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**REPIC**  
Renewable Energy &  
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Promotion in  
International  
Cooperation

Final Report:

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## Bali: Combating Climate Change and Poverty – Recycling Used Cooking Oil and Transforming it into Biodiesel



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The author(s) of this report are alone responsible for its content and conclusions

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## 0. Summary

Between August 2011 and July 2013 the project *Combating Climate Change and Poverty – Recycling Used Cooking Oil and Transforming it into Biodiesel* has been implemented successfully in Bali, Indonesia. The project's goal is to contribute to climate change mitigation by recycling used cooking oil (UCO) and transforming it into biodiesel. This biodiesel will in turn substitute fossil fuels, thereby reducing greenhouse gas emissions.

The project has been implemented by Caritas Switzerland in cooperation with the Municipality of Denpasar, myclimate and KUONI. Within the framework of the project the social enterprise Yayasan Lengis Hijau (YLH) has been established running the oil collection and processing system for recycling of UCO from hotels and restaurants:

- The UCO – accumulated at the hotels and restaurants in canisters – is collected with small vans in regular routines.
- In the plant, the oil is mechanically pre-treated and chemically transformed into biodiesel. The technology applied is a fully automatic biodiesel processor build in the UK and imported to Indonesia.
- The produced biodiesel is usable in almost all types of diesel engines and burners and is sold to partnering hotels and other interested customers as substitute for fossil diesel fuel.

By substituting fossil fuels, the project contributes to the reduction of green house gas emissions. This emission reduction is verified by myclimate according to the Gold Standard and traded in form of carbon offset certificates to KUONI.

Besides the mitigating effect, the project contributes also to the protection of the local environment and human health. In Bali UCO is commonly discharged directly into the environment and causes pollution of water bodies, groundwater and soil. A big share of the oil is also reused as foodstuff. The reuse of UCO as foodstuff causes high health risks (cancer etc.) to consumers, who are often from lower social strata.

The social enterprise established in the course of the project offers jobs and training to socially marginalised, underprivileged people, allowing them to improve their living conditions and the livelihoods of their families. Any financial surplus generated by the social enterprise will be reinvested in the enterprise and used for social/ environmental activities. The Board of Trustees decides on the use of surplus on request of the Executive Director.

The structures and mechanisms established are planned to remain running for at least ten years, constantly contributing to climate change mitigation and generating tradable emission certificates.

The physical implementation of the project has been successfully finished and the social enterprise took over the management of the recycling operations. While all structures and processes have been established successfully, the amount of oil recycled is still too low to operate on a cost effective basis. In case the current growth rate can be continued, the social enterprise YLH will breakeven in about one year.

## 1. Objectives

The project's goal is to contribute to climate change mitigation by recycling UCO and transforming it into biodiesel. This biodiesel in turn substitutes fossil fuel, thereby reducing greenhouse gas emissions. The project is implemented in Bali, Indonesia, by Caritas Switzerland and its local and Swiss partner organizations. A social enterprise is established running an oil collection & processing system for recycling yearly 400–600 m<sup>3</sup> of UCO from hotels and restaurants in a sustainable manner. (cf. processing scheme in Appendix 1):

The UCO is collected in regular routines from hotels and restaurants. In the processing plant, the oil is purified and chemically transformed into biodiesel. The recycling product – a standard biodiesel fuel can be used in almost all types of diesel engines and burners and will be sold to partnering hotels and

other interested customers as substitute for diesel fuel. By substituting fossil fuels, the project contributes to the reduction of green house gas emissions. This emission reduction is verified according to the Gold Standard <sup>1</sup> and traded in form of carbon offset certificates.

Beside the mitigating effect, the project contributes also to the protection of the local environment and to avoid health risks: At the moment, UCO is disposed of in an unregulated way leading to a significant pollution of waters and land areas in Bali. A significant share of the UCO is reused in small food stalls for food preparation. This procedure bears high health risks for the consumers. By recycling the UCO in a sustainable manner, environmental pollution and health risks can be reduced.

The social enterprise established in the course of the project offers jobs and training to socially marginalized, underprivileged people from the area, allowing them to improve their living conditions and the livelihoods of their families.

Any surplus generated by the enterprise is reinvested in the enterprise and in its social-environmental activities.

Initially it has been planned to establish the project within 13 month. In total the implementation took 24 month (18 month physical implementation and 6 month initiate and support of operation). The structures and mechanisms established are planned to remain running for at least 10 years, constantly contributing to climate change mitigation while offering ecologically and economically sustainable jobs and training to local people.

The project serves as a best practise example. It is planned to replicate the project in other countries with similar frame work conditions. Further the UCO recycling in Bali may be extended to other areas and customer segments.

## **2. Technical Solution / Applied Method**

The utilization of UCO as a feed stock for biodiesel production is not a new development. At least since the oil crisis in the 70s, there are increased private, commercial and public initiatives for utilization of UCO as fuel. Through the project the production of standard biodiesel complying with international standards such as American Standard ASTM 6751-02 and/or the European Standard EN 14214 (2005)<sup>2</sup> will be established. In the following, the different phases of the recycling process are outlined:

### 2.1 Collection

UCO accumulated at the hotels and restaurants is collected by the enterprise's staff in regular routines. For the collection, canisters of 20 l volume are set up in the cooperating hotels and restaurants. The full canisters are exchanged in regular routines with empty, cleaned canisters.

