ASIAN DEVELOPMENT BANK

TAR: INO 36557

TECHNICAL ASSISTANCE
(Cofinanced by the Canadian Cooperation Fund on Climate Change)

TO THE

REPUBLIC OF INDONESIA

FOR THE

GAS GENERATION FROM WASTE PROJECT

May 2004

CURRENCY EQUIVALENTS

(as of 14 April 2004)

Currency Unit	–	rupiah (Rp)
Rp1.00	=	$0.000116
$1.00	=	Rp8,602

ABBREVIATIONS

ADB	–	Asian Development Bank
CDM	–	clean development mechanism
DGEEU	–	Direktorat Jendral Listrik dan Pemanfaatan Energi (Directorate General of Electricity and Energy Utilization)
EA	–	executing agency
EIA	–	environmental impact assessment
EIRR	–	economic internal rate of return
FIRR	–	financial internal rate of return
ICB	–	international competitive bidding
IA	–	implementing agency
PGN	–	Perum Gas Negara (state gas corporation)
PLN	–	Perusahaan Listrik Negara (State Electricity Enterprise)
POM	–	palm oil mill
TA	–	technical assistance

NOTE

In this report, "$" refers to US dollars.

This report was prepared by S. Gupta (team leader) and T. Gallego-Lizon.

I. INTRODUCTION

1. Rapid development in Indonesia has given rise to large quantities of waste, the disposal and management of which is an environmental challenge. Appropriately managed, waste can be a source of energy while adverse environmental impacts are mitigated. To evaluate this potential, during the 2002 Country Programming Mission the Government requested the Asian Development Bank (ADB) to include in the Country Strategy and Program (CSP) 2003–2005 an advisory technical assistance (TA) on gas generation from waste. From 29 September to 3 October 2003, therefore, ADB fielded a Fact-Finding Mission to prepare the TA paper on Gas Generation from Waste Project.[1] The Mission and Government reached an understanding on the goals, scope, implementation arrangements, cost, financing arrangements, and terms of reference for the TA.[2] The TA logical framework is in Appendix 1, and an initial poverty and social analysis in Appendix 2.

II. ISSUES

2. Growth and development in any economy often give rise to waste disposal and management problems. In Indonesia, acceleration of urban settlement and industrial growth has also resulted in production of solid and liquid wastes that contaminate the soil and groundwater, and in emissions of harmful gases. The uncontrolled decomposition of organic waste under anaerobic conditions produces methane, a powerful greenhouse gas causing global warming. However, methane from waste can be captured to provide a renewable source of energy and, in the process, help abate the enhanced greenhouse effect. Other waste products can also be used in an environmentally benign manner to generate energy and other useful material such as fertilizers. The World Bank has an adaptable loan program[3] in Indonesia to manage urban waste and convert it to compost. Yet, waste from important agro-industries in remote and rural settings—the palm oil industry, for example—contributes to local and global environmental pollution, and is not covered by the World Bank program.

3. Indonesia is the second largest producer, after Malaysia, of palm oil in the world. In Indonesia over 3 million hectares are under palm oil plantations, which provide inputs to a large number of palm oil mills (POMs). It is estimated that there are nearly 300 mills, of which 240 are in Sumatra and 40 in Kalimantan. New POMs are being planned to meet the shortage of milling capacity and rising production of palm oil. The Indonesia palm oil industry produces over 4,000 million tons (t) of palm oil, providing over $1 billion in export earnings,[4] and directly and indirectly providing livelihood to a large number of rural people.

4. POMs produce significant amounts of biomass waste and generate large quantities of wastewater. Now, wastewater from POMs is discarded in waste disposal ponds, resulting in leaching of contaminants that pollute the groundwater and soil, and in the release of methane gas. Almost all POM waste can be processed to produce energy and fertilizer. Processing includes capture of methane, which is a potential source of clean and renewable energy for remote locations. Wastewater has some crude palm oil that can be recovered to produce bio-diesel. Solid waste from POMs, in the form of fresh fruit bunches, can be converted to energy or

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[1] The Mission comprised S. Gupta, project economist (energy), Southeast Asia Infrastructure Division.
[2] The TA first appeared in *ADB Business Opportunities* (Internet edition) on 27 September 2003.
[3] World Bank. 2001. *Indonesia: Western Java Environmental Management Project*. Washington DC. (a three-tranche adaptable loan of $96.13 million).
[4] Badan Pusat Statistik. 2000. *Statistical Year Book of Indonesia*. Jakarta.

fertilizer. Given the economic importance of this agro-industry, it is imperative to minimize adverse environmental impacts and for the industry to operate on a sustainable basis.

