Indonesia: MICROTURBINE COGENERATION TECHNOLOGY APPLICATION PROJECT (MCTAP)

TERMINAL EVALUATION REPORT

Submitted by:

Rogelio Z. Aldover
International Consultant and TE Team Head

and

Budi Prasetyo
National Counterpart

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INDONESIA: MICROTURBINE COGENERATION TECHNOLOGY APPLICATION PROJECT (MCTAP)

Terminal Evaluation

PIMS Number:	3471
Atlas Award Number:	00049011
Atlas Project Number :	00059512
Country:	Indonesia
Implementing Agency:	United Nations Development Programme (UNDP)
Executing Agency:	Badan Pengkajian dan Penerapan Teknologi (BPPT) or the Agency for Assessment and Application of Technology
GEF Operational Program/Strategic Program	
Original Duration of Project Implementation:	2008 – 2013, Five (5) years
Date of Project Document signing:	15 December 2008
Date Project Manager hired:	February 2009
Date of First Disbursement:	April 2009
Original Closing Date:	December 31, 2013
Revised Planned Closing Date:	February 2014
Period Mid-Term Review Conducted:	February 14 to April 15, 2012
Period Terminal Evaluation Conducted	May – July 2014

Allocated resources in Project Document (in USD)	
Grant Fund	
GEF	$ 2,587,300
UNDP	425,000
Subtotal Grant	3,012,300
Co-financing	
Government	2,741,000
Private Sector	12,592,000
Subtotal Co-financing	15,333,000
Total budget	**$18,345,300**

Acronyms

Acronym	Meaning
APKENINDO	Asosiasi Perusahaan Penunjang Konservasi Energi Indonesia (Association of Indonesia Energy Conservation Supporting Company)
APR/PIR	Annual Project Review/Project Implementation Review
AWP	Annual Work Plan
BPPT	Badan Pengkajian dan Penerapan Teknologi (Agency for the Assessment and Application of Technology)
BBTE/B2TE	Balai Besar Teknologi Energi (Energy Technology Center)
CO_2	Carbon dioxide
CDM	Clean Development Mechanism
COGEN	Cogeneration
CCHP	Combined Cooling and Heating Power System
CHP	Combined Heat and Power
CAP	Country Assistance Program
DJLPE	Direktorat Jenderal Listrik dan Pemanfaatan Energy (Directorate General for Electricity and Energy Utilization or DGEEU)
DJEBTKE	Direktur Jenderal Energi Baru Terbarukan dan Konservasi Energi (Directorate General for New Energy Resources and Energy Conservation)
DG	Distributed Generation
DFO	Domestic Fuel Obligation
EC&EE	Energy Conservation and Energy Efficiency
ESCO	Energy Service Company
ExA	Executing Agency
FE	Final Evaluation
GWe	Gigawatt electricity, 1000 MWe
GW,	Gigawatt, 1000 MW
GWh	gigawatt-hours
GEF	Global Environment Facility
GOI	Government of Indonesia
GHG	Greenhouse Gas
GDP	Gross Domestic Product
HPP	Harga Pokok Penjualan – Cost of Electricity Supply
HS	Highly Satisfactory
HU	Highly Unsatisfactory
IA	Implementing Agency
IPP	Independent Power Producer
IDR	Indonesian Rupiah
ICE	Industrial and Commercial Establishments Sector
IC	International Consultant
IPC	International Project Coordinator
Jabotabek	Jakarta Bogor Tangerang Bekasi
KEN	Kebijakan Energy Nasional (National Energy Policy)
KUBE	Kebijakan Umum Bidang Energi (General Guidelines on Energy Policy)
kW	Kilowatt, 1000 watts
kWh	kilowatt hour
LED	Light Emitting Diode
LNG	Liquid natural Gas
LPG	Liquid Petroleum Gas
LFA	Logical Framework Analysis
MS	Marginally Satisfactory

Acronym	Meaning
MU	Marginally Unsatisfactory
MOV	Means of Verification
MW	Megawatt, 1000 kW
MCT	Microturbine Cogeneration Technology
MCTAP	Microturbine Cogeneration Technology Application Project
MTR	Mid-Term Review
MEMR	Ministry of Energy and Mineral Resources
MTI	Ministry of Trade and Industry
M&E	Monitoring and Evaluation
NAC	National Advisory Council
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Development Planning Agency)
NEX	National Execution
NPD	National Project Director
NPM	National Project Manager
NSS	National Strategy Study on the Clean Development Mechanism
NGO	Non-Government Organization
O&M	Operation and Maintenance
PGN	Perusahaan Gas Negara
PLN	Perusahaan Listrik Negara (State-Owned Electric Company)
PLFD	Project Logical Framework Design
PMU	Project Management Unit
PPM	Project Planning Matrix
QPR	Quarterly Progress Report
RE	Renewable Energy
RISTEK	Kementerian Riset dan Teknologi (Ministry of Research and Technology)
R&D	Research and Development
S	Satisfactory
SME	Small Medium Enterprise
Kep.Men	State Minister Decision
TA	Technical Assistance
TWG	Technical Working Group
TOR	Terms of Reference
TPR	Tripartite Review
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
U	Unsatisfactory
YBUL	Yayasan Bina Usaha Lingkungan (Foundation for Environmental Development)

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EXECUTIVE SUMMARY

Introduction

This Terminal Evaluation (TE) Report is for the evaluation of the MICROTURBINE COGENERATION TECHNOLOGY APPLICATION PROJECT (MCTAP) with PIMS #3471.

The project is aimed at introducing Microturbine Cogeneration Technology (MCT) to the industrial and commercial establishments (ICE) sector as an option to meet both thermal and electrical energy demand. MCT is considered as a combined heat and power (CHP) system that helps to enhance energy efficiency and improve equipment utility up to 80% or even 85%, thus enhancing energy efficiency and reducing CO2 emissions. It is claimed as the best alternative option for the growing captive or in-plant power generation in lieu of diesel internal combustion engines or natural gas engines.

The major issues that were to be addressed at the beginning are:

- Lack of comprehensive policy and suitable financing schemes to lessen high first cost which is affecting private investor interest in the MCT projects;
- Lack of local MCT supporting industry capacities;
- Lack of confidence in MCT technology and information needs; and
- Insufficient demonstration of sustainable MCT application.

MCTAP is designed to introduce, promote, demonstrate and facilitate the marketing and application of MCT.

Project Goal - The overall goal of MCTAP is the reduction of the growth of GHG emissions from the MCT deployment in the industrial, commercial and energy (ICE) sectors in Indonesia.

Project Objective - The overall project objective is the reduction of the long-term cost of MCT in order to accelerate the entry and increase the share of MCT in the Indonesian market.

Findings

The summary of ratings of accomplishment in achieving various Components' outcomes is shown below:

Component 1: Technical Assessment & MCT Application Development	MU
Component 2: MCT Demonstration & Market Development	MU
Component 3: Technical Support for MCT Financing	HU
Component 4: Policy & Institutional Support	MU
Component 5 : MCT Promotion Activities	S
Component 6 : Technical Support For Local MCT Industry	MS
Overall Project Rating	**MU**

Factors affecting the achievement of expected results

The TE Team observed the following factors and related market situation throughout the project implementation which have affected the achievement of expected project results:

a) Development of the market for gas-fueled microturbine with cogeneration technology (MCT) application as a new technology system in Indonesia took longer than was expected during the project design.
b) PGN natural gas fuel price rose to more than $ 10/MMBTU compared the gas prices which were then below $ 6/MMBTU when the MCTAP project started to select companies for MCT demonstration based on the feasibility studies conducted.
c) PGN plan for the development of transmission and distribution networks to consumers including network Kalimantan-Java did not fully materialize to reach targeted market areas for MCT.
d) PGN's present policy is to give priority to supply gas produced for power and fertilizer production. Government encouragement for gas supply conversion to CNG fuel for the transportation sector has also limited the supply of gas to the power generation sector. As a result, gas allocation quotas for industrial needs (even for energy efficiency projects such as cogeneration), has been significantly limited.
e) The government subsidy for power sold through the electricity grid makes the grid power cheaper than that produced by industrial independent power producers using gas microturbines. The cogeneration application as an energy efficiency improvement alternative has been affected by the said energy price disincentive.
f) Consequently, the maintenance and after-sales service costs become high for the present small number of MCT users (as in a chicken-and-egg situation and unrealized economies of scale). The greater population of more mature technologies (e.g. diesel engine and gas engine generators) has continued to be the trend and has also been a material consideration for prospective users before buying gas microturbine for cogeneration.
g) Gas-fueled microturbine technology is still quite expensive at capital expenditure at $ 2,000 - $ 3,000 / kW (e) compared to diesel engine ($ 300 - 500) and gas engine ($ 700 -800). Potential users still view this as a hindrance in MCT acquisition despite the knowledge that MCTs will have lower total energy generating cost when coupled with heat recovery systems.

Thus, at the end of the project, the following risks and assessed risk level were identified by the TE Team to exist based on the above situation:

- Limited number of microturbine technology providers (Moderate)
- Lack / limited gas supply from PGN to the potential MCT users (High)
- Delay and failure on the MCT demo units operation (High)
- Maintenance problems of the MCT technology (Risk Level: Moderate to High)
- Increasing the price of natural gas (Risk Level: High)

Sustainability and project exit strategy

The TE Team suggests the Exit Strategies for the MCTAP that focus on the following as discussed with the Project Management and key stakeholders during the TE process:

1. Further studies on other applications including combined heat and power uses in small and medium enterprises (SMEs) that can be served by MCTs
2. Promoting ESCOs and adopting viable business models
3. Strengthening policy and institutional support

CONCLUSIONS, RECOMMENDATIONS & LESSONS

1. Corrective actions for the design, implementation, monitoring and evaluation of the project

   Conclusion: The project design appeared to have over-estimated the targets on demonstration capacities and replication projection. However, upon review of the project development history, the targets were considered to be realistic and achievable on the basis of prevailing price, private sector's interest on the potential energy savings and GHG reduction benefits. However, these assumptions changed drastically over the 6 year implementation period which became unfavorable to MCT market development. The monitoring and evaluation have been effectively carried out using the prescribed GEF/UNDP system on the Annual Project Report/ Project Implementation Review (APR/PIR).

   Recommendations: A more rigid market projection methodology should be used in similar future projects that will include conservative and ambitious target levels and their corresponding carefully-assessed assumptions and conditions.

2. Actions to follow up or reinforce initial benefits from the project

   Conclusion: The problems met by MCTAP in achieving fully its objectives were related to replication which is mainly marketing MCT to more potential users. The present project has reached significant start-off achievements in demonstrating a new technology which can be continued in the future. For follow-up actions, MCT marketing activities can be done in 4 marketing patterns consisting of: marketing penetration, market development, product development and diversification. On market expansion, there are areas with existing gas supply networks and a number of industrial and commercial enterprises that can be further encouraged to use MCTs. On the other hand, in the pursuit of better MCT system efficiencies, it is expected that MCT product development will continue to introduce advance and higher efficiency MCT system (both in the power generation and heat recovery sides) which can be offered to existing and new customers. Still another step is in the form of diversification in generating equipment production and is intended for increasing MCT producers from related and unrelated crafts.

   Recommendations:

   - Focus on marketing or development of the MCT market in the above-mentioned four patterns in a more aggressive, stepwise approach, as follows:
     - Focus MCT marketing primarily to existing MCT demo users who are still in need of thermal energy and have still excess quantities from its quota of fuel gas supply from PGN by installing one or more MCTs operated in parallel to match load-following schemes in cogeneration to optimize system efficiencies and be good marketing models.
     - Target expanded markets for new customers (existing or relocated) in areas with well-developed gas distribution networks with extensive promotion based on success stories of current MCT users.

- Encourage more local product research and development that will introduce to the market some advance, operationally-improved and higher-efficiency MCT systems (in both the power and heat generation sides).
- Encourage more equipment producers to diversify by venturing into MCT production whether they are related or unrelated to present business because they will benefit from good synergy and creativity in combining power generation and heat recovery for higher system energy efficiency in MCT systems.
- Promote more for low-BTU microturbines such as EnerCore products for abundant low calorie gas on landfill sites and mining areas.

3. Proposals for future directions underlining main project objectives

Conclusion: Based on the foregoing current situation analysis, the project has experienced an overall situation that is different and unfavorable vis-à-vis the expectations during project design.

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Recommendation (as in the proposed project Exit Strategy):

- Address the existing market situation so that the MCT market will be developed and result to an increased MCT technology replication:
  - Conduct further studies on other applications including combined heat and power uses in small and medium enterprises (SMEs) that can be served by MCTs
    - Open up new market for MCTs
    - Establish technical support particularly in the after-sales services for the local MCT industry
    - Encourage local research for MCT development on the power generation side and heat recovery side.
  - Promote ESCOs and adopting viable business models
    - Adopt applicable business models by providing relevant information
    - Capacity building in the banking / financial institutions in developing financial packages, credit schemes and loan guarantee windows to strengthen MCT market.
    - Adopt innovative financing schemes, smart subsidies and incentives for ESCOs to invest in MCTs
  - Strengthen policy and institutional support in favor of energy efficiency technologies such as cogeneration which includes MCT.
    - Adopt necessary policies and regulations to support COGEN market application and development (where MCT is a sub-set) and the necessary incentives for both MCT technology provider and user
    - Adopt rationalized policy guidelines on gas supply on making gas more available to efficient industrial applications as part of Five-Year (2015-2020) National Plan
    - Strengthen organizational structure and harmonize mandates to support energy efficient gas usage in COGEN in industries.

4. Best and worst practices in addressing issues relating to project relevance, performance and success

Conclusion:

a) The MCT program has continued to be very relevant to the current thrust of Indonesia and fits very well in the national cogeneration program being pursued by MEMR and BPPT.

b) While the performance indicator in the achievement of objectives in the replication target of 200 MW was not attained by the project within its timeframe due to various reasons as explained in the TE observations, the great potential of MCT remains valid and can be considered as an opportunity in developing new program for MCT under the national energy efficiency program which include the significant contribution of cogeneration projects.
c) While the project has accomplished all relevant project activities in the six components, success in achieving the project objectives in the demonstration and replication of MCTs was affected by the unexpected market circumstances in introducing a new technology.

Recommendation:

- Pursue the successful completion of the MCT demo highlighting the achievement of the energy efficiency improvement learning from best and worst practices resulting to substantial energy savings and GHG reduction benefits and dissemination of the results to encourage a wider MCT market development program under the national energy efficiency program of Indonesia.

5. Lessons Learned

- Economic considerations for marketing new technology products in any country are always relevant and major factor. For Indonesia, even if the microturbine promised to be a highly efficient and of excellent quality, it is still not the top choice for power generators because microturbine unit prices are 2-3 times the price of gas engines for the same size.
- While the MCT technology is being introduced, potential users and distributors need ample incentives to justify their participation in the demonstration stage in addition to the assistance in promotion and capacity development due to the risks involved.
- Higher capacities of microturbine could be more attractive to be used under the national program in the field of energy efficiency involving cogeneration systems and therefore provide a much larger contribution.
- The MCT technology could be more flexible and customized regarding local specifications in terms of operating parameters, such as the operating limit voltage should be adjusted to the lowest voltage that the grid can accommodate (e.g. 250V), so that MCTs can be operated in parallel with the PLN system.

INDONESIA: MICROTURBINE COGENERATION TECHNOLOGY APPLICATION PROJECT (MCTAP)

Terminal Evaluation

1. INTRODUCTION

1.1 Purpose of the Evaluation

In accordance with UNDP and GEF M&E policies and procedures, all full and medium-sized UNDP support GEF financed projects are required to undergo a terminal evaluation upon completion of implementation. This Terminal Evaluation (TE) Report is for the evaluation of the MICROTURBINE COGENERATION TECHNOLOGY APPLICATION PROJECT (MCTAP) with PIMS #3471.

The objectives of the evaluation are: (a) to assess the achievement of project results; and (b) to draw lessons that can both improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming.