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<sup>1</sup> The Gold Standard label distinguishes renewable energy and energy efficiency projects under the CDM, JI and in the voluntary offset market. The Gold Standard means environmental quality, sustainable development, and a sound investment in any policy climate. For further information cf. [www.cdmgoldstandard.org](http://www.cdmgoldstandard.org); [http://www.cdmgoldstandard.org/wp-content/uploads/2011/10/GS\\_Biodiesel\\_from\\_waste\\_oil\\_and\\_fat\\_06\\_08\\_2009.pdf](http://www.cdmgoldstandard.org/wp-content/uploads/2011/10/GS_Biodiesel_from_waste_oil_and_fat_06_08_2009.pdf)

<sup>2</sup> EN 14214 and the ASTM D6751 describe the requirements and test methods for the most common type of biodiesel. For information on the international standards for biodiesel cf.; [www.astm.org/Standards/D6751.htm](http://www.astm.org/Standards/D6751.htm) or [http://en.wikipedia.org/wiki/EN\\_14214](http://en.wikipedia.org/wiki/EN_14214)



*Illustration 1: Small trucks loaded with canisters used for UCO collection*

## 2.2 Processing

### Technical procedure and background

The UCO is first cleaned from solid particles by means of a filtering process (cf. Illustration 2).



*Illustration 2: Filtration of UCO*

Afterwards, the oil is freed from excess water through phase separation. Then the oil quality is tested, to determine the required amount of chemicals to be added. Subsequently, the oil is processed with methanol and under utilization of potassium hydroxide as a catalyst into fatty acid methyl ester (bio-diesel, FAME) and glycerol.

The chemical equation is shown in *Illustration 3*. The chemical conversion is called transesterification. Through the chemical conversion, the glycerol part of the oil is replaced by methanol. For the reaction potassium methylate is used as an alkaline catalyst. The result of the transesterification is called fatty acid methyl ester (FAME) or biodiesel. A by-product from this conversion is glycerol which can be used in various ways, for example to produce soap, lubricants, cosmetics, plastics, or as an additive to increase productivity of biogas plants.

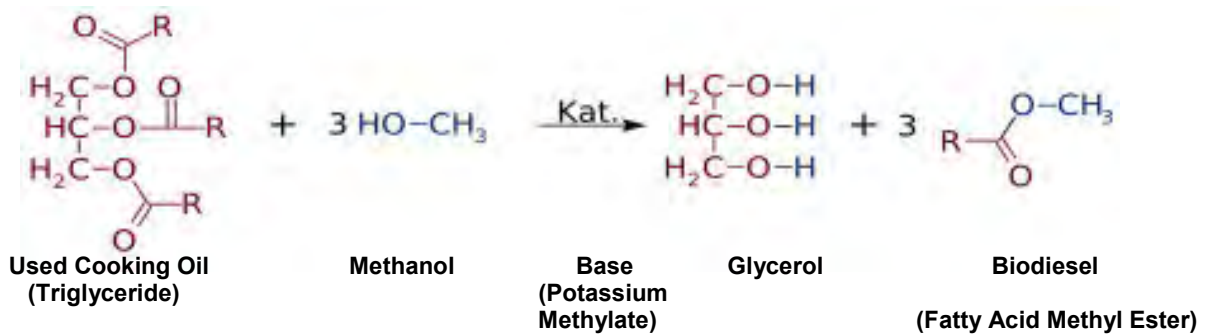


Illustration 3: Chemical equation of oil esterification process

For the phase separation (glycerol from biodiesel), the product alloy is left standing for a while. The floating biodiesel phase is freed from impurities in a dry washer (ion exchanger). After this final step, the biodiesel can be used as fuel. A simplified process scheme is shown below in *Illustration 4*.

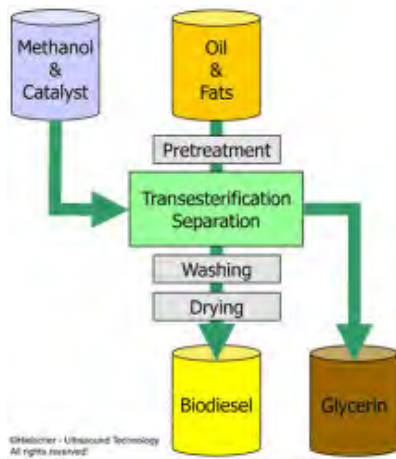


Illustration 4: Simplified process scheme on oil esterification

### Applied technology

After the pretreatment step a biodiesel processor (Fuelmatic GSX 3) developed by Greenfuels Ltd. (<http://greenfuels.co.uk/case-studies/caritas-biodiesel/>) is used. The Fuelmatic GSX 3 is a small scale fully automatic but discontinues batch processor with a max. capacity of 3 m<sup>3</sup> per day. The processor has been build and tested in the UK at Greenfuels Ltd. and subsequently shipped to Bali. The bulk tanks used at the plant, two for UCO feedstock and two for biodiesel, as well as the complete piping system has been developed by Mecan, an engineering company based in Surabaya, Indonesia. The biodiesel processor, the bulk tanks and part of the piping system are shown in *Illustration 5*.



*Illustration 5: Fuelmatic GSX 3 biodiesel processor and bulk tank after installation in Bali*

### Plant layout and location

For processing a small factory site located in a commercial area north west from the city centre of Denpasar has been leased for a period of 10 years. The premises include a processing hall, space for offices and a laboratory as well as outside storage and car park. In Appendix 2 a site plan of the leased premises as well as maps showing the location of the factory are included.

### 2.3 Utilization of Biodiesel

The biodiesel produced is of high quality and can be used for almost all technical purposes wherefore fossil diesel fuel is used. The substitution of diesel fuel is feasible in applications as e.g.: cars, trucks, warm water boilers, power generating sets or ships.

Fuel for cars and trucks is subsidized in Indonesia. The subsidized diesel fuel is sold for about CHF 0.55 per liter which is below the production costs of biodiesel. The biodiesel is currently sold for a rate of CHF 0.85. Consequently biodiesel is only used for applications (warm water boilers, power generating sets, or ships) where the use of subsidized fuel is legally not allowed.