5. The national energy policy aims to reduce dependence on fossil fuels by developing and using indigenous new and renewable energy resources. Biomass is a renewable source of energy that is often used inefficiently. If used efficiently, biomass could provide more energy to remote, rural areas. Solid biomass waste and liquid waste from POMs can be transformed into electricity, gas, bio-diesel, and fertilizer, improving use efficiency and substituting fossil fuels.

6. Public and private POMs lack knowledge and access to suitable waste management, fertilizer production, bio-diesel conversion, and methane-capture technologies. POMs could meet all their energy requirements and produce surplus energy. Despite being in energy-deficient areas, this surplus energy is wasted due to limited opportunities to market it. One POM with the capacity to process 60 tons of fresh fruit bunches per hour could produce 11,400 cubic meters of methane per day from wastewater, and provide over 1.5 megawatts of electricity. Oil palm fruits are harvested through out the year, with peak production from July to December, potentially ensuring year-round processing and availability of energy.

7. Integrated waste management will enable POMs' sustainable operation and provide the following multifaceted benefits that help improve the quality of life in distant, and often isolated, locations:

(i) Mitigate contamination of soil and groundwater resulting from uncontrolled disposal of POM solid and liquid waste.
(ii) Provide a clean, renewable, and local source of energy to remote areas.
(iii) Produce organic fertilizers to enhance land productivity.
(iv) Reduce emissions of greenhouse gases and contribute to global environmental benefits.

8. A debate is ongoing over the proliferation of palm oil plantations, which results in deforestation. However, the issue is beyond the scope of this TA.

9. The 2003–2005 Country Strategy and Program addresses the main medium-term needs of the economy, stressing (i) improvements in governance, (ii) meeting local needs through decentralization, (iii) human development, (iv) environmental management and sustainable use of natural resources, and (v) raising long-term growth prospects and economic potential. The TA thus contributes directly to effective environmental management and sustainable natural resource use as well as indirectly helps meet local needs. The TA will promote the use of clean and renewable energy, improve access of remote and rural populations to efficient and modern forms of energy, and enable environmentally sustainable operation of an important agro-industry. The interventions examined and developed under the TA will encourage public-private partnerships and provide simultaneous global and local environmental benefits.

III. THE TECHNICAL ASSISTANCE

A. Purpose and Output

10. The goal of the TA is to support sustainable development. The purpose of the TA is to (i) improve integrated waste management practices in the palm oil industry and (ii) evaluate the potential of POM waste as a renewable and commercially viable source of clean energy. The

TA will (i) establish a waste management framework for the industry, (ii) conduct a technical and economic assessment of different alternatives for energy recovery and conversion from POM waste, (iii) develop a sustainable plan for effective waste management and energy capture for a cluster of public and private sector POMs, (iv) evaluate the potential social and environmental benefits of improved waste management practices, and (v) assess the need for further ADB support for energy generation from waste.

11. The deliverables from the TA include (i) review of solid waste management practices in the palm oil sector; (ii) assessment of technologies available for waste management in POMs, including those for collection and use of methane gas from wastewater; (iii) identification of a process to facilitate transfer of such technologies; (iv) development of methane recovery and use from POM effluent as potential clean development mechanism (CDM) projects; (v) conversion and transmission options for surplus energy from a POM cluster and evaluation of their viability; and (vi) implementation plan to market surplus energy produced from POM waste. Deliverables (v) and (vi) would include preparing a feasibility report on recovering energy from POM waste for a cluster of POM, including an evaluation of the options to directly feed recovered methane into the local gas network, generate electricity for local consumption and/or wheel electricity to the grid, or develop a local network to distribute electricity. The TA will also assess the impact of suggested interventions on the local population, including indigenous people.

