewing the other two operations and discussions with Carr, it was obvious that all held Mr. Denn in high esteem but there were serious reservations about the suitability of the equipment that he was supplying for the production of continuous CNO. All users visited were having or had experienced serious jamming difficulties which had caused a considerable amount of consternation and production down time. I talked through these issues with Denn



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who admitted that the equipment had its limitations since it was primarily built for the production of oil from cereal seeds and not coconuts or copra. The differences in the source materials seemed to be the largest factor in the production difficulties. It was hoped that, with further testing and modifications, that this challenge would be overcome without compromising the production rates and efficiencies of the equipment. The ongoing work being done by Carr, Horn and NFA would need to be monitored and could assist in finalisation of the recommendations on the suitability of the Chinese expellers. Discussions with PSS also focused on the support of any such equipment into Solomon Islands. It was noted that technologies imported into a developing country were often not well supported. It was noted that the history of product support for CNO expellers was not good in either PNG or Solomon Islands. Although there is supposed to be an exclusive agent for Tiny Tech mills in Solomon Islands, it is well known that this system does not work well and that some investments were sitting idle lacking the technical support to rejuvenate the operations. Other technologies were also discussed and viewed for their suitability in Solomon Islands; in particular farming equipment that could be run on CNO, solar panels, dry cell batteries and 12v lighting systems.

Key points to note from Lae visit included:

- Technical and physical support for any introduced technology needed to be set up in conjunction with the supply of the equipment.
- History had proved that failure to support new technology had contributed to the failure of industries, especially in developing and emerging countries
- Viable solar panel, lighting and battery technologies were coming on to the market all the time at more and more competitive prices that could be deemed useful and appropriate in Solomon Islands.
- Although PSS supported its expellers, they were still unproven in long term production. Further research and development needed to be undertaken to give more confidence in the package
- Where production of CNO was to be required in constant and reliable quantities, multiple small units, in close proximity, were going to be more sustainable than fewer (or one) larger unit.
- Electricity supply, to operate machinery to produce CNO, is a major consideration.
- If a CNO extraction operation was to be in production on customary land, how does this interact with the community and what would be their benefit?



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Day Ten – Brisbane

In transit back through Brisbane, I arranged to meet with the Managing Director of Techso Limited, Mr. Jeyom Segarame. Techso have been producing custom built copra expellers across the Pacific for a number of years. These are of different sizes and applications from very big government sponsored commercial factories to small village units for rural and remote applications.

Segarame discussed the companies' history in the Pacific and more especially the relationships that have been established in the Solomon Islands. Techso supplied eight (8) units to Solomon Islands in the mid 1990's under a Commodities Export Marketing Authority (CEMA)/Solomon Island Govt program. This program was built on premise that the major production unit on Russel Islands (RIPEL) would purchase all oil and support the industry. However with the failure and closure of RIPEL and the civil crisis, almost all commercial CNO production failed. Furthermore, Segarame suggested that the lack of physical, technical and managerial support for the units would have meant that these units would have failed, irrespective of other commercial and social influences.



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It should be noted that CEMA still have contact with the owners of these Techso supplied units. Their knowledge extends to the physical conditions, opportunities and prospects of the machinery and this could be taken into consideration in the event that CNO production in Solomon Islands again becomes a commercial operation.

Techso now build their own machinery and support the installations up to the commissioning stages. They have complete system designs and technical support for their units and have indicated a level of accountability that would need to be considered in any widespread installation or production system.

Key points to note from Techso Pty Ltd visit included:

- Technical support must be available ‘in-country’ for any installations
- Techso have a wide range of expellers and complete systems available, costs were not discussed
- Recommissioning of existing expellers could be factored into any production requirements for power generation.
- Multiple smaller units, rather than fewer larger units were confirmed as the best operation model for remote and regional applications.
- Brisbane Australia has easy and fast access to Solomon Islands. Support from there would be the most accessible and most timely.
- As an Australian company, Techso’s costs come in Australian Dollars (AUD) which is currently very strong in world market terms.

Conclusions

There is no doubt that 100% CNO can be used in the operation of diesel engines. Fuel mix percentages, minor engine modifications operational management are all dependant on the type of machine and its application. Standing or fixed engines are easier to manage in this type of application as systems can be set in place and safeguards and protocols instituted to ensure that operations are maintained.

There is considerable discussion in the use of ‘direct’ and ‘indirect’ injection systems. Both will operate on 100% CNO but the indirect engines are far more robust in this type of application.

Production of CNO using copra has been around for many years. Expellers are available on the world market from a number of sources but most are built for cereal seed oil extraction and few are specifically built for coconuts. This has caused some technical difficulties in the operations and reliability of some units is still in question. Tiny Tech Mills are not particularly ‘user friendly’. Having been in use in the region for some time seem reasonably reliable with the right technical knowledge readily on hand, although the support for these units is disjointed and difficult.

Any introduction of new technologies, equipment or manufacturers will need to have a support system built into the program. Too many projects have failed because the technologies were not adequately supported locally. Offers of help desks, email support and fax contacts are not realistic where the technology is in remote or rural settings. If the



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assistance is going to be true and effective, it must be local to the country it is applied to and be able to supply a measure of support with strong local and cultural understanding.

There is a strong argument that CNO for electricity generation is long overdue. However, strong organisational systems would have to be in place to ensure that the production of oil and the transfer to other energy systems is as seamless as possible; and cost effective. This organisation will take considerable community and individual participation. Solomon Islands is the least developed Pacific nation and as such has challenges on many levels. An energy transfer program that is not supported by government, the private sector and the State Owned Enterprises (SOE's) concerned will not be sustainable unless one body is charged with the responsibility to make it work. It could be anticipated that this will take outside capital and donor assistance to get operational and financially sustainable on all levels. Challenges of communication, distance and technical expertise will always be present, but they can be overcome with commitment and dedication.

Report Compiled by

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