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TECHNOLOGY NEEDS ASSESSMENT

for Climate Change Mitigations 2012

INDONESIA

Technology Needs Assessment for Climate Change Mitigation 2012

Indonesia
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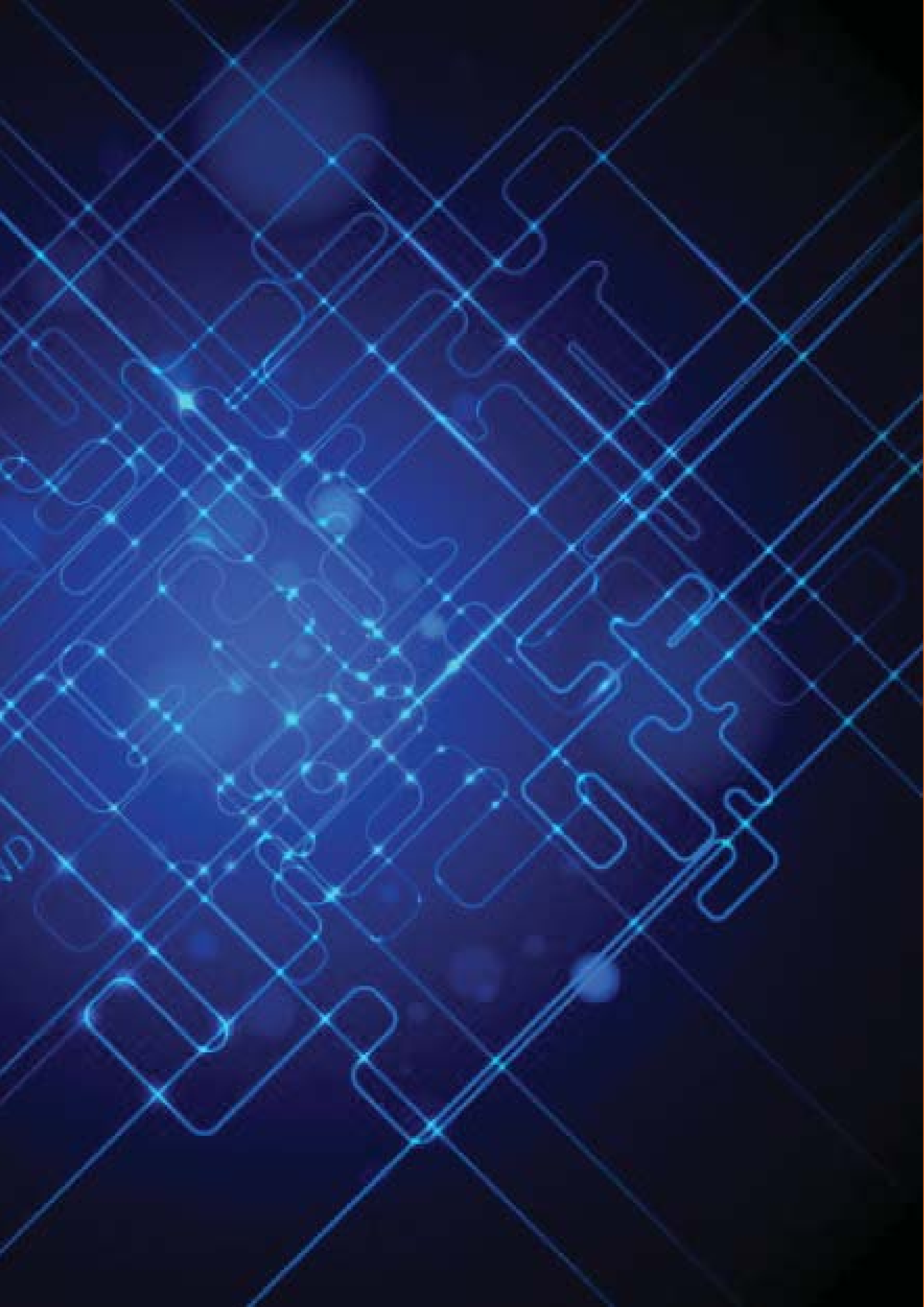

PREFACE

Global climate change is one of the most important issues facing the world today, that has major effects on the world economy. One of the primary issues in the global climate change is how to adapt to a variety of impacts from climate change that might occur. The purpose of the Technology Needs Assessment (TNA) and Technology Action Plans (TAPs) Mitigation Synthesis Report or just called TNA Mitigation Synthesis Report document is to identify and analyse the needs of the prioritized technologies, which can form the basis for a portfolio of environmentally sound technology (EST) projects and programs to facilitate the transfer of, and access to, the ESTs and know-how into Indonesia.

Based on the writing sequence, the TNA mitigation synthesis report document is divided in three sections. Section I outlines the synthesis report on TNA for Mitigation, Section II gives synthesis report on TAP for Mitigation, and Section III contains Cross-cutting Issues for the National TNA and TAPs.

Section I of the TNA mitigation synthesis report consists of Executive Summary of TNA, Introduction of TNA, Institutional Arrangement, Sector Prioritization, Technology Prioritization of each Sector, and Conclusions. The introduction covers the objectives of TNA being developed, the national circumstances, sustainable development strategies, national climate change mitigation policies, and how TNA relevance to national development priorities. Sectors prioritization consists of an overview of sectors, projected climate change and the GHG emission status and trends of the different sectors, processes and criteria of prioritization, inventory/ status of technologies in each selected sector. Technology prioritization for selected sector contains an overview of possible mitigation technology options in that sector and their mitigation benefits, criteria and processes of technology prioritization, as well as result of technology prioritization.

Section II of the TNA Mitigation Synthesis Report 2012 is started with Executive Summary and followed by outlining Technology Action Plans (TAPs) for each sector starting with forestry, energy and waste. This section covers preliminary targets for technology transfer and diffusion based on Section I, barrier analysis (Economic, Regulatory, Institutional, Capacity, IPR and Social and Cultural aspects), barrier identification and analysis for the transfer and diffusion of each technology, and linkages of the barriers identified. Next is enabling framework for overcoming barriers that consists of possible solutions to address the barriers for the transfer and diffusion of each technology, and recommended solutions for each sector. Concrete Actions Plans and Ideas are also outlined in this section. These include plans for domestic actions and measures, project ideas for international support, and possible measures to address IPR barriers, if any.
Section III, Crosscutting Issues for the TNA Mitigation Synthesis Report consists of crosscutting technologies for the TNAs in the three sectors and crosscutting issues for the TAPs in the three sectors. Finally, the report is completed with the Annexes that consist of Technology Fact-sheets, Market Maps for Technologies, Project Ideas, and List of Stakeholders involved in this study.

This TNA Mitigation Synthesis Report 2012 document would have been impossible to write had it not been for the outstanding contributions of several stakeholders and resource persons in the related sectors of forestry, energy and waste. Tribute need to be paid to the individuals for their insight, influence, and perspective for which this study are based. Special thank you is directed to UNEP-RISØ who have supported and read carefully and given suggestions to make this report become a better document. A high appreciation is given to resource persons from the Ministries and other Institutions who have all contributed in the completion of TNA Mitigation Synthesis Report. Special thank you to Deputy Chairman of BPPT on Natural Resources Development and Director of Environmental Technology Center who have injected the spirit to all of the team members in completing this report document. Finally, many appreciations are dedicated to all members of the team who have worked very hard from learning how to start the work to completing the report.

FOREWORD FROM CHAIRMAN OF DNPI

Indonesia is actively involved in world efforts to combat climate change, and Indonesia was the first developing nation to commit to reduce its emissions by 26 percent voluntarily, or by 41 percent with international assistance by 2020. Through the Presidential Decree No. 61/2011, Indonesia has established the National Action Plan for Green House Gas Emissions Reduction (RAN-GRK), as the guidance for all sectors. This action plan addresses sectoral issues in detailed plans with the best available mitigation technologies.

The Indonesia Climate Change Council (DNPI) as the focal point of Indonesia in climate change has been mandated by the Indonesian Government to prepare the Technology Needs Assessment (TNA) and the Technology Action Plans (TAPs) on both mitigation and adaptation of climate change specific to the context of Indonesia.

With the support of UNEP-RISØ Centre, DNPI through the Working Group of Technology Transfer has collaborated with the Agency for the Assessment and Application of Technology (BPPT) in the completion of the Global TNA for Mitigation. This work involved all the cross-sectoral stakeholders including the related Ministries, Governmental Institutions, and the related experts.

I thank the efforts of all parties involved in the development of this document, in particular to BPPT and the Working Group of Technology Transfer DNPI, who have coordinated and arranged all the activities. I would like also to extend appreciation and gratitude to the UNEP-RISØ Center for their technical support and the funding of this TNA.

Jakarta, February 2012

National Council for Climate Change

Prof.(Hon).Ir. Rachmat Witoelar
Executive Chairman

FOREWORD FROM CHAIRMAN OF BPPT

Since industrial revolution in Europe in the 18th Century, slowly but surely the concentration of carbon dioxide (CO2) in the atmosphere has continued to increase. This has also been followed by increasing atmospheric temperature resulting global warming, one cause of climate change. This means that since humans used the technology for developing their economy, there has always been a threat to the environment.

Given the technology becomes an ‘amplifier’ for environmental damage, to technology as well we hope that it could be able to control and restrain the rate of environmental damage through the application of environmentally sounds technologies (EST). As a country that has a high vulnerability due to climate change, Indonesia needs to master and implement mitigation and adaptation technologies in accordance with their conditions including the social and cultural aspects.

The Agency for the Assessment and Application of Technology (BPPT) as the government agency that is responsible for the assessment, acquisition and dissemination of technology has coordinated to produce Technology Needs Assessment (TNA) document in the year 2009. This document contains some prioritized mitigation technologies in the energy, industry, transportation, agriculture, forestry, waste and marine sectors. During its progress, with the support of UNEP - RISØ Centre, it has now been compiled TNA Global which is actually an updated and completed previous TNA, particularly for TNA Mitigation. On the new Global TNA, it focuses on the prioritization of mitigation technologies for the forestry, energy and waste sector whereas for adaptation technologies it focuses on the sector of food security, coastal vulnerability and water resources. Furthermore, based on the selected technologies, their Technology Action Plans (TAPs) are developed.

For this opportunity, we would like to thank to the TNA executing team, DNPI, related ministries and other institutions who work very hard to complete this study. Special thank is also given to UNEP-RISØ Center along with the ranks of its advisors and reviewers for reviewing and guiding this study from the beginning until the completion of this document.

Jakarta, February 2012

Agency for Assessment and Application of Technology (BPPT)

Dr. Marzan A. Iskandar
Chairman

Table of Content

List of Table

List of Figure

List of Abbreviation

APBN	State Budget
APBD	Local Budget
AIT	Asian Institute of Technology
BAPPENAS	National Development Planning: Indonesia
BPPT	Badan Pengkajian dan Penerapan Teknologi
Agency for the Assessment and Application of Technology	
BSN	National Standardization Body
BAU	Business As Usual
CAFTA	China ASEAN Free Trade Agreement
CIFOR	Centre for International Forest Research
CER	Certified Emission Reduction
CCS	Carbon Capture Storage
CDM	Clean Development Mechanism
CMM	Carbon Measurement and Monitoring
CRC	Cold Rolled Coil
DNPI	Dewan Nasional Perubahan Iklim
	National Council on Climate Change of Indonesia
EPR	Extended Producer Responsibility
ESC	Environmentally Sound Technology
FGD	Focus Group Discussions
FNC	First National Communication
GEF	Global Environmental Facilities
GHG	Green House Gases
HTI	Industrial Forest Plantation
HPH	Forest Concessions
HRC	Hot Rolled Coil
HTR	Small-Scale Forest Plantation
ICCSR	Indonesia Climate Change Sectoral Roadmap
ICCTF	Indonesia Climate Change Trust Fund
IESR	Institute for Essential Services Reform
INSWA	Indonesia Solid Waste Association
IPB	Bogor Institute of Agriculture
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Right
ITS	Intelligent Transport System
ITF	Intermediate Treatment Facilities
IVT	In-Vessel Composting
IWF	Indonesia Waste Forum
kgC/t	Kilogram per Ton
KWh	Kilowatt Hour
KNI-WEC	Indonesia National Committee – World Energy Council
KPH	Forest Management Units
LIPI	Indonesian Institute of Sciences
LFG	Landfill Gas
LEI	Eco-Labelling Institute
LSAD	Low Solid Anaerobic Digestion
LULUCF	Land Use and Land Use Change and Forestry
LREP	Land Resources Evaluation and Planning Project
MACC	Marginal Abatement Cost Curve

MCA	Multi Criteria Analysis
MBT	Mechanical Biological Treatment
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MEMR	Ministry of Energy and Mineral Resources
MoI	Ministry of Industry
MoF	Ministry of Finance
MoF	Ministry of Forestry
MoT	Ministry of Transportation
MSW	Municipal Solid Waste
MRT	Mass Rapid Transit
MRV	Measured, Reported, and Verified
NEDO	Industrial Technology Development Organization
NAMAS	National Appropriate Mitigation Actions
NGO	Non Governmental Organization
ODA	Official Development Assistance
PLN	Perusahaan Listrik Negara (State-Owned Electricity Company)
PLTS	Solar Electric Generation System
PLTD	Diesel Generator
PP	Government Regulation
PPET	Electronics and Telecommunications Research Centre
PRM	Peat Re-mapping
PPTKE	Technology Centre for Energy Conversion and Conservation
PV	Photovoltaic
PWM	Peat Water Management
R&D	Research and Development
RAN	National Action Plan
RAD-GHG	Regional Action Plan for Reducing Emissions
RBCS	Regenerative Burner Combustion System
RDF	Refuse Derived Fuel
RIL	Reduced Illegal Lodging
RPJPM	National Long-Term Development Plan
ROI	Return of Investment
SAR	Synthetic Aperture Radar
SC	Steering Committee
SNC	Second National Communication
SNI	Indonesian National Standard
SFM	Sustainable Forest Management
SWDS	Solid Waste Disposal Sites
SHS	Solar Home System
SRI	Soil Research Institute
TAP	Technology Action Plans
TC	Technical Committee
TEWS	Tsunami Early Warning System
TNA	Technology Need Assessment
TPA	Final Disposal Facilities
TPS	Intermediate Treatment Facilities
TT	Transfer of Technology
TTD	Technology Transfer and Diffusion
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nation Framework Convention on Climate Change

SECTION I

SYNTHESIS REPORT ON TNA FOR MITIGATION

Executive Summary

This report updates the Indonesia's previous Technology Needs Assessment Report 2009 submitted to UNFCCC in 2010, which entitled "Indonesia's Technology Needs Assessments for Climate Change Mitigation". It also summarizes and updates the dynamic national views to deal with latest issues on transfer of technology.

The government of Indonesia has endorsed a voluntary action to reduce the country's GHG emissions as high as 26 % by 2020, based on the business as usual (BAU) emission level. It indicates that Indonesia wishes to be a part of the solutions to the global climate change. Based on that target Indonesia through National Council on Climate Change of Indonesia (DNPI) is preparing the updating TNA on mitigation and preparing TNAs on adaptation of climate change and supported by UNEP- RISØ.

Based on the results of the first meeting with UNEP- RISØ and TNA's stakeholders from related Ministries, Non-Ministerial Government Institutions, Non-Governmental Organizations (NGOs) and Private Companies conducted on 24 March 2010, it was concluded that this Global TNA covers 3 (three) sectors for TNA on mitigation. Those three sectors of TNA on mitigation of climate change are forestry (including peat), energy and waste. Determining three sectors of TNA on mitigation of climate change is based on the fact that those sectors are the first three biggest contributors to GHGs emissions in the country (about 87 per cent of CO2e).

Criteria used in prioritizing the mitigation technologies are grouped into costs and benefits. The technologies of each sector were basically inventoried from published national documents prepared by several related ministries and institutions of Indonesia as well as inputs from the stakeholders meetings. Those published national documents are Indonesia TNA for Climate Change Mitigation (Government of Indonesia, 2009), Second National Communication (KLH, 2009), Indonesia Climate Change Sectoral Road Map (BAPPENAS, 2009), and others. If the number of proposed technologies from each sector is found to be greater than 10 technologies, they are first pre-screened based on their opportunities of being implemented and their possibilities of being measured, reported, and verified (MRV). Then, Multi Criteria Analysis (MCA) methodology is applied to prioritize those technologies. The best 3 (three) prioritized technologies of each sector are finally chosen.

Those selected prioritized groups of technologies of each sector will be then determined for their types of technologies. This work must first be done to have the barriers for the purpose of the technology transfer analysed. Thus, barriers relating to regulatory, financial, institutional, capacity building, IPR, and social cultural aspects in the mitigation could then be carried out.

For forestry sector, there were 13 technologies identified by stakeholders but after intensive discussion being made there were 12 technologies concluded. Stakeholders agreed to merge the "growth and yield modelling technology" into "sequestration measurement and monitoring technology". These 12 technologies of the forestry sector were left with no pre-screening. By employing MCA, those technologies of forestry sector were then prioritized. After scoring being concluded, the stakeholders also decided that the "sequestration measurement and monitoring technology" (the first highest score) was combined with the "measurement and monitoring for reducing emission technology" (the second highest score) to become the "measurement and monitoring of carbon sequestration and emission technology". "Peat re-mapping"and"water management" then follows it.

For the energy sector, the stakeholders meeting did pre-screening 79 technologies to become 12 technologies. Of these 12 technologies, the three prioritized technologies were initially found. Those are photovoltaic, efficient electric motor and mass rapid transit (MRT). Of three prioritized technologies, the photovoltaic technology has the highest scores. It is chosen among six prioritized technologies of energy supply: PV, wind power, advanced coal power plant, geothermal power plant, biomass power plant, and nuclear power plant technologies. It is then followed by the efficient electric motor and mass rapid transport (MRT) technology from the energy of industry and transportation sub-sector; respectively. During its development however, an efficient electric motor technology did not get an approval from the Ministry of Industry as a Coordinating Institution because it is still in a free market. Developing domestic industry of electric motor will not compete with imported products. To that end, this technology was replaced with cogeneration. It is precisely called as a "regenerative burner combustion system (RBCS)" technology. In addition, the MRT was omitted from this TNA study due to the difficulty in choosing the specific technology being transferred and a responsible institution. After intensive discussions with the related stakeholders and Technical Committee as well as Steering Committee Meetings following these technological decisions, those changes were finally agreed.

Technology prioritization for waste sector focuses on municipal solid waste (MSW) treatment. The stakeholders meeting did pre-screening 15 technologies to become 13 technologies. Of these 13 technologies, the three prioritized technologies were found. The highest rank is mechanical-biological treatment followed by in-vessel composting technology and low-solid anaerobic digestion.

For decision-making processes, there were two levels: the first level was technically decided by the Technical Committee (echelon 2 members) and the second level is politically approved by the National Steering Committee (echelon 1 members). The high level consideration done by the National Steering Committee includes potential barriers of technical, economic, political and policy aspects.

1.1. Introduction

United Nations Environment Programme (UNEP) is carrying out a new cycle of the Technology Needs Assessments (TNAs) with the aim of improving the TNA conducted by several states by identifying the more focus technology needs. With TNA, participating countries are expected to develop Technology Action Plans (TAPs). In the TAPs, the prioritization of technology is conducted to facilitate the technology transfer. TAPs contain the necessary practical measures to reduce and eliminate barriers to policy, funding, technology and other necessary measures in mitigation. Referring to the Strategic Program on Technology Transfer that was designed to support 35 to 45 countries to carry out improved Technology Needs Assessments within the framework of the UNFCCC, Indonesia has participated in the first round with the period from March 2010 – July 2011.

The purpose of the TNA project is to assist participants from developing countries to identify and analyse priority technology needs, which can form the basis for a portfolio of environmentally sound technology (EST) projects and programs to facilitate the transfer of, and access to, the ESTs and expertise in the implementation of Article 4.5 of the UNFCCC. Hence TNAs are central to the work of Parties to the Convention on technology transfer and present an opportunity to track an evolving need for new equipment, techniques, practical knowledge and skills, which are necessary to mitigate GHG emissions and/or reduce the vulnerability of sectors and livelihoods to the adverse impacts of climate change. It also includes identifying barriers to the acquisition, deployment, and diffusion of prioritized technologies, and developing enabling frameworks to overcome the barriers and facilitate the transfer of technologies, leading to development of “Technology Action Plans (TAPs)”

To be a part of the solution to global climate change, the Government of Indonesia has endorsed a voluntary action to reduce the country’s GHG emission by 26%, within ten years starting from 2010 using national budget and increase to 41% with additional support of foreign aid, benchmarked to the emission level from a business as usual (BAU). This government policy was announced by the President of the Republic of Indonesia himself on the G-20 meeting in Pittsburgh, USA, in September 2009. The top three sectors that contribute to the country’s emissions are from forestry, waste and the energy sectors.

The Government of Indonesia has contributed significant efforts to realizing the solution to the global climate change. On February 5, 2007, the Indonesian Government issued a Law No. 17 of 2007 on National Long-Term Development Plan (RPJPN) Year 2005-2025. As stated in the RPJPN 2005-2025, the sustainability of the development will face challenges due to climate change. To anticipate these challenges it sets several goals concerning adaptation and mitigation of climate change to be achieved in the next 20 years, which will give comprehensive targets for all related sectors. The goals are as follows:

- Advanced research on the impact of climate change and the mapping of local vulnerabilities will be carried out to strengthen the information system for the adaptation to climate change in 2015.
- Inventory of CO2 emissions is refined and the target of the emission reduction will be adjusted to that in 2015.
- As the institutional capacity of national ministries and agencies to anticipate climate change impacts will be strengthened in year 2015, the climate-proof policy-making process and regulation will be achieved in 2020.
- The emission of GHG will decrease by 26% from the projected “BAU” emission in 2020.
- National development goals will be optimized with the influence of adaptation actions in 2025.
- Alternative sources for energy use will be significantly increased, while the use of non-renewable energy sources will be proportionately reduced.
- The risks from climate change impacts on all sectors of development will be considerably reduced in year 2030, through public awareness, strengthened capacity, improved knowledge management, and the application of adaptive technologies.
- All sectors that contribute to GHG emissions will operate using low-carbon development concept.

Some national documents related to climate change have been prepared by Indonesia. Some of those are the First National Communication under the United Nations Framework Convention on Climate Change (2000), Identification of Less Greenhouse Gases Emissions Technologies in Indonesia (2001), National Action Plan on Climate Change 2007 (RAN-PI, 2007), National Development Planning: Indonesia Responses to Climate Change (2007 revised in 2008), Second National Communication under UNFCCC (2008), and Indonesia's GHG Abatement Cost Curve (2010).

Indonesia presented the First National Communication (FNC) to the UNFCCC in 1999. One of the most important sections was the first National Greenhouse Gases Emissions Inventory for the year 1990 and the results of the first studies on the country's vulnerability to climate change.

As technology plays a very crucial role on the effort of tackling the adverse effects of the climate change issues, Indonesia launched Identification of Less Greenhouse Gases Emissions Technologies in Indonesia, in 2001. The document carried out by the State Ministry of Environment, comprises of several important sectors in the economy related to the climate change, and may be cited as the first Indonesia TNA.

Mitigation and adaptation efforts to climate change cannot only be done by one sector alone. It would require a national plan with contributions from many related sectors. For this reason in 2007, the National Action Plan in the face of Climate Change (RAN-PI) was published. This is a first national document that contains a variety of mitigation and adaptation plans involving many stakeholders. In 2008, a year after publication of the RAN-PI, the Government of Indonesia (GOI) released the Second National Communication (SNC) as the renewal of the First National Communication (FNC). The SNC presents the National Greenhouse Gases Emissions Inventory for the years 2000 to 2005. The communication was supported by the Global Environmental Facilities (GEF) through UNDP along with further funding from the GOI.

One of the important and useful documents for the preparation of this TNA is Indonesia's GHG Abatement Cost Curve (2010) published by DNPI. This study evaluates the potential for emissions reductions come from a variety of initiatives, including the estimated costs associated with the reduction initiatives.

To further elaborate the documents mentioned above and to speed up the implementation by various relevant sectors, a roadmap of mainstreaming climate change issues into national development planning called "Indonesia Climate Change Sectoral Roadmap" (ICCSR) has been set up in December 2009. The ICCSR outlines the strategic vision that places particular emphasis on the challenges emerging in the forestry, energy, industry, transport, agriculture, coastal areas, water resources, wastes and health sectors.

Furthermore, BAPPENAS issued a document namely, National Development Planning: Indonesia Responses to Climate Change in 2010. This document is an iteration of similar documents that have been published in 2007 and 2008. This "Yellow Book" outlines the GOI's commitment to timely supported and coordinated climate change mitigation and adaptation policies and activities. This document is complementary to the concurrent ICCSR and provides a comprehensive reference for integrating climate change into development plan process.

Aligning to the ICCSR, GOI through the Agency for the Assessment and Application of Technology (BPPT) and Ministry of Environment (MoE) has accomplished the TNA Mitigation in 2009. It sets seven sectors, namely energy, transport, industry, forestry, agriculture, waste and marine. Technologies identification and prioritization was done based on expert judgment.

Through the support of UNEP-RISO, TNA 2009 for mitigation will be refined and added with TNA for adaptation, which has not been made in TNA 2009. For technology prioritization of the current TNA, a Multi Criteria Analysis (MCA) is used which involves wider stakeholders in each sector so that a better result of selected best applicable and available technologies are expected. Furthermore, Technology Action Plans (TAPs) for multiple technologies of each sector considered to be prioritized will be integrated into the TNA 2011.

The platform of Indonesia development mentions that economic development of Indonesia must be based upon competitive advantages, wealth of natural resources, culture and human resources of which are managed through the application of science and technology. The final goal is actually to improve people's welfare that embodies the nationally democratic and equitable life. However, as a developing country, Indonesia has a challenge in the development, especially with global environmental conditions. Challenges include climate change, energy security, food security, and sustainable resources to be considered in achieving the MDGs targets as well as building competitiveness. Thus, “low carbon development” planning is an option while maintaining its economic growth.

Although Indonesia is not a member of Annex-I countries that are obliged to reduce carbon emissions, Indonesia is in fact a vulnerable country to climate changes particularly in agricultural and marine/fisheries sectors. For that end Indonesia needs contributing to the global efforts through mitigation and adaptation of climate change. Mitigation efforts are manifested through Presidential Decree no. 61 of 2011 concerning the National Action Plan for Reducing Emissions of GHGs (RAN-GHG). Basically, RAN-GHG is an order to follow up the Bali Action Plan agreement on the Conferences of the Parties (COP-13) to the UNFCCC and the COP-15 in Copenhagen as well as COP-16 in Cancun. Targets in the RAN-GHG itself based on the GOI's commitment in the G-20 Summit in Pittsburgh to reduce GHG emissions by 26% with their own funding efforts and 41% in total with the international aid by 2020 from business as usual (BAU) conditions. Emission reduction of 26% will be achieved from forestry sector (87.61%), energy sector (5.08%), waste sector (6.25%), and other sectors. RAN-GHG document is a reference to efforts to reduce GHG emissions for society and business entities, as well as for Local Government as a reference in preparing the Regional Action Plan for Reducing Emissions of GHG (RAD-GHG).

Basically, national development of Indonesia is prepared by the National Development Planning Agency (BAPPENAS), including various activities related to the response to climate change. While the National Council on Climate Change (DNPI) is in charge of formulating national policies on climate change, coordinating related activities covering aspects of climate change such as adaptation and mitigation to climate change, technology transfer and financing scheme. In addition, DNPI has a task to formulate rules and mechanisms of carbon trading, monitoring and evaluation of the policies implementation on climate change response.

It mentions in RAN-GHG that the effort to reduce GHG emissions is the responsibility of ministries or related sectors. While the funding will come from the State Budget (APBN), Local Budget (APBD) and other sources. Understanding other sources of funding here is among others from bilateral, multilateral and CDM. The GOI welcomes financial assistance from bilateral and multilateral donors who support national planning efforts on climate-change-related initiatives. Several bilateral and multilateral donors are currently offering funding to Indonesia through two broad categories: the UNFCCC financing mechanism and the Official Development Assistance (ODA) framework.

Thus the funding mechanisms that comply with Government Regulation No.2/2006 are: (a) Grant, (b) Loan (Sector / Project Loan and Program Loan), (c) CC (local) Trust Fund and, (d) Debt for Nature Swap. Loan resources can be utilized when grant funding is insufficient and should be the last alternative for climate change financing. Sector/ Project loan is allowed to support the Kyoto Protocol's Clean Development Mechanism (CDM) as long as the Certified Emission Reduction (CER) credits obtained from the project will be owned by GOI or project developers (in the case of state-owned enterprise). A new key source of financing climate change is emerging in the form of a trust fund scheme. The Indonesia Climate Change Trust Fund (ICCTF) is one of the mechanisms that GOI intends to use to mobilize the required funding for the promotion of coordinated national action to respond to climate change mitigation and adaptation activities.

1.2. Institutional arrangement for the TNA and the stakeholders involvement

Participation of different institutions from the beginning of the process will ensure the ownership and in-depth discussion for defining selected and prioritized technologies. At the end, it will make easier for each sector to utilize this TNA for technology transfer program.

Stakeholder engagement processes are outlined as follows:

- Inviting various stakeholders to discussion forum.
- Conducting focus group discussions (FGDs), workshops and meetings with related sectors.
- Involving reviewers to check the content of the TNA study.
- Inter- sectoral meetings for cross cutting issues and consultation meeting with the related policy makers of Indonesia.

1.2.1. TNA team, national project coordinator and consultants

The Indonesia TNA program is coordinated by National Council on Climate Change (DNPI), and DNPI gives a mandate to the Agency for the Assessment and Application of Technology (BPPT) to technically coordinate the development of Indonesia TNA Mitigation Synthesis Report 2011 from a series of stakeholder engagement until the finalization of the study. The decision making scheme of Indonesia TNA is described in the Figure 1-1. There are two levels of decision-making processes: the first one is decisions taken by Technical Committee, and the second decisions are done by National Steering Committee. Both committees were officially endorsed by the decree of the Executive Chairman of DNPI. Prior to having approval from Technical Committee, TNA team has prepared the list of technologies of each sector and it was then discussed in facilitated workshop and FGD among members of relevant sectors and experts. The members of workshop and FGD focused only discussing and giving input on technical matters and they did not do the decisions. Hence, the TNA outputs resulted from workshop and from FGD still need to be decided by Technical Team Committee and to be approved by National Steering Committee. The Technical Committee Meeting was conducted on 9 March 2011 and it technically agreed the proposed prioritized technologies of all three sectors of mitigation with minor changes.

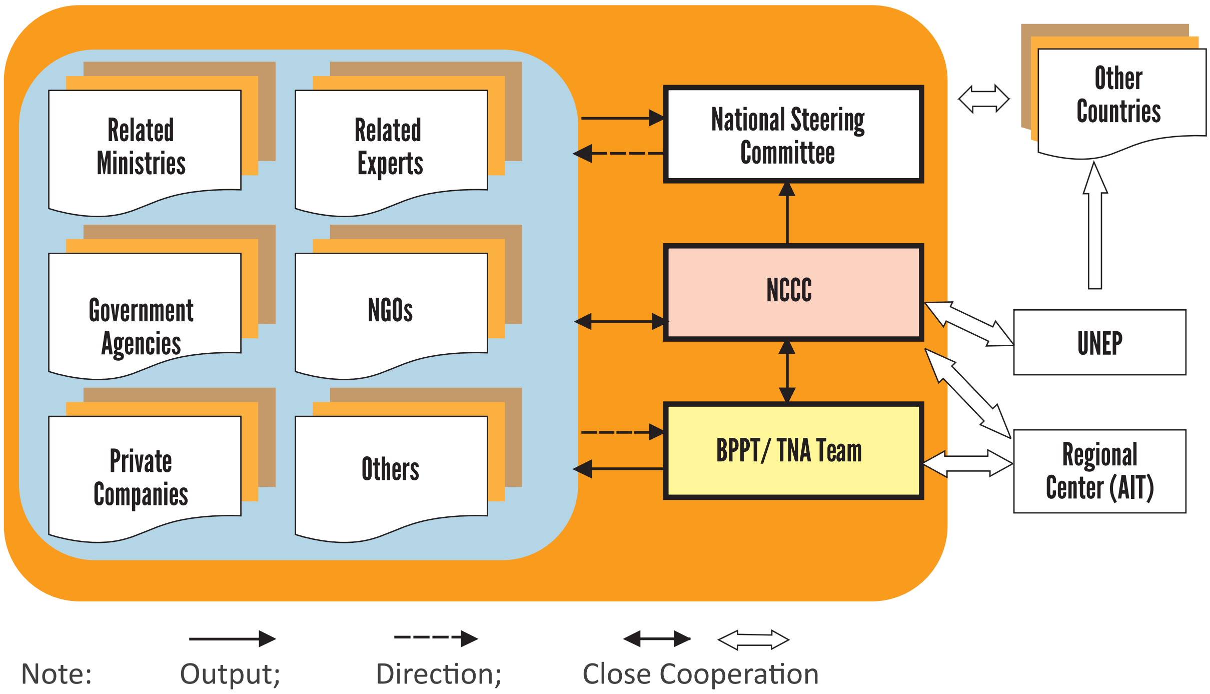

Figure 1-1 Indonesia National TNA Organization

1.2.2. Stakeholder engagement process followed in TNA

Stages in establishment of current TNA are as follows:

a) Set up expert working groups from various stakeholders and representatives from the related ministries, government agencies, NGOs and private sectors.
b) Formulate multi-stakeholders' core team and develop a work plan of the TNA study.
c) Do arrangements of meeting, discussion, workshop of related institutions and engagement of the stakeholder to decide the proposed sector and technologies;
d) Develop draft TNA, consisting of:

- Overview of existing documents, such as TNA 2009, Second National Communication (SNC), Indonesia Climate Change Sectoral Roadmap (ICCSR), the National Appropriate Mitigation Actions (NAMAs);
- Establishment of criteria for prioritizing mitigation measures;
- Definition of priority sectors and sub-sectors; and
- Selection of prioritized measures and sectors.

1) Develop Technology Action Plans (TAPs) which consist of

- Barrier analysis for market penetration;
- Policy options-enabling framework.

2) Consolidate and prepare synthesis report; and
3) Do the final launching.

This work was officially started by a kick off meeting that was conducted on 24 August 2010. From this event, the related institutions from different sectors have started to involve. As an initial step before carrying out series of stakeholders meeting, TNA team reviewed the available national documents or studies published by different ministries as stated above, developed draft criteria based on TNA 2009, identified relevant resource persons and potential contact persons from different institutions. It is noted that in 2010, there were some reorganizations in the ministries and in other governmental institutions of Indonesia and therefore there were change in the persons in charges who become members of the TNA Technical and Steering Committees.

In November 2010, there was a meeting to discuss the potential members of Steering and Technical Committees. It was not easy to appoint them and in fact, the appointment process of Steering and Technical Committee's members required much longer time than that as predicted. This is due to high-level persons in charge from related ministries and other government institutions were not officially appointed yet.

In addition to having official meeting, TNA team also did the informal meetings with experts and resource persons from different ministries and institutions as well as from NGOs to speed up the process of TNA study.

In February 2011, TNA team finally carried out mitigation workshop for 3 sectors (energy, forestry and waste). The result of workshop was the draft of the prioritized technologies (2 or 3 technologies from each sector). This draft of the TNA study was then discussed and decided during technical meeting conducted on 9 March 2011 and attended by Technical Committee of Echelon 2 Officials from different ministries and governmental institutions.

The mitigation workshop was attended by different experts from different ministries, governmental institutions and NGOs. For example, for forestry sector there were the representatives from Ministry of Forestry, Ministry of Environment, Soil Research Institute, Bogor Institute of Agriculture (IPB), and Tropical Peat Research Center (CIFOR). For energy sector, there were representatives from Ministry of Energy and Mineral Resources, the Ministry of Transportation, Environmental Business Development Foundation, Indonesia National Committee – World Energy Council (KNI-WEC), Ministry of Research and Technology, Ministry of Industry, and the Institute for Essential Services Reform (IESR). For waste sector, there were representatives from the Center of Environmental Technology-BPPT, DNPI, the Ministry of Public Works, Ministry of Environment, Indonesia Waste Forum (IWF), the National Development Planning Agency (BAPPENAS) and Indonesia Solid Waste Association (INSWA).

1.3. Sector prioritization

The first meeting of the stakeholders and experts in the beginning of the project has concluded that there were three sectors for TNA Mitigation namely forestry including peat, waste and energy.

1.3.1. An Overview of sectors and their GHG emission profile and potential for GHG

1.3.1.1. Forestry sector

The forestry sector had been the second backbone of national economic development between 1980 and 1990 and will continue to be one of the prime movers of economic development. Indonesia h as forest land of 120.3 Million hectares (~ 60% of the country's land area), spreading into seven geographical areas started from beach forest, peat forest, mangrove forest, low land tropical rain forest, savannah, and mountain to alpine forest. Along with the shift of the national development direction during 1970s, forestry also generated employment as well as business opportunities. In early 1990s, the forestry provided direct employment for 1.35% of the labour forces or even 5.4% for indirect employment.

Forest has two major mitigation functions: to act as carbon sink and source of GHG emission. High rates of deforestation, degradation of peat lands and forests degradation constitute the key sources of emissions. The results of the SNC study, in 2000, total GHG emissions for the three main GHG (CO2, CH4 and N2O) without LULUCF (LUCF and peat fire) reached 594.738 Gg CO2e. With the inclusion of LULUCF, total GHG emissions from Indonesia increase significantly to about 1,415,988 Gg CO2e. The main contributing sectors were Land Use Change and Forestry, followed by energy and waste.

Whereas according to the National Development Planning: Indonesia Responses to Climate Change report, it is predicted in 2020, GHG emissions from the forestry sector will reach 1.570 Gt CO2e. The figure of peat land reaches 1.44 Gt CO2e and forest fire and deforestation at 0.13 Gt CO2e. According to the latest survey (BAPPENAS, 2009) peat land-related emissions was 900 Mt CO2/year the between 2000 and 2006. From the above information it can be concluded that emissions from the forestry sector is above 85%, so it will be very significant if the mitigation done to reduce its GHG emissions.

The Ministry of Finance (MoF, 2005) estimated that 17% of Indonesia's total population relied on the forestry sector both in formal and informal sectors. Climate change mitigation in forestry can be achieved through carbon sinks namely forest plantation, rehabilitation of degraded protection forest and conservation forest. Additionally, reduction of greenhouse gas emissions can be realized by improving management of natural forests (production forest/HPH, protection forest, and conservation forest).

This is in line with the sectors that have been specified in the RAN-GHG in order to reduce emissions of GHG by 26% in 2020. In Indonesia, the role of forest in the context of climate change is crucial for its adaptation and mitigation functions. Indonesia adaptation and mitigation policies for forestry sector will affect both national and global levels because of the sector significant levels of GHG emissions as well the need to enhance the resilience of forest ecosystem.

1.3.1.2. Energy sector

The energy sector is the third largest contributors to GHG emissions in Indonesia. In 2004, GHG emissions from energy utilization reached 22.5% of total national GHG emissions amounting to 1,711,443 Gg CO2e. Emission reduction strategy is outlined by improving energy efficiency, increasing utilization of new and renewable energy, cleaner fuels (fuel switching) and clean energy technologies. The program includes energy efficiency, energy audit, energy efficient lighting program, renewable energy development program (Desa Mandiri Energi/ Energy self-sufficient village), Bio fuel (BBN) and Non-BBN (MHP, PLTS, fired plant), development of rural biomass furnaces (Healthy and Energy Efficient Furnace Program). Fuel switching programs is done through utilization of biogas program, the development of city gas in the household sector, program substitution of fuel oil (BBM) to the Fuel Gas (CNG) or Bio Fuel (BBN), and optimizing the utilization of geothermal.

Final energy consumption in Indonesia in the last 10 years increased by an average 4.24% while the GDP in the same period grew by an average 7.16%. Growth in energy consumption in recent years is decreasing due to world economic crisis and causing some commodity has decreased and the enactment of the CAFTA free market which resulted in a de-industrialization, especially for certain industries. In fulfilling the final energy consumption, nearly 50% of the energy mix in the form of petroleum, followed by natural gas, and coal. The mix of New and Renewable Energy (geothermal and hydropower) only reaches 5% of total Indonesia's energy mix by 2010.

In mitigating climate change in the energy sector, Indonesia needs to address its heavy reliance on fossil-based fuels properly. The GHG emissions from the energy sector must be managed as this sector is crucial to the development of the national economy, both for earning export/ foreign exchange revenue and for fulfilling the need for domestic energy.

1.3.1.3. Waste sector

Waste sector was chosen, apart because it is the second highest total GHG emissions in Indonesia. Its contribution to the GHG emission is mainly due to Municipal Solid Waste (MSW) and urban wastewater. The amount of Indonesia MSW is estimated to be about 48.8 Mt/year, calculated from its population of 218.8 million people and MSW generation rate of 0.61 kg/ cap/day. Most of MSW (40%) is transported to the Solid Waste Disposal Sites (SWDS/'landfill) and the rest is illegally dumped (8%), composted and recycled (2%), open burned (35%) and treated in other ways (15%). Indonesia faces many problems in terms of MSW issues. Most cities have no consistent master plan on managing solid waste. MSW management has not been prioritized by local government policy as indicated with limited budget allocation.

These problems are slowly beginning to be addressed by the issuance of Law no. 18/2008, where the MSW service is the domain of government (central and local). The birth of this Act is a form of government political commitment. Based on experience so far, the problem of MSW cannot only be solved by technology alone. There are at least 4 (four) other aspects that need to be considered: financial, organizational (institutional), legal and social awareness aspects.

In accordance with the agreement among stakeholders in the workshop, the mitigation technology in the waste sector only covers municipal solid waste (MSW) treatment. MSW becomes a focus in this study because it causes huge problems in the urban area due to its large quantity and its disposal. In addition, MSW could emit significant GHG emissions into atmosphere if it is not properly treated. Moreover, the Law no. 18/2008 about Solid Waste Management regulates that all open dumping landfills, which is currently in operation, must be replaced with the sanitary or controlled landfill in 5 years to come starting from the implementation of that law. This implies that the new technology of landfill might be necessary to be implemented in order to significantly mitigate potential GHG emission of MSW. Besides, the need for the application of intermediate treatment technology becomes important. One method to reduce GHG emissions at the landfill is to reduce the waste transported to landfill.

1.3.2. Process and criteria of prioritization

For mitigation technologies, it is suggested to use technology prioritization criteria as those used in the TNA 2009. Those were weighting criteria for energy, transportation and industry sectors. These criteria were grouped into general and specific ones. The grouped of general and specific criteria was shown in Table 1.