B. Methodology and Key Activities

12. To achieve the TA objectives, the consultants will review national and international waste management practices in the palm oil industry. Based on the quantity of biomass and liquid waste generated by POMs, the TA will undertake a technical and economic evaluation of interventions to minimize adverse environmental impacts and to harness energy from all types of waste. The options evaluated will include technologies to convert energy, such as production of electricity from biomass waste and methane gas or production of bio-diesel from crude palm oil in wastewater. The evaluations will provide the basis to develop guidelines for waste management.

13. The TA will identify a cluster of POMs that could generate sufficient quantities of energy (electricity or gas) from waste, and design systems for in situ and/or local energy use. If surplus energy potential is significant, the TA will propose common off-take systems for the cluster. As POMs are a mix of private, community-managed, and state-owned entities, a model for public-private partnership in waste management and energy use for POMs, and a plan to commercialize surplus energy will be prepared. A feasibility study for the interventions, including a financial and economic analysis, will be undertaken. The TA will require the involvement and cooperation of local authorities, indigenous people, POMs, and local subsidiaries of conventional energy suppliers such as the state electricity enterprise (PLN) and state gas corporation (PGN). An important TA component will be the environmental and social analysis, and assessment of impact on indigenous people, if any, of the proposed interventions.

14. The TA will also help identify the greenhouse gas abatement potential of emissions capture and energy generation interventions, and determine availability of additional international resources under various greenhouse gas mitigation initiatives such as CDM. Detailed terms of reference for the consultants are in Appendix 3.

C. Cost and Financing

15. The total cost of the TA is estimated at $625,000 equivalent, comprising $347,000 in foreign exchange costs and $278,000 equivalent in local currency costs. The Government has requested ADB to finance $500,000 equivalent, covering the entire foreign exchange cost, and $153,000 equivalent of the local currency cost. Financing for the TA will comprise $250,000 on a grant basis from ADB's TA funding program and cofinancing of $250,000 on a grant basis to be administered by ADB from the Canadian Cooperation Fund on Climate Change financed by the Government of Canada. The Government of Indonesia will finance the remaining $125,000 equivalent of the local currency costs. The cost estimates and financing plan are in Appendix 4.

D. Implementation Arrangements

16. As the TA Executing Agency, the Directorate General of Electricity and Energy Utilization (DGEEU) will have overall responsibility for TA management. PGN will be the Implementing Agency. A steering committee will be set up to review and advise on TA implementation. The committee will be chaired by DGEEU, and consist of representatives from the Ministry of Environment, Ministry of Agriculture, the state-owned palm oil plantation corporation, PLN or other relevant power transmission and distribution companies, research institutes, universities, and associations of concerned stakeholders. The PGN development director will be the project director, responsible for TA implementation.

17. The TA will be carried out in 9 months, from September 2004 to May 2005. A consulting firm with expertise in policy analysis and formulation, economic analysis, and energy from waste will be engaged to undertake the major TA components. Domestic consultants or resource persons will also be engaged separately as individuals for approximately 5 person-months. Total consulting services will include 10 person-months of international expertise in economic and financial analysis and in energy conversion technologies; and 20 person-months of domestic expertise in social, economic, and environmental impact assessment; anaerobic technologies; and energy conversion and distribution. All consultants will be engaged by ADB in accordance with its *Guidelines on the Use of Consultants* and other arrangements satisfactory to ADB for the engagement of domestic consultants. Simplified technical proposals will be evaluated using the quality- and cost-based selection method for the consulting firm. The consultants will work closely with DGEEU, and PGN. Equipment will be procured in accordance with *ADB Guidelines for Procurement*, and retained by the Executing Agency upon TA completion. The study findings will be disseminated to and discussed with concerned stakeholders through workshops and seminars.

IV. THE PRESIDENT'S DECISION

18. The President, acting under the authority delegated by the Board, has approved (i) ADB administering a portion of technical assistance not exceeding the equivalent of $250,000 to be financed on a grant basis by the Canadian Cooperation Fund on Climate Change, and (ii) ADB providing the balance not exceeding the equivalent of $250,000 on a grant basis, to the Government of Indonesia for the Gas Generation from Waste Project, and hereby reports this action to the Board.