1.2 Scope & Methodology

As described in the Terms of Reference (TOR) also seen in **Annex A**, the scope of this TE of the MCTAP covers the entire UNDP/GEF-funded project and its components as well as the co-financed activities.

The evaluation involved analysis at two levels: component level and project level. At the component level, the progress of implementation was reviewed against each outcome, output, activity (including sub-activities) and impact indicators listed in the log frame or PPM of the MCTAP project document. At the project level, the TE assessed the project accomplishments and implementation performance.

The Terminal Evaluation Team (TE Team) used the criteria of **relevance, effectiveness, efficiency, sustainability, and impact,** using a set of questions covering each of these criteria. Terminal evaluations of GEF projects include, at a minimum, ratings on a project's relevance, effectiveness, efficiency, and monitoring and evaluation implementation, plus the likelihood that results (outputs and outcomes) can be sustained.

The evaluation followed an evidence-based information gathering approach that is credible, reliable and useful through direct participation and consultation with government counterparts through BPPT (Badan Pengkajian dan Penerapan Teknologi or Agency for the Assessment and Application of Technology) which is the Executing Agency of the project. The TET also conducted a field visits to MCT demo sites and MCT technology suppliers and users. Interviews were also held with the relevant representatives of the organizations and individuals involved in the project as arranged by the Project Management Office (PMO).

The TET also reviewed all relevant sources of information, such as the project document, project reports – including Annual APR/PIR, project budget revisions, midterm review, progress reports, project files, national strategic and legal documents, and any other materials that the TET considers useful for this evidence-based assessment. A list of documents that the team referred to for this review is included in **Annex B** of this report. **Annex C** lists the persons interviewed as part of the evaluation process

The TET also assessed the key financial aspects of the project, including the extent of co-financing planned and realized. The GEF Project cost and funding data were analyzed, including annual expenditures. Variances between planned and actual expenditures were assessed and explanations sought from the PMO. The TET was assisted by the Country Office (CO) and PMO to obtain financial data on the GEF funds and the co-financing which are also included in this TE Report.

1.3 **Structure of the TE Report**

The TE Report is composed of four (4) parts: Part 1 introduced the purpose and mechanics of the evaluation process; Part 2 described the project and its development context briefly; Part 3 presented the main findings of the evaluation in terms of project design and formulation, project implementation, and the actual project results; Part 4 offers the conclusions, recommendations and lessons learned; and lastly, Part 5 includes the required annexes of the report.

2 **PROJECT DESCRIPTION AND DEVELOPMENT CONTEXT**

The project titled, Microturbine Cogeneration Technology Application Project (MCTAP) is aimed at introducing Microturbine Cogeneration Technology (MCT) to the industrial and commercial establishments (ICE) sector as an option to meet both thermal and electrical energy demand. MCT is considered as a combined heat and power (CHP) system that helps to enhance energy efficiency and improve equipment utility up to 80% or even 85%, thus enhancing energy efficiency and reducing CO2 emissions. It is claimed as the best alternative option for the growing captive or in-plant power generation in lieu of diesel internal combustion engines or natural gas engines.

Heat recovered from MCT can be applied to various applications such as absorption refrigeration for cooling and air conditioning, drying processes, low enthalpy binary cycle engines, etc. It is particularly appropriate in areas, where fuel resources are abundant and easy to get such as natural gas. MCT can also use other fuels such as biogas, landfill gas and other commercially available liquid fuels.

2.1 **Project start and duration**

The MCTAP project document was approved for funding support by the Global Environmental Facility (GEF) and the project implementation has started from December 2008 for a period of five (5) years up to December 2013.

2.2 **Problems that the project sought to address**

There are multiple barriers hindering the development and application of alternative and clean energy technologies, such as MCT, in most countries like Indonesia. MCTAP is designed to remove key market, policy, technical and financial barriers to MCT development and application in the

country, particularly to reduce the initial acquisition cost of this technology which is considered still high for the country's private sector.

The major issues that were to be addressed at the beginning are:

- Lack of comprehensive policy and suitable financing schemes to lessen high first cost which is affecting private investor interest in the MCT projects;
- Lack of local MCT supporting industry capacities;
- Lack of confidence in MCT technology and information needs; and
- Insufficient demonstration of sustainable MCT application

At the outset of project implementation in 2008, the following were the identified barriers:

1. Institutional Barriers

    - National energy policies are not translated to specific guidelines, rules and regulations with particular focus on low GHG emitting technologies such as MCT applications in industrial and commercial sectors development activities
    - Low local government capacity in developing comprehensive local energy planning

2. Technical Barriers

    - Technical viability of MCT applications is unknown
    - Capacity of local equipment manufacturing industry to produce MCT components is unknown
    - Lack of program and human capacity in R&D and local manufacturing of MCT components
    - Local service providers cannot provide quality installation, reliable products and basic awareness for the clients
    - Low level of competency of local technology service providers on MCT applications
    - No code of practice and technical guidelines for MCT installation, operation and maintenance
    - There are no guarantees for the technical requirements necessary to ensure the safety and the reliability of planned on-grid MCT systems

3. Information and Awareness Barriers

    - Insufficient information and dissemination of policies and regulations
    - Lack of documentation and publication of existing cogeneration technology achievement
    - Lack of up-to-date and transparent information on MCT
    - Lack of information on the cost-effectiveness of MCT applications

4. Market Barriers

    - No fully functional focal point for the provision of market development services for MCT
    - Lack of skilled human resources for designing, implementing, and managing MCT projects
    - Lack of effective technical human resources development

- Lack of accessibility to information on MCT applications
- Limited local industrial capacity to support MCT development
- Lack of MCT equipment product standards and standardization program

2.3 **Immediate and development objectives of the project**

MCTAP is designed to introduce, promote, demonstrate and facilitate the marketing and application of MCT through six key components: (a) Technology Assessment and MCT Application Development; (b) MCT Demonstrations & Market Development; (c) Technical Support for MCT Financing; (d) MCT Policy & Institutional Support; (e) MCT Promotion Activities; and, (f) Technical Support for Local MCT Industry.

Project Goal - The overall goal of MCTAP is the reduction of the growth of GHG emissions from the MCT deployment in the industrial, commercial and energy (ICE) sectors in Indonesia.

Project Objective - The overall project objective is the reduction of the long-term cost of MCT in order to accelerate the entry and increase the share of MCT in the Indonesian market.

2.4 **Baseline Indicators established**

Indonesia has been one of the fastest growing countries in the ASEAN region with growing demand for electricity. To meet this demand, the GoI would continue to install new conventional power generation facilities. In addition, coal fired power plants and diesel power plants will still be the option for electricity generation, in view of the availability of fuel and the relatively lower cost for the technology involved. To mitigate the environmental pollution caused by the high level of coal and oil utilization in the country's renewable energy development and the widespread practice of EC&EE have been encouraged by the GoI. Although there is high level of awareness of the economic and environmental benefits of MCT implementation, such technology was not expected to be employed in the short to medium term because of its high cost.

Indonesia with its growing captive power market, an insufficient power supply market, and availability of huge natural gas resources is definitely a promising market for cogeneration. Cogeneration has only been popular amongst the big industries, such as pulp & paper, petrochemical, textile and food processing, mainly because the past cogeneration technologies are usually only cost effective for bigger power and heating generation capacities. Recently, small-scale cogeneration has become popular in smaller industries.

2.5 **Main stakeholders**

The Badan Pengkajian dan Penerapan Teknologi or the Agency for the Assessment and Application of Technology (BPPT), through its BBTE (Balai Besar Teknologi Energi or the Energy Technology Center) is the Executing Agency of the MCTAP under the nationally-executed project arrangement with the United Nations Development Programme (UNDP). MCTAP is supported by the GEF in order to realize the long-term smaller cogeneration technology market penetration in Indonesia. The BBTE is a BPPT subsidiary working in the field of energy technologies, especially in energy conversion and conservation. BBTE's main task is to assist the government in the national economic development through research, assessment and application of energy technology

BBTE has been working closely with the Ministry of Energy and Mineral Resources (MEMR), through its newly organized DJEBTKE for the necessary policy formulation and coordination of energy efficiency (EE) programs that could support the commercial application of MCT in Indonesia. DGEEU no longer exists. It was already split into DJEBTKE (Direktorat Jenderal Energi Baru, Terbarukan, dan Konservasi Energi) and DJK (Direktorat Jenderal Ketenagalistrikan). This was a result of government reorganization. MCTAP is now under the DJEBTKE which assumed the DGEEU responsibilities and duties under the project as a major stakeholder of the MCTAP. BBTE is also coordinating with the Ministry of Trade and Industry (MTI), particularly in the development of sound policy frameworks on gas utilization, electricity generation, technology application and commercialization. The state gas company, Perusahaan Gas Negara (PGN), with its new gas distribution development project is expected to contribute to the establishment of policy frameworks to ensure sustainable access to affordable gas for microturbine users.

Under the project implementation strategy, the MEMR and MTI is expected to play central roles in promotion activities and capacity building that would involve all stakeholders interested in the development of the microturbine market in Indonesia. Several government financing institutions, private and commercial banks are also expected in the design and development of financing mechanisms to help in solving the financial-related barriers in the acquisition of MCT systems and heat recovery units (HRUs). Private companies, owners of industrial and commercial establishments, including energy service companies (ESCOs) and MCT user will be enjoined to adopt the technology through demonstration schemes, technical assistance, market development and promotions.

At present, there are four (4) host companies to the MCT demonstration facilities: PT. Hikari, PT. Nipress, PGN Palembang Metering Gas System and Hotel Borobudur Jakarta. There are five (5) MCT units demonstrated with one (1) unit each company, while two (2) units were installed in PT. Nipress.

The Project Organizational Chart is seen in **Annex D**. The project oversight was performed by the National Project Board as the project's policy making body and the UNDP Indonesia for the Project Assurance. At the side of the executing function, the National Project Director and two (2) deputies represented the BPPT as the Executing Agency for this nationally-executed project. The National Project Manager was in-charge of the day-to-day operations and reporting with the assistance of the PMO staff. The technical functions for the six 6) components were performed by four (4) technical consultants.

2.6 **Expected Results**

From the 6 components of the project, the following are the expected outcomes:

a) Enhanced knowledge of potential MCT applications; system benefits, availability and cost, as well as capacity and capability of local service providers for MCT systems;
b) Increased MCT applications in ICE sectors as well as market share of MCT, with resulting in GHG emission reduction, and reduction in MCT cost by about 25% average;
c) Increased investments on MCT: banks/financing institutions providing loans for MCT projects;
d) Approval and implementation of policies supportive of MCT projects;

e) Enhanced awareness of the benefits of MCT in order to increase the number of MCT users and planned MCT projects; and,
f) Availability of locally made and enhanced local manufacturing capability of MCT system components.

The following are the major results of the 5-year MCTAP expected by end-of-project:

- Cumulative reduction of GHG emissions from the MCT deployment in the ICE sector in Indonesia of 1.528 million tons CO2 (0.674 million tons CO2 in Year 5)
- Cumulative energy savings in ICE sectors from the application of MCT of about 3.2 million BOE
- Total installed capacity of MCT facilities of around 200 MW
- Average % reduction in the cost of MCT of about 25%

3 FINDINGS

3.1 Project Design / Formulation

3.1.1 Analysis of LFA/Results Framework

The Project strategy is to promote the application of the natural gas-fueled MCTs in the industry by demonstrating the combined heat and power applications in selected sites so that the familiarization and operational experience will draw the sector's interest in the efficient and environment-friendly technology that is considered to be of great potential. This would have involved the installation of 3.6 MW MCT systems in selected demonstration enterprises. Through these demonstrations, it was anticipated that the initial users would be able to better appreciate MCT, and with a wider understanding of its benefits, the market growth is accelerated and enhanced, leading to the long-term cost reduction of the technology. By end of the project, the expected installed MCT capacity in Indonesia is 200 MW. The MCT applications were expected to optimize the utilization of both the electricity generated and the waste heat used for process heating or for cooling/refrigeration.

The 200 MW MCT installed capacity target by end of the project was based on the portion of the current diesel generating set captive capacity that can shift to MCT on the basis of successful and encouraging results of the demo units. The project design included in the said target the potential MCT applications in the industry and commercial enterprises (ICE) in the textile, plastics, paper, ceramics, metal plating, and other industries and in commercial buildings such as hotels, apartments, hospitals, shopping malls and offices. As reported by the Center for Energy and Power Technologies, there is about a total 4GW of captive diesel power plant capacity, such that a portion of which was considered to be replaceable by MCTs in case there is available natural gas distribution network. The project target of 200MW installed MCT capacity is only 5% of the total captive diesel power capacity mentioned.

At the time of project preparation, the availability of natural gas is perceived to be relatively abundant as rapidly growing number of power plants using gas as fuel and increasing quantity of gas reserves resulting from new oil and gas explorations. In addition, there was a gas distribution network development plan to install gas pipelines in Java, Sumatra and Kalimantan which was expected to be partly completion in 2019.

3.1.2 Assumptions and Risks

The target of 200 MW installed MCT capacity was deemed achievable and realistic at the time of project design in 2008, which was based on a 5% share of the in-plant diesel generating sets being used by the industry in Indonesia which was projected to be at 4,000 MW. When the feasibility studies were conducted, the price of natural gas was at US$ 6/ million Btu (MMBtu) which was assumed to be available for industries desiring to shift to natural gas not only for its low cost but also because it is environment-friendly. With MCT being used, the heat from the exhaust can be recovered that will enhance the overall system efficiency from the usual 25 – 30% to a very favorable 60 – 80% system efficiency level. Thus, with fuel economy and environmental protection in mind, a diesel engine user would be attracted to shift to MCT and therefore the MCT market share grows in spite of the fact that the first cost of MCTs are higher than that of diesel engine generator sets and the other technology using natural gas, i.e. gas

engines. The project aimed at showcasing the market development for MCT because of its low operating cost. Hence, the MCT market growth was assumed to pull down the first cost of MCTs as more MCT units are installed.

The project document states that application of the MCT technology in the country was then still perceived to be a technical risk. Although this technology implementation was expected to pay off by itself through savings gained from lower energy consumption, it was unlikely that this technology would be utilized seriously by any enterprise as there are no documented evidence to assure the market that the savings claimed by MCT manufacturers would be attainable under the market conditions and the fuel prices in Indonesia. Besides, the industry is already familiar and has been using diesel-fueled engine generating sets with ease. Availability and accessibility of gas supply where it is needed was also recognized as another risk that would deter the industry in locating the MCT installations.

Thus, at the outset the project the technology introduction was accompanied by several barrier removing activities which would substantially reduce any risk in the adaptation of MCT implementations in close consultation with the stakeholders. Nevertheless, the project was designed with activities that will enhance local technical capacity to improve understanding and implementation of all aspects of MCT designs, financing, installations and operations; to build effective awareness programs targeted to optimize technology diffusion; to build the confidence of financing institutions to reduce risks of loans to finance MCT projects; and to develop policies and regulations to reduce the regulatory efforts of MCT project implementations, which therefore in combination would be sufficiently capable to ensure the risks mitigation as the technology would have already been accepted by the market and the project cost would be more affordable.

3.1.3 Lessons from other relevant projects (e.g., same focal area) incorporated into project design

The project design took into consideration the experiences and lessons learned from other countries in the use of MCT. It cited that with MCT applied together with heat recovery for hot water supply, the overall energy (combined heat and power or cogeneration) generating cost was lowered down at a very beneficial level of US$ 0.07/kwh in the U.S.A. At a price of natural gas of US$ 6.85/MCF. With an average natural gas cost of US$ 4.99/MCF in Indonesia in 2008, the net cost would be US$ 0.041/kwh. Average power cost in the grid then was US$ 0.07 to 0.09/kwh. On this basis, the project looked forward to demonstrating this advantage with the consideration that potential MCT users would not take this very seriously unless proven and demonstrated in Indonesia.