The specific criteria are first national policy target and specific local situation, such as relevant to existing energy policies and targets, and utilizing local energy resources. The second specific criteria are economics and cost effectiveness of technology, such as total capital cost, IRR, payback period, GHG abatement cost. The third is technology development, such as advanced but proven technology, possibilities for local manufacturing and production. Moreover, the fourth one is social acceptability, such as good impact on local socio-economic development.

Table 1-1 Specific and general criteria

General Criteria	Specific Criteria
1. Conformity with national regulations and policies, such as (food security, natural resource security, energy security, incentive for participation)	1. National policy target and specific local situation, such as (relevant to existing energy policies and targets, and utilizing local energy resources)
2. Conformity with institutional and human development, such as (capacity building)	2. Economics and cost effectiveness of technology, such as (total capital cost, IRR, payback period, GHG abatement cost)
3. Conformity with technology effectiveness, such as (reliability of technologies, and ease for wider use of technology)	3. Technology development, such as (advanced but proven technology, possibilities for local manufacturing and production).
4. Conformity with the environmental effectiveness, such as (greenhouse gasses reduction and improvement of local environmental quality)	4. Social acceptability, such as (good impact on local socio-economic development).
5. Conformity with the economic efficiency and cost, such as capital and operational costs relative to alternatives, and commercial availability	

The process of technologies prioritization was done as follows. First, the criteria suggested by UNEP was adopted and then discussed with experts and stakeholders to be changed or revised if necessary. Each of these criteria was given the weight and then use to value the available technologies. Finally, the scoring was given by all participated experts and stakeholders of each sector to those technologies fulfilled for each criteria and sub-criteria of those proposed technologies. All weighting and scoring of those criteria and sub-criteria for all proposed technologies were achieved through stakeholder engagement processes. The example of prioritization processes for sector was shown in Figure 1-2.

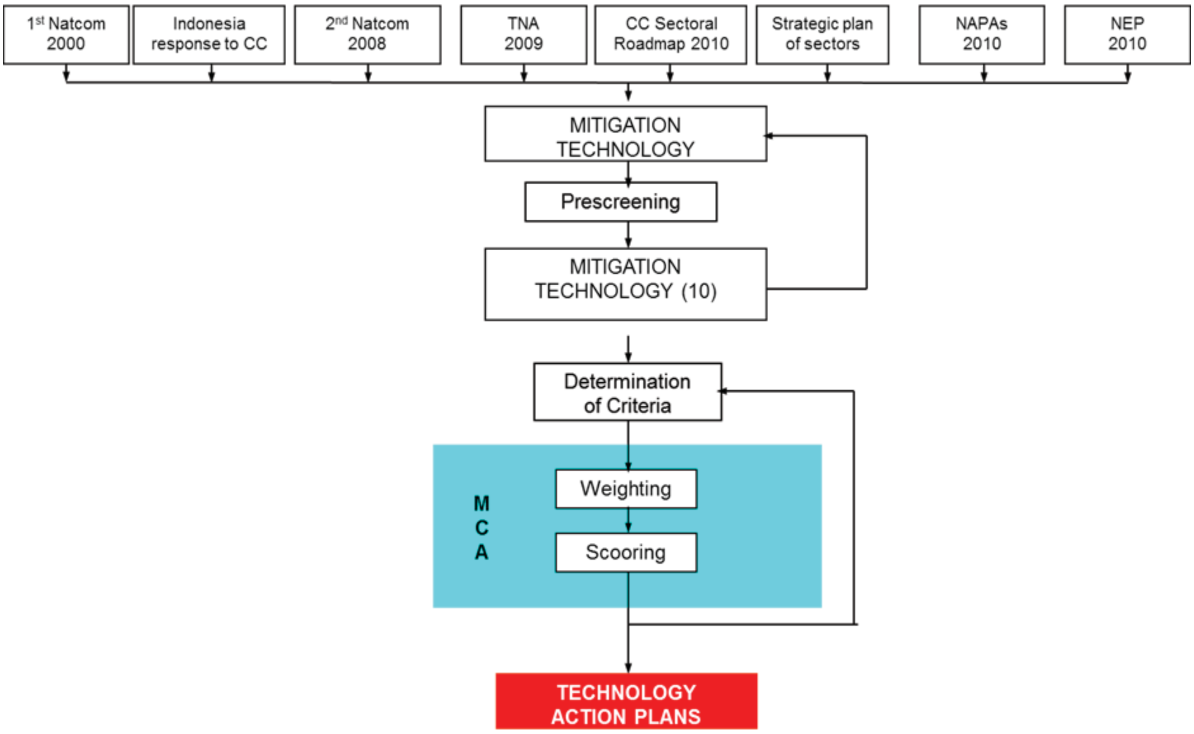

Figure 1-2 Process of TAPs establishment

Criteria determination is based on the TNA 2009, it is already in line with criteria developed by UNEP RISO (AIT), including capital costs, financial viability (IRR, NPV, etc.), reduction of GHG emissions, relevant to existing energy policy & target, utilization of local energy resources, energy security, incentive for participation, advanced and proven technology, potential of local manufacturing and production, reliability of technologies, applicability of technology, environmental effectiveness, economic growth, commercial availability (market), support to sustainability, good impact (employment, health, welfare), capacity building, social acceptance.

1.3.3. Inventory/current status of technologies in the selected sectors

1.3.3.1. Forestry sector.

Forest plays a unique role in Indonesia. Their management is complex, and in most cases barriers of proper forest management are caused by institutional issues as well as by technology insufficiencies. Addressing climate change issues in the forestry sector cannot be separated from the effort in tackling the challenges in forest management, which includes institutional especially governance issues, the gaps between available domestic funds and the magnitude of the problem to be dealt with, and market failure for forest products and services. Sustainability of forest resources is crucial for the continuation of national development, as well as in mitigation and adaptation to climate changes. Prioritized technologies for GHG emissions mitigation in forestry sector are divided into category of sink enhancement and emission reduction. For sink enhancement it is silvicultural, growth and yield modelling, advanced tree improvement, pest disease, weed and fire management, site species matching, carbon related measurement and monitoring for carbon sequestration activities, industrial forest plantation (HTI), small-scale forest plantation (HTR, HR), and rehabilitation/ restoration technology. Whereas for emission reduction, it is Reduced illegal lodging (RIL) in production forest, Use of molecular biology to support chain of custody (e.g. DNA analysis for log tracking), Zero burning technology, and Carbon related measurement and monitoring for reduced emission activities.

1.3.3.2. Energy sector.

In 2008, the national primary energy supply, including biomass amounted to 1,292.34 million BOE (Handbook of Energy & Economic Statistics of Indonesia, 2009). The amount of the national primary energy supply (excluding biomass) is 1,014.38 million BOE and 44.9% which is dominated by crude oil (including fuel), then respectively followed by coal (31.4%), gas (19.1 %), hydropower (2.9%), and geothermal (1.3%). Renewable energy by 2008 was still very low i.e. 3% of total primary energy, and 9% of total fuel power plants. Types of renewable energy sources currently used are waterpower, geothermal, bio energy, solar, and wind power. However, the use of new and renewable energy is not optimal yet, since the price of renewable energy is still relatively expensive compared to fossil energy. In order to speed up deployment of renewable energy in wider impact, government intervention will play significant role in terms of providing financial support and policy instruments.

1.3.3.3. Waste sector.

For MSW, sanitary landfill with landfill gas (LFG) recovery has become a more common technology to reduce CH4 emissions from SWDS. LFG recovery technology will be suitable for CH4 recovery both in open dumpsites and sanitary landfills. In Indonesia the transfer of LFG recovery technology, its methodology and sanitary landfill technology are still needed. It is suitable for Indonesian conditions and can replace the used open dump sites.

Composting technology is widely used in several Indonesian cities using windrow composting systems. If a windrow system is treated in the proper way, it will generate high quality compost. Such system is operated manually involving the support of scavengers to segregate the waste. The type of in-vessel composting technology is not applied yet due to high cost in investment, operation and maintenance. Beside the composting technology, mechanical-biological treatment starts to be introduced in several cities. Meanwhile, waste to energy from anaerobic digestion and incineration also becomes popular to be discussed as an alternatives waste treatment in metropolitan cities.

1.3. Technology prioritization for forestry sector

1.3.3. An overview for forestry sector

Under a business-as-usual (BAU) scenario, peat and LULUCF-related emissions are the main contributors to Indonesia's current and future GHG emissions. They also provide the largest opportunities to reduce emissions.

In the past, GHG emissions contributed by deforestation and forest degradation have received more attention than those contributed by peatland. Deforestation is caused by land conversion for (smallholder) agriculture, oil palm cultivation and pulp wood plantation but also illegal logging. Forest degradation caused by non-sustainable logging activities in Indonesia's production forests reaches the average of 250 MtCO2e of gross emissions per year if current logging practices are not changed. Deforestation in Indonesia peaked in the late 1990s, at a rate of more than 1.8 million hectares annually. It has significantly decreased since then and is expected to remain constant at the current rate of 1.1 million hectares annually.

Currently the importance of peatland's GHG emissions has however received more attention by both national and global concerns. This is due to the impacts resulted from fires on peatland, the depth of peatland more than 0.5 meter and the huge land of peatland in Indonesia more than 20,6 million hectares or approximate 10,8 per cent of Indonesian land. At the same time, the scientific understanding of peat land has improved significantly in recent years. Many researches on peat emissions and their measurement have been ongoing in Indonesia, marking a new era on recognizing the importance of peat as a source of carbon emissions (DNPI, 2010).

Fires are the main sources of peat related emissions. DNPI (2010) estimated that in 2005, fires accounted for 472 MtCO2e, more than 60 per cent of all peat land related emissions. Decomposition of peat land as a consequence of drainage is the second largest source of peat related emissions, accounting for another 300 MtCO2e. Other estimation of GHG emitted from peat fire and peat decomposition relative to that of year 2005 was also carried out by various parties such as CIFOR (Centre for International Forest Research), World Bank, Ministry of Environment, and DNPI. BAPPENAS Roadmap Scenario relies on dominant proportion (i.e., 59%) of emission reduction from peat sector. Whereas DNPI abatement cost curve scenario relies on the dominant proportion of emission reduction from LULUCF sector (i.e., 58%).

DNPI estimated the Indonesia's annual greenhouse gases (GHGs) emissions amounted to about 2.15 Giga tons (GT) in 2005. Approximately 772 Mt CO2e of which (38%) was contributed by peat lands and 838 Mt CO2e (41%) was contributed by net emission from LULUCF. In other words, peat and forestry sectors contributed more than 75% to the total Indonesia's annual GHG emissions in 2005.

Second National Communication (SNC) also considered peat and LULUCF sectors as main contributors of GHC emission. Annual emission estimation of both peat and LULUCF sectors are 440 MtCO2e and 617.28 MtCO2e, respectively, summing in a proportion of approximately 60% of total emission in 2004.

The ICCSR assessed three non BAU scenarios (SCs) namely SC1, SC2, and SC3. These three scenarios were applied to forestry (LULUCF) sector. The results of assessment revealed that SC3 increasing sink and creating conditions for preventing further deforestation is a feasible scenario to reach the target of reducing GHG emissions by 26% in the year of 2020. Most of the mitigation efforts in SC3 come from the improvement of management practices implemented on 2,440 newly developed FMU (forest management units) – KPH (Kesatuan Pemangkuan Hutan) in an area extent of 24 million hectares. SC3 has the lowest abatement cost per unit of emission reduction and is intended to reduce annual GHG net emission of 800 MtCO2e to 496 MtCO2e within a period of 2011 – 2020. In addition, the suggested ICCSR mitigation options of the peat sector are policy oriented associated with improvement of peat land management practices and directed at "low carbon" peatland management by enforcing existing legal requirement and establishing new standards. Two main mitigation options are suggested to reduce annual emission of 470 MtCO2e, from 1,700 MtCO2e of BAU down to 1,230 MtCO2e within a period of 2011 – 2020.

1.3.4. Criteria and process of technology prioritization for forestry sector

General criteria for selecting the most needed technologies were established based on national regulations and policies as well as the basic principles of Sustainable Forest Management (SFM), specifically from three different aspects of sustainability: economy, social, and ecology. Five basic criteria based on SFM were established for the purpose of TNA 2009. Brief descriptions of such general criterias are as follows:

a. Conformity with National Regulation and Policy
   The role of Indonesia's forests is as a prime mover of national development and as a resource of livelihood to which millions of people depend upon as well as provide environmental services for both national and international communities.

b. Institutional and Human Development
   From the institutional and human-development perspective, technology used in forestry must contribute to human and institutional capacities improvement, as a result of increased efficiency and effectiveness in resource utilization and technology application.

c. Technology Effectiveness
   Technology selection must serve the user needs by considering the existing potential capacities of human resources, institutions and financial resources to maintain and improve the technology.

d. Environmental Effectiveness
   Technology selection must seek the lowest environmental negative impacts and, whenever feasible, must contribute to the improvement of environmental conditions. The use of reduced impact logging technology for example, will contribute to the improvement of the remaining forest-stands after harvesting.

e. Economic Efficiency and Cost Effectiveness
   Low cost technology must also be considered as an option in selecting technology. In addition, it must also consider a trade-off between costs and quality from using the selected technology. In forest inventory or forest carbon accounting, for example, the trade-off is the increase level of accuracy of data as against the information produced and costs incurred.

The general criteria were also supported by specific criteria normally used for natural, plantation, and community-based forest. The criteria were adopted from criteria of sustainable forest management enforced by the Ministry of Forestry for the implementation of forest management in Indonesian. The criteria also adopted ones used by the Indonesian Eco-labelling Institute (LEI) for voluntary forest certification. The specific criteria for assessment on forestry sector are given as follows:

- Sustainability of production function
- Sustainability of ecological function
- Sustainability of social functions
- Technology (availability, applicability, least cost and environmental friendliness)

Finally, these two second level criteria were broken down into 20 third level criteria. The hierarchical structure of these three levels of criteria is illustrated in Figure 1-3.

The process of technology prioritization of forestry and peat sector was carried out through stakeholder workshops attended by experts, scientists, and decision makers. The task of the workshop was to:

- Re-identify technology by modifying, adding, and/ or omitting the identified technology;
- Pre-screen and define the re-identified technology and select approximately 12 technologies to be then assessed by using multi criteria analysis;
- Assess the 12 selected technologies by means of defining 'scores' based on expert judgement and consensus for each technology on each parameter; and
- Select the top three technologies based on the rank defined by the output of multi criteria analysis.

Based on the intensive discussion in the workshop regarding the list of technologies for GHG mitigation identified in Table 1-2, stakeholders agreed to modify technology number 1, i.e., "silvicultural technology" to become "intensive silvicultural technology". In addition, the stakeholders proposed another technology, i.e., "peat re-mapping" to be added into the list. Besides, the stakeholders recognized that there was a significant difference between mitigation measures of increasing carbon absorption capacity (sink) and reducing emission (conservation) of carbon stock. Therefore, they agreed not to merge technology number 6 (carbon sequestration measurement and monitoring) with technology number 10 (measurement and monitoring for reducing emission), and therefore they change technology title of number 6 to become "sequestration measurement and monitoring". Based on the agreement in the stakeholders meeting, it was also proposed the addition of technology, i.e. peat re-mapping. This technology makes the list in Table 1-2 in the right column to become 13 types of technology.

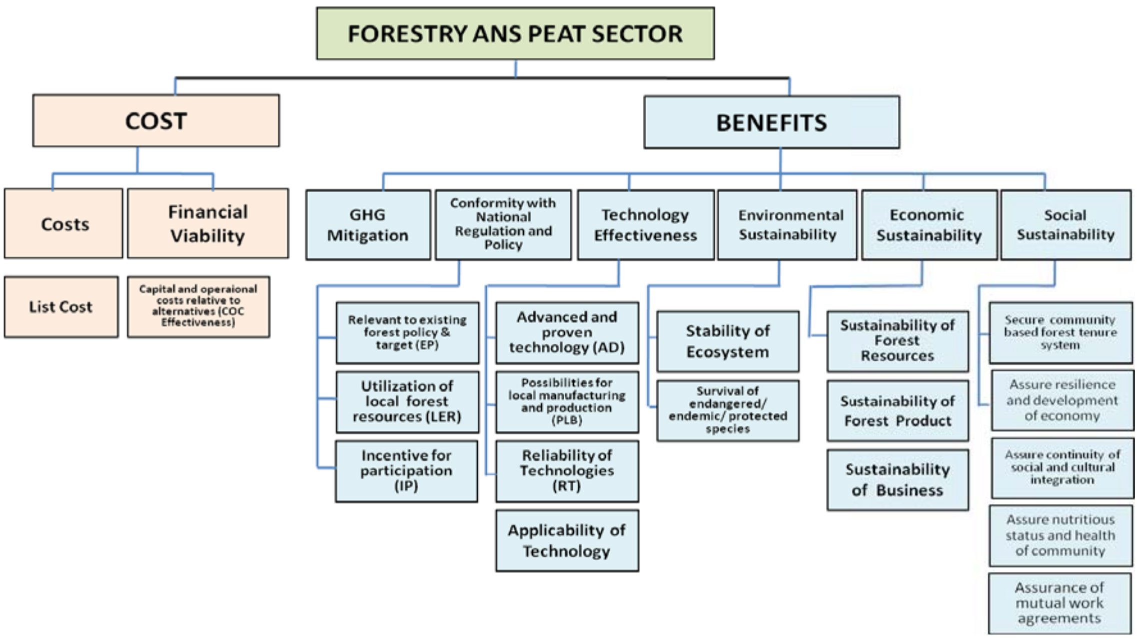

Figure 1-3 Hierarchical structure of technology selection criteria of forestry sector

Table 1-2 Re-identified technology for GHG mitigation of forestry and peat sector

Identified Technology		Reidentified Technology by Stakeholders	
1	Silvicultural technology	1	Intensive Silvicultural technology
2	Growth and yield modelling technology	2	Growth and yield modelling technology
3	Advanced Tree improvement	3	Advanced Tree improvement
4	Pest, disease, weed and fire management	4	Pest, disease, weed and fire management
5	Site species matching	5	Site species matching
6	Carbon sequestration measurement and monitoring	6	Carbon sequestration measurement and monitoring
7	Reduce Impact Logging in production forest	7	Reduce Impact Logging in production forest
8	Molecular biology for log tracking	8	Molecular biology for log tracking
9	Zero burning technology	9	Zero burning technology
10	Measurement and monitoring for reducing emission	10	Measurement and monitoring for reducing emission
11	Best cultivation practices compliant with < 3m peat	11	Best cultivation practices compliant with < 3m peat
12	Water Management	12	Water Management
		13	Peat Remapping

All these 13 technologies were done a pre-screening process and were obtained 11 types of technologies. Overall, eleven technologies are shown in Table 1-3. The followings are some important arguments to support the results of pre-screened technologies recognized by the stakeholders.

Pest, disease, weed and fire management. This packet of technology is considered part of silviculture; therefore, it should be merged into an intensive silvicultural technology.

Growth and yield modelling technology. This technology is dedicated to increase the capacity of carbon absorption therefore; it should be merged into sequestration measurement and monitoring.

Zero burning technology. Two types of fire management were recognized i.e., normal fire management as part of silvicututural practices and zero burning technology dedicated to land preparation practices for forest conversion (forest plantation estate, tree estate, small holder agriculture).

Table 1-3 Mitigation technology for forestry and peat sector (pre-screened)

No	Pre-screened Technology by Stakehoders	Note
1	Intensive Silvicultural technology	Include Pest, disease, weed and fire management
2	Advanced Tree improvement	
3	Site species matching	
4	Sequestration measurement and monitoring	Include Growth and yield modelling technology
5	Reduce Impact Logging in production forest	
6	Molecular biology for log tracking	
7	Zero burning technology	For forest conversion and fire management
8	Measurement and monitoring for reducing emission	
9	Best cultivation practices compliant with < 3m peat	Include water management and soil amendment /ameliorant/fertilizing to reduce peat decomposition
10	Water Management	Dedicated to peat dome conservation
11	Peat Remapping	Dedicated to redefining baseline information

Water management technology. Water management technology is intended for production processes, and for hydro topography conservation of peat domes. Therefore, water management for production purposes was included into best cultivation practices that comply with the peat depth of less than 3 meters (technology of number 9). Besides, to reduce the rate of peat decomposition, technology of number 9 needs to include peat soil management such as ameliorant and fertilization.

Peat re-mapping. Peat maps are now available at wide variety of scales and themes provided by many different mapping entities at different mapping times. These maps are not compatible and do not conform to each other. They need to be compiled and verified in a common standard to meet with and to conform to IPCC guidelines.

1.3.5. Results of technology prioritization for forestry sector

The element of performance matrix comprises of cells of selection criteria's weight and scores of pre-screened technologies. Determination of the weight of each criterion is based on the stakeholder discussions. Multi Criteria Analysis for mitigation of forestry sector with the weight of each criterion is given in Table 1-4. The cells were discussed among and assigned by the stakeholders.

Table 1-4 Multi criteria analysis for mitigation of forsetry sector

Sr. No.	Technology Options	Capital Costs	Financial viability (IRR, NPV, etc.)	Reduction of GHG emissions	Relevant to existing forest policy & target (EP)	Utilization of local forest resources (LER)	Incentive for participation (IP)	Advanced and proven technology (AD)	Possibilities for local manufacturing and production	Reliability of Technologies (RT)	Applicability of Technology	Stability of Ecosystem	Survival of endangered/ endemic/ protected species	Sustainability of Forest Resources	Sustainability of Forest Product	Sustainability of Business	Secure community based forest tenure system	Assure resilience and development of economy	Assure continuity of social and cultural integration	Assure nutritious status and health of community	Assurance of mutual work agreements	Total
		4.5	5.6	5.6	3.9	4.2	3.4	2.8	5.0	5.0	5.6	5.6	5.6	5.6	5.6	5.6	5.6	4.5	5.0	5.6	5.6	100
1	Intensive Silvicultural Technology	90	100	80	80	50	40	80	70	100	90	100	100	100	100	80	20	60	30	30	30	1430
2	Advanced Tree Improvement	90	100	90	80	20	20	70	30	90	90	100	100	100	100	100	40	40	40	20	20	1340.0
3	Site species matching	90	100	70	90	90	40	70	40	90	90	100	100	100	100	100	30	20	20	20	20	1380.0
4	Carbon sequestration	100	60	100	90	60	90	90	70	90	100	100	100	100	100	100	90	90	100	40	90	1760.0
5	Reduced impact logging in production	70	70	90	100	20	40	30	80	70	100	100	100	100	100	100	30	80	40	20	20	1360.0
6	Molecular Biology for log tracking	100	60	60	60	20	20	100	10	100	100	100	70	60	60	90	20	80	20	20	60	1210.0
7	Zero burning technology (for forest [illegible]	100	40	90	90	90	20	50	90	90	90	100	100	90	90	80	20	20	20	60	60	1390.0
8	Measurement and monitoring for reducing emission	100	50	100	100	80	90	100	90	100	100	100	80	100	100	100	90	90	90	40	90	1790
9	Best cultivation practices compliant with < 3m peat	100	90	80	80	70	60	90	90	80	90	100	80	90	90	90	40	90	90	40	80	1620
10	Water Management	100	90	80	80	80	70	90	80	90	100	100	80	90	90	80	20	90	90	40	90	1630
11	Peat Re-Mapping	100	100	80	90	80	60	100	90	100	100	90	70	100	90	70	70	70	70	40	80	1650

Further analytical work was performed to select top three prioritized technologies based on their total scores obtained from the aforementioned matrix (MCA). The final scores were re-grouped into two clusters: cost and benefits. The performance matrix of technology selection of forestry and peat sector is presented in Table 1-5. Result of technology prioritization is presented in Table 1-6. The final scores of Table 1-6 indicate that there are three technologies having the highest scores, i.e.:

1) Measurement and monitoring for reducing emission.
2) Carbon sequestration measurement and monitoring.
3) Peat re-mapping.

Table 1-5 Performance matrix of technology selection of forestry and peat sector

Technology	Cost		Benefit						Total	Rank
	List cost	Capital and Operational	GHG Mitigation	Conformity with National Regulation and Policy	Technology Effectiveness	Environmental Sustainability	Economic Development	Social Development		
Intensive Silvicultural Technology	4.0	5.6	4.5	6.6	15.9	11.2	15.7	8.7	130.1	
Advanced Tree Improvement	4.0	5.6	5.0	4.6	13.1	11.2	16.8	8.3	122.7	
Site species matching	4.0	5.6	3.9	8.7	13.6	11.2	16.8	5.8	125.7	
Carbon sequestration measurement and monitoring	4.5	3.4	5.6	9.1	16.2	11.2	16.8	21.4	162.8	2
Reduced impact logging in production forest	3.1	3.9	5.0	6.1	14.0	11.2	16.8	9.5	127.4	
Molecular Biology for log tracking	4.5	3.4	3.4	3.9	13.9	9.5	11.8	10.2	109.8	
Zero burning technology (for forest conversion) and fire management	4.5	2.2	5.0	8.0	15.5	11.2	14.6	9.7	129.8	
Measurement and monitoring for reducing emission	4.5	2.8	5.6	10.3	18.0	10.1	16.8	20.9	165.0	1
Best cultivation practices compliant with < 3m peat	4.5	5.0	4.5	8.1	16.1	10.1	15.1	17.5	148.0	5
Water Management	4.5	5.0	4.5	8.9	16.7	10.1	14.6	17.0	148.3	4
Peat Re-Mapping	4.5	5.6	4.5	8.9	18.0	9.0	14.6	17.3	150.0	3

The above-mentioned top three prioritized technologies of forestry and peat sector are characterized by their non-physical mitigation measures, which have no direct efforts to reduce GHG emission. In other words, their characteristics are more dedicated to MRV (monitoring, reporting, and verification) than to direct reduction of GHG emission. Recognizing these facts, the assessment suggests the followings:

- Merge the two first technologies into one cluster of measurement and monitoring technology for both sequestration and emission.
- Assign peat re-mapping technology as rank 2.
- Assign water management technology from rank 4 into rank 3.
- Define the top three selected technologies of forestry and peat sector as follows:

  1) Measurement and monitoring of carbon sequestration and emission.
  2) Peat re-mapping.
  3) Water Management

The three-selected technology does not directly associate with a decrease in GHG emissions, except for water management. To note that the largest GHG emissions from forestry sector is a result of forest fires rather than anthropogenic. Therefore, water management technologies are needed in order to prevent and deal with forest fires. While the magnitude of emissions and carbon sequestration is vital to be t known and reported, so it would require monitoring and measurement technologies both as an emitter and as carbon sinks. Peat land as a big source of emissions needs to be mapped to known quantities and the potential emissions. These three technologies are expected to be implemented in a single location so that the pilot can be replicated to other locations.

Table 1-6 Result of technology prioritization

No	Technology	Costs	Benefits		Total	Priority Rank
			GHG Mitigation	Development Benefits		
1	Intensive Silvicultural Technology	9.6	4.5	58.0	72.1	6
2	Advanced Tree Improvement	9.6	5.0	54.0	68.7	10
3	Site species matching	9.6	3.9	56.1	69.6	9
4	Carbon sequestration measurement and monitoring	7.8	5.6	74.7	88.1	2
5	Reduced impact logging in production forest	7.1	5.0	57.6	69.7	8
6	Molecular Biology for log tracking	7.8	3.4	49.3	60.5	11
7	Zero burning technology (for forest conversion) and fire management	6.7	5.0	59.0	70.8	7
8	Measurement and monitoring for reducing emission	7.3	5.6	76.1	89.0	1
9	Best cultivation practices compliant with < 3m peat	9.5	4.5	67.0	81.0	5
10	Water Management	9.5	4.5	67.2	81.2	4
11	Peat Re-Mapping	10.1	4.5	67.7	82.3	3

1.4. Technology prioritization for energy sector

1.4.3. An Overview for energy sector

Energy sector is one of the biggest greenhouse gases (GHGs) emission contributors in Indonesia. In 2004, GHGs emission due to energy utilization reached 22.5% of the total national GHGs emission that was 1,711,443 Gg CO2e including LULUCF (Land Use and Land Use Change and Forestry). Because of the important role of energy sector in contributing GHGs emission in Indonesia, several analyses and assessments of GHG emission reduction technologies have been carried out since 2000. The implementation efforts of GHGs mitigation have been making progress since the announcement of the Government of Indonesia's policy to reduce GHGs emission as many as 26% with national budget or even 41% with additional foreign aid by 2020.

For example, the assessment of GHG mitigation on the energy sector was started in 2000 when the First National Communication under the United Nations Framework Convention on Climate Change was prepared by State Ministry of Environment (MoE) in cooperation with the United Nations Development Programme (UNDP). In this study several GHGs mitigation technologies in the transportation sector, electricity generation, coal upgrading, energy labelling and energy standardization were recommended to be prioritized.

In 2001, the MoE and the UNDP also carried out a study on the identification of less greenhouse gases emissions technologies in Indonesia. Several energy technology options in reducing GHGs emissions at both supply and demand sides were resulted from this study. It also reported several criteria for selecting the GHGs mitigation technologies in the energy sector.

Based on the marginal abatement curve criteria it was concluded that the prioritized groups of technologies were as the following orders: co-generator, electric motor, solar thermal pump, CF lamp, improved refrigerator, high technology refrigerator, new biomass furnace, new mini hydro generator, gas combined cycle generator, advanced compact fluorescent lamp, compact refrigerator, compact panel refrigerator, new gas furnace, new biomass power plant, new gas turbine, geothermal generator, new HSD gas turbine, new 600 MW coal power plant, and new 400 MW coal power plant.

The study done by the Second National Communication (SNC) under UNFCCC described about the GHGs emissions of each sector as well as the mitigation technologies of electricity generation, energy supply, energy for industry, energy for households and energy for transportations. However, this study did not mention how much CO2 emission could be reduced by the use of those mitigation technologies. It did not also inform the cost spent as a result of employing each of those mitigation technologies.

In the Indonesia TNA 2009 study coordinated by BPPT, the energy sector was separated in the following groups: electricity generation and fuel production, energy use in industry, and energy use in transportation. This TNA study did the detailed mitigation technology analysis of each sector. It was also set up the criteria in selecting GHGs mitigation technologies, particularly for the energy sector. The expert judgment was used to prioritize energy technologies in this TNA mitigation. The sort of prioritized mitigation technologies in the energy sector from highest to the lowest scores was then established.

The study of Indonesia Climate Change Sectoral Roadmap coordinated by the National Development Planning Agency (2010) comprehensively evaluated energy priority for GHGs mitigation. In the same year of 2010 the assessment of Indonesia's GHG Abatement Cost Curve was carried out by the National Climate Change Council (DNPI) and McKinsey. This study also evaluated marginal abatement cost curve (MACC) of the energy sector. The MACC for electric generation, industry (especially cement industry), transportation, petroleum refinery and building of energy sector was discussed. In terms of the national energy policy, it was described the important of cleaner technology application to enhance national energy security, and fuel substitution, as well as energy utilization, conservation and efficiency for the future national energy demands.

1.4.4. Criteria and process of technology prioritization for energy sector

Weighting the criteria for selecting GHG mitigation technologies in the energy sector has been explained in TNA 2009 report, including industrial and transportation sectors. These criteria were then grouped into general and specific ones as shown in Table 1-1.

From related national studies or documents mentioned above it was summed up to be 79 types of energy technologies that could be used to mitigate the GHG emissions from the energy sector in Indonesia. Based on the consensus of stakeholders, the overall mitigation technology is still relevant to be assessed in the current study. All the technologies proposed in the previous TNA tabulated, compiled, and eventually produce about 79 technologies. The results of 79 GHG mitigation technologies in the previous TNA were then narrowed by selecting top 10 technologies with the highest scores in each sub-sector; power generation, industry, and transportation. Therefore, the total for the energy sector is then 30 technologies.

Those thirty technologies from the three sub-sectors were compared with the technology proposals put forward in a variety of previous studies. The results of comparison then tabulated and obtained 12 GHG mitigation technologies that represent sub-sector power generation, industrial, and transportation. These 12 technologies were finally prioritized using Multi Criteria Analysis (MCA).

In this current TNA study, UNEP-RISO suggests to use certain criteria for prioritizing mitigation technologies grouped into cost and benefit which is actually similar to the criteria used during TNA 2009 study. Therefore, in order to prioritize 12 types of mitigation technologies for energy sector it is used the criteria structure suggested by UNEP-RISO and employing sub-criteria used in the TNA 2009 study. This combination of prioritizing structure and its criteria is shown in Figure 1-4.

The criteria that the mitigation technologies measurable, reportable and verifiable (MRV) were used in pre-selection process. The selection also took into consideration the purpose of technology transfer, clear and concise contracts, and clear executing agencies.

The criteria put in Table 1-1 are essentially an umbrella for "tree" criteria of Figure 1-4. This means that the criteria in Figure 1-4 become more details as a result of the development of Table 1-1. The criteria are grouped into benefit and cost as suggested by UNEP/URC during the workshop. They are also to be more practical and operational, but not contrary to criteria listed in Table 1. Some adjustments might be made. For example, the criteria for GHG mitigation of Figure 1-4 are put in the cluster of benefits and more highlighted, while in Table 1, these criteria are included in the technology effectiveness. The criteria for social benefits of cluster development of Figure 1-4 previously entered into the specific criteria in Table 1. Based on Figure 1-4, it is obtained 18 criteria for the MCA energy sector.

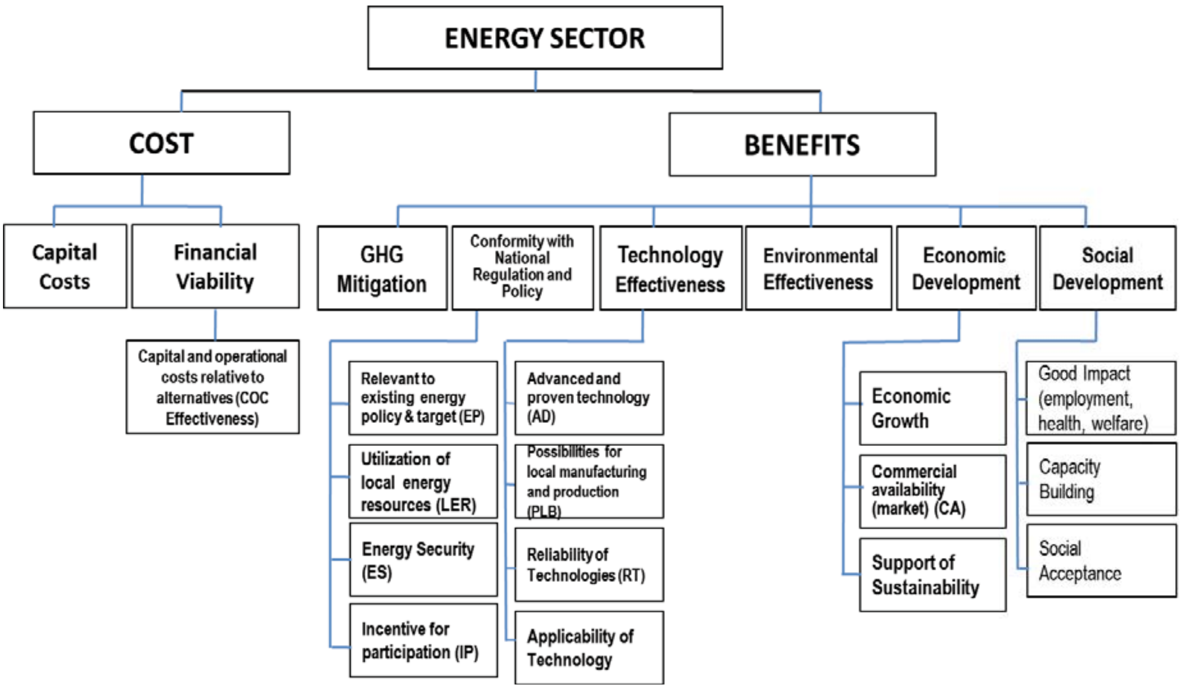

Figure 1-4 Structure and criteria used for prioritizing mitigation technologies in energy sector

Table 1-7 shows 12 types of technologies in the energy sector that are proposed to be prioritized using MCA. Technology receiving highest score in each sub-sector (energy generation, energy for transportation, energy for industry) was chosen and thus three mitigation technologies were finalized in the energy sector. The scoring of the mitigation technologies among sub-sectors in this work was done separately. For example, technology scoring for transportation sub-sector did not interfere the scoring for energy generation sub-sector or for industrial sub-sector, or vice versa. Table 1-8 shows the scoring results of the MCA as a whole.

Before the best technology from each sub-sector was established, there was an intensive discussion among related stakeholders to investigate whether that technology really connected the national program and could be implemented in the mitigation of GHG emission from energy sector. A significant time was spent in this process because it had to go back over to score until to obtain the ones that were really priority of the sector as well as in line with the national policy and program. Discussions were always made to determine what technologies would be prioritized through pre-screening or MCA procedure. The technology chosen must be realistic and sector or ministry priority.

Table 1-7 Options of GHG mitigation technologies for energy sector

No	Sectoral/Technology	TNA 2009	NAMA's		Cost Curve	Roadmap	2nd Natcom	NEP	1st Natcom	Less GHG
			26%	41%						
		2009	2010		2010	2010	2009	2010	2000	2001
A	ENERGY									
1	Advanced Coal Power Plant	XX		XX	XX		XX	XX		XX
2	Geothermal Power Plant	XX		XX	XX		XX	XX	XX	XX
3	Biomass Power Plant	XX	XX		XX	XX	XX	XX	XX	XX
4	Wind Power	XX	XX		XX	XX	XX	XX	XX	XX
5	Photovoltaic	XX	XX			XX	XX	XX	XX	XX
6	Nuclear	XX								
B	INDUSTRY									
7	Cogeneration	XX			XX		XX			XX
8	Electric Motors	XX				XX	XX			XX
9	Pump and Fan System	XX								XX
	TRANSPORTATION									
	Improvement of Public Transport	XX	XX		XX	XX	XX	XX	XX	XX
	I T S	XX		XX	XX	XX	XX	XX	XX	
	C N G	XX	XX			XX	XX	XX	XX	XX

In order to gain support politically these prioritized technologies were brought to the technical team meeting consisting of Echelon 2 ranking Government Officials from related ministries (Ministries of Energy, Transportation, Industry and Research and Technology). Then, the final decision was made by the steering committee meeting chaired by the Chairman of The National Council on Climate Change (DNPI) with the members consisting of highest rank of Echelon 1 Government Officials from related ministries.

Table 1-8 Scoring of multi criteria analysis for mitigation of energy sector

Mitigation Technology	CRITERIA																		
	COST		BENEFIT																TOTAL
			GHG	Policy				Technology				Environmental	Economic			Social			
	Capital Costs	Financial viability (IRR, NPV, etc.)	Reduction of GHG emissions	Relevant to existing energy policy & target (EP)	Utilization of local energy resources (LER)	Energy Security (ES)	Incentive for participation (IP)	Advanced and proven technology (AD)	Possibilities for local manufacturing and production (PLB)	Reliability of Technologies (RT)	Applicability of Technology	Environmental Effectiveness	Economic Growth	Commercial availability (market) (CA)	Support of Sustainability	Good Impact (employment, health, welfare)	Capacity Building	Social Acceptance	
PV	9.3	8.4	5.2	3.3	5.2	7.4	4.5	3.7	9.3	2.2	2.6	4.6	6.0	1.7	1.3	2.5	2.2	2.6	82
Wind Power	7.0	5.9	0.7	3.3	5.2	3.7	2.8	3.7	7.4	2.6	2.6	3.9	3.6	1.7	1.3	2.0	2.2	2.2	62
Advanced Coal Power Plant	2.8	2.5	7.4	5.9	4.6	6.7	4.5	4.7	7.4	3.0	3.0	5.2	4.8	2.2	1.5	2.2	3.3	3.0	75
Geothermal Power Plant	5.6	5.0	3.7	6.5	5.9	7.4	5.6	4.7	4.7	3.0	3.3	6.5	3.6	1.7	1.5	2.0	3.0	3.3	77
Biomass Power	4.7	5.0	3.7	3.9	5.2	3.7	2.8	2.8	7.4	3.0	3.0	3.9	3.6	1.4	1.3	2.0	2.2	2.6	62
Nuclear	7.4	5.9	3.0	3.3	2.6	7.4	5.0	4.2	4.7	3.0	2.6	3.9	4.2	1.7	1.5	2.0	3.0	2.2	67
Cogeneration	9.3	6.7	3.7	5.2	4.6	5.2	3.9	4.2	4.7	2.6	2.6	5.2	3.6	2.0	1.3	2.0	1.9	2.2	71
Electric Motors	9.3	7.5	6.7	5.2	2.6	5.2	4.5	3.7	6.5	1.5	2.2	4.6	4.2	2.0	0.7	1.4	2.6	1.5	72
Pump and Fan System	9.3	5.9	3.0	5.2	4.6	4.5	3.3	3.3	8.4	2.6	1.9	3.9	4.2	2.0	0.9	2.0	2.6	2.6	70
ITS	7.4	5.0	6.7	6.5	2.6	6.0	2.2	4.7	5.6	2.6	3.3	5.9	5.4	2.2	1.5	2.5	2.6	1.9	75
Improvement of public transport	9.3	8.4	7.4	6.5	5.2	7.4	2.2	4.7	5.6	1.5	3.7	5.9	6.0	1.1	1.5	2.5	3.3	3.3	86
CNG	5.6	6.7	6.7	6.5	6.5	7.4	2.2	3.3	5.6	1.9	3.7	6.5	6.0	2.8	1.9	2.8	3.3	3.7	83

1.4.5. Results of technology prioritization for energy sector

From technology prioritization done by stakeholders using MCA for each sub-sector, photovoltaic technology obtained the highest score among six prioritized technologies of energy supply sub-sector (PV, wind power, advanced coal power plant, geothermal power plant, biomass power plant, and nuclear power plant). For industrial and transportation sub-sectors, the respective highest scores of mitigation technologies were an efficient electric motor and MRT. Even though these three technologies have been agreed by the stakeholders during the workshop, the final decision was then made by the technical team meeting and steering committee meeting. The concluded result of the prioritized GHG emission mitigation technologies from energy sector is given in Table 1-9.