TECHNICAL ASSISTANCE LOGICAL FRAMEWORK

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
Goal Support sustainable development in Indonesia	• Improved waste management practices are adopted. • Palm oil mill (POM) waste is used to provide a cleaner source of energy to poor and remote areas. • Methane from palm oil waste is captured, reducing methane emissions and their negative impact on poor population.	• Government statistics • Government policy statements	
Purpose 1. Improve integrated waste management practices in the palm oil industry 2. Evaluate the potential of POM waste as a renewable and commercially viable source of clean energy in poor and remote areas	• Waste management guidelines and strategies are integrated into POM cluster regular operation. • Suitable technology for energy capture from POM waste is established. • Commercial means to recover and use methane from POM waste are identified. • Social and environmental benefits of producing pro-poor clean energy from POM waste are defined.	• Final report from team of consultants • Technical assistance (TA) completion report prepared by Directorate General of Electricity and Energy Utilization (DGEEU) • TA completion report prepared by Asian Development Bank (ADB) • TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes	• Stakeholders and institutions have a clear vision of the sector goal to which the TA will contribute, and how the goal is to be achieved.
Outputs 1. Waste management framework is established for POM industry. 2. A technical and economic assessment of different alternatives for energy recovery and conversion from POM waste is conducted.	• Guidelines, plans, and budgets are drafted. • Waste management practices established. • A successful technology assessment is conducted. • Economic viability is assessed and commercialization mechanism defined.	• TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes	• Institutions and other stakeholders clearly understand the project. • The Government has the political will to pursue the TA goals, and stakeholders are interested in the project. • TA outputs are disseminated and lend themselves to follow-up analysis and action.

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
3. A sustainable plan for effective waste management and energy capture for a POM cluster is developed. 4. Potential social and environmental benefits from improved waste management practices are evaluated.			
Activities 1. Waste management framework is established for the POM industry. - Review of waste management practices - Development of guidelines for waste management in the palm oil industry	• International POM waste management practices are appraised. • Local POM waste management practices are screened. • Meetings are organized with stakeholders for option gathering and information sharing. • Waste management options are identified. • Guidelines for waste management in the palm oil industry are drafted and published upon acceptance. • Focus group discussions are held with local communities so they will understand and accept the framework.	• TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes • Guidelines for waste management	• Information is available. • POM clusters are willing to adopt new practices. • Linked activities are scheduled appropriately. • All logistical and administrative arrangements are understood and in place.
2. A technical and economic assessment is undertaken of different alternatives for energy recovery and conversion from POM waste - Technical evaluation	• Technology will be identified and reviewed. • Technical considerations in ongoing projects will be reviewed.	• TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes • Technology evaluation reports • Technical implementation plan	• Suitable technology is commercially available. • Sufficient information regarding key technical parameters is available. • “Perfect information” is available for economic evaluation.

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
- Economic evaluation 3. A sustainable plan for effective waste management and energy capture for a POM cluster is developed. - Evaluation of operation models for the selected POM cluster - Preparation of a plan to market surplus energy produced from waste for the cluster of POMs	• Waste management technology selection will be carried out based on selected parameters and estimated volumes. • Conversion and transmission technology options for surplus energy will be established. Viability will be evaluated. • A biomass and liquid waste inventory will be established. • A strategy to include a plan and mechanism to commercialize surplus energy will be defined. • A techno-economic implementation plan will be designed. • A viably sized cluster of POMS for implementation will be identified. • A range of public-private partnership models in waste management and energy utilization will be generated. The best model for the cluster will be selected. • Suitable technology for the cluster will be identified. • Local demand for energy and availability will be determined. • Based on a feasibility study, a financial and economic analysis for the POM cluster will be produced. • An implementation plan for the POM cluster will be prepared. • Investment risk will be analyzed.	• TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes • Commercialization strategy	• POM clusters are willing to participate in a pilot demonstration project. • Information to determine local demand for energy exists is available. • The Government has the political will and commitment to act.