3.1.4 Planned stakeholder participation

The project document listed the stakeholders to be involved in the implementation of the project to include:

a) Government: Agency for Assessment and Application of Technology (BPPT), Ministry for Environment, Ministry of Energy and Mineral Resources/Directorate General of Electricity and Energy Utilization (MEMR/DGEEU), BAPPENAS (National Planning Development Agency), BP Migas, State Ministry of Cooperatives and Small and Medium

Enterprises (SMOC&SME), Ministry of Finance, and, the Center for Research and Development of Energy Technology and Electricity.

b) NGOs/CBOs: Energy Efficiency Society Forum (FKMHE), Indonesian Renewable Energy Society (METI), PELANGI Research Institute
c) Private Sector: PGN, Petamina, PLN, and more than 20 companies and enterprises with some were identified as potential demonstration hosts.
d) International organizations: UNDP and World bank/IFC

All government agencies and NGOs/CBOs participated in the project. However, in the private sector, not all the companies listed as demo hosts were able to join the project for various reasons including high project cost and unavailability of affordable and accessible gas supply.

3.1.5 Replication approach

The project activities were designed to address the interest of the industrial and commercial enterprises (ICE) sector in the application of MCT, and to ensure a wider level of acceptance and better understanding of the technology and its benefits, since this is an important key to the realization of the technology replications that are expected at the end of the MCTAP. The activities were designed to remove the financing barriers to widespread MCT project development and implementation through provision of technical and financial assistance packages to companies and project proponents interested in applying MCT to realize the MCT replication stage.

The project assumed that incentives to bring about cost reduction by increasing the local content on the MCT projects would be determined and adopted so that the MCT acquisition cost of MCT could be lessened and that appropriate pricing policy for electricity sold to the grid and for heat used for in-plant use can enhance profitability of MCT investments.

Based on the project achievements, the replication target of 200 MW was not realized due to unfavorable market and gas supply situations. The expected number of MCT project proponents did not materialize.

3.1.6 UNDP comparative advantage

UNDP in its role in country development mandates has provided full support in the project and was in a vantage position to look into the sustainability and market development and other related areas of development and long-term national planning that encompasses energy, environment, industry and other relevant program areas.

MCTAP has proven to be another very relevant EE project, manifesting very strong UNDP comparative advantage as an Implementing Agency for GEF projects. UNDP links MCTAP effectively with other similar EE and climate change projects and interventions consistent with United Nations Development Assistance Framework (UNDAF) and the Country Assistance Program (CAP) for Indonesia's economic development.

UNDP, in cooperation with key government and private partners, has set the stage for sectoral and institutional coordination mechanisms and the definition of clear and appropriate management arrangements for the project.

3.1.7 Linkages between project and other interventions within the sector

The project is well linked with other similar projects and interventions in the energy efficiency and industrial application sector of Indonesia. The project has worked very closely with MEMR, and other relevant agencies in the promotion of MCT technology in line with national programs on energy efficiency.

3.1.8 Management arrangements

The project's intermediate objective of providing technical support for the local MCT industry was supplemented by BPPT's activities in supporting the improvement of the local manufacturing industry. Lastly, the GOI support to the project, through the BPPT, was in terms of the management of the project activities. The project management expenses were covered by the co-financing which are mainly for the personnel and meeting costs of the PSC and PMO, as well as the office rental and travel costs of the PMO.

3.2 **Project Implementation**

3.2.1 Adaptive management

The project management continued to exercise adaptive management during the third year of the project as seen in the mid-term review of the project. The targets were reviewed and remedial measures were adopted in order to pursue the achievement of the targets in the remaining two years of implementation. However, the main factors that affected the progress of the project in achieving the objectives were primarily affected by the inability of the target companies to apply MCTs due to high price of natural gas, unavailability of gas supply, high investment cost on MCT units and inability of the demo units to perform as expected.

3.2.2 Partnership arrangements

The partnership arrangements with relevant stakeholders involved were realized during project implementation. However, the original list of enterprises that were slated to be host companies or be included in the MCT replication plan did not materialize for various reasons. In the implementation of the project in order to achieve the target of 200MW MCT application, the project has worked with a variety of partners that could become key demo MCT users, technology providers, prospective users, and policy makers.

Cooperation with PGN to install one of the MCT demo units in its natural gas off-take station in one of the national gas distribution network is very strategic, because PGN is also the lead company mandated to be the national gas distributor and gas trader. Off-take stations of PGN located in many remote areas and away from the grid electricity supply are usually using diesel power generator for their power supply. PGN agreed with the partnership arrangement and highly benefited with the use gas-fueled microturbine to replace its diesel engine generator set that has high operating cost.

Green energy-related cooperation that has existed before MCTAP project between PT. Nipress Tbk and BPPT paved the way for the company to be an MCT user for 2 demo units with drying application. Nipress has gas allocation already and the MCT is also consistent with the vision of PT Nipress as a green energy company that manufactures energy storage battery.

PT. Hikari, a manufacturer of energy saving compact fluorescent lamp (CFL) with its gas allocation also was chosen for one MCT demo unit with heating process application from electricity generated or waste heat recovery from fuel gas combustion products in a cogeneration system.

The project also pursued cooperation arrangement with associations or professional organizations related to the use of MCT, namely, the Indonesia Hotel Engineers Association (ASATHI), the Building Engineer Association (BEA) of Indonesia, and the Association of Energy Conservation Support Indonesia (APKENINDO) which proved to be very helpful in finding the potential users which will be interested in MCT application with cogeneration. Hotel Borobudur Jakarta became the fifth of the 5 MCT demo hosts which is the result of recommendations from these associations.

In addition to partnering with MCT users, MCTAP cooperated with MEMR so that energy saving policies gain a wider scope making it appropriate for the application of MCT in energy conservation efforts.

The project also collaborated with MCT technology providers that provide benefits for both parties. Technology providers make the latest information about the MCT application available to MCTAP, while the MCTAP provides the technology providers the means to promote and implement their MCT replication plans through the demonstration activities.

3.2.3 Feedback from M&E activities used for adaptive management

The project followed the monitoring and evaluation scheme as designed in the project document and was able to use relevant information in the management of the project towards completion by end of Year 5.

3.2.4 Project Finance

In summary, **Table 1** presents that overall project finance realized compared to what were planned in the Project Document.

Table 1: Realization of the Project Finance and Cost Sharing (in '000 US$)

	Total Committed (USD)	**Actual Realized as of Year 5***	**% Realized**
Allocated Resources			
GEF & UNDP	2,587,300	2,491,900	96%
Co-Financing			

	Total Committed (USD)	Actual Realized as of Year 5*	% Realized
Government	2,741,000	4,531,453	165%
Private Sector	12,592,000	480,659	4%
Sub Total	15,333,000	5,012,112	33%
TOTAL	**17,920,300**	**7,504,012**	**42%**

***Project closure extended until June 2014.

At project closing on June 30, 2014, the project has incurred US$ 2,491,900 out of the allocated US$ 2,587,300 GEF funds or 96% expenditure level.

The TE Team observed very low realization (at 33%) of the co-financing commitments which were made during the PPG stage. The bulk of unrealized commitments were in the planned private sector's demonstration and replication of MCT installations that did not push through due to various reasons and barriers as discussed in this TE report. However, government co-finance is realized up to 165% because BPPT and MEMR (DGEEU) have several programs of energy efficiency that are also in line with the project objectives and actively support the MCTAP goals.

a) GEF Funding

The details of the GEF fund expenditures are seen in **Table 2**.

Significant variances are observed in Component 6 (Technical Support for Local MCT Industry) where only 53% were spent out of planned budget activities. The expenditures for Project Management exceeded the budget amount at 215%.

Table 2: Details per Component of GEF Fund Expenditures

Activity	Actual Disbursement Year 1-3	Actual Disbursement Year 4-5*	Total Amount disbursement	Total Available Budget	Percent spent
Comp. 1 : Technical Assessment & MCT Application Development	153,188	61,253	214,441	250,700	86%
Comp. 2 : MCT Demonstration & Market Development	993,112	58,698	1,051,810	1,060,500	99%
Comp. 3 : Technical Support for MCT Financing	203,481	20,291	223,772	274,100	82%
Comp. 4 : Policy & Institutional Support	214,872	20,285	235,157	263,000	89%
Comp. 5 : MCT Promotion Activities	300,900	69,242	370,142	348,000	106%

Activity	Actual Disbursement Year 1-3	Actual Disbursement Year 4-5*	Total Amount disbursement	Total Available Budget	Percent spent
Comp. 6 : Technical Support for Local MCT Industry	112,700	34,162	146,862	275,000	53%
Project Management	186,795	62,921	249,716	116,000	215%
GRAND TOTAL	**2,165,048**	**326,852**	**2,491,900**	**2,587,300**	**96%**

*****Project closure extended until June 2014.

b) Co-Financing

The details of the co-financing contributions are seen in **Table 3**.

Significant variances are observed in the unrealized commitments in the 19 companies from the private sector in MCT installations for the technology demonstration and initial stage of replication. New arrangements have to be made in order to replace the companies who were not able to participate in the project.

Table 3: Details per Contributor of Co-financing

Contributor	Classification	Committed Amount during PPG (US$)	Actual Cumulative Co-Financing as of Year 5 (US$)	% Realized
GOVERNMENT				
Previous Commitment				
BPPT (BBTE)	Government Agency	2,241,000	3,627,033	162%
DGEEU	Government Agency	500,000	154,556	31%
New Commitment				
PGN MRS Palembang Demo site	Government Agency		744,059	
Bank Indonesia	Government Agency		5,805	
Sub Total		**2,741,000**	**4,531,453**	**165%**
PRIVATE SECTOR				
19 Privated Companies Committed to co-financing MCT demo but differed decision	Private Sector	12,592,000		
New Commitment				

Contributor	Classification	Committed Amount during PPG (US$)	Actual Cumulative Co-Financing as of Year 5 (US$)	% Realized
PT. Hikari *)	Private Sector		67,320	
PT. Nipress *)	Private Sector		131,128	
Borobudur Hotel *)	Private Sector		53,842	
PT. Tridinamika Jaya	Private Sector		19,022	
PT. Solusi Mitra Integrasi Teknologi (SMIT)	Private Sector		12,500	
PT. Turbec	Private Sector		163,043	
PT. Serba Dinamik Indonesia (SDI)	Private Sector		33,804	
Sub Total		**12,592,000**	**480,659**	**0.04**
NEW CO-FINANCING PARTNERS				
International Organization (IFC, Eco Asia-USAID, SMBC, UNDP/BRESL)	Private Sector		30,835	
Associations (METI, ISTN, Moslem Association for Climate Change Action)	Private Sector		776,445	
Sub Total			**807,280**	
Grand Total		**15,333,000**	**5,819,392**	**38%**

Government co-finance is realized more than expected in the ProDoc, because BPPT has contributed more through its parallel energy efficiency program about cogeneration that also supporting MCTAP activities.

Significant variance of private sector co-finance in unrealized commitment of 19 companies is due to lack of gas supply on company site, and thus a new arrangement has to be made to replace those companies.

3.2.5 Monitoring and evaluation[1]*

The standard UNDP-GEF M&E process was adopted by the project during the design stage. During the project implementation, the M&E system that was adopted was implemented through the quarterly reporting, the Annual Progress Report (APR), the Project Implementation

[1] * To be rated as required in the UNDP-GEF Terminal Evaluation Guide by Evaluation Office 2012 using a six-point rating scale: 6: Highly Satisfactory, 5: Satisfactory, 4: Marginally Satisfactory, 3: Marginally Unsatisfactory, 2: Unsatisfactory and 1: Highly Unsatisfactory

Review (PIR), Tripartite Review (TPR), etc. The system has strongly supported project monitoring and detecting problem areas and concerns that need to be addressed and to provide action plans.
The Mid-Term Review (MTR) was conducted in Year 3 and has assessed the MCTAP implementation taking into account the status of the project activities and outputs and the resource disbursements made up to December 31, 2011.

The UNDP Regional Technical Advisor (RTA) for Climate Change in the Asia-Pacific Region and UNDP Indonesia CO Program Manager have very effectively provided periodic oversight in implementation and check-ups on efficiency for inputs, work schedules and other required actions vis-à-vis the expected outputs by seeing to it that the implementation has been progressing according to plan. They have provided ample guidance to the PMO regarding the aforesaid implementation issues.

**Rating: 5 - Satisfactory*

3.2.6 UNDP and Implementing Partner implementation / execution coordination, and operational issues (*)

The project implementation, coordination and operation was observed to be effective and following the norms expected in nationally-executed project. The BPPT and UNDP Indonesia Country Office in close coordination with the UNDP RTA have implemented the project in active consultation with all project stakeholders keeping watch on the mitigation of the identified risks mentioned above as well as the overall market situation and government priorities.

**Rating: 5 - Satisfactory*

3.3 **Project Activities and Results (*)**

3.3.1 Overall activities and results in Components

Component 1: Technology Assessment & MCT Application Development

The project identified more than 8 MCT products in the world. But with the capacity requirement of gas microturbines to fit the project scope to be smaller than 1MW, only four brands were identified: Capstone (USA), Turbec (Italy), Ener-Core (USA) and FlexEnergy (USA) with their local authorized distributors in Indonesia. It required that the MCT product should have models for possible demonstration and technology transfer that have operating examples or case studies in actual industrial applications.

On the technology supply side, the technology assessment and feasibility study conducted by the project depended on limited literature and case study applications in foreign countries. The study recommended the Capstone turbine to be used as the MCT demo unit to test its application in the Indonesian industry. The project also signed an MoU with Turbec (represented by PT Benua Green Energy in Indonesia) to be involved in the MCT market development efforts in Indonesia.

On the power demand side and MCT application, MCTAP also conducted a study of the existing cogeneration applications in Indonesia to determine how MCT with the combined heat and power (or cogeneration) applications can be adopted in Indonesia. The commercial sector (such as in Summarecon Serpong Mall and Grand Indonesia), the hospitality sector (such as hotels Pullmann, Gran Melia, Park Lane) and the industrial sector (such as in Argo Pantes, Amrita Indah Otsuka, Panarub, Panasonic) and other similar enterprises were included in the target companies.

On the fuel gas supply side, the project also coordinated with PGN on the development of a map of existing plans for the development of the gas supply networks in Indonesia in order to determine the availability of the fuel to support cogeneration projects using MCT. PGN's R&D Division also became a member of the Project Board which was viewed to be an opportunity to closely coordinate with PGN the gas supply requirements of the targeted MCT replication. Another strategy was to involve PGN's gas marketing division along with its strategic business unit (SBU) on the possibility of MCT applications in PGN gas clients. MCTAP also includes the PGN in any of its road show and promotional activities with the industrial gas customers. Through these strategies, the preparation of a national map of potential MCT applications and gas supply points to be facilitated by the PGN resulted to a general map only. The project had difficulty in obtaining an overall picture of the existing and planned gas development and potential customers because the gas fuel supply agreements are confidential regarding sharing of customer information. This affected the plan to have a more detailed map to guide the market development of MCTs.

In the course of project implementation, the Project has experienced risks related to the natural gas fuel supply for industries and commercial establishments in Indonesia, greater than what were expected during the project planning stage in 2008. For instance, during the 8 MCTAP road shows conducted, targeted gas customers presented difficulties in securing gas supply for their projects. Aside from the supply concern, gas prices increased significantly from the initial assumption of US $ 5.5 / MMBTU to $ 10-12 USD / MMBTU thus aggravating the economic feasibility calculations on MCT application. Some companies postponed to install their planned MCTs, e.g., PT. Winner Sumbiri Knitting which has Turbec microturbine in factory storage.

Because of said situation, MCTAP explored alternatives to natural gas as a fuel such as biogas. It conducted surveys and studies on four landfill sites including Bengkala Bulelelen in Bali, Banda Aceh Gampong in Java, Supit Urang in Malang and Cipayung in Depok. It also conducted a study of applications of MCT with gasified POME fuel and coal. With the issuance of Feed-in Tariff for electricity generated from municipal wastes, the MCT application opportunities from these possible alternative fuel gas sources appeared to be interesting and promising for distributors, investors and the local government.