Table 1-9 Summary of twelve prioritized GHG emission mitigation technologies for energy sector

Technology	COST		BENEFIT						TOTAL
	Capital Costs	Financial viability (IRR, NPV, etc.)	Reduction of GHG emissions	National Regulation and Policy	Technology Effectiveness	Environmental Effectiveness	Economic Development	Social Development	
PV	9.3	8.4	5.2	20.4	17.9	4.6	9.0	7.3	82.0
Wind Power	7.0	5.9	0.7	15.0	16.4	3.9	6.6	6.4	61.9
Advanced Coal Power Plant	2.8	2.5	7.4	21.6	18.0	5.2	8.6	8.6	74.7
Geothermal Power Plant	5.6	5.0	3.7	25.4	15.6	6.5	6.8	8.3	76.9
Biomass Power	4.7	5.0	3.7	15.6	16.2	3.9	6.3	6.8	62.2
Nuclear	7.4	5.9	3.0	18.3	14.4	3.9	7.4	7.2	67.5
Cogeneration	9.3	6.7	3.7	18.9	14.0	5.2	6.9	6.0	70.8
Electric Motors	9.3	7.5	6.7	17.5	14.0	4.6	6.9	5.5	72.0
Pump and Fan System	9.3	5.9	3.0	17.6	16.1	3.9	7.1	7.2	70.0
ITS	7.4	5.0	6.7	17.3	16.2	5.9	9.2	7.0	74.7
Improvement of public transport	9.3	8.4	7.4	21.4	15.4	5.9	8.7	9.2	85.7
CNG	5.6	6.7	6.7	22.7	14.4	6.5	10.7	9.9	83.2

1.5. Technology prioritization for waste sector

1.5.3. An overview for waste sector

In term of municipal solid waste (MSW) management, Indonesia is facing many problems, such as:

- There is no consistent master plan of municipal solid waste (MSW) management in most cities of Indonesia;
- An appropriate MSW management has not become a prioritized policy for the local government as indicated by very limited budget for MSW management;
- Facilities for waste collection, transportation, and disposal are limited;
- Almost all final disposals are open dumping sites that cause problems due to water pollution discharges, gaseous and smoke emissions and disgusting odor releases.

It is predicted that by the year 2020, the amount of solid waste generation in Indonesia will be double, compared to that of now, if the business as usual management of MSW is still done. Currently, MSW management paradigm in Indonesia still relies on the existence of final disposal facilities (TPA/landfill) that the majority are still open dumping landfills. By Law number 18/2008, this paradigm will be shifted to the source reduction. Thus, the role of technology that support the principles of the 3Rs (Reduce, Reuse and Recycle) becomes very important. One that is discussed in stakeholders meeting is how to improve technological capacity in the intermediate treatment facilities (TPS). Given the nearly more than 60% of MSW in Indonesia is degradable materials (organic), the application of technology that can make composting more efficient is important. While in the final disposal, it is expected to leave open dumping and switch to controlled landfills or semi-aerobic landfill in the management of MSW in the future.

1.5.4. Criteria and process of technology prioritization for waste sector

The development of Global TNA in the waste sector has an objective to prioritize technologies that suit to Indonesian's conditions and has significant capabilities to reduce GHGs emissions of MSW.

Stakeholders involved in this workshop were from the Ministry of Public Works, the Ministry of Environment, the Agency for Assessment and Application of Technology (BPPT), National Development Planning Agency (BAPPENAS), Indonesia Solid Waste Association (INSWA), Indonesia Waste Forum (IWF), etc. The process of the TNA for waste sector was accomplished by conducting a series of discussions and facilitated workshops attended by related stakeholders to gather inputs and to evaluate the overlapping issues of the technologies to be appraised.

For MSW management, there is basically no single best technology that can effectively overcome the waste problem because of the diverse characteristics and composition of the waste as well as the different conditions of urban where the waste is located. However, during the technology prioritization, it tends to choose the individual technology instead of integration one as a system.

It was agreed that the boundaries of selecting technology in waste sector were that the selected waste treatment technology has to be mature, advanced and able to reduce the GHG emission. In addition, it should be considered as a new technology in Indonesia. Besides that, it must relate to the issue of technology transfer and international funding. Therefore, technologies that have commonly been applied in Indonesia and at a household scale were not included in these options. Thus, the selected technologies were not only individual, advanced, mature, able to reduce GHGs emission, and new in Indonesia, but also relatively large scale and centralized.

Mitigation technology for waste sector is grouped into two folds: intermediate and final treatment technology. MSW intermediate treatment technology consists of aerobic digestion, anaerobic digestion, mechanical biological treatment, combustion, gasification and pyrolysis technology. MSW final treatment technology includes anaerobic and semi-aerobic sanitary landfill.

For the waste sector, in the process of prioritization mitigation technologies, various technologies are initially screened with the general and specific criteria contained in Table 1 above. As suggested in Table 1, the criteria are basically grouped into costs and benefits. In principle, the criteria that are developed in the "tree" structure of cost-benefit for waste sector (Figure 1-5) do not conflict with the general and specific criteria of Table 1. For waste sector, 5 sub-criteria under the cluster of benefits is basically in accordance with the general criteria, number 3, 4 and 5 of Table 1.

In accordance with national interests and policies, as well as technology need assessment, the stakeholders placed five clusters of benefit criteria that comprised of GHG mitigation, technology effectiveness, environmental sustainability, economic development and social development aspects. Each cluster was then divided into several sub-criteria except for GHG mitigation. In the cluster of GHG mitigation, it gave only one criterion that was greenhouse gas emission reduction. It means that the selected technology must be able to reduce the reasonable amount of greenhouse gases emissions.

In the cluster of cost, stakeholders put two criteria. Those were capital cost and operational and maintenance cost. The low capital cost means that the technology can be built in relatively low investment cost. Moreover, low operational and maintenance cost means that the technology can achieve its high performance in low operational and maintenance cost.

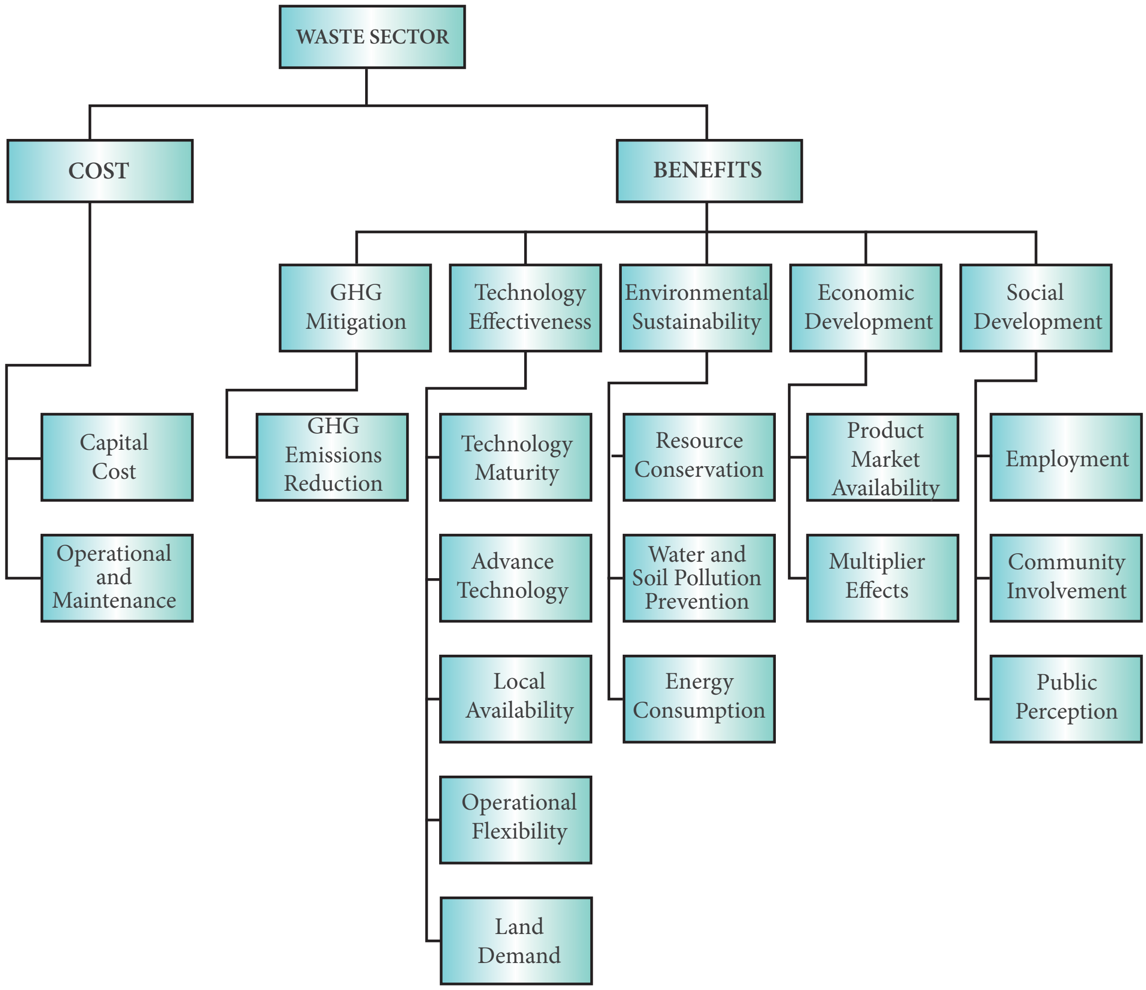

Figure 1-5 Structure and criteria used for prioritizing mitigation technologies

For the technology cluster effectiveness, stakeholders set up five criteria as follows:

1) Technology maturity means that the technology has been operated for at least 10 years and has reached in a full commercial scale.
2) Advance technology means that it is a relatively new technology in Indonesia.
3) Local availability means that the technology can be designed and built based on local conditions and with high local content.
4) Operational flexibility means that the technology can be easily operated by locally skilled people at wide ranges of operational conditions, and with diverse waste input conditions.
5) Less land demand means that the installation of technology can be applied on relatively less land area.

For the cluster of environmental sustainability, stakeholders set up three criteria as follows:

1) Resource conservation means that the technology can conserve the use of resources such as through reduce, reuse and recycle of raw materials and water.
2) Water and soil pollution prevention means that the technology discharges no or less harmful waste that causes water, soil and air pollution.
3) Low energy consumption means that the technology consumes relatively low energy.

For the cluster of economic development, stakeholders set up two criteria:

1) Product market availability meaning that the product of the technology has a high captive market,
   - The availability of market for selected technology
   - Create other business opportunities
2) Multiplier effect meaning the technology has a good impact on public in creating secondary businesses.

For the cluster of economic development, stakeholders set up two criteria: 1) product market availability meaning that the product of the technology has a high captive market, and 2) multiplier effect meaning the technology has a good impact on public in creating secondary businesses.

For the cluster of social development, stakeholders set up three criteria as follows:

1) Employment means that the technology application needs many employees for operating the process.
2) Public perception means that the technology can be accept by surrounding communities and people has a good perception on that technology.
3) Community involvement means that the technology application will involve the surrounding people to work on it.

Each criterion was given different weight depending on the level of its importance. From the stakeholders viewpoint the cluster of technology effectiveness criteria should have the highest weight due to its importance for the technology transfer program. The high technology that will be transferred should be in the way of effective and efficient. Meanwhile, the cluster of environmental sustainability and social development also has a high weight because of their importance in the environmental protection from pollution, technology acceptance by community, and a new job creation. The other clusters of criteria (cost, GHGs mitigation and economic development) relatively have the same weight because the high technologies selected have similar characteristics as those of other cluster area. From the result of stakeholders' discussion, the weight of each criterion was agreed upon. The weight of cluster criteria and sub-criteria is given in Table 1-10.

Then, every stakeholder fulfilled the scoring to each criterion of the technology options listed based on his or her experience and knowledge. The technology option was scored with a preference score between 0 and 100. The average score for each criteria technology option was combined with their weight and calculated to get the value of overall weighted scores. Overall weighted scores can be seen at Table 1-10.

Table 1-10 Weighting criteria of waste sector

Cluster	Criteria	Weight
Cost	Low Investment	4.5
	Low O&M	6.8
GHG Mitigation	Greenhouse Gas Emissions Reduction	9.0
Technology Effectiveness	Technology Maturity	7.5
	Advance Technology	6.0
	Local Availability	4.5
	Operational Flexibility	6.0
	Less Land Demand	6.0
Environmental Sustainability	Resource Conservation	6.0
	Water and soil pollution prevention	9.0
	Low Energy Consumption	6.0
Economic Development	Multiplier effect	5.0
	Market Availability	3.8
Social Development	Employment	7.5
	Public Perception	10.0
	Community Involvement	2.5

Table 1-11 Matrix of overall weighted score of technology option

Technology	Cluster																						
	Cost			GHG		Technology						Environmental				Social				Economic			
	Low Investment	Low O&M	Sub Total	Greenhouse Gas Emissions Reduction	Sub Total	Technology Maturity	Advance Technology	Local Availability	Operational Flexibility	Less Land Demand	Sub Total	Resource Conservation	Water and soil pollution prevention	Low Energy Consumption	Sub-Total	Employment	Public Perception	Community Involvement	Sub-Total	Multiplier effect	Market Availability	Sub-Total	Total
Final Disposal																							
· Sanitary Landfill	2.14	4.95	**7.09**	6.15	**6.15**	7.00	3.80	2.89	5.75	1.80	**21.24**	2.05	5.70	3.80	**11.55**	3.50	3.33	0.54	**7.38**	1.08	2.56	**3.65**	**57.05**
· Semi Aerob Landfill	1.80	5.29	**7.09**	6.90	**6.90**	5.63	5.10	2.93	5.85	1.80	**21.30**	2.60	5.70	4.25	**12.55**	3.50	3.33	0.54	**7.38**	1.08	2.50	**3.58**	**58.80**
Aerobic Composting																							
· In-Vessel Composting	2.55	3.94	**6.49**	8.25	**8.25**	7.50	4.50	2.85	2.80	2.10	**19.75**	4.70	7.65	3.00	**15.35**	3.88	8.50	1.08	**13.46**	2.17	2.25	**4.42**	**67.71**
Anaerobic Digestion																							
· Low-Solids Anaerobic Digestion	2.18	3.26	**5.44**	8.25	**8.25**	7.50	4.40	2.85	2.80	2.10	**19.65**	4.70	7.65	3.00	**15.35**	3.75	8.50	1.13	**13.38**	2.17	2.25	**4.42**	**66.48**
· High-Solids Anaerobic Digestion	2.03	3.15	**5.18**	7.95	**7.95**	6.00	4.40	2.70	2.90	2.10	**18.10**	4.70	7.65	2.40	**14.75**	3.75	8.50	1.08	**13.33**	2.25	2.25	**4.50**	**63.81**
Mechanical-Biological Treatment	2.03	3.15	**5.18**	7.80	**7.80**	7.50	4.90	2.55	3.35	2.30	**20.60**	5.00	8.18	2.35	**15.53**	3.88	8.67	1.13	**13.67**	3.08	2.75	**5.83**	**68.60**
Thermal Convertion Technology																							
· Mass-Fired Combustion	1.28	1.69	**2.96**	4.65	**4.65**	7.50	5.10	1.80	3.20	5.00	**22.60**	2.60	7.05	4.70	**14.35**	3.00	3.67	0.58	**7.25**	1.25	2.75	**4.00**	**55.81**
· RDF-Fired Combustion	1.09	1.69	**2.78**	4.95	**4.95**	7.50	5.10	1.80	2.70	5.00	**22.10**	2.70	7.05	4.90	**14.65**	2.88	4.33	0.63	**7.83**	1.33	2.75	**4.08**	**56.39**
· Fluidized Bed Combustion	0.79	1.24	**2.03**	4.80	**4.80**	7.50	5.40	1.73	4.00	5.00	**23.63**	2.60	6.90	4.80	**14.30**	3.00	4.00	0.58	**7.58**	1.25	2.72	**3.97**	**56.30**
Gasification Technology																							
· Vertical Fixed Bed	1.13	1.46	**2.59**	5.25	**5.25**	7.50	5.20	1.80	4.40	5.00	**23.90**	3.00	7.65	4.90	**15.55**	2.88	3.50	0.54	**6.92**	1.17	2.69	**3.85**	**58.06**

1.5.5. Results of technology prioritization for waste sector

Based on the comparison among the overall weighted scores of technology options, the rank of technologies was concluded. The technology with a higher score would get a higher rank. The ranking list of the prioritized technologies is given in Table 1-12. From that Table, the rank order of the prioritized technologies is mechanical biological treatment (1st rank), in-vessel composting technology (2nd rank), and low-solid anaerobic digestion (3rd rank).

Table 1-12 Result of prioritized 13 GHG emission mitigation technologies for waste sector

Technology	Cost	Benefit					Total	Rangking
		GHG Mitigation	Technology Effectiveness	Environmental Sustainability	Economic Development	Social Development		
Final Disposal								
· Sanitary Landfill	7.09	6.15	21.24	11.55	3.65	7.38	57.05	7
· Semi Aerob Landfill	7.09	6.90	21.30	12.55	3.58	7.38	58.80	5
Aerobic Composting								
· In-Vessel Composting	6.49	8.25	19.75	15.35	4.42	13.46	67.71	2
Anaerobic Digestion								
· Low-Solids Anaerobic Digestion	5.44	8.25	19.65	15.35	4.42	13.38	66.48	3
· High-Solids Anaerobic Digestion	5.18	7.95	18.10	14.75	4.50	13.33	63.81	4
Mechanical-Biological Treatment	5.18	7.80	20.60	15.53	5.83	13.67	68.60	1
Thermal Convertion Technology								
· Mass-Fired Combustion	2.96	4.65	22.60	14.35	4.00	7.25	55.81	11
· RDF-Fired Combustion	2.78	4.95	22.10	14.65	4.08	7.83	56.39	8
· Fluidized Bed Combustion	2.03	4.80	23.63	14.30	3.97	7.58	56.30	9
Gasification Technology								
· Vertical Fixed Bed	2.59	5.25	23.90	15.55	3.85	6.92	58.06	6
· Horizontal Fixed bed	2.78	5.10	22.70	14.65	3.85	7.08	56.16	10
· Fluidized Fixed Bed	2.51	4.65	23.00	14.80	3.31	7.17	55.44	12
Pyrolysis Technology								
· Fluidized Bed	1.99	4.80	20.50	14.05	2.31	7.17	50.82	13

From the assessment results shown in Table 1-11 and Table 1-12, they can be concluded that the three technologies selected for the waste sector is the Mechanical Biological Treatment (MBT), In-Vessel Composting (IVC) and Low Solid Anaerobic Digestion (LSAD), respectively. All three technologies are actually intermediate MSW treatment facilities. Using these technologies, it is expected that MSW can be reduced before being transported to landfill. MBT is expected to increase capacity and accelerate composting process so it will indirectly reduce emissions of CH4 in landfill. Recycle process for inorganic materials in MBT will also enhance the role of scavengers who formerly worked at the landfill. Similarly, the IVC and LSAD technology that is expected to reduce the number of CH4 emissions in this sector.

1.6. Conclusion

From stakeholders engagement process during a series of meeting and facilitated workshops, it was concluded that there were three technologies chosen of each sector. The technology selection was done using criteria prepared by the executing team, and then received input from and agreed by the stakeholders during the workshop. The criteria were given weight and then scored by the stakeholders. The calculated scores of the technology options of each sector were carried out and the results were as follows.

For forestry sector, the highest scores were technology of measurement and monitoring of carbon sequestration and emission, peat re-mapping and water management. For energy sector, the suggested mitigation technology was photovoltaic industry, Improvement of

Public transport (MRT and BRT) and efficient electric motor (motor drive). For waste sector, there were mechanical-biological treatment, in-vessel composting technology, and low-solid anaerobic digestion. During its development however, an efficient electric motor technology did not get an approval from the Ministry of Industry as a Coordinating Institution. Instead, it was replaced with a “regenerative burner combustion system (RBCS)” technology. Also, the MRT was omitted from this TNA study due to the difficulty in finding supporting data for this study. Thus, there are only two technologies prioritized for the energy sector.

For the waste sector, there are three selected technologies: Mechanical Biological Treatment (MBT), In-Vessel Composting (IVC) and Low Solid Anaerobic Digestion (LSAD). All three technologies are applied to the intermediate stage, so that treatment can be expected to reduce MSW transported to landfill. MBT is expected to increase capacity and accelerate composting process so it will indirectly reduce emissions of CH4 in the landfill. Recycle process for inorganic materials in MBT will also enhance the role of scavengers who formerly worked at the landfill. Similarly, the IVC and LSAD technologies are expected to reduce the number of CH4 emissions in this sector.

These selected technologies of TNA Mitigation were technically agreed by the Technical Committee meeting and politically approved by the Steering Committee meeting.

SECTION 2

SYNTHESIS REPORT ON TAPs FOR MITIGATION

Executive Summary

Following technology needs assessment (TNA) processes, the technology actions plans (TAPs) for two or three prioritized technologies of each of three selected sectors were developed. Prior to do an identification and analysis of barriers of the selected technologies, an analysis of conditions of market and non-market to facilitate technology transfer and diffusion (TTD) of these technologies was performed.

Each selected technology that usually includes elements of expertise, experience and equipment is transferred and used under four different types of economic frameworks: (1) consumer goods, (2) capital goods, (3) public goods, and (4) non-market technologies. Technologies of the first three types of framework are primarily transferred as products or equipment, whereas technologies in the fourth market type are knowledge-dominated technology (UNEP 2010).

The selected technological types of each sector were recognized from analyzing the role of them to support key mitigation measures within the framework of TTD scenario. Some prioritized technologies of the sectors were recognized as non-market technologies whereas some others were recognized as market/public goods.

After that, the identification of barriers was performed based on the barriers reported in the TNA 2009 with some additions from other sources including from the experts and stakeholders. The barriers were further analyzed for their relevance to five or six selected categories suggested by UNEP's guide for identification of TTD barriers (UNEP 2010) as well as their association with the types of technologies recognized in the TTD framework of condition through stakeholders and experts involvement. The selected barrier's categories presented are (1) economic and financial, (2) policy, legal and regulatory, (3) institutional network and coordination, (4) professional capacity of organization/Institution and human skill, (5) social, behavioral, public information, and awareness, and (6) IPR issues.

Up to this point, prerequisite for identification of TTD of the prioritized technologies have been done. The results of such prerequisite analysis works were then used for detail analysis of individual prioritized technology. This individual analysis includes four steps outlined in Figure 2-1: (1) identify all possible barriers, (2) screen for non-relevant barriers, (3) establish hierarchy of barriers, and (4) analyse causal relation (UNEP 2010).

It is important to note that each sector selected under TNA mitigation has its owned unique characteristics. Therefore, the format of the prioritized technologies of each sector is also uniquely different. Forestry sector for example is very dominant contribution in reducing GHGs in Indonesia since it contributes more than 80% of targeted national GHG emission reduction of 26% by 2020. The format of technology transfer from forestry sector is then based on combination of technologies applied in Forest Management Units (KPH) in order for it to prevent the potential forest and peat burning and finally preventing the release of CO_2 into atmosphere. Unlike forestry sector, the format of technology transfer from energy sector is based on individual technology selected from different sub-sector since energy is actually belongs to many different sectoral activities. For waste sector, it is selected from the dominant

Analysed Barriers	Prioritized Technologies 1. Technology CMM 2. Technology PRM 3. Technology PWM	Analyse framework conditions of TTD for both market and non-market technologies
Identify all possible barriers	Identify barriers from existing information or documents such as from TNA 2009 document (institutional, social, technical and financial barriers).	• Define S-curved of TTD based on the "innovation system" concept for both R&D and diffusion chain of processes including their phase if possible. • Identify significant support of the three prioritized technologies to facilitate key mitigation measures. • For each key mitigation measure, identify its technological nature whether is characterized by capital good or non-market technology.
	For each prioritized technology, remap these barriers into six barrier categories of TTD suggested by UNEP: regulatory, financial, institutional, social, capacity and IPR.	
Screen for non-relevance	Identify key barriers for each prioritized technology based on its importance with relevance to chains of TTD 'innovation systems' process.	
Establish hierarchy of barriers	For each prioritized technology, decompose barriers or arrange in a hierarchical framework for each of six aspects of barriers.	
Analyse causal relation	Analyse the results of decomposing barriers in logical framework relationships of all six barrier aspects based on the process of "innovation system", from R&D chain up to diffusion chain.	
Find initial solutions		

Figure 2-1 A Conceptual framework for identification and analysis of barriers

waste to be treated that is municipal solid waste (MSW). The selected technologies are the combination ones that are considered intermediate treatment technologies in order to reduce the volume of landfill final disposal. Therefore, waste treatment technologies are dedicated for the intermediate MSW treatment.

The following is the summary of TAPs of each sector: forestry and peat, energy and waste:

Forestry and Peat Sector

Three prioritized technologies of Forestry and Peat sector were suggested to facilitate Technology Action Plan (TAP). The technologies are (1) Carbon Measurement and Monitoring (CMM), (2) Peat Re-mapping (PRM), and (3) Peat Water Management (PWM). Technologies CMM and PRM were characterized with non-market technology, whereas PWM was characterized with two technology types, public good or capital good technology.

Technology transfer and diffusion (TTD) process scenario is characterized by heavy investments on the establishment of hundreds of newly developed Forest Management Units (KPH) in order to guarantee significant improvement of sustainable forest management (SFM) of all state forests: natural forests, rehabilitated forest, and productive plantation. Within the first period of Forestry Sector's roadmap (2010 – 2019), 244 newly developed KPHs will be established and by the end of the second period (2020-2029), a total number of 344 KPHs will be established.

For barrier analysis of the three prioritized technologies, the concept of TTD process of "Innovation System" was applied to the KPH-HTI-SFM scenario. The process of technology transfer follows two phases of innovation system: R&D maturation and technology diffusion. Problem tree analysis applied to the barriers of the TTD process of the three prioritized technologies reveals the followings:

1) Maturing R&D process of CMM technology deals with a problem starter barrier and its follow-on effect barriers to provide a reference project of viable, credible and reliable integrated forest—peat carbon measurement, whereas technology diffusion deals with barriers of adopting this technology for facilitating mitigation measures to achieve a complete and updated unified peat mapping system, which covers sub-national levels and the availability of data and information of forest-peat carbon accounting.

2) A similar starting problem barrier of TTD process of PRM technology was identified. Lack of a reference project for viable, credible, and reliable unified peat mapping system is a barrier: absence of such a project, lack of a complete and updated unified peat mapping system, which covers sub-national levels; absence of mapping system result in a condition of lack of data and spatial information for 'low carbon' peatland management.

3) The starting point problem barrier of TTD process of technology PWM lack of reference of viable, credible and reliable peat water management system project, which further works within technology diffusion process, impede the effectiveness of water management for "low carbon" peatland management, causing the high risk of peatland degradation, peatland fire, and peat forest fire.

To assess possible solutions for overcoming barriers, a hierarchical logical framework analysis was applied to objective trees, followed by a rapid benefit cost/consequence analysis, with special consideration of critical and difficult nature of "take off" – the initial phases when the reliability, practicality and financial feasibility of the technology is demonstrated. Furthermore, the results of such assessment were used to recommend the following overcoming barrier solutions:

Policy Action

- Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of (1) newly invented integrated peat-forest carbon measurement and monitoring technology during Technology Diffusion Phase, (2) unified peat mapping system technology during R&D Maturation Phase, and (3) process of Peat Water Management technology during Technology Diffusion phase.
- Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement (1) the newly invented prototype of integrated peat-forest carbon measurement and monitoring technology during Technology Diffusion Phase, (2) unified peat mapping system technology during R&D Maturation Phase, and (3) process of Peat Water Management technology during Technology Diffusion phase.

Mode of Action

- Get International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of (1) integrated peat-forest carbon measurement and monitoring technology during Technology Diffusion Phase, (2) unified peat mapping system technology during R&D Maturation Phase, and (3) process of Peat Water Management technology during Technology Diffusion phase are carried out on national demonstrator.
- On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain period of trial and adjustment in their areas. The program is designed and implement by national expertise consultation working group during Technology Diffusion Phase.

The aforementioned recommended solutions consist of policy actions and their approaches for implementation. For the R&D maturation phase, the recommended policy action is to establish "National Demonstrator" project for demonstrating the reliability, practicality and financial feasibility of newly invented technological system by the use of International Capacity Building mode of action dedicated for the development of operational, reliable, credible, and feasible technological system prototypes. For the diffusion phase, the recommended policy action is to establish "collaborative learning" program by means of "on the job training" carried out on national demonstrator R&D field stations followed by trial and adjustment implemented in the newly developed KPH jurisdiction areas.

The recommended solutions may be implemented through two types of "concrete actions": domestic actions and international supports. To facilitate these actions, for each prioritized technology, a technology action plan in the forms of Domestic Action Plans and Project Ideas for International Supports are formulated.

Project ideas for domestic actions plans are sub-national collaborative learning for forest-peat carbon measurement and monitoring, unified peat re-mapping technology, and peatland water management technology. Whereas project ideas for international support is provided for national capacity building on technology for forest-peat carbon measurement and monitoring, unified peat re-mapping technology, and peatland water management technology.

Energy sector

There are only two technologies decided to be evaluated more detail in the Technology Actions Plant for energy sector. Those are (1) photovoltaic PV) cell development (industrialization) and (2) regenerative burner combustion system (RBCS).

The PV cell is proposed because it will be in line with national program on expanding the use of renewable energy resources particularly solar energy. PV cell is one of very important components of the solar electric generation system (PLTS) which has been becoming a priority in the national energy use of the country. On the other hand, RBCS is a waste heat recovery technology that is widely used especially in the steel industry. The purpose is to retrofit the burner system by changing a conventional burner with a new one of RBCS. This is a highly efficient heat recovery system by reusing waste heat of the furnace exhaust gas to heat-up combustion air at the furnace section through heat recovery regenerator. Hence, it could secure stable combustion and highly efficient combustion in order to lower the CO2 as well as NOx emissions.

In Indonesia, utilization of Solar Electric Energy Generation (PLTS) as a solar home system (SHS) has been done for about two decades with total installed capacity of about 13.5 MWe. In recent years, PLTS has also been utilized in several areas as a hybrid generator to other energy sources such diesel power. Besides, with a limited scale, electricity output of PLTS has already been connected to the grid. In 2011, State Owned Electrical Company (PT. PLN Persero) is installing PLTS for 100 islands of the 1000 islands planned. With the support of suitable regulations, PLTS utilization is predicted to increasing intensively in the future. However, the cell component of photovoltaic is still imported causing high price of PLTS in total. Actually, Indonesia has abundant quartz sand resource, and exports it to foreign countries for making PV cell raw material.

For supporting PLTS development in Indonesia, industrialization of PV cell must be carried out. The PV cell development needs supporting from improved laboratory of PV cell of crystalline type and for internationally standardized testing facility of PLTS system. However, technology transfer of those three activities – PV cell industrialization, laboratory capacity of crystalline type PV cell, and internationally standardized testing facility of PLTS system are predicted to face some barriers. First barrier is the regulation of the electricity price of the PV system, which is still expensive. The government has actually provided fiscal incentive for the development of renewable energy, such as reduction of tariff, income tax and value added tax. So far, regulation on electrical pricing for electric generation of biomass, biogas and municipal solid waste (MSW) has been revised to meet their economical price. Revision of selling price of electricity generated through PLTS that connects to the national electrical grid will be carried out at least in the incoming two years. Other barriers are those of financial, capacity building, institutional, intellectual property right (IPR) and social and cultural aspects. The budget for the development of PV cell, capacity improvement of cell laboratory and internationally standardized PLTS system testing facility are proposed finance through transfer of technology mechanism.

RBCS is one of the waste heat utilization technologies in industries. In Indonesia, this technology has been applied in one steel industry and is expected to expand to other steel industries. The purpose is to accelerate the process of dissemination of this technology to steel industries in Indonesia. The other industries that use furnaces in the production process, such as ceramics industries are also the target of the next application of this RBCS technology. The advantages of implementing RBCS are that it can save energy consumption up to 35%, increase the production of about 15%, improve production quality, reduce defective (cracked) product, and reduce maintenance costs. From the experience of installation of the RBCS in the steel industry, it is estimated to have a return of investment (ROI) of approximately 13 months.

In conjunction with the installation of RBCS technology in the selected steel industries, to increase mastering in RBCS and control room facility design can be done through transfers of knowledge and experiences from foreign experts to Indonesian experts, such as to BPPT's and other institutions' researchers. This transfer of knowledge and experiences is an integral part of the total technology transfer of the RBCS technology. With an increased ability of Indonesian personnel mastering RBCS technology and control room facility design, it is expected to be able to reduce the cost of RBCS investment in Indonesia. For example in 2011, BPPT researchers are currently preparing a prototype technology of RBCS so they are already gaining some knowledge and experiences in the RBCS technology. In addition, the engineers of existing RBCS implementing steel industry who actively involved in the installation process of RBCS are good experienced human resources for the next implementation. Thus, human resources capacity building for that technology implementation will not start from the beginning so that it will reduce the cost for capacity building of the human resources. In addition, the main obstacle of the RBCS implementation is due to installation costs and revenue loss because of the operation time of reheating furnaces during the trial period. To that end, the cost of procurement of RBCS in the selected industry (steel) for the purpose of the technology transfer is best provided in the form of grant so it will not burden the financial balance of the chosen industry. Similarly, the cost for capacity enhancement of personnel in RBCS and control room facility design are also proposed in the form of grants.

Waste Sector

The mitigation technologies selected for waste sector are (1) mechanical-biological treatment, (2) in-vessel composting, and (3) low-solid anaerobic digestion technologies. They are all considered to be relatively high technology, mechanically operated equipment, and semi-automatic process specifically treating organic waste.

For implementing these technologies, there are six groups of barrier aspects found. Those are the aspect of regulatory, finance, institution, social and culture, capacity, and intellectual property right (IPR). The barriers of the regulatory aspect consist of insufficient legal and regulatory framework aspects. The regulatory barrier aspect can be overcome by encouraging the government to create and complete the implementing regulations as a reference for the technical implementation in the field. Meanwhile, the barriers from the financial aspect are broken down into three groups: high cost of capital and maintenance of the project, high cost of construction and management of the project, and market failure for recyclable materials. To overcome these barriers, they require the establishment of mechanical workshops to produce waste treatment machineries. In addition, reduction of the tariffs for imported equipment, subsidy to the waste project management, budget assistance from the central government, increase waste retribution fee, increase of community awareness, drafting policy on subsidies for waste treatment projects, and a campaign of compost utilization are needed.

Institutional aspect contains two barriers: dualism roles on management and coordination, and weak inter-sectoral coordination. These barriers can be overcome by separating the role of regulator to that of operator. Meanwhile, the barriers on social aspect are differenced into bad behaviour of community on waste handling and bad perception of community on operation of waste treatment system. These barriers might be overcome by increasing the campaign, socialization, training, and education of those technologies to the communities. The barrier of capacity building aspect, limited qualified human resources, can be resolved by having professional training program for the operators on the specific area of work. The last barrier, the IPR barrier, is due to its royalty. IPR of these technologies is still dominated by foreign companies and therefore it needs to negotiate with the help of government in order to minimize investment cost.

Based on the analyses of barriers and overcoming them, several recommendations suggested. Those are the needs on the implementation of solid waste management act, privatization of solid waste treatment operation, increase of cross-sectors coordination for solid waste management, establishment of regulation on tax reduction, investment subsidy and tax reduction, national standards of the technologies, R & D of the technologies, and improvement of negotiation ability to minimize the royalty cost of the IPR.

For implementing waste treatment technology, the mechanical-biological treatment (MBT) could actually be combined with two other selected technologies: in-vessel composting technology and low solid anaerobic digestion. MBT application has been raised to implement in several cities of Indonesia. This plan is actually in line with the existing national waste management program.

Implementation of MBT plant is predicted to be in 3 years. The first year of activity will be for coordination, feasibility study, and detail engineering design. The second year of activity will be for construction and installation, running test, evaluation and improvement of the system. The last year of activity will be for full operation and maintenance.

The domestic partners for this future project are BPPT, Ministry of Public Works, Ministry of Environment, Municipality Cleansing Office and Indonesia Solid Waste Association.

2.1. TAPs for forestry and peat sector

2.1.1. Preliminary targets for technology transfer and diffusion based on forestry and peat

Forests, in the context of climate change, can be a source or a sink of greenhouse gas emissions. Good practices in the context of Sustainable Forest Management (SFM) of production forest, conservation and protection forest, limiting the conversion of forest to non-forest areas, as well as forest fire prevention, contribute to the reduction of CO2 emissions. In addition, rehabilitation of degraded forest, timber and estate crops plantation development in degraded land could enhance the sink capacity of forests.

The conceptual of TTD process of “Innovation System” was applied to the KPH-HTI-SFM scenario, which depicts the phases of “Innovation System” through the S-curved, starting from R&D maturation phases towards the end of Technology Diffusion phase. In the first five year, the first two year of which is devoted to develop 10 prototypes of newly invented prioritized technologies CMM, PWM, and PWM. These prototypes are implemented in 10 KPHs, selected from 50 newly developed KPHs. By the end of year five, 25% of which – 50 KPHs and the second five years is 220 out of 244.

The Ministry of Forestry has proposed a number of activities formulated in the Indonesia Climate Change Sectoral Roadmap – ICCSR (BAPPENAS 2009) to support SFM and emission reduction from forestry sector). The key mitigation measures can be summarized as follows:

Sink enhancement

- Forest rehabilitation activities mostly on protection forest and watershed
- Development of industrial plantations (HTI), plantations with private entrepreneurs and communities (HTR) on production forest
- Stimulate plantations outside forest lands for rehabilitation or wood production
- Management of natural secondary forests in production, protection and conservation forests

Emission reduction

- Improved silviculture and logging activities in productive natural forest
- Reducing emissions form forest land conversion particularly on peat forest land
- Reducing emissions from illegal logging and fire

Peatland, in the context of greenhouse gas emissions is the source of CO2 emission in terms of their contribution trough peat decomposition and peat fires from degraded peatlands. The Indonesian government has already begun to address peat emission through a decree that prohibits land conversion of peat, which is more than three meters deep. In addition to this, abatement opportunity exists in the peat sector across several levers (DNPI 2009) as follows:

Fire prevention

- prohibiting fire as a tool for land preparation
- providing appropriate and practical technologies for manual land clearing
- developing appropriate early-warning systems based on fire risk status and field-based fire detection
- strengthening fire brigades
- ensuring strong enforcement and large penalties for rule violations
- building public awareness of the local economic and social costs of forest fires

Peatland rehabilitation

- restoration of the hydrological functions of the peat
- replanting with native species and fostering natural regeneration of existing tree cover

Water management

- water management in existing timber plantations
- water management in oil palm plantations
- water management in areas under agricultural use

There are three out of ten clusters of technology priority were selected for the targets of TTD (Technology Transfer and Diffusion). The selection was performed based on the calculated values of Priority Rank of each prioritized technology. The top three technologies having the highest scores for prioritization are as follows:

2.1.1.1. Carbon measurement and monitoring

Within the context of Sustainable Forest Management, technology for measurement and monitoring deals with measurement and monitoring of forest standing stock by the use of conventional forest inventory method. This conventional method has been somewhat developed into new invention initiatives for measurement and monitoring of carbon stock in the context of both reducing emission as well as sink enhancement on forest area. In addition to invention of conventional forest inventory technology, multi spectral as well as SAR (Synthetic Aperture Radar) remote sensing technologies have also been initially invented for measurement and monitoring of carbon stock.

Within the context of Sustainable Peat Management, measurement and monitoring of carbon stock to estimate CO2 emission from peat decomposition/subsidence and peat fire using of newly invented of peat soil surveys as well as remote sensing technology for estimating peat deposit have also been initially practiced.

Within the context of TTD, particularly from the point of view of 'Innovation System', the above mentioned technologies need to be integrated in such a way to make the first chain of innovation process – research and development (R&D) – fully completed. Furthermore, the early stage of second chain of innovation process – the initial phase of diffusion – in which the demonstration of its reliability, practicality and financial feasibility of the integrated technology have to be well prepared. Finally, to complete the whole process of the second chain of innovation of the technology, the diffusion should focus on 'interactive learning' of the three components of technology for carbon measurement and monitoring:

- Make use of all available knowhow and expertise (software) from the previous R&D experiences on measuring biomass of forest and peatland using the synthesis of forest biometrics, peat deposit estimation, and the integration of the two.
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for direct as well as remotely sensed measurement, and the combination of the two
- Define the most effective coordination (org-ware) among the key players (i.e., BPPT, Min of Forestry, Min of Environment, and Min of Agriculture).

2.1.1.2. Peat re-mapping

Two methods of land resource mapping technology (in the contexts of knowledge, tools, and orgware) have been practiced to derive peat map in Indonesia. The first method refers to land resources mapping conducted by Land Resources Evaluation and Planning Project) – LREP (1990) and the second method refers to Land System mapping conducted by Regional Physical Planning Programme for Transmigration – RePPProT (1988). Both land resources and land system maps are represented in the same spatial scale of 1 to 250,000. The main difference of these two mapping methods lays on the entity or object of mapping and the knowledge used for mapping. The LREP method was dedicated to map land and soil resources, whereas the RePPProT were aimed to map ecosystems of landforms (land system).

Peat maps can be derived from both LREP as well as RePPProT maps. Because of the difference knowledge underlying mapping method, deriving peat map from these land resources map leads to two different themes of peat maps. Consequently, there exists several disagreement of spatial information such as:

- LREP derived peat map provides spatial distribution and variability of peat depth and its degree of decomposition
- RePPProT derived peat map provides those of peat ecosystem typology and description of typical characteristic of each type including physiographic setting, peat depth, degree of decomposition, sub soil, etc.

TTD of re-mapping technology has to use the same "Innovation System" approach applied to technology CMM. Prior to TTD, a newly innovation on peat mapping technology for remapping peatland needs to be established in a framework of finalization of the first chain of innovation. This key measure could be done by:

- synthesizing LREP methodology and RePPProT methodology
- Utilizing all of technology components resulted from previous and current R&D on peat mapping, including expertise, tools and equipment, and key players.

Whenever the first chain is completed, the second chain of innovation – technology diffusion – could be started. Again, analogous to technology CMM, this diffusion would consider the use of and be focused on "interactive learning" approach of key players of technology diffusion for demonstrating reliability, practicality and financial feasibility of the newly invented re-mapping technology. This process of technology diffusion peat mapping should:

- Use of all available knowhow and expertise of the first chain of innovation
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for direct as well as remotely sensed peat mapping
- Define the most effective coordination among the key players of peat mapping (i.e., BPPT, Bakosurtanal, LAPAN, Ministry of Forestry, Ministry of Environment, and Ministry of Agriculture).