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
4. Social and environmental factors are evaluated. - Assessment of environmental impacts and benefits - Preparation of social impact evaluation	• An environmental impact analysis of proposed projects will be undertaken. • Greenhouse gas abatement potential of energy capture will be identified. • Availability of international resources under various greenhouse gas mitigation initiatives, such as the clean development mechanism (CDM), will be identified. • CDM projects will be prepared from reports on methane recovery and use from POM effluent. • A social impact analysis of proposed projects will be conducted, with specific attention to indigenous people. • A socioeconomic and poverty profile of primary project beneficiaries will be prepared.	• TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes	• Information is available. • Stakeholders are involved and interested in the project.
Inputs 1. Consultants 2. Workshops 3. Government counterparts 4. Other costs	• International consultants (10 person-months) and domestic consultants (20 person-months) ($370,000) • Workshops and seminars ($10,000) • Counter staff and logistic support allocated to the TA ($125,000) • Report, equipment ($65,000) • Contingencies ($55,000)	• TA reports and review missions • Tripartite meetings • Workshop findings and recommendations • Monthly progress notes	• Consultants have sufficient capacity. • The team leader manages resource specialists effectively. • All logical and administrative arrangements are understood and in place.

INITIAL POVERTY AND SOCIAL ANALYSIS (IPSA) REPORT FORM

A. Linkages to the Country Poverty Analysis

Sector identified as a national priority in country poverty analysis? Yes	Sector identified as a national priority in country poverty partnership agreement? Yes

Contribution of the sector/subsector to reduce poverty in Indonesia: The palm oil sector, spread across an estimated 3.5 million hectares, is economically significant. Approximately 30% of the occupied area is owned and managed by communities, which often have limited access to the means and information to soundly manage toxic waste produced in palm oil mills. Leaching of waste contaminants from waste disposal ponds pollutes soil, groundwater, and drinking water, endangering the health and well-being of communities. Anaerobic decomposition of solid waste results in emission of gases, some of which are toxic above a certain concentration, and some of which contribute to the "greenhouse" effect. Of the latter, methane represents a large source of unused energy that could benefit remote, rural communities, as a source of clean energy for local use and a source of income generation, from surplus production.

B. Poverty Analysis — Proposed Classification

Proposed Classification: Pro-poor economic growth — Thematic: Environmental protection

What type of poverty analysis is needed? Poverty analysis is not needed, but a socioeconomic and poverty profile of primary project beneficiaries in targeted provinces will be prepared.

C. Participation Process

Stakeholder analysis? No

Stakeholder participation will be ensured throughout the project by conducting appropriate consultation to integrate their views and needs into the waste management guidelines. Stakeholders will be identified at an early stage of the project, and a benefit distribution analysis conducted in relation to the intervention plan. Project success will largely depend on employing good practices identified for and with local communities, as well as ensuring good maintenance and operation in technology transfer activities.

Participation strategy? No

D. Gender and Development

Strategy to maximize impacts on women: Women's involvement will be monitored throughout the project. Special attention will be paid to the role of women in decision-making, particularly for activities they perform.

Gender plan prepared? No

E. Social Safeguards and other Social Risks [a]

	Significant/ Not Significant/ None[b]	Strategy to Address Issues	Plan Required[c]
Resettlement[d]	None		None
Indigenous Peoples	Not significant	To ensure that the project has no negative impacts on indigenous people, a social study on the potential impact that waste management, and energy recovery and use will be conducted among selected communities. Benefits from interventions, especially those to create POM waste into renewable clean energy, may accrue to the local population, including indigenous people.	No
Labor	None		No
Affordability	None		No
Other Risks/ Vulnerabilities			Yes/No

[a] Initial poverty and social analysis and/or summary poverty reduction and social strategy criteria for assessing the significance of social issues are available in ADB's *Handbook for Poverty and Social Analysis,* version available at http://adb.org/Documents/Handbooks/Poverty_Social/default.asp

[b] If not known, a contingency should be included in the technical assistance budget to predict the need of a plan.

[c] A plan will be required at design stage if any potential issues are found significant.

[d] Significant involuntary resettlement requires a full resettlement plan; not significant requires a short one.

OUTLINE TERMS OF REFERENCE FOR THE CONSULTANTS

A. Introduction

1. The national energy policy aims to reduce dependence on fossil fuel by developing and using indigenous new and renewable energy resources. Biomass is a renewable energy source that is often used inefficiently. If used more efficiently, biomass could meet the energy requirements of remote, rural areas. Over 3 million hectares are under palm oil plantations, which provide inputs to a large number of palm oil mills (POMs), a significant proportion of which are community-managed. POMs produce solid and liquid waste that can be transformed into electricity, gas, bio-diesel, and fertilizer, substituting the use of fossil fuels. Methane, a powerful greenhouse gas, could be used to meet energy requirements.

2. To meet the objectives set in this Technical Assistance (TA) document, a team of consultants will do the following:

(i) Review international experience for waste management in the POMs.
(ii) Review and develop guidelines for waste management in the palm oil industry.
(iii) Determine the quantity of biomass waste and liquid waste generated by POMs.
(iv) Identify the size and distribution of POMs and select a cluster to implement a system to use energy from waste.
(v) Determine techniques for use of solid and liquid waste from POMs.
(vi) Determine technologies for energy capture from solid and liquid POM waste, including anaerobic methane from POM wastewater.
(vii) Evaluate specific interventions for integrated waste management and energy production from POM waste.
(viii) Evaluate the techno-economic potential for energy production from POM waste, including bio-diesel from crude palm oil and liquid waste, and its subsequent use.
(ix) For technological interventions that produce significant quantities of energy, determine systems for in situ and local use of energy from waste.
(x) Undertake a feasibility study for the interventions, including a financial and economic analysis.
(xi) Determine a model for public-private partnership in waste management and energy use for POMs and develop an action plan to commercialize the use of energy from POMs.
(xii) Identify the greenhouse gas abatement potential of methane capture and energy-generation interventions and determine availability of additional international resources under various greenhouse gas mitigation initiatives such as the clean development mechanism (CDM).
(xiii) Undertake an environmental and social analysis and determine the impact on indigenous people, if any.

3. The Directorate General of Electricity and Energy Utilization (DGEEU) will be the Executing Agency, with State Gas Corporation (PGN) as the Implementing Agency. They will help the consultants access data and coordinate with other government agencies and stakeholders. Ten person-months of international and about 20 person-months of domestic consultant inputs are proposed. The study will take 9 months, from September 2004 to May 2005.

B. Terms of Reference

4. The consultants will work as a team to carry out various tasks, including, but not limited to the following. The international energy economist will be the team leader.

1. International Energy Economist (team leader, 6.5 person-months)

5. The energy economist will do the following:

(i) In consultation with the technical and domestic experts, DGEEU, and PGN, identify a POM cluster where appropriate technologies can be applied.
(ii) For the cluster determine the local demand for energy and availability of a local energy distribution network.
(iii) Define a strategy to include a plan and mechanism to commercialize surplus energy (methane gas and other forms of energy) from POMs.
(iv) Conduct an economic evaluation of proposed technical interventions for waste management, gas capture, and energy conversion and transmission, including calculation of the internal rate of return (economic and financial).
(v) Prepare an implementation plan for the POM cluster, including an estimate of investments required and a financing plan for the proposed interventions, estimate of the return on investment for auto-generation (captive power), assessment of the viability of power sales to the grid (existing or proposed), and assessment of sale of gas recovered to a local grid (existing or proposed) and other possible use of energy from waste.
(vi) Recommend procedures, guided by ADB's *Guidelines on Benefit Monitoring and Evaluation*, and identify indicators that can be monitored to assess project benefits.
(vii) Prepare a project framework, according to ADB standards, which clearly identifies the project goals and objectives, required inputs, targets or benchmarks, monitoring indicators and mechanisms, potential risks, and assumptions.
(viii) Identify direct and indirect indicators that can be monitored and link the project intervention with poverty reduction.
(ix) Generate a CDM feasibility report focusing on recovery of energy and methane from palm oil waste and its transformation into energy. The report will address baseline emissions and estimate carbon emissions savings.

