Global Sustainable Biomass Fund

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Capturing methane emissions from palm oil mill effluent for fossil fuel replacement in power generation in Palembang, Indonesia

Public Final Report
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Context and reasons to start the project

Context and justification for the project
Since 1997, Zebra is active in the Indonesian palm oil market with engineering, technical advice and training. Special measurement equipment for the palm oil industry has been developed and installed in a large number of mills, refineries and bulking stations in Sumatra. The need and scope for innovation to raise efficiency and environmental sustainability of the palm oil sector is huge but only a few companies are active in this field. Zebra, in cooperation with international and local partners, has experience, knowhow and technological solutions that can significantly raise the performance of the palm oil industry in South-East Asia, while contributing to substantial reduction of carbon emissions.

In 2003, Zebra was invited by government of South Sumatra to establish a mill to process oil palm fruit produced by smallholders in the Palembang region, where such facilities were lacking. The smallholders are recent settlers who were provided with two hectares of oil palm plantation per household following their transmigration to this area. Zebra designed a project that would not only fulfil this local need but also to establish a pilot and demonstration project for efficient processing of palm oil, serving as a reference project for Zebra’s business relations and other organisations. The plant, which was commissioned in August 2006 with a modest initial capacity of 7.5 tons per hour, is modular and thus can be easily scaled up. The plant requires 75% less energy than conventional palm oil mills. The smallholders have been organised in three cooperatives that are planned to gradually take over ownership of the plant from PT PalmPro, a 100% sister company of Zebra. The project, which was co-financed by PSOM, ended in 2007. The University of Sriwijaya has undertaken an environmental impact study (Amdal) at the outset of the project and continues to be involved in monitoring of efficiency and environmental parameters.

Parallel to the PalmPro project, Zebra has been developing expertise and appropriate technology in the field of capturing methane from palm oil production and the CDM certification of such projects in cooperation with strategic partners. At the core of the technology is the state-of-the-art ‘bioreactor’ where POME is converted into useful biogas by creating optimal conditions to achieve 90%+ conversion efficiency, leaving a very clean effluent and generating maximum amounts of biogas. This reactor is sealed using a specially developed cover and the gas is channelled to a burning installation. For generation of carbon credits, the flaring of the methane gas is sufficient and this is indeed what most CDM projects are all about. Unsatisfied about the flaring of biogas, however, Zebra has developed and tested a biological gas scrubbing system to clean biogas from harmful sulphuric acid and a system to mix the clean gas into a standard diesel generator. With this system, up to 70% of diesel consumption can be replaced by biogas, leading not only to substantial costs savings but also further carbon reductions by fossil fuel replacement in power generation. At project initiation, the implementation and CDM certification of this total technology package for the palm oil industry were new to Indonesia.
Zebra was keen to implement this approach at the PalmPro factory and obtain CDM status accordingly, making it the first project of its kind in Indonesia and therefore even more interesting as a reference project for the palm oil industry. In combination with the 75% energy savings in palm oil processing compared to conventional mills, the PalmPro model could be the most energy-efficient palm oil plant worldwide.

The proposed technology package with co-generation of electricity is most relevant to small, off-grid mills – which applies to 50% of the industry. In Malaysia alone, Zebra has identified and contacted more than 30 palm oil mills in this category that will be interested to adopt the technology once demonstrated. Indonesia, lacking behind Malaysia in technological innovation, has many palm oil mills that would benefit from adopting the same technology as proposed in this pilot project. CDM certification, at the time of project initiation, was considered to be a basis for financing such projects on a sector-wide scale, benefitting both the producers and the buyers of carbon credits. The cooperation with Dutch and Indonesian knowledge institutions ensures that the learnings of the pilot project become available to industry and policymakers alike.

**Target group**
The immediate subject of the project is the PalmPro factory in Palembang, indirectly benefitting the smallholders organised in three cooperatives that are the main suppliers of fruit and have been planned to take over ownership of the plant when it was built. However, through the realisation of this reference project, Zebra targets the entire palm oil industry in Indonesia and Malaysia (and possibly other countries to follow on), notably relatively small mills in off-grid locations.