2.1.1.3. Water management

By nature, peat ecosystem is typically characterized by landscape of peat swamp environment. Whenever this natural landscape is utilized into human-made landscapes such as agriculture land, plantation estate, or industrial forest, the most common way is by draining out the peat swamp water to get the largest possible dryer land surfaces. By doing so, the anaerobic environment condition of the peat swamp is converted into aerobic environment of newly built peatland surfaces suitable for cultivation.

From the perspective of CO2 emission, the use of proper water management on such newly built landscapes is critical. Lack of proper water management would lead to over-drained condition of peatland, which promote rapid decomposition and peat fires. Peat decomposition and peat fire contribute annual emission of 300 MtCO2e and 472 MtCO2e in 2005 respectively. Under BAU conditions, they will increase to 370 MtCO2e and 532 MtCO2e in 2020. Installing a dam-based water management system in timber and estate crops plantations located on peatland is a powerful tool to reduce emissions, with technical abatement potential of 90 MtCO2e by 2030. In addition, restoration of the hydrological functions of the peat by blocking drainage channels is relatively cheap and facilitates abatement of more than 100 MtCO2e by 2030 (DNPI 2010).

To summarize, application of water management technology will generate more than 190 MtCO2e abatement potential of CO2 emission from peatland by 2030. This implies that TTD of water management technology will facilitate the abatement potential turn into reality. The prerequisite for TTD should be conducted, aiming to formulate key prototypes of water management technology through the following measures:

- Compile all of technology components resulted from previous and current R&D on water management, including expertise, tools and equipment, and key players.
- Formulate "ready to test" prototypes of water management technology, such as regulatory dams and vegetation belt, aimed to facilitate three mitigation options: conservation, rehabilitation, and rehabilitation of peatlands.

Once such prototypes are formulized, the second chain of "innovation system" for TTD will be ready to start. Again, by the use of the same approach employed by dissemination of technology CMM and PRM, the following innovation process should be conducted by employing and focusing on "interactive learning" of key players of technology diffusion for demonstrating reliability, practicality and financial feasibility of the newly invented prototypes of water management technology:

- Use of all available knowhow and expertise of the first chain of innovation
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for the operation of water management prototypes applied for peatland conservation, rehabilitation, and or restoration
- Define the most effective coordination mechanism among the key players of water management (i.e., BPPT, Ministry of Forestry, Ministry of Environment, Ministry of Agriculture, Ministry of Public Works, plantation industries, and smallholder agriculture).

2.1.2. Barrier identification and analysis

Barrier identification and analysis of TTD (Technology Transfer and Diffusion) of the three prioritized technology comprise of four steps: identify all possible barriers, screen for non-relevance, establish hierarchy of barriers, and analyse causal relation (UNEP 2010). Prior to do these steps an analysis of framework condition of TTD for market and non-market has to be performed. Using conceptual framework given in Figure 2-2, barrier identification and analysis for forestry sector are reported in Figure 2-3. This framework was applied based on the KPH-HTI-SFM scenario formulated in the Indonesia Climate Change Sectoral Roadmap – ICCSR (Bappenas 2009), using an initial identification of barriers of implementing SFM (Sustainable Forest Management) suggested by TNA 2009 of forestry sector as the common barriers for the TTD process of the aforementioned three prioritized technologies.

For the purpose of the framework of identification and analysis of barriers, a framework condition of TTD of the three prioritized technologies was conceptually defined based on the KPH-HTI-SFM scenario formulated in the Indonesia Climate Change Sectoral Roadmap – ICCSR (BAPPENAS 2009). This scenario is characterized by heavy investments on the establishment of hundreds of newly developed Forest Management Units (KPH) in order to guarantee significant improvement of sustainable forest management (SFM) of all state forests: natural forests, rehabilitated forest, and productive plantation. Within the first period of Forestry Sector's roadmap, (2010 – 2019) 244 newly developed KPHs will be established, and by the end of second period (2020-2029) a total number of 344 KPHs will be established. Mitigation efforts in this scenario are based on a mix of activities:

1) Industrial forest plantations (HTI) established on dry land, where KPH have been developed;
2) Emission reduction enhancement comes from better sustainable forest management (SFM) of production, conservation and protection forests under the KPHs; and
3) Some modest REDD activities during the first period of 2010-2014.

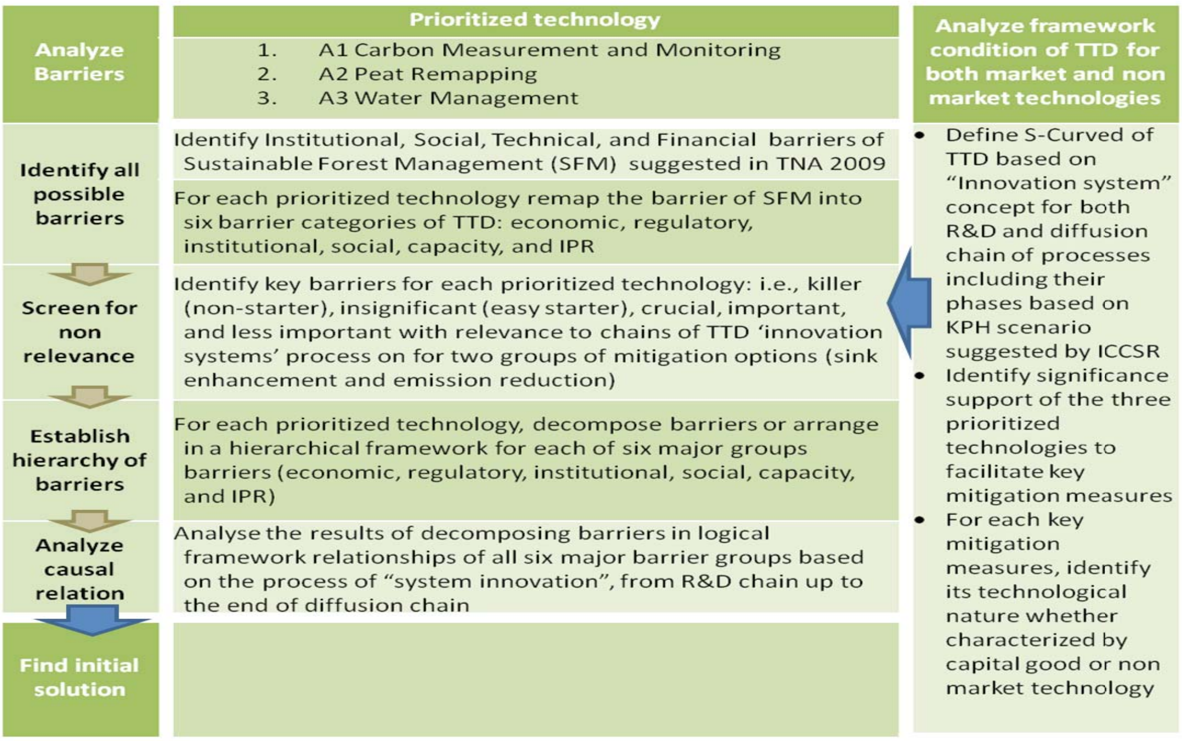

Figure 2-2 Conceptual framework of barrier identification and analysis of forestry sector

Furthermore, the scenario was used to define a conceptual S-curved of "Innovation System" to represent the framework condition of TTD process for the three prioritized technologies. Two interlinked-chained processes of Innovation system are recognized: R&D maturation (1st chain of TTD process) and technology diffusion (2nd chain of TTD process). The first chain of TTD process deals with maturing the results of previous technology R&D into newly developed invention ready for diffusion, in the forms of technology prototypes. Whereas the second chain of TTD process deals with implementing key measures of technology, diffusion (i.e., replication and market penetration) through five-stages of TTD processes follows a sigmoid curved. These five stages are awareness, interest, evaluation, trial, and adoption which correspond to five stages of consumers' adoption: innovators (first to adopt), early adopters, early majority, late majority and laggards (last to adopt) according to the time of adoption since the technology is first introduced (UNEP, 2010).

The conceptual of TTD process of “Innovation System” was then applied to the KPH-HTI-SFM scenario (Figure 2-3), which depicts the phases of “Innovation System” through the S-curved, starting from R&D maturation phases towards the end of Technology Diffusion phase. In the first five year of the TTD curve, the first two year of which is devoted to develop 10 prototypes of newly invented prioritized technologies CMM, PWM, and PWM. These prototypes are implemented in 10 KPHs, selected from 50 newly developed KPHs. By the end of year five, when the numbers of newly developed KPHs reach 199, 25% of which – 50 KPHs – is targeted for the implementation of the prototypes, marking the end of awareness phase. The ratio of KPHs selected for the implementation of prototypes to the total number of newly developed KPHs continues to increase by 90% that is 220 out of 244, by the end of the second five years. This marks the initiation of trial phase. Finally, during adoption phase, the ratio reaches 100% at the end of the third five year of KPHs development period.

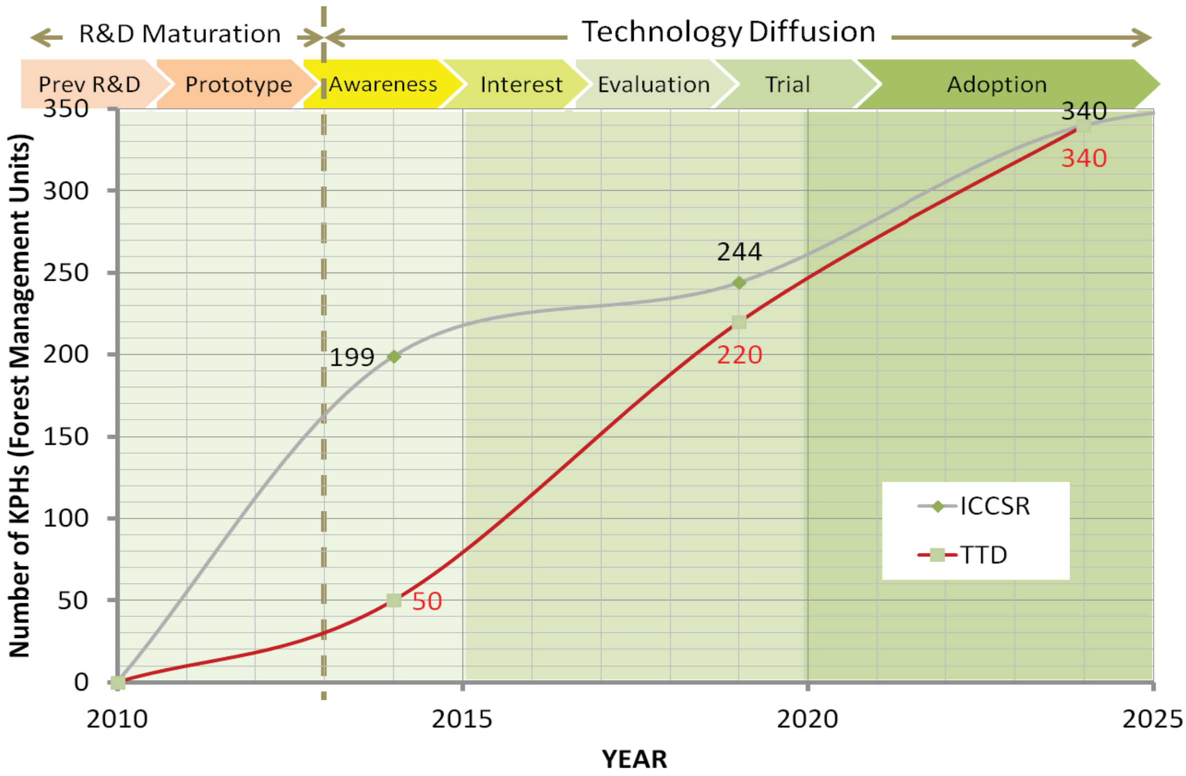

Figure 2-3 S-Curved of TTD process of “innovation system” under KPH-HTI-SFM scenario

Three types of technology were recognized from analysing the role of the three prioritized technologies to support key mitigation measures within the framework of TTD using KPH-HTI-SFM scenario (Table 2-1). Prioritized technology CMM and PRM were recognized as non-market technology and, the TTD processes are characterized by the transfer and diffusion of knowledge dominated technological component. TTD of prioritized technology CMM transfers knowhow on measurement and monitoring above and below ground biomass. Whereas TTD of prioritized technology PRM transfer that of unified peat-mapping system. Government should provide both of them and they are not transferred in a commercial marketplace, therefore, it is logically valid to recognize then as non-market good technologies.

Table 2-1 The role of prioritized technologies in supporting key mitigation measures

<table>
<tr><th colspan="2" rowspan="2">Key Mitigation Measures</th><th colspan="3">Role of Prioritized Technology</th></tr>
<tr><th>CMM</th><th>PRM</th><th>PWM</th></tr>
<tr><td rowspan="2">Sink Enhancement</td><td>Afforestation/Reforestation:
• Gerhan/RHL
• One Mill tree program
• HTI
• HTR
• HR
• Community Forest
• Village Forest
• Natural Forest</td><td rowspan="8">Integrated method, manual , tools, and skill for measurement and monitoring of above and below ground biomass on:
• newly planted area
• improved degraded areas by better SFM
• Protection and conservation forest using better SFM
• Prevention and reduction of forest fire
• Low carbon peatland management</td><td rowspan="8">Newly invented unified peat re-mapping method, manual, tools, and skills to facilitate key mitigation measures:
• Afforestation/ reforestation of peat swamp forest and peatland
• Improvement of SFM of degraded protection and conservation forest on peat swamp
• Forest fire prevention and reduction on peat
• Low carbon peatland management</td><td rowspan="2">Regulated irrigation/ drain-age/ channel networks and or vegetation belts to avoid over-drainage of HTI areas, facilitating sink enhancement of peat swamp</td></tr>
<tr><td>Improve Sustainable Forest Management (SFM) to Increase stock on degraded forest:
• Stock enhancement on protected forest
• Stock enhancement on conservation forest</td></tr>
<tr><td rowspan="6">Emission Reduction</td><td>Increase of Protection forest land under SFM</td><td rowspan="6">Regulated channel networks and or vegetation belts to avoid over-drainage of agriculture land and plantation estate areas, facilitating emission reduction of peatlands</td></tr>
<tr><td>Increase of Conservation forest land under SFM</td></tr>
<tr><td>Prevention of forest fire</td></tr>
<tr><td>Management of productive natural forest</td></tr>
<tr><td>Reduction of forest fire</td></tr>
<tr><td>Low Carbon Peatland Management
• Enforce strict compliance by existing forest and plantation concessions on >3m peat
• zero burning for land clearing
• water management to reduce subsidence and carbon emissions from oxidation</td></tr>
<tr><td colspan="5">CMM= Carbon Measurement and Monitoring; PRM=Peat Remapping; PWM= Water Management</td></tr>
</table>

The prioritized technology PWM was recognized having two types of technology: capital good technology and public goods technology. The first case recognizes dominant elements of this technology (i.e., knowledge and water management infrastructures) are transferred within an economic framework of HTI and or plantation estate marketplace. The latter case recognizes a transfer of technology within a public area such as peat agricultural land.

Following the prerequisite step of analysis of TTD framework conditions, the identification of barriers was performed based on the barriers reported in the TNA 2009. Such barriers were grouped three mitigation options, i.e., sink enhancement, emission reduction, and the combination of the two. The barriers were further analysed for their relevance to five selected categories suggested by UNEP's guide for identification of TTD barriers (UNEP 2010) as well as their association with the type of technologies recognized in the TTD framework of condition. The results of such analyses of identified barriers are presented in Table 2-2.

The selected barrier's categories presented in Table 2-2 are:

- Economic and financial issues and market failure/imperfection(E)
- Policy, legal and regulatory issue (R)
- Institutional network and coordination failure (I)
- Professional capacity of organization/Institution and human skill (C),
- Social, behavioural, public information, and awareness issue (S).

The results of such prerequisite analysis works were then used for detail analysis of individual prioritized technology. This individual analysis includes four steps outlined in Figure 2-2:

- Identify all possible barriers;
- Screen for non-relevance;
- Establish hierarchy of barriers; and
- Analyse causal relation.

Table 2-2 Identified barrier for mitigation options, their category and type of technology

	Identified Barriers (TNA 2009)	Barrier Category					Associated Type of Technology	
		E	R	I	C	S	NM/PG	CG
Sink Enhancement (SE)	Lack of data and information for forest carbon accounting					●	yes	
	Lack of appropriate growth and yield models that can best estimate the future yield and assist in yield scheduling and forest management as a whole				●		yes	
	Limited qualified researchers and equipment on silviculture, tree improvement and growth-yield modelling				●		yes	
	Low productivity of tree planted because of lack of appropriate silvicultural practices and the absence of genetically-improved seeds				●			yes
	Poor availability of good quality planting materials of some tree species				●			yes
	Limited research budget for silviculture, tree improvement and growth-yield modelling	●					yes	
	Limited and unattractive investment incentives	●						yes
	Existing Land-clearing methods without fire are still too expensive	●					yes	
	High risk of forest-fires pests and disease	●					yes	
	Forest plantation investment is considered less attractive compared to other commodities such as estate crops plantation					●		yes
Emission Reduction (ER)	Lack of a complete and updated information system on forest carbon stock which covers sub-national levels				●		yes	
	Lack of records on enrichment planting after logging lead to difficulties in evaluating what improvements are needed					●	yes	
	Development for Molecular /DNA timber-tracking as a robust method in combating illegal logging is still expensive	●					yes	
	Unreasonable price of good quality planting materials	●						yes
	Existing Land-clearing methods without fire are too expensive					●		yes
	Implementation of RIL is less attractive, as the practice of unsustainable timber- harvesting still continues					●		yes
SE + ER	Weak coordination among government institutions at the central and autonomous governments			●			yes	
	Modest institutional capacity for enforcing SFM implementation, conflict resolution, and policy formulation		●				yes	yes
	Lack of inter-sectoral policy, law enforcement and effective forestry administration		●				yes	
	Lengthy and complex process to obtain permits and licenses				●			yes

E= Economic, R= Regulatory, I = Institutional, C = Capacity, S = Social NM = Non Market Technology,
PG= Public Good Technology, CG = Capital Good Technology
● = Relevant

Up to this point, prerequisite for identification of TTD of the three prioritized has been done. To summarize, the results of this prerequisite works are as follows:

1) Framework conditions of TTD were recognized from the following conditions:

   a. Recognition of conceptual setting of S-Curved TTD based on KPH-HTI-SFM mitigation scenario suggested by ICCSR aimed to the establishment of 199 newly developed KPHs in the year of 2015, 244 KPHs in 2020, and continued to the establishment of final target of a total number of 340 KPHs in 2030.

   b. Recognition of the 3 prioritized technology in facilitating key mitigation measures which are grouped into two mitigation options: sink enhancement and emission reduction

   c. The recognition of the three prioritized technology as non-market technology and capital good technology

2) Initial identification of 19 common barriers, grouped according to their relevance to five broad category and association with two technology types

2.1.2.1. Barrier identification and analysis of carbon measurement technology (CMM)

Prioritized technology CMM – carbon measurement and monitoring – is characterized by integrated knowledge for facilitating two in one measurements: timber standing stock inventory and peat deposit survey. This integrated measurement technology would facilitate estimation of carbon stock from proper combination of the result of conventional forest inventory (above ground biomass) and the result of peat survey (below ground biomass).

Identification of barriers for the TTD process of prioritized technology CMM was performed by selecting barriers associated with non-market type of technology listed in Table 2-2. The selected barriers were then reformulated by inference and decomposed using the list of hierarchical barrier structure suggested by UNEP's guide for identification of TTD barriers (UNEP 2010) particularly Annex A as the main reference. The results of identification and analysis technology CMM barriers, their decomposition, and ranking assignment are presented in Table 2-3.

The decomposition was performed up to level 3 (element of barriers). Each of them was ranked and assigned in five level (killer=1, crucial=2, important=3, less important=4, insignificant=5) to identify whether a certain barrier is a key barrier. The analysis of rank assignment for each level three was focused on its associated phases of TTD process, i.e., R&D Maturation and Technology Diffusion depicted in S-Curved of TTD Process (Figure 2-3).

Table 2-3 Barrier identification, decomposition, and rank for prioritized technology CMM

IDENTIFIED BARRIER	BARRIER' DECOMPOSITION	TTD Focus and Rank*	
Barrier's Broad Category (UNEP 2010)			
SFM Generic Barriers (TNA 2009's)	Barrier Category Barrier (inferred from generic barriers)	R&D	Diff
Economic and financial issues and market failure/imperfection			
Limited research budget for growth-yield modelling Development for Molecular /DNA timber-tracking as a robust method in combating illegal logging is still expensive High risk of forest-fires pests and disease	Economic and financial issue Inadequate incentives for R&D High cost of modelling development	3 3	
	Market failure/imperfection Lack of Reference Project of Viable, Credible and Reliable Integrated Forest—Peat Carbon Measurement		1
Policy, Legal, and Regulatory Issues			
Modest institutional capacity for enforcing SFM implementation and policy formulation Lack of inter-sectoral policy, law enforcement and effective forestry administration	Policy, legal and regulatory Insufficient TTD policy and regulatory framework for carbon measurement Inefficient enforcement	1	4
Institutional Network and Coordination Issues			
- Weak coordination among government institutions at the central and autonomous governments - Lack of a complete and updated information system on forest carbon stock which covers sub-national levels	Network Failures Insufficient coordination between relevant ministries and other stakeholders Insufficient cooperation between R&D institutions Weak of collaborative learning	2	2 1
Organizational and Human Capacity and Technical Issue			
Lack of appropriate growth and yield models Limited qualified researchers and equipment Lack of a complete and updated information system on forest carbon stock which covers sub-national levels Lack of records on enrichment planting High risk of forest-fires pests and disease	Human skill: Insufficient growth and modelling expertise	1	
	Insufficient organization capacity - Lack of organizational mechanism in generate and distribute information - Inadequate R&D facilities	2	3
	Technical Issue Modest reliability of methodology	2	
Social, Behavioural, Information and Awareness Issues			
Lack of data and information for forest carbon accounting High risk of forest-fires pests and disease	Inadequate Information insufficient of knowledge and or access to appropriate and reliable technology	1	
	Inadequate understanding - Lack of stakeholder participation		3
Note: * TTD Focus: R&D = Maturing R&D Phase, Diff = Technology Diffusion Phase Barrier Rank : killer=1, crucial=2, important=3, less important=4, insignificant=5			

The final step of analysing barriers of prioritized technology CMM was the performing causal relationship among the decomposed barriers listed in Table 2-2. The causal relationship analysis was performed according to logical framework relationships in the form of logical flow chart of logically linked barriers, starting from barriers associated with maturing R&D phases up to the technology diffusion phases. The result of such causal relationship analysis is presented in such a way to form a 'problem tree' in Figure 2-4.

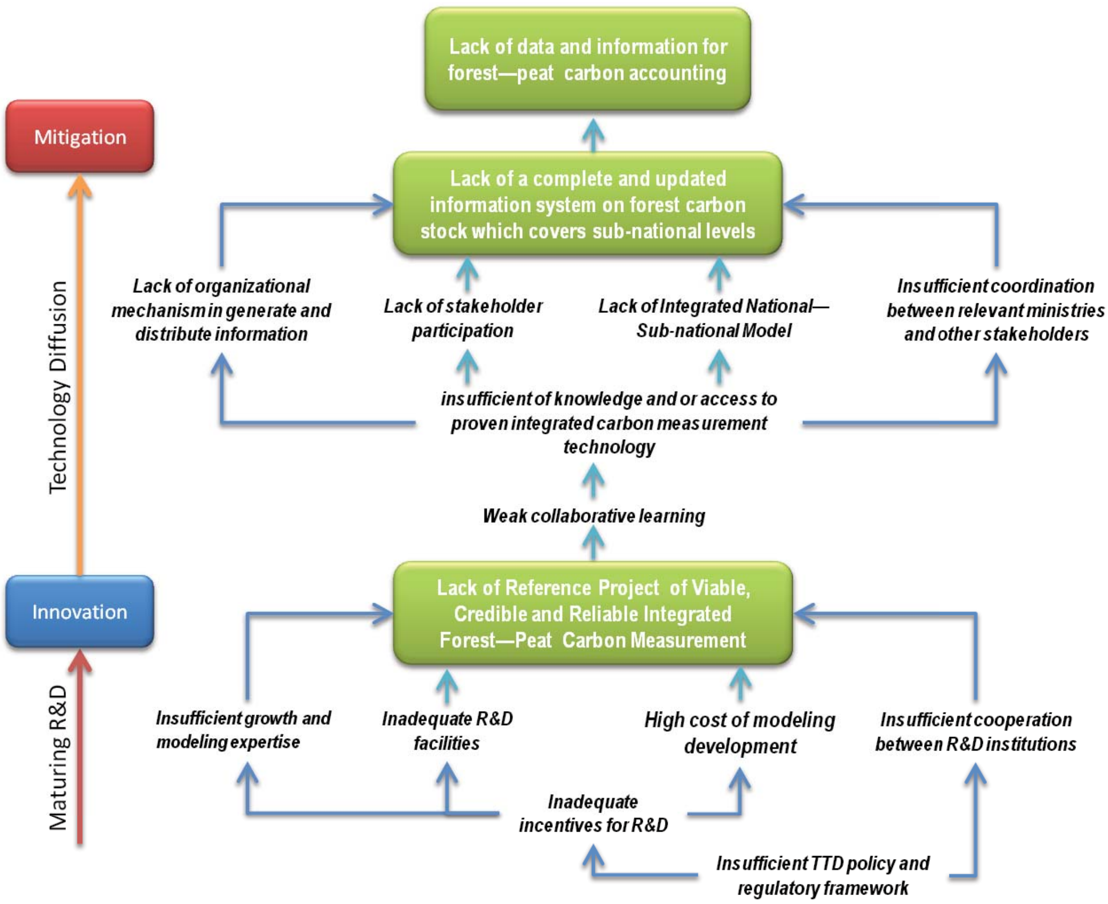

Figure 2-4 Problem tree of prioritized technology CMM

It is important to note that the problem tree illustrated in Figure 2-4 was defined by selecting a starter problem: Lack reference project of viable, credible and reliable integrated forest—peat carbon measurement. This starter problem roots from a total number of six barriers and propagate to six 'canopy' barriers. In terms of innovation system TTD process, the root barriers correlate with maturing R&D chain and the canopy barriers correlate with technology diffusion chain. In other words, the maturing R&D process deals with barriers to provide a reference project of viable, credible and reliable integrated forest-peat carbon measurement, whereas the chain of technology diffusion deals with barriers of adopting this technology in facilitating mitigation measures to achieve complete data and information for forest-peat carbon accounting at both national and sub national levels.

2.1.2.2. Barrier identification and analysis peat re mapping (PRM)

Technology PRM – peat re-mapping – is characterized by integrated knowledge for facilitating unification of two peat mapping system – LREP mapping system and RePPProT system to produce newly invented unified peat mapping system. The same analytical procedures performed for prioritized technology CMM were applied. The results of identification and analysis technology CMM barriers, their decomposition, and ranking assignment are presented in Table 2-4. The results of causal relationship logical framework analysis are presented in Figure 2-5.

Having the same technology type with the prioritized technology CMM, a similar starting problem of TTD process of prioritized technology PRM was recognized, that is, Lack reference project of viable, credible, and reliable unified peat mapping system. This starting problem was recognized having four root barriers, which roots into one common barrier: Insufficient TTD policy and regulatory framework for unified peat mapping. These four root barriers accumulate to starting problem and further propagate to six 'canopy' barriers, which end up to a problem of lack of a complete and updated unified peat mapping system, which covers sub-national levels and further propagates to a condition of lack of data and spatial information for 'Low Carbon' Pealtand Management.

It is important to note that having the same technology type with prioritized technology CMM, the root barriers of prioritized technology PRM correlate with maturing R&D chain and the canopy barriers correlate with that of technology diffusion chain.

Table 2-4 Barrier identification, decomposition, and rank for prioritized technology PRM

IDENTIFIED BARRIER	BARRIER' DECOMPOSITION	TTD Focus and Rank*	
Barrier's Broad Category (UNEP 2010)			
• SFM Generic Barriers (TNA 2009's)	Barrier Category • Barrier (inferred from generic barriers)	R & D	Diff
Economic and financial issues and market failure/imperfection			
• Limited research budget for growth-yield modelling • Development for Molecular /DNA timber-tracking as a robust method in combating illegal logging is still expensive • High risk of forest-fires pests and disease	Economic and financial issue • Inadequate incentives for R&D • High cost of peat mapping pilot project	3 3	
	Market failure/imperfection • Lack of Viable, Credible and Reliable Unified Peat Mapping Reference Project		1
Policy, Legal, and Regulatory Issues			
• Modest institutional capacity for enforcing SFM implementation and policy formulation • Lack of inter-sectoral policy, law enforcement and effective	Policy, legal and regulatory • Insufficient TTD policy and regulatory for unified peat mapping	1	
Institutional Network and Coordination Issues			
- Weak coordination among government institutions at the central and autonomous governments - Lack of a complete and updated information system on forest carbon stock which covers sub-national levels	Network Failures • Insufficient coordination between relevant ministries and other mapping stakeholders • Insufficient cooperation between R&D institutions in peat mapping • Weak of collaborative learning	 2	2 1

Table 2-4 (Continued)

IDENTIFIED BARRIER	BARRIER' DECOMPOSITION	TTD Focus and Rank*	
Organizational and Human Capacity and Technical Issue			
Lack of appropriate growth and yield models Limited qualified researchers and equipment Lack of a complete and updated unified peat mapping system which covers sub-national levels Lack of records on enrichment planting High risk of forest-fires pests and disease	Human skill Lack of functional expert group for unified peat mapping	1	
	Insufficient organization capacity - Lack of organizational mechanism in generate and distribute information - Inadequate R&D facilities	2	3
	Technical Issue Inadequate R&D facilities for unified peat mapping	2	
Social, Behavioural, Information and Awareness Issues			
Lack of data and spatial information for 'Low Carbon' Pealtand Management High risk of forest-fires pests and disease	Inadequate Information insufficient of knowledge and or access to proven unified peat mapping technology	1	
	- Lack of stakeholder understanding and participation		3
Note: * TTD Focus: R&D = Maturing R&D Phase, Diff = Technology Diffusion Phase Barrier Rank : killer=1, crucial=2, important=3, less important=4, insignificant=5			

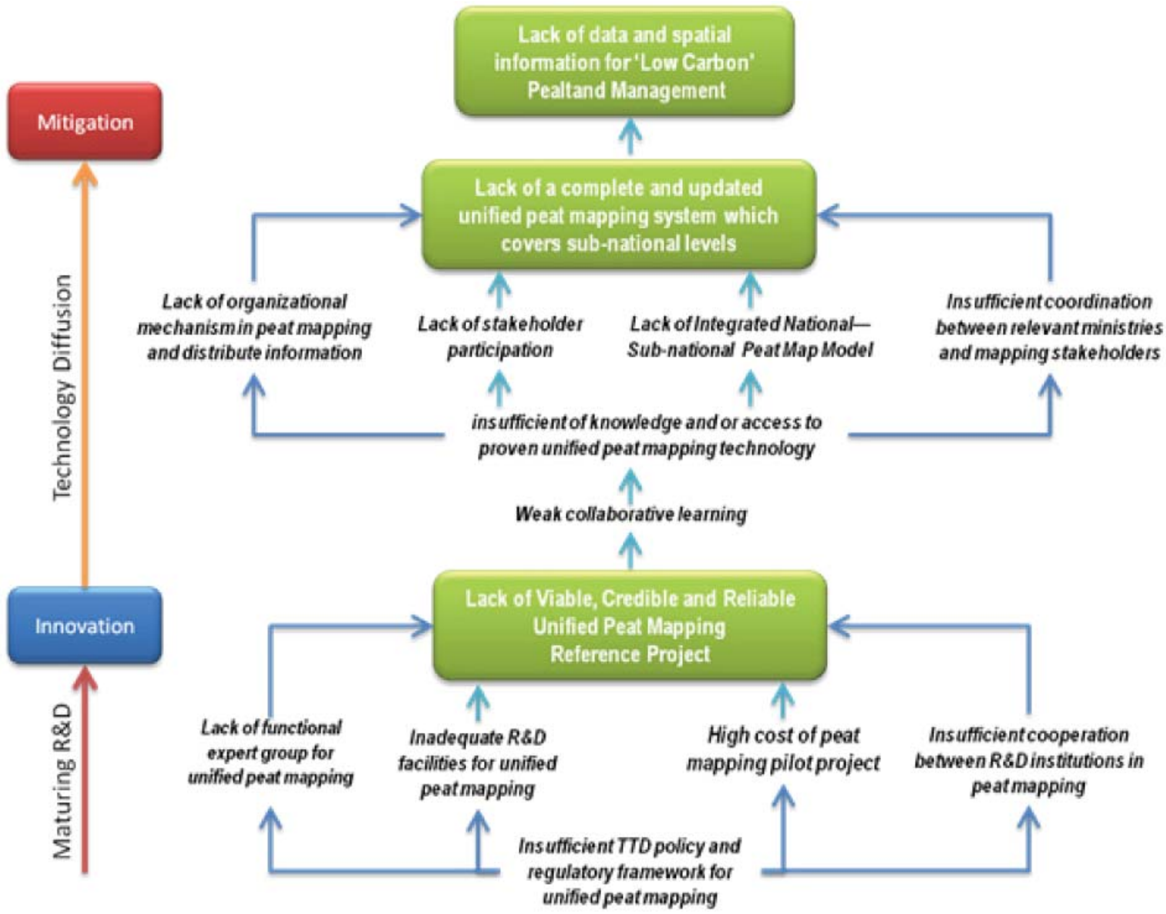

Figure 2-5 Problem tree of prioritized technology PRM

2.1.2.3. Barrier identification and analysis water management (PWM)

Technology PWM – Water Management – is characterized by integrated knowledge and water management infrastructures in forms of irrigation channel networks, drainage channel networks, vegetation barriers aimed to reduce emission from cultivated and planted peatlands.

Identification of barriers for the TTD process of prioritized technology PWM was performed by selecting barriers associated with non-market and public good type technologies listed in Table 2-2. The selected barriers were then reformulated by inference and decomposed using the list of hierarchical barrier structure suggested by UNEP's guide for identification of TTD barriers (UNEP 2010) particularly Annex A as the main reference. The results of identification and analysis technology CMM barriers, their decomposition, and ranking assignment are presented in Table 2-5.

Table 2-5 Barrier identification, decomposition, and rank for prioritized technology PWM

IDENTIFIED BARRIER	BARRIER' DECOMPOSITION	TTD Focus and Rank	
Barrier's Broad Category (UNEP 2010)			
SFM Generic Barriers (TNA 2009's)	Barrier Category - Barrier (inferred from generic barrier)	R&D	Diff
Economic and financial issues and market failure/imperfection			
- Limited and unattractive investment incentives - Existing Land-clearing methods without fire are still too expensive - High risk of peat and forest-fires - Forest plantation investment is considered economically less attractive - Unreasonable price of good quality planting materials	Economic and financial - Inadequate incentives - High cost of capital	2	2
	Market Imperfection - Lack of Viable, Credible and Reliable Reference Project - Inadequate access to technology	2	1 2
Policy, Legal, and Regulatory Issues			
- Lack of inter-sector policy, law enforcement and effective forestry administration - Lack of law enforcement and effective SFM - Lengthy and complex process to obtain licenses	Policy, legal and regulatory - Lack of Inter-sector TTD policy in water management for "Low Carbon" peat management - Complex regulatory procedures for obtaining licenses and permits - Inefficient regulatory enforcement	1	3 4
Institutional Network and Coordination Issues			
- Weak coordination among government institutions at the central and autonomous governments - poor public service	Network Failures - Insufficient coordination between relevant ministries and stakeholders - Weak collaborative learning	2	
Organizational and Human Capacity and Technical Issue			
- Low productivity of tree planted because of lack of appropriate silvicultural practices and the absence of genetically-improved seeds - Poor availability of good quality planting materials of some tree species	Human skill - Limited qualified personnel - Insufficient expertise to apply technology	3 2	
	Technical - Unfamiliarity of proven technology	2	2

Table 2-5 (Continued)

IDENTIFIED BARRIER	BARRIER' DECOMPOSITION	TTD Focus and Rank	
Social, Behavioural, Information and Awareness Issues			
- Forest plantation investment is considered less attractive compared to other commodities - Implementation of Reduced Impact Logging (RIL) is less attractive, as the big creating profits practice of unsustainable timber-harvesting still continues	Stakeholder Behavioural - Insufficient stakeholder involvement - Conflict of interest between public and corporate stakeholders	3	3
	Information and awareness - Lack of demonstration plant of proven technology		2
Note: * TTD Focus: R&D = Maturing R&D Phase, Diff = Technology Diffusion Phase Barrier Rank : killer=1, crucial=2, important=3, less important=4, insignificant=5			

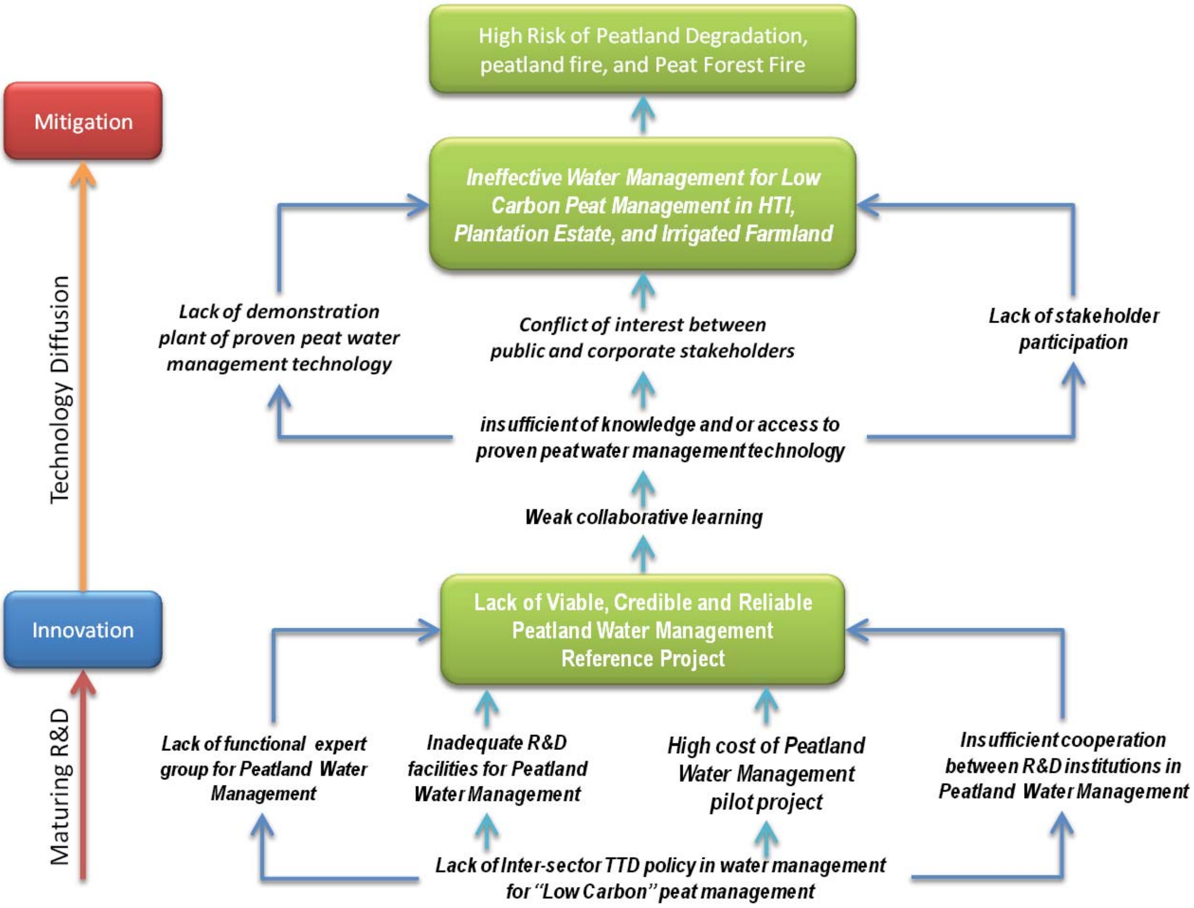

Figure 2-6 Problem tree of prioritized technology PWM

The results of barrier analysis of prioritized technology PWM listed in Table 2-4 were then brought to the causal relationship analysis among the decomposed barriers. The causal relationship analysis was performed according to logical framework relationships in the form of logical flow chart of logically linked barriers, starting from barriers associated with maturing R&D phases up to the technology diffusion phases. The result of such causal relationship analysis is presented in such a way to form a 'problem tree' in Figure 2-6.

The problem tree reveals that the root barriers work within the first chain of innovation system, i.e., maturing R&D, causing a lack of viable, credible, and reliable project in peatland water management. The problem tree also reveals that canopy barriers, which work within technology diffusion process, impede the effectiveness of water management for low carbon peatland management, causing high risk of peatland degradation, peatland fire, and peat forest fire.

2.1.2.4. Linkages of the barriers identified

2.1.3. Enabling framework for overcoming the barriers

TTD Framework Condition

The results of analysing framework conditions of the three prioritized technologies suggest that they are associated with two technology types: public goods (water management) and non-market (Carbon Measurement and Peat Re-mapping) technologies. Particular framework conditions of these types of technologies are briefly summarized as follows (UNEP 2010):

Capital good technology

Typical characteristics:

- Very few sites
- Large investment, government/donor funding
- Public ownership or ownership by large international companies
- Simple market chain; technology procured through national or international tenders.
- Investments in large-scale technologies tend to decide at the government level and depend heavily on existing infrastructure and policies.

Governments can play a role in supporting people and businesses to overcome some of the barriers involved here, create a conducive environment to the appropriate technology decisions and increase the opportunities for technology diffusion.

Technologies in this category may trade in a market place like consumer goods and capital goods, as they are purchased by public entities from private constructors and manufacturers. However, the market is often not as liquid, as the public entities purchase their goods through a tendering process, which may be restricted to a limited number of invited national and international construction companies.

Non-market technology

Typical characteristics:

- Technologies are transferred within a public non-commercial domain.
- Serves overall political objectives, such as energy saving and poverty alleviation
- Donor or government funding
- Information, capacity-building

Non-market technologies are transferred and diffused in non-market conditions by governments, public or non-profit institutions, international donors or NGOs. With regard to identifying barriers for transferring these technologies, this category is similar to public goods, but while the hardware element is high in the public goods category, non-market technologies are dominated by the software and orgware elements of technology.