6. The energy economist, recruited for 6.5 person-months, will have expertise in (i) energy and financial economics, (ii) policy analysis and formulation, and (iii) CDM. The economist will be the team leader (TL) and have overall responsibility for the TA outcome, coordinating domestic consultants' work plans and helping assimilate consultants' and stakeholders' inputs and take the process forward. The TL will liaise and consult with DGEEU, PGN, and other concerned ministries such as the ministries of environment, state-owned enterprises, agriculture, and other stakeholders (such as selected communities involved in the management of POMs) throughout the study, ensuring overall coordination. The economist will be responsible for reporting inception and interim progress to ADB, and for submitting a high-quality report to ADB at the end of the project.

2. International Technology Specialist (3.5 person-months)

7. The outputs provided by the technology specialist will include the following:

(i) Critically review ongoing waste management practices in the palm oil industry and elsewhere, where appropriate. Evaluate alternatives and provide more information validating conversion of waste to power.
(ii) Review technical parameters and performance of ongoing palm oil effluent waste anaerobic treatment projects and production of other energy in POMs, such as bio-diesel, in Indonesia and elsewhere in the region.
(iii) Based on the review and experience, and in collaboration with the domestic technical experts, identify technologies that can use solid and liquid waste from POMs, including technologies that recover methane from palm oil waste, methane collection and use, other technologies for processing waste to produce energy and/or fertilizer, the techno-economic potential for production of bio-diesel from crude palm oil and liquid waste, and its subsequent use.
(iv) For technological interventions that produce significant quantities of energy, determine systems for in situ and local use of energy from waste.
(v) Identify a viably sized cluster of POMs to implement different waste management and energy production technologies, and to transmit surplus energy.
(vi) Technically evaluate the recovery and use of methane from POM waste and use of other forms of energy in the cluster. This feasibility study will take into account potential barriers such as physical dispersion of biomass volumes, collection and transportation of residues to central locations, and seasonal availability of the fuel. The study will provide waste-to-energy project options, including direct feeding of recovered methane in an existing or proposed network, generation of electricity for local consumption and/or wheeling electricity to local grid, and the use of energy from waste for other purposes.
(vii) Design a technical implementation plan for interventions identified in (v) above in agreement with the DGEEU, PGN, and other stakeholders.
(viii) Prepare guidelines for waste management in the palm oil industry.

8. The technology expert, recruited for 3.5 person-months, will have expertise in (i) waste management and methane recovery technology, (ii) energy transformation and transmission, and (iii) engineering practice. The international consultant will help the team leader ensure effective and timely implementation of the study and (i) provide guidance to domestic consultants, (ii) jointly report inception and interim progress to ADB, and (iii) jointly submit a high-quality report to ADB at the end of the project.

3. Domestic Technology Experts (two, 4 person-months each)

9. The technology experts will specialize in anaerobic technology and energy conversion and distribution and provide the following specific outputs:

(i) Help the international consultant identify technologies that can use solid and liquid waste from POM (including technologies to recover, collect, and use methane from palm oil waste, and others for processing waste to produce energy and/or fertilizer) and the techno-economic potential for production of bio-diesel from crude palm oil and liquid waste, and its subsequent use.

(ii) Identify a viably sized POM cluster to implement different waste management and energy production technologies, and to transmit surplus energy. Help develop a set of criteria for POM cluster selection, including technical components.
(iii) Technically evaluate the recovery and use of methane from POM waste and use of other forms of energy in the cluster. This feasibility study will take into account potential barriers such as physical dispersion of biomass volumes, collection and transportation of residues to central locations, and seasonal availability of the fuel. The study will provide waste-to-energy project options, including direct feeding of recovered methane in an existing or proposed network, generation of electricity for local consumption and/or wheeling electricity to the local grid, or the use of energy from waste for other purposes.
(iv) Design a technical implementation plan for interventions identified in (v) above in agreement with the DGEEU, PGN, and other stakeholders. This study will include concepts such as that of replicability.
(v) Contribute technical advice to prepare guidelines for waste management in the palm oil industry.