**Location**
The project concerns PT PalmPro in Inderlaya, some 60 km from the town of Palembang, South Sumatra, Indonesia, which sources palm oil fruit from smallholders, who are located up to 200 km from the mill.

**Project partners**
Partners to this project are Zebra Special Products BV and PT PalmPro. Subcontractors include:
- Zebra Industrial Projects BV
- VO Consultancy
- Landbouw-Economisch Instituut BV (LEI)
- University of Sriwijaya
- Advance Consulting BV
2. Objectives of the project

The aim of the project was to contribute to sustainable production of palm oil by setting up a reference project in Indonesia, (a) demonstrating innovative technology for conversion of biomass waste into biogas for power generation, (b) building up empirical knowledge, (c) increasing local capacity and transferring of knowhow to local counterparts and (d) addressing sustainability certification issues.

On an overall level, the following results were defined:

1. CDM Certification
2. Technology for methane capturing and conversion into electricity implemented
3. Sustainability effects assessed and project results disseminated
3. Activities undertaken in the project

During the project implementation period (1 October 2009 – 30 June 2013) the following project activities have been carried out:

1. CDM certification

At the start of the project, Zebra assigned VO Consultancy to design the necessary Project Design Document (PDD). To that end, Zebra and VO Consultancy have organised stakeholder meetings in Indonesia and jointly prepared the technical documentation needed for developing the PDD. The development of the PDD took longer than expected due to the fact that the PDD designer needed to verify the technical specs with the equipment suppliers. On top of that, the earlier chosen baseline definition changed. The initial chosen definition included a “Greenfield” approach taking data from similar projects as reference. The alternative approach (based on “historical” data) at that time was not preferred as historical data initially was tagged as impossible to verify. However, during the process it became clear that the Greenfield approach would entail a substantial reduction on the amounts of CERs achieved. As the absolute number of CERs achieved in any case would be limited (as PalmPro is a relative small pilot factory), in consultation with the PDD designer it was decided to apply the historical data approach.

The process of coming to a conclusion by the Ministry of Environment - the DNA Jakarta - on the HCA (Host Country Approval) request took considerable time. First of all, LEI, Zebra and NL Agency decided to consider the EU-RED, RSPO and CDM regulatory within the monitoring schedule. Subsequently, the PDD application needed to be adapted in terms of the monitoring approach. The PDD had to be translated into Bahasa Indonesia and had to be presented through an Indonesian Consultant which, as it concerned technical language, took much longer than expected. Next, the PDD had to be translated into Bahasa Indonesia and to be presented through an Indonesian Consultant. In February 2011, the PDD presentation was held at DNA, which positively received the proposal. A next hearing was planned in April 2011 where technical reports about the existing mill condition and some supporting documents regarding local permits had to be submitted. Instead of the promised LOA, more doubts and questions were posed to the consultant. In order to sort these out, the partners requested and were granted a second hearing in early June. Unfortunately, this all led to the rejection of the approval request in June 2011. In the opinion of the DNA the expected number of CERs to be generated was limited in relation with the total investment required. New members of the board expressed their feeling that the project investment was not in relation to the achieved 7,000 annual CERs. Zebra’s comment and reference to the feasibility calculations that also reduction of fossil fuel and spin-off from this pilot project must be taken into account were rejected as non-relevant. Based on the HC autonomy the PDD proposal was eventually declared “non-sustainable” and Zebra were advised to restart the mill and apply for a new project. In fact this meant that the DBM project could not be validated and registered as CDM project at the UNFCCC.

Instead of chasing CDM validation and registration, after the HCA was not obtained, the project partners filed a request with NL Agency to assess the possibility of reducing carbon dioxide emissions under the Voluntary Emission Reduction (VER), Gold Standard. In the meantime, the project would continue to implement the remaining activities. In short, these activities entail implementation of proposed hardware structure through which methane gas is captured and
utilised for energy purposes (result 2); and implementing a sustainability monitoring system with LEI and UNSRI to assess the effects related to the Cramer Criteria (result 3).

For assessing the viability of having the project registered as a VER/Gold Standard activity, several negotiations with German utility company RWE were undertaken. This company initially showed interest in buying CERs, however lost interest in the end as the VER market price was perceived too low. RWE withdrew from the process and other potential buyers remained uninterested. Eventually there were no CER/VER buyers found. These negotiations and (lacking) results are in line with the global recession of carbon trading in the years 2010-2013.

Parallel to the Methane Capture and Usage project, PalmPro has tried to get the supplying farmers and its mill certified for RSPO compliance. Although these activities are not strictly part of the Methane Project, it’s worth to know the lessons learned. In terms of RSPO certification, several negotiations with Solidaridad, Neste Oil Ltd, St. Doen and Wilmar Edible Oils BV were held. The idea was to verify and certify the oil palm smallholders against the RSPO sustainability criteria. Each partner had an interest to take an active stake in the supply chain for certifying supplying smallholders. Solidaridad and St. Doen both were interested to provide Technical Assistance, while Wilmar was interested in the production and export (against reduced export tariffs) of palm oil derivatives (by-products such as PFAD), to be further refined into biodiesel by Neste in Singapore. Already in 2011, Neste and PalmPro drafted an agreement for a risk assessment study which should clear the path to a supply agreement for green CPO. The final deal with Neste, however, did not materialise due to a juridical complication in processing 3rd parties CPO (from PalmPro) into biodiesel at the Wilmar refinery.

2. Technology implemented
Parallel to initiating the CDM/VER registration activities, the project partners were active in drawing up the parameters and requirements related to the technical design and engineering activities of the technology. The technology to be implemented included methane generation from POME ponds, capturing of the biogas, scrubbing and mixing for co-generation of electricity. The technical description of the technology was realised and shared with other stakeholders including FFB suppliers at stakeholder meetings. Engineering plans and drawings were prepared. Subsequently, quotations from different equipment suppliers were acquired, as well as quotations for infrastructural works and geomembrane lining. The ‘Amdal’ (environmental impact assessment) for PalmPro was updated by Zebra to include the bioreactor and power generation system. UNSRI was contracted and the necessary (building) licenses were acquired.

Local contractors fabricated and installed the bioreactor, de gas scrubber, pipelines, measurement equipment and flare equipment. Commissioning was done in January 2012. On top of that, Zebra BV invested in almost doubling its processing capacity at the mill to increase its production from 10,000 kg of FFB per hour to 18,000 kg of FFB per hour. To that end, the mill was extended with infrastructure and machinery: the off-loading platform was extended, an additional steriliser, thresher and boiler was installed;
and the mill ensured that both presses operated in parallel to each other. Commissioning of the new processing capacity was done in April 2013, after which the plant became fully operational.

3. **Sustainability effects assessed and disseminated**

At an early stage of the project, Zebra contracted social-economic research institute LEI and Indonesian University UNSRI to set up a structure for sustainability monitoring and assessment. LEI drafted a monitoring structure based on the Cramer Principles as defined by the Testing Framework for Sustainable Biomass. As a next step, a baseline survey was prepared for benchmarking the "without project" situation as a reference for assessment towards the end of the project. Against this framework, LEI benchmarked the sustainability aspects of the project together with the Indonesian University in Sriwijaya (UNSRRI). On basis of data gathered, LEI prepared a sustainability impact assessment report which evaluates the impact of the project against the Cramer Criteria.

The partners presented their findings at different seminars, amongst others the Bio-based Economy seminar in Jakarta in March 2011 and in April 2012. The final sustainability impact assessment report, made available in May 2013, has been sent to numerous organisations, private sector parties and media. Between 28 March and 3 April 2013 several stakeholders and interested parties were invited by Zebra and PalmPro to participate in round-table meetings and in on-site visits in Palembang to demonstrate the technology, to promote sustainability and to discuss project results achieved. Farmers, government organisations (a.o. Amdal, DOE), NGOs (a.o. University of Sriwijaya, GSA) participated.

An inventory of mills of similar intervention was made but yielded no concrete interest, as the commercial roll-out of such methane capturing projects in the palm oil industry is concluded to be commercially non-viable. The fact that palm oil mills already use biomass for power and heat production is in this case contra-productive for promoting the switch to methane gas. Usage of methane gas instead of the common biomass (fibres and shells) make these last mentioned feedstock available for sales, but the income is small – even taking into account potential income from CERs for which the market price is considered too low at the moment. Only CSR driven arguments or certification driven obligations can provide some support in selling these projects. Both CSR and certifications are not top of the list or suffer from small budgets by most of the palm oil producers.

According to LEI, the project complies with the RSPO certification criteria and in principle should be able to acquire RSPO certification. However, It made no sense to certify the mill without certifying the fruit-supplying farmers, as certified CPO needs both parties to be certified. As certification comes with substantial annual cost, the farmers need to be compensated for these costs as well as they need a premium as financial stimuli to join the certification process. The idea was that from the premium, paid by Neste Oil to PalmPro, PalmPro could pay the for the certification costs for Mill and farmers (and pay some premium to these farmers for joining the certification programme). The agreement with Neste didn’t materialise, so the fact itself that the mill complies with the RSPO criteria, is not sufficient for making certification viable.
4. Results of the project

The achieved results of the project are described below:

1. CDM certification
The project partners have applied for HCA for the proposed investment. However, the Project Design Document (PDD) which was submitted to the Designated Operational Entity (DOE) in Jakarta was not approved – officially due to insufficient carbon credit potential in relation with the investment. The project has gained considerable experience in implementing a trajectory for submission of a PDD. The PDD itself was realised on basis of consensus reached with a group of stakeholders, which included conceptual input from the FFB suppliers in Palembang. To that end, the project has yielded firm commitment from the outgrowers in the region.

The project has also resulted in a good insight in the commercial market potential for methane capturing investment projects. Although alternatives for CDM were found in the form of the VER regime, the negotiations with German utility RWE in the end were fruitless because of the perceived low market prices of VER credits. It led to the conclusion that such methane projects are only commercially viable if there is sufficient cash flow to be earned with the generation and sales of CO2-credits.

2. Technology implemented
The palm oil factory in Palembang underwent construction activities whereby methane capturing, scrubbing and mixing equipment was installed for the purpose of co-generation of electricity. The equipment was designed to process 150 Nm3/hr of biogas from an anaerobic pond with the following dimensions: 26m x 32m x 5m. The acidification pond covers an area of 30m x 32m x 3m.

The flare equipment includes the following:

**Biogas Flare, 6 m height**
- Flame enclosure, SS 316
- Carbon steel flare body, heat resistant coating
- Guy wire c/w deadman
- Pilot burner c/w thermocouple
- Gas bottle and regulator

**Pipe train**
- Butterfly valve
- Actuator valve
- Pressure gauge
- Flame arrester 3"

**Control Panel**
- Control system with Siemens LOGO
- weatherproof panel
- cable from flare to control panel

**Ring Blower**
**Mist Separator**
- SS casing
- Poli propylene demister
Furthermore, Zebra invested in installing additional processing capacity of the mill, which after expansion reached 18,000 kg of FFB per hour. As a result of the investments made in the palm oil mill, the mill is expected to make more margin on processing. This allows the mill to pay IDR 100 per kg fruit as premium to the supplying smallholders. 90% of the price premium of IDR 100 ending up at smallholder FFB producer level. This would lead to an extra annual income per smallholder producer of about IDR 2.7m (EUR 214), which is a substantial increase of 8.4%. Middlemen also profiting from the price premium (IDR 10 per kg of FFB).

An annual increase in income for all 1,600 smallholders who supply to PalmPro mill and the middlemen combined, of at least IDR 4.3bn (EUR 342,000). This appears to be a substantial financial injection into the region in which the PalmPro mill operates.
3. Sustainability effects assessed and disseminated

The sustainability monitoring framework has been defined by subcontractor LEI. Against this framework, LEI benchmarked the sustainability aspects of the project together with the Indonesian University in Sriwijaya (UNSRI). On basis of data gathered, LEI prepared a sustainability impact assessment report which evaluates the impact of the project against the Cramer Criteria.

Some of the conclusions regarding the sustainability impact of the project are:

1. Methane capture of POME results in an 80% reduction of GHG emissions during CPO extraction, both for the UNFCCC and the BioGrace tools.
2. The total reduction under the UNFCCC tool is over 9,000 tonnes of CO2 at 100,000 tonnes of FFB processed. Under the BioGrace tool the reduction is almost 17,000 tonnes of CO2. The difference is largely explained by a higher GHG emission value for methane and a higher methane production per MJ CPO produced in the BioGrace tool. If similar parameter values are used for both tools, they give very similar results of CO2 produced per MJ CPO produced.
3. Utilisation of POME methane may replace over 207 tonnes of diesel annually (at 100,000 tonnes of FFB processed). This may lead to cost-savings of EUR 186,701.
4. Methane capture also leads to a reduction of odour emission, especially H2S.
5. A positive economic return (‘economic value retained’) because of the investment.
6. As effect of the extended capacity at almost the same operational costs, the mill is expected to make more margin on processing. This allows the mill to pay IDR 100 per kg fruit as premium to the supplying smallholders. 90% of the price premium of IDR 100 ending up at smallholder FFB producer level. This would lead to an extra annual income per smallholder producer of about IDR 2.7m (EUR 214), which is a substantial increase of 8.4%.
7. Middlemen also profiting from the price premium (IDR 10 per kg of FFB).
8. An annual increase in income for all 1,600 smallholders who supply to PalmPro mill and the middlemen combined, of at least IDR4.3bn (EUR 342,000). This appears to be a substantial financial injection into the region in which the PalmPro mill operates.
At different stakeholders meetings and seminars, the project sought support and commitment from various players in the sector. Various stakeholder meetings with participants from Indonesian Government Agencies (e.g. Economic Affairs Bureau of South Sumatra Province, Department of Mines, Energy and Environment Ogan Ilir, Bepelda Ogan Ilir, etc.), Village Government, local NGOs (e.g. Forum for Environment 0 WALHI – South Sumatra, Environment Division of the Legal Aid Institute LBH, Plembang, Community Leaders, etc), and Media (National Daily KOMPAS, and Seputar Indonesia, Local Daily’s Sumatera Express, Sriwijaya Post, etc) yielded broad consensus and support for the project and proposed investments. On a regular basis, the project communicated (interim) results and progress towards the stakeholders and third parties. Presentations were held at the Bio-based Economy seminar in Jakarta in March 2011 and in April 2012.

The publication of results and the dissemination of the LEI sustainability report yielded positive response from various public and private entities, amongst which UNFCCC and private palm oil companies in Taiwan and Colombia. With the company from Colombia (Daabon, holding company of Tequendama which until recently has also implemented a POME project under DBM) currently discussions are ongoing on possible collaboration.
5. Lessons learned

Specific lessons learned include the following:

1. The project should have included a more realistic time planning for synchronising the PDD with the EIA and sustainability monitoring framework, whilst more time and costs should have been allocated to having the PDD comply with the DNA requirements, including translation costs.

2. As NDA has denied HCA based on the (relatively) low amount of CER in relation to the investment costs, the actual project costs (f.i. as for a project roll-out) and the initial development costs for this pilot could have been divided into separate budgets.

3. The project finance was partly based on CER income and during the project duration the global carbon market recessed. Increasing the processing capacity made the project-investment viable again. These kind of projects may require a plan B for succeeding.

4. Biomass projects have to be financed on base of the energy-value rather than the potential of CER/VER. Although this is hardly possible in the palm oil industry yet (remote area without access to grid or gas distribution), it may be viable in the future if the project can concentrate, clean and compress the combustible gas for cooking purposes.
6. Follow up of the project

During the realization of this project, the need for scaling up became apparent and so it has been included. As being advised in the LEI report, a possible follow up on this project is the use of excess gas which is currently being flared. Ideas of compressing this gas and supplying it as cooking means to villagers have come up, but need further investigation as trading in energy products is a governmental monopoly. The roll-out or duplication of this kind of project is troubled by the recessed carbon market. The carbon trading market no longer offers project financing and the only remaining drive for entering into methane capture projects are certification requirements such as from RSPO. Unfortunately many CPO producers are certified conform ISPO (Indonesia) or ISCC (Malaysia and Indonesia), both lacking the strict requirement regarding methane treatment. In conclusion, the use of biogas for cooking purpose may be the idea with potential. In line herewith, biogas, ones compressed, may be used as automotive fuel as well.
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