In related effort to strengthen the capability of local personnel in the technology assessment of CHP systems, MCTAP conducted four intensive training activities including: (a) in America for a project official; (b) in Singapore for 4 participants; (c) in Indonesia for an operation and maintenance training on MCT C65 for 25 people and (d) in each location of the MT demo units (PT Nipress, PT Hikari, PGN and Hotel Borobudur).

Component 2: MCT Demonstration & Market Development

With successful demonstration activities in industrial and commercial MCT application in Indonesia, it was hoped that market development will be accelerated. Based on the results of assessments done in Component 1, the project decided to acquire 5 units of Capstone microturbine units: 2 pieces of 65 kW (C65) and 3 pieces of 30kW (C30) MCTs in mid-2009. In mid-2010, the project purchased 2 units of gas compressors and a Heat Recovery Unit (HRU) to be coupled with the two units of C65 microturbines to complete the required cogeneration systems. As an incentive, the scheme offered to the demo host companies was that if they utilize the MCT systems in their operations, the MCT demonstrations will be evaluated for possible grant award of the equipment to the user at the end of the project.

Selection of enterprises for the 5 demo application of the MCT units became the focus of the initial project implementation through road shows, events, site visits, meetings, etc. with potential users in cooperation with the demo unit microturbine distributor (Capstone) and with the fuel supplier (PGN). There were 40 potential demo hosts in 9 industry sub-sectors, including: oil & gas (Pertamina); chemical (Nipress and Panasonic); hotel (Horizon, Parklane, Pullmann, Sahid, Borobudur Hotel, and Gran Melia); malls (Mall Serpong and Summarecon); lighting (Hikari); fuel supply (biogas from Pome and coal gasification); tourism (SariAter); gas off-take (PGN station); and food (Nutri food). In addition to performing FS for the demo application of the MCT units, the project also evaluated the feasibility for MCT application opportunities in landfill gas landfills in Banda Aceh, Malang, Depok and Bali.

By the end of the project, the project has installed the 5 MCT demo units with the corresponding the applications and operational data:

Demo Sites, Capacity and Cogen Application[/*]	Operations and energy output applications	Delivery of required EE output
1. PT. Hikari, Jakarta (1 x 65 kWe unit); Direct heating for drying CFL bulbs manufacturing	• Operational 8 hrs/day, 5 days/week; underutilized capacity • 50 kW(e) power output: connected to the PLN grid and 54 kW(th) output for drying CFL bulbs	• Capacity factor is low because factory production is not optimized to match the MCT designed loading requirements used for direct heating for 54 kW(th) out of the 136 kW(th) potential. Based on energy efficiency calculations on the effective capacity used, the efficiency is 51%. However, on the total system, the untapped 82kW(th) can still be utilized for greater energy savings and GHG reduction.
2. PT. Nipress, Bogor (2 x 30 kWe units); direct heating for lead-acid battery production	• Operation was 24 hrs/day; but was stopped after about 1 year operation due to faulty internal compressor which is non-repairable • MCT1 C30 supports a dryer (curing process) facility equivalent upto max 34 kW (th), while recoverable heat	• MCT1 operates at 66% efficiency and the MCT2 is at 70%; but efficiency can still be improved if production is optimized and additional conduits can be connected to the other drying machines to match the MCT designed loading requirements

Demo Sites, Capacity and Cogen Application[/*]	Operations and energy output applications	Delivery of required EE output
	from the MCT2 C30 thermal is equivalent to 63 kW(th) for flat drying process	
3. PGN Talang Duku, Palembang Metering Gas System (1x 30 kWe unit); Absorption chiller for airconditioning	• Operational 24 hrs/day; parasitic load of absorption chiller is high (because there was no available smaller chiller capacity to match the waste heat output • 22kW(e) was used for electricity supply for building and surrounding area and 25.8 kW(th) was used for an absorption chiller for cold water supply.	• Total efficiency = 57% • Need to balance to right sizing of the MCT and heat recovery system with the existing higher chiller capacity
4. Hotel Borobudur (1 x 65 kWe unit) Water heating for hotels	• Operational; 24 hrs/day; after 3 months operation, operation stopped for maintenance. Service provider restored system operation last June 18, 2014. • Aside from power generation, heat recovery for hot water supply is equivalent to 89 kW(th).	• Energy efficiency is calculated at 64%; the project suggested that the user should enter into a preventive maintenance service contract with MCT supplier

[/*] Estimated CO_2 emission is 0.16 – 0.18 kg/kwh.

As seen in the above table, each demo unit had different process application and the evaluation of efficiency performance resulted to different levels with regards to the matching of available power and thermal capacities of the MCT and the thermal recovery load. The time involved for the design, installation and commissioning of MCT demo units took 6-8 months because of a number of preparatory activities: technical assessment and design (gas pipelines, pipe thermal application, electrical and thermal utilization, etc.); calculation of techno-economics, investment counterpart for project proponents and savings opportunities; preparations for civil building permit; licensing and installation of a gas pipeline network; and approval by management.

During the execution of the demo projects, several problems were encountered in the MCT demo units, namely:

1. Installation must be certified by the PGN Pipeline administrator (as learned from the case of PT. Nipress, delay MCT operation up to 8 months).
2. Derating engine that reduced significantly the kW output
3. Voltage drops below 360V from PLN supply caused frequent unexpected trippings as in the case demo units in PT. Hikari and in Nipress.
4. Determining the MCT demo unit locations has to satisfy management policies, making the process quite complicated and the problems cannot be resolved quickly.
5. Some technical problems were difficult and took longer time to resolve because the actual service provision has to depend on the MCT distributor (Capstone) company policy (warranty, insurance, etc.) which are more applicable to commercialized units.

6. Lack of local technical support for the product demo unit (Capstone).

The results of the energy audit calculations (on energy saving and GHG emissions) at all four MCTAP demo locations were monitored and analyzed for further improvement and used for promotion, standards development for MCT application and MCT market development plans. These observations and operating experience were used as basis for technical, economic and emission assessments and were presented in project brochures such as "MCT di Indonesia", compiled in the MCT database and promoted through: events, newsletters, website, magazines, and potential client discussions.

Component 3: Technical Support to MCT Financing

As designed, the project expected that installation of more MCT capacities will be supported by financing under the MCT replication program. This development stage would have less obstacles after successful demonstration and satisfactory technical performance of the MCT demo units. However, the replication stage did not take off during the project implementation period. This was supposed to be the basis for a sustainable financing arrangement with banks and funding institutions. At the beginning of the project, it was expected that the need for financing will be met while the project provides technical support to companies wanting to avail of financial assistance in anticipation of energy efficiency and GHG reduction benefits through the application of MCTs. The project though has geared up for investment opportunities in the industrial and commercial sectors which should have needed intensive capacity building for financial institutions. But because of the change in the market situation that affected MCT replication, the program remains to be affected by: relatively high initial investment for MCTs; lack of appropriate funding scheme to be applied to the concept of energy efficiency project in the Indonesian energy economics context; undetermined investment opportunities in the energy efficiency sector; and slow entry of financial institutions to support energy efficiency projects.

In mid-2009, MCTAP capacity building activities were held for the banking and financial institutions which included a Seminar and Workshop on "Energy Efficiency through Cogeneration -- an Opportunity for Financial Institutions". This event was attended by 11 banking institutions and 2 leasing companies to promote MCTAP. Based on identified problems and other inputs from the banks, it showed that there was a need for Bank Indonesia (BI) and MCTAP to conduct capacity building and identify any gaps in funding for energy efficiency schemes. The banks perceive that the basis for collateral for financing EE which included MCT application is still not enough. This has led to an investment guarantee agency created for EE projects in Indonesia.

In encouraging the establishment of this institution, a more intensive coordination was carried out in collaboration with the Fiscal Policy Office (BKF), Ministry of Finance, EBTKE of MEMR, banking and several similar projects (such as the ones supported by DANIDA, ICED, etc.). The Project also conducted promotion and capacity building activities to firms that are likely to be the ESCOs in Indonesia, in cooperation with APKENINDO.

Among other activities which were conducted to encourage EE financing in the sector include: (a) meetings with Indonesia Clean Energy Development (ICED)-USAID about the opportunities of EE project financing, (b) meetings with REX-Asia Capital to have benchmarked on the EE project

financing programs in Singapore; (c) participation in the "Sustainable Energy Roundtable Programs" conducted by EINCOPS – DANIDA to conduct capacity building on the MCT program to other EE programs, as well as to get inputs and information on the EE project financing options in Indonesia; (d) in partnership with EBTKE/DGNEREC, BPPT-MCTAP conducted the Focus Group Discussion (FGD) on the "Financing Energy Efficiency Project, an Opportunity" which was attended by relevant stakeholders, such as: EBTKE/ DGNEREC, BKF-Ministry of Finance; BNI 46; Pusat Investasi Pemerintah; ESCO PT.EMI; APKENINDO and the BRESL Project; (e) discussion with DJEBTKE and BKF in identifying fund sources and establishment of financing plan for EE projects, including MCT; (f) participation in the Clean Energy Investor Forum which was held by the Private Financial Advisory Network to identify opportunities for building partnership with potential investors interested in clean energy projects; (g) meetings with ADB - Indonesia EXIM Bank project to assess the possibility of MCT projects to be financed through their energy efficiency financing programs; (h) meetings with PT. Indonesia Infrastructure Finance (IIF), a subsidiary of PT. SMI to promote the MCT financing; and (i) promoting opportunity of financial investment for landfill power generation to microturbine distributors and stakeholders.

In 2013, the coordination and cooperation with other agencies has produced some outcomes, in which BKF allocated USD 50 million to support EE programs in Indonesia for implementation starting in 2014. MCTAP also entered into a strategic cooperation agreement with ICED-USAID, in which the two programs can encourage each other EE projects in Indonesia. The details of the recommended funding scheme for MCT are seen in **Annex E**.

Component 4: Policy & Institutional Support

This component is expected to develop and adopt policies and regulations that will support the MCT program development and market stimulation process through the conduct of several policy studies, conduct of workshops, development of incentive packages, inter-agency coordination, setting up of monitoring system, capacity building and institutional development on new policy implementation and organization of an independent association of MCT retailers and manufacturers.

Among the significant outputs of the component are: draft policy recommendation to provide financial support to energy efficiency (EE) projects, regulations concerning energy management that include cogeneration systems like MCTs, policy recommendation from head of BPPT to Bappenas to encourage and incorporate cogeneration system in the Mid-Term Development Plan 2015-2019, and conduct of energy audits in MCT demo sites regarding energy savings and GHG reduction benefits.

Component 5: MCT Promotion

At the beginning of the project, the project team collected both technical studies and other supporting materials that can be used for promotion of MCT as a new technology in Indonesia. The promotional materials developed by the project included: technical support on MCT, conduct of MCT application case studies, calculation on application demo units, support policies, financial support, readiness of the local components and engineering support. The promotional tools included: MCTAP Database Communication System (internal and external), brochures, video presentation, presentation tools, newsletter, demo unit publication tools, and mail

communication tools. The cooperation arrangements done by the project in line with promotion were with: PGN on customer data and the availability of natural gas, MCT distributors for market development, financial institutions for financial support, government agencies for supporting policies (EBTKE, KLH, etc.) and institutions and similar projects to encourage the application of MCT. The other promotional activities include: road shows and workshops, exhibitions and events, Database Communication Center, events combined with other institutions, MCT distributors, other projects etc., personal approach to the target segment, publication in both print and online media, interactive talk shows and gathering of energy efficiency activists.

The project developed the www.mctap-bppt.com web site which is now attached to the BPPT website (from a project-based independent website) for better sustainability and maintenance. The new MCTAP database and website has been visited 2,865 times by 1,996 visitors up to 2013, with visitor satisfaction rate reaching 90%. In terms of promotional events held, the project conducted the following number of events: 3 independent by MCTAP, and in cooperation with other parties – viz, PGN (3), BPPT (8), EBTKE (5), other agencies (4) and other promotions with radio talk shows (2), print media (6), and on-line media (14). The project always involves local retailers and manufacturers and representatives from the financial institutions in various promotional activities.

To strengthen cooperation with the MCT distributors/retailers in Indonesia, MCTAP held a special meeting which was attended by representatives from turbine technology distributors in Indonesia (Capstone, Turbec, Opra, Kawasaki, etc.) which resulted to an MOU with Turbec on cooperation in MCT market development in Indonesia.

In support of development of business plan and models, MCTAP has involved MCT manufacturers in Indonesia in the promotion of MCT and discussions with prospective clients which included the following: (a) PT. Serba Dinamik Indonesia designing schemes rental business marketing with MCT, (b) PT. SMIT formed a partnership with a subsidiary of PGN and sold in package of energy supply, (c) PT. Benua Green Energi selling energy supply package, and (e) PT. Maxi Utama Energi support to get distributorship of microturbine of Ener-Core and micro-steam turbine Technopa.

Component 6: Technical Support for Local MCT Industry

The project has targeted a decrease in MCT price by 25% through the development of local components of MCT. Components referred to herein may be a component of microturbine cogeneration systems, particularly in the heat recovery application side in cogeneration which includes: absorption chiller unit, battery microturbine, heat recovery unit, thermal piping, gas compressors and organic Rankine cycle systems.

In the process of identifying the local components for local production, the project conducted several activities, among others: (a) discussions with PT. Nipress, Tbk (one of the project proponents) to analyze the possibility of making battery MCT units (especially with the Capstone demo units), (b) meetings with BTMP-BPPT to discuss the technology of absorption chiller as one of the cogeneration systems equipment, as well as to identify the possibility of modifying the components and being locally made, (c) meeting with P3TKEBT to explore use of biogas

(landfill gas) fuel with locally developed organic Rankine cycle engines, (d) introducing of MCTAP to PT. National Turbine Propulsion - Bandung as one of national turbine service company as well as (steam) turbine manufacturer, (e) research focusing on the gas conditioning and sulfur removal in landfill gas system to support proper fuel for microturbine with Environment Center BPPT. The project also regularly met with MCT technology providers in Indonesia to discuss the possibility modifying or making some parts of microturbine in Indonesia and also discuss marketing opportunities.

MCTAP has also produced documents on information for the installation of MCT and SOPs based on the case studies in the demo installation process and operation of MCT units in Indonesia which includes: information on applications loading of MCT and evaluation of cost saving applications of MCT; and information on MCT application and installation phases with direct thermal heating applications (studies in Hikari and Nipress), HRU for hot water applications (Hotel Borobudur) and applications with absorption chiller in PGN. The project also developed information for MCT application with the direct use of thermal heating, hot water use by using the HRU and the absorption chiller applications, in accordance with the conditions in Indonesia. All above information are valuable lesson learn for setting up related standards later.

The project also strengthened the capability of the local operators of the demo units by providing special training on MCT operation and maintenance and on the standard procedures for data gathering and reporting. The project also made way in identifying and supporting local producers of the waste heat application side such as PT. Waru Teknikatama for the heat recovery unit (HRU) and PT. Benua Green Energy for the absorption chiller for the MCT demonstration in the PGN Talang Duku.

3.3.2 Project actual versus expected results

In the following page, **Table 4** presents the detailed results of the actual outputs as compared to the expected outputs as indicated in the MCTAP ProDoc.