10. The experts will be recruited for 4 person-months each. One expert will specialize in anaerobic waste treatment technology, and the second in power generation and transmission. The experts will (i) help the team leader select technology and analyze and formulate measures related to their field of expertise; and (ii) contribute to the inception, interim, and final reports to be submitted to ADB.

4. Domestic Environmental Specialist (3 person-months)

11. The specialist will provide the following outputs:

(i) Review waste management practices in the palm oil sector, relevant laws, and existing policies. Report and provide recommendations.
(ii) In conjunction with the international technology specialist, prepare guidelines for waste management in the palm oil industry.
(iii) Conduct an environmental impact and environmental benefit analysis on the technical implementation plan for the POM cluster.
(iv) Contribute to the CDM feasibility report focusing on environmental gains and benefits.

12. The specialist will be recruited for 3 person-months and will have expertise in environmental and waste management and policy analysis. The specialist will (i) help the team leader formulate measures related to the consultant's field of expertise; and (ii) contribute to the inception, interim, and final reports to be submitted to ADB.

5. Domestic Social Impact Specialist (4 person-months)

13. The outputs of the social-economic impacts specialist will include the following:

(i) Study the potential impact of waste management and recovery and use of energy from POM waste on the local population, including indigenous people, in the POM cluster.
(ii) Liaise with community-managed POMs in the cluster area, establish their perception of the project and technology, and identify energy requirements and

demand. Where relevant, identify how biomass gasification and or bio-diesel can benefit these communities and increase the project's acceptability.

(iii) Identify stakeholders and analyze distribution of benefits of the intervention plan;

(iv) Prepare a socioeconomic and poverty profile of primary project beneficiaries in the target provinces, including poverty status and causes of poverty and vulnerability.

(v) Analyze access to clean and modern forms of energy, affordability, consumption levels, and consumer satisfaction across socioeconomic groups in target provinces in a with- and without-project scenarios.

(vi) Identify direct and indirect indicators that can be monitored and link the project intervention with poverty reduction.

14. The socioeconomic impact specialist will be recruited for 4 person-months and have expertise in socioeconomic analysis, social impact assessment, and indigenous people. The specialist will (i) help the team leader formulate measures related to the specialist's field of expertise; and (ii) contribute to the inception, interim, final reports to be submitted to ADB.

6. Domestic Economic-Financial Specialist (5 person-months)

15. The outputs of the economic-financial impacts specialist will include the following:

(i) Review and evaluate the economic parameters and performance of ongoing palm oil solid and liquid waste effluent treatment projects and production of energy in POMs in Indonesia and elsewhere in the region.

(ii) Help the team leader undertake the economic and financial analysis of the proposed technological interventions and implementation plan for the POM cluster.

(iii) Identify risks and undertake appropriate sensitivity and risk analyses with respect to the economic internal rate of return in accordance with ADB's *Handbook for Integrating Risk Analysis in the Economic Analysis of Projects*.

16. The specialist will be recruited for 5 person-months and will have expertise in economic and financial analysis. The specialist will (i) help the team leader formulate measures related to the specialist's field of expertise; and (ii) contribute to the inception, interim, and final reports for ADB.

COST ESTIMATES AND FINANCING PLAN
($'000)

Item	Foreign Exchange	Local Currency	Total Cost
A. Asian Development Bank (ADB) Financing[a]			
1. Consultants			
a. Remuneration and Per Diem			
i. International Consultants	220	0	220
ii. Domestic Consultants	0	100	100
b. International and Local Travel	35	15	50
c. Reports and Communications	5	5	10
2. Training, Seminars, and Workshops	0	10	10
3. Data Collection and Consultation	20	10	30
4. Equipment	25	0	25
5. Contingencies	42	13	55
Subtotal (A)	**347**	**153**	**500**
B. Government Financing			
1. Office Accommodation and Transport	0	25	25
2. Remuneration and Per Diem of Counterpart Staff	0	60	60
3. Logistic Support, Translations, Reports	0	20	20
4. Contingency	0	20	20
Subtotal (B)	**0**	**125**	**125**
Total	**347**	**278**	**625**

[a] Cofinanced by ADB's technical assistance funding program and the Canadian Cooperation Fund on Climate Change.
Source: Asian Development Bank estimates.