Non-market technologies can be divided into three main groups within which technologies share some characteristics in terms of barriers and how to overcome them:

- Technologies provided by institutions
- Institutional change with the objective of reducing vulnerability and improving rural livelihoods
- Behavioural change at the individual level

Enabling environments

The enabling environment of TTD for the three prioritized technologies, within the context of the aforementioned particular framework of conditions of both public goods and non-market technologies can be identified as follows:

Policy Options

Policy measures and instruments for mitigation efforts in forestry and peat sector have been formally addressed in the ICCSR – Indonesia Climate Change Sectoral Roadmap document. The policy measures and instruments addressed in the roadmap suggest the dominant role and strong commitment of the government to mitigate CO2 emission through:

- Increasing the sink and creating conditions for preventing further deforestation based on KPH – HTI scenario
- Improvement of peat land management practices to reduce emissions in peat land currently under forestry and agricultural land use

A brief summary the policy measures and instruments of forestry and peat sector is presented in Table 2-6.

National Innovation System

Technology transfers are influenced greatly by what have been called national systems of innovation, the institutional and organizational structures that support technological development and innovation.

Indonesia has been fostering National Innovation System since the year of 2002 marked by the establishment of National System of Science and Technology Constitution (UU 18/2002). The constitution was further followed up by Government Regulation (PP 20/2005) for Technology Transfer.

Table 2-6 Policy measures and instruments for GHG mitigation of forestry and peat sectors*)

SECTORS	Policy Measures and Instruments
LULUCF (Forestry)	Increasing the sink and creating conditions for preventing further deforestation based on KPH – HTI scenario Mitigation efforts are based on mixed of activities: 1) Industrial plantations development on dry land, where KPH has been developed; 2) Emission reduction enhancement comes from better management of production, conservation and protection forests under the KPHs (11.4 tCo2/ha/year), 3) Some modest REDD activities during the first period. In SC3, 4 million ha of HTI/HTR are planted on 24 million ha of KPH. Mitigation comes also from better management of natural forest, less illegal logging and fire.
Peat	Improvement of Peatland Management Practices to reduce emissions in peatland currently under forestry and agricultural land use. This policy might be directed at enforcing existing legal requirements and establishing new standards for best practices in 'low carbon' peat land management. Three main mitigation actions are defined: • Enforce strict compliance by existing forest and plantation concessions with regulations forbidding the cultivation of peat more than three metres thick. • Provide incentives, sanctions and enforce (a) the zero burning policy for land clearance by companies and (b) best practices for water management to reduce subsidence and carbon emissions from oxidation in peat land under cultivation

***) the ICCSR – Indonesia Climate Change Sectoral Roadmap (BAPPENAS 2010)**

BPPT – The Agency for Assessment and Application of Technology proposed a conceptual framework of National Innovation System for strengthening scientific and technical educational institutions and modify the form or operation of technology networks - the interrelated organizations generating, diffusing, and utilizing technologies. The diagram of such National Innovation system is presented in Figure 2-7. This framework has been nationally adopted by Ministry of Science and Technology for implementing TTD of several national programs such as INA tsunami early warning system (INA TEWS), Development of Renewable Energy, and Development of Legal Software based on Open Source Software.

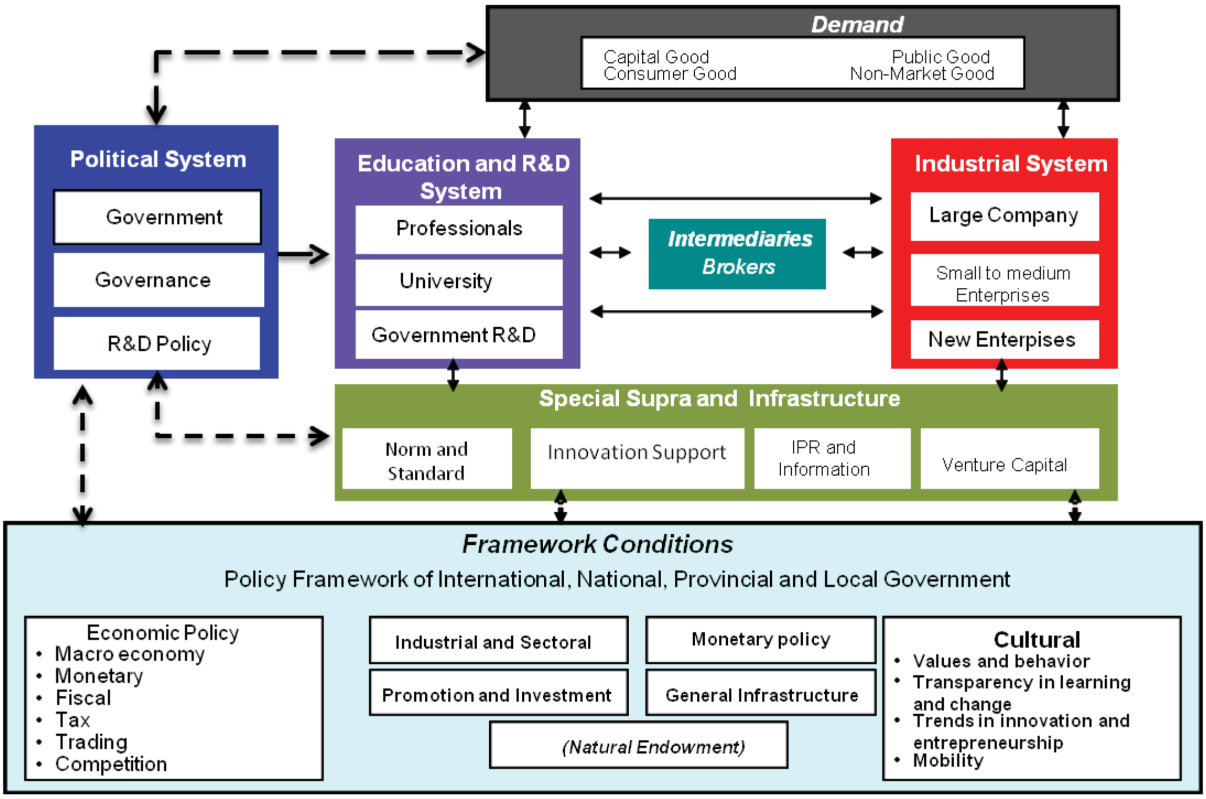

Figure 2-7 The framework of Indonesia national innovation system

2.1.3.1. Possible solutions to address the barriers for the transfer and diffusion of carbon measurement (CMM)

The possible solution for overcoming barriers of TTD process of prioritized technology CMM is formulated in an "Objective Tree" depicted in Figure 2-9, which comprises measures and incentives presented in Table 2-7.

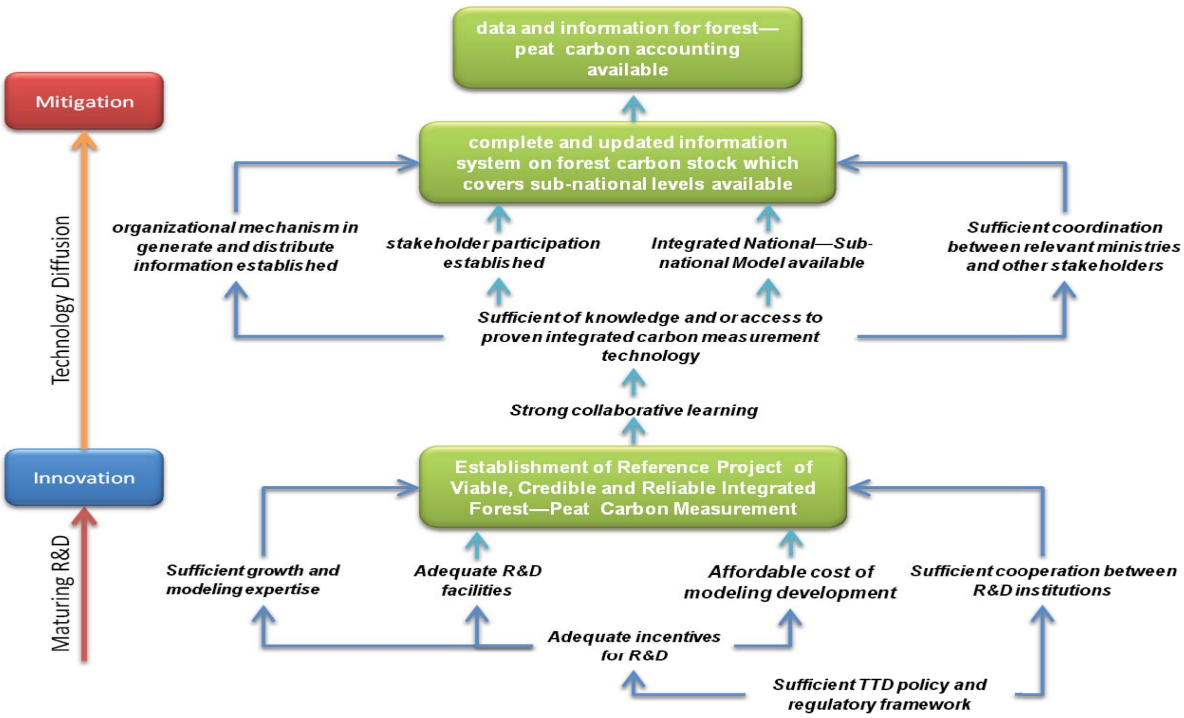

Figure 2-9 Objective tree of prioritized technology CMM

Table 2-7 Measures and incentives for overcoming barriers of TTD of prioritized technology CMM

Objective (TTD Focus)	
Incentive	**Measures**
Establishment of reference project of viable, credible, and integrated Forest—Peat carbon measurement (R&D)	
Provide sufficient TTD policy and regulatory framework to ensure Adequate incentives for R&D, Sufficient cooperation between R&D institutions, Affordable cost of modelling development, Adequate R&D facilities, sufficient number of growth and modelling Experts	■ Establishment of Forest—Peat carbon measurement Task Force and Expert Consultation Working group for growth and modelling ■ Provide adequate R&D Facilities (hardware and software) ■ Establishment of carbon measurement modelling prototype development
Provide complete and updated information system on forest carbon stock covering sub-national level (Diffusion)	
Facilitate strong collaborative learning to ensure sufficient knowledge and access to proven integrated carbon measurement technology	Carry out sub-national capacity building program to transfer knowhow of and facilitate access to proven integrated carbon measurement technology, including establishment of ■ organization mechanism to distribute information ■ stake holder participation ■ Integrated national-sub national carbon measurement model ■ Sufficient coordination between relevant ministries and other stakeholders

The possible solution for overcoming barriers of TTD process of prioritized technology PRM is formulated in an "Objective Tree" depicted in Figure 2-10, which comprises measures and incentives presented in Table 2-8.

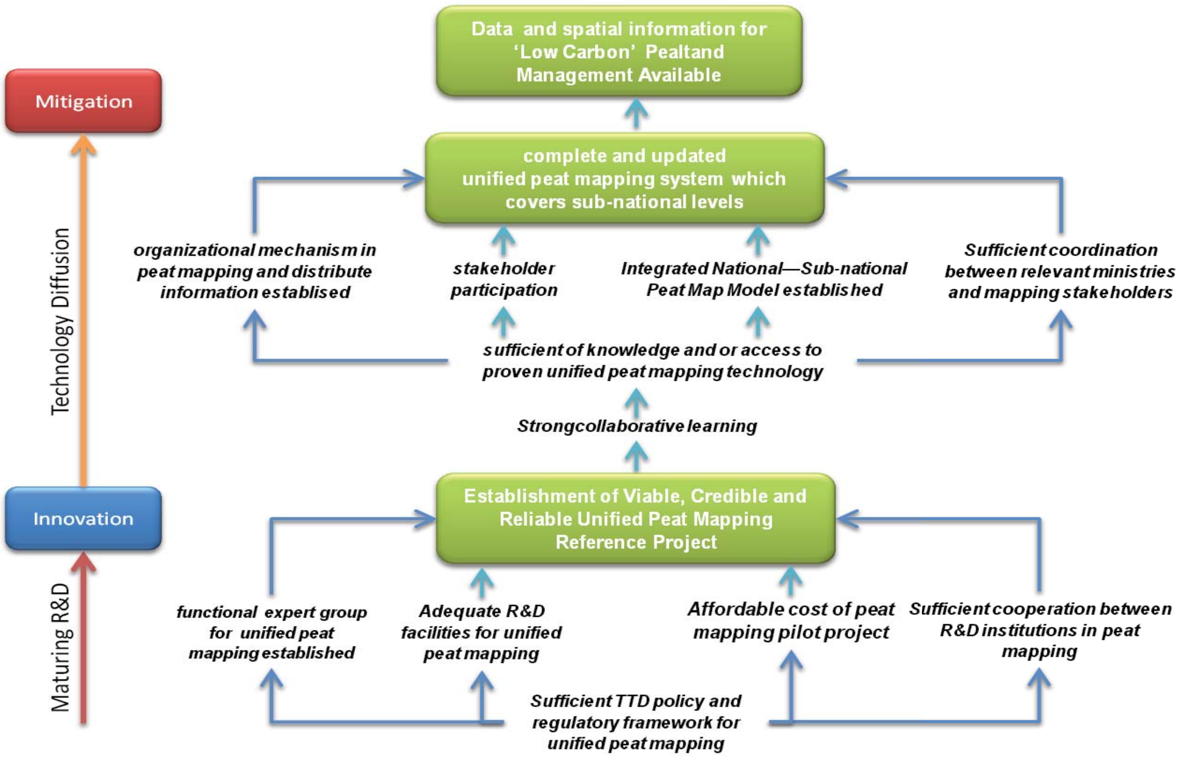

Figure 2-10 Objective tree of prioritized technology PRM

Table 2-8 Measures and incentives for overcoming barriers of TTD of prioritized technology PRM

Objective (TTD Focus)	
Incentive	**Measures**
Establishment of reference project of viable, credible, and reliable unified peat mapping (R&D)	
Provide sufficient TTD policy and regulatory framework to ensure Adequate incentives for R&D, Sufficient cooperation between R&D institutions, Affordable cost of peat mapping pilot project, Adequate R&D facilities, sufficient number of Peat Mapping Functional Experts	■ *Provide adequate R&D Facilities (hardware and software)* ■ *Establishment of unified peat mapping expert consultation working group* ■ *Establishment of peat mapping pilot project*
Provide complete and updated peat mapping system covering sub-national level (Diffusion)	
Facilitate strong collaborative learning to ensure sufficient knowledge and access to proven integrated carbon measurement technology	Establishment of ■ *organization mechanism to distribute information* ■ *stakeholder participation* ■ *Integrated national-sub national carbon measurement model* ■ *Sufficient coordination between relevant ministries and mapping stakeholders*

The possible solution for overcoming barriers of TTD process of prioritized technology PWM is formulated in an "Objective Tree" depicted in Figure 2-11, which comprise measures and incentives presented in Table 2-9.

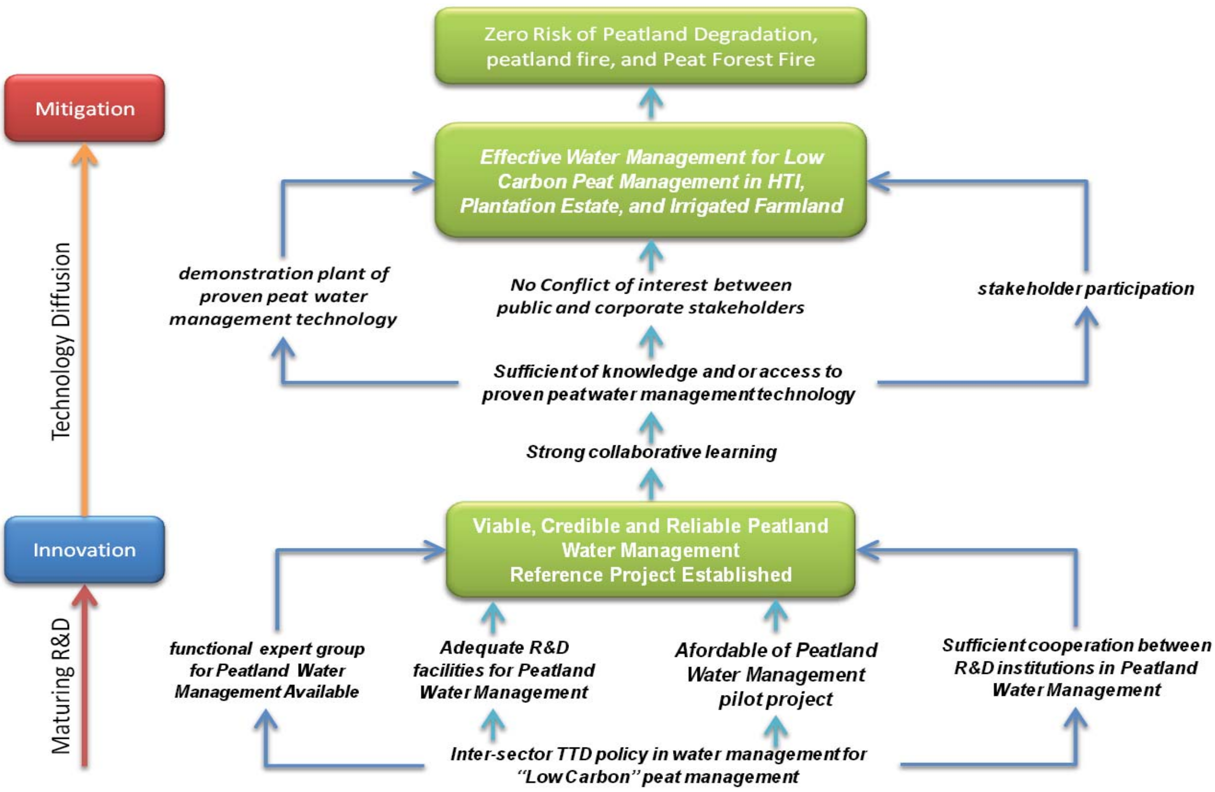

Figure 2-11 Objective tree of prioritized technology PWM

Table 2-9 Measures and incentives for overcoming barriers of TTD of prioritized technology PWM

Objective (TTD Focus)	
Incentive	**Measures**
Establishment of reference project of viable, credible, and reliable peatland water management (R&D)	
Provide sufficient inter-sector TTD policy and regulatory framework to ensure Adequate facilities for R&D, Sufficient cooperation between R&D institutions, sufficient number of Peat Mapping Functional Experts, and affordable peatland water management pilot project	■ *Provide adequate R&D Facilities (hardware and software)* ■ *Establishment of unified peat mapping expert consultation working group* ■ *Establishment of peatland water management pilot project*
Provide effective water management for "Low Carbon" peat management on HTI, plantation estate, and irrigated farmland (Diffusion)	
Facilitate strong collaborative learning to ensure sufficient knowledge and access to proven peatland water management technology	Establishment of ■ *organization mechanism to distribute information* ■ *peat water management stakeholder participation* ■ *Demonstration plant of proven water management technology*

2.1.3.2. Recommended solutions for forestry and peat sector

The initial phase of diffusion – sometimes referred to as 'take-off' – includes 'innovators' phase (corresponds to 'awareness' and two other preceding phases of 'maturing R&D' of TTD curved in Figure 2-3) and 'early adopters' phase (corresponds to 'interest' phase) of TTD process. During this initial phase the reliability, practicality and financial feasibility of the technology is demonstrated. Therefore, these phases are commonly recognized as very difficult and critical to overcome phases.

The use of logical framework approach by means of problem tree and objective tree revealed that this approach was effective for barrier identification and selection of key measures and incentives for overcoming barriers. Problem trees illustrated in Figures 9, 10, and 11 were used for identifying starting problems, root barriers, canopy barriers, and causal relationships of the barriers. Objective trees presented in Figures 13, 14, and 15 were effective for suggesting measures and incentives for possible barrier's solution.

Within the context of critical nature of the initial phase of TTD, additional logical framework assessment of the aforementioned possible solutions was performed to evaluate the priority level of measures. It is important to note that the guidance to evaluate priority level of a measure follows Jacobson's view suggested by UNEP (2010):

- For measures of the maturing R&D: Key actors, or groups of actors, who can promote the new technology need to emerge first. Any measure that promotes the innovation of technological systems is considered high priority in terms of minimizing the uncertainty and complicated process for the emergence of a new technological system.
- For measures of the technology diffusion: The actors of innovation – innovators – need to be expanded to promote the "prime movers" – a constellation of actors who share an interest in promoting and performing four important tasks: raise awareness, undertake investments, provide legitimacy and diffuse the new technology. Any measure that promotes the emergence of prime movers and supports their tasks is considered having a high priority level.

To complete the assessment a follow on rapid assessment of benefit and cost for each measure was carried out. The assessment was performed by estimation of qualitative, simple figures of potential benefit and cost in three levels: high, moderate, and low. A combination of priority level and simple figures of potential benefit and cost would provide an insight whether a measure need a significant, moderate, or fair of policy support in the form of incentive. Once the assessment was completed, the following recommended solutions were suggested:

1) Policy of action and mode of implementation to promote the emergence of newly developed technological innovation system by innovators and the emergence of appropriate actors of early adopters within the phase of maturing R&D
2) Policy of action and mode of implementation to promote the emergence he emergence of appropriate actors of "Prime Movers" within the phase of technology diffusion

The results of the additional logical framework assessment are presented in Tables 22, 23, 24.

Table 2-10 Additional logical framework assessment of measures and incentives and recommended solution for technology CMM

Technology Transfer and Diffusion of Technology CMM Goal: To make data and information available for Forest—Peat carbon accounting							
Maturing R&D				Technology Diffusion			
Objective To establish a reference TTD project of Forest—Peat carbon measurement and monitoring				Objective To provide complete and updated information system on forest carbon stock covering sub-national level			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of Forest—Peat carbon measurement national task Force	M	L	H	Carry out sub-national collaborative learning program to transfer knowhow of and facilitate access to proven integrated carbon measurement and monitoring technology:	M	L	H
M2. Establishment of expert working group for growth modelling biomass measurement	H	L	M	M6. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	H	H	H
M3. Establishment of expert working group for peat biomass measurement modelling	H	L	M	M7. Carry out on-site job training for development and implementation of Integrated national-sub national carbon measurement model	L	M	M
M4. Establish international capacity building for Forest—Peat carbon measurement prototype development	H	H	H	M8. Develop and implement organization mechanism to distribute information			
M5. Provide adequate R&D field stations and facilities for carbon measurement prototyping (hardware and software)	H	M	H				
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							
Incentive (I)			S	Incentive (I)			S
Provide an operational policy and regulation for Forest—Peat carbon measurement and monitoring, which governs, supports, and controls:				Provide collaborative learning operational policy and regulation which governs, supports, and controls:			
I1: Inter ministerial task force and expert working groups			F	I5: Sub-national coordination forum			F
I2: International capacity building arrangement			H	I6.: On-site job training for integrated National-sub national modelling and implementation			H
I3: R&D field stations and supporting facilities			H	I7: Organization mechanism to distribute information			M
I4.: Financial schemes for M1,M2,M3,M4,M5			M	I8. I8: Financial schemes for M6,M7,M8			M

S= Significance, H= High, M= Moderate, F=Fair	
Recommended Solutions	
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented integrated peat-forest carbon measurement and monitoring technology. Mode of Action: International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of integrated peat-forest carbon measurement and monitoring carried out on national demonstrator R&D field stations.	Policy Action: Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of integrated peat-forest carbon measurement and monitoring technology. Mode of Action: On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group

Table 2-11 Additional logical framework assessment of measures and incentives and recommended solution for technology PRM

Technology Transfer and Diffusion of Technology PRM Goal: To make data and spatial information available for "Low Carbon" Peatland Management							
Maturing R&D				Technology Diffusion			
Objective Establishment of a TTD reference project of viable, credible, and reliable unified peat mapping				Objective To provide complete and updated information system on forest carbon stock covering sub-national level			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of unified peat mapping national task Force	M	L	H	Carry out sub-national collaborative learning program to transfer knowhow of and facilitate access to proven unified peat mapping technology:			
M2. Establishment of expert working group for unified peat mapping	H	L	M	M5. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	M	L	H
M3. Establish international capacity building for unified peat mapping prototype development	H	H	H	M6. Carry out on-site job training for development and implementation of unified peat mapping methods and practices	H	H	H
M4. Provide adequate R&D field stations and facilities for unified peat mapping prototyping (hardware and software)	H	M	H	M7. Develop and implement organization mechanism to establish a unified peat mapping system covering sub national level	L	M	M
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							
Incentive (I)			S	Incentive (I)			S
Provide an operational policy and regulation for Forest—Peat carbon measurement and monitoring, which governs, supports, and controls:				Provide collaborative learning operational policy and regulation which governs, supports, and controls:			
I1: Inter ministerial task force and expert working groups			F	I5: Sub-national coordination forum			F
I2: International capacity building arrangement			H	I6.: On-site job training for integrated National-sub national unified peat mapping			H
I3: R&D field stations and supporting facilities			H	I7: Organization mechanism to establish unified peat mapping system			M
I4.: Financial schemes for M1,M2,M3,M4,M5			M	I8. I8: Financial schemes for M6,M7,M8			M
S= Significance, H= High, M= Moderate, F=Fair							

Table 2-11 (Continued)

Technology Transfer and Diffusion of Technology PRM Goal: To make data and spatial information available for "Low Carbon" Peatland Management	
Recommended Solutions	
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented unified peat mapping system technology. Mode of Action: International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of unified peat mapping system carried out on national demonstrator R&D field stations.	Policy Action: Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of unified peat mapping system technology. Mode of Action: On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group

Table 2-12 Additional logical framework assessment of measures and incentives and recommended solution for technology PWM

Technology Transfer and Diffusion of Technology PWM Goal: To Achieve Zero Risk of Peatland Degradation, peatland fire, and Peat Forest Fire							
Maturing R&D				Technology Diffusion			
Objective Establishment of reference project of viable, credible, and reliable peatland water management				Objective Provide effective water management for "Low Carbon" peat management on HTI, plantation estate, and irrigated farmland			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of peatland water management task Force	M	L	H	Carry out sub-national collaborative learning program to transfer knowhow of and facilitate access to proven peatland water management technology:			
M2. Establishment of expert working group for peatland water management	H	L	M	M5. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	M	L	H
M3. Establish international capacity building for peatland water management prototype development	H	H	H	M6. Carry out on-site job training for development and implementation of peatland water management practices	H	H	H
M4. Provide adequate R&D field stations and facilities for peatland water management prototyping (hardware and software)	H	M	H	M7. Develop and implement organization mechanism to establish peatland water management	L	M	M
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							
Incentive (I)			S	Incentive (I)			S
Provide an operational policy and regulation for Forest—Peat carbon measurement and monitoring, which governs, supports, and controls:				Provide collaborative learning operational policy and regulation which governs, supports, and controls:			
				I5: Sub-national coordination forum			F
I1: Inter ministerial task force and expert working groups			F	I6.: On-site job training for peatland water management			H
I2: International capacity building arrangement			H	I7: Organization mechanism to establish peatland water management			M
I3: R&D field stations and supporting facilities			H				M
I4.: Financial schemes for M1,M2,M3,M4,M5			M	I8. I8: Financial schemes for M6,M7,M8			
S= Significance, H= High, M= Moderate, F=Fair							

Recommended Solutions	
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented peatland water management technology. Mode of Action: International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of peatland water management carried out on national demonstrator R&D field stations.	Policy Action: Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of peatland water management technology. Mode of Action: On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group

2.1.4. Concrete actions plans and ideas

2.1.4.1. Plans for domestic actions and measures

Plans for domestic actions and measures are presented in Tables 25, 26 and 27 for Sub-National Collaborative Learning for Forest-Peat Carbon Measurement and Monitoring, Unified Peat Re-Mapping Technology, and Peatland Water Management Technology, respectively.

Table 2-13 Sub-National collaborative learning for forest-peat carbon measurement and monitoring

Description				
Policy action	Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototype of integrated peat-forest carbon measurement and monitoring technology			
Objective	To provide complete and updated information system on forest carbon stock covering sub-national level			
Approach	On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group.			
Measures	M6. Establish coordination forum of relevant ministries , KPHs, and other stakeholders M7. Carry out on-site job training for development and implementation of Integrated national-sub national carbon measurement model M8. Develop and implement organization mechanism to distribute information			
Incentives	I5: Sub-national coordination forum I6.: On-site job training for integrated National-sub national modelling and implementation I7: Organization mechanism to distribute information I8. Financial schemes for M6,M7,M8			
Timeline				
	Action	Year 1	Year 2 - 5	Year 6 - 10
	Measures	M6,M7	M7, M8	M7, M8
	Incentives	I5,I6,I7,I8		
Geographic Scope	West Indonesia		Sumatra, Kalimantan	Sumatra, Kalimantan
	East Indonesia		Sulawesi, Irian	Sulawesi, Irian

Table 2-13 (Continued)

Description			
Resources Needed			
	Software	Knowhow from previous R&Ds, Forest-peat biomass and carbon models	
	Hardware	"National Demonstrator" Field station and supporting R&D facilities	
	Organiware	coordination forum of relevant ministries , KPHs, and other stakeholders	
	Policy	I5,I6,I7,I8	
	Budget	P.M.	
Coordinating, Implementing, Contributing Agency			
	Coordinating Agency	Implementing Agency	Participating Agency
	Ministry of Forestry	DG of Forest Planning of Ministry of forestry	KPH HTI HPH Conservation forest Institutions Other local stakeholders

Table 2-14 Sub-National collaborative learning for unified peat re-mapping technology

Description				
Policy action	Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototype of integrated peat-forest carbon measurement and monitoring technology			
Objective	To provide complete and updated information system on forest carbon stock covering sub-national level			
Approach	On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group.			
Measures	M6. Establish coordination forum of relevant ministries , KPHs, and other stakeholders M7. Carry out on-site job training for development and implementation of Integrated national-sub national carbon measurement model M8. Develop and implement organization mechanism to distribute information			
Incentives	I5: Sub-national coordination forum I6.: On-site job training for integrated National-sub national modelling and implementation I7: Organization mechanism to distribute information I8. Financial schemes for M6,M7,M8			
Timeline				
	Action	Year 1	Year 2 - 5	Year 6 - 10
	Measures	M6,M7	M7, M8	M7, M8
	Incentives	I5,I6,I7,I8		
Geographic Scope	West Indonesia		Sumatra, Kalimantan	Sumatra, Kalimantan
	East Indonesia		Sulawesi, Irian	Sulawesi, Irian
Resources Needed				
	Software	Knowhow from previous R&Ds, Forest-peat biomass and carbon models		
	Hardware	"National Demonstrator" Field station and supporting R&D facilities		
	Organiware	coordination forum of relevant ministries , KPHs, and other stakeholders		
	Policy	I5,I6,I7,I8		
	Budget	P.M.		

Coordinating, Implementing, Contributing Agency			
	Coordinating Agency	Implementing Agency	Participating Agency
	Ministry of Forestry	DG of Forest Planning of Ministry of forestry	KPH HTI HPH Conservation forest Institutions Other local stakeholders

Table 2-15 Sub-National collaborative learning for peatland water management technology

Description				
Policy action	Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototype of Peatland water management technology			
Objective	Provide effective water management for "Low Carbon" peat management on HTI, plantation estate, and irrigated farmland			
Approach	On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group.			
Measures	M5. Establish coordination forum of relevant ministries , KPHs, and other stakeholders M6. Carry out on-site job training for development and implementation of peatland water management practices M7. Develop and implement organization mechanism to establish peatland water management			
Incentives	Provide collaborative learning operational policy and regulation which governs, supports, and controls: I5: Sub-national coordination forum I6.: On-site job training for peatland water management I7: Organization mechanism to establish peatland water management I8. Financial schemes for M6,M7,M8			
Timeline				
	Action	Year 1	Year 2 - 5	Year 6 - 10
	Measures	M6,M7	M7, M8	M7, M8
	Incentives	I5,I6,I7,I8		
Geographic Scope	West Indonesia		Sumatra, Kalimantan	Sumatra, Kalimantan
	East Indonesia		Sulawesi, Irian	Sulawesi, Irian
Resources				
	Software	Knowhow from previous R&Ds, Forest-peat biomass and carbon models		
	Hardware	"National Demonstrator" Field station and supporting R&D facilities		
	Organiware	coordination forum of relevant ministries , KPHs, and other stakeholders		
	Policy	I5,I6,I7,I8		
	Budget	P.M.		
Coordinating, Implementing, Contributing Agency				
	Coordinating Agency	Implementing Agency	Participating Agency	
	Ministry of Forestry	DG of Forest Planning of Ministry of forestry	KPH HTI HPH Conservation forest Institutions Other local stakeholders	

2.1.4.2. Project ideas for international support

Project ideas for international support are presented in Tables 28, 29 and 30 for National Capacity Building on Technology for Forest-Peat Carbon Measurement and Monitoring, Unified Peat Re-Mapping Technology, and Peatland Water Management Technology, respectively.

Table 2-16 National capacity building on technology for forest-peat carbon measurement and monitoring

Justification	Self Capacity Building by a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of integrated peat-forest carbon measurement and monitoring on national demonstrator R&D field stations				
Resources Requirement	International experts for biomass and carbon measurement of Forest and Peatland				
Objective	To establish a reference TTD project of Forest—Peat carbon measurement and monitoring technology				
Indicator of Success	"National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented integrated peat-forest carbon measurement and monitoring technology established				
Measures	M1. Establishment of Forest—Peat carbon measurement national task Force M2. Establishment of expert working group for growth modelling biomass measurement M3. Establishment of expert working group for peat biomass measurement modelling M4. Development of Forest—Peat carbon measurement prototype as an interface for related international capacity building for Forest—Peat biomass and carbon modelling M5. Provide adequate R&D field stations and facilities for carbon measurement prototyping (hardware and software)				
Incentives	I1: Development of inter-ministerial task force and expert working groups I2: Self capacity building arrangement for inter-ministerial expert working groups I3: Regulation for facilitation of R&D field stations and supporting facilities I4: Financial schemes for M1,M2,M3,M4,M5				
Timeline					
	Action	Year 1	Year 2	Year 3	Year 4
	Measures	M1,M2,M3	M4,M5		
	Incentives	I1,I2,I3,I4			
Geographic Scope	National WG	✔	✔	✔	✔
	field Stations for National Demonstrator	Sumatra	Sumatra Kalimantan Sulawesi	Kalimantan Sulawesi Irian	Irian
Resources					
	Software	Knowhow from previous R&Ds, Forest-peat biomass and carbon models			
	Hardware	"National Demonstrator" Field station and supporting R&D facilities			
	Organiware	Inter-ministerial expert consultation working group			
	Policy	I1,I2,I3,I4			
	Budget	P.M.			

Coordinating, Implementing, Contributing Agency			
	Coordinating Agency	Implementing Agency	Contributing Agency
	Ministry of Forestry	DG of Forest Planning of Ministry of forestry	Ministry of Finance BPPT LIPI Soil Research Institute Forest Research Institute CIFOR Universities

Table 2-17 National capacity building on technology for forest unified peat re-mapping technology

Justification	Self Capacity Building by a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of unified peat re-mapping technology carried out on national demonstrator R&D field stations				
Resources Requirement	International experts for biomass and carbon measurement of Peatland mapping				
Objective	Establishment of a TTD reference project of viable, credible, and reliable unified peat mapping				
Indicator of Success	"National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented unified peat mapping system technology established				
Measures	M1. Establishment of unified peat mapping national task Force M2. Establishment of expert working group for unified peat mapping M3. Establish national capacity building for unified peat mapping prototype development M4. Provide adequate R&D field stations and facilities for unified peat mapping prototyping (hardware and software)				
Incentives	I1: Development of inter-ministerial task force and expert working groups I2: Self capacity building arrangement for inter-ministerial expert working groups I3: Regulation for facilitation of R&D field stations and supporting facilities I4: Financial schemes for M1,M2,M3,M4,M5				
Timeline					
	Action	Year 1	Year 2	Year 3	Year 4
	Measures	M1,M2,M3,M4	M3,M4		
	Incentives	I1,I2,I3,I4			
Geographic Scope	National WG	✔	✔	✔	✔
	Peat Re-Mapping Prototype	Sumatra	Sumatra Kalimantan Sulawesi	Kalimantan Sulawesi Irian	Irian
Resources	Software	Knowhow from previous R&Ds and practices on forest and peat mapping			
	Hardware	"National Demonstrator" Field station and supporting mapping facilities			
	Organiware	Inter-ministerial expert consultation working group			
	Policy	I1,I2,I3,I4			
	Budget	P.M.			
Coordinating, Implementing, Contributing Agency					
	Coordinating Agency	Implementing Agency	Contributing Agency		
	Ministry of Forestry	DG of Forest Planning of Ministry of forestry	Ministry of Finance BPPT BAKOSURTANAL LAPAN Soil Research Institute Forest Research Institute CIFOR Universities		

Table 2-18 National capacity building on technology for peatland water management technology

Justification	Self Capacity Building by a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of peatland water management technology carried out on national demonstrator R&D field stations				
Resources Requirement	International experts for biomass and carbon measurement of Peatland Water Management				
Objective	Establishment of a TTD reference project of viable, credible, and reliable peatland water management				
Indicator of Success	"National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented peatland water management technology established				
Measures	M1. Establishment of peatland water management task Force M2. Establishment of expert working group for peatland water management M3. Establish international capacity building for peatland water management prototype development M4. Provide adequate R&D field stations and facilities for peatland water management prototyping (hardware and software)				
Incentives	I1: Development of inter-ministerial task force and expert working groups I2: Self capacity building arrangement for inter-ministerial expert working groups I3: Regulation for facilitation of R&D field stations and supporting facilities I4: Financial schemes for M1,M2,M3,M4,M5				
Timeline					
	Action	Year 1	Year 2	Year 3	Year 4
	Measures	M1,M2,M3,M4	M3,M4		
	Incentives	I1,I2,I3,I4			
Geographic Scope	National WG	✔	✔	✔	✔
	Peatland Water Management Prototype	Sumatra	Sumatra Kalimantan Sulawesi	Kalimantan Sulawesi Irian	Irian
Resources					
	Software	Knowhow from previous R&Ds and practices on peatland water management			
	Hardware	"National Demonstrator" Field station and supporting R&D facilities			
	Organiware	Inter-ministerial expert consultation working group			
	Policy	I1,I2,I3,I4			
	Budget	P.M.			
Coordinating, Implementing, Contributing Agency					
	Coordinating Agency	Implementing Agency		Contributing Agency	
	Ministry of Public Works	Ministry of forestry		Ministry of Finance Ministry of Agriculture Ministry of Public Works Soil Research Institute Forest Research Institute CIFOR Universities	

2.1.4.3. Possible measures to address IPR barriers

2.1.5. Summary

Three prioritized technologies of Forestry and Peat sector were suggested to facilitate with Technology Action Plan (TAP). The technologies are Carbon Measurement and Monitoring (CMM), Peat Re-mapping (PRM), and Peat Water Management (PWM). Technologies CMM and PRM were characterized having non-market technology types, whereas PWM was characterized having two technology types either public good or capital good technology types.

Technology transfer and diffusion (TTD) process of the prioritized technologies follows KPH-HTI-SFM scenario formulated in the Indonesia Climate Change Sectoral Roadmap – ICCSR (Bappenas 2009). This scenario is characterized by heavy investments on the establishment of hundreds of newly developed Forest Management Units (KPH) in order to guarantee significant improvement of sustainable forest management (SFM) of all state forests: natural forests, rehabilitated forest, and productive plantation. Within the first period of Forestry Sector's roadmap (2010 – 2019), 244 newly developed KPHs will be established and, by the end of the second period (2020-2029) a total number of 344 KPHs will be established.

For the purpose of barrier analysis of the three prioritized technology, the concept of TTD process of "Innovation System" was applied to the KPH-HTI-SFM scenario (Figure 2-3), depicting the process of technology transfer follows a TTD's S-curved go through two phases of "Innovation System": R&D Maturation and Technology Diffusion.

Problem tree analysis applied to the barriers of the TTD process of the three prioritized technologies revealed the followings:

1) Maturing R&D process of CMM technology deals with a problem starter barrier and its follow on effect barriers to provide a reference project of viable, credible and reliable integrated forest—peat carbon measurement, whereas that of technology diffusion deals with barriers of adopting this technology for facilitating mitigation measures to achieve a complete and updated unified peat mapping system which covers sub-national levels and hence the availability of data and information of forest-peat carbon accounting (Figure 2-4).

2) A similar starting problem barrier of TTD process of PRM technology was recognized, that is, Lack reference project of viable, credible, and reliable unified peat mapping system, which end up to a problem of lack of a complete and updated unified peat mapping system which covers sub-national levels and further propagates to a condition of lack of data and spatial information for 'Low Carbon' Peatland Management (Figure 2-5).

3) The starting problem barrier of TTD process of technology PWM Lack of Reference Project of Viable, Credible and Reliable Peat Water Management System, which further works within technology diffusion process, impede the effectiveness of water management for "low carbon" peatland management, causing the high risk of peatland degradation, peatland fire, and peat forest fire (Figure 2-6).

To assess possible solutions for overcoming barriers, a hierarchical logical framework analysis was applied to objective trees, followed by a rapid benefit cost/consequence analysis, with special consideration of critical and difficult nature of "take off" – the initial phases when the reliability, practicality and financial feasibility of the technology is demonstrated. Furthermore, the results of such assessment were used to recommend the following overcoming barrier solutions:

1) Recommended solution for TTD process of carbon measurement and monitoring technology

	R&D Maturation Phase	Technology Diffusion Phase
Policy Action	Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented integrated peat-forest carbon measurement and monitoring technology	Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of integrated peat-forest carbon measurement and monitoring technology
Mode of Action	International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of integrated peat-forest carbon measurement and monitoring carried out on national demonstrator R&D field stations	On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group

2) Recommended solution for TTD process of peat re-mapping system technology

	R&D Maturation Phase	Technology Diffusion Phase
Policy Action	Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented unified peat mapping system technology	Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of unified peat mapping system technology
Mode of Action	International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of unified peat mapping system technology carried out on national demonstrator R&D field stations	On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group

3) Recommended solution for TTD process of peat water management technology

	R&D Maturation Phase	Technology Diffusion Phase
Policy Action	Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented unified peat water management technology	Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of peat water management technology
Mode of Action	International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of peat water management technology carried out on national demonstrator R&D field stations	On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain time of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group

The aforementioned recommended solutions consist of policy actions and their approaches for implementation. For the R&D maturation phase, the recommended policy action is to establish "National Demonstrator" project for demonstrating the reliability, practicality and financial feasibility of newly invented technological system by the use of International Capacity Building mode of action dedicated for the development of operational, reliable, credible, and feasible technological system prototypes. For the diffusion phase, the recommended policy action is to establish "collaborative learning" program by means of "on the job training" carried out on national demonstrator R&D field stations followed by trial and adjustment implemented in the newly developed KPH jurisdiction areas.

