Asia-Pacific
Economic Cooperation

Strategy for Large-Scale Implementation of Biogas Capture from Palm Oil Mill Effluent and Reuse for Renewable Electricity Generation

Energy Working Group

March 2017

APEC Project: EWG 25 2015A

Produced by
Winrock International
Beltway Office Park, Tower C Building
Floor 3A, Suite 3A-2
Jl. Ampera Raya No. 9-10
Jakarta Selatan, Indonesia 12550
Tel: (62) 21 782 2425
Website: www.winrock.org

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#216-RE-01.31

Acknowledgements

Work on this APEC project, *EWG 25 2015A — Strategy for Large-Scale Implementation of Biogas Capture from Palm Oil Mill Effluent and Reuse for Renewable Electricity Generation* — was funded by the APEC Secretariat upon the APEC Energy Working Group's endorsement of the project proposal. The project was proposed by the United States and co-sponsored by Indonesia; Chinese Taipei; and Thailand. Work on the project was performed by Winrock International, in partnership with Allotrope Partners, under a contract with the APEC Secretariat. Special thanks are given to the interviewees and reviewers who contributed to this project report.

TABLE OF CONTENTS

Acronyms

APEC:	Asia-Pacific Economic Cooperation
ADB:	Asian Development Bank
BPS:	*Badan Pusat Statistik* (Indonesian Bureau of Statistics)
BPDP:	*Badan Pengelola Dana Perkebunan* (Plantation Fund Management Board)
CAPEX:	Capital Expenditure
CDM:	Clean Development Mechanism
CER:	Certified Emissions Reduction
CIRCLE:	USAID-funded Capacity for Indonesian Reduction of Carbon in Land Use and Energy project
CPO:	Crude Palm Oil
CSPO:	Certified Sustainable Palm Oil
CSR:	Corporate Social Responsibility
EBTKE:	*Direktorat Jenderal Energi Baru Terbarukan dan Konservasi Energi* (Indonesia's Director General of Renewable Energy and Energy Conservation, part of ESDM)
EPA:	US Environmental Protection Agency
EPC:	Engineering Procurement Construction
EPP:	Entry Point Project
ESDM:	*Energi dan Sumber Daya Mineral* (Indonesian Ministry of Energy and Mineral Resources)
EU:	European Union
EPMASC:	Engineering, Procurement, Management, Administration, Supervision of Work, and Commissioning
FFB:	Fresh Fruit Bunch
FIT:	Feed-In-Tariff
GHG:	Greenhouse Gas
GIZ:	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GOI:	Government of Indonesia
GTFS:	Green Technology Financing Scheme
IPP:	Independent Power Producer
ISCC:	International Sustainability and Carbon Certification
ISPO:	Indonesian Sustainable Palm Oil System
IRR:	Internal Rate of Return
LCD:	Low-Cost Debt
MDB:	Multilateral Development Bank
MOU:	Memorandum of Understanding
NDC:	Nationally Determined Contribution
NGO:	Non-Governmental Organization
OJK :	*Otoritas Jasa Keuangan* (Financial Service Authority of Indonesia)
OPEX:	Operational Expenditure
PLN:	*Perusahaan Listrik Negara* (Indonesian National Electric Utility)
PO:	Palm oil
POM:	Palm oil mill
POME:	Palm Oil Mill Effluent

PPA: Power Purchase Agreement
PPP: Public-Private Partnership
PT SMI: PT Sarana Multi Infrastruktur (Persero)
RE: Renewable Energy
RED: European Union's Renewable Energy Directive
ROI: Return on Investment
RSPO: Roundtable on Sustainable Palm Oil
SEDA: Sustainable Energy Development Authority of Malaysia
SLCD: Super Low Cost Debt
WRI: World Resources Institute
WWF: World Wide Fund for Nature

Abbreviated units of measurement:

CO_2: Carbon Dioxide
Ha: Hectare (area)
Km: Kilometer (distance)
tCO_2: Tonnes of CO_2
tCO_2/yr: Tonnes of CO_2 per year
tCO2e: Tonnes of CO_2 equivalent
ton: Tonnes
TPH: Tonnes per Hour
MW: Mega Watts (power)
MWe: Mega Watts Electricity

1.0 Executive Summary

1.1 Background

The worldwide palm oil industry has undergone rapid expansion over the past three decades, but advances in the utilization of palm oil's methane-intensive waste stream for electricity generation have not kept pace. This is despite positive technology, market and environmental drivers. The result has been a significant missed opportunity to reduce greenhouse gas (GHG) emissions and increase renewable electricity production.

From a "bird's eye view," palm oil mill effluent (POME)-to-energy technology implementation should be "low-hanging fruit" from both economic and government policy perspectives. In addition to the positive impact on GHGs and electricity access, the technology is increasingly understood and has been widely used in other contexts. Positive project economics and a legal framework for feed-in-tariffs indicate the potential for solid financial returns, and capital markets "are looking" for investments in renewable energy. Yet the technology is not widely adopted, strikingly so in Indonesia, where less than 10 percent of the industry POME is utilized for electricity production.[1] The primary reasons behind this are multiple market and political challenges that complicate policy and project implementation.

The purpose of this report is to provide a strategy around which a public-private partnership (PPP) can converge to finance and implement projects that capture and utilize biogas from POME for renewable electricity generation at large scale that will encompass a significant portion of the APEC region's palm oil mills. The primary, intended audiences are the stakeholders that would implement the strategy and form the core of the PPP, including palm oil mills, financial institutions, government institutions, donors and funders, developers, and technology and service providers.

Our approach toward developing the strategy in this report was to first document stakeholder perspectives on the challenges that hinder implementation of POME-to-electricity projects in APEC economies, and then to propose a solution in the form of a PPP. Our approach focused on Indonesia, but also looked at Malaysia.

The strategy provided in this report would most directly benefit Indonesia and Malaysia, which together produce 85-90 percent of the world's palm oil. Indonesia alone has more than 600 palm oil mills. However, this strategy can be adapted and is applicable to other industries concentrated in APEC economies that involve biogas-emitting wastewater lagoons, including the tapioca starch industry (e.g., in Indonesia; Thailand; and Viet Nam) and the rubber industry (e.g., in Indonesia; Malaysia; Thailand; and Viet Nam).

APEC member economies, and particularly their representatives in the APEC Energy Working Group, will need to decide whether it is most effective to implement the strategy and form the PPP within APEC or under another existing, or new, umbrella organization. The potential benefits to APEC economies from implementing this strategy are significant. Capturing and reusing biogas can result in more environmentally and economically

[1] "Resource Assessment for Livestock and Agro-Industrial Wastes-Indonesia," 31 August 2015, Global Methane Initiative (prepared in part by Winrock).

sustainable growth for developing economies in the APEC region. The renewable electricity generated from biogas combustion can displace a portion of the government revenues often spent on subsidies for electricity generation from high-cost and carbon-intensive diesel fuel. Implementation of the strategy can lead to electrification of remote communities surrounding palm oil mills, which can foster increased productivity and economic empowerment for the people in those communities. Palm oil mills can earn additional revenues from the sale of renewable electricity to the grid or reduce the costs of fuel that would otherwise be used to generate electricity at the mills.

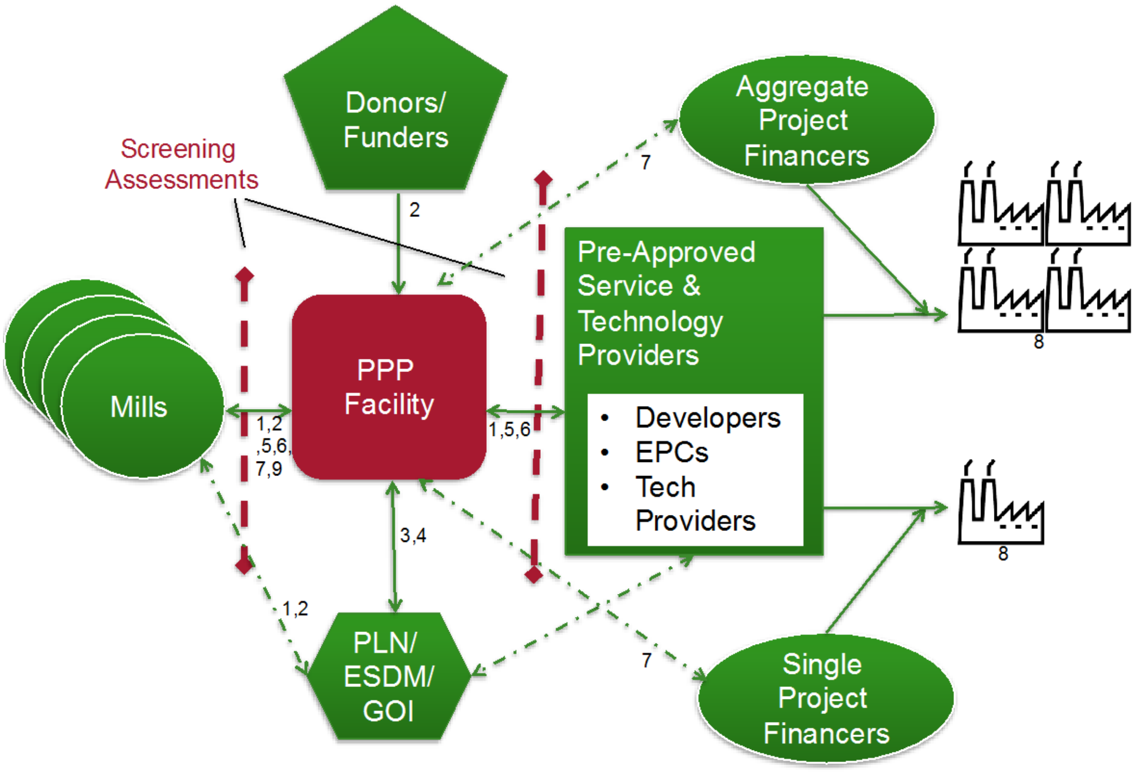
1.2 Highlights

Our own on-the-ground experience and interviews with 32 organizations lead to the following observations about the challenges that have hindered broad implementation of POME-to-electricity projects:

- Capital for financing exists in theory, but in practice, market and policy uncertainties significantly increase the cost of capital and hinder investment;
- The recently released USD denominated feed-in-tariff (FIT) is high enough in theory to make projects feasible and bankable, but the National Electric Utility company *(Perusahaan Listrik Negara - PLN)* is hesitant to approve new power purchase agreements (PPAs) because the mandated FIT levels in some cases result in financial losses for PLN, but are not compensated by government subsidy;
- New projects that receive support from PLN are in locations with high electricity generation costs, low electrification and high demand in the form of excess power agreements. However, these offer lower electricity purchase rates and are approved on a short term basis (typically annual), thus undermining project feasibility and bankability;
- Mills are largely focused on the core business of crude palm oil (CPO) production, so they often have limited capacity and interest in other opportunities such as POME-to-energy projects, or they may be focused on other investment priorities that yield a higher return;
- International investment and multilateral development banks generally prefer investment opportunities that bundle multiple mills through a project aggregator to realize economies of scale, but some mills prefer to develop projects on their own;
- Local banks are interested in small-scale investments, but have limited capacity to assess technical feasibility and project bankability;
- International technology options are numerous and the quality is high;
- Local technical capacity and market experience are limited, and failed projects in the past have negatively impacted the perceptions of market actors; and
- The Indonesian and Malaysian markets share many similar challenges that offer the opportunity to apply similar interventions.

To address these and other challenges, we have developed a strategy founded on a PPP model that establishes a PPP Facility to reduce project risks as seen from the perspective of mills, developers, technology and service providers, financiers and public stakeholders to facilitate funding and construction of POME-to-electricity projects. Figure 1, below, depicts the relationships between the stakeholders in the PPP, while the numbers within the diagram relate to specific activities, highlighted immediately below. The details of this model are described in Chapter 5.

Figure 1. PPP model for POME biogas projects



The specific tasks carried out by the PPP Facility, in collaboration with the other stakeholders depicted in the figure above, are highlighted below.