The summary of ratings of accomplishment in achieving various Components' outcomes is shown below:

Component 1: Technical Assessment & MCT Application Development	MU
Component 2: MCT Demonstration & Market Development	MU
Component 3: Technical Support for MCT Financing	HU
Component 4: Policy & Institutional Support	MU
Component 5 : MCT Promotion Activities	S
Component 6 : Technical Support For Local MCT Industry	MS
Overall Project Rating	**MU**

Table 4: MCTAP Rating in the Achievement of Outcomes and Outputs

PROJECT GOAL: Reduction of the growth of GHG emissions from the MCT deployment in the ICE sectors in Indonesia.						
GOAL/OBJECTIVE/ OUTCOME	**Performance Indicator**	**2008 Baseline**	**End of Project Target**	**2014 End of Project Status***	**Terminal Evaluation Comments**	**Rating[2]**
Project Objective: Removal of barriers and project cost reduction that inhibit the adoption of MCT implementation in the ICE sectors	GHG emissions reduced by MCT, million tons of CO_2	0	1.528 million tons if replication was realized	584.86 tons	Project achieved 0.038% because replication was not realized due to various reasons	HU
	Cumulative energy savings from ICE sector, million BOE	0	3.2 million BOE	773 BOE	0.024% (same comment about replication not realized)	HU
	MCT installed, MW	0	· 200MW (100 MWe + 100 MWth)	220 KWe + 440 KWth	0.33% (same comment about replication not realized)	HU
	Average % reduction of MCT cost	No data	· 25%	Nil	MCTAP has no significant influence yet on MCT cost structure, because the	HU

[2] **6**: **Highly Satisfactory (HS):** The project had no shortcomings in the achievement of its objectives in terms of relevance, effectiveness, or efficiency; **5: Satisfactory (S):** There were only minor shortcomings; 4: **Moderately Satisfactory (MS)**: There were moderate shortcomings; 3. **Moderately Unsatisfactory (MU)**: The project had significant shortcomings **2**. **Unsatisfactory (U):** There were major shortcomings in the achievement of project objectives in terms of relevance, effectiveness, or efficiency; **1**. **Highly Unsatisfactory (HU):** The project had severe shortcomings.

PROJECT GOAL: Reduction of the growth of GHG emissions from the MCT deployment in the ICE sectors in Indonesia.						
GOAL/OBJECTIVE/ OUTCOME	**Performance Indicator**	**2008 Baseline**	**End of Project Target**	**2014 End of Project Status***	**Terminal Evaluation Comments**	**Rating[2]**
					cost is predominantly by technology price which is setup by principal	
Outcome 1: Thorough understanding and appreciation of technology options and their environmental impacts of MCT systems by ICE sector, government and other stakeholders	No. of MCT applications identified and assessed for techno-economic and market feasibility	0	· 10	15 [3]	150%. 15 application areas of MCT-identified and assessed for the techno-economic and market feasibility	HS
	Total capacity of installed MCT planned to be developed and implemented in ICE sector	0	· 200 MW	6.9 MW[4]	3.5 % (Same comment about replication not realized)	U
	Outcome 1 Rating					**MU**

[3] 15 cases studied: Gran Melia Hotel, PT. Hikari, PT. Nipress., PGN (National Gas Company), Park Lane Hotel, Hotel Borobudur, PT. Panasonic, landfill Gampong Jawa, Buleleng landfill Bali, landfill Supit Urang Malang, landfill Depok, PT Nutrifood, Pullman Hotel, Sari Ater Resort and Lucky Print.

[4] Hotel applications: (5 x 65kWe) + (5 x 130kWth); General Industries: (855kWe) + (1710kWth); Oil & Gas: 30kWe + 60kWth (PGN Talang Duku); Landfill: 160kW (Aceh) + 31kW (Buleleng) + 1900kW (Malang) + 1180kW (Depok)

PROJECT GOAL: Reduction of the growth of GHG emissions from the MCT deployment in the ICE sectors in Indonesia.						
GOAL/OBJECTIVE/ OUTCOME	**Performance Indicator**	**2008 Baseline**	**End of Project Target**	**2014 End of Project Status***	**Terminal Evaluation Comments**	**Rating[2]**
Outcome 2: Establishment of a critical mass of demonstration projects that will provide detailed information of MCT operations, energy savings and environmental impacts to enterprises interested MCT systems from ICE sectors	Total capacity of MCT demonstration projects implemented and operational	0	8MW[5]	220 kWe + 440 kWth	8.25%.	U[3]
	Total capacity of installed MCT by enterprises, MW	0	· 200 MW	220 kWe + 440 kWth	0.33%	HU
	No. of comprehensive technical and economic feasibility evaluation of different engineering designs and applications of MCT demonstrations to meet market requirements	0	· 10	7 [6]	70%	S
	Improvement in the overall specific energy consumption in the ICE sector	No data	· 5% based on Year 1 Data	Not determined[7]	0%	HU
	Outcome 2 Rating					**MU**
Outcome 3: Availability of financial and institutional support to encourage enterprises from ICE sector to adopt	No. of banks/financial institutions offering loan/credit facilities for EC&EE projects MCT projects by end of project	0	· 12	0 [8]	0%	HU
	Total capacity of EC & EE and MCT projects assisted through bank financing, MW	0	· 200 MW	0 MW	0%[9]	HU

[5] Original target was 8 MW, but with budget consideration and mid-term status of the project the total demo capacity was scaled down to 660 KW (electricity and heat).

[6] Sectors: Hotel, general industries, landfill biogas, mall & buildings, food & beverages, oil & gas, tourism.

[7] The % improvement in energy consumption was not determined because there was no available baseline data in SEC in sectors which applied MCT. Nevertheless, around 454 MWh was estimated to be the total cumulative energy saving from MCT demo installed until June 2014.

[8] There were 11 banks and 2 leasing companies that have been informed about EE benefits through MCT application. There are no banks offering loans/credit specifically for MCT yet on commercial basis. MCTAP funding scheme has been developed to encourage the formation of EE program, together with BKF, EBTKE, banking and industry. The result is the allocation of USD 50 million to support the application of BKF EE and EC projects in Indonesia.

PROJECT GOAL: Reduction of the growth of GHG emissions from the MCT deployment in the ICE sectors in Indonesia.						
GOAL/OBJECTIVE/ OUTCOME	**Performance Indicator**	**2008 Baseline**	**End of Project Target**	**2014 End of Project Status***	**Terminal Evaluation Comments**	**Rating[2]**
energy efficient MCT systems	Total capacity of project financing agreed by MCT implementers and the bank/financial institutions, MW	0	· 200 MW	0 MW	0% [9]	HU
	Outcome 3 Rating					**HU**
Outcome 4: Promulgation of and compliance to regulations that encourage adoption of MCT systems	No. of new policies and regulations favorable to EC&EE initiatives in the ICE sector, together with policy support program implementation, developed, completed and implemented	0	· 1	0[9]	0%	MS
	Strategies and regulations on minimizing air pollution from ICE activities are developed and implemented	None	· Completed	0[10]	0%	MS
	Percentage of ICE sector which is compliant to set emission standards for MCT operations	0	· 5%	Not determined	0%	N/A[11]
	M & E for policy implementation and installation of systems MCT-adopted and operationalized in a designated agency	None		N / A	0%	N/A
	Outcome 4 Rating					**MU**

[9] O passed but there is 1 draft policy to provide financial support to EE projects in Indonesia. Other policy related outputs include regulations concerning energy management that incorporate cogeneration system in Regulation No.14- 2012 and 1 recommendation of KaBPPT to KaBappenas to encourage and incorporate cogeneration system in the Medium Term Development Plan.

[10] Energy and emissions audits have been carried out in four locations MCT). MCT emissions under the emissions standards Candy LH no.21/2008 Emission Standard Indonesian generating turbines in the audit results have been disseminated and promoted to the ministry of Environment, industry and relevant government agencies.

[11] There were 3 sectors (commercial building, general industry and oil& gas) out of 9 industrial sectors (as per MoI definition) that have applied MCT. However, compliance on emission standards in these applications has not been determined yet. Hence, there is no data to base rating.

PROJECT GOAL: Reduction of the growth of GHG emissions from the MCT deployment in the ICE sectors in Indonesia.						
GOAL/OBJECTIVE/ OUTCOME	**Performance Indicator**	**2008 Baseline**	**End of Project Target**	**2014 End of Project Status***	**Terminal Evaluation Comments**	**Rating[2]**
Outcome 5: Enhanced awareness of the public and other stakeholders on the efficient use of MCT for EC&EE practices in ICE sector	MCT Information Center operational	None	· Completed	Completed[12]	100%	S
	Fully functioning database and information exchange services programs operated by BPPT	None	· Completed	Completed[13]	100%	S
	Percentage of satisfied clients in ICE sectors served by the MCT Information Centre	0	· 5% each year starting Year 2	90%[14]		S
	MCT energy performance rating scheme completed and implemented	None	· Completed by mid Year 2	Completed[15]	100%	S
	Outcome 5 Rating					**S**
Outcome 6: Improved local vocational, technical; and	Total capacity of MCT installed	0	200 MW	660 kW	0.33%	HU
	No. of certified developers in each year MCT	0	· 8	0	0% [16]	HU

[12] MCT Information Center through www.mctap-bppt.com is regularly being maintained and updated. The stakeholders and public are continuously informed on the results of the status and performance of the application of MCT demo units. MCTAP website has been receiving good response. During July 2013 – June 2014 period, it was visited by 1,873 users in 2,479 sessions based on Google Analytics.

[13] MCTAP Brochures have been prepared and published. Databases were created with a standalone server system and maintained with support by BPPT directly.

[14] Positive response was over 90% for the websites accessed about MCTAP and same for evaluation of MCTAP publication.

[15] Energy Performance rating has been created and published as a basis for the application of MCT based energy audits, financial and emissions in four demo unit locations. For example, MCT energy performance (in terms of Specific Fuel Consumption) for MCT installed in Hotel Borobudur was estimated that SFC is 12,723.6 kJ/kWh when Cogen is not included and the SFC was improved to be at 7,989.4 kJ/kWh when Cogen is included.

[16] There is no certification body established for MCT in Indonesia yet. However, there are trained personnel for the MCT application in each distributor company. Under MCTAP project, there is one project personnel who was certified for MCT application through the technology provider.

PROJECT GOAL: Reduction of the growth of GHG emissions from the MCT deployment in the ICE sectors in Indonesia.						
GOAL/OBJECTIVE/ OUTCOME	**Performance Indicator**	**2008 Baseline**	**End of Project Target**	**2014 End of Project Status***	**Terminal Evaluation Comments**	**Rating[2]**
managerial capacity to manage and sustain operations of MCT for EC&EE practices in the ICE sectors	Minimum no. of trained local equipment manufacturers producing equipment and / or components for the MCT	0	· 2	2[17]	100%	S
	Minimum no. of trained local engineering firms registered and profitably engaged in the MCT industry providing technical support services	0	· 2	2	100% [18]	S
	A set of manufacturing standards for systems and components of MCT-adopted by industry	None	· Completed by Year 3	3[19]	100%	S
	Outcome 6 Rating					**MU**
	Overall Project Rating					**MU**

[17] This includes 1 local manufacturer for MCT HRU unit and 1 local manufacturer for absorption chiller unit. It was noted that 1 of 2 cogen manufacturers was evaluated last year, namely PT. Metalindo Prima Engineering, to have successfully manufactured heat exchanger for microturbine cogeneration.

[18] There is one among local engineering firms as MCT providers, namely PT. Benua Green Energi that has been successful in integrating design and installation of an absorption chiller to recover the microturbine waste heat. The heat exchanger needed here is locally designed and manufactured by PT. Metalindo Prima Engineering.

[19] Standard application of MCT and installation phases of the application in direct thermal heating (studies in Hikari and Nipress), HRU for hot water applications (Hotel Borobudur) and application in absorption chiller in PGN demo site.

3.3.3 Factors affecting the achievement of expected results

In the discussion of project achievements with the stakeholders, the TE Team observed the following factors and related market situation throughout the project implementation which have affected the achievement of expected project results:

h) Development of the market for gas-fueled microturbine with cogeneration technology (MCT) application as a new technology system in Indonesia took longer than was expected during the project design.
i) PGN natural gas fuel price rose to more than $ 10/MMBTU compared the gas prices which were then below $ 6/MMBTU when the MCTAP project started to select companies for MCT demonstration based on the feasibility studies conducted.
j) PGN plan for the development of transmission and distribution networks to consumers including network Kalimantan-Java did not fully materialize to reach targeted market areas for MCT.
k) PGN's present policy is to give priority to supply gas produced for power and fertilizer production. Government encouragement for gas supply conversion to CNG fuel for the transportation sector has also limited the supply of gas to the power generation sector. As a result, gas allocation quotas for industrial needs (even for energy efficiency projects such as cogeneration), has been significantly limited.
l) The government subsidy for power sold through the electricity grid makes the grid power cheaper than that produced by industrial independent power producers using gas microturbines. The cogeneration application as an energy efficiency improvement alternative has been affected by the said energy price disincentive.
m) Consequently, the maintenance and after-sales service costs become high for the present small number of MCT users (as in a chicken-and-egg situation and unrealized economies of scale). The greater population of more mature technologies (e.g. diesel engine and gas engine generators) has continued to be the trend and has also been a material consideration for prospective users before buying gas microturbine for cogeneration.
n) Gas-fueled microturbine technology is still quite expensive at capital expenditure at $ 2,000 - $ 3,000 / kW (e) compared to diesel engine ($ 300 - 500) and gas engine ($ 700 - 800). Potential users still view this as a hindrance in MCT acquisition despite the knowledge that MCTs will have lower total energy generating cost when coupled with heat recovery systems.

Thus, at the end of the project, the following risks and assessed risk level were identified by the TE Team to exist based on the above situation:

- Limited number of microturbine technology providers (Moderate)
- Lack / limited gas supply from PGN to the potential MCT users (High)
- Delay and failure on the MCT demo units operation (High)
- Maintenance problems of the MCT technology (Risk Level: Moderate to High)
- Increasing the price of natural gas (Risk Level: High)

The Team assessed the MCT market situation with overall Risk Rating to be a High rating as elaborated below. The non-achievement of the 200MW target could be explained also by this risk situation.

a. Limited number of microturbine technology providers

At the beginning of the project, there were four MCT brands being promoted by technology providers in Indonesia: Capstone (USA), Turbec (Italy), Ener-Core (USA) and FlexEnergy (USA). Capstone microturbine was selected for demonstration because: the product was promoted as a low maintenance microturbine. Capstone has many projects and declared emission reference that are environmentally friendly. Global market for Capstone is also quite broad because it is supported by more than 60 distributors worldwide. There were also some known brands of microturbine which were either already not produced or does not have a distributor in Indonesia, such as Bowman, Eliot, Ingersol Rand, Toyota Turbine and Yanmar. Ingersol Rand's Energy Systems was acquired by FlexEnergy in 2010 to be developed as Flex Turbine. Flex Turbine was introduced for special application using low BTU fuel gas (such as landfill gas) using technology developed by Ener-Core oxidizer. In addition to the MCT manufacturers, MCTAP also communicated with the providers of gas turbine technology that have small capacities such as Kawasaki, OPRA and Vericor so that they too can develop its market in Indonesia.

However, as the project targets to promote replication of microturbines up to 200 MW of total installed capacity by developing the MCT market and drawing from the demonstration experience. If more brands are promoted and the market for MCT favorably grows, the MCT units in the market were expected to have more competitive prices.

As the project closes, in spite of the project's MCT promotion and coordination and assistance to distributors of microturbine, only three brands has remained active in Indonesia: Capstone, FlexEnergy and Turbec. The project has continued to communicate with the principals of Ener-Core (USA) which is willing and planning to develop its marketing of its MCTs in Indonesia after a cooperation and partnership arrangement is reached with local distributors.

b. Lack / limited gas supply from PGN to the potential MCT users

During the selection and site location of the MCT demo units in 2008-2009, the identified host companies had difficulty in getting gas fuel supply from PGN. Establishing this important element of the MCT market development has been challenge for the project since the fuel gas has to be distributed through its network to reach the target MCT users. PGN is not ready to neither increase the quota of gas for their customers nor receive installation for new customers since the project started. Instead of an open market approach, the project was forced to change its strategy to find PGN customers who have available quota to accommodate microturbines. This made MCT market target even smaller than previously calculated. Therefore, since the situation still persists at present, this risk is considered to have a high impact on the success of the MCT replication program, a situation that was already experienced at the outset when putting up demo unit to introduce MCTs and try to develop the MCT market.

c. Delay and failure on the MCT demo units operation

Although literature studies and technical assessments of the microturbine and cogeneration application abroad had been conducted thoroughly, the implementation of the demo units with cogeneration application was the first in Indonesia. Some of the technical issues surfaced during the actual installation of the MCT systems where additional equipment and spare parts became necessary to completely implement the microturbine cogeneration, such as the gas booster, which was required to elevate the pressure of fuel gas supply to the operating pressure of the microturbine. Among others, this was the caused by the special requirements of the microturbine fuel supply conditions.

To address the issue, the project had conducted special technical assistance to the proponents starting from the feasibility study, designing the MCT application and also providing the additional equipment to ensure success of the demonstration activities. Satisfying those conditions had delayed the installation and operation of the MCT demonstration units. Nevertheless, all the MCTS demo unit were successfully established at PT. Nipress Tbk with the total capacity of 2x30kW, PT. Hikari with the total capacity of1x65kW, PGN Talang Duku with the total capacity of 1x30kW and 1x65kW at Hotel Borobudur but with a delayed timetable.

The delay of the implementation of MCT demo was not only the caused by the technical issues, but also in the process of searching and selecting the potential proponents who were willing to host the demonstration units. Beside the special requirements of the MCT fuel, the lack of confidence from the potential users in hosting the MCT demonstration resulted to additional delay. Intense activity of capacity building through seminars, workshops and one-to-one approach had been conducted by the project to promote not only the microturbine, but also the cogeneration application.

The promotion activities seemed to work in introducing the new technology. However, the high initial and maintenance cost of the MCT seems to be another factor hampering MCT acceptance, not only in the demonstration stage but most especially in the replication activities.

d. Maintenance problems of the MCT equipment

After MCT demo units began operating, the project gathered experience and lessons related to operation and maintenance of the Capstone microturbine demo units. Although the microturbine is claimed to have less maintenance concerns than a gas engine which has more frequent maintenance periods, there were a few times the demo units tripped due to damage to some non-fast-moving parts so the turbine operation has to be stopped. The project saw the need for a better maintenance readiness so that it can reduce operational downtime, as experienced in PT Nipress demo units.

The internal gas compressor of the microturbine technology is another critical part that needs attention due to the potential risk of high cost of maintenance of this part. To overcome this, the fuel gas supply system was modified in the PGN Talang Duku demo unit so that it will no longer require internal gas compressor and find every possibility manage the cost of maintenance and repair. Preventive maintenance agreements with suppliers are seen to help address this issue.

Another possibility is for the maintenance concern to be removed from the MCT user and passed on a technology provider such as an energy supply company (ESCO) which can specialize in MCT operation and maintenance and energy supply services (electrical and thermal) to be provided by the ESCO to the MCT user. The project was originally designed to finance the formation of ESCO companies, but because of budget limitation, the project was only able to study and review the policies that are needed to support the development of energy efficiency (EE) in general where MCT belongs. The project collaborated with MEMR and Ministry of Finance to support the EE policy and to promote the availability of financing and the issuance of incentive policies related to EE, including MCT applications.

e. Increasing Price of Natural Gas

At the time the project was designed and feasibility studies were conducted, the price of natural gas was at the $ 6/MMBTU level. The current price has gone up more than $ 10/MMBTU. The increase is certainly very high risk for the development of the MCT market that uses natural gas as its primary energy. Cogeneration was hoped to alleviate this gas price concern through efficiency improvement, i.e. for the same fuel input, the MCT user can derive more benefits in terms of electricity and process heat produced in combination by recycling waste heat. However, the market prices of energy (electricity and petroleum fuel) are subsidized by the government which runs counter to the energy efficiency promotion objectives, particularly for natural gas for microturbines and other gas-fueled facilities and equipment like gas engines.

As an alternative to natural gas, the project has also been promoting the use of alternative fuels such as biogas for microturbines which can be obtained from industrial wastes, e.g. POME (palm oil mill effluent) processing and landfill gas.

The increasing trend for the natural gas price will remain in the medium to long term in its priority application in electric power and fertilizer production.

3.3.4 Relevance(*)

MCTAP is relevant to the UNDP and GEF focal areas on energy efficiency and climate change. The project was justified by the country's needs and opportunities such as forecast increase in energy demand especially in the industry and commercial sectors and the huge of natural gas reserves in Indonesia which redounds to the adoption of MCT as a viable alternative to diesel engine. Considering the synergies and benefits of MCT application with the heat recovery to attain a cogeneration scheme, the project continues to be relevant and will have an important impact when MCT partially substitutes the use of coal and oil for electricity generation and industrial process heating. While the project was not able to realize the replication targets because of fuel natural gas price increase and its unavailability and lesser accessibility at the point of demand, MCT continues to offer opportunities towards being commercially viable as alternative for electricity generation and industrial process heating/cooling as the desired increased market for MCT is expected to lower down the investment cost for MCT.

**Rating: 5 - Satisfactory*

3.3.5 Effectiveness & Efficiency (*)

The project has not been successful in achieving its expected outcomes and objectives in view of the drastic change in the actual market situation in terms of risk factors on technical preparedness, natural gas prices and accessibility to fuel supply. Nevertheless, the institutional capacity and policy support to the MCT technology development program under a more general national cogeneration program is effectively established in the long-term program of BPPT being in the lead role in Indonesia's technology innovation thrusts. However, the said market risks remain to be a concern and need to be properly managed by the government in terms of risk mitigation strategies that will involve key agencies including MEMR, PLN, PGN, MOI, MOF, State Ministry of Cooperatives and Small and Medium Enterprises (SMOC&SME), Ministry of Environment and BAPPENAS with their respective roles in the policy and regulatory aspects of the MCT under the national cogen program in the coming years. The project has several lessons learned regarding the risk management aspects and may be considered in future related activities as MCT is developed to be a included in the national program.

On the other hand, the project has met to some extent the international and national norms on efficient implementation of projects because it is fully supported by the involved stakeholders and partnership arrangements. However, the project was not able to efficiently utilize the local capacity of the proposed enterprises to be MCT demo hosts as listed in the ProDoc at the beginning because of the apprehension of the companies on the cost of MCT technology and the uncertainty in the gas price and supply. The project experienced unexpected delay in installing and operating the MCT demo units.

**Rating: 4 -Marginally Satisfactory*

3.3.6 Country ownership

The Government of Indonesia through BPPT, MEMR, MOI, MOE, MOF and other relevant agencies has continued to manifest its strong ownership and commitment in the National Energy Efficiency Program which has been supported by UNDP and GEF. The Project as a nationally-executed project has proven to be directly driven by the government through the active involvement and visionary leadership of BPPT in cooperation with the various participating agencies under its project organizational structure.

The Project has also significantly aided the Government in accelerating and integrating ongoing and planned EE program development and application of selected project partners.

The Project has also mobilized strong support from the manufacturers and the private sector as a whole in integrating the project as a country-wide initiative. The demonstration projects are funded through co-financing arrangements by the project partners. The joint efforts have pointed towards achieving the reduction of the identified barriers to MCT application in the Indonesian industry and commercial sectors.

3.3.7 Mainstreaming

The Project has started to mainstream MCT with other UNDP and Government priorities on energy efficiency as a means to mitigate climate change effects through GHG reduction.

Cogeneration technology as an EE option has been included in the BPPT and MEMR national energy efficiency (including cogeneration) program for 2015 – 2019 as well as in the overall UNDP Country Program Action Plan (CPAP) for Indonesia. While the Project has not contributed significantly yet to the GHG reduction targets at the end of the project because of the delay in the MCT replication in the industries, the Project has laid the groundwork for future activities to be mainstreamed in the national EE program of the government.

3.3.8 Sustainability and project exit strategy(*)

Considering the significant achievements in other outcomes of the Project in policy and institutional support, capacity development, technical assessment, market demonstration and promotion, the likelihood of sustaining the outcomes at the project termination will continue to be affected by the remaining risks that were discussed in Section 3.1.2 of this TE Report. As such, the TE Team believes that continuing risk mitigation measures should be discussed and comprehensive strategies adopted at the government level in cooperation with key private stakeholders.

At the minimum, the TE Team suggests the Exit Strategies for the MCTAP (please see **Annex F** for details) that focusing on the following as discussed with the Project Management and key stakeholders during the TE process:

Actions needed to be done	Details of Actions/ Roadmap
1. Further studies on other applications including combined heat and power uses in small and medium enterprises (SMEs) that can be served by MCTs	1.1. Open up new market for MCTs 1.2. Establish technical support particularly in the after-sales services for the local MCT industry 1.3. Encourage local research for MCT development on the power generation side and heat recovery side.
2. Promoting ESCOs and adopting viable business models	2.1 Adopt applicable business models by providing relevant information 2.2 Capacity building in the banking / financial institutions in developing financial packages, credit schemes and loan guarantee windows to strengthen MCT market. 2.3 Adopt innovative financing schemes, smart subsidies and incentives for ESCOs to invest in MCTs
3. Strengthening policy and institutional support	3.1 Adopt necessary policies and regulations to support COGEN market application and development (where MCT is a sub-set) and the necessary incentives for both MCT technology provider and user 3.2 Adopt rationalized policy guidelines on gas supply on making gas more available to efficient industrial applications as part of Five-Year (2015-2020) National Plan 3.3 Strengthen organizational structure and harmonize mandates to support energy efficient gas usage in COGEN in industries.

**Rating: Moderately Unlikely (MU) - Significant Risks*

In summary, the following are the ratings of the other project elements that were required to be rated:

Monitoring and evaluation	S
UNDP and Implementing Partner implementation / execution coordination, and operational issues	S
Relevance	S
Effectiveness & Efficiency	MS
Sustainability and project exit strategy	MU

4 CONCLUSIONS, RECOMMENDATIONS & LESSONS

4.1 Corrective actions for the design, implementation, monitoring and evaluation of the project

Conclusion: The project design appeared to have over-estimated the targets on demonstration capacities and replication projection. However, upon review of the project development history, the targets were considered to be realistic and achievable on the basis of prevailing price, private sector's interest on the potential energy savings and GHG reduction benefits. However, these assumptions changed drastically over the 6 year implementation period which became unfavorable to MCT market development. The monitoring and evaluation have been effectively carried out using the prescribed GEF/UNDP system on the Annual Project Report/ Project Implementation Review (APR/PIR).

Recommendations: A more rigid market projection methodology should be used in similar future projects that will include conservative and ambitious target levels and their corresponding carefully-assessed assumptions and conditions.

4.2 Actions to follow up or reinforce initial benefits from the project

Conclusion: The problems met by MCTAP in achieving fully its objectives were related to replication which is mainly marketing MCT to more potential users. The present project has reached significant start-off achievements in demonstrating a new technology which can be continued in the future. For follow-up actions, MCT marketing activities can be done in 4 marketing patterns consisting of: marketing penetration, market development, product development and diversification. For instance, the demo unit in PGN's Talang Duku which has an unbalanced system can accommodate one or more MCT power generator units to match the large existing heat absorption chiller in order to optimize efficiency by proper system load balancing. Other MCT demo sites are also experiencing unoptimized operations. On market expansion, there are areas with existing gas supply networks and a number of industrial and commercial enterprises that can be further encouraged to use MCTs. On the other hand, in the pursuit of better MCT system efficiencies, it is expected that MCT product development will continue to introduce advance and higher efficiency MCT system (both in the power generation and heat recovery sides) which can be offered to existing and new customers. Still another step is in the form of diversification in generating equipment production and is intended for increasing MCT producers from related and unrelated crafts. For example, a manufacturer of gas engines can be encouraged to diversify into MCT production as a somewhat related field from the present endeavor, or a producer gas boiler manufacturer into MCT production or heat recovery systems. In so doing, a number of combinations in the power and heat generation configurations is always possible in a variety of creative approaches in improving overall cogeneration efficiency performance.

Recommendations:

- Focus on marketing or development of the MCT market in the above-mentioned four patterns in a more aggressive, stepwise approach, as follows:
    - Focus MCT marketing primarily to existing MCT demo users who are still in need of thermal energy and have still excess quantities from its quota of fuel gas supply from

PGN by installing one or more MCTs operated in parallel to match load-following schemes in cogeneration to optimize system efficiencies and be good marketing models.

- Target expanded markets for new customers (existing or relocated) in areas with well-developed gas distribution networks with extensive promotion based on success stories of current MCT users.
- Encourage more local product research and development that will introduce to the market some advance, operationally-improved and higher-efficiency MCT systems (in both the power and heat generation sides).
- Encourage more equipment producers to diversify by venturing into MCT production whether they are related or unrelated to present business because they will benefit from good synergy and creativity in combining power generation and heat recovery for higher system energy efficiency in MCT systems.
- Promote more for low-BTU microturbines such as EnerCore products for abundant low calorie gas on landfill sites and mining areas.

4.3 Proposals for future directions underlining main project objectives

Conclusion: Based on the foregoing current situation analysis, the project has experienced an overall situation that is different and unfavorable vis-à-vis the expectations during project design characterized by the following:

- Development of the MCT market for a new technology system took longer than expected
- MCT's initial and maintenance costs are not competitive against those of the gas engine which is the existing mature technology that is aimed to be replaced by MCT
- Natural gas fuel price rose to more than double as compared to when the MCTAP project started.
- Plan for the development of transmission and distribution networks to targeted MCT users did not fully materialize.
- Gas allocation quotas for industrial needs (even for energy efficiency projects such as cogeneration) have been significantly limited.
- The relatively low selling price of energy (especially in subsidized grid power) has affected the viability of energy efficiency project.
- The economies of scale in MCT commercialization has not been reached to significantly lower the MCT acquisition and operating costs.

Recommendation (as in the proposed project Exit Strategy):

- Address the existing market situation so that the MCT market will be developed and result to an increased MCT technology replication:
  - Conduct further studies on other applications including combined heat and power uses in small and medium enterprises (SMEs) that can be served by MCTs
    - Open up new market for MCTs
    - Establish technical support particularly in the after-sales services for the local MCT industry
    - Encourage local research for MCT development on the power generation side and heat recovery side.
  - Promote ESCOs and adopting viable business models
    - Adopt applicable business models by providing relevant information

        - Capacity building in the banking / financial institutions in developing financial packages, credit schemes and loan guarantee windows to strengthen MCT market.
        - Adopt innovative financing schemes, smart subsidies and incentives for ESCOs to invest in MCTs
    - Strengthen policy and institutional support in favor of energy efficiency technologies such as cogeneration which includes MCT.
        - Adopt necessary policies and regulations to support COGEN market application and development (where MCT is a sub-set) and the necessary incentives for both MCT technology provider and user
        - Adopt rationalized policy guidelines on gas supply on making gas more available to efficient industrial applications as part of Five-Year (2015-2020) National Plan
        - Strengthen organizational structure and harmonize mandates to support energy efficient gas usage in COGEN in industries.

4.4 Best and worst practices in addressing issues relating to project relevance, performance and success

Conclusion:

d) The MCT program has continued to be very relevant to the current thrust of Indonesia and fits very well in the national cogeneration program being pursued by MEMR and BPPT. MEMR completed a study on COGEN applications which was presented in the ASEAN Cooperation on COGEN, and can be used as reference in drafting guidelines. BPPT has already included MCT under COGEN in the long-term National Program and required budgets.

e) While the performance indicator in the achievement of objectives in the replication target of 200 MW was not attained by the project within its timeframe due to various reasons as explained in the TE observations, the great potential of MCT remains valid and can be considered as an opportunity in developing new program for MCT under the national energy efficiency program which include the significant contribution of cogeneration projects.

f) While the project has accomplished all relevant project activities in the six components, success in achieving the project objectives in the demonstration and replication of MCTs was affected by the unexpected market circumstances in introducing a new technology.

Recommendation:

- Pursue the successful completion of the MCT demo highlighting the achievement of the energy efficiency improvement learning from best and worst practices resulting to substantial energy savings and GHG reduction benefits and dissemination of the results to encourage a wider MCT market development program under the national energy efficiency program of Indonesia.

4.5 Lessons Learned

- Economic considerations for marketing new technology products in any country always relevant and major factor. For Indonesia, even if the microturbine promised to be a highly

efficient and of excellent quality, it is still not the top choice for power generators because microturbine unit prices are 2-3 times the price of gas engines for the same size. But potential users have not really been shown an efficient and economically-operated microturbine that is still possible through a good and optimized size/capacity matching of the power generation side with the heat recovery side.

- While the MCT technology is being introduced, potential users and distributors need ample incentives to justify their participation in the demonstration stage in addition to the assistance in promotion and capacity development due to the risks involved.
- Higher capacities of microturbine could be more attractive to be used under the national program in the field of energy efficiency involving cogeneration systems and therefore provide a much larger contribution.
- The MCT technology could be more flexible and customized regarding local specifications in terms of operating parameters, such as the operating limit voltage should be adjusted to the lowest voltage that the grid can accommodate (e.g. 250V), so that MCTs can be operated in parallel with the PLN system.

5 ANNEXES

A. Terms of Reference
B. List of Documents Reviewed
C. List of Persons Interviewed
D. MCTAP Project Organizational Chart
E. Recommended Funding Scheme for MCT
F. Exit Strategies for the MCTAP Project

Annex A. Terminal Evaluation Terms of Reference (ToR)

United Nations Development Programme

Terms of Reference

GENERAL INFORMATION

Title: INTERNATIONAL CONSULTANT FOR THE FINAL EVALUATION OF MICROTURBINE COGENERATION PROJECT
Project Name : Microturbine Cogeneration Technology Application Project (MCTAP)
Reports to: Programme manager, Environment Unit UNDP
Duty Station: Jakarta & home based
Expected Places of Travel (if applicable): within Indonesia
Duration of Assignment: From 27th March 2014 to: 15th May 2014 (25 working days)

REQUIRED DOCUMENT FROM HIRING UNIT

x	TERMS OF REFERENCE
8	**CONFIRMATION OF CATEGORY OF LOCAL CONSULTANT , please select :** (1) Junior Consultant (2) Support Consultant (3) Support Specialist (4) Senior Specialist (5) Expert/ Advisor **CATEGORY OF INTERNATIONAL CONSULTANT , please select :** (6) Junior Specialist (7) Specialist **(8) Senior Specialist**
x	APPROVED e-requisition

REQUIRED DOCUMENTATION FROM CONSULTANT

x	CV
x	Copy of education certificate
x	Completed financial proposal
x	Completed technical proposal

Need for presence of IC consultant in office:
X partial (Jakarta and Home-Based)
☐intermittent (explain)
☐full time/office based (needs justification from the Requesting Unit)

Provision of Support Services:

Office space:	☐ Yes	x No
Equipment (laptop etc):	☐Yes	x No
Secretarial Services	☐Yes	x No

If yes has been checked, indicate here who will be responsible for providing the support services: < Enter name >

Signature of the Budget Owner:.....

I. BACKGROUND

Cogeneration technology has only been popular amongst the big industries mainly because of its cost effectiveness due to its scale of operation i.e. large-scale power and heating generation facilities, an ideal solution to meet captive power and heat energy demand. With the availability of large natural gas resources, cogeneration combined with captive power and heat applications, is definitely a promising market for the promotion of Microturbine Cogeneration Technology (MCT) as it offers a new perspective on clean, efficient and high quality of on-site power and heat generation.

Microturbine Cogeneration Technology Application Project (MCTAP) is being implemented by the Energy Technology Center (BBTE) of Agency for the Assessment and Application of Technology (BPPT) from 2009-2013 with the support from United Nations Development Programme (UNDP). This project aims to assist the Government of Indonesia in the development and application of MCT as alternative and clean energy technologies which produce less greenhouse gas (GHG) emissions. MCTAP was designed to remove key market, policy, technical and financial barriers to MCT development and application in the country. The project also focuses of cost-reduction and capacity building activities as part of strategy apart from pilot demonstration of MCT in various feasible applications. The overall objective of the MCTAP is the reduction of the long-term cost of MCT in order to accelerate the entry and increase the share of MCT in the Indonesian market.

Expected outcomes of MCTAP

- ***Component Activity 1: Technology Assessment and MCT Application Development***

  Outcome 1: Through understanding and appreciation of technology options and their environmental impacts of MCT systems by ICE sector, government and other stakeholders.

- ***Component Activity 2: MCT Demonstration & Market Development***

  Outcome 2: Establishment of a critical mass of demonstration projects that will provide detailed information of MCT operations, energy savings and environmental impacts to enterprises interested MCT systems from ICE sectors

- ***Component Activity 3: Technical Support for MCT Financing***

  Outcome 3: Availability of financial and institutional support to encourage enterprises from ICE sector to adopt energy efficient MCT systems

- ***Component Activity 4: Policy & Institutional Support***

  Outcome 4: Promulgation of and compliance to regulations that encourage adoption of MCT systems

- ***Component Activity 5: MCT Promotion***

  Outcome 5: Enhanced awareness of the public and other stakeholders

- ***Component Activity 6: Technical Support for Local MCT Industry***

  Outcome 6: Improved local vocational, technical; and managerial capacity to manage and sustain operations of MCT for EC&EE practices in the ICE sectors

In accordance with UNDP/GEF M&E policies and procedures, all regular and medium-sized projects supported by the GEF should undergo a final evaluation upon completion of implementation. Final evaluations are intended to assess the relevance, performance and success of the project. It looks at early signs of potential impact and sustainability of results,

including the contribution to capacity development and the achievement of global environmental goals. It will also identify/document lessons learned and make recommendations that might improve design and implementation of other UNDP/GEF projects.

Objectives of the evaluation

The UNDP Indonesia is initiating this evaluation to determine to what extent the project has achieved its objectives and has removed barriers to microturbine market development and utilization in Indonesia. It is intended to analyze and assess the relevance, sustainability, impact and effectiveness of the strategies, project design, implementation methodologies and resource allocations that have been adopted for the purpose of achieving the objectives stated in the project document.

II. SCOPE OF WORK, RESPONSIBILITIES AND DESCRIPTION OF THE PROPOSED ANALYTICAL WORK

1. Scope of Evaluation

The scope of the Final Evaluation (FE) covers the entire project and its components as well as the co-financed components of the project.

The FE will assess the Project implementation taking into account the status of the project activities and outputs and the resource disbursements **made up to February 31, 2014**.

The review will involve analysis at two levels: component level and project level.

Component level: progress against each outcome, output, activity (including sub-activities) and impact indicators listed in the project document along with the following shall be assessed:

- Whether there is effective relationship and communication between/among components so that data, information, lessons learned, best practices and outputs are shared efficiently, including cross-cutting issues.
- Whether the performance measurement indicators and targets used in the project monitoring system are specific, measurable, achievable, reasonable and time-bounded to achieve desired project outcomes.
- Whether the use of consultants has been successful in achieving component outputs.

The evaluation will include such aspects as appropriateness and relevance of work plan, compliance with the work and financial plan with budget allocation, timeliness of disbursements, procurement, coordination among project team members and committees, and the UNDP country office support. Any issue or factor that has impeded or accelerated the implementation of the project or any of its components, including actions taken and resolutions made should be highlighted.

On the project level, it will assess the project performance in terms of: (a.) Progress towards achievement of results, (b.) Factors affecting successful implementation and achievement of results, (c.) Project Management framework, and (d.) Strategic partnerships.

4.1 *Progress towards achievement of results* (internal and within project's control)

- Is the Project making satisfactory progress in achieving project outputs vis-à-vis the targets and related delivery of inputs and activities?
- Are the direct partners and project consultants able to provide necessary inputs or

achieve results?

- Given the level of achievement of outputs and related inputs and activities to date, is the Project likely to achieve its Immediate Purpose and Development Objectives?
- Are there critical issues relating to achievement of project results that have been pending and need immediate attention in the next period of implementation?

4.2 *Factors affecting successful implementation and achievement of results* (beyond the Project's immediate control or project-design factors that influence outcomes and results)

- Is the project implementation and achievement of results proceeding well and according to plan, or are there any outstanding issues, obstacles, bottlenecks, etc. on the consumer, government or private sector or the microhydro industry as a whole that are affecting the successful implementation and achievement of project results?
- To what extent does the broader policy environment remain conducive to achieving expected project results, including existing and planned legislations, rules, regulations, policy guidelines and government priorities?
- Is the project logical framework and design still relevant in the light of the project experience to date?
- Is the project well-placed and integrated within the national government development strategies, such as community development, poverty reduction, etc., and related global development programs to which the project implementation should align?
- Do the Project's purpose and objectives remain valid and relevant, or are there items or components in the project design that need to be reviewed and updated?

4.3 *Project management* (adaptive management framework)

- Are the project management arrangements adequate and appropriate?
- How effectively is the project managed at all levels? Is it results-based and innovative?
- Do the project management systems, including progress reporting, administrative and financial systems and monitoring and evaluation system, operate as effective management tools, aid in effective implementation and provide sufficient basis for evaluating performance and decision making?
- Is technical assistance and support from project partners and stakeholders appropriate, adequate and timely?
- Validate whether the risks originally identified in the project document and, currently in the Annual Project Report, are the most critical and the assessments and risk ratings placed are reasonable.
- Describe additional risks identified during the evaluation, if any, and suggest risk ratings and possible risk management strategies to be adopted.
- Assess the use of the project logical framework and work plans as management tools and in meeting with UNDP-GEF requirements in planning and reporting.
- Assess the use of electronic information and communication technologies in the implementation and management of the project.
- How have the Annual Project Report/Project Implementation Review (API/PIR) process helped in monitoring and evaluating the project implementation and achievement of results?

4.4 *Strategic partnerships* (project positioning and leveraging)

- Are the project partners and their other similar engagements in the implementation, strategically and optimally positioned and effectively leveraged to achieve maximum effect of the RE program objectives for the country?

- Asses how project partners, stakeholders and co-financing institutions are involved in the Project's adaptive management framework.
- Identify opportunities for stronger collaboration and substantive partnerships to enhance the project's achievement of results and outcomes.

4.5 Are the project information and progress of activities disseminated to project partners and stakeholders? Are there areas to improve in the collaboration and partnership mechanisms?

2. Evaluation Methodology

The Final Review Team is expected to become well versed as to the project objectives, historical developments, institutional and management mechanisms, activities and status of accomplishments. Information will be gathered through document review, group and individual interviews and site visits. Review relevant project documents and reports will be based on the following sources of information: review of documents related to the Project and structured interviews with knowledgeable parties

The Evaluation Team will conduct an opening meeting with the National Project Director (NPD), Deputy NPD-I, Deputy NPD-II, National Project Manager,Team Leaders and, experts to be followed by an "exit" interview to discuss the findings of the assessment prior to the submission of the draft Final Report.

Prior to engagement and visiting the Project Management Office, the Final Review Team shall receive all the relevant documents including at least:

- MCTAP Project Document and Project Brief
- Inception Report
- Annual Work and Financial Plans
- Annual Project Report/Project Implementation Review (API/PIR) for 2007, 2008, 2009 and Quarterly Reports

To provide more details, as may be needed, the following will be made available for access by the Final Review Team:

- Executive summary of all quarterly reports
- Internal monitoring results
- Terms of Reference for past consultants' assignments and summary of the results
- Past audit reports

The Final Review Team should at least interview the following people:

- National Project Director
- Deputy NPD-I, and Deputy NPD-II
- National Project Manager
- Team Leaders
- Experts
- Project Administrative Officer
- Project Financial Officer
- PSC Members
- Board Members
- UNDP Country Office in Indonesia in-charge of the MCTAP Project

With the aim of having an objective and independent evaluation, the Final Review Team is

expected to conduct the project review according to international criteria and professional norms and standards as adopted by the UN Evaluation Group.

3. Review Team

The Final Review Team will be composed of one International Lead Consultant and one National Consultant (as assistant). The Team is expected to combine international standards of evaluation expertise, excellent knowledge of the RE and Climate Change projects and national context of RE project and program implementation in Indonesia. The team should review the provided project documents and publications. The main sources of information will be provided by MCTAP Project Management Unit. Interviews with various stakeholders and field visits will add important information to the evaluation. The allocation of tasks in the execution of this TOR shall be decided mutually between the International and National consultants.

International Expert

The International shall be responsible for completing and delegating tasks as appropriate for the terminal evaluation to the National counterpart. He/she will ensure the timely submission of the first draft and the final version of the terminal evaluation with incorporated comments from UNDP and others.

National Counterpart

The National counterpart will, jointly with, and under the supervision of the International consultant, support the evaluation. He/she will be responsible to review documents, translate necessary documents and interpret interviews, meetings and other relevant events for the International consultant. He/she will work as a liaison for stakeholders of the project and ensures all stakeholders of the project are aware of the purposes and methods of the evaluation and ensures all meetings and interviews take place in a timely and effective manner.

III. REQUIREMENTS FOR EXPERIENCE AND QUALIFICATIONS

At the minimum, the International Consultant of the Final Evaluation (FE) Team shall have the following professional background and responsibilities:

International Lead Consultant

- Post-Graduate in Engineering, Management or Business
- Minimum of ten years accumulated and recognized experience in energy efficiency and climate change projects
- At least 3 years technical experience in power generation and/or cogeneration engineering or operations.
- Technical experience in the application of microturbines in power generation and/or cogeneration and/or Microturbine Cogeneration Technology is advantageous as well as
- Minimum of five years of project evaluation and/or implementation experience in the result-based management framework, adaptive management and UNDP or GEF Monitoring and Evaluation Policy
- Demonstrated ability to assess complex situations, succinctly, distils critical issues, and draw forward-looking conclusions and recommendations.
- Ability and experience to lead multi-disciplinary and national teams, and deliver quality reports within the given time
- Familiar with developing countries context or regional situations relevant to that of

Indonesia
- Experience with multilateral and bilateral supported EE/RE and climate change projects
- Comprehensive knowledge of international Energy Efficiency (EE)/ Renewable Energy (RE) industry best practices
- Very good report writing skills in English

Responsibilities

- Documentation of the review
- Leading the FE Team in planning, conducting and reporting on the review
- Deciding on division of labor within the Team and ensuring timeliness of reports
- Use of best practice review and evaluation methodologies in conducting the evaluation
- Leading presentation of the draft review findings and recommendations in-country
- Conducting the debriefing for the UNDP Country Office in Jakarta and MCTAP Project Management
- Leading the drafting and finalization of the FE Report
- Validate and complete appropriate sections in tracking tool for mid-term review of climate change mitigation projects

The members of the Team must be independent from both the policy-making process and the delivery and management of the UNDP/GEF assistance. Therefore, candidates who had any direct involvement with the implementation of the WHyPGen Project will not be considered.

IV. EXPECTED RESULTS

Final Evaluation Schedule and Deliverables
A review report will be produced after 25 working days, but not later than 15 May 2014. The report shall highlight important observations, analysis of information and key conclusions including its recommendations as mentioned earlier. Based on the scope of the FE described above, the evaluation report will include, among others:

- Findings on the project implementation achievements, challenges, and difficulties to date;
- Assessments of the progress made towards the attainment of outcomes;
- Recommendations for modifications and the future course of action;
- Lessons learned from the project structure, coordination between different agencies, experience of the implementation, and output/outcome and,

The report will be initially shared with the National Project Director and National Project Manager to solicit comments or clarifications and will be presented to the UNDP Country Office (CO) in Jakarta for further deliberations.

There will be two main deliverables:

- Based on agreed FE work plan, the consultant should provide FE report, including an executive summary, fulfilling the review requirements set out in this Terms of Reference (TOR). The final report is to be cleared and accepted by UNDP CO in Jakarta before final payment. The final report (including executive summary, and annexes) should not exceed 50 pages.

The review report outline should be structured along the following lines:

1. Executive summary
2. Introduction
3. The project and its development context
4. Findings and Conclusions
   - 4.1 Project formulation
   - 4.2 Implementation
   - 4.3 Results
5. Completed tracking tool
6. Conclusions on the findings, observations and results of MTR
7. Lessons learned
8. Recommendations
9. Annexes

More guidance on the GEF project review criteria and explanation of terminology provided in the Annex 1.

- A power-point presentation of the findings of the review. Depending upon the complexity of the review findings, UNDP CO in Jakarata may consider organizing a half-day stakeholders meeting at which to make a presentation to the partners and stakeholders.

Deliverables/ Outputs	Target Due Dates	Payment
1. Upon acceptance of consultant's proposed Final Evaluation work plan by MCTAP and UNDP	**01 April 2014**	**30%**
2. Upon acceptance of Final version of Final Evaluation report by UNDP.	**10 th May 2014**	**70%**

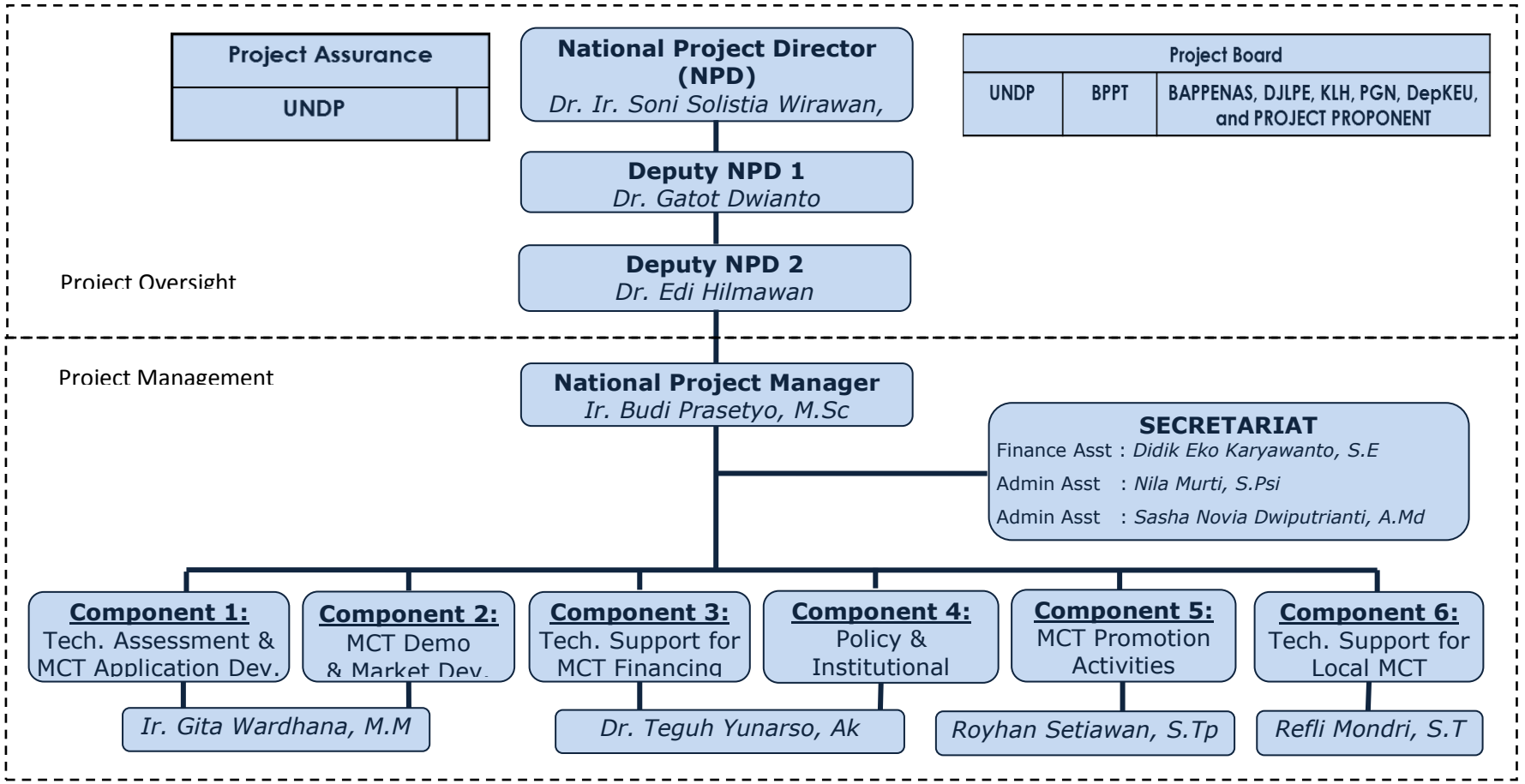
Annex B. List of Documents Reviewed

1. MCTAP Final Version Project Document (January 27, 2008)
2. Minutes of the Inception Workshop (April 2009)
3. MCTAP PIR Reports 2010, 2011, 2012 & 2013 (2014 submitted for information)
4. MCTAP Annual Work Plans 2009 – 2014
5. Minutes of Project Board Meetings (2009 – 2013)
6. MCTAP Mid-Term Report (June 6, 2012)
7. MCTAP Study – Energy Conservation through Cogeneration - Presentation on BPPT Energy Partner Gathering (December 4, 2013)
8. MCTAP Recommendation – Endorsing National Cogeneration Implementation – Presentation for BPPT Chairman (December 2013)
9. Various financial models on Capstone for landfill gas, Flex Power, waste heat recovery generator, payback calculation (December 2013)
10. MCTAP presentations for the Project Board Meetings 2012 & 2013
11. Draft Final Report MCTAP Project (June 2014)
12. Emission Reduction Analysis for MCTAP Project (December 31, 2013)

Annex C: List of Persons Interviewed

No	Name	Institution	Occupation	Email
1	Gita Wardhana	PGN DRPT	Energy Expert	gita.wardhana@pgn.co.id
2	Fetrian	PGN	Kadis Riset dan Optimasi Teknologi	fetrian@pgn.co.id
3	Edi Hilmawan	BPPT	DNPD-2	hilmi0374@yahoo.com
4	Verania Andria	UNDP	Program Manager	verania.andria@undp.org
5	Royhan Setiawan	MCTAP-BPPT	Consultant	royhan.setiawan@mctap-bppt.com
6	Soni S Wirawan	B2TE-BPPT	NPD	soni.solistia@bppt.go.id
7	Gatot D	B2TE-BPPT	DNPD-1	gdwianto@yahoo.com
8	Didik Eko K	MCTAP-BPPT	Fin Associate	didik_ek@yahoo.com
9	Arief H Kuncoro	DJEBTKE-KESDM	Kasubdit	ariefher@yahoo.com
10	Budi P	MCTAP-BPPT	NPM	prasbudi@gmail.com
11	Nila Murti	WhyPGen-BPPT	Consultant	nila@whypgen-bppt.com

Annex D: MCTAP Project Organizational Chart



Annex E: Recommended Funding Scheme for MCT

Funding schemes for MCT, or more broadly for EE sector is needed for the deployment of the MCT application in industries and commercial establishments. The scheme in question is a loan for the initial investment, which returns are paid from the value in savings obtained. This has become barriers to disburse loans in the banking world, where collateral / guarantee of energy savings study obtained values are still not strong and still very risky from the banking point of view.

The MCTAP Project has made great efforts and ways to do capacity building in the banking / financial institutions, and it was agreed that there should be a guarantee agency to strengthen it. The guarantor institutions of government or private companies will position the business as part of the Energy Service Company (ESCO). The Project also conducted a study on the success of sustaining funding in some other countries such as Thailand, Brazil, China and the Philippines. Broadly speaking, nevertheless, it is very necessary to guarantee institution for the passage of such schemes.

In general, banks and financial institutions who are interested in finance are constrained by several factors or issues , among others, regarding: (i) collateral, (ii) resale value, and (iii) experts in the field of EE. Therefore, learning from successful measures that have been implemented by other countries, the project identified a range of alternative patterns / funding strategies, namely as follows:

a. *Credit Scheme (debt scheme) through the establishment of a special bank serving EE projects*

- Source of funding: Funding sources can be derived from the participation of government and third-party sources of funding other than the International financial institutions and from other sources.
- Fund distribution: Distribution of funds as a special commercial loan for EE projects
- Constraints: The banking institutions should be subject to the regulations of Bank Indonesia, the issue of collateral and therefore resale value of investment will remain a issue that inhibits the development.

b. *Subsidy scheme on EE projects, through the establishment of a revolving fund.*

- Source of funding: Sources of funds from the state budget.
- Distribution of funds: Channeling a certain portion of the funds in a special subsidy for EE projects
- Constraints: Distribution of allocation of funds for EE projects with this system is done through government agencies should be subject to government financial administration system, so that the implementation will be ineffective for further developments.

c. *Guarantee Scheme through EE Investment Guarantee Company Incorporation*

- Source of funding: At first source of funds can come from the inclusion of government and third-party sources of funding other than the International financial institutions and from other sources.
- Distribution of funds: The agency does not distribute funding, while funding projects by and derived from the Bank or financial institution.

- Constraints: The issue of re-sale value of collateral and no longer an issue explicitly by banks and financial institutions, because the matter has been taken over by the insurance companies.

Noting the potential for EE projects and state government budget constraints, the initiatives to encourage the growth of energy efficiency projects, the government can establish a guarantor company investment in EE. As for the frame work of the company formation can be briefly described as follows:

a. The position of Insurance Agency
   The company is a company that is majority ownership by the State and can be set up by the government directly or by PT SMI (medium multi-infrastructure).

b. Duties and Scope of Business
   The scope of business of the company is the guarantor; implement the guarantee, made an investment and a special collaboration on EE investment projects in Indonesia.

c. Sources Equity: Equity comes from the state budget

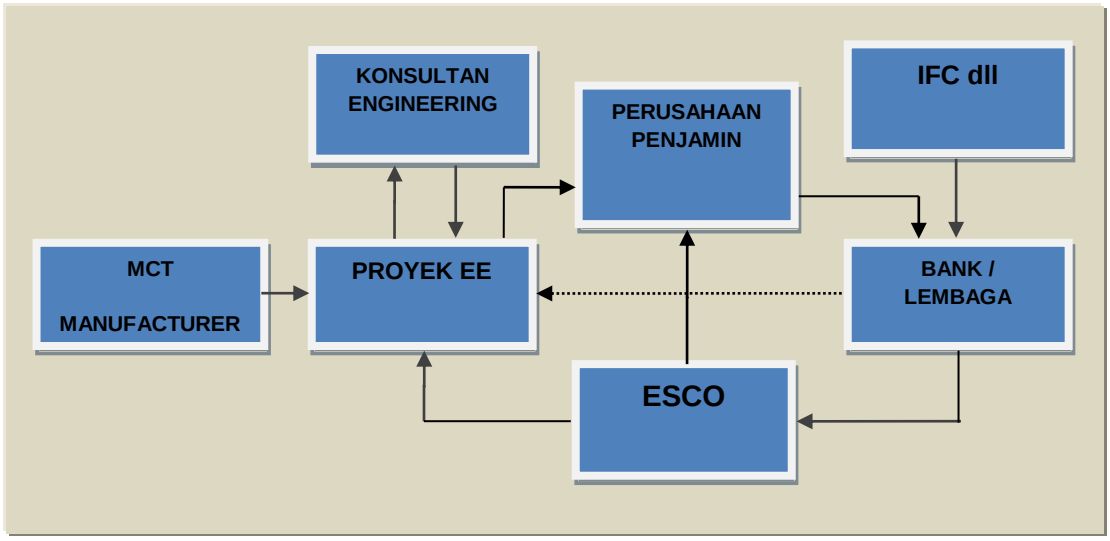
d. Source of Income
   The company's revenue derived from services or from underwriting and cooperation above profit projects handled.

e. Funding Sources Project, a source of funding to be able to cooperate with the Bank and or private financial institutions nationally and internationally.

f. Criteria for Projects that could be funded
   - Project Type, is a special project of energy efficiency
   - Project Value, therefore there is the potential for EE projects on a small scale, medium and large, the value of projects that could be funded should not be limited.
   - The company can be financed, is a company or a program of EE and energy services company (ESCO).

g. Project Funding Scheme

   As described above that the financing of investment projects has a specific energy efficiency when compared to funding for other projects, therefore, as described above, the following schematic framework proposed funding scheme as follows:



The above EE financing schemes were just discussed with (MCTAP, PT. SMI, PIP, EBTKE-EMR, BKF-Finance, Banking and other financial institutions) and were proposed to the Ministry of Finance to be able to support the application of EE in Indonesia.

Annex F: MCTAP Exit Strategy (Sustainability Plan)

Actions needed to be done	Details of Actions/ Roadmap	Output indicators of the Exit Strategies	Proposed Post-project Responsible Institutions	Remarks on Present Status as of EOP
1. Further studies on other applications including combined heat and power uses in small and medium enterprises (SMEs) that can be served by MCTs	1.1. Open up new market for MCTs 1.2. Establish technical support particularly in the after-sales services for the local MCT industry 1.3. Encourage local research for MCT development on the power generation side and heat recovery side.	• List of other MCT applications which can also be under the overall COGEN program • After-sales support and preventive maintenance program established • Updated MCT technology development and available models for more efficient and reliable models	ESDM, BPPT, MoI, MEMR, EE Associations, Local Government Units	• MEMR & PGN have developed a general map and can be expanded to show specific locations at the regional level vis-à-vis fuel demand from industries. • MCTAP completed and disseminated studies on possible cogeneration application in various industry and power sectors • BPPT has endorsed to Bappenas the COGEN Program (including MCT) to be included in the National Planning Development RPJM 2015-2019 • Local capability can be assessed to undertake R&D on new MCT models particularly the heat recovery aspects
2. Promoting ESCOs and adopting viable business models	2.1 Adopt applicable business models by providing relevant information 2.2 Capacity building in the banking / financial institutions in developing financial packages, credit schemes and loan guarantee windows to strengthen MCT market. 2.3 Adopt innovative financing schemes, smart subsidies and	• Promotional plan developed and implemented • No. of MCT suppliers and service providers increased • Updated business models and financial analysis	MEMR, MOF, MOI, BPPT, Investment Board, Potential ESCOs, Universities, LIPI	• MEMR completed a study on the potential of improving energy efficiency (EE) in industrial systems and applying ESCO business model. • MEMR conducted a techno-economic analysis through its energy audit program that identified and recommended 43 possible EE applications

Actions needed to be done	Details of Actions/ Roadmap	Output indicators of the Exit Strategies	Proposed Post-project Responsible Institutions	Remarks on Present Status as of EOP
	incentives for ESCOs to invest in MCTs			
3. Strengthening policy and institutional support	3.1 Adopt necessary policies and regulations to support COGEN market application and development (where MCT is a sub-set) and the necessary incentives for both MCT technology provider and user 3.2 Adopt rationalized policy guidelines on gas supply on making gas more available to efficient industrial applications as part of Five-Year (2015-2020) National Plan 3.3 Strengthen organizational structure and harmonize mandates to support energy efficient gas usage in COGEN in industries.	• Policy and regulation for gas supply and pricing scheme for efficient gas applications in COGEN (including MCT) adopted and disseminated • Integrated government organization and coordination mechanisms to promote and implement the MCT program under the National COGEN Program	MEMR, MOF, PGN, MOI, Investment Board, MCT suppliers, process heat and chillers producers and EE Associations	• MEMR completed a study on COGEN applications which was presented in the ASEAN Cooperation on COGEN, and can be used as reference in drafting guidelines • PGN is planning to also sell services as an ESCO • PGN is involved in finding additional local gas supply and has already started to implement PGN FSRU in Lampung to expand volume of supply in addition to local natural gas supply to meet increasing demand for fuel gas. • BPPT has already included MCT under COGEN in the long-term National Program and required budgets. • National Gas Marketing policy (ESDM Regulation No. 2- 2008) has 75 % of production allocated for free market (local and export) and 25% for domestic market obligations