The recommended solutions may be implemented through two types of "concrete actions": domestic actions and international supports. To facilitate these actions, for each prioritized technology, a technology action plan in the forms of Domestic Action Plans and Project Ideas for International Supports are formulated as follows:

Prioritized Technology	Domestic Action Plans	Project Ideas for International Supports
Carbon measurement and monitoring	Sub-National Collaborative Learning for Forest-Peat Carbon Measurement and Monitoring	National Capacity Building on Technology for Forest-Peat Carbon Measurement and Monitoring
Peat re-mapping	Sub-National Collaborative Learning for Unified Peat Re-Mapping Technology	National Capacity Building on Technology for Forest Unified Peat Re-Mapping Technology
Peat water management	Sub-National Collaborative Learning for Peatland Water Management Technology	National Capacity Building on Technology for Peatland Water Management Technology

2.2. TAPs for energy sector

2.2.1. Preliminary targets for technology transfer and diffusion for prioritized technologies for energy sector

2.2.1.1. PV technology

As a tropical country, Indonesia has a huge potential of solar energy. It reaches about one million MWe of energy or equivalent to 1,800 TWh per year. The average daily solar radiation reaching the Indonesian land is approximately 4.8 kWh/ m2. In the eastern region of Indonesia, the solar energy potential reaching the land is equal to 5.1 kWh/m2 with monthly variation of about 9%. In the western region, it is about 4.5 kWh/m2 with a monthly variation of about 10%. The potential availability of this solar energy will result the high potential benefits of Solar Power Plant (PLTS) implementation. This potency will enhance the increased national electrification ratio in the future for both rural and urban areas. It is noted that the national electrification ratio of Indonesia is only 65% in 2010.

In line with the huge potential of solar radiation, Indonesia has significantly owned quartz sand resource that is a raw material of solar cell. Therefore, the solar cell manufacturing in Indonesia is considered very promising. In this regard, the Government has set up a vision on renewable energy utilization by 2025, which is targeted to 25% of the total energy use in Indonesia. Previously, the Government through Blue Print of National Energy Management 2005-2025 stated that the photovoltaic energy would only contribute about one GWe of installed capacity in 2025.

In conjunction with the efforts to increase national electrification ratio for meeting the electricity needs for the single home independently (only connected to the network in that single home), especially in areas that are not reached by the grid, off-grid pattern, the use of PLTS for rural electrification has already been carried out for some time. However, it has been only at small scales. Since 2005, the implementation of PLTS program for rural electrification has increased significantly. It has been developed through both a dispersed and a centralized pattern. Currently, the installed capacity of PLTS for rural electrification has reached around 17 MWp. In general, the source of funding for that implementation comes from state and local budgets with a tendency to increase each year. It is carried out by some relevant institutions such as Ministry of Energy and Mineral Resources (ESDM), Ministry of National Education, Ministry of Maritime Affairs and Fisheries, Ministry of Culture and Tourism, Ministry of Cooperatives and Small and Medium Enterprises, Ministry of Transportations, Ministry of Labour and Transmigration, Ministry of Interior, Ministry of Communications and Information, and Ministry of Regions (Villages) Improvement. The total government budget for that program was about 800 Billion Indonesia Rupiahs (around one Million USD) in 2009. About 50% of that budget was used for buying imported components including photovoltaic solar modules. This program activity is expected to continue in the future because solar home system (SHS) is one of our national energy programs. It is also considered one of the mitigation technologies to climate change. Therefore, it could contribute in achieving the target of national GHG emission reduction of 26% by 2020.

PLTS has also been used in integration with a diesel generator as a hybrid system. This hybrid system could optimize the operation of diesel system in the region. Examples of the system are installed in the regions of South Sulawesi, Central Sulawesi, Southeast Sulawesi, Gorontalo and East Nusa Tenggara (NTT). It is known that there are about 4,700 diesel units scattered throughout the archipelago. Around 936 units with a total capacity of approximately 987 MW of diesel power is operated between 6 and 12 hours a day. In this system, PLTS is main energy generator. The PLTD (diesel generator) is used to compensate when the PLTS system is not in operation. This system is operated in anticipating the uncertainty of weather and sunlight intensity. In addition, PLTD will be used as a "bank up" to cope with maximum loads. A new PLTS hybrid can be implemented in some different areas so that its potential utilization is highly open.

Furthermore, in order to achieve the target of electrification ratio in 2011, State Owned Electricity Company, PT PLN (Persero), will install communal PLTS in 100 remote islands of the eastern part of Indonesia. This is a program for electrifying 100 remote islands of Indonesia The total capacity of 18.15 MWp is targeted. Budget for this program has been prepared that is about 900 Billion Indonesia Rupiah (around 1 Million USD). It is estimated to be able to electrify approximately 30,000 customers. This investment includes for the construction of the transformer and the network. Therefore, electricity production managed by the investor will be distributed to consumers through the network. This program indicates that PLN's vision has changed that is from providing to selling electricity. For that, PLN can sell electricity at a price higher than that set by the government (the basic electricity tariff). The PLN program above is aimed to achieve the objective of national electrification ratio of 72% by 2011. This target requires a high growth in photovoltaic solar energy utilization through a variety of technological applications of PLTS on various uses. It is estimated that the implementation growth of PLTS system will be equivalent to 50 MWp of photovoltaic solar modules per year.

In the long run, it is expected that utilization of on-grid PLTS will become an attractive option. It is especially installed in commercial buildings and high-income households of urban areas. To that end, the use of PLTS-grid pattern on the building has actually been in progress. For examples are those installed at the buildings of the Ministry of Energy and Mineral Resources (90 kWp), Agency for the Assessment and Application of Technology (10 kWp), Ministry of National Education (1 kWp), and the German International School (11.2 kWp). Meanwhile, the “Alam Sutera” housing complex of Tangerang plans to install and utilize on-grid PLTS at a maximum capacity of 1 kWp each unit to meet some of its electricity needs. It is noted that PT. LEN Industry (Persero) has built a stabilized and advanced grid of connected PV system with a capacity of 80 kWp. In addition, at the Department of Physics Engineering, Bandung Institute of Technology, on-grid PLTS has been installed with a capacity of 1 kWp for educational purposes. Those whole efforts of on-grid PLTS installation are intended to have learning and assessment experiences in the development of that type of PLTS in Indonesia.

The promising utilization of PLTS needs to be followed by potential industrialization of photovoltaic cells. It is known that raw material of PV is made from silica that is mainly found in quartz sand. Quartz sand composes of mineral crystals of silica (SiO2) and other compounds of pollutants. The use of quartz sand has extensively developed, both directly as primary raw materials and as follow-up materials. Examples of follow up materials are industrial glass, cement, tiles, mosaic tiles, ferrous raw material, silicon carbide, abreast materials (sandpaper and sand blasting), industrial castings, industrial petroleum and mining, and refractory bricks (refractory). Indonesia owns quite much of quartz sand. The potential of national quartz sand resource in 2010 reached 18.3 billion tons with production levels in 2009 as many as 29.2 million tons. The largest quartz sand reserve has been found in West Sumatra, West Kalimantan, West Java, South Sumatra, South Kalimantan, and the islands of Bangka and Belitung.

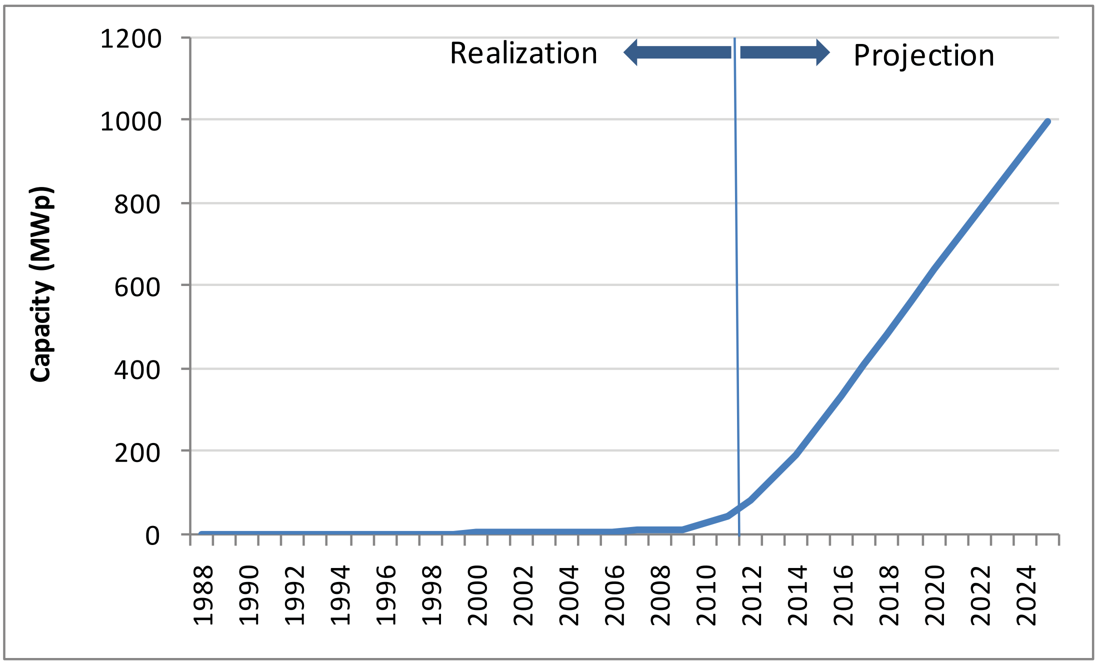

Figure 2-12 Realization and projection of PV technologies

The potential market of PV and PV cell industry is largely open. Unfortunately, it has not been yet supported by adequate testing facilities of the PLTS system and infrastructures of PV cells manufacture. Energy Technology Laboratory, the Agency for the Assessment and Application of Technology has testing facilities of the PLTS system. However, they have not met yet the international standards. Electronics and Telecommunications Research Center (PPET) of Indonesian Institute of Sciences (LIPI) also has a laboratory-typed crystalline PV cell manufacture but it is still limited. In addition, there have not been available yet professional certification bodies for PLTS manufacture and testing in Indonesia.

2.2.1.2 Regenerative burner combustion system technology

Regenerative burner combustion system (RBCS) is a waste heat recovery technology that is widely used especially in the steel industry. Since 2005, the government of Indonesia has implemented that technology in a project called a Model Project for High Performance Industrial Furnace. One of the steel industries that produce various kinds of steels was chosen by the government to implement the technology. The aim of the project was to retrofit the burner system by changing a conventional burner with a new one namely regenerative burner in the reheating furnace. The function of the burner system is to reuse hot waste gas that still has potential energy (sensible heat) to increase the energy efficiency of the system.

Regenerative burner is a highly efficient heat recovery system by reusing waste heat of the furnace exhaust gas to heat-up combustion air at the furnace section through heat recovery regenerator. The key technology of RBCS is to set a pair of burners with a regenerator at each one. During combustion, one side of the burner burns the fuel where the other side accumulates heat of exhaust gas. It is then sent into heat recovery regenerator. Hence, it could secure stable combustion and highly efficient combustion as well as low NOx emission.

Combustion process could be controlled by computer, installed in the control room. This model is aimed to have energy conservation during reheating semi-finished steel material before it is processed to become finished products of various types such as H-Beam and IWF-Beam. It could save up to 30% of gas fuel consumption. The model is expected to improve the competitive edge of the country's steel industry. At the same time, it also protects the environment from highly gaseous emissions.

NEDO of Japan and Indonesia has had cooperation to carry out the project. The project costs around US$ 4 million. In this project, energy conservation and environmental (ambient air) protection are gained without requiring the change of all equipment. It needs only an additional equipment of regenerative burner system in the reheating furnace. Therefore, it lowers the amount of investment and fuel cost significantly. The benefits of this project are reduced energy consumption, improved steel product quality, increased steel production, reduced crack products, and reduced furnace maintenance cost.

It is known that the steel industry is considered a strategic industry. This sector plays a major role in supplying raw materials. The raw materials are vital to development in various fields ranging from the provision of infrastructure (buildings, roads, bridges, electricity & telecommunications), the production of capital goods (machinery and plant materials and supported spare parts), transportation (ships, trains & rail, automotive), until the weapons. Hence, the steel industry role is very important because the presence of the steel industry is strategic for the prosperity of a nation.

Entering year 2010, the progress of the national steel industry has still been "shaky" and has not fully recovered from hard shocks (steel price fluctuations) of global steel industry experienced from September 2008 until the year 2009. These conditions greatly affect the performance of production and sales of the domestic steel industries. Consequently, domestic steel production had dropped drastically during 2009, with a utilization rate of only 35% - 40% or downed sharply from the normal utilization rate of 60% of the installed capacity of national steel production. The same conditions were also underway for the world steel industry, except for the steel industry in Iran, India, and China.

Since January 1, 2010, according to the framework of the China ASEAN Free Trade Agreement (CAFTA), exemption to tariffs is applied to products that are included in the Normal Category of Track 1. A number of steel products, especially semi-finished steels like Hot Rolled Coil (HRC) and Cold Rolled Coil (CRC), are products of Normal Category of Track 1, and therefore they are already applied tariffs to 0%. This makes steel imports from China becoming more competitive because they are no longer subject to tariffs. In the era of the implementation of CAFTA, the entry of Chinese steel imports has caused much concern. Understandably, the current domestic steel production of Indonesia has not been able to meet the needs of the national steel consumption. For example in 2010, the national steel production was estimated only 5 to 6 million tons while consumption of steel in Indonesia reached 8 -10 million tonnes. Therefore, there is a shortage of supply by 36% of the consumption. Therefore, the steel shortage was supplied with imported one.

This situation is very unfavourable for domestic steel industry. In addition to dealing with China's steel products that are highly competitive, local steel industry is still burdened by various problems. Those include shortages of raw material, high reliability of energy supplies, and lack of transportation networks. With the use of RBCS in the national steel industries, it is expected that the competitiveness of the national steel industries could be enhanced.

Actually, RBCS not only can be implemented in the steel industry but also can be used in other industries that use furnaces in their production process, such as the ceramics industry. Potential used of RBCS technologies in steel and ceramics industries is estimated around 100 units.

Seeing the extent of utilization of this technology and the magnitude of the potential energy savings, in 2011, the Agency for the Assessment and Application of Technology (BPPT) has been carrying out the test on the prototype scale of RBCS to understand the technical aspects of this technology. This will eventually supported the transfer of technology of the RBCS to Indonesian industries in the future.

2.2.2. Barrier analysis

2.2.2.1. Barrier identification and analysis for the transfer and diffusion of PV

Potential opportunities of PLTS utilization and the photovoltaic cell manufacture or industrialization are anticipated to face some barriers. These barriers can generally be categorized into six groups: policy/regulatory, financing, institutional, capacity, intellectual property rights, and social and cultural barriers. Figure 2-12 outlines the causal relation for the barrier identification and analysis for the transfer and diffusion of PV technology.

Regulatory aspect

Barriers to the utilization of solar energy based electricity generator (PLTS) is due to the lack of appointed national development of PV cell industry. Moreover, it is also because of the lack of regulations governing the market price of PLTS. Currently, the FITs PLTS is being discussed that will govern the market price of electricity per region on the PLTS grid without a battery (above ground). Hopefully, with FITs, then the realization of the PLTS development on the grid can follow the (minimal) prediction of necessary PLTS until 2025. Given the experience of other countries in developing policy about FITS, Indonesia also requires a special law on PLTS, which can be used as legal protection in the industry and the utilization of national PLTS. Regulation of the PLTS selling price as regulated by the Ministry of Energy and Mineral Resources Regulation (Permen ESDM) No. 31/2009, Regulation on the electricity price generating from renewable energy (including PLTS) did not reflect the economical aspect of PLTS.

Financing aspect

PV manufacture is still considered to be relatively high technology and requires a significant amount of investment. It is especially caused by fully imported components of PV cells and they cannot be separated from the obligation of import duties. In order to reduce the cost of investment, the Government through the Ministry of Finance has issued net value added tax, depreciation and amortization, loss compensation for longer time (5-10 years), exemption from import duty on goods of imported components associated with energy infrastructure including PV as stipulated in the Minister of Finance No. 21/PMK.11/2010, No. 176/PMK.11/2009, and no. 154/PMK.01.1/2008. Exemption of import duty on imports of industrial machineries for industry development will be valid only in two years. Those are for goods that are not yet produced domestically, they are already produced domestically but do not meet the required specifications, or they are already produced domestically but their number was not sufficient for the industrial needs. As it is known that the investment costs of PLTS system is mostly for the cost for PV cells so that the development of the PV cell industry nationwide scale is essential. In addition, the interest rate imposed for PLTS investment activities has been primarily commercial interest rates that cause the price of electricity of PLTS to be quite expensive. In order to encourage the use of PLTS, the government through the Ministry of Energy and Mineral Resources (EMR) has set up the price of PLTS electricity into the PLN grid system as stipulated in the Minister of EMR Regulation No. 31/2009. However, the selling price of electricity generated by renewable energy resources is height compared to price stipulated in the EMR 31/2009, so that it is not attractive for investors to investing in on-grid PLTS system.

Institutional aspect

Implementation activities budget, especially for the application of PLTS of Solar Home System (SHS) in different corners of the country carried out by various Ministries or related institutions are generally in the form of grants. In the implementation, it seems to have a weak coordination at the central level between ministries or institutions that resulted incomparable hardware, unequal payment and rural electrification planning patterns. In addition to these barriers, there does not exist yet Product Certification Institute (IPC) in charge of certifying each component of PLTS, so that the circulation of the different types of PLTS components cannot be avoided. In addition, standardization of components and PV systems are still limited because of limited human resources and financing capabilities in making Indonesian National Standard (SNI) for PLTS and its components.

Capacity Building Aspect

To support the increased use of PLTS it is necessary to have human resources support. It is also important to have suitable equipment for producing and testing PV cells as well as for testing other supporting components and whole systems of PLTS. The numbers of qualified human resources, and types and quality of equipment availability to perform these activities are still limited.

IPR Aspect

IPR policies for PV cells are very diverse and so far, none of IPR licenses on PV cell have been discovered by the Indonesian people. The higher number of PV cells licenses will play an important role in determining the price of PV cell and rate of technology diffusion.

Social and Culture Aspect

Utilization of SHS (solar home systems) in a remote village will be an advantage because the villages are so far not all electrified yet. The existence of SHS could contribute in enhancing economic and social activities in the villages of this country. On the other hand, the increased activities will require the support of energy, which one of them is coming from SHS. As a result, the utilization of the SHS will be ultimately high. Very often, the energy utilization from SHS is over the capacity of the specified design. This habit of energy utilization of SHS will cause the batteries to be quickly broken. Finally, the SHS system does not function as expected. This problem is considered to be the problem of social and cultural aspect that needs to be solved.

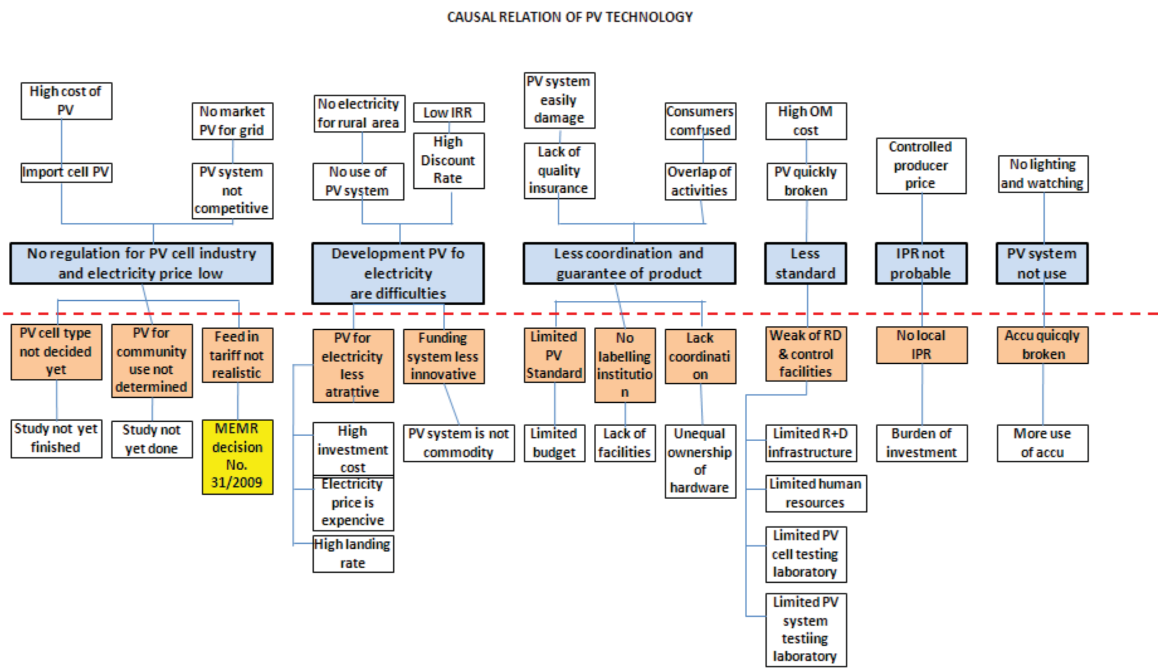

Figure 2-13 Causal relation of PV technology

2.2.2.2. Barrier identification and analysis for the transfer and diffusion of RBCS

Barrier preparation process performed by the methodology described in Guiding the Process of: Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. First of all gathered around the possibility of inhibiting the use of PLTS and RCBS. Furthermore, the barrier is considered less relevant and very limited effect in increasing the utilization of PLTS and RBCs are ignored. Selection is done through the scoring of each barrier in order to obtain a major effect on the development of PLTS technology and RBCs at a later date. Scoring on a variety of barriers that are grouped into the regulation, financing, institutional, capacity, IPR, and social / culture.

Regulatory Aspect

In accordance with Minister of EMR regulation No. 70 of 2009 on Conservation of Energy, it is states that every energy user for greater than or equal to 6,000 TOE per year should make energy savings. If the user does not implement this energy conservation programs it will be subject to disincentives. However, the technical regulation on implementing this disincentive mechanism has not been issued yet by the Government. Figure 2-13 outlines causal relation for barrier identification and analysis for the transfer and diffusion of RBCS.

Financing Aspect

The use of RBCS technology requires significant investment, both for procurement of goods and losses due to cessation of operation of the plant during the installation of RBCS. Import duty on imported components related to the energy infrastructure is 0%, as stipulated in the Minister of Finance regulation No. 176/PMK.11/2009. The high investment required to use this technology is one of the barriers that need to find the solution. It is not included yet the cost to be incurred by the industry during the installation of this technology because the industry will lose revenue (industry off) and the salary of permanent employees must still be paid.

Institutional Aspect

Institutionally, the utilization of RBCS technology has not resulted any problems because the institution in charge has been obvious even though the socialization of the use of RBCS is not yet in the maximum efforts. In addition, RBCS technology is a new technology so the ability of local consultants in designing the RBCS including the ability of experts to conduct training is limited. As stated that the RBCS has been mounted on one of the steel industries in Indonesia, and technically, it can be operated by the operator of that industry, including training on the operation of the RBCS.

Capacity Building Aspect

RBCS technology is relatively complex equipment and not freely available in the national market. Therefore, they need to be imported. In addition to these barriers, there are also other barriers such as lack of institutions or initiatives to set standards, lack of facilities for testing and certification, insufficient quantity and quality of controlling and measuring equipment, and no obligatory standards.

IPR Aspect

Utilization of RBCS associated with IPR and experts in IPR contract negotiations are still limited.

Social and Culture Aspect

Implementation of RBCS is usually at highly technological industries. They are generally located in urban areas. The owners and employees are mostly all educated. The aim of this implementation is to contribute in enhancing the national economic of the country. Therefore, these conditions of implementation will not raise any barriers on social and culture aspects.

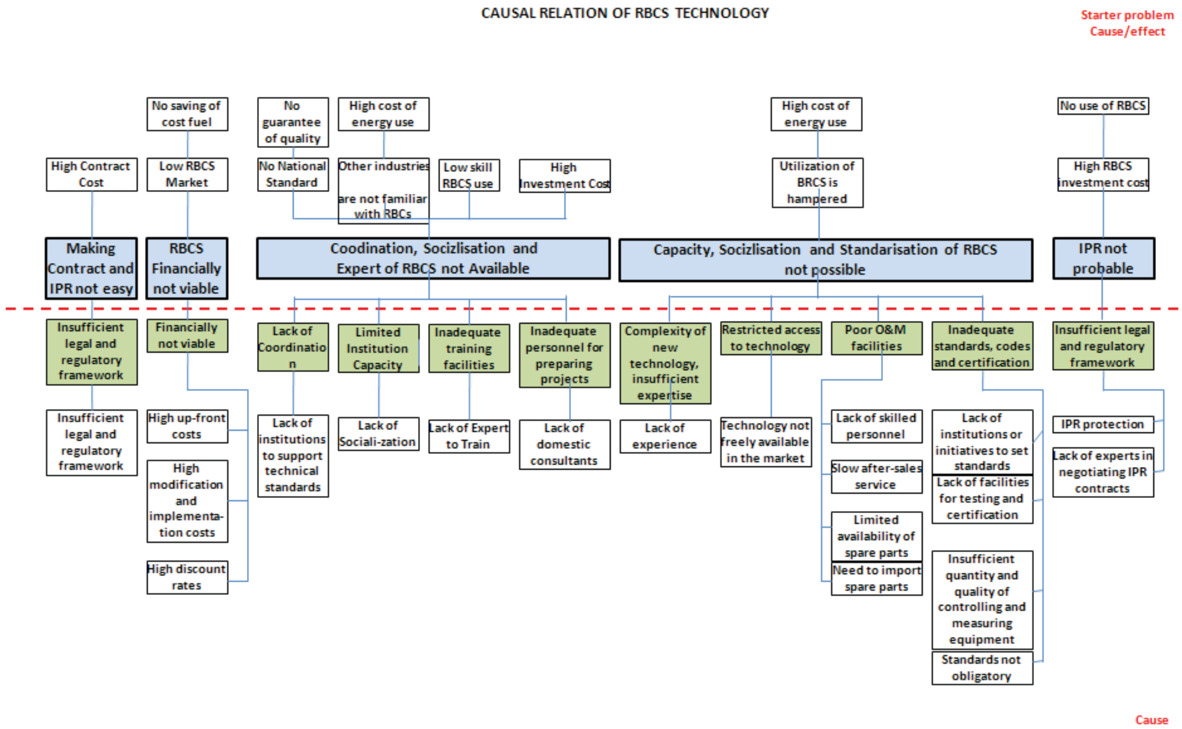

Figure 2-14 Causal relation of RBCS technology

2.2.2.3. Linkages of the barriers identified

Technology of PV cell is considered to be a main core of PV system in producing energy (electricity) and it is proposed to be industrialized in Indonesia. Whereas, regenerative burner combustion system (RBCS) technology is a waste heat recovery technology and it is intended to be employed as a retrofit in steel industry for energy saving. These two technologies are quiet different and therefore they are not found any barrier linkage of each other.

PV technology is designated for electricity supply under the authority of Ministry of Energy and Mineral Resources, while the utilization RBCs is for energy efficiency under the authority of the Ministry of Industry. However, the development of PV cell industry also involve the Ministry of Industry. Similarly, the standardization of PV cells and RBCs need to be coordinated with the relevant directorates in the Ministry of Industry. However, the solution of PV industry construction barrier does not necessarily resolve the barrier in the installation of RBCs technology in the selected steel industry. So that, the solution of each barrier for each activity is not related to each other.

2.2.3. Enabling framework for overcoming the barriers

2.2.3.1. Possible solutions to address the barriers for the transfer and diffusion of PV

In order to encourage the development and utilization of PV in Indonesia, the government needs to set the cell type that will be created or manufactured locally through Presidential Regulation. In order for the national PV industry can be competitive, in addition to providing tax incentives and import duties mentioned above, it needs a provision of fiscal and non fiscal incentives for the construction and operation of the national PV industry. Furthermore, the Ministry of Energy needs to prepare regulations about the use of PLTS for consumers or certain capable consumers. In addition, the need to revise Minister of EMR Regulation No. 31 Year 2009 on the Power Purchase price of PLN's power plants that use renewable energy on a small and medium scale or excess electricity, which the selling price of electricity to the grid is still lower than the cost of generating, or make special regulations concerning the purchase price of electricity by PLN from PLTS. If the subsidy of PLTS is required, the government needs to make regulations about feed-in tariffs of PLTS. It is expected that the regulation of the PLTS price and its feed-in tariffs will be able to encourage national financial institutions to finance national programs or PV industry.

As mentioned that the use of PLTS is divided into SHS, PLTS off-grid, PLTS on-grid, and PLTS hybrid. So far, the use of PLTS is generally in the form of SHS, and a small portion of PLTS and PLTD hybrid. Utilization of SHS requires coordination between relevant agencies coordinated by Ministry of EMR in order to achieve the same SHS standardization. PV utilization of various categories would need the support from LSPro, so the government needs to establish institution that is entitled to issue product certification. Besides, Ministry of EMR together with relevant stakeholders need to expedite the issuance of various standardization of components and systems of PLTS so that various types of imported components can meet the approved standards. Barrier and Enabling Framework Industry Photovoltaic National can be seen in Table 2-19.

With a highly promising potential development and utilization of national PV, the government needs to encourage the growth and the development of national testing laboratory for PLTS system in accordance with the international standards. To that end, supporting to the increase of the capacity of testing equipment of PLTS system including capacity building on human resources needs to be pursued. In addition, the improvement of laboratory testing capacity, especially for the type of crystalline PV cells, including human resource capacity building is also essential in order to increase the effort on socialization to SHS consumers so that its implementation can be done as planned.

Because of a very high market for PLTS, the government should negotiate with the owner of IPR in order to not overburden investment due to royalty cost. Furthermore, the government through Ministry of EMS and relevant Ministries need to increase the efforts on the socialization on its utilization to consumers so that the utilization of the SHS can be carried out as planned as possible. The scenario of possible solutions to address the barriers for the transfer and diffusion of PV is given in Figure 2-14.

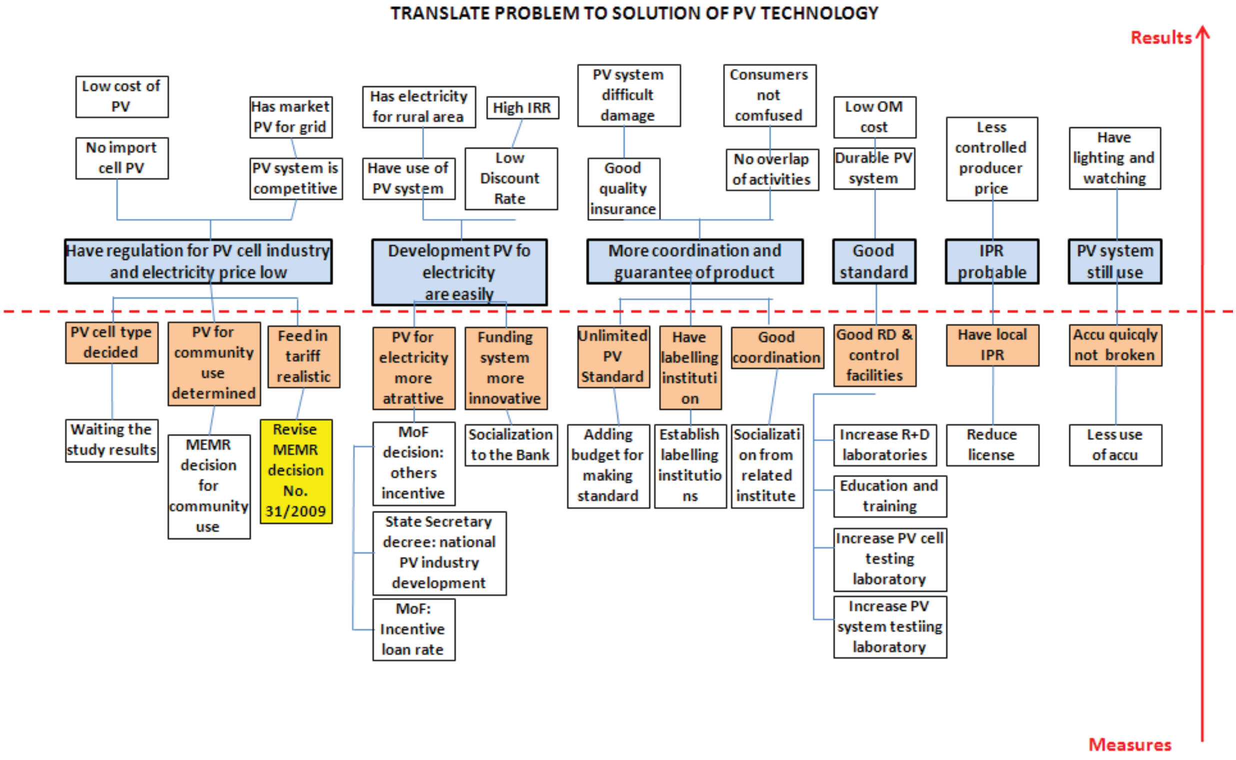

Figure 2-15 Translated problem to solution of PV technology

2.2.3.2. Possible solutions to address the barriers for the transfer of RBCS

In accordance with Minister of EMR regulation number 70 of 2009 regarding the conservation of energy, if an industry consumes energy equal or greater than 6000 TOE per year, it has an obligation to conserve its energy use. For that effort, the government through the Ministry of EMR should provide incentives for that industry in order to spur the growth of efficient energy technology implementation in the industrial sector. Therefore, the Ministry of EMR needs to issue regulation on incentive and disincentive measures for industries, which implement energy conservation.

RBCS technology is a capital-intensive technology and almost all of the components are imported from abroad. Associated with imported machinery and equipment, Government through the Minister of Finance has issued a Regulation No. 176/PMK.011/2009 on the exemption of import duty of machinery, and goods and materials for development or extension of industries in the framework of investment enhancement. Development is the establishment of new companies or factories to produce goods and or services. Extension is an enlargement of company or a factory that already exists that includes the addition, modernization, rehabilitation, and/ or restructure of the production means, including machinery. The purpose is to increase the numbers and types of products, and to improve the quality of production. Investments are all forms of investment activities by both domestic and foreign investors to do businesses in the territory of the Republic of Indonesia. Exemption of import duty is provided when the machine, goods, and materials are not yet produced domestically. This exemption is also given when those items are already produced in the country but do not meet the required specifications, or are produced domestically but are insufficient number for industrial needs.

With the exemption of import duty it is expected to reduce the barriers of RBCS use. Barrier and Enabling Framework Regenerative Burner Combustion System can be seen in Table 32.

With the increased use of RBCS in the country, the government can encourage the development of RBCS industry nationally so that the availability of spare parts and after-sale service can be maximized. For that, it is necessary to have a standardization of RBCS according to the condition and the capacity of user's industries including the establishment of testing laboratory and establishment of certification body. As explained that the work of this technology is operated from the control room through computerized control. This computerized control is actually considered to be the determination factor for the success of the utilization of this technology. Currently, BPPT is conducting testing of RBCS prototype technologies and in the future Indonesia also needs to develop a control system of RBCS through the guidance of the owner of the technology.

The scenario of possible solutions to address the barriers for the transfer of RBCS is laid out in Figure 2-15.

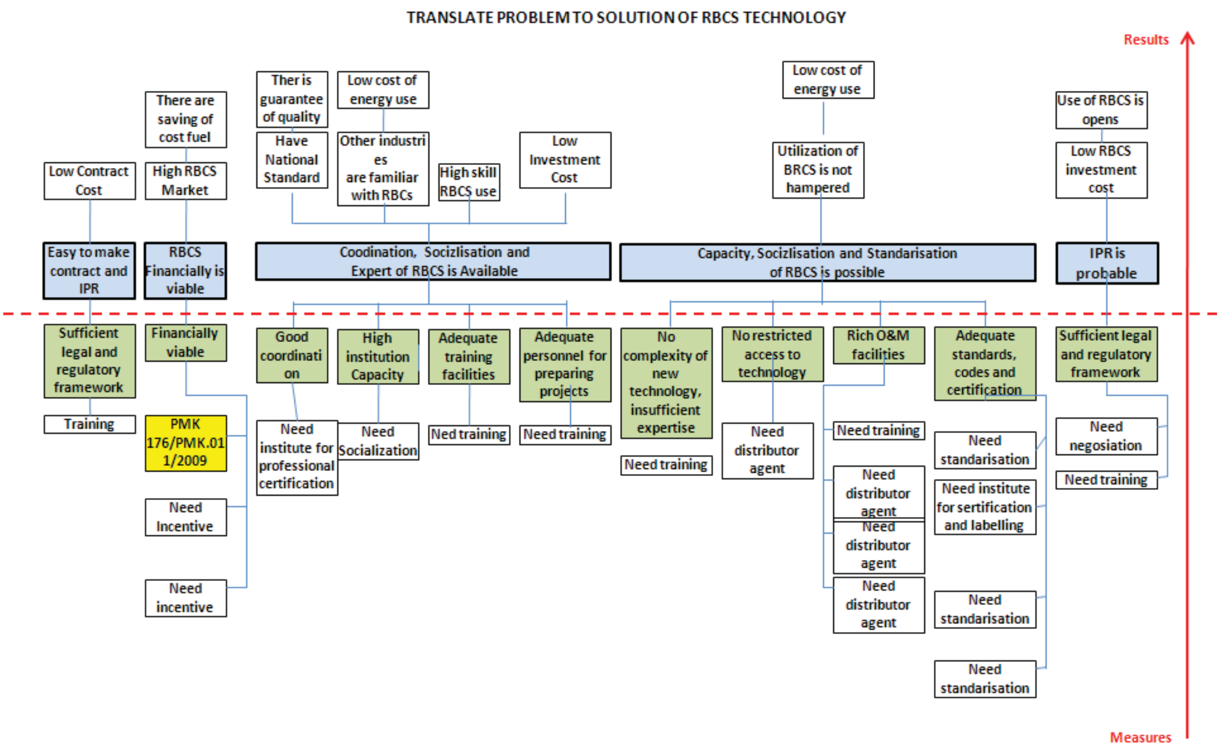

Figure 2-16. Translated problem to solution of RBCS technology

Table 2-19 Barrier and enabling framework of national photovoltaic industry

Category	Barrier	Sub Barrier	Policy Incentives Existing	Policy Incentives Lacking
Policies	Policy of PV cell technology to be developed has not been established	Technology of PV cell has not been determined		BPPT to study the feasibility of developing a national PV State Secretary: Presidential Industry PLTS
	PLTS for community use policy not yet determined	Study of society have not been able to do		MEMR: Chewing concerning the use of PLTS for people capable
	Mandatory policies, bonds, quotas, or feed-in tariffs in place to promote PV		Feed-in Tariff concept being discussed	MEMR: Ministerial regulation of Feed-in Tariff
	PV cell industry development policy has not been decided	Which was developed PV types being studied		State Secretariat: Decree of the national PV Industry Development
Financing	PLTS investment less attractive	High investment cost	Tax breaks and import duty exemption: PMK No 21/ PMK.11/2010 PMK No 176/ PMK.11/2009 PMK No 154/ PMK.01.1/2008	Ministerial of Finance regulation on reduction of tax, investment subsidies, cuts costs,
		PV cell components are still imported		State Secretariat: Decree of the national PV Industry Development
		High lending rates		MoF Regulation on incentive loan rates
		The electricity selling price is expensive	MEMR Regulation No 31 Year 2009	MEMR: Regulation on Feed-in Tariff PLTS
	Funding systems that are less innovative	Financial institutions see PLTS as a consumer product and not a commodity		MEMR: Cooperation and Socialization
Category	Barrier	Sub Barrier	Policy Incentives Existing	Policy Incentives Lacking
Institutional	Limited the number of National Standard on PLTS	The budget number of the technical team on national standard is limited		Preparation of standard PV and National PLTS system (KESDM, NTSC, BPPT, LIPI, ITB, UI, PT SEI, BSN, Associations)
	Labelling institutions PLTS has been no	Lack of laboratory facilities		Appointment of the National institute PLTS labelling system (KESDM, NTSC, BPPT, LIPI, ITB, UI, PT SEI, Kemerind)
	Coordination among the implementing relief activities SHS of several ministries is still weak	Unequal ownership of hardware, payment patterns and rural electrification planning at the central level		related institutions: the socialization

Table 2-19 (Continued)

Category	Barrier	Sub Barrier	Policy Incentives Existing	Policy Incentives Lacking
Capacity	R & D and Control Technology weak	Limited R & D PLTS		Develop the concept of research and development to enhance national capacity in order to ensure the mastery of science and technology in the field of photovoltaic (KESDM, KNRT, BPPT, LIPI, ITB, UI, PT SEI)
		PLTS limited field of human resources		Related institutions: Education to doctoral programs
		Cell testing capacity is limited		LIPI: Increased capacity of PV cell testing
		PLTS system testing capacity is limited		BPPT: Increased capacity PLTS system testing
IPR	There are currently no local IPR	burden of investment		Related institutions: Negotiation
Social	Accu quickly broken	SHS usage that exceeds the ability for increased welfare		Related institutions: Socialization

Table 2-20 Barrier and enabling framework regenerative burner combustion system

Category	Barrier	Sub Barrier	Policy Incentives Existing	Policy Incentives Lacking
Policies	Insufficient legal and regulatory framework	Absence of laws and bylaws on climate technologies (contract law, IPR protection)		Related agencies: training
Financing	Financially not viable	High up-front costs	PMK 176/ PMK.011/2009	
		High modification and implementation costs		Ministry of Finance: incentive rate
		High discount rates		Ministry of Finance: incentive rate
Institutional	Lack of coordination	Lack of institutions to support technical standards		Related institutions: Institute for Professional Certification
	Limited institutional capacity	Lack of socialization		Ministry of Industry and AIBBI: socialization
	Inadequate training facilities	Lack of experts to train		Related agencies: training
	Inadequate personnel for preparing projects	Lack of domestic consultants (to reduce transaction costs)		Related agencies: training of consultant

Category	Barrier	Sub Barrier	Policy Incentives Existing	Policy Incentives Lacking
Capacity	Complexity of new technology, insufficient expertise	Lack of experience		Related agencies: training
	Restricted access to technology	Technology not freely available in the market		Ministry of Industry: Distributor
	Poor O&M facilities	Lack of skilled personnel		Related agencies: training
		Slow after-sales service		
		Limited availability of spare parts (few suppliers, long supply routes)		Ministry of Industry: Distributor
		Need to import spare parts		Ministry of Industry: Distributor
	Inadequate standards, codes and certification	Lack of institutions or initiatives to set standards		Ministry of Industry and BSN: RBCS standardization
		Lack of facilities for testing and certification		Ministry of Industry: Institute for professional certification
		Insufficient quantity and quality of controlling and measuring equipment		Ministry of Industry and BSN: RBCS standardization
		Standards not obligatory		Ministry of Industry and BSN: RBCS standardization
IPR	Insufficient legal and regulatory framework	Absence of laws and bylaws on climate technologies (IPR protection)		Ministry of Industry: negotiation
		Lack of experts in negotiating IPR contracts		Ministry of Industry: training

2.2.3.3. Recommended solutions for energy sector

From results of barriers analyses, there are several possible recommendations proposed for PV cell industry and RBCS implementation.