1. Vetting parties for participation in the PPP Facility: The Facility screens mills, project implementers (developers, technology and service providers) and investors to build transparency and trust among the parties that become partners in the Facility.
2. Sustainability screening: The Facility establishes a sustainability screening protocol to ensure that palm oil producers entering into the PPP meet minimum sustainability criteria.
3. Early-stage development activities: Bridges the gap before developers and institutional funders come in by conducting market engagement and analysis necessary for development, but too risky for developers or funders to invest in without reasonable confidence in the outcomes. This could include performing assessments in partnership with PLN to identify regions where PLN is more interested in signing PPAs.
4. Facilitating PLN and Government of Indonesia (GOI) buy-in: To facilitate the issuance of PPAs and other permits, the Facility will partner with PLN in the design of mill screening criteria to determine technical and geographic screens to increase the likelihood of PPA signing. The Facility will work with PLN and other GOI entities,

such as *Energi dan Sumber Daya Mineral* (Indonesian Ministry of Energy and Mineral Resources [ESDM]), to develop templates and agree on procedures for administrative documentation templates and submittals, particularly for feasibility and grid studies.

5. Feasibility Studies: The Facility will conduct feasibility studies at candidate mills based on standards developed by the Facility. The studies will be funded through a cost-sharing mechanism with the mills to ensure mill engagement, and will later be fully reimbursed by the project development partners into a revolving fund upon financial close.
6. Construction partnering and advising: Based on the interests of mills, developers, and technology and service providers, the Facility will introduce and match these vetted partners for project development activities. The project types will be split into those where the mill is the owner and those where an external partner is the owner.
7. Finance partnering and advising: The Facility presents packaged project structures (construction and operating partnership arrangements, bankable feasibility and grid studies, and signed PPAs) to vetted investors and advises partners on financing options and arrangements.
8. Monitoring: To ensure quality control and effective maintenance, and to capture and disseminate lessons learned to overcome the impact of previously failed projects, the Facility will conduct systematic monitoring of the projects it facilitates.
9. Communications and capacity building: To increase market awareness and capacity, the Facility will communicate project successes and provide training to mills, PLN, and local banks on project basics, feasibility assessments, permitting requirements and project development processes.

The PPP would focus its initial efforts on mills with characteristics that at least partially mitigate the challenges hindering POME-biogas projects, making them better candidates for initial project development, or “low-hanging fruit.” Those key characteristics are highlighted in Table 1, below:

Table 1. Characteristics of mills that constitute “low-hanging fruit”

Characteristic	Low-Hanging Fruit
Sustainable operations	Mills with existing sustainability certifications or corporate sustainability programs
Mill size	60-90 tonnes per hour; able to generate ~2 MW of biogas power
Use of power	If sold to the grid, regions where PLN is amenable; if used locally, where power supply can be well-matched to demand.
Distance to the grid	Ideally <1km but no more than 5km, except for self-generation, where the greater distance from the grid may make the project more attractive.
Mill ownership	Mill groups or single owners of multiple mills; possibly also government-owned mills.
Project developer position	Mills wishing to own and operate the projects themselves will make it harder to aggregate projects than those allowed to be owned and operated by third-party developers.

Characteristic	Low-Hanging Fruit
Feedstock supply	Mills with reliable long-term feedstock access; typically, these mills have their own plantations and/or established plasma supplier relationships.
Mill location	Regions where there are greater numbers of mills, with favorable FIT values and an amenable local PLN. More than 80 percent of palm oil mills are located on Sumatra and Kalimantan. Those locations also have relatively favorable regional FIT multipliers.

1.3 Recommendations

Depending on available resources, the PPP Facility presented in this report may be developed in full or as disaggregated stand-alone activities that would still reduce project risks. For full PPP Facility implementation, priorities for initial startup should be:

1. Identify and engage interested donor and financing partners; and
2. Secure donor funding for PPP Facility startup.

For partial PPP Facility implementation, stand-alone activities are:

3. Develop case studies and technical resources;
4. Conduct in-depth analysis of regions with PLN to prioritize project locations;
5. Conduct a market-level screening to identify mills with characteristics most likely to result in cost-effective projects.
6. Conduct mill outreach, engagement and awareness-raising;
7. Develop and disseminate project-assessment templates and procedures; and
8. Elaborate on the design of a blended capital facility.

2.0 Purpose and Approach

The purpose of this report is to provide a strategy around which a public-private partnership (PPP) can converge to implement and finance biogas capture from palm oil mill effluent (POME) and reuse for renewable electricity generation at large scale that will encompass a significant portion of the APEC region's palm oil mills. The primary, intended audiences are the stakeholders that would implement the strategy and form the core of the PPP, including palm oil mills, financial institutions, governments and government institutions, donors and funders, developers, and technology and service providers.

Our approach toward developing the strategy in this report was to first document stakeholder perspectives on the challenges that hinder implementation of POME-to-electricity projects in APEC economies, and then to propose a solution in the form of a PPP. Our approach focused on Indonesia, but also looked at Malaysia.[2]

The strategy provided in this report would most directly benefit Indonesia and Malaysia, which together produce 85-90 percent of the world's palm oil. Indonesia alone has more than 600 palm oil mills.[3] However, this strategy can be adapted and is applicable to other industries concentrated in APEC economies that involve biogas-emitting wastewater lagoons, including the tapioca starch industry (e.g., in Indonesia, Thailand and Viet Nam) and the rubber industry (e.g., in Indonesia, Malaysia, Thailand and Viet Nam).

APEC member economies, and particularly their representatives in the APEC Energy Working Group, will need to decide whether it is most effective to implement the strategy and form the PPP within APEC or under another existing, or new, umbrella organization. The potential benefits to APEC economies from implementing this strategy are significant. Capturing and reusing biogas can result in more environmentally and economically sustainable growth for developing economies in the APEC region. The renewable electricity generated from biogas combustion can displace a portion of the government revenues often spent on subsidies for electricity generation from high-cost and carbon-intensive diesel fuel. Implementation of the strategy can lead to electrification of remote communities surrounding palm oil mills, which can foster increased productivity and economic empowerment for the people in those communities. Palm oil mills can earn additional revenues from the sale of renewable electricity to the grid or reduce the costs of fuel that would otherwise be used to generate electricity at the mills.

To explore the challenges faced by stakeholders, our team first performed an assessment of our own experiences in this sector, which was informed by direct experience in the development of POME-to-electricity projects and financing renewable-energy projects, to develop an initial list of challenges and a starting position for a PPP model. We organized interviews with stakeholders from subsectors of the POME-to-energy landscape, including government, NGO/civil society, development agency, finance and industry. Using our internal assessment of the challenges and the draft PPP model as the starting point for the

---

[2] Under Indonesian law, PPPs have a specific legal definition; the PPP developed in this report is not intended to meet that legal definition, but instead describes a general partnership between a range of public and private entities to achieve a common goal.

[3] "Facts of Indonesian Oil Palm," Indonesian Palm Oil Board, 2010.

interviews, we explored stakeholder perspectives to update our market assessment and fine-tune our model, as presented in this report. We also collected data from the interviews and a desktop study to assess the market for POME biogas projects in Indonesia.

The interviews we conducted for this report are listed in Appendix B. The results of these interviews are incorporated into the body of the report. The observations and opinions gathered through interviews are not attributed to individual interviewees, so are largely included in this report without reference.

3.0 Market Context

3.1 Market Opportunities for POME-to-Electricity

3.1.1 Climate Change and Renewable Energy

Climate and electrification commitments

In December 2015, Indonesia, alongside nearly 190 other countries, supported the Paris Climate Agreement and committed to reducing its national greenhouse gas (GHG) emissions, in part through renewable-energy (RE) deployment. Indonesia set a target, known as a Nationally Determined Contribution (NDC) under the Paris Agreement, of 29 percent GHG emissions reductions compared to business as usual by 2030, or 41 percent with support from international partners. Separately, Indonesia has set goals for increasing power capacity by 35 GW, with 25 percent coming from renewable sources, and for increasing national electrification to 97 percent by 2019. These international and national goals support the scaling of investment in RE projects, including POME-to-energy projects.

Although the Government of Indonesia (GOI) has not published estimates of costs associated with its climate and clean energy goals, there is significant untapped potential for bioenergy, and POME-to-energy in particular, to play a role in delivering on Indonesia's commitments.

Potential to reduce GHG emissions and increase renewable energy generation

Indonesia is the world's largest producer of crude palm oil, credited with roughly 50 percent of global production.[4] The GOI is planning to increase production, which was 33 million tonnes in 2014, to 40 million tonnes by 2020.[5] Indonesia currently has approximately 600 mills, largely concentrated in Sumatra and Kalimantan.[6,7] The US Environmental Protection Agency's Global Methane Initiative estimates that up to 37.7 million tCO_2e could be reduced each year if all of these mills were fitted with methane capture and conversion technologies. To date, less than 10 percent of the mills are estimated to employ these technologies.[8] If all the captured methane from these mills were used to offset emissions from diesel generators, which are often used to power the remotely located grids nearest to palm oil mills, an additional 5.2 million tCO_2e/year could be avoided.[9]

If all of the more than 600 palm oil mills in Indonesia were to implement POME-to-energy projects, the total energy generation capacity would be more than 1,000 MW.[10]

---

[4] FAOSTAT3.fao.org
[5] http://blog.cifor.org/17798/fact-file-indonesia-world-leader-in-palm-oil-production?fnl=en
[6] "Facts of Indonesian Oil Palm," Indonesian Palm Oil Board, 2010.
[7] Ministry of Agriculture, Directorate General of Data and Agriculture Information System Centre, January 2013.
[8] "Resource Assessment for Livestock and Agro-Industrial Wastes-Indonesia," 31 August 2015, Global Methane Initiative (prepared in part by Winrock).
[9] Calculated based on 37.7 million tCO_2eq methane capture and utilization potential.
[10] Obi Partners Pte., Ltd. "Palm oil waste-to-biogas: an environmental and energy opportunity." Presented at the 15th World Renewable Energy Congress, September 19-23, 2016.

Legal requirements and voluntary GHG standards

In some cases, compliance with criteria of legal or voluntary standards drives POME-to-energy initiatives. With an aim of reducing GHG emissions, governments have established requirements or incentives for these projects; sustainability certification schemes such as Indonesian Sustainable Palm Oil (ISPO) and Roundtable on Sustainable Palm Oil (RSPO) have also established relevant criteria. Several interviewees indicated that Indonesia is considering requiring all mills to implement methane capture by 2020; Malaysia has its own national plan encouraging all mills to install biogas capture technologies by 2020.[11] However, interviews with experts have indicated that there is uncertainty about how these requirements will be implemented and enforced, and that mills are not responding to the requirements yet.

Requirements in consumer markets may also drive projects. The European Union's (EU) Renewable Energy Directive (RED) and Fuel Quality Directive both increase demand for palm oil for biofuel in the EU and require that biofuels meet specified GHG reduction thresholds. The RED requires a 50-percent GHG reduction of lifecycle emissions relative to the petro-fuels they replace. For palm oil used as a biofuel feedstock to meet these reduction requirements, methane capture must be implemented. The implication is that palm oil producers intending to sell to the EU for biofuel production must realize emissions reductions through methane capture, thus supporting mill installation of POME-to-energy systems.

To qualify as a certification that demonstrates equivalence with the EU requirements, many certification schemes have incorporated these GHG requirements in their own standards. The International Sustainability and Carbon Certification (ISCC) EU and the RED voluntary add-on to the RSPO standard are examples of certifications that incorporate the EU GHG requirements.[12]

Indonesian palm oil is widely exported; India, China and the EU were the biggest importers of Indonesian palm oil in 2015.[13] According to the Palm Oil Fund Management Agency, Indonesia produces 32-33 million tonnes of crude palm oil (CPO) per year; 25 million tonnes are exported, while the remainder is consumed within Indonesia. Roughly 20 percent of the export CPO goes to the EU, where sustainability requirements have the potential to drive POME biogas implementation. The interviewees noted that sustainable-certified CPO brings a premium, but demand is only significant enough to drive certain exporters' investments in POME biogas technology implementation as opposed to industry-wide investment.

In addition, there are regulations and certifications with less stringent criteria that do not quantify required emissions reductions but nonetheless promote methane capture and biogas use. The most relevant of these are listed here:

---

[11] http://www.mpob.gov.my/images/stories/pdf/2014/2014_nkea.pdf
[12] Full text of the RSPO-RED add-on can be found at: http://www.rspo.org/file/RSPO-RED-requirements-Final-for-Submission-Feb12.pdf
[13] Source: Statistik Kelapa Sawit Indonesia *Indonesian Oil Palm Statistics* 2015 Katalog/Catalog: 5504003 – completed by BADA PUSAT STATISTIK (BPS-STATISTICS INDONESIA).

- ISPO standard: Introduced in 2009, all oil palm growers in Indonesia are required to comply with ISPO, although compliance is not universal. One of the principles of the ISPO standard is the mitigation and reduction of GHG emissions. Currently, the standard only requires mills to report their GHG emissions (a focus on methane capture does not yet exist). ISPO has indicated that new criteria that will go into effect by 2020 will require methane capture for specified mills, with an aspiration that this will result in 60 percent of the country's mills implementing the technology.[14]
- RSPO: RSPO is an international sustainability standard for palm oil that certain companies and markets require. Its Criterion 5.6 pertains to plans for reducing pollution, including GHG emissions. The criterion is that these plans are developed, implemented, and monitored, and one of the indicators is recording the treatment plan for POME. In addition, Criterion 4.4 on practices to maintain quality and availability of surface and groundwater contains guidance on the adequate disposal of POME.
- Carbon credits: In the past, some POME-to-biogas systems have been implemented for the purpose of generating compliance and/or voluntary carbon credits that can be sold under emissions trading programs, such as the Clean Development Mechanism (CDM), or to offset corporate or personal emissions. However, in recent years, prices for these credits have largely collapsed and are not a significant driver of POME-to-biogas systems at this time. Largely as a result of this, of the 34 registered CDM projects, only 12 successfully obtained Certified Emissions Reductions (CER) in Indonesia. Despite this, voluntary markets and the opportunity for expanded compliance markets in the future offer potential drivers. Of particular note, the International Civil Aviation Organization recently approved use of offsets by airlines starting in 2020. This could create a significant market and boost demand for carbon credits and increase their prices.

3.1.2 Economic Potential

The scale of potential investment in POME-to-electricity is significant: if all of the more than 600 palm oil mills in Indonesia were to implement POME-to-energy projects, the total investment requirement would be on the order of USD 2.5 billion.[15]

A 10-percent penetration rate is sometimes used as a rule of thumb for indicating a technology tipping point, at which point market forces can largely drive growth; further, in some GHG project benchmarking methodologies, it is the threshold beyond which a project using a certain technology type is no longer considered additional. If investments were made in Indonesia to achieve a 10-percent market penetration rate, or roughly 60 mills, the total investment opportunity would be on the order of USD 430 million.[16]

An initial PPP facility to support early adoption of these "tipping point" projects could focus on an even smaller set of project opportunities: the lowest hanging fruit. For example, a facility focused on scaling up projects to achieve a 5-percent market penetration for POME-

---

[14] Additional information can be found at: http://mpoc.org.my/upload/P6_Rosediana-Suharto.pdf
[15] This assumes a cost of USD 2-4 million per MW; 600*1.8 MW installations representing average mill size.
[16] This assumes a cost of USD 2-4 million per MW; 60*2.4 MW 1MW installations representing 60 TPH "low-hanging fruit" mills as the lower bound cost estimate, and 160 2MW installations as the upper bound.

to-energy projects (in addition to roughly 50 already installed), could support approximately 30 additional projects at an average cost of USD 3 million per project.[17] Project costs to financiers could be reduced and more projects could be achieved if some of the projects were partially financed by the mills themselves, particularly in the cases of those mills owned by larger multinationals with strong balance sheets.

Table 2, below, provides typical financial performance indicators for a 2.3 MW POME-to-electricity system.[18]

Table 2. Typical POME-to-electricity project financial performance indicators

	Average Project	Example 2.4 MW system*
Project IRR	10-23%	18.05%
Equity IRR	Variable	28.12%
Payback period	4-7 years	Year 5
Cost/MWe	USD 2-4M	USD 2.3M
CAPEX costs	Variable	USD 5.49M

***Data are from a confidential project in Jambi, Indonesia, performed under the USAID CIRCLE project.**

The GOI is seeking to increase the amount of renewable energy on its electrical grids, the national electrification ratio and access to electricity in remote locations. As a means to these ends, in addition to the national goals mentioned in the previous section, the GOI utilizes technology-specific FITs to encourage private companies to invest in renewable energy generation technologies.

Under Ministerial Regulation (PERMEN) No. 21/2016, biogas project owners can sell power through power purchase agreements (PPAs) or excess power agreements with PLN. The PLN FIT, with a base tariff of USD 0.1064/kWh, location factors up to 1.5x, and contract periods of 15-20 years, makes projects appealing to developers. However, securing PPAs to sell power with this FIT for extended periods can be challenging, and there are concerns among project developers about the reliability of excess power agreements, which must be renewed regularly (typically annually) and are therefore difficult to “bank.”

The amount and quality of the electricity that can be produced from POME biogas projects extends the economic value afforded by PLN’s FIT. The nature of the palm oil industry means that the electricity generated serves as a reliable source of baseload power for PLN’s grid or internal mill consumption. Mill throughput is cyclical, but reliably so, and the peaks and troughs of energy production are not drastically different. Further, mills often operate continuously and can plan maintenance downtime, so electricity generation is not intermittent. Such reliability is important for PLN, who must be able to integrate multiple electricity sources into its demand management planning.

[17] Corresponding to the 600 mill estimate.
[18] Based on a 60 TPH mill, from Winrock International's CIRCLE overview presentation.

The amount of POME generated by a mill supports electricity generation capacity that far exceeds mill demand, so mills can use the electricity for multiple uses: to replace diesel generators or other onsite electricity generation capacity for mill and ancillary operations such as employee housing; for sale to the PLN grid; and/or for local community use. The latter can be particularly important as a means for mills to develop and maintain positive relationships with surrounding communities.

Financial assessment

There are several cost and revenue considerations that mills and/or project developers must evaluate for a POME-to-energy project. The investment costs consist of: the bio-digester system, which includes soil test analysis, access clearing, mobilization of equipment and some civil works such as road and access; the biogas management system, which consists of the lagoon works, including soil movement, soil compacting, piping and lagoon cover; the electrical and instrumentation system, which consists of installing instrumentation, and electrical wiring and equipment; and installation, logistics and EPMASC (engineering, procurement, management, administration, supervision of work and commissioning).

Indicative costs for engineering, procurement and construction (EPC), financing and working capital are shown in Table 3, below.[19]

Table 3. Indicative POME-to-electricity EPC, financing and working capital costs

System	Components		Costs
EPC Costs			**As % of EPC Costs**
Bio-digester system	1	Preliminary Works and Mobilization	~ 25%
	2	Civil and hydraulic works	
	3	Equipment	
Biogas management system	1	Preliminary works & mobilization	~ 15%
	2	Civil and hydraulic works	
	3	Equipment	
Electrical and instrumentation system	1	Control and electrical room	~ 10%
	2	Instrumentation and control	
	3	E&I connections for digester and biogas system	
	4	Electrical works for connection to biogas MSB	

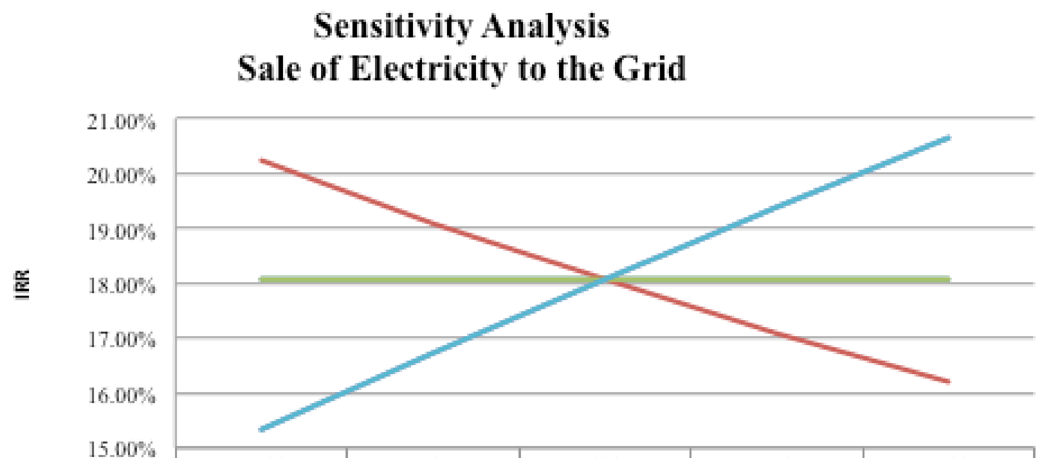
[19] The source of the relative costs of the components (i.e., percentages) is the USAID/Winrock 2015 "Handbook-POME-to-Biogas Project Development in Indonesia." Specific EPC and investment costs come from a confidential feasibility study for 2.4 MW POME-to-biogas system in Jambi, Indonesia.

System		Components	Costs
Installation, logistics and EPMASC	1	Mounting and logistics	~ 20-25%
	2	Shipping and insurance	
	3	Engineering	
	4	Procurement	
	5	Management	
	6	Administration	
	7	Supervision of works	
	8	Commissioning	
Gas engines (including installation)			~ 20-30%
Grid connection			~IDR 280 – 420M per km
Contingency (2%)			~5-10%
		TOTAL EPC COSTS	**USD 5,341,000**
		Costs	
Other costs	1	Financing costs	2% of CAPEX
	2	Initial working capital	3 mo. of OPEX
		TOTAL INVESTMENT COSTS	**USD 5,486,000**

Figure 2, below, provides an IRR sensitivity analysis for a typical 60 tonnes-per-hour mill selling to the electrical grid.[20]

[20] Ibid.

Figure 2. Example of POME-to-electricity project IRR sensitivity analysis.



	-10%	-5%	0%	5%	10%
Base Case	18.05%	18.05%	18.05%	18.05%	18.05%
Investment Costs	20.23%	19.09%	18.05%	17.09%	16.21%
Processed FFB	18.05%	18.05%	18.05%	18.05%	18.05%
COD Level	15.33%	16.71%	18.05%	19.36%	20.64%
Gas Engine Efficiency	15.33%	16.71%	18.05%	19.36%	20.64%

Financing Options

Most POME projects in Indonesia have received their funding through equity or corporate financing, whereby a bank analyzes credit worthiness based on the balance sheet of the group or holding company. Project financing for projects, wherein the project itself becomes the collateral for the loan, is not yet common practice in Indonesia. Project financing tends to be more time intensive and requires robust banking capacity to identify and mitigate risks. Project aggregation is also necessary, as individual projects are often too small for larger financial institutions to consider.

A number of institutions may be able to provide finance for POME-to-energy projects. Broadly speaking, these fit into three categories: grant funding, concessional capital and private capital. Grant funding does not require re-payment, but typically entails specific uses that match donor goals. Concessional capital, sometimes referred to as soft loans, require repayment, but the terms are typically less stringent than private loans, and reflect the lender's willingness to take on higher risk projects with the goal of supporting economic or market development. Private capital terms and risk levels more closely reflect market conditions. Examples include the following:

Grant funding

- Bi- and multi-lateral donors: Financing could be provided directly by the government of a donor economy, such as through the US Agency for International Development (USAID), the German Corporation for International Cooperation (GIZ) or the Global Green Growth Institute (GGGI). These typically involve strict sustainability requirements.

- Philanthropic sources: Philanthropists may be interested in supporting POME-to-energy projects; their capital would likely come in the form of grants that could be used for early project screening and/or de-risking purposes. These also often involve significant sustainability requirements.

Concessional capital

- Multilateral development banks (MDBs): MDBs such as the Asian Development Bank (ADB) have expressed interest in providing finance for POME-to-energy projects, but are looking for larger investments than the standard USD 2-4 million individual mill ticket size. Aggregation of projects through the proposed PPP facility could help to address this challenge.
- Other potential concessional funding: Other sources of concessional funding could include funding provided by government trade-promotion offices, family trust funding, impact investors and program-related investments (PRIs). These types of loans are generally focused on social or other impacts of the investments, and typically involve strict sustainability criteria.

Private capital

- Local banks: Small local or regional banks, many of which are state-owned enterprises in Indonesia, are willing to finance individual POME projects, particularly with mills they already have as customers. Securing local bank financing can be challenging, however, due to limited banking experience with POME project risk assessment and project finance more generally, reliance on balance sheet financing, and high collateral requirements.
- International financial institutions: This broad category could include international project financiers, traditional investment banks, private equity, venture capital and impact investors.
- Project developers: Companies directly involved with project implementation such as developers, independent power producers (IPPs), and technology providers may be willing to provide project financing.

A blend of these types of capital could be utilized to bring down the cost of capital to early adopters, and to tailor lending to the risk appetites of different investors, which in turn will have implications for interest rates, loan tenors, etc. The proposed design of such financing is outlined later in this document.

3.2 Limited Implementation

Despite the support and interest in POME biogas projects, many barriers remain. The financial tools and frameworks required to help scale these projects remain underdeveloped and underutilized. Incentives remain misaligned and perceptions about financial viability remain out of line with reality (in both directions). National data show that the development of POME-to-energy projects is still limited in Indonesia compared to its estimated potential.[21] Total installed capacity of palm biomass waste (such as empty fruit bunches, fiber and shells)

[21] According to the publication *Potensi dan Peluang Investasi EBTKE* (published by Directorate General of Renewable Energy and Energy Conservation/EBTKE).

and POME-to-energy projects, both on-grid and off-grid, that were recorded by ESDM through 2014 was 14 MW, or under 2 percent of the total estimated POME-to-energy potential.[22,23] Other estimates based on population figures in the 600 mill range have put the total number of existing projects at less than 10 percent of mills.[24]

In expert interviews, estimates of the total number of POME-to-energy projects ranged from 12 to up to 50, which may include additional projects completed after 2014. Interviewees identified a few dozen specific POME-to-energy facilities, including the first-ever pilot project supported by the Riau government, the 5 undertaken through the CIRCLE project, between 8 and 12 developed by Musim Mas, and a handful by Asian Agri, Wilmar, Alternative Energy Corporation and others.[25,26,27,28,29] It is believed that some of these existing projects may not be working well due to operational issues and the fact that only 5-7 are connected to the grid.

Despite market limitations, the USAID-funded CIRCLE project catalyzed project implementation. This was largely due to the project's role as an honest broker in building trust among the stakeholders and bringing technical rigor to the feasibility assessments. By the end of the almost four-year project, two projects reached commercial operation and four reached financial closure. The total capacity from these six projects is expected to reach 11.2 MWe, reducing greenhouse gas emissions by more than 240,000 tCO_2 annually. The status of these six projects are as follows:

- Two projects that are in commercial operation use generated electricity for their own consumption and sell the excess to PLN.

[22] According to the publication *Statistik EBTKE 2015* and *Laporan Kinerja* EBTKE (published by Directorate General of Renewable Energy and Energy Conservation/EBTKE).
[23] According to the publication *Potensi dan Peluang Investasi EBTKE* (published by Directorate General of Renewable Energy and Energy Conservation/EBTKE).
[24] Conrad, Lisa and Ikke Prasetyaning. "Promotion of Least Cost Renewables in Indonesia (LCORE-Indo): Overview of the Waste-to-Energy Potential for Grid-connected Electricity Generation (Solid Biomass and Biogas) in Indonesia." March 2014.
[25] Hidayat, Ali. "Indonesia Builds First POME Power Generator." Published on 16 September 2014 at http://en.tempo.co/read/news/2014/09/16/056607446/Indonesia-Builds-First-POME-Power-Generator.
[26] http://www.iced.or.id/usaid-program/ According to this source, the first Indonesian project was a government-supported pilot in the village of Rantau Sakti in Riau Province, with an installed capacity of 1 MW that supplies power to 1050 households, and was funded by the Ministry of Energy and Mineral Resources with a contract value of Rp28 billion.
[27] The Capacity for Indonesian Reduction of Carbon in Land Use and Energy (CIRCLE) project provided technical assistance to interested palm oil mills (POMs) in Indonesia to create renewable energy from POME. Winrock International implements the USAID-funded CIRCLE project in partnership with World Wide Fund for Nature (WWF) Indonesia. CIRCLE assists Indonesian POMs with sustainability assistance, pre-feasibility studies, in-depth feasibility studies, technical assistance and capacity building.
[28] "Harnessing palm oil waste." The Jakarta Post (Editorial). Published January 27, 2016. This article cites five POME-to-energy facilities installed by Asian Agri.
[29] Goon, Jeremy (Wilmar International Limited, Singapore). "Voluntary Action to Reduce GHG Emissions by RSPO Members: Methane Capture of POME." In this paper Wilmar notes that they have implemented four closed-tank anaerobic digestion systems in Indonesia and Malaysia, and two covered lagoon systems in Indonesia, where the captured methane are utilized either in a boiler for steam generation or a biogas generator for power generation.

- One of the four projects that reached financial closure is in the commissioning stage; 100 percent of the electricity is planned for captive use.
- The three remaining projects are under construction, with one planning to sell electricity with a long-term PPA, and the other two using the electricity for their own consumption and selling the excess to the PLN.

CIRCLE identified 24 other projects with the potential for further development: 9 have completed feasibility studies, 11 have pre-feasibility studies, and 4 have done preliminary assessments.

4.0 Stakeholder Challenges

Through our interviews, we identified the challenges that each type of stakeholder perceives as influencing their and others' decisions to invest or direct resources toward POME project development. For some stakeholders, such as investors, high risks can translate to financial losses or lost revenue. For others, such as policymakers, high risks may mean organizational capacity wasted on ineffective policy support structures.

This chapter describes the key challenges identified during interviews; the proposed PPP model detailed in Chapter 5 is designed specifically to address these challenges. For each stakeholder group, we describe the key risks below. Detailed tables that highlight all the risks identified by stakeholders are provided in Appendix A.

4.1 Mills

Through our conversations with mill operators and owners and palm oil company energy managers, we learned that the primary reasons mills have not more broadly implemented biogas projects are related to their **hesitancy to divert resources from core business activities**; **limited familiarity with the technologies**; and a **lack of experience with, and trust in, the sub-sector stakeholders**.

Palm oil (PO) companies have built business models around maximizing revenues from their core crude palm oil (CPO) production business to great success, as evidenced by the industry's rapid expansion and comfortable margins over the past three decades. Business models for the mills are relatively homogeneous, with new mills designed and operated in largely the same manner since the early days of industry growth. Over that time, waste byproducts such as POME have been largely treated as a cost that must be managed for compliance instead of a potential revenue source. Further, most mills already have functioning POME management systems and energy-production capacity via on-site biomass boilers and diesel generators. As such, new POME-to-energy projects are largely seen as distractions from CPO production, or worse, as competing with functional equipment already on the mills' balance sheets.

The effect is that mills do not allocate resources to investigating the costs and benefits of biogas projects, and are even less likely to invest the funds required for quality feasibility studies to assess the potential for project development. At the same time, the approximately 10 percent of mills that do integrate biogas projects into their business models and operations do so to enhance their competitive advantage, so they do not freely share the pertinent technical and investment-related information, such as costs and operating requirements. As a result, many mills are not aware of successful projects, so they are not comfortable assessing project risks and bankability.

The PO industry tends to be relatively closed and guarded, so mills often respond with skepticism to efforts by outside organizations to offer new technologies or sustainability improvements. This lack of trust in the biogas subsector comes from the fact that mills are often not familiar with biogas technologies or providers, or have heard examples of failed projects. This has roots in both reality and hearsay. A number of projects have failed over the past decade. Some can be traced to inexperienced developers and engineers, but others relate to the failed Clean Development Mechanism (CDM) market and mills or developers seeking to reduce costs with substandard designs or equipment. The issues behind these failures have largely been recognized and overcome by developers, but mills still hear about them.

The industry also largely sees itself as being under scrutiny by the public and environmental organizations. The result is that when mills are approached with business propositions, their initial reaction is to reject the inquiries. This presents a particular challenge for third-party IPPs and investors who prefer to own and operate multiple projects located on mill properties.

4.2 Financial Institutions

While many investors are interested in low-carbon opportunities such as POME biogas projects, there are significant gaps in the financial landscape, and mismatches between the types and tenors of capital available and what is needed, particularly in the early stages of the market. This has severely limited market liquidity. Our interviews indicate that financial institutions have access to funding, but are hindered by **limited local financial industry technical capacity** needed to assess project risks, a **lack of revenue certainty** for projects in Indonesia, a **dearth of bankable projects** to fill a pipeline for investment and **limited availability of financing and aggregation vehicles**. These factors contribute to high capital costs — often prohibitively high — which depresses interest in early-stage project origination, development and implementation.

Because so few biogas projects have been developed in Indonesia, Indonesian banks have not had the opportunity to build capacity to assess project risks or feasibility studies. The banks are largely unfamiliar with financing for renewable energy in general, and POME biogas projects in particular. These banks do not have established benchmark figures or personnel with experience assessing technical considerations, working with developers, or dealing with PPAs. In addition, Indonesian financial institutions have little experience utilizing project financing, thus limiting developers' borrowing capacity. As a result, the banks may demand high interest rates, require extensive collateral, expect breakeven/ROI timelines that are inconsistent with project realities and developers' capacities, or be unwilling to provide any capital at all.

Reliable project income depends on PPAs signed with PLN as the electricity off-taker.[30,31] Although PERMEN No. 21/2016, signed in mid-2016, requires PLN to purchase electricity at a FIT that would provide sufficient financial returns, PLN does not agree with the requirements and is delaying signing any PPAs at the new rate pending internal deliberations.

---

[30] Mills typically produce 50-100 percent of their own power needs through existing biomass combustion systems, and POME biogas projects generate more power than mills require. As such, biogas-based electricity used for captive power does not provide sufficient economic benefit for investors, so an external off-taker is necessary for beneficial project economics.

[31] The collapse of carbon prices has also diminished the value of Certified Emissions Reductions as a source of reliable revenue.

There are several examples of PLN creating its own rules regarding electricity purchases from IPPs and withholding payments on signed PPAs.[32] The result is that financial institutions will hesitate to invest until PLN's position is clear. In the meantime, PLN is willing to sign excess power agreements, but these must be renewed annually, so they do not provide investor certainty and are not "bankable."

In addition, the market has a limited capacity to support and produce high-quality technical and financial feasibility studies because of the limited number of projects that have been implemented. This, coupled with weak interest by mills in the projects, and limited early-stage funding to assess project bankability and to bring them to "investment ready" status, has meant that no attractive pipeline of projects has been developed in Indonesia. As such, there is little incentive for potentially interested financial institutions to invest their own resources to investigate a very challenging market.

Further, larger financial institutions prefer development models that allow for the aggregation of individual biogas projects into larger investments with an individual external IPP, which runs counter to the structure of the PO mill market, with predominantly small individual projects. Bundling projects for larger investments is more attractive to financial institutions because it allows for economies of scale and streamlined administrative transactions. However, there are very few vehicles for project aggregation; to the extent that these exist, they take place through project developers who themselves often face high capital costs and/or difficulty in accessing capital at the appropriate cost and tenors. Smaller Indonesian banks and some smaller international investors may be less concerned about the need to aggregate projects because they have less access to capital at a smaller scale and are less able to manage risks across multiple stakeholders. However, the scale of capital they are able to access may be much more limited than the larger institutions.

4.3 Developers

Project developers can be the mills themselves or third-party entities. In some instances, due to the market's limited experience with these projects, the key risks and challenges they face are similar: **onerous PLN and ESDM permitting and administrative requirements**, and **producing quality feasibility and grid studies**. The key risk of **project discovery costs** that may not generate a return is unique to third-party IPPs.

The primary administrative and permitting requirements for project developers are IPP registration with ESDM and PLN, and PPA approval and grid interconnection studies with PLN; in the past, these have taken more than 12 months to complete. As noted, PLN is not currently signing PPAs, meaning the required time cannot even be estimated. When active, these processes require developers to commit resources not only for the studies' completion, but also to regularly work with PLN on the documentation, which can strain resources and conflict with other mill commitments.

[32] "APR Energy Decides to Postpone the Plan to Leave Nias," *Jakarta Globe*, June 2016, http://jakartaglobe.id/business/apr-energy-decides-postpone-plan-leave-nias/.

Limited technical capacity means that mills and developers alike have difficulty conducting reliable feasibility and grid studies, or finding capable experts to do so. Suspicion of project developers or a desire to "cut out the middle man" may actually cost mills more as they attempt to "learn by doing" themselves rather than relying on those who have implemented projects before. Submissions of poor quality further extend the time requirements to finish PLN and ESDM permitting requirements.

Because of the limited number of parties interested in project development due to market challenges, project developers must work hard to identify and cultivate potential projects. The project discovery costs associated with these efforts can be a high hurdle, particularly for smaller local companies and/or startups with limited access to development funding.

4.4 Technology and Service Providers

Technology and service providers, including EPCs, technology suppliers, and service providers, have limited experience in the POME biogas sector in Indonesia because of the limited number of market opportunities. However, these service providers often have experience in other countries and in related sectors in Indonesia, such as cassava waste-to-energy. These stakeholders are challenged by the **high cost of project discovery**, **onerous contracting requirements** and **local content requirements**.

Through PERMEN No.54/2012, the GOI requires minimum local content for equipment for biogas power plants: 68 percent for equipment, 96 percent for services, and 70.79 percent overall.[33] These requirements for renewable energy projects are not clear and are not uniformly enforced; GOI requirements for minimum local content may result in forced equipment and service choices, and often mean inferior products and services that increase costs or reduce revenues.

4.5 Government

Government institutions are driven to serve the interests of Indonesia and its people. Related to the POME biogas sector, this means providing access to electricity, reducing GHG emissions, growing the economy through expansion of technical and financing capacity, and supporting the strength of the PO sector. The key challenges faced by the government in relation to these goals are **resource constraints** and **workforce technical capacity**.

Like all governments, the GOI has limited resources to achieve many goals, meaning efforts to set and enforce environmental and other legal requirements, fund GHG emissions projects, build technical capacity in the construction and banking sectors, or to otherwise promote POME biogas projects, sometimes compete with other national priorities. These resource constraints also mean that the GOI sometimes relies on support from external parties, such as multi-lateral donors and the private sector, to deliver on their policy objectives.

---

[33] "Renewable Energy Guideline on Biomass and Biogas Power Project Development in Indonesia, 2nd Edition" GIZ, February 2015.

Further, PLN is challenged by **conflicting mandates to support renewables (regardless of cost) while remaining profitable**, and **limited technical and resource capacity to support POME biogas project permitting and integration**.

PLN is a state-owned enterprise regulated by multiple government agencies, including the Ministry of State-Owned Enterprises, which dictates that PLN must work to operate at a profit, and ESDM, which sets electricity provision goals and policies. Through PERMEN No. 21/2016 and renewable energy goal setting, ESDM requires PLN to purchase electricity from biogas with stipulated FITs. In some of the more remote locations where electricity is generated using diesel fuel, logistical and operational costs lead to high generation costs, and POME-based electricity makes economic sense. However, in other locations with lower generation costs, PLN incurs economic losses when forced to pay the FIT. PLN's economic losses on renewable energy generation are not covered by the GOI, so PLN is forced into an economic loss in some cases. PLN has yet to sign long-term PPAs under this new PERMEN, as it is working to determine its longer-term policy implementation strategy.

In addition, PLN's office of renewable energy is staffed to meet the demands of a relatively small POME biogas market, and is not scaled for rapid growth in the market.

4.6 Funders and Civil Society

Donors and other development funders are driven by the desire for social returns on their investments. These investments have a high potential for failure, particularly because they are made in sectors where the market has not been successful. Ultimately, the idea is to transition from the need for grant or concessional funding to a vibrant self-sufficient market, but that process can be challenging. Grant and concessional funders typically demand **high-quality projects** that encourage increasing market capacity, lead to **sustainable and equitable economic growth** and contribute to **GHG reductions**.

Civil society, considered here to be made up of the public and non-governmental bodies acting to protect the public interest, largely seeks the same results as do donors and development funders. A significant difference, however, is that civil society has less access to and control of funding that can be put toward these issues.

4.7 Comparison Between Indonesia and Malaysia

The bulk of the interviews conducted for this project were with stakeholders in the Indonesian market, but we held interviews with several representatives of the Malaysian market to assess similarities and differences.[34]

The Indonesian and Malaysian markets share many of the same characteristics and challenges. Malaysia is the world's second largest PO producer and is also in the early stages of market-wide implementation of POME biogas projects, though further along than the

[34] Interviewees for the Malaysian market included individuals from Green & Smart and True Eco. The interviewees' views represent personal opinions and experiences, not company positions.

Indonesian POME biogas market. Malaysian policies and regulations more aggressively pursue methane capture as an industry standard, as evidenced by the eight core Entry Point Projects (EPPs) implemented by the Palm Oil National Key Economic Area program. Through EPP 5, the National Biogas Implementation Plan, all mills are being encouraged to install biogas capture technologies by 2020.[35] However, enforcement and financial challenges have meant that fewer than 20 percent of all mills have installed the technologies.[36]

Interviewees highlighted the following as key issues in Malaysia, which broadly mirror issues seen in Indonesia:

- The market lacks technicians with the skills to operate and monitor facilities.[37] The lack of skilled technicians is even more acute for palm oil mills located in remote areas.[38] In general, the palm oil industry operates with optimized manpower such that wages may not be high enough to attract enough skilled workers to these locations;
- The market lacks professional engineers to supervise, analyze and troubleshoot power plants;
- Financiers and investors lack an understanding of POME biogas implementation issues and scenarios; and
- High interest rates reflect market uncertainties and currency risk. The Government of Malaysia recognizes the financial challenge and has tried to remedy the situation by subsidizing 2 percent of the bank interest charges through the Green Technology Financing Scheme (GTFS) program. Despite this support mechanism, few POME biogas projects have been approved under the energy sector for the GTFS.[39]

A number of challenges apply distinctly to Malaysia. In particular, interviewees highlighted the following:

- Local authorities in Malaysia appear to put a lower priority on general energy strategy compared to other economic development goals, potentially because Malaysian electricity provision capacity is already relatively robust and does not face the challenges raised by the dispersion of Indonesia's islands;
- Malaysian utilities require that grid connection equipment costs be covered by project developers;[40]
- The Malaysian FIT challenges are centered around quota limits rather than prices. Malaysia's Sustainable Energy Development Authority (SEDA) intends to make available as many renewable-energy licenses and FIT allocations as possible. However, since the payment for the FIT comes from the RE fund, which is supported by the electricity bill payment of the Malaysian population (currently 1.6 percent goes into the RE fund), there is an inherent limitation on the quota. To increase the available quota, SEDA has introduced a degression rate on the FIT, and has set a limit on large-scale project awards to favor more small-scale projects. Further, the quota pool covers all biogas projects, so POME competes within the pool; and

[35] http://www.mpob.gov.my/images/stories/pdf/2014/2014_nkea.pdf
[36] http://pjsrr.upm.edu.my/wp-content/uploads/2015/11/20151125-PJSRR-Vol-11-33-39.pdf
[37] http://pjsrr.upm.edu.my/wp-content/uploads/2015/11/20151125-PJSRR-Vol-11-33-39.pdf
[38] http://www.theborneopost.com/2015/02/11/sarawaks-palm-oil-industry-in-dire-need-of-workers/
[39] https://www.gtfs.my/
[40] http://seda.gov.my

- Feedstock security seems to be a bigger issue in Malaysia because there are more mills without their own plantations.

5.0 Strategy

We have developed the following public-private partnership model in consultation with interviewees and experts in the POME biogas field to address the project development challenges highlighted in the previous chapter. The general concept is to establish a PPP Facility that mitigates key project development risks as seen from the perspective of mills, developers, technology and service providers, and public-sector stakeholders. The explicit aim of the PPP is to de-risk individual projects, and eventually the broader POME biogas asset class, by accelerating the funding, construction and successful operation of POME-to-energy projects.

The PPP will screen the mills, technology and service providers, and developers; conduct pre-financing and early-stage project preparation services such as feasibility studies and grid studies; coordinate with PLN to identify the most viable projects; support arranging financing; and connect stakeholders to make project deals. The PPP removes the primary uncertainties in POME-to-electricity biogas financing deals by building trust and knowledge, conducting first-round activities and bringing together project stakeholders to advance the most promising project structures.

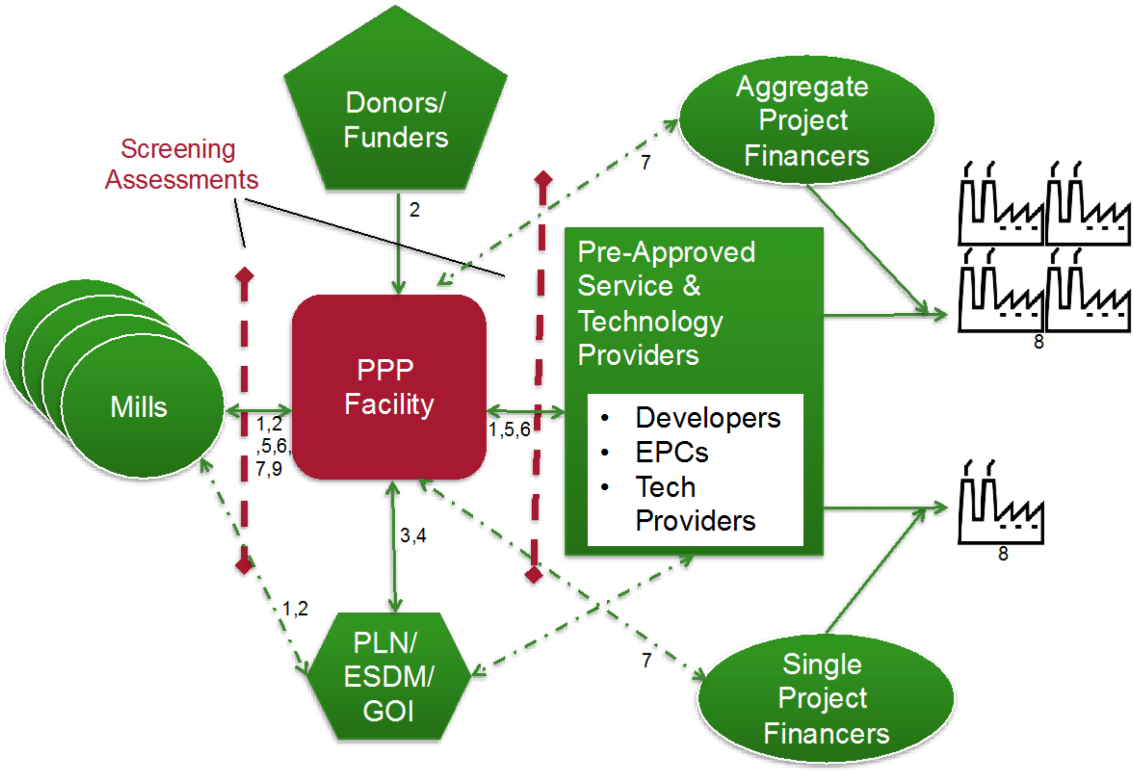
This chapter describes the role of the PPP Facility, the stakeholders involved in the PPP structure, and the primary mechanisms used by the PPP to address critical stakeholder risks. The key risks and mechanisms to address them are highlighted in Table 4, below, and detailed in the following sections.

Table 4. Key challenges and corresponding PPP mechanisms

Key Challenge	PPP Mechanism
Mill owner buy-in and trust	Mill engagement through outreach and workshops; pre-approval of project implementers.
Availability of early-stage capital	Donor/funder resources capitalize feasibility study revolving fund.
Generation of bankable feasibility studies	High-quality feasibility studies performed by the PPP Facility.
Environmental and social impacts of operations	Sustainability screening as part of initial mill screening, and a stipulation for engaging with the PPP.
PPA approval	Streamlined permitting processes through MOUs with PLN.
Technical capacity at mills, banks, PLN	Outreach and training provided by the PPP Facility.

Figure 3, below, depicts the components and relationships established by the model. The diagram numbering corresponds to specific roles of the PPP Facility, introduced in Section 5.2 and discussed in detail in Section 5.3.

Figure 3. Public-Private Partnership model for POME biogas projects



5.1.1 Focusing on the Low-Hanging Fruit

The PPP would not attempt to implement POME-to-energy projects at all mills, but would rather focus its initial efforts on a subset of mills that constitute the "low-hanging fruit." These mills share certain characteristics that make them the best candidates for initial project development. These characteristics mitigate some of the challenges highlighted in the previous chapter, and include the following:

- Sustainable operations: Mills entering into the Facility partnership will have to meet environmental and social sustainability standards. Mills that already have corporate sustainability programs, ISPO/RSPO certified operations, or otherwise proven track records in sustainability will more easily complete the steps needed to meet the PPP Facility's requirements.

- Mill size: Mills below 30 tonnes per hour (TPH), equivalent to 1 MW, are less viable candidates for POME-to-energy due to economies of scale; mills that have a FFB production capacity of 60-90 TPH can generate at least 2 MW of biogas power and fall in the "low-hanging fruit" for project development. This is because the marginal costs of electricity production are lower for larger mills, representing a better value and potential return on investment. For example, in a study of North Sumatra, about half of the mills surveyed had 30 TPH capacity or more, and just under 15 percent had 60 TPH capacity or more; this is typical within Indonesia.[41]

- Use of power: Mills can use the power generated by POME-to-energy projects for captive use, or to sell through local cooperatives or directly to PLN's grid. Because many mills already use some of the waste biomass they generate (such as empty fruit bunches, fiber and shells) for captive power and heat generation, the economic potential of a POME-to-energy project can significantly depend on the possibility of selling the electricity generated to others.

  Mills able to secure a PPA with PLN have a guaranteed source of revenue. Currently, there are numerous challenges and uncertainties associated with securing PPAs, discussed further in Chapters 3 and 4. Excess power agreements with PLN are easier to obtain but have lower tariffs and shorter time horizons, as they must be renewed, typically, on an annual basis.

- Distance to the grid: When considering interconnection and grid extension costs, and transmission and distribution losses, the closer a mill is to the grid, the better the project economics. Mills that reside within 2km of a medium-voltage grid line are considered within the "low-hanging fruit" for POME-to-energy projects, and 5km is considered the maximum distance for which PLN is willing to consider bearing the costs of grid extension.[42] Beyond 5km, a mill would be expected to bear the costs of interconnection; developers have estimated costs at IDR 400-600 million (USD 30,000 to 46,000) per km if the interconnection is straightforward. Furthermore, the approval process for right-of-way can be lengthy, sometimes requiring more than 12 months to get through the grid study and PPA approval process. In the North Sumatra study, an estimated 48 percent of mills were less than 1km from a medium-voltage grid line, and an additional 29 percent were within 5km of a medium-voltage grid line.[43] Mills located more than 5km from the grid may be candidates for captive power projects or other uses of biogas.

- Mill ownership: Mills owned by large multinationals are more likely to have the resources and access to capital required to implement projects outside of their core business, such as POME-to-energy, and may be more responsive to broader supply-chain sustainability drivers.[44] Privately owned mills may also have higher productivity levels, which improve project economics.[45] These mills, as well as

[41] Nasution, Muhammad Ansori, et al. "Analysis of Palm Biomass as Electricity from Palm Oil Mills in North Sumatra." Conference and Exhibition Indonesia Renewable Energy and Energy Conservation [Indonesia EBTKE CONEX 2013].
[42] Conrad, Lisa and Ikke Prasetyaning. "Promotion of Least Cost Renewables in Indonesia (LCORE-Indo): Overview of the Waste-to-Energy Potential for Grid-connected Electricity Generation (Solid Biomass and Biogas) in Indonesia." March 2014.
[43] Muhammad Ansori Nasution et al. 2014.
[44] As evidenced by the fact that the largest uptake of POME technologies is by larger multinationals such as Cargill, Sampoerna and Mus Mas.
[45] TetraTech. "Methane Capture and Use Potential at Palm Oil Mills in Indonesia." Methane Expo 2013. Vancouver, Canada. March 14, 2013.

groups of mills under one owner, may be considered among the “low-hanging fruit” as they act as a natural project aggregator. Individual mills may be less willing to focus resources on projects perceived to be outside of their core business. There are several potential strategies for aggregating POME-to-energy project pipelines in Indonesia, including targeting the roughly seven state-owned companies and other privately owned mill groups with at least four mills.

Approximately half of all palm oil mills are owned by groups and/or multinational companies.[46] These companies include Sinarmas, Asian Agri, Musim Mas, Golden Agri, and First Resources, among others. The number of mills owned by a single group ranges from 2 to more than 30, and these can be located across several provinces. An additional 74 mills are operated by the state-owned companies alone.[47]

- Project developer position: Mills must decide if they would like to develop POME biogas projects themselves or go through a third-party developer. With third-party project developers, the mill site acts as the project host and secures passive income through an agreement with the developer. While some mills prefer to keep their business focus on CPO and not on electricity generation from POME, others may not want external parties operating on their property and may prefer to “cut out the middle man.” Third-party IPPs allow for easier project aggregation if one IPP owns multiple projects.

- Feedstock supply: Mills with their own plantations and established long-term relationships with farmers through plasma structures provide reliable and consistent supplies of the FFB feedstock to the mill, which is directly related to the generation of POME. Secure supplies of feedstock ensure consistent power production, which is important for efficient biogas system design and sizing, reliable revenue streams over time, and provision of consistent baseload power to the grid.

- Mill location: Based on the cost of generation, local electricity supply, and demand characteristics, PLN gives preference to certain provinces and regions. Where there is a shortage of electricity supply, PLN may be more amenable to paying the FIT rather than paying a high price for diesel. Further, the FIT under PERMEN No. 21/2016 applies various location-based multipliers to incentivize underserved regions.

5.2 PPP Facility

The strategy for implementing and financing POME-to-electricity projects revolves around the central PPP Facility. The PPP Facility would be established as a not-for-profit that maintains objectivity and independence in decision-making. Under Indonesian law, PPPs have a specific legal definition; the PPP discussed here is not intended to meet that legal definition, but instead describes a general partnership between a range of public and private entities to achieve a common goal. APEC member economies, and particularly their

[46] According to the publication: Direktori Perusahaan Perkebunan Kelapa Sawit 2015 (Published by BPS-Statistics Indonesia).
[47] According to discussions with the Ministry of Agriculture.

representatives in the APEC Energy Working Group, will need to decide whether it is most effective to implement the strategy and form the PPP within APEC or under another existing, or new, umbrella organization. The establishment of the PPP Facility will require early partnering with the GOI and development funders driven to implement POME biogas projects to meet Indonesia's energy, environmental, or economic goals. These champions will help establish buy-in from government counterparts and facilitate completion of administrative and legal requirements for establishing the Facility.

The roles of the PPP Facility are introduced below, and the specific activities are described in detail in Section 5.3.

1. Vetting parties for participation in the PPP Facility: The Facility screens mills, project implementers (developers, technology and service providers) and investors to increase success rates through quality partners, and to build transparency and trust among the parties that become partners in the Facility. Partners must meet minimum qualifications to participate. Screened mills are introduced to a menu of vetted implementers with proven credentials and track records, and all parties will have transparent access to the deal flow that can meet their particular requirements. Implementers and financial institutions have access to a pipeline of bankable projects. Vetting financial institutions creates a more transparent marketplace for finance.
2. Sustainability screening: The Facility establishes a sustainability screening protocol to ensure that palm oil producers entering into the PPP meet minimum sustainability criteria. These criteria would be developed with GOI, funder, and civil-society advisors, and would rely on either established standards or PPP-driven criteria based on existing best practices. The intent of the screening would not be to require a certification of PPP mills, but to rule out sites with the highest sustainability risks and to engage sites that are committed to improving sustainability performance. In this light, at a minimum, screening should address the following topics:
    - Plantation not newly established in areas of high conservation or high carbon-stock values.
    - Plantation does not drain new peatland.
    - Feedstock is secure and sustainable, and will be provided without conflict from other competing uses.
    - There is no planned expansion into forest areas.
    - There is no history of violation of labor laws or human rights abuses.
3. Early-stage development activities: Bridges the gap before developers and institutional funders come in by conducting market engagement and analysis of parties necessary for development, but too risky for developers or funders to invest in without reasonable confidence in the outcomes. This could include performing assessments in partnership with PLN to identify regions where PLN is more interested in signing PPAs — based on local PLN generation costs, reserve power and demand projections — to reduce uncertainties about long-term electricity sales contracts.
4. Facilitating PLN and GOI buy-in: To facilitate the issuance of PPAs and other permits, the Facility will partner with PLN to design mill screening criteria to determine technical and geographic screens to increase the likelihood of PPA signing. The Facility will work with PLN and other GOI entities, such as ESDM, to develop templates and agree on procedures for administrative documentation templates and

submittals, particularly for feasibility and grid studies. The Facility will establish a memorandum of understanding (MOU) with PLN and other GOI offices to agree on an approach to the partnerships.

5. Feasibility studies: The Facility will conduct feasibility studies at candidate mills, either with in-house capacity or through contracts with external assessors based on standards developed by the Facility. The studies will initially be funded through a cost-sharing mechanism with the mills to ensure mill engagement. The studies would be of high quality and would serve to build trust with stakeholders; they would produce bankable documents owned by the PPP Facility and be provided to the vetted developers and financial institution partners for investment assessment. Upon financial closure, the project partners pay the PPP for the feasibility studies into a revolving fund. The mills may buy the feasibility studies for a cost plus fee if they wish to exit the Facility.
6. Construction partnering and advising: Based on the interests of mills, developers, and technology and service providers, the Facility will introduce and match these vetted partners for project development activities. This step occurs prior to bringing financing partners into the arrangement. As mills may or may not prefer to serve as the project developers, they would have two options in this step:
    a. *Option 1:* Mill-driven deals: For mills that seek to own and operate the energy project, the PPP will facilitate mill partnering arrangements with technology and service providers through a bidding or direct selection process. Mills may either self-finance or seek external financing.
    b. *Option 2:* Developer-driven deals: Mills interested in allowing projects to be owned and operated by external parties will be introduced to developers and technology and service providers, who may themselves already be partnered. Under this scenario, the developers may seek to engage individual mills or mill groups to which they can make offers for a commercial relationship.
7. Finance partnering and advising: The Facility presents packaged project structures (construction and operating partnership arrangements, bankable feasibility and grid studies, and signed PPAs) to vetted investors and advises partners on financing options and arrangements. Investors work with developers (which could be the mills or third-party IPPs) to negotiate financing arrangements. The first tranche of projects will be inherently higher risk as the Facility establishes itself and gains the trust of market stakeholders. These early projects require the Facility to work closely with investors and/or existing concessional finance facilities to support more complex financing mechanisms, such as blended capital arrangements to mitigate early-stage risks. Eventually, the finance component of the PPP will consist of stand-alone financial institutions.
8. Monitoring: To ensure quality control, effective maintenance, and the capture and dissemination of lessons learned to overcome the impact of previously failed projects, the Facility will conduct systematic monitoring of the projects it facilitates.
9. Communications and capacity building: To increase market awareness and capacity, the Facility will communicate project successes and provide training to mills, PLN, and local banks on project basics, feasibility assessments, permitting requirements and project development processes.

5.3 Stakeholders

The sections below describe the characteristics and roles of the stakeholders within the PPP structure.

5.3.1 Mills

Mills participate in the PPP as the site of the project, either developing the POME-to-energy system themselves or making their POME facilities available to external developers. Their CPO operations produce the POME used to generate biogas, and they are the stakeholders ultimately responsible for deciding if projects can be implemented on their property.

Viable mills have characteristics aligned with those described for "low-hanging fruit" projects in Section 5.1.1. Mills may come with individual projects or packaged as a group, offering multiple installations for one deal.

The PPP engages mills by:

1. Disseminating information about the technology and systems, including communicating success stories and mitigating project failures that make investors hesitant about the technology;
2. Capacity building through outreach and workshops to help mills prepare for projects;
3. A two-stage screening of mills against technical, financial and sustainability criteria. This screening will occur after an initial, broader evaluation, potentially in partnership with PLN, that would assess electricity demand and map grid lines as well as identify the regions where PLN is most keen to sign PPAs. These are the key gating factors that would help narrow down the list of mills, which would then be considered against the following criteria:
   - An initial screening process, with costs covered by the Facility, would indicate whether it is worth further engagement with the mill and identify any shortcomings the mill may need to correct to continue in the process. This screen is the baseline to determine whether mills meet basic financial, maturity and sustainability standards. It includes an assessment of the number of mills per company and area, size and scale of the mills, power output potential, assessment of owners, likelihood of PPA signing, distance from the grid and a sustainability screening. Based on this screening, the mills would receive guidance on actions they would need to take to pass through a second screening.
   - The second screening, with costs shared between the Facility and the mill, would assess mills against more rigorous technical and financial feasibility criteria for full entry into the PPP.
4. Conducting studies of vetted mills to generate the information needed for financiers to determine whether to invest. This includes technical and financial feasibility and grid studies. These studies are paid for by the revolving feasibility assessment fund described in Section 5.2.

The role of the mills within the PPP is to:

1. Attain owner commitment and apply to the Facility for entry into the PPP process for individual projects or aggregated projects;
2. Agree to and prepare for a screening assessment of the mill's environmental sustainability and project financial and technical feasibility;
3. Provide data and site access for the assessments and feasibility studies;
4. Decide whether the mill will own the project or whether they are looking for a developer to own the project;
5. Assess pre-approved project partners, potentially through a bidding process; collaborate with partners to agree on construction and operating arrangements;
6. Assess financing options; collaborate with financial institutions to determine the deal structure and agree to financing terms;
7. Lead or support project construction as appropriate; and
8. Agree to and meet sustainability certification requirements.

5.3.2 Donors/Funders

Concessional or donor funding, such as from multilateral development banks (MDBs), bilateral funders, the GOI, or philanthropies, would fund the operations of the PPP Facility as well as the funding for early-stage project preparation activities. Although preconstruction costs (feasibility studies, grid studies, environmental impact assessments, etc.) for a single project are a small fraction of project development costs, they can be more difficult to finance because of the risk that a potential project will not be found to be feasible. Support from funders will also provide institutional legitimacy for the PPP Facility.

The PPP engages donors/funders by:
1. Securing initial capitalization from grant funding and concessionary debt. The Facility is expected to include a range of outcomes across the portfolio, from stable but less-than-anticipated returns, to successful outperformance against initial expectations. Some proportion of concessionary capital will be necessary given the risk profile of this particular asset class, although it is expected to quickly diminish over time;
2. Establishing and managing a revolving feasibility assessment fund with donor funds. The feasibility assessment fund covers the costs of the technical and financial feasibility assessments for the mills, which are reimbursed by the mills or project developers for projects that reach financial close; and
3. Providing sustainability assurance through the sustainability screening that assures funders of the environmental and social risk management of activities their funding supports.

The role of the donors/funders is to:
1. Provide funding to capitalize the Facility, including inception funding, operating costs and stakeholder engagement;
2. Provide early-stage capital for project preparation, to be paid back to a revolving fund for a successful project. This capital also protects the overall portfolio against underperformance;
3. Initiate the feasibility study revolving fund;
4. Provide legitimacy to the screening and vetting requirements; and
5. Provide resources for training and capacity-building activities.

5.3.3 Public Sector Stakeholders (PLN, ESDM and GOI)

The challenge of obtaining a PPA is one of the key barriers for POME-to-energy projects and, as such, the mechanism by which ESDM, PLN, and other government partners participate in the PPP is one of the highest priorities. Other government institutions to engage could include the Palm Oil Fund (*Badan Pengelola Dana Perkebunan – BPDP*) and the Financial Service Authority (*Otoritas Jasa Keuangan – OJK*).

The PPP engages PLN and ESDM by:
1. Building trust with PLN and ESDM and building trust between the public sector and project developers;
2. Engaging PLN in developing the criteria and support for screening mills to ensure that locations and mills participating in the PPP are acceptable to PLN and that PLN priority areas are the PPP's initial focus;
3. Collaborating to develop standardized PPA templates and procedures, and facilitate connections that result in more PPAs being executed between PLN and project developers;
4. Developing streamlined permitting guidance that provides a simplified and known process for project developers;
5. Developing grid study templates and procedures that meet PLN's requirements for decisions about interconnection; and
6. Providing training for national and local PLN offices to support assessment of project viability and technical challenges for grid integration.

The roles of PLN and ESDM are to:
1. Contribute to the development of standardized PPA templates for a streamlined permitting process for projects developed through the PPP and commit to using the templates and process;
2. Set minimum criteria for the PPP to screen for potential projects and agree to a standard process and criteria for permits and licenses;
3. Share specific expectations of grid studies that will be accepted by PLN;
4. PLN commits to working toward PPAs with power producers who meet established criteria; and
5. Review and approve PPAs or excess power agreements with project developers; ESDM is part of the review and approval process for IPPs and PPAs, and PLN reviews and enters into PPAs.

5.3.4 Developers, Technology and Service Providers

Unqualified developers and technology and service providers have been involved with numerous failed POME biogas projects, making mills and investors reluctant to develop projects. The PPP will screen developers, EPCs, technology providers, and other entities that provide services to the project, including equipment providers and sustainable palm oil certifiers, to ensure a level of quality that will lead to successful projects. This will build mills' trust in potential partners. In some cases, developers will be third-party companies and in others, the mills themselves will be the developer.

The PPP will engage these entities by:

1. Screening them against a set of established criteria; successfully screened entities will be able to access pre-screened projects with completed feasibility studies and initial vetting through PLN;
2. Screening on a rolling or regular basis, in order to maintain independence and to keep the Facility current when it comes to new technologies and companies;
3. Providing developers and technology and service providers with access to a pipeline of the most viable POME biogas projects;
4. Providing a platform to engage mills and other providers to structure and agree on project partnerships;
5. Facilitating PLN approval of projects and PPAs; and
6. Providing a platform to connect bankable projects with financial institutions.

The roles of the developers and technology and service providers are:

1. Apply for entry into the PPP; pass through Facility screening requirements based on criteria, including quality and work experience;
2. Interface with potential mills and other service providers to assess project structures (i.e., mill as the developer vs. third-party IPP);
3. Enter into partnerships with mills and other service providers based on bankable feasibility studies and project assessments performed by the Facility;
4. Developers obtain permits and licenses, including for IPPs and PPAs, as appropriate;
5. Present partnership arrangements and bankable studies to potential financiers;
6. EPCs and technology providers supply equipment and engineering and construction services for financed projects; and
7. Sustainability assessors provide review, mitigation and certification.

5.3.5 Financial Institutions

Financial institutions provide capital to construct the projects and obtain sustainability certification. This type of funding could be provided by individual financial institutions or blended through a capital financing facility that seeks to address the financial barriers outlined in Section 4.2 by investing in "first mover" projects to help the POME-to-energy sector scale more quickly. Financial institutions could include local banks, project developers, investors, merchant banks, international financial institutions, multilateral development banks such as the World Bank and ADB, and the state-owned infrastructure bank, PT SMI. For the purpose of this model, two groups of financial institutions are considered: aggregate project financiers who are looking to finance groups of projects, and single-project financiers who are willing to consider investing in individual projects.

The first tranche of projects performed through the PPP Facility will likely require concessional construction funding more tolerant of project risk. The Facility would need to identify existing finance facilities aimed at such development projects, or seek to organize and structure a blended capital facility for this purpose. Over time, after the Facility demonstrates successful projects, such concessional construction capital would not be needed, leaving the provision of capital to commercial financial institutions.

The PPP will engage financial institutions by:

1. Providing project packages ready for investment, complete with bankable feasibility studies, PPAs, and established project implementation partnership structures;
2. Bifurcating projects into one category for individual or smaller projects, and another for aggregated or larger projects;
3. Supporting finance structuring for the first tranche of projects by inviting financial institutions, alongside donors and funders, to participate in and help structure a blended capital facility; and
4. Providing outreach and capacity building for local banks so they can better understand and manage POME project risks.

The role of financial institutions in the PPP model is to:

1. Apply to the Facility to become an approved investor;
2. Collaborate with screened mills to determine the deal structure and agree to financing terms;
3. Assess project risks and incorporate de-risking mechanisms into financing terms; and
4. Provide access to capital for mills.

6.0 Recommendations and Next Steps

This report demonstrates that the challenges facing the stakeholders in the POME biogas project development market are wide ranging, but can be categorized by exploring them from each stakeholder's perspective. The PPP Facility model introduced here is an effort to reduce the key project challenges through one mechanism. However, a less costly and more straightforward approach that considers the risks on an individual basis could also be applied to focus on specific issues. Further, the individual challenges may be addressed in a piecemeal fashion and built up toward the full PPP Facility functionality.

For full PPP Facility implementation, priorities for initial startup of the PPP should be:

1. Identify interested partners, starting with GOI and development funder champions to garner government buy-in, followed by donors for Facility startup and concessional lenders for financing the first tranche of projects.
2. Secure donor funding for PPP startup. Initial startup funding should establish the management structure for the PPP and get buy-in for a pilot of a PPP deal.

Beyond these two high-level initial startup steps, the following activities could be conducted as part of full implementation or as stand-alone activities that would still reduce project risks in the absence of full PPP Facility implementation:

3. Develop case studies and resources. Design technical assistance tools to engage mills and government stakeholders to overcome challenges associated with lack of familiarity of the technology and successful projects.
4. Conduct in-depth analysis with PLN of regions to prioritize. Identify early- developer areas where successful relationships with PLN can be established and result in multiple projects due to favorable mill concentrations, grid conditions and PLN's power-generation costs.
5. Conduct a market-level screening to identify "low-hanging fruit" mills with characteristics most likely to result in cost-effective projects.
6. Conduct mill outreach, engagement and awareness-raising. Focus on mills where projects are more viable and where success stories will be generated.
7. Develop templates and procedures. Standardize processes that streamline project assessment, particularly with regard to mill screening, feasibility studies, grid studies, sustainability certification and financial due diligence.
8. Elaborate on the design of a blended capital facility. Undertake a design process to structure a blended capital facility that could go hand-in-hand with the PPP Facility to provide construction finance to an initial tranche of projects.

Appendix A – Stakeholders' Challenges

Table 5. Mills' challenges

Challenge	Description
Limited business capacity outside of PO	Mills are often hesitant to invest in activities outside of their core business, or to trust outsider interventions that may be perceived as potentially having a negative impact on the bottom line of their CPO business.
PO mills unfamiliar with the technology	Mill owners are often unfamiliar with POME-to-energy technologies; particularly costs, benefits and operational requirements. Their understanding is often skewed by rumors of failed CDM and other POME projects.
Uncertainty around viability of projects	Availability of biomass fuel supply, ability to meet minimum energy off-take, viability of technology, and ability to secure purchase of power are all seen as uncertain. There are few successful models for biomass-based grid-connected power generation.
High upfront costs for uncertain return	While investments should pay off within five years, EPC costs as well as smaller additional costs prior to establishment of financial viability may make mills hesitant to implement biogas capture, particularly with few examples of successful projects to point to. Companies hesitate to invest USD 2-4 million per MW in an unfamiliar technology and with uncertainty around FITs. Investment costs can be even higher if feasibility studies are not carried out properly.
Demand for sustainable PO is limited and requires extensive investment	Mills often must choose between low-cost production of "unsustainable" CPO and higher cost (but higher value) certified-sustainable CPO. Demand for CPO that is not certified as sustainable is strong/sufficient, so justification for investment in sustainability is limited.
Mixed priorities between mills and HQ	Local mills are interested in providing electricity to nearby communities to help dissuade protests and mill shut down; owners in Jakarta, etc. are focused on direct financial benefits.
Uncertainty around sustainability requirements	Mill owners and financiers are confused by sustainability requirements; in particular, there is uncertainty about sustainability definitions, certification requirements, costs and existence of multiple/competing standards.
Payback period	Projects may have longer payback periods than mills are willing to accept for a variety of reasons, including balance sheet liquidity.
Mills located far from the grid	Mills that are far from electrical grids face additional costs and technical challenges, since the developer must pay the cost of interconnection to transmission facilities.

Challenge	Description
Feedstock security	Mills without guaranteed or long-term access to palm fruits have difficulties ensuring long-term revenues from electricity sales, so are challenged by project bankability. This applies primarily to small-scale facilities or other companies without integrated plantation capacity.

Table 6. Financial institutions' challenges

Challenge	Description
Financial industry technical capacity	Limited POME project experience within national and local financing organizations hinders assessment of project bankability. This results in a lack of risk discovery, quantification and mitigation to allow the risks to be accurately priced. It also results in a lack of reliable benchmarking figures for investment decisions.
Limited availability of financing vehicles/poor fit for purpose	National and local banks typically only provide balance sheet financing, and not project-level financing; this limits mills' willingness to take a loan.
Uncertainty around incentives	Uncertainty about the existence or longevity of FITs means these tariffs must be incorporated into the balance sheet of a given project with caution, making it less financially attractive.
Size of individual deals/projects	Projects are too small on a one-off basis for the large multilateral development banks that could provide concessionally priced capital. For other financial institutions, the risks surrounding individual deals are perceived as too high.
Currency fluctuation	Although the new FIT is in USD, uncertainty around the implementation of the new regulation means FITs may still be paid in rupiah; upwards of 50 percent of project costs are denominated in dollars or euros.
Opportunity cost of capital	POME projects compete with other potential mill investments that may have higher IRR, shorter payback periods, or less investment risk.
Low project liquidity	Projects lock up capital for an extended period of time, which can lead to capital strain on project developers or mills/parent companies if they choose to keep projects on the balance sheet.
Uncertain commitment to payment for renewables from PLN and MoF	Poor coordination and cooperation between PLN and government counterparts has meant PLN is often not reimbursed to cover its mandated subsidy payments for renewables purchases. As a result, owners and investors fear PLN could stop FIT payments. Furthermore, PLN is postponing the issuance of, or requiring extensive negotiations for, PPAs due to its uncertainty of being reimbursed for subsidies.
High collateral requirements	PLN PPAs for biogas-energy systems require collateral of equivalent or higher value than any loan provided. This causes project developers to steer clear of biogas projects.

Challenge	Description
Cost of capital	The existence of all challenges/risks laid out herein means the cost of capital is greater than it might be otherwise.

Table 7. Developers' challenges

Challenge	Description
Complex and lengthy permitting processes	The process for permitting/approvals for IPPs, PPAs, excess power, transport/use of residues, water and land use, electricity-generation equipment and sub-leases on GOI property is poorly coordinated among government offices and typically results in extensive and costly delays.
Difficulty (real and perceived) of working with PLN	Mills are not accustomed to dealing with PLN, and PLN is often perceived as difficult to work with. PLN is also currently resisting negotiating PPAs under new FIT regulations due to concerns about sufficient capitalization of the incentive.
Low quality studies and designs	Due to limited mill and industry experience, and mills' desire to "cut out the middle man," project feasibility studies, grid-connection studies and system designs may be underfunded, resulting in inaccurate or insufficient analyses. This may result in delayed approvals, project failure and reduced income.
Early-stage working capital gap	Limited early-stage working capital to fund project preparation and development to bring projects to "investment ready" status, and limiting growth of businesses that could deliver POME-to-energy projects.
Lack of operations and maintenance services	The lack of adequate operations, maintenance services and spare parts for these projects leads to more failed projects and lower revenue streams. Mills may not be interested in having dedicated staff for POME operations and management.
Sustainability often required by donors or public subsidy	Publically financed or subsidized projects (in particular) must ensure that sustainability standards are met, thus increasing costs.

Table 8. Technology and service providers' challenges

Challenge	Description
Project discovery costs	Because the market for POME biogas projects in Indonesia is not well developed, a robust national network through which to build partnerships and engage potential clients is just beginning to develop. As a result, technology and service providers must invest more extensively in project discovery than in other, more-developed markets, and the rate of failure is higher.

Challenge	Description
Onerous contracting requirements	Demands on resources for contacting and permitting are onerous, particularly when dealing with mills, developers and government offices with limited sector experience.
Local content requirements	GOI requires minimum local content for equipment. These requirements for renewable-energy projects are not clear and are not uniformly enforced; they may result in forced equipment and service choices, and often mean inferior products and services that increase costs or reduce revenues.
Workforce technical capacity	Indonesia's limited experience with POME biogas projects means that PO, engineering and construction, and banking sectors are not sufficiently equipped to assess and implement projects at an industry-wide scale.

Table 9. GOI challenges

Challenge	Description
Competing government priorities	Conflicting agendas, strategies and champions within the government: desire for the state-owned electricity company to be profitable; for the oil and gas company to maintain market; to expand the electrification ratio; to reduce emissions; to expand CPO production for economic growth, etc. PLN/ESDM is an example.
Confusing policy implementation	Limited coordination among government offices results in conflicting standards, goals and implementation of regulations; this leads to uncertainty for mills and financiers. Poor training, funding, transparency and consistency at all levels leads to lack of institutional memory, thus weakening capacity to formulate and implement policies.
PLN's conflicting mandates for profitability and renewable energy project support	Through various regulations, ESDM dictates that PLN must support biogas projects through stipulated FITs, which in some cases mean a financial loss for PLN that is not covered by government subsidy. At the same time, the Ministry of State Owned Enterprises requires PLN to work to generate a profit.
Inconsistent application of laws	Waste management and ISPO requirements are inconsistently or ineffectively enforced, leaving mill owners unsure of the requirements.
Sustainability requirements are perceived to be counter to smallholder well-being	GOI is deeply concerned about a perceived tradeoff between smallholder economic well-being and the costs of making the industry sustainable. Any strategy must take this into account if it is to be implemented
PLN technical and resource capacity	PLN has limited resources and experience administering the permitting and integration of POME biogas projects. PLN's structure requires technical expertise and approvals at the national and local levels. As a

	result, the approval and implementation processes are often delayed or ineffectively conducted.

Appendix B – Interviews

No.	Stakeholder	Name	Role/Position	Relevance
1	PLN (Area & Wilayah Bangka)	Mr Adip	Deputy Planning Manager	Involved in approvals and standards for PPA, IPP and grid connections
		Mr Made	Deputy Power Generation Manager	
		Ms Susan	Assistant Planning Manager	
		Mr Eko	Technical Manager	
2	US Treasury	Mr Milosz Mogilnicki	Resident Advisor Indonesia	Government/US Department of Treasury Infrastructure Finance Team
3	METI	Mr Paul Butarbutar	Chairman for Policy and Regulatory Advocacy	Represents renewable energy industry concerns
4	Rainforest Action Network	Mr Lafcadio Cortesi	Asia Advisor	Civil Society/NGOs
		Mr Bill Barclay	Senior Research and Policy Advisor	
5	Asia Development Bank (ADB)	Ms Lazeena Rahman	Investment Specialist	Provides development assistance via assessments and soft loans
6	PT SMI	Mr Gan Gan Dirgantara	Head of Division, Project Development: RE, EE & Climate	State-owned company supporting financing via loans, equity and soft-loan support
		Ms Farida Zaituni	Lead Environmental Social Safeguards	
		Mr Suksmo Pangarso	Advisor, Project Development: RE, EE & Climate	
7	Packard Foundation	Ms Belinda Morris	Program Officer for Climate and Land Use	Philanthropic/Program-Related Investor perspective
		Mr Justin Guay	Program Officer for Climate and Land Use	
8	ADM Capital	Mr Martijn Hoogerwerf	RE and Impact Investment	Project Financier
9	Bank Rakyat Indonesia (BRI)	Mr Gilang Ramadhan Singabela	Relationship Manager	Project Financier
10	Bank Sumatra Selatan (Bank SUMSEL)	Mr Ary Anthonius Pasaribu	Marketing Division	Project Financier
		Mr Andri Subroto		
11	Obi Partners	Ms Emilie Flanagan	Founder	Project Developer

No.	Stakeholder	Name	Role/Position	Relevance
		Mr Jason Jones		
12	Putra Bangka Mandiri	Mr Djeniman	Lead Project Manager	Mill owner and operator
13	Green & Smart	Mr Silvadas Kumar	CEO	Technology provider/developer
		Mr M. Mailapan	Executive Director	
14	True Eco	Ms Elaine Wong	Technical and Development Manager	Technology provider/developer
15	Green Energy Specialists One	Mr Mahader Hassan	Founder	Project developer
16	PT Sampoerna	Mr Oke Dillard	Advisor	Mill owner and operator
		Ms Rochmania Sukmawati	Advisor	
17	PLN (Pusat)	Mr Budi Mulyono	Senior Manager EBT Division Alternative Energy	Involved in approvals and standards for PPA, IPP and grid connections
		Mr Andrew	Deputy Manager EBT Division Alternative Energy	
18	Palm Oil Fund (BPDP)	Mr Bayu Krisnamurti	Chief Executive	Fund established to support sustainable palm oil industry
19	ISPO (Indonesian Sustainable Palm Oil)	Mr Aziz	ISPO committee	Facilitate and verify audit and certification for palm oil growers
		Mr Herry		
		Mr Sartono		
		Mr Ardianto		
20	USAID ICED Project	Mr Bill Meade	Deputy Chief of Party	Advising GOI on energy policy and technology deployment
		Mr Raymond Bona	Sustainable Finance Specialist	
		Ms Amy	RE Specialist	
21	World Bank	Mr Puguh Imanto	Energy Specialist	Provide development assistance via assessments and soft loans
		Mr Gailius Draugelis	Lead Energy Specialist	
22	GIZ	Ms Vega	Advisor	Supporting creation of Indonesian Climate Change Trust Fund (ICCTF)
		Mr Adnan	Advisor	
23	IFC	Mr Ernest Bethe	Principal Operations Officer	Project Financier

No.	Stakeholder	Name	Role/Position	Relevance
		Mr Triyanto Fitriardi	Project Leader (smallholder development)	
24	PT Sumberdaya Sewatama	Mr Stefanus Johan	Manager of Business Development	Developer
25	ADI Systems	Mr Grenville Delfs	President Director	Technology Provider
26	PT Austindo Aufwind New Energy	Mr Thomas Wagner	President Director	Project owner and operator
27	Millennium Challenge Account-Indonesia	Mr Jeffrey Dickinson	Project Management	Development infrastructure grant manager
28	PT Prima Power Nusantara (PPN)	Mr Mochamad Sofyan	Commissioner	PLN Engineering Subsidiary, former PLN RE Director
29	PT Tigris Infrastructure Partners	Mr Ghalib Chauduri	Managing Director	Private capital investor
30	ESDM - EBTKE	Dr Sudjoko Harsono	Director of Bioenergy	GOI bioenergy planning and rulemaking
31	IDH	Mr Reuben Blackie	Program Manager	Civil society - sustainable trade
32	UTZ	Ms Chandra Panjiwibowo	Country Representative for Indonesia	Palm oil buyer with sustainable commodity certification program

APEC Project: EWG 25 2015A

Produced by
Winrock International
Beltway Office Park, Tower C Building
Floor 3A, Suite 3A-2
Jl. Ampera Raya No. 9-10
Jakarta Selatan, Indonesia 12550
Tel: (62) 21 782 2425
Website: www.winrock.org

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#216-RE-01.31