Emission standards for cars and trucks have been set up in Indonesia but are not controlled in Bali. The other applications (warm water boilers, power generating sets, or ships) are economically interesting for an application of the more expensive biodiesel. But for these applications no emission standards exist.

## **3. Results**

Below the results at the end of the project implementation phase as of July 2013, including activities carried out, results achieved and problems faced, are outlined. The descriptions are structured in accordance with the defined project results.

Initially the project was planned to be finished after an implementation time of 13 months in August 2012. As explained in the intermediate reports submitted in 03/ 2012, 09/ 2012 and 03/ 2013 the project implementation time had to be extended. The infrastructure has been set-up and oil recycling operation has been commenced after 18 months, end of January 2013. Consequently the total implementation period took five months longer than initially planned. The delay has mainly been caused by lack of project support through authorities till December 2011. It took the project team about half a year to overcome bureaucratic hurdles and to convince authorities to officially support the project. Mid of December 2011 an official support letter has been received from the provincial environmental authority.



End of 2012 an additional delay of about one month has been caused through a bureaucratic and time consuming import process for the biodiesel processor. In February 2013 it has been clear that after technical implementation of the infrastructure there is further support required for the newly founded social enterprise Yayasan Lengis Hijau (YLH). Consequently from March to July 2013 the managerial and operational responsibility has been gradually handed over from Caritas to YLH. Since August 2013 YLH is fully responsible for the oil recycling. But to assure sustainability of the oil recycling, Caritas will still be available for backstopping of YLH at least as long as emission certificates are generated, which is for a period of 10 years.

**Result 1: A sufficient high number of hotels and restaurants are participating in the project to provide a minimum amount of 1m<sup>3</sup> of UCO per day.**

The cost/income ratio for oil recycling hinges on the amount of UCO processed. The more biodiesel is produced, the better the cost/income ratio. At projects start calculations of profitability have shown that at least 1m<sup>3</sup> of UCO per day will have to be recycled to assure a cost covering recycling operations. These initial calculations have been based on theoretical assumptions and technical references. Current analyses based on real figures roughly affirm these initial calculations. For results of the latest profitability analysis, which are based on real data refer to Result 5.

Between project start in January 2011 and March 2012 one of the focus activities has been to convince as much hotels and restaurants as possible to participate in the project. For this purpose 436 hotels and restaurants have been visited, many of them several times. The aim of the visits was to raise awareness on the current bad practice of UCO disposal causing environmental and health risks and to promote the participation on the recycling of as much hotels and restaurants as possible. The calculated amount of UCO generated in all visited hotels and restaurants amounts to about 15 m<sup>3</sup> per week.

Further meetings were held together with hotel and restaurant associations. The aim of the meeting has been to gain wider support and to convince hotels and restaurants to participate on the project. On 15<sup>th</sup> November 2012, a large workshop has been organized together with the Balinese environmental authority. Approximately 200 representatives from hotels and restaurants, government agencies and associations participated in the workshop. The local TV station Alam TV produced a piece on the workshop. The report is available on YouTube (<http://www.youtube.com/watch?v=XkfRBRIARg>).

Generally the promotion resulted into an increased public interest in the project and an increased interest from hotels and restaurants to participate. Several articles about the project have been published in different newspapers. Some of the English language articles are included in Appendix 3.

The overall interest from hotels and restaurants in the project is high. Many of the hotel and restaurant managers understand the uncontrolled sale and reuse of UCO as foodstuff as a potential threat to their reputation. Especially international hotels are worried about that media would report on the current practice of waste oil reuse which could negatively affect their business. On the other hand, a commitment for cooperation is often difficult to achieve. Common problems are well established work routines in hotels and restaurants that need to be changed and the fact that hotel staff may lose profits from the informally arranged sale of UCO.

After more than one year of continuous project promotion, in February 2012, the minimum amount of UCO, required to assure an economically sustainable operation had still not been achieved. Until end of February 2012 cooperation agreements for about 6.2 m<sup>3</sup> of used cooking per week have been concluded with hotels and restaurants. This was 89% of the minimum amount required according to the initial calculation of profitability. For this reason it has been decided to offer a financial compensation for the oil to hotels and restaurants.

This decision has been taken because a lot of UCO generated in hotels and restaurants is sold. This is very often not directly done by the hotels or restaurants but by kitchen or service staff, who earn a little extra money through this procedure. While hotel or restaurant managements normally are interested to participate in the project, they avoid internal conflicts and don't force their employees to participate. As a reaction to this circumstance, the project team decided to offer all hotels and restaurants to buy the UCO instead of requesting it for free. The offered price rate for buying the UCO is CHF 0.25 per

litre. To pay for the oil is meanwhile also very common in other countries. While ten to fifteen years ago restaurants in Western Europe had to pay for an environmental friendly disposal of UCO, now most of this oil is sold as an energy source.

The decision to buy the oil has been thoroughly considered and intensively discussed within the project team and at the headquarter of Caritas. Fact is that as long as there are no proper regulations and law enforcement mechanisms in place a high share of the hotels and restaurants will not be willing to give the oil away for free.

After offering to buy the UCO to about 30 of the biggest hotels and restaurants which initially had refused to cooperate, the available amount of UCO increased to about 8.7 m<sup>3</sup> per week, which is almost 25% above the target amount.

In order to compensate the additional costs to purchase the UCO, it has been decided to sell the produced biodiesel for an equivalent higher price rate than initially planned. For further information please refer to Result 3.

Beginning of December 2012 the project started gradually with oil collection. In Table 1 below are all data on collection and production included. Until July 2013 formal agreements on regular oil collection routines have been established with 106 hotels and restaurants. But the number of hotels and restaurants that regularly provide their UCO to YLH is still much lower (cf. Table 1).

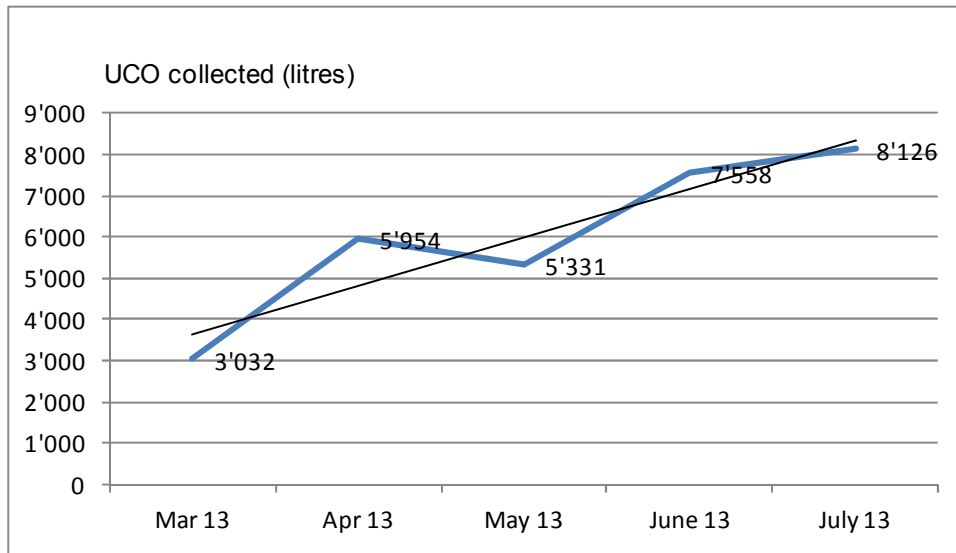
	No. of H&R UCO collect. from *	UCO collected	UCO processed	Biodiesel produced	UCO stored	Biodiesel stored	Biodiesel sales sample & own consumption	Biodiesel sold
		litres						
Dec 12	16	2'656			2'656			
Jan 13	27	3'884	2'666	1'980	3'874	1'980		
Feb 13	32	4'784	4'666	4'606	3'992	6'586		
Mar 13	25	3'032	1'000	1'074	6'024	7'580	80	
Apr 13	35	5'954	2'000	2'093	9'978	9'643	30	
May 13	37	5'331	3'333	3'160	11'976	12'690	113	
June 13	46	7'558	7'555	6'873	11'979	14'463	100	5'000
July 13	55	8'126	1'000	1'008	19'105	14'956	115	400
<b>TOTAL</b>		<b>41'325</b>	<b>22'220</b>	<b>20'794</b>			<b>438</b>	<b>5'400</b>

\* The total number of H&R who have agreed to cooperate on UCO recycling was 106 in July 2013

*Table 1: Monthly collection and production data*

The UCO collected in July 2013 amounts to 8'100 litres. The graph in Illustration 6 shows that the amount of collected oil is still relatively low and fluctuates strongly from one month to another. But in average an increasing trend is evident. In March, the collection quota has been about 3'000 litres, while in July an amount of 8'100 litres has been collected. In average, the quantity of collected UCO is increasing from one month to another between 900 and 1'100 litres.

Looking at the current collection quota and the number of cooperating hotels and restaurants the project target has not yet been achieved. In the initial assumption the structural strength of the existing UCO black market has been underestimated. Additionally YLH is currently still in a market penetration phase and has not yet reached its full potential. The current trend of the collection quota is promising with growth rates of about 30 to 50%. Economic conclusions from the current collection and recycling quota will be drawn under Result 5.



*Illustration 6: UCO collection quota from March to July 2013*

One of the main activities in future will be to further increase the amount of oil collected. The two liaison officers of YLH are continuously visiting hotels and restaurants. Further, the UCO recycling is promoted at meetings of hotel and restaurant associations. Information campaigns are also supported by local environmental authorities. Part of these joint campaigns has been an inauguration ceremony on the 18<sup>th</sup> of February 2013. The vice mayor of Denpasar inaugurated the recycling plant. More than 100 hotel and restaurant managers have been participating in the ceremony. The local TV station Alam TV produced a piece on the inauguration. The report is available on YouTube ([www.youtube.com/watch?v=pxMicenznxs](http://www.youtube.com/watch?v=pxMicenznxs)).

Further Kuoni and its Balinese subsidiary Asian Trails will arrange a workshop for hotels in Bali in November 2013. The aim of the workshop is to improve Corporate Social Responsibility strategies within international hotels and to increase the number of participation hotels in the oil recycling project.

## **Result 2: The collection and processing infrastructure is established and ready for operation.**

In June 2012 an appropriate operations building has been leased (cf. site plan in Appendix 2). The lease contract started on 1<sup>st</sup> of August 2012 and has been agreed for a period of ten years. The operation building is logistically well located in the municipality of Denpasar north-west of the city centre in a commercial area (cf. maps in Appendix 2). End of July 2013 the lease agreement with all rights and duties has been transferred from Caritas to the social enterprise.

A civil engineering consultant developed technical designs for renovation and modifications of the operations building. All modifications have been made in coordination with Greenfuels Ltd. and with the aim to fulfil technical and work flow requirements for oil processing. The technical modifications of the building started end of August 2012 and have been finished in October 2012. Around the same time the electricity supply for the processing plant has been upgraded to a three phase connection.

The biodiesel processor has been assembled and tested in the UK and subsequently shipped to Indonesia beginning of October 2012. After arrival at the port of Surabaya around mid of November 2012 a time consuming import process which involved the approval from three different Indonesian ministries followed. Beginning of January the customs clearance process was successfully finished. Subsequently the installation and commencement of the processor followed. The task has been carried out by technicians from Greenfuels. Subsequently to installation the workflow for oil processing has been optimised and processing staff has been trained to operate and maintain the system. The project schedule is included in Appendix 5.

Beside the raw material and product bulk tanks an air compressor which is required for the processing plant as well as vehicles and jerry cans for oil collection have been purchased between October and November 2012 locally.

As for the optimization of the oil collecting routes, geographic coordinates of all visited hotels and restaurants are recorded in a database, which has been developed by IDSIA (Istituto Dalle Molle di Studi sull'Intelligenza artificiale), a Computer Research Institute in Manno, near Lugano. Based on geographical data, transport volumes and durations, IDSIA is developing a routing software for oil collection. The routing systems accuracy is still improved by entering empirical data. Till today the system is not in use since the frequency of collection is still relatively low and the drivers have already a lot of local knowledge.

Since operational start in February 2013 the collection as well as the recycling infrastructure has been properly operated through staff of YLH without any problems.

### **Result 3: Sales channels are established and the produced biodiesel is sold.**

In the beginning a biodiesel price equal to the subsidized diesel market price has been intended. Now the biodiesel is sold for a rate of about CHF 0.85 (for further details refer to Result 1). Due to the higher price, the biodiesel will be used for different purposes: Diesel fuel for vehicles is subsidised in Indonesia and is currently sold for about CHF 0.55. Diesel fuel for industrial purposes is not subsidised which results in a price of about CHF 1.05. Consequently almost all customers who are interested in the biodiesel will use it for industrial purposes, power stand-by units and ships but not for normal vehicles as e.g. cars.

The sale of biodiesel started around May 2013, after analytic results from an independent laboratory have been received. The results show that the biodiesel is of high quality (cf. Appendix 6) with a purity level of 99.33 %.

Different to the positive assumptions drawn from the surveys carried out between 2011 and 2012 it is rather difficult to effect a sale. But the general interest of different stakeholders to buy the biodiesel is still high. The following points appear to be a problem for the sale of biodiesel:

- Potential customers buy subsidized diesel fuel on the black market which is illegal.
- Many prospective customers already have long-term purchase contracts with other suppliers for industrial diesel fuel. To change these contract agreements takes time.
- Some potential customers are skeptical about a new product and whether a long-term supply security can be guaranteed.

Till end of July only two sales agreements have been concluded for a total amount of 5'400 liters biodiesel.

YLH liaison staff is currently working intensively on the development of new sales options. Also some of the board members, who have good business contact, support this activity.

Potential customers are hotels that use the diesel fuel for hot water or power generation as well as operators of excursion boats. In principle, one or two larger customers are sufficient to dispose the complete quantity of biodiesel produced. Due to the low sales rate currently about 15 m<sup>3</sup> biodiesel and 20 m<sup>3</sup> UCO are stored at YLH. The stored UCO is processed only gradually, according to the available biodiesel storage capacities. The total value of the biodiesel and UCO currently stored is about CHF 30'000.

In general it is assumed that the sales of biodiesel should be of no problem in the medium term. The fuel has ecological advantages compared to normal diesel fuel, which customers can use for CR measures. Further biodiesel is about 20% cheaper than industrial diesel fuel. But to convince potential customers and to establish sales channels is difficult.

### **Result 4: A social enterprise is established and manages successfully all tasks of the oil recycling. Jobs and training opportunities for socially disadvantaged people have been established.**

The oil recycling operations is carried out by the social enterprise Yayasan Lengis Hijau (YLH) which has been established as part of the project. The organisation form of a Yayasan is similar to an NGO. Lengis

Hijau means “Green Oil” in Balinese language. YLH has been legally acknowledged by the Government of Indonesia on 4<sup>th</sup> June 2013 (cf. Appendix 7.1). Six individuals have been selected and are assigned as board members of YLH. The board members work voluntarily and are responsible for steering and monitoring of YLH. They normally are not involved into daily operations. The board is a well balanced mixture of Balinese and international individuals with different professional backgrounds. YLH is properly connected through its board members to different Balinese stakeholder groups as e.g. the government, civil society groups and the tourism industry. The board and the operational structure of Lengis Hijau is included in Appendix 7.2. A short profile of the board members is also included in Appendix 7.3.

Since Lengis Hijau as a social enterprise will carry out business activities, it additionally has to be registered as a Perusahaan Terdaftar (PT) i.e. a “registered company” which is similar to a limited liability company (LLC or Ltd.). The combination of Yayasan and PT is resulting in a “non for profit limited liability company” or a social enterprise. Registration of the PT has been initiated but is not yet finished. The process is rather bureaucratic and time consuming. But the pending PT registration doesn’t affect the operations of YLH. An enterprise has the legal right to start operating after the PT registration process with the responsible authorities has been initiated.

YLH is responsible for collection and processing UCO as well as the sale of the produced biodiesel. It offers jobs and training to socially marginalized, underprivileged people from the area, allowing them to improve their living conditions and the livelihoods of their families. Different socially disadvantaged individuals are employed to work at the processing plant or to collect UCO from restaurants and hotels. But to assure a professional management of the oil recycling, executive and key positions are filled with professionals, independently from their social situation.

So far eight positions on the operational level have been filled. The filled positions are highlighted yellow in the organisational chart in Annex 7.2. More employees may be recruited with the gradual increase of work load, which mainly depends on the amount of oil processed.

Technical training for oil processing has been carried out by Greenfuels. Greenfuels will also further provide support by phone and e-mail on all issues related to oil processing. Further, the processor includes a diagnostic tool which allows Greenfuels to access the systems control via remote data transmission from the UK. The Caritas team together with an organisational development consultant developed all other procedures for (1) finance and administration, (2) liaison and promotion and (3) logistics.

End of July 2013 the responsibility for management of the UCO recycling and all relate tasks have been handed over from Caritas to YLH. The handing over agreement with all rights and responsibilities for the 10 years period of emission trading is included in Annex 8.

The web presence of YLH can be found under: <http://www.lengishijau.or.id/en/>

### **Result 5: The income of the oil recycling activities covers the operation costs. Any financial surplus is reinvested in the social enterprise and in further social-environmental activities.**

#### YLH – current and projected profitability

Currently the cost coverage from the sale of biodiesel is still very low (cf. Result 1 and 3). Since start of operation about 41m<sup>3</sup> of oil were collected. But only 5.4 m<sup>3</sup> (14%) of produced biodiesel have been sold till end of July (cf. Result 3). Additionally an amount of about 19 m<sup>3</sup> (48%) of UCO and 15m<sup>3</sup> (38%) Biodiesel are stored at YLH and became part of its assets.

In June 2013 YLH has been collecting about 7m<sup>3</sup> of UCO. The total operation costs for YLH in June are CHF 10'700. This includes all activities as collection of the 7 m<sup>3</sup> UCO and processing it into biodiesel, administration, liaison, salaries etc. Applying now the conditions described above (48% of the collected UCO is stored, 38% has been processed to biodiesel but is stored and 14% of the UCO is processed to biodiesel and sold), the following conclusions can be drawn (cf. Table 2):

Only 0.98 m<sup>3</sup> of the produced Biodiesel has been sold in June. This results in an income of CHF 850. The remaining 2.66 m<sup>3</sup> biodiesel and 3.36 m<sup>3</sup> UCO are stored and become part of created assets equivalent to CHF 5'221. Comparing cost and income for June, a loss of CHF 4'657 is resulting.

Since the amount of collected oil is increasing for about 0.9 m<sup>3</sup> each month (cf. Result 1) it can be expected that losses will decrease from month to month. Based on this assumption profit and loss

have been calculated and projected for the period from June 2013 to July 2014. The results are summarized in Table 2. It can be seen, that, if the production increase is maintained according to the current trend, YLH will be profitable from July 2014 onwards. For a period of 13 month, till July 2014, losses of totally CHF 30'700 (in average CHF 2'360 per month) will be covered by Caritas. For a cost-effective operation in July 2013 18'700 litres UCO are required, which is equal to a daily amount of 900 litres for 5 work days per week. To achieve the results explained here it is certainly required, that the amount of biodiesel produced can be completely sold in the future (cf. Result 3).

	date	litres UCO	expenditure	income	profit / loss (subsidy Caritas)
2013	June	7'000	-10'700	6'000	-4'700
	July	7'900	-11'200	6'900	-4'300
	August	8'800	-11'800	7'600	-4'200
	September	9'700	-12'300	8'400	-3'900
	October	10'600	-12'800	9'200	-3'600
	November	11'500	-10'700	9'100	-1'600
	December	12'400	-13'300	10'800	-2'500
2014	January	13'300	-13'700	11'500	-2'200
	February	14'200	-14'200	12'300	-1'900
	March	15'100	-14'700	13'100	-1'600
	April	16'000	-14'800	13'900	-900
	May	16'900	-15'300	14'700	-600
	June	17'800	-15'700	15'400	-300
	July	18'700	-16'200	16'200	0

Table 2: Profit/ loss calculation for biodiesel production with a monthly increasing recycling quota of 900 l

Based on the current economic data and assuming a maximum feasible recycling quota of 1 m<sup>3</sup> UCO per day, for 5 work days per week, the monthly profit of YLH would be approximately CHF 700. In Table 3 and Illustration 7 operating expenditures, operating income and profit – as well as the total accumulated profit for the operation are displayed for a period till 2022. Based on the assumptions concluded above a total accumulated profit of CHF 37'700 for 10 years of operation can be concluded. In case it would be feasible to collect more UCO than 1m<sup>3</sup>/d the resulting profit would be accordingly higher.

The economic situation explained here is based on empirically data determined between March and June 2013. These data have been extrapolated according to the current trend of the recycling quota (increase of 0.9 – 1.1 m<sup>3</sup> per month) up to a maximum production of 1 m<sup>3</sup> per day. To calculate the economic viability of different recycling quotas, some of the cost positions have assumed to be fix costs and others to be variable costs. The raw materials (as e.g. chemicals and UCO) required for the production of biodiesel have been categorized as variable costs. For a recycling quota of 7 m<sup>3</sup> per month the consumed raw material amounts to 42% of the total costs. The other cost items such as transport (4% of total costs), administration and PR (3% of total costs), lease of building (4% of total costs) and salaries for staff (48% of total costs) have been categorized as fixed costs. Transportation costs are actually variable, but have been assumed to be fixed, since the collection tours are currently carried out with only 1/3 of the total loading capacity. Further the costs share of transportation is rather small compared to the total costs. The salary for employees has been assumed to be fixed costs, since the number of employees is sufficient for a recycling quota up to 1m<sup>3</sup>/d.

per half year	output biodiesel (m <sup>3</sup> /0.5a)	operating expenditure	operating income	operating profit	accumulated profit
2013-2	61	-78'000	52'800	-25'200	-25'200
2014-1	93	-88'400	80'900	-7'500	-32'700
2014-2	120	-101'100	104'300	3'200	-29'500
2015-1	123	-102'500	106'700	4'200	-25'300
2015-2	123	-102'500	106'700	4'200	-21'100
2016-1	123	-102'500	106'700	4'200	-16'900
2016-2	123	-102'500	106'700	4'200	-12'700
2017-1	123	-102'500	106'700	4'200	-8'500
2017-2	123	-102'500	106'700	4'200	-4'300
2018-1	123	-102'500	106'700	4'200	-100
2018-2	123	-102'500	106'700	4'200	4'100
2019-1	123	-102'500	106'700	4'200	8'300
2019-2	123	-102'500	106'700	4'200	12'500
2020-1	123	-102'500	106'700	4'200	16'700
2020-2	123	-102'500	106'700	4'200	20'900
2021-1	123	-102'500	106'700	4'200	25'100
2021-2	123	-102'500	106'700	4'200	29'300
2022-1	123	-102'500	106'700	4'200	33'500
2022-2	123	-102'500	106'700	4'200	37'700
<b>Summe:</b>	<b>2'242</b>	<b>-1'907'500</b>	<b>1'945'200</b>	<b>37'700</b>	

Table 3: Projection of the accumulated profit of YLH until 2022 at a recycling quota of 1m<sup>3</sup>/d

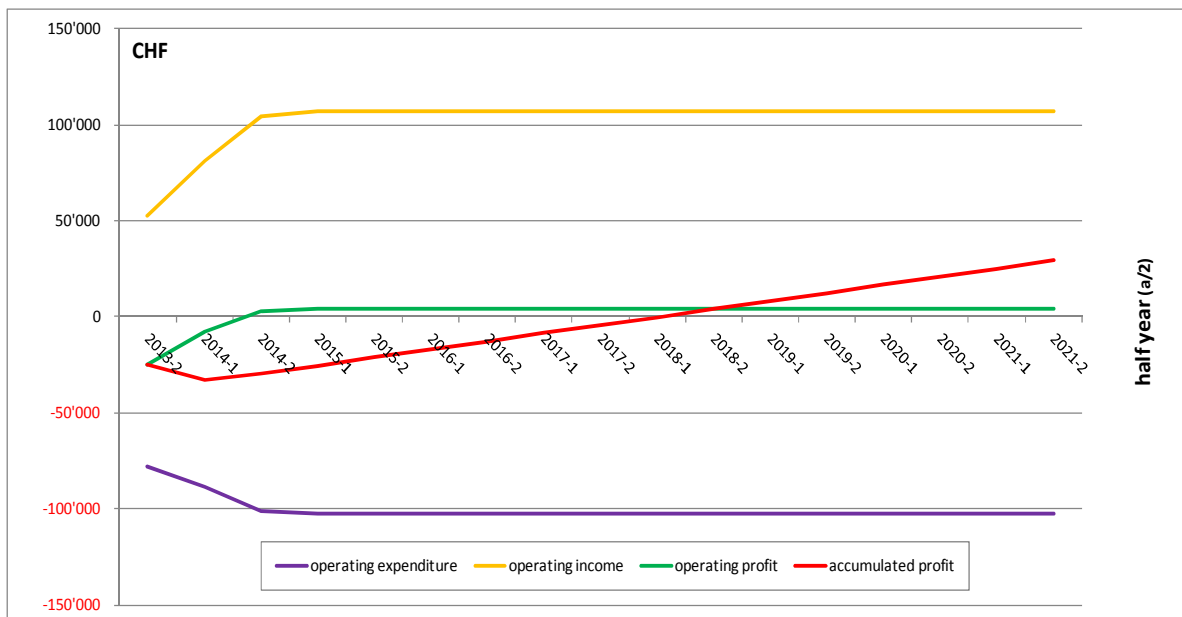


Illustration 7: Projection of the accumulated profit of YLH until 2022 at a recycling quota of 1m<sup>3</sup>/d

## 2.2 Comparison between the actual cost benefit analysis and the cost benefit analysis included in the project proposal from 2011

The current analysis is based on empirical figures. The analysis carried out in 2011 has been based on assumptions and technical references. Both analyses (pre- and post-implementation) show a very similar picture for a recycling quota of 1 m<sup>3</sup>/d. In the cost benefit analysis submitted with the project proposal in 2011 an annual profit of about CHF 23'300 (see Table 3) has been stated. The profit calculated now based on empirical figures for the same recycling quota results in an annual profit of CHF 8'400.

		Prognosis 2011 for a recycling quota of 1 m <sup>3</sup> /d	Prognosis 2013 for a recycling quota of 1 m <sup>3</sup> /d
<b>Cost (CHF/a)</b>	Operation processing plant	-46'500	-136'400
	Operation collection UCO	-4'000	-6'000
	Employees	-125'800	-62'600
	<b>Total</b>	<b>-176'300</b>	<b>-205'000</b>
<b>Benefit (CHF/a)</b>	Sale of Biodiesel	197'000	213'400
	Sale of by-product Glycerin	2'600	0
	<b>Total</b>	<b>199'600</b>	<b>213'400</b>
<b>Profit (CHF/a)</b>		<b>23'300</b>	<b>8'400</b>

*Table 3: Comparison of the cost benefit analysis from 2011 with a cost benefit analysis prepared 2013*

Comparing the two analyses, the following differences (see Table 3) can be concluded:

### a) Costs

- The processing costs are now about three times higher than predicted in 2011. About half of the additional costs arise from buying UCO for about CHF 0.25 per litre. In 2011 it has been assumed that the oil is available for free. The other half of the additional costs is resulting from higher price and consumption rates for chemicals.
- In turn costs for employees are lower than assumed in 2011. Actual costs are only half as high as predicted in 2011. The reason for this is a much lower number of employees as originally planned.
- The actual costs are, 16% higher than predicted in 2011.

### b) Benefit

- Contrary to the assumption from 2011 it is rather unlikely that the Glycerine can be sold, but the resulting losses through this change are comparatively low.
- The benefit from selling biodiesel is about 7% higher than originally assumed. The benefit is resulting from a higher price rate for biodiesel. Further, it can be assumed that the price for biodiesel will continue to rise in future since government subsidies for fossil fuels will continue to be cut.

### c) Profit

- The actual profit per year is CHF 8'400 and therefore 65% below the profit stated in 2011. This looks like a big difference but it is actually not. In both cases the profits are still very close to the breakeven point. Further, total costs and total benefits are the multiple of the profit and in both cases pretty close to each other.



The overall picture shows, that the current economic situation is relatively close to the economic analysis from 2011. The most influential factor for profitability is still economies of scale. In case it would be feasible to process substantially more oil than 1m<sup>3</sup>/d significant higher profits could be gained.

Currently the economic situation of YLH is still far away from generating financial surplus. Nevertheless it is still feasible that YLH may process substantially more than 1 m<sup>3</sup> of biodiesel per day. In this case the financial surplus will be used for other social or environmental activities. What kind of activities will be supported has to be decided jointly by the board members of Lengis Hijau. The charitable use of any surplus has already been approved by different stakeholders as e.g. the government and is part of the handing over agreement between Caritas and YLH (cf. Appendix 8).

The emission trading component of the project is managed by myclimate with support of Caritas. The Project Design Document (PDD) has been prepared by myclimate and submitted to the Gold Standard. Since the approval is still pending the emission trading may start some month later than planned. This is not of a problem since the duration for emission trading will be the same but start a bit later.

#### **4. Impacts**

Through the project a best practise example for UCO collection has been developed and implemented. The integrated approach provides impacts on different levels:

- Balinese stakeholder as e.g. hotels, restaurants, the government, tourism associations, other NGOs and the public has been sensitized for the ecological and health risks of an inappropriate disposal or reuse of UCO.
- Training and income opportunities for socially disadvantaged people have been created. The number of required employees is lower than initially planned but may further rise with an increasing amount of oil recycled.
- So far no economic surplus from oil recycling has been created. Consequently no other activities are currently financed through revenue from the recycling. In the future this may still be feasible if the output of the oil recycling rises substantially above 1m<sup>3</sup> per day.
- The project contributes to climate mitigation by substituting fossil diesel fuel with biodiesel generated from UCO.
- For Caritas the pilot project provides new knowledge and experiences with regard to subjects as renewable energies, carbon finance mechanisms, closing material flows (circular economy), social business approaches.
- Currently a 45 min. film documentary about the recycling project is shoot for Radiotelevisione Svizzera (RSI). Broadcasting the documentary is planned for beginning of 2014. The producers plan to use the documentary also as an educational film for schools in Indonesia and Switzerland.

#### **5. Future Prospects**

With 7'000 litres (June 2013) the amount of UCO recycled is still far below the planned target. To breakeven at least 18'700 litres per month will have to be recycled. Assuming the current average growth rate between 900 and 1'1000 litres per month can be maintained, YLH will become economically viable in July 2014. Within one more year YLH is still depend on financial support from Caritas (cf. Result 5) Therefore future targets are, first to achieve YLH's economic viability and subsequently further to increase the oil recycling quota continuously. Besides increasing the number of cooperating

Hotels and Restaurants, this can also be achieved by identifying other UCO sources, as for example the collection of UCO from households.

Currently the cooperation between Hotels/ Restaurants and YLH is based only on voluntarily agreements. At the same time YLH faces strong competition from the UCO black market. It would be desirable if a legal basis for an eco-friendly and health-safe recycling of UCO could be created in the near future. But Caritas and YLH are not influential enough and the interest of authorities is still too low to initiate this change. Currently the only options for YLH, to increase participation on the UCO recycling, are PR and awareness raising measures towards different stakeholders.

Beyond Bali the project is promoted through YLH and the government as best practise example for UCO recycling in Indonesia. This is especially of interest for environmental authorities from other areas of the country. In June 2013 a government group from the Province of Riau visited YLH.

For 2014 Caritas plans to examine the feasibility of a similar project in other Asian countries. Cambodia is one of the options for a replication. A replication will only be carried out if the economic viability can be proofed and the project is fully supported by the government authorities in charge.

## 6. Conclusions

The physical implementation of the project has been successfully finished and the social enterprise is responsible for the recycling operations. While all structures and processes have been established successfully, YLH is not yet operating on a cost effective basis, since the amount of oil recycled is still too low. If the current growth rate can be continued the social enterprise will become economically viable in about one year in July 2014.

The successful project implementation and an orderly recycling operation is only feasible:

- Through a team with a high level of professional knowledge, experiences in the region and a very high commitment to achieve the project goals. This applies for Caritas project team and the employees as well as the board members of YLH.
- Further the technology provider proofed to be very experienced. The technology is of high quality and very appropriate for the context of the project.
- The network of project stakeholders as e.g. myclimate, KUONI, the Municipality of Denpasar and the organisation development consultant is a valuable asset to assure a high level of knowhow and high quality outcomes.

Main challenges during the implantation and threats for the recycling operations can be summarised as follows:

- The biggest challenge of the project is, despite a baseline study with very promising outcomes, the relatively low number of hotels and restaurants participating in the project. This is mainly caused through the competition with a very intransparent UCO black market and the lack of regulations with regard to disposal of UCO.
- A lot of hotels pretend to have a high responsibility for environmental and social issues. But it is still very difficult to convince them to participate in the UCO recycling.
- Fuel subsidies of about 50% of the world market price are a big challenge for economic viability of the UCO recycling.

For replication of the project more importance should be attached to the following points:

- It should not be assumed that good and correct arguments necessarily will convince stakeholder in a short term.

- There should be a strategy how to overcome existing informal structures and procedures, even if they seem to be wrong and not economically viable.
- A clear plan how to tackle extralegal situations and weak law enforcement should exist.
- A formal cooperation agreement for operational support with the local government should be concluded before starting the project.
- Unexpected delays should be included in the schedule.
- For a pure market based approach, without any donor contribution, the investment costs of the project would be too high for redemption. Therefore bigger systems with accordingly higher output would be required. This again is a contradiction to the low recycling quota currently feasible.

## 7. Appendices

- A 1: Concept scheme
- A 2: Site plan & maps
- A 3: Newspaper articles
- A 4: Photo documentation
- A 5: Project schedule
- A 6: Analytic result Biodiesel
- A 7: YLH founding document
- A 8: Handing over Caritas - YLH

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