PV Technology

- There should be a Presidential Regulation on the establishment of PLTS industry in Indonesia.

- There should be Minister of EMS Regulation on implementation of PLTS for high-income people as mandatory.
- There should be Minister of EMS Regulation on Feed-in Tariff PLTS.
- There should be Minister of Finance Regulation on tax reduction, investment subsidy, and cost reduction.
- There should be national standards on PV and national PLTS system.
- There should be institution that is responsible for system labelling of national PLTS.
- There should be program on R & D on PV and PLTS to improve national capacity of that area.
- There is a need to improve a capacity of negotiation for solving the IPR barrier.
- There is a need to socialize this technology to communities.

RBCS Technology

- There should be Minister of Finance Regulation on incentive of interest rate and discount rate for capital goods.
- There should be an institution that does certification for professionals in this area.
- There is a need of socialization of the benefit of this technology to related industries that could be done by Ministry of Industry and AIBBI.
- There is a need of training for the operators and consultants for improving negotiation ability.
- There is a need of capable distributors for having spare parts from abroad.
- There is a need a standardized RBCS that could be done by Ministry of Industry and National Standardization Body (BSN).
- There is a need to improve the testing facilities that could be done by Ministry of Industry.
- There is a need to improve a capacity of negotiation for solving the IPR barrier.

2.2.4. Concrete actions plans and ideas

2.2.4.1. Plans for domestic actions and measures

PV Technology

- National PV Cell Industry Development with a minimum capacity of 50 MWp
  So far, a state owned industry of PT LEN (Persero) has engaged in laminating and packaging PLTS system. The company is located in Bandung of West Java Province. Development of national PV cell industry needs to be carried out as quickly as possible because the privately national industries of PV have still been the industries to make solar panels, laminated panels up to the panel control with a capacity of 50 MWp and significantly increase of PLTS needs. Therefore, the development of PV cell industry is absolutely needed. This development, in addition to strengthening the resilience of the national PV, will be able to lower the investment costs of PV. For that, a Presidential Regulation on the national PV industry development is required. Accordingly, the necessary coordination between the Ministry of Industry with other institutions and companies such as PT LEN Industry (Persero), Ministry of Research and Technology, Agency for the Assessment and Application of Technology, Ministry of State-Owned Enterprises, and Ministry of Finance has to be done for the implementation of the PV cell industrialization. The development of that national PV cell industry needs some requirements in accordance with applicable regulations.

- Increase of PLTS system testing capacity

  Along with the increased use of PLTS, the PLTS system testing capacity owned by the Energy Technology Laboratory (B2TE), the Agency for the Assessment and Application of Technology (BPPT) needs to be improved their capacity. B2TE is located in Serpong, Tangerang Municipality, Banten Province is the only one testing laboratory for PLTS and its components owned by Indonesia that has been accredited with ISO / IEC 17025. B2TE has done testing for PV Module Components, Battery components, Battery Charge Regulator (BCR) components, and components of the DC lamp inverter. The equipment testing facilities owned by B2TE for PLTS and PLTS components testing are relatively limited, such as sun simulator, cycle test equipment, and electronic equipment. Those equipment components need to be increased in variety, quantity and capacity in order for B2TE to comply with international standards of IEC 61215 for photovoltaic modules testing. The testing equipment might be added with equipment for testing batteries, inverters, and others. Implementation of these activities under the coordination of BPPT can be done in the medium term of 3-5 years.
- Improvement of PV cell manufacturing laboratory

  In Indonesia, there are two PV cell production laboratories: laboratory of thin film under the Bandung Institute of Technology, Department of Physics and laboratory of crystalline under Laboratory Electronics and Telecommunications Research Center (PPET), Indonesian Institute of Sciences (LIPI). Both laboratories are located in Bandung of West Java Province. The ability of PV cells laboratory of PPET-LIPI is for polycrystalline solar cells/ new multi-crystal with maximum efficiency of 10% for dimensions of 5x5 cm^2. The low efficiency found is because it is carried out with limited and old enough (20-25 years) available equipment facilities and must be processed in the available laboratory room that is unclean. Despite the lower cell efficiency than that of commercial one, it can still be used for low-power PLTS such as for garden lighting, public lighting lamps or tower lamp. Silicon wafer (Si) used so far are imported from Germany with a dimension of 10x10 cm^2 and a minimum of 270 microns of thickness. Currently the thickness of Si wafers on the market is about 200 microns so that the facilities of available tools are no longer sufficient. To improve the efficiency of the cell it is required plasma etching and PECVD tools. In terms of human resources, PV cells laboratory of PPET-LIPI only owns as many as 8 employees and most of them enter retirement stage. Similar to the improvement of B2TE-BPPT cell laboratory, PPET-LIPI cell laboratory improvement can be done in coordination with LIPI. This activity can only be implemented after the determination of cell types are known so that it will be implemented in the medium up to long-term program.

RBCS Technology

- Installation of RBCS in the selected steel industry

  National steel production capacity reaches 8 million tons per year. The technology used is commonly conventional technology because the steel industry was built a long time ago in addition to its modifications within the framework of energy conservation is very limited. To that end, the potential use of RBCS in Indonesia is very potential, especially when considering the use of RBCS in other energy intensive industries. Selection of the steel industry for RBCS implementation will be determined based on the agreement between the Ministry of Industry and the Indonesian iron and steel industry association (AIBBI).

Installation of RBCS in other steel industries is still required even though the technology RBCS has already been mounted in one Indonesian steel industry. It is intended to accelerate the process of socialization of RBCS technology in other steel industries so that the energy conservation of the steel industries in Indonesia will be boosted. The amount of investment required depends upon the capacity of the furnace and the time required for installation up to commissioning which is about 5 months. During installation and commissioning of the RBCS, the involvement of research institutions such as BPPT, particularly the Technology Center for Energy Conversion and Conservation (PTKKE) and Energy Research Laboratory (B2TE) is required in order to maximize technology transfer activities of RBCS.

- Increase of control room and RBCS technology design capacity.
  As described earlier that PTKKE BPPT in 2011 has done test and analysis of small-scale (prototype) of RBCS technology. The design and engineering work of RBCS technology was carried out by BPPT engineers. To enhance human resources capabilities of BPPT in the design of RBCS and its control room, it would require the technology transfer from technology owners that are usually from abroad. It is expected that through this technology transfer to BPPT engineers, the implementation of RBCS for several types of industries (steels, ceramics, others) will be accelerated.

2.2.4.2. Project ideas for international support

PV Technology

- Development of National PV Industry at 50 MWp capacity (minimum)
  - ✔ Transfer technology needed is industrial PV cell (wafer to cell).
  - ✔ Capacity building required is the upgrading of human resources capability.
  - ✔ Financing aid preferred is in the form of grant and / or soft loans from donor countries.
  - ✔ Timeline is short-term (1-2 years).
  - ✔ Success indicators are the construction of a national PV industry and skilled engineers.
  - ✔ Domestic Partner is PT LEN Industri (Persero).

- Increase of testing capacity of PLTS system
  - ✔ Transfer technology needed is improvement of laboratory facilities according to standard IEC 61215, and addition of other components of equipment such as testing tools for batteries, inverters, and others.
  - ✔ Capacity building required is the upgrading the human resources capability.
  - ✔ Financing aid preferred is in the form of grant from donor countries.
  - ✔ Timeline is mid-term (3-5 years).
  - ✔ Indicators of success are upgraded PV testing facilities and their standardization according to laboratory standard of IEC 61215, as well as improvement of skilled engineers.
  - ✔ Domestic partners are PV research institutions such as B2TE-BPPT.

- Improvement of PV cell manufacturing laboratories (crystalline)
  - ✔ Transfer technology needed is industrial PV cell.
  - ✔ Capacity building required is improvement of human resources capability.

- ✔ Financing aid preferred is grant aid from donor countries.
- ✔ Timeline is mid-term (3-5 years).
- ✔ Indicators of success are installed PV cell manufacturing laboratory according to laboratory standard as well as improvement of related skilled engineers.
- ✔ Domestic partners are PPET LIPI and the Department of Physics, ITB

RBCS Technology

- Installation of RBCS in the selected steel industries.
  - ✔ Transfer technology needed is installation of RBCS in selected steel industries.
  - ✔ Capacity building required is improvement of human resources capabilities in the construction, operation, and maintenance of RBCS.
  - ✔ Financing aid preferred is the form of grant from donor countries.
  - ✔ Timeline is short-term to mid-term (1-5 years)
  - ✔ Indicators of success are the installation of RBCS at a selected steel industry.
  - ✔ Domestic partner is Ministry of Industry and AIBBI.

- Improved design of RBCS
  - ✔ Transfer technology needed is the RBCS and control room design.
  - ✔ Capacity building required is the improvement of RBCS and control room design capability of local human resources.
  - ✔ Financing aid preferred is in the form of grant from donor countries.
  - ✔ Timeline is short-term to mid-term (1-5 years).
  - ✔ Indicators of success are the implementation of RBCS and Control Room design.
  - ✔ Domestic partners are PTKKE and PTIK of BPPT.

2.2.5. Summary

There are only two technologies decided to be evaluated more detail in the Technology Actions Plant for energy sector. Those are photovoltaic (PV) cell development (industrialization) and regenerative burner combustion system (RBCS). The PV cell is proposed because it will be in line with national program on expanding the use of renewable energy resources particularly solar energy. PV cell is one of very important components of the solar electric generation system (PLTS) which has been becoming a priority in the national energy use of the country. On the other hand, RBCS is a waste heat recovery technology that is widely used especially in the steel industry. The purpose is to retrofit the burner system by changing a conventional burner with a new one of RBCS. This is a highly efficient heat recovery system by reusing waste heat of the furnace exhaust gas to heat-up combustion air at the furnace section through heat recovery regenerator. Hence, it could secure stable combustion and highly efficient combustion in order to lower the CO2 as well as NOx emissions.

In Indonesia, utilization of Solar Electric Energy Generation (PLTS) as a solar home system (SHS) has been done for about two decades with total installed capacity of about 13.5 MWe. In recent years, PLTS has also been utilized in several areas as a hybrid generator to other energy sources such diesel power. Besides, with a limited scale, electricity output of PLTS has already been connected to the grid. In 2011, State Owned Electrical Company (PT. PLN Persero) is installing PLTS for 100 islands of the 1000 islands planned. With the support of suitable regulations, PLTS utilization is predicted to be intensely increased in the future. However, the cell component of photovoltaic is still imported causing high price of PLTS in total. Actually, Indonesia has abundantly owned quartz sand resource and has been exported to foreign countries for making PV cell raw material.

For supporting PLTS development in Indonesia, industrialization of PV cell must be carried out. The PV cell development needs supporting from improved laboratory of PV cell of crystalline type and for internationally standardized testing facility of PLTS system. However, technology transfer of those three activities – PV cell industrialization, laboratory capacity of crystalline type PV cell, and internationally standardized testing facility of PLTS system - are predicted to face some barriers. First barrier is the regulation of the electricity price of the PV system, which is still expensive. The government has actually provided fiscal incentive for the development of renewable energy, such as reduction of tariff, income tax and added value tax. So far, regulation on electrical pricing for electric generation of biomass, biogas and municipal solid waste (MSW) has been revised to meet their economical price. Revision of selling price of electricity generated through PLTS that connects to the national electrical grid will be carried out at least in the incoming two years. Other barriers are those of financial, capacity building, institutional, intellectual property right (IPR) and social and cultural aspects. The budget for the development of PV cell, capacity improvement of cell laboratory and internationally standardized PLTS system testing facility are proposed to be grantly-financed through transfer of technology mechanism.

RBCS is one of the waste heat utilization technologies in industries. In Indonesia, this technology has been applied in one steel industry and is expected to be expanded to other steel industries. The purpose is to accelerate the process of dissemination of this technology to steel industries in Indonesia. The other industries that use furnaces in the production process, such as ceramics industries are also the target of the next application of this RBCS technology.

The advantages of implementing RBCS are that it can save energy consumption up to 35%, increase the production of about 15%, improve production quality, reduce defective (cracked) product, and reduce maintenance costs. From the experience of installation of the RBCS in the steel industry, it is estimated to have a return of investment (ROI) of approximately 13 months. In conjunction with the installation of RBCS technology in the selected steel industries, to increase mastering in RBCS and control room facility design can be done through transfer of knowledge and experiences from foreign experts to Indonesian experts, such as to BPPT's and other institutions' researchers. This transfer of knowledge and experiences is an integral part of the total technology transfer of the RBCS technology. With an increased ability of Indonesian personnel mastering RBCS technology and control room facility design it is expected to be able to reduce the cost of RBCS investment in Indonesia. For example in 2011, BPPT researchers are currently preparing a prototype technology of RBCS so they are already gaining some knowledge and experiences in the RBCS technology. Also, the engineers of existing RBCS implementing steel industry who actively involved in the installation process of RBCS are good experienced human resources for the next implementation. Thus, human resources capacity building for that technology implementation will not start from the beginning so that it will reduce the cost for capacity building of the human resources. In addition, the main obstacle of the RBCS implementation is due to installation costs and revenue loss because of the operation time of reheating furnaces during the trial period. To that end, the cost of procurement of RBCS in the selected industry (steel) for the purpose of the technology transfer is best provided in the form of grant so it will not burden the financial balance of the chosen industry. Similarly, the cost for capacity enhancement of personnel in RBCS and control room facility design are also proposed in the form of grants.

2.3. TAPs for waste sector

2.3.1. Preliminary targets for technology transfer and diffusion for prioritized technologies for waste sector

From a waste sector few point, the contribution of Indonesia to the GHG emissions is mainly from municipal solid waste (MSW) that has not been managed properly. The amount of Indonesia MSW is approximately 48.8 Mt per year and about 40% is transported to the open dumping solid waste disposal sites (SWDS/landfill). The open dumping sites could trigger the water pollution and release the GHG of methane particularly after disposal of MSW. Moreover, the Act number 18 year 2008 about Solid Waste Management regulates that all open dumping landfills of MSW currently in operation must be replaced with the sanitary or controlled landfills starting in the year 2012 when after 5 years of the issuance of the Act in 2008. Thus, source and intermediate MSW treatment technologies must be applied in order to reduce its potential disposal to the landfills.

In line with those thoughts and in accordance with the agreement among stakeholders involved in the workshop, the mitigation technology in the waste sector is only focused on municipal solid waste (MSW) treatment. Specifically, the technologies screening processes came up with intermediate treatment technologies of MSW. Those are mechanical-biological treatment, in-vessel composting, and low-solid anaerobic digestion technologies. These technologies are predicted to be problem solvers of MSW at the intermediate treatment.

2.3.1.1. Mechanical biological treatment technology

Mechanical Biological Treatment is one of the technology solutions to cope organic waste problem faced by Indonesia's cities. The application of MBT has started to become an issue in several cities of Indonesia, such as in Malang, Sidoarjo, Jombang, Pekalongan, and Jambi. In addition, Ministry of Public Works has initiated cooperation with foreign partner to do a feasibility study of MBT application in the near future.

MBT is a pre-treatment option of Municipal Solid waste (MSW) for the purpose of landfilling. Raw MSW, after removing the recyclable materials, is processed by combination of mechanical processes (shredding, sieving), and biological treatment (composting and sometimes anaerobic digestion) to reduce the volume and biological activity of the processed waste, which is then landfilled to cover or restore the landfill site. Recyclable or combustible materials may be removed from the waste and they are then recycled or incinerated. Pre-treatment of MSW by MBT prior to landfilling significantly reduces methane emissions from the landfill.

The products of the Mechanical Biological Treatment are recyclable materials (such as metals, paper, plastics, and glass), unusable materials (safely disposed inert materials to sanitary landfill), biogas (anaerobic digestion), stabilized organic end products, and high calorific value of refuse derived fuel (RDF).

The application of low-mechanical intensity of MBT technology needs an upfront investment of 10,000–20,000 US$ per ton capacity per day and maintenance and operations costs of 20–40 US$ per ton. The investment of a high-mechanical intensity of MBT technology is about 25,000–50,000 US$ per ton capacity per day and cost for maintenance and operations is about 30–50 US$ per ton of MSW.

2.3.1.2. In-vessel composting technology

In-vessel composting technology is an aerobic process that produces CO2 emission as a by-product. The methane production from the degradation of organic waste through this technology is avoided. Mechanical system is designed to minimize odor release and reduce process time by controlling environmental conditions of the process, such as airflow, temperature, and oxygen content. The popularity of in vessel system increases because of odor control, fast in operation, low labor cost, and small area requirements. This technology generally needs fewer workers. It is also suitable in tropical conditions (warm and high humidity) like Indonesia.

The process is carried out inside an enclosed container or vessel. Type of vessel that has been used includes vertical tower, rectangular and circular horizontal tank, and circular rotating tank. In-vessel composting system can be divided into plug flow and agitated bed system. The detention time in vessel composting varies from one to two weeks. However, the system virtually takes about four to 12 weeks of curing period. The compost product can be used for soil improvement and can replace fertilizers and peat to some extent. The application of in-vessel composting technology needs an upfront investment of 25,000 – 50,000 US$ per ton capacity per day and maintenance and operational costs of 30 – 50 US$ per ton.

2.3.1.3. Low-solid anaerobic digestion technology

Low-solid anaerobic digestion is a biological process in which organic wastes are fermented at solid content of equal to or less than 4-8 percent. The low solid fermentation process is used in many parts of the world to generate methane gas from human excrement, animal dung and agricultural waste, as well as from the organic fraction of MSW.

There are three basic steps for low-solid anaerobic digestion process of organic fraction of MSW. The first step is the preparation of the organic wastes such as sorting, separation, and size reduction. The second step involves the addition of moisture and nutrient, material blending, pH adjustment to about 6.8, and heating of the slurry to between 55oC and 60oC. The anaerobic digestion is then carried out in a continuous-flow reactor whose substrates are mixed completely. The third step in the process involves the capture, storage, and, if necessary, separation of the gas components. The dewatering of the digested sludge is an additional task that must be accomplished. In general, processing the digested sludge is expensive so that the process has seldom been used.

2.3.2. Barrier analysis

Barriers analysis for implementing the three selected technologies (Mechanical Biological Treatment, In Vessel Composting, Low-Solid Anaerobic Digestion) was done through several stages: identifying all possible obstacles, screening to remove non relevant barriers, setting up the hierarchical barriers, and analyzing causal relations. Generally, the implementation barriers of the three selected technologies are similar each other because they have similar properties and characteristics. They are all considered to be high technology, mechanical system in operation, semi-automatic process, and specifically treated organic waste. In addition, those three technologies have not been implemented in Indonesia. The implementation barriers of these technologies are given in 6 (six) aspects as follows.

Regulatory Aspect

The barrier on regulatory aspects is found to be an insufficient legal and regulatory framework. There has been a solid waste management act in place available however, the regulations under the act have not been implemented yet and some of them are still under process. According to the act, available open dumping landfills of Indonesia must be closed in five years to come starting from 2008 when the act was officially issued. It means that in 2013 existing open dumping landfills must be closed and replaced with sanitary or controlled ones.

Besides, the act also stipulates that the municipal solid waste (MSW) must be treated in the intermediate treatment facilities (ITF) using 3R principles. To do these actions the implementing regulations under the act must be made. For example, draft of regulation for domestic waste management has been set up, but it is still under discussion with the stakeholders especially industrial sector. This sector has raised a concern for the chapter of extended producer responsibility (EPR) which will strongly affect to their businesses in managing and recycling their wastes.

As mentioned earlier that these three technologies are considered to be high technology of MSW treatment. Therefore, they contain barriers such as lack of institutions or lack of initiatives to set up standards, lack of facilities for testing and certification, insufficient quantity and quality of controlling and measuring equipment, and no obligatory measures to use them.

Financial Aspect

The main barriers from the financial aspect are broken down into three groups: high cost of capital and maintenance of the project, high cost of construction and management of the project, and market failure for recyclable materials (products) such as compost. Each barrier is then divided into several elements.

The first barrier, the high cost of capital and maintenance of the project, consists of 4 (four) barrier elements. Those four barrier elements are mostly imported equipment and machineries, very high tax for those equipment and machineries, high cost of land acquisition, and high maintenance cost of machineries. Most of the waste treatment machineries are imported because of lack of demand so that no producers want to build this equipment. The high tax for machineries purchases is because there is no tariff reduction or incentive provided by the government. It is still attracts commercial tax rates similar to other common goods.

The high cost of land acquisition is because of limited land in the urban area where the technology is located so that land use competition occurs. The land is also limited because there are commonly restrictions from the publics to use their land for waste treatment facilities. The land for waste treatment facilities is also scared because of public restrictions and competing with other usage. Meanwhile, the high maintenance cost is due to mechanically complicated equipment and automatically operated system. It is important to pay attention for the maintenance of the system. It should be done appropriately and controlled tightly in order to avoid the rusting of machinery because the treated waste usually contains acid compounds. The second barrier, high cost of construction and management of the project, consists of three elements, namely low allocated budget for waste management, low retribution fee collected (below marginal cost), and lack of project subsidies. Low allocated budget for waste management is because of limited available budget of local government. The local government budget is still prioritized to be used for other developments that are considered more urgent than MSW treatment. Generally, in Indonesia, the budget allocated for waste management is a very low percentage of the total budget (around 1.5 percent). The problem why retribution fee collected below the marginal cost is because of lack of community awareness or low willingness to pay from the communities. The retribution fee collected generally only about 22 percent of the total cost of MSW treatment. The element barrier of lack of subsidies is caused by no regulations available that regulate subsidies to such kinds of projects.

The third barrier, market failure for recyclable materials (products), is due to the compost product price. The price of this product in the market is relatively low because compost product cannot compete with the chemical fertilizers. There is also unbalance supply and demand of the compost. The demand of the compost is very low. Farmers or users still choose and utilize chemical fertilizers rather than organic compost. For other recyclable materials such as metals, plastics and papers there have no problems because they are reused by informal business sectors due to their high demand in the market.

Institutional Aspect

The institutional barrier consists of 2 (two) elements. Those two are dualism roles of management and weak cross-sectors coordination. Both roles of regulator and operator are commonly done under one institution. This institution, a Cleansing Office of the local government, operates all activities of waste treatment and has authority in all regulatory aspects. In a professional management, operator and regulator are clearly separated. The operator can be a private sector and controlled by the public institution that enforces the regulations. This is actually in agreement with the Minister Regulation of Public Work No 2/ PRT/M/2006 and No. 28/PTS/KE/2003.

The second element barrier of this institutional aspect, weak cross-sectors coordination, is a problem in the cooperation among sectors. To solve the problem appearing from the implementation of MSW treatment requires cooperation among sectors, such as Ministry of Environment, Ministry of Public Works, and Cleansing Office of local government. The coordination practices are, in fact very weak because the position of the Cleansing Office is not equal to position of other related municipal offices. According to government regulation No. 8/2003, the municipal offices have to be made more efficient, so in several cities, the Cleansing Office is put together with other offices to become one office. Consequently, the management authority of Cleansing Office has lowered down so that it has had limitations in plan development.

Social and Cultural Aspect

The barriers on social aspect based on the screening process consist of two elements. Those are bad community's behavior on waste handling and bad community's perception on waste treatment technologies. The bad behavior is indicated by their resistance to change in sorting and collecting the waste at its source. Their habit that litters waste anywhere cannot easily be changed to collect the waste at a suitable place. Another habit that is difficult to be changed is their willingness to participate in waste sorting at the source. These problems might be caused by low community's awareness on the environment and lack of environmental education.

Barrier element of social aspect, bad community's perception on waste treatment technologies, is caused by many unsuccessful implementations of waste treatment technologies in the country. For example is the construction and implementation of many small MSW incinerators that were operated without any flue gas treatment so they produce air pollutants. The waste treatment technologies that have been implemented do not meet the technical requirements. It is generally due to the limited budget for construction as well as for operation and maintenance. As a result, they cause the negative impact on the environment. Some efforts on the improvement of project management and technological applications have been made but they are still lack of socialization and campaign so that perception of the community on waste treatment technology is still poor.

Capacity Building Aspect

Mechanical Biological Treatment, In Vessel Composting, Low-Solid Anaerobic Digestion is considered to be a high technology with mechanically complicated equipment, and semi-automatic process system. They specifically treated organic waste. All of the three technologies have not been implemented yet in Indonesia. So, the numbers of qualified human resources, and types and quality of equipment to perform these activities are not there.

IPR Aspect

IPR policies for Mechanical Biological Treatment, In-Vessel Composting, Low-Solid Anaerobic Digestion are not known yet. The high cost of the licenses will play an important role in determining the rate of technology diffusion.

2.3.3. Enabling framework for overcoming the barriers

Various barriers on the regulatory, financial, institutional, social and cultural, capacity, and IPR aspects, have to be solved together. The procedure to solve the barriers use causal relationship of each barrier and barriers linkage.

Barriers and their possible overcomes are similar to the three selected technologies due to the same level of intermediate waste treatments that face the same problem in all aspects.

Regulatory Aspect

The barrier of regulatory aspect, insufficient legal and regulatory framework, can be overcome by encouraging the government to create and complete the implementing regulations for the references of the technical implementation in the field.

For implementation of Act No.18 of 2008, it initially required several follow up Government Regulations. However as a time goes on, they are finally united into one single Draft of Government Regulation (RPP) only. This RPP covers regulations on management of household solid wastes (MSWs) and similar ones. The draft is currently in the process of harmonization in the Ministry of Justice and Human Rights (Kemenhukham) and Ministry of Economy. This RPP is actually very important to be used as a guide to technically manage MSW in Indonesia.

Financial Aspect

To overcome the barriers of a high capital and maintenance cost of the project, it requires the establishment of workshops that can produce waste treatment machineries, reduction of the tariffs or taxes for imported equipment, and subsidy of waste project management.

The financial barrier, not enough budget to build and manage the project, can be solved with budget assistance from the central government, increase waste retribution fee, increase community awareness through campaigns and socialization, and policy issuance on subsidies for waste treatment projects.

Meanwhile, to overcome the barriers of market failure for recyclable materials or compost product, it needs to have a campaign on compost utilization and establish a demonstration plant for compost applications.

Institutional Aspect

The barrier of institutional aspects, dualism role of management and weak cross-sectoral coordination can be overcome by separating the regulator role from operator role. The operator could be handled by the private waste management whereas the regulator is of course still in the hand of government. Besides, the cross-sectoral coordination should be enhanced by municipal leaders and institutions.

Social Aspect

The barrier of the social and cultural aspects, a bad community behavior and a bad perception of technologies, can be overcome by increasing campaign, socialization, training, and environmental education since the early childhood. The incentives and disincentives for the communities are needed and the demonstration plant of the technology is implemented.

Capacity Building Aspect

Lack of qualified human resources can be overcome by the professional training program on the specific area of work. Local human resources need to be improved their skill and knowledge to become qualified workers.

IPR Aspect

IPR aspect is very important for the effort of technology dissemination. When the technology is disseminated in several Indonesia's cities, the government has to help in negotiating the IPR with the owner in order to reduce the investment cost due to IPR royalty.
Diagram of the relationship between the cause of barriers, barriers, and possibility to solve the barriers of technology transfer can be seen in Figure 2-17 below.

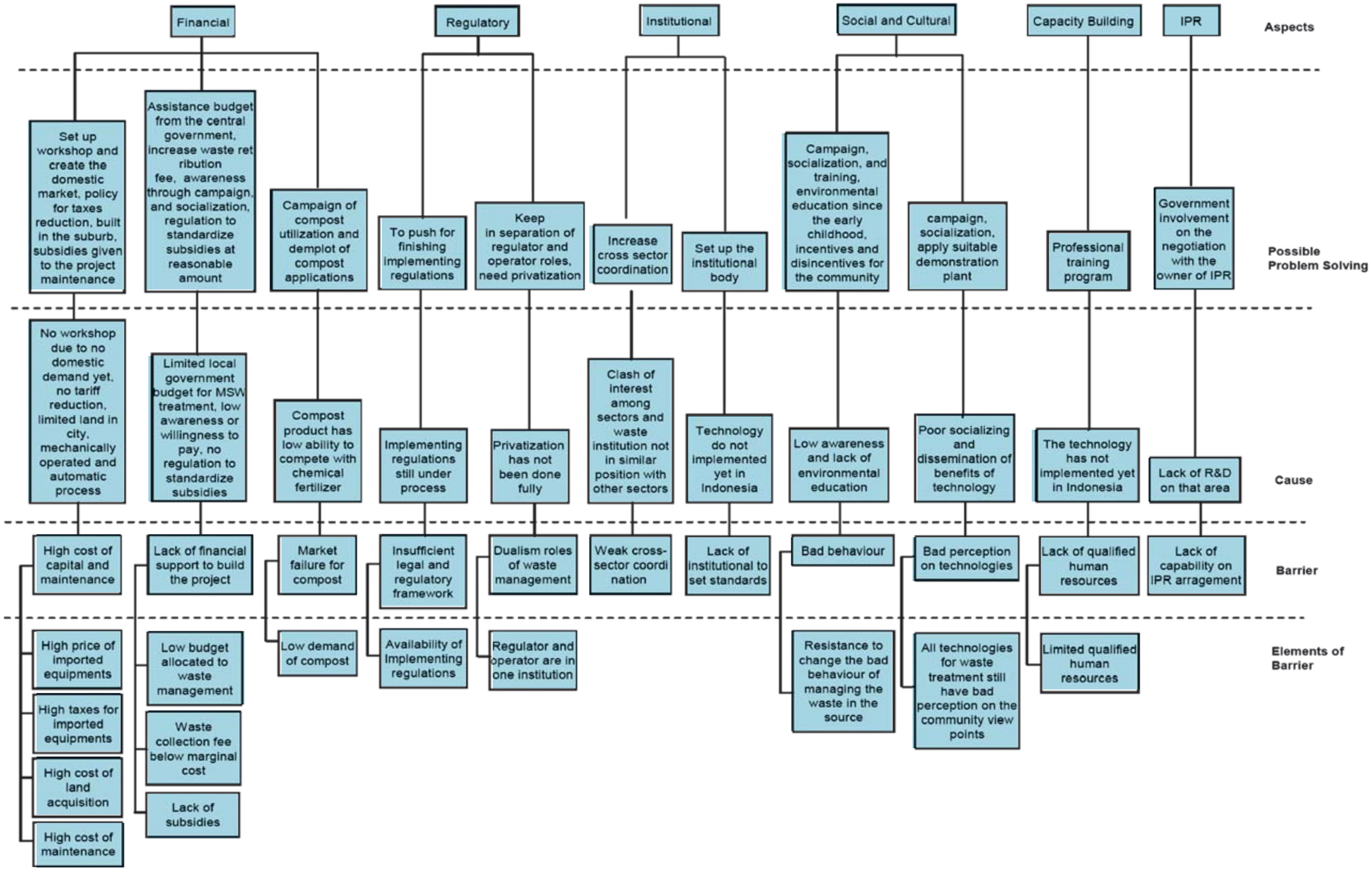

Figure 2-17. Causal relation and possible problem solving in the implementing selected technologies

Table 2-21 Barriers analysis of application of MBT, in-vessel composting, low-solid anaerobic digestion technology

ASPECT	BARRIER	BARRIER ELEMENTS	CAUSES	HOW TO OVERCOME
Financial	High cost of capital and maintenance	Mostly imported machinery and equipment	No manufacturing facility in the country to produce the equipment due to no domestic market demand yet.	Set up workshop and create the domestic market for these technologies
		High taxes applied for heavy duty machinery, including for that of waste treatment	No tariff reduction awarded	Policy for tariff (taxes) reduction
		High cost of land acquisition	Limited land in city and high competition of land uses	Built in the suburb.
		High cost of machinery maintenance	Mechanically operated equipment and automatic process	Subsidies given to the project maintenance
	Insufficient financial resources to build and manage the project	Low budget allocated for the waste management	Limited local government budget dedicated for MSW treatment	Assistance budget from the central government budget Increase waste retribution fee
		Retribution fee collected below the marginal cost	Low awareness or willingness to pay for retribution fee	Increasing awareness through campaign, socialization, etc.
		Lack of subsidies to the project	No regulation to standardize reasonable subsidies of the project	Issue the regulation to standardize subsidies given to the project at reasonable amount
	Absence of market failure for recyclable materials	Low demand of compost	Compost product has low ability to compete with chemical fertilizer	Campaign of compost utilization and demonstration plant of compost applications
Regulatory	Insufficient legal and regulatory framework	Implementing regulations not all available	Still under process	To push for finishing implementing regulations
Institutional	Overlapping management of responsibilities	Regulator and operator roles in one institution	Privatization has not been done fully	Keep in separation of regulator and operator roles Need privatization
	Weak cross sectoral coordination		Clash of interest among sectors and waste institution not in similar position with other sectors	Increase cross sectoral coordination
	Lack of institutional to set standards		The technology do not implemented yet in Indonesia	Set up the institutional body
Social and Cultural	Bad behavior	Resistance to change the bad behavior of managing the waste in the source	Low awareness and lack of environmental education	Increase campaign, socialization, and training Do environmental education since the early childhood Give incentives and disincentives for the communities
	Bad perception on environmental technologies	All technologies for waste treatment still have bad perception on the community view points	Poor socializing and dissemination of benefits of technology	Increase campaign, socialization Apply suitable demonstration plant
Capacity Building	Lack of qualified human resources	Limited qualified human resources	The technology has not implemented yet in Indonesia	Professional training program
IPR	Lack of capability on IPR arrangement		Lack of R&D on that area	Government involvement on the negotiation with the owner of IPR

2.3.4. Recommended solutions

In accordance with the analysis of barriers and attempt to overcome the barriers, there are several recommendations proposed as follows:

- There is a need in implementing related and follow up regulations of solid waste management act.
- There is a need of privatization of solid waste treatment operation.
- There is a need to increase cross-sectoral coordination in solid waste management.
- It should be issued a tax reduction of imported waste treatment components.
- There should be a regulation on tax reduction, investment subsidy, and cost reduction.
- There should be national standards imposed for mechanical biological treatment, in-vessel composting, or low-solid anaerobic digestion technology.
- There should be R & D on mechanical biological treatment, in-vessel composting, or low-solid anaerobic digestion to improve national capacity on that area.
- There is a need to improve the ability of negotiation for solving the IPR barrier.
- There is a need to socialize this technology to communities.

2.3.5. Concrete actions plans and ideas

2.3.5.1. Plans for domestic actions and measures

Description

The establishment of demonstration plant of intermediate treatment facilities can be chosen from one of the following selected technologies: mechanical biological treatment, in-vessel composting, or low-solid anaerobic digestion. This application depends on the technology transfer agreement between owner from foreign country and user from Indonesia. However, a mechanical-biological treatment (MBT) is considered to be the best choice because it can actually be combined with an in-vessel composting technology or a low-solid anaerobic digestion as a specific treatment of organic waste contained in MSW. Therefore, MBT can be an alternative option to overcome the garbage problems faced by Indonesia urban cities at small, medium or large scales.

MBT application has already been raised to be implemented in several cities of Indonesia that is in line with the national waste management program initiated by Ministry of Public Works as the implementing agency. The Ministry of Public Works together with foreign partner has already initiated cooperation with local governments to implement this technology.

Timeline

The demonstration plant development is anticipated to be carried out in 3 years. Detailed activities are as follows:

First year:

- Do coordination with all stakeholders (Municipality, Ministry of Public Work, Ministry of Environment, local community, foreign body, etc.).
- Prepare project planning.
- Determine financial sharing
- Establish demonstration plant organization.
- Determine project locations and do socialization to the surrounding communities.

- Prepare basic design and feasibility study.
- Prepare detailed engineering design (DED).

Second year:

- Order imported machineries and equipment.
- Prepare site and land for the establishment of project.
- Construct buildings.
- Install machineries and equipment.
- Have operators training.
- Do the running test

Third year:

- Continue more detail of running test.
- Conduct evaluation of test results.
- Improve the system according to the evaluation.
- Do operation
- Do evaluation

Geographic locations for the implementation

Determination of the geographic location of chosen MSW treatment technologies is based upon the criteria where sites in the selected municipality are located and the local government has high commitment to operate the project. Besides, the municipality should have a plan of MSW recycling program in the medium and long-term periods. These cities can be a medium, big, or metropolitan types that are facing solid waste management problems. After considering those criteria, the proposed cities are selected that might include:

1) Bogor (West Java)
2) Yogyakarta (Center-south Java)
3) Surabaya (East Java)
4) Palembang (South Sumatera)
5) Makassar (South Sulawesi)
6) Balikpapan (East Kalimantan)

Resources Needed

Resources needed include:

- Professional institution or a private company that manages the demonstration plant can work with existing waste management;
- Qualified expert who can transfer the technology and operating demonstration plant;
- Professional workers who have got training, had high discipline and owned good commitment;
- Managers who fully support the existing waste supply and transporting residual waste to landfill continuously;
- Local and central government that fully support the construction and operation of demonstration plant;
- Sharing of adequate funding from both the donors and local governments;
- High community participation in waste sorting at source;

- Local workshops that support the provision of mechanical machinery (belt conveyor, magnetic separator, shredder, mobile rotary screen, in-vessel composter, etc.);
- Facilities and infrastructure for waste collection and transportation programs that support waste segregation at source; and
- Laws to support the operation of demonstration plant.

Regulatory Change

The umbrella laws of demonstration plant are:

- Act No. 32 of 2009 on Environmental Protection.
- Act No.18 of 2008 on the Management of Municipal Solid Waste.
- Act No.7 of 2004 regarding Water Resources.
- Act No.32 of 2004 regarding Regional Government.
- Ministry of Home affairs Regulation (Permendagri) No. 33 of 2010 concerning Municipal Solid Waste Management.
- Local regulations relating to waste management.
- Mayoral Decree related to waste management.

Coordinating or Implementing Institution

Implementing or coordinating institution is the Ministry of Public Works, while supporting Institutions include the Ministry of Environment, Ministry of Home Affairs, BPPT, DNPI and the local governments.

2.3.6. Project ideas for international support

Type of Technology

MBT is heavy mechanized waste treatment facility. Actually, some equipment of the MBT can be possibly made in Indonesia, but some of complicated equipments have to be imported. This situation needs international support in technology transfer and IPR negotiation.

Capacity Building Aspect

In order for the application of MBT to be sustainable in its operations, the ability of local engineers and the operators must be improved. Therefore, the international support for this technology transfer is directed to help in improving the capacity building of Indonesian researchers and users by foreign experts. This can be done through training, tutoring and knowledge transferring during practical work at the plant. If there is a technology innovation arising during MBT operation it should be set in the agreement, especially relate to Intellectual Property Rights (IPR).

Financial Aspect

Grants and/or loans with low interest rate from foreign aid are needed. The use of this aid is such as for:

- Pre-Instalment cost: planning, FS and DED
- Capital cost: construction and machineries installation.
- Operation and maintenance cost: salaries, utility bills, tools and supplies, fuels of machines. Etc.

Resources Requirement

MBT development also requires some resources that should be prepared in the country. In general, these needs include local industries producing mechanical machinery, waste transportation and transfer stations support, land, expert and professional workers, etc.

Timeline

Implementation of MBT plant requires a period of 3 years with the following stages;

First Year:

- Planning and coordination
- Feasibility Study
- Detail Engineering Design

Second Year:

- Construction and Installation
- Running test
- Evaluation and improvement

Third Year:

- Full Operation

Indicators of Success

- Good cooperation and networking between stakeholders (foreign partner/donors, Ministry of Public Work, Ministry of Environment, Cleansing Office of the Municipality, community based organization).

Domestic Partners

Domestic partners will be involved in this project are BPPT, Ministry of Public Work, Ministry of Environment, Municipality Cleansing Office and Indonesia Solid Waste Association.

2.3.7. Summary

The mitigation technologies selected are mechanical-biological treatment, in-vessel composting, and low-solid anaerobic digestion technologies. They are all considered to be high technology, mechanical system in operation, semi-automatic process, and specifically treated organic waste. Actually, those technologies have not been implemented yet in Indonesia. For implementing those technologies, there are six aspects of barriers: regulatory, financial, institutional, social and cultural, capacity building and intellectual property right aspects. The barrier on regulatory aspects is an insufficient legal and regulatory framework. It can be overcome by encouraging the government to create and complete the implementing regulations as references for the technical implementation in the field. Meanwhile, the main barriers from the financial aspect are broken down into three groups, a high cost of capital and maintenance of the project, high cost of construction and management of the project, and market failure for recyclable materials. To overcome these barriers, they require the establishment of workshops that can produce waste treatment machineries, reduction of the tariffs for imported equipment, the subsidy to the waste project management, the budget assistance from the central government, increase the waste retribution fee, increase community awareness, drafting policy on subsidies for waste treatment projects, and a campaign of compost utilization.

Another aspect, institutional aspect, has two barriers, dualism roles of management and weak cross-sectoral coordination. These barriers can be resolved by separating the regulator and the operator roles. Privatization waste management could take over the role of operator done so far by government. Cross-sectoral coordination among municipal leaders and institutions as well as role of regulation issuance has to be done by the government. Meanwhile, the barriers on social aspect are bad communities' behavior on the waste handling and bad communities' perception on waste treatment technologies. These can be overcome by increasing numbers of campaign, socialization, training, and environmental education. The needs of incentives and disincentives for the community as well as the implementation of suitable demonstration plant of the technology are also needed. The barriers of capacity building aspect, the limited qualified human resources, can be solved through professional training program on the specific area. Then the last barrier, the IPR barrier that it still dominated by foreign country can be negotiated by the help of government so the royalty cost of the IPR will not overburden the investment cost.

Those barriers have to be considered in suitably implementing selected technologies. The implementation of technologies is predicted to take about 3 year period. The first year activities consist of planning and coordination, feasibility study, and detail engineering design. The second year activities consist of construction and installation, running test, evaluation and improvement. And the last year consist of full operation and maintenance. The domestic partners for this future project are BPPT, Ministry of Public Works, Ministry of Environment, Municipality Cleaning Office and Indonesia Solid Waste Association.

SECTION 3

CROSS-CUTTING ISSUES FOR THE NATIONAL TNA AND TAPS

3.1. Cross-cutting technologies for the TNAs in the three sectors

Mitigation of GHG can be done through technology implementation either in one single sector or in multiple sectors.

Although it uses a sectoral approach in GHG emissions, its mitigation plans and actions can also be done in multiple technologies for the results to be efficient and effective. By changing a particular policy, it can sometime remove barriers in different sectors. The result of prioritization technologies in each sector of TNA for mitigation is as follows.

It was concluded that prioritized technologies for the forestry sector are (a) Measurement and monitoring of carbon sequestration and emission, (b) Peat re-mapping, (c) Water management. While for the energy sector comprises of (a) Photovoltaic and (b) Regenerative Burner Combustion System (RBCs). For the Waste sector, the prioritized technologies were concluded to be (a) Mechanical Biological Treatment (MBT), (b) In-Vessel Composting and (c) Low Solid Anaerobic Digestion.

From the results of technologies prioritization in each sector, it is difficult to encounter cross-cutting technologies that can mitigate GHG emissions in more than one sector at once. However, it might be possible to have cross cutting technologies of the waste sector to the energy sector. For example, the integrated MBT with IVC and LSAD aims to process waste into compost and methane gas. This methane gas will be utilized for energy otherwise it escapes into the atmosphere as GHG. Therefore, this technology is assumed to be able to mitigate GHG. On the other hand, the production and capture of methane through this technology can be utilized for energy, for example, it is used for electric generation and cooking. Therefore, this methane gas is capable of replacing energy from fossil fuels that we normally use. This means that the methane gas from MBT technology is considered to be able to mitigate GHG from the energy sector.

3.2. Cross-cutting issues for the TAPs in the three technologies prioritized

All three selected technologies in the forestry sector are essentially intended to manage forestry in a sustainable manner. Forest becomes an important issue in terms of climate change because it can function as CO2 sink and carbon storage (carbon stock). Indonesia that owns large forest area has strongly protected its forest from potential fire burning. As known, that forest burning will highly contribute to the carbon emission of Indonesia. For that purpose, many developed countries have offered cooperation in the forestry sector, such as through debt for nature swept scheme. One of the important technologies to prevent the potential forest burning especially peat forest is to carry out the good water management in the peat-forestry sector. However, it needs supporting technologies of monitoring and measurement of carbon, and peat re-mapping. Thus, three prioritized technologies for forestry sectors support each other in order to manage forest at the sustainable manner.

Similarly, for waste sector the selected technologies are found to be MBT, In Vessel Composting and Low Solid Anaerobic Digestion. These three technologies are considered to be integrated technologies in treating MSW. Therefore, they have potential cross-cutting Issues for the TAPs.

For energy sector, it has however two prioritized technologies that cannot support each other since the PV cells is dedicated to generating electricity while the RBCS is intended to increase efficiency of energy use in the industry.

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Annex 1

Annex 1.1. Technology factsheets forestry and peat sector

Annex 1.1.1. Integrated forest-peat carbon measurement and monitoring technology

1 — Introduction

The ICCSR (Indonesia Climate Change Sectoral Roadmap) of forestry sector (BAPPENAS 2009), suggested the most feasible scenario to reach the target of reducing GHG emissions by 26% in the year of 2020 called SC3: increasing sink and creating conditions for preventing further deforestation. Most of the mitigation efforts in this scenario come from the improvement of management practices implemented on 244 newly developed FMU (forest management units) – KPH (Kesatuan Pemangkuan Hutan), in an area extent of 24 million hectares. This scenario has the lowest abatement cost per unit of emission reduction and to reduce annual GHG net emission of 800 abate to 496 MtCO2e within a time period of 2011 – 2020.

In addition, the ICCSR suggested policy oriented mitigation options for the improvement of peat management practices aimed at "low carbon" peatland management by enforcing existing legal requirement and establishing new standards of best practices. Two main mitigation options are suggested: zero burning and water management best practices to reduce annual emission of 470 MtCO2e, from 1700 MtCO2 e of BAU down to 1230 MtCO2e within a period of 2011 – 2020.

Considering the large size of spatial forest extent and the large number of KPH involved for implementing the mitigation scenario, scientifically credible data and information for carbon accounting of the results of implementing the above mentioned mitigation scenario must be available. This implies that a technological system – a proper combination of expertise (knowledge and skills), tools (equipments and models), and institutional framework (workgroup, task force, teamwork, etc.) – to facilitate integrated forest-peat measurement and monitoring of carbon stock on targeted forest and peatland areas of mitigation measures needs to be newly invented. Furthermore, its technical reliability and economic feasibility need to be demonstrated for the purpose of technology transfer and diffusion.

2 — Technology characteristics

Carbon measurement and monitoring technology in the context of CHG mitigation of Forest and Peat Sectors deals with integrating knowledge, tools, and institutional framework aimed at facilitating two in one measurements: timber standing stock inventory and peat deposit survey. This integrated measurement technology would facilitate estimation of carbon stock from proper combination results of conventional forest inventory (above ground biomass) and the result of peat survey (below ground biomass).

Conventional forest inventory is a standardized method of SFM for estimating standing stock of timber volume and re-growth condition of a certain area extent of forest management unit. The method is based on statistical estimation of timber volumes of trees of more than 30 cm Dbh (diameters at breast height).

Forest timber volume of trees and poles is estimated by means of a standardized statistical methodology based on sampling technique and analysis. For this purpose, a nested stripped sample plots are defined. Within each sample plot, trees and poles diameters at breast height and their first branch heights are measured. Timber volume within each sampling plot is calculated from the sum of volume of trees and pole. Finally, total volume of the forest extent is statistically estimated from calculated timber volume of the sampling plots.

3 — Country specific applicability

The use of conventional forest inventory method has been used for estimating carbon stock of forest biomass (in ton of biomass weight) from standing stock volume (m3 of timber standing stock) multiply by 2.5. Carbon stock (ton of carbon) is estimated about 50% of forest biomass. CO_2 equivalent (ton of CO_2) can be estimated, simply by multiplication of 3.67 to the carbon stock. For the time being, more accurate estimation of carbon stock has been developed using allometric equations from measuring tree diameter at breast height (Dbh) only. An allometric equation is species and site specific, it is developed based on statistical correlation of Dbh and biomass of a single tree of certain species or forest type on a certain geographical site.
In addition to singe tree carbon estimation method, several area methods for forest carbon estimation have been developed by means of remote sensing technology. Multi spectral as well as SAR (Synthetic Aperture Radar) remote sensing technologies have been initially invented for measurement and monitoring of carbon stock. Vegetation indices and leaf area indices are the common methods of multispectral remote sensing for estimation of forest carbon stock, whereas multi polarization and interferometry are the common method of that of SAR remote sensing.

The aforementioned conventional forest inventory and its further development of allometric equation and remote sensing methods are utilized for estimating above ground biomass for forest of non-peat environment. An additional below ground carbon stock measurements of peat deposit is required for peat swamp forest, timber plantation on peat, tree estate on peat environment. The amount of biomass of peat deposit is usually estimated from the result of soil survey by combining peat depth, peat bulk density, area measurements. Similar to the forest inventory, soil survey has been recently supported by multispectral and SAR remote sensing technology for wide area measurement of estimating peat deposits.

4 — Status of technology in country

Within the context of Sustainable Peat Management, measurement and monitoring of carbon stock to estimate CO_2 emission from peat decomposition/subsidence and peat fire using of newly invented of peat soil surveys as well as remote sensing technology for estimating peat deposit have been initially practiced.

Within the context of TTD, particularly from the point of view of 'Innovation System', the above mentioned technologies need to be integrated in such a way to make the first chain of innovation process – research and development (R&D) – fully completed. Furthermore, the early stage of second chain of innovation process – the initial phase of diffusion – in which the demonstration of its reliability, practicality and financial feasibility of the integrated technology have to be well prepared. Finally, to complete the whole process of the second chain of innovation of the technology, the diffusion has to be focused on 'interactive learning' of the three components of technology for carbon measurement and monitoring:

- Make use of all available knowhow and expertise (software) from the previous R&D experiences on measuring biomass of forest and peatland using the synthesis of forest biometrics, peat deposit estimation, and the integration of the two.
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for direct as well as remotely sensed measurement, and the combination of the two
- Define the most effective coordination (org-ware) among the key players (i.e., BPPT, Ministry of Forestry, Ministry of Environment, and Ministry of Agriculture).

5 — Barriers

Barriers of Technology Transfer and Diffusion (TTD) for this technology is illustrated as a problem tree presented in Figure 2-10. of this report. It is important to note that the problem tree was defined by selecting a starter problem: Lack reference project of viable, credible and reliable integrated forest—peat carbon measurement. This starter problem roots from a total number of six barriers and propagate to six 'canopy' barriers. In terms of innovation system TTD process, the root barriers correlate with maturing R&D chain and the canopy barriers correlate with technology diffusion chain. In other words, the maturing R&D process deals with barriers to provide a reference project of viable, credible and reliable integrated forest—peat carbon measurement, whereas the chain of technology diffusion deals with barriers of adopting this technology in facilitating mitigation measures to achieve a complete data and information for forest-peat carbon accounting at both national and sub national levels.

To assess possible solutions for overcoming barriers, a hierarchical logical framework analysis was applied to objective trees, followed by a rapid benefit cost/consequence analysis, with special consideration of critical and difficult nature of "take off" – the initial phases when the reliability, practicality and financial feasibility of the technology is demonstrated. The results of such assessment recommended the following solution for overcoming barriers:

Table A-1 Assessment recommended the following solution for overcoming barriers

Recommended Solutions	
Maturing R&D Phase	**Technology Diffusion Phase**
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented integrated peat-forest carbon measurement and monitoring technology. **Mode of Action:** International Capacity Building for a national expert consultation workgroup through the development of an operational, reliable, credible, and feasible prototype of integrated peat-forest carbon measurement and monitoring carried out on national demonstrator R&D field stations.	**Policy Action:** Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of integrated peat-forest carbon measurement and monitoring technology. **Mode of Action:** On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain period of trial and adjustment in their areas. The program is designed and implement by national expert consultation workgroup

6 — Benefits

The ultimate benefit GHG mitigation measures are

- annual GHG net emission of will be 800 reduced to 496 MtCo2e by implementing KPH-HTI mitigation scenario within a time period of 2011 – 2020
- annual emission of 1700 MtCO2 will be reduced to 1230 MtCO2e by implementing "low carbon" peatland management (zero burning policy and water management best practice).

These benefits are not the direct benefits of carbon measurement and monitoring technology, however, they cannot be properly quantified without the use of reliable carbon measurement and monitoring technology. Further qualitative assessment of specific benefits of TTD of unified peat mapping technology suggested the followings:

Table A-2 Goal: To make data and information available for forest—peat carbon accounting

Goal: To make data and information available for Forest—Peat carbon accounting							
Maturing R&D				Technology Diffusion			
Objective To establish a reference TTD project of Forest—Peat carbon measurement and monitoring				Objective To provide complete and updated information system on forest carbon stock covering sub-national level			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of Forest—Peat carbon measurement national task Force	M	L	H	Carry out sub-national collaborative learning program to transfer knowhow of and facilitate access to proven integrated carbon measurement and monitoring technology:			
M2. Establishment of expert workgroup for growth modelling biomass measurement	H	L	M	M6. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	M	L	H
M3. Establishment of expert workgroup for peat biomass measurement modelling	H	L	M	M7. Carry out on-site job training for development and implementation of Integrated national-sub national carbon measurement model	H	H	H
M4. Establish international capacity building for Forest—Peat carbon measurement prototype development	H	H	H				
M5. Provide adequate R&D field stations and facilities for carbon measurement prototyping (hardware and software)	H	M	H	M8. Develop and implement organization mechanism to distribute information	L	M	M
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							

7 — Operations

At local area levels, carbon measurement and monitoring technology need to be operated by well-trained personnel of KPHs, HTIs, HPHs and tree estate enterprises. At wide areas levels, this technology needs to be operated by personnel of the Ministry of Forestry and Ministry of Agriculture supported by local area personnel. The personnel of both levels have to be well equipped with adequate tools and equipment accordingly. In other words, trained personnel and adequate tools and equipments are the hearth and prerequisite for the operations of this technology.

To maintain the operation of this technology in an optimum performance, therefore, should cover maintaining and improving personnel's knowledge and technical expertise as well as maintaining and improving supporting measurement and monitoring tools and equipment. Several possible maintenance and improvement efforts are:

- Operate local area measurement field stations as a network of field stations which can be functioning as sub national and national carbon monitoring permanent sampling plots. This effort will improve the performance of sub national and national carbon monitoring information system
- Establish a regular (e.g., once a year) meeting at national level as a forum of experts and technical personnel for communication and staying experience of implementing their works. This effort will broaden knowledge and improve technical expertise of the local area personnel as well as wide area personnel
- Maintain tools and equipment always in a ready to use condition to prevent them from fail to operate. Establish a 'station help station' servicing network at sub national as well as at national levels.

8 — Costs

The estimation of cost of this technology faces with selecting a wide variety of options of the combination of capital costs, operations and maintenance costs, administration costs, and other costs associated with developing an enabling environment.

Given the rather high level of uncertainty that accompany technology cost estimates, the list of cost estimation of this technology (low, mid, and high estimates) are as follows:

Table A-3 Accompany technology cost estimates forest-peat carbon measurement and monitoring technology

	Item	Estimated Cost (USD)		
		Low	Medium	High
A.	Capital costs (1 set of measurement and monitoring equipments)	720,000	800,000	880,000
1.	Additional forest inventory equipments and facilities			
2.	Peat survey equipment and facilities			
3.	Allometric and peat biomass lab equipment and facilities			
4.	GIS, Remote sensing, and biomass modelling facilities and equipments			
5.	Allometric and biomass modelling development			
B.	Annual operations and maintenance cost	36,000	40,000	44,000
1.	Forest inventory operation cost and supplies			
2.	Peat survey operation cost and supplies			
3.	Allometric and peat biomass lab operation and supplies			
4.	GIS, RS, and modelling operation and supplies			
C.	Annual administration costs	18,000	20,000	22,000
1.	Data processing and analysis for forest inventory			
2.	Data processing and analysis for peat survey			
3.	Data processing and analysis for allometric and biomass modelling			
4.	Data processing, analysis, and cartographic for GIS and RS			
D.	Annual costs for developing and enabling environment			
1.	National Workshops 2 times per year @15,000		30,000	
2.	National Seminar and Conference once per year@25,000		25,000	

9 — References and additional information

1. http://www.irmforestry.com/services_forest_inventory_systems.php
2. http://www.fao.org/docrep/007/y5490e/y5490e05.htm#TopOfPage
3. http://www.benmeadows.com/Eijkelkamp-Peat-Sampler_31220745/
4. http://en.wikipedia.org/wiki/Forest_inventory
5. http://www.hubbardbrook.org/w6_tour/biomass-stop/how-to-quantify.htm
6. http://indonetwork.co.id/MitraGunaInstrument/2478853/digital-geo-resistivity-meter-geolistrik-hp-081380328072.htm

Annex 1.1.2. Peat re-mapping technology

1 — Introduction

The ICCSR (Indonesia Climate Change Sectoral Roadmap) of forestry sector (BAPPENAS 2009), suggested the most feasible scenario to reach the target of reducing GHG emissions by 26% in the year of 2020 called SC3: increasing sink and creating conditions for preventing further deforestation. Most of the mitigation efforts in this scenario come from the improvement of management practices implemented on 244 newly developed FMU (forest management units) – KPH (Kesatuan Pemangkuan Hutan), in an area extent of 24 million hectares. This scenario has the lowest abatement cost per unit of emission reduction and to reduce annual GHG net emission of 800 abate to 496 MtCo2e within a time period of 2011 – 2020.

In addition, the ICCSR suggested policy oriented mitigation options for the improvement of peat management practices aimed at “low carbon” peatland management by enforcing existing legal requirement and establishing new standards of best practices. Two main mitigation options are suggested: zero burning and water management best practices to reduce annual emission of 470 MtCO2e, from 1700 MtCO2 e of BAU down to 1230 MtCO2e within a period of 2011 – 2020.

Two methods of land resource mapping technology (in the contexts of knowledge, tools, and orgware) have been practiced to derive peat map in Indonesia: 1990 LREP (Land Resources Evaluation and Planning Project) land resources map and 1988 RePPProT (Regional Physical Planning Programme for Transmigration) land system map. The differences of knowledge underlying the mapping methods lead spatial information disagreements.

Considering that deforestation and degradation (through timber extraction) of peatland forests contribute annual emission of 0.25 Gt Co2e (DNPI 2010), a unified methodology for peat mapping is required to facilitate the availability of data and spatial information for the KPHs involved in the implementation of the mitigation scenario based on the “low carbon” peatland management policy. In other words, each newly developed KPH needs to be facilitated with a complete and updated unified peat mapping information system whose technical reliability and economic feasibility need to be demonstrated for the purpose of technology transfer and diffusion

2 — Technology characteristics

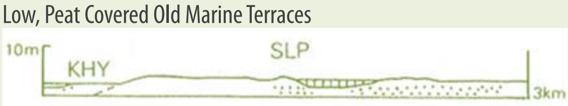
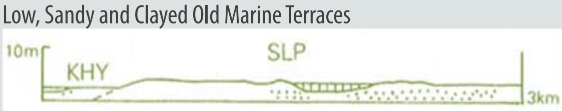
Two methods of land resource mapping technology (in the contexts of knowledge, tools, and orgware) have been practiced to derive peat map in Indonesia. The first method refers to land resources mapping conducted by Land Resources Evaluation and Planning Project) – LREP (1990) and the second method refers to Land System mapping conducted by Regional Physical Planning Programme for Transmigration – RePPProT (1988). Both land resources and land system maps are represented in the same spatial scale of 1 to 250,000. The main difference of these two mapping methods lays on the entity or object of mapping and the knowledge used for mapping. The LREP method was dedicated to map land and soil resources, whereas the RePPProT were aimed to map lands systems.
Table A-4 shows how the approach of deriving peat map from LREP's land resources mapping scheme of Sumatra Island. The island is spatially mapped into 12 physiographic group of landforms. Peat map is derived from physiographic group of Peat Domes, which are sub divided into two types of landforms euthropic and olygothrophic peat domes. Each type of peat dome landform is further sub divided into fresh water peat dome, tidal/saline peat dome, and cultivated peat dome. Finally they are classified into three classes of peat depth thin (<0.5m), medium (0.5-2.0m), and thick (>2.0m).

Table A-4 Peat mapping approach derived from LREP's land resource mapping scheme

SYMBOL	PHYSIOGRAPHIC GROUP	SUB DIVISION		
A	Alluvial			
B	Marine			
D	Peat Domes	1.Euthropic	1.Fresh 2.Tidal/Saline 3.Cultivated	1.Thin (<0.5m) 2.Med (0.5-2.0 m) 3.Thick (>2.0m)
		2.Olygothropic	1.Fresh 2.Tidal/Saline 3.Cultivated	1.Thin (<0.5m) 2.Med (0.5-2.0 m) 3.Thick (>2.0m)
H	Hilly			
I	Acid Tuff Plane			
K	Karst			
M	Mountain/Plato			
P	Plain			
Q	Toba Acid Tuff			
T	Marine terrace			
V	Volcanic			
X	Miscellaneous Landform			

A different approach of deriving peat map of Sumatra Island from RePPProT's Land System mapping scheme is presented in Table A-5 The Land System mapping scheme spatially divide Sumatra Island into eleven physiographic type, each of which is further divided into landforms having similar type of landscapes with certain types of rocks, topography, climate, soil, and vegetation termed as Land Systems. Peat landform types are derived from any land system whose contains partially peat or completely peat lithologic materials. Peat domes (GBT) and seven other peat or peat containing landforms (BLW, KHY, MDW, KLR, BLI, BBK, and SLP) can be spatially delineated.

Table A-5 A different approach of deriving peat map of Sumatra Island from RePPProT's land system mapping scheme

raphic type	LANDSYSTEMS*)		PEAT LANDFORM TYPE	LITHOLOGY
	Symbol	Name		
Beach	BLW	Banjar Lawas	Peat Covered Beach Deposits 	Peat Alluvium, recent marine
Tidal Swamps				
Alluvial Plains	KHY	Kahayan	Coalescent Estuarine/Riverine Plains 	Peat Alluvium, recent marine - riverine Alluvium, recent riverine
Meander Belts				
Swamps	GBT	Gambut	Deeper Peat Swamps, commonly Domed 	Peat
	MDW	Mendawai	Shallower Peat Swamps 	Peat
	KLR	Klaru	Permanently Water Logged Peaty Floodplains 	Peat Alluvium, recent riverine
	BLI	Beliti	Swampy Floodplains of Narrow Valley 	Peat Alluvium, recent riverine
Alluvial Valeys				
Fans and Lahars				
Terraces	BBK	Benjah Bekasik	Low, Peat Covered Old Marine Terraces 	Peat Alluvium, old clays
	SLP	Sikladi panjang	Low, Sandy and Clayed Old Marine Terraces 	Peat Alluvium, old clays Alluvium, old sands
Plains				
Hills				
Mountains				

*) Land systems are distinctive landscapes in which certain types of rocks, topography, climate, soil, and vegetation are closely interrelated. The same landscape components and properties should be found in the proportion whenever a land system occurs

3 — Country specific applicability

Peat maps can be derived from both LREP as well as RePPProT maps. Because of differences of using knowledge underlying their mapping methods, deriving peat map from these maps lead to disagreements of spatial information. The disagreements are demonstrated in the following peat maps of Riau area derived from LREP and RePPProT maps (Figure A-1).

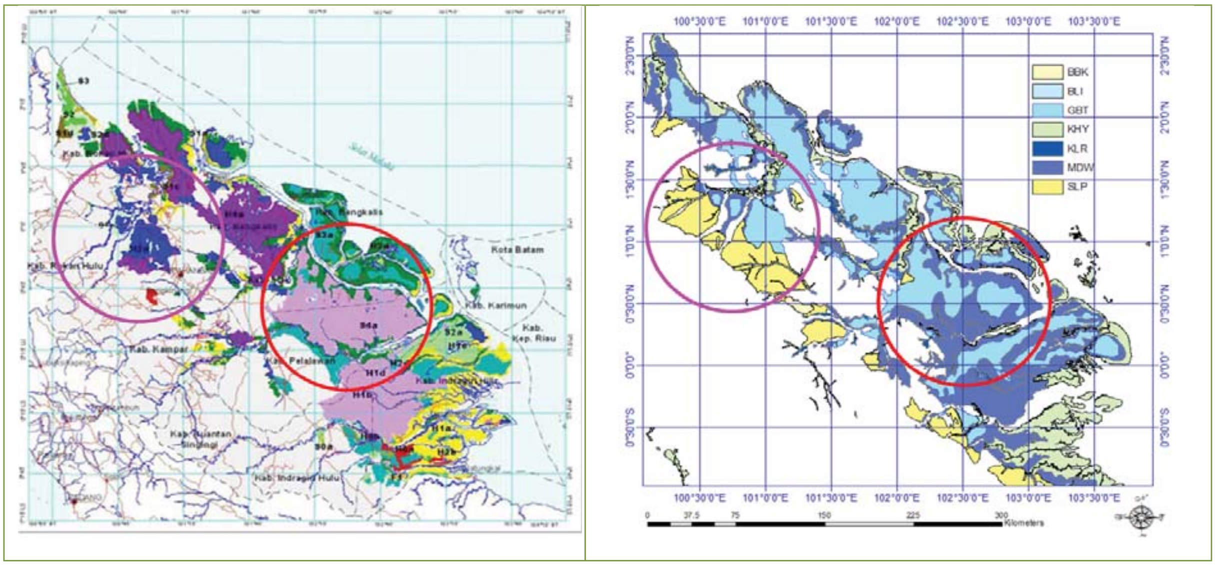


Figure A-1 Disagreements are demonstrated in the following peat maps of Riau area

Observing peat maps of Figure A-1 some of the disagreements are summarized as follows:

- LREP derived peat map provides spatial distribution and variability of peat depth and its degree of decomposition.
- RePPProT derived peat map provides those of land systems of peat landform types.
- LREP derived peat map does not include peat area over physiographic type terraces which can be recognized from within the magenta circles.
- RePPProT derived peat map provide more variability of peat types than that of LREP derived peat map which can be recognized from within red circles

The above listed disagreements imply that a newly innovation on peat mapping technology for remapping peatland needs to be established. This key measure could be done by:

- Synthesizing LREP methodology and RePPProT methodology
- Utilizing all of technology components resulted from previous and current R&D on peat mapping, including expertise, tools and equipments, and key players.

4 — Status of technology in country

Despite the fact that the unified peat mapping system that synthesizes LREP and RePPProT mapping methodology has not been established yet in Indonesia, only recently, the initial serious efforts have been taken by DNPI (National Council of Climate Change of Indonesia) and UKP4 (Presidential Working Unit for Development Supervision and Control).

This means that the initial stage of first chain of innovation system has been established. This stage needs to be facilitated for the development of the unified peat-mapping prototype, accomplishing the main target of the first chain of innovation. Whenever the first chain is completed, the second chain of innovation – technology diffusion – could be started. Again, analogous to technology A1 (Carbon measurement and monitoring), this diffusion would consider the use of and be focused on "interactive learning" approach of the key players of technology diffusion, aiming for demonstrating reliability, practicality and financial feasibility of the newly invented re-mapping technology. This process of technology diffusion of unified peat mapping should:

- Use of all available knowhow and expertise of the first chain of innovation
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for direct as well as remotely sensed peat mapping
- Operate the most effective coordination among the key players of peat mapping (i.e., BPPT, Bakosurtanal, LAPAN, Min of Forestry, Min of Environment, and Min of Agriculture).

5 — Barriers

Barriers of Technology Transfer and Diffusion (TTD) for this technology is illustrated as a problem tree presented in this report. It is important to note that the problem tree was defined by selecting a starter problem: Lack reference project of viable, credible and reliable unified peat mapping reference project. This starter problem roots from a total number of five barriers within the root zone and further propagates to four 'canopy' barriers through two stem barriers weak collaborative learning and insufficient knowledge of and or access to proven unified peat mapping technology.

Within the context of innovation system TTD process, root barriers correlate with maturing R&D chain and those of canopy barriers correlate with technology diffusion chain. In other words, the maturing R&D process deals with barriers to provide a reference project of viable, credible and reliable unified peat mapping project, whereas the chain of technology diffusion deals with barriers of adopting this technology in facilitating mitigation measures to establish a complete and updated peat mapping system to provide data and spatial information for "low Carbon" peatland management.

To assess possible solutions for overcoming barriers, a hierarchical logical framework analysis was applied to objective trees, followed by a rapid benefit cost/consequence analysis, with special consideration of critical and difficult nature of "take off" – the initial phases when the reliability, practicality and financial feasibility of the technology is demonstrated. Furthermore, the results of such assessment were used to recommend the following overcoming barrier solutions:

Table A-6 Recommend the following overcoming barrier solutions for peat re-mapping

Recommended Solutions	
Maturing R&D Phase	**Technology Diffusion Phase**
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented unified peat mapping system technology. **Mode of Action:** International Capacity Building for a national expert consultation workgroup through the development of an operational, reliable, credible, and feasible prototype of unified peat mapping system carried out on national demonstrator R&D field stations.	**Policy Action:** Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of unified peat mapping system technology. **Mode of Action:** On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain period of trial and adjustment in their areas. The program is designed and implement by national expert consultation workgroup

6 — Benefits

The ultimate benefit GHG mitigation measures are

- annual GHG net emission of will be 800 reduced to 496 MtCO2e by implementing KPH-HTI mitigation scenario within a time period of 2011 – 2020
- annual emission of 1700 MtCO2 will be reduced to 1230 MtCO2e by implementing "low carbon" peatland management (zero burning policy and water management best practice).

These ultimate benefits are not the direct benefits of carbon measurement and monitoring technology, however, they cannot be properly quantified without the establishment of a complete and updated peat mapping system supported by unified peat-mapping technology. Further qualitative assessment of specific benefits of TTD of unified peat mapping technology suggested the followings:

Table A-7 Goal: To make data and spatial information available for "Low Carbon" peatland management

Goal: To make data and spatial information available for "Low Carbon" Peatland Management							
Maturing R&D				**Technology Diffusion**			
Objective Establishment of a TTD reference project of viable, credible, and reliable unified peat mapping				Objective To provide complete and updated information system on forest carbon stock covering sub-national level			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of unified peat mapping national task Force	M	L	H	M5. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	M	L	H
M2. Establishment of expert workgroup for unified peat mapping	H	L	M	M6. Carry out on-site job training for development and implementation of unified peat mapping methods and practices	H	H	H
M3. Establish international capacity building for unified peat mapping prototype development	H H	H M	H H	M7. Develop and implement organization mechanism to establish a unified peat mapping system covering sub national level	L	M	M
M4. Provide adequate R&D field stations and facilities for unified peat mapping prototyping (hardware and software)	H	L	2				
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							

7 — Operations

At the national level, unified peat mapping technology needs to be maintained by Planning and Mapping unit at the Ministry of Forestry in tandem mechanism with Soil Mapping Unit of Ministry of Agriculture, supported by the expert consultation workgroup. Whereas at sub national and local area levels, the unified peat mapping technology need to be operated by well trained personnel of regional office of planning and mapping entities of the Ministry of forestry in tandem with those of Soil Mapping Unit of The Ministry of Agriculture. Both levels have to be well equipped with adequate tools and equipment accordingly. In other words, trained personnel and adequate tools and equipments are the hearth and prerequisite for the operations of this technology.

To maintain the operation of this technology in an optimum performance, therefore, should cover maintaining and improving personnel's knowledge and technical expertise as well as maintaining and improving supporting unified peat mapping tools and equipment. Several possible maintenance and improvement efforts are:

- Establish a regular (e.g., once a year) meeting at national level as a forum of experts and technical personnel for communication and staying experience of implementing their works. This effort will broaden knowledge and improve technical expertise of the national, local area as well as wide area unified peat mapping personnel
- Maintain tools and equipment always in a ready to use condition to prevent them from fail to operate. Establish a unified peat mapping hierarchical network, i.e., national to local servicing network at local, sub national, as well as at national levels.

8 — Costs

The estimation of cost of this technology faces with selecting a wide variety of options of the combination of capital costs, operations and maintenance costs, administration costs, and other costs associated with developing an enabling environment.
The list of cost estimation of this technology (low, mid, and high estimates) are as follows

Table A-8 List of cost estimation of this technology

Item	Estimated Cost (USD)		
	Low	Medium	High
A. Capital costs (1 set of equipment and facilities for peat mapping) 1. Conventional peat survey and mapping equipment and facilities 2. Geodetic GPS, GPR and Multi Channel Resistivity (Geoscanner) 3. GIS, Remote Sensing, and cartographic equipment and facilities	540,000	600,000	660,000
B. Annual operations and maintenance cost 1. Peat survey operation cost and supplies 2. Geodetic GPS, GPR and Geoscanner operation and supplies 3. GIS, RS, and modelling operation and supplies	27,000	30,000	33,000
C. Annual administration costs 1. Conventional peat survey, data processing, and analysis 2. GPS, GPR, and Geoscanner Survey 3. GIS,RS, and Cartographic data processing and analysis	22,500	25,000	27,500
D. Annual costs for developing and enabling environment 1. National Workshops 2 times per year @15,000 2. National Seminar and Conference once per year@25,000		 30,000 25,000	

9 — References and Additional information

RePPProT. 1990. The Land Resources of Indonesia: A National Overview. Land Resources Department, Natural Resources Institute (NRI) of Overseas Development Administration, Foreign and Commonwealth Office, London, England and Direktorat Bina Program, Direktorat Jendral Penyiapan Pemukiman, Departemen Transmigrasi, Jakarta Indonesia

Kristijono, Agus. 2010. Mapping and Monitoring of Peat Ecosystem and Peatland: Available Knowledge and Technologies. Presentation Material, 3rd Technical Round Table on MRV Peatland Mapping: Uncertainties and Available Technologies. National Council of Climate Change (DNPI), Hotel Akmani Jakarta, Sept 20 2010

1. http://www.fao.org/docrep/007/y5490e/y5490e05.htm#TopOfPage
2. http://www.benmeadows.com/Eijkelkamp-Peat-Sampler_31220745/
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Annex 1.1.3. Peat water management technology

1 — Introduction

The ICCSR (Indonesia Climate Change Sectoral Roadmap) of forestry sector (BAPPENAS 2009), suggested the most feasible scenario to reach the target of reducing GHG emissions by 26% in the year of 2020 called SC3: increasing sink and creating conditions for preventing further deforestation. Most of the mitigation efforts in this scenario come from the improvement of management practices implemented on 244 newly developed FMU (forest management units) – KPH (Kesatuan Pemangkuan Hutan), in an area extent of 24 million hectares. This scenario has the lowest abatement cost per unit of emission reduction and to reduce annual GHG net emission of 800 abate to 496 MtCo2e within a time period of 2011 – 2020.

In addition, the ICCSR suggested policy oriented mitigation options for the improvement of peat management practices aimed at "low carbon" peatland management by enforcing existing legal requirement and establishing new standards of best practices. Two main mitigation options are suggested: zero burning and water management best practices to reduce annual emission of 470 MtCO2e, from 1700 MtCO2 e of BAU down to 1230 MtCO2e within a period of 2011 – 2020.

Considering the large size of spatial forest extent and the large number of KPH involved for implementing the mitigation scenario, scientifically credible data and information for carbon accounting of the results of implementing the above mentioned mitigation scenario must be available. This implies that a technological system – a proper combination of expertise (knowledge and skills), tools (equipments and models), and institutional framework (workgroup, task force, teamwork, etc.) – to facilitate integrated forest-peat measurement and monitoring of carbon stock on targeted forest and peatland areas of mitigation measures needs to be newly invented. Furthermore, its technical reliability and economic feasibility need to be demonstrated for the purpose of technology transfer and diffusion.

2 — Technology characteristics

By nature, peat ecosystem is typically characterized by landscape of peat swamp environment. Whenever this natural landscape is utilized into human-made landscapes such as agriculture land, plantation estate, or industrial forest, the most common way is by draining out the peat swamp water to get the largest possible dryer land surfaces. By doing so, the anaerobic environment condition of the peat swamp is converted into aerobic environment of newly built peatland surfaces suitable for cultivation.

Peatland Water Management technology is characterized by integrated knowledge and water management infrastructures in forms of irrigation channel networks, regulated drainage channel networks, and or vegetation barriers aimed to reduce emission from cultivated and planted peatlands. Figure A-2 shows blocking drainage channel technologies of HTI in Riau and agriculture land in Central Kalimantan.

Figure A-2 Water management technology: comb structures applied to HTI drainage channel at Kampar Peninsula, Riau (left) and Tabat (right) applied to agriculture land rehabilitation in central Kalimantan (Hooijer at al, 2007)

Knowledge of proper spatial configuration of water management structures over a peat domes area is suggested by Ritzema (2007) as depicted in Figure A-2.

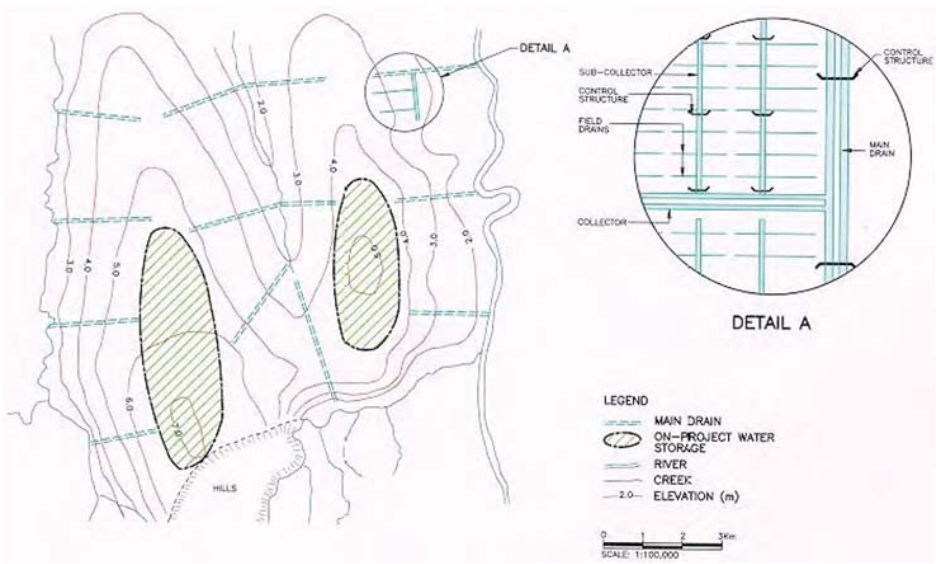

Figure A-3 Spatial configuration of water management structures over a peat domes area

Knowledge of vegetation barriers for protecting hydrological function of peat-domes was only recently recognized by Gunawan et al (2007). The initial purpose of the green belts was to protect the Acacia plantation blocks from wind disturbance, but they also affect hydrological and ecological functions. Such green belts were recognized to maintain water table of no more than 50 cm from the forest surface.

Knowledge on such longitudinal vegetation barriers were also recognized by Hooijer et al (2007). They recognized that most effective buffer would be vegetation belts of non-drained area. Where drained areas are allocated as buffer zones, these should be intensively managed to keep water levels as high as possible given the production requirements; alternative water-tolerant crops should be considered.

3 — Country-Specific Applicability

Most of peat swamps in Indonesia have been drained and converted into agricultural lands, plantation estates, and production forest. The most common impact of draining peat swamps for such newly developed landscapes is the significant increase of CO2 emission because of peat decomposition and subsidence. In addition, over-drained peatlands also promote the occurrence of peat fire during dry season and thus increasing CO2 emission.

Water management strategies by the use of regulated dams and or stripped vegetation buffer applied to timber and estate crops plantations as well as agriculture lands are proven effective to reduced carbon emissions from drained peatlands. Pilot projects of such water management strategies carried out on timber and estate crops plantations areas of Kampar peninsula's peat domes (Fig 23 left) and on ex mega rice project of Central Kalimantan (Figure A-2 right) have demonstrated the effectiveness of elevating water tables as much as possible, which is achieved by controlling surface water (in drains and channels).

Based on tentative findings in ongoing peatland water management pilot projects, which are funded by APRIL (Asia Pacific Resources International Holdings, Ltd), Hooijer et al (2007) suggested implementing water management improvements at a large scale as soon as possible. The longer it takes to start this, the further peatlands will degrade and the higher the cost of stopping or reversing this process. Ongoing pilot projects provide knowledge on water management measures and strategies suitable for different land use targets, which can be applied to other areas in the future. DNPI (2010) estimated that Restoration of the hydrological functions of the peat by blocking drainage channels facilitates abatement of more than 100 MtCO2e by 2030. Annual emission of 1700 MtCO2e will be reduced to 1230 MtCO2e by implementing “low carbon” peatland management (zero burning policy and water management best practice).

4 — Status of Technology in Country

Peatland water management technology is still in the stage of R&D to demonstrate and test its benefits for reducing carbon emission of peatlands because of peat decomposition, peat subsidence, and peat fires. The locations of pilot projects of water management demonstration and test pilot project are Kampar Peninsula (KP) in Riau and the Ex Mega Rice Project (EMRP) area in Kalimantan consist predominantly of peatland, covering many hundreds of thousands of hectares.

The projects in which water management methods and strategies are being tested are (Hooijer et al, 2007):

- The Kampar Science Based Management Support Project, which promotes water management improvements in and around APRIL's pulp wood plantations on the Kampar Peninsula peatlands in Riau (Sumatra), with the aim of optimizing peatland forest and carbon conservation;
- Central Kalimantan Peatlands Project (CKPP), which pilots rehabilitation methods including dams in part of the Ex Mega Rice Project peatlands in Central Kalimantan.
- RESTORPEAT project, also active in the Ex Mega Rice Project in Central Kalimantan, is testing different approaches to channel blocking and retarding water runoff linked to vegetation rehabilitation.

CIMTROP (Center for International Cooperation in Sustainable Management of Tropical Peatland) of the University of Palangkaraya also carried out blocking canal experiments by constructed 8 tabats (blocking dams) along the Kalampangan and Taruna canals in Block C of the former Mega Rice Project (Sulimin et al, 2007). The dams were constructed in July and August 2005 and, resulting elevated water tables in proximity of 400 m on each side of the channel. The maximum water table increase after dam construction in October 2005 by 151 cm compared with that of prior August 2005.

A major policy which facilitates the implementation of technology for water management of peatland was initiated in the form of Presidential Instruction No. 2 2007. The instruction which is directed specifically to peat water management was directed to Ministers of Forestry, Public Works, and Environmental Affair. These ministers were instructed to block the cutting peat dome canal.

The president instruction No2 2007 has limited geographical area of implementation. It is enough to support national target of annual emission CO2 emission abatement from implementing "low carbon" peatland management facilitated by new approach to peatland water management. Up scaling of water management methods to national geographical area urge more than 'business as usual' measures. Current ongoing knowledge and techniques of water management acquired from the aforementioned pilot project and experiments have to be improved and utilized. International supports would also need to be justified especially for the benefit of reducing global CO2 missions. This implies that TTD of water management technology will facilitate the abatement potential turn into reality. The prerequisite for TTD should be conducted, aiming to formulate key prototypes of water management technology trough the following measures:

- Compile all of technology components resulted from previous and current R&D on water management, including expertise, tools and equipments, and key players.
- Formulate "ready to test" prototypes of water management technology to facilitate three mitigation options: conservation, rehabilitation, and rehabilitation of peatlands.

Once such prototypes have been formulized, the second chain of "innovation system" for TTD will be ready to start. Again, by the use of the same approach employed by dissemination of technology A1 and A2, the following innovation process should be conducted by employing "interactive learning" of key players of technology diffusion for demonstrating reliability, practicality and financial feasibility of the newly invented prototypes of water management technology:

- Use of all available knowhow and expertise of the first chain of innovation
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for the operation of water management prototypes applied for peatland conservation, rehabilitation, and or restoration
- Define the most effective coordination mechanism among the key players of water management (i.e., BPPT, Min of Forestry, Min of Environment, Min of Agriculture, Min of Public Works, Universities, plantation industries, and smallholder agriculture).

5 — Barriers

Barriers of Technology Transfer and Diffusion (TTD) for this technology is illustrated as a problem tree presented in Figure 2-5 of this report. It is important to note that the problem tree was defined by selecting a starter problem: Lack reference project of viable, credible and reliable peatland water management reference project. This starter problem roots from a total number of four barriers within the root zone and further propagates to four 'canopy' barriers through two stem barriers weak collaborative learning and insufficient knowledge of and or access to proven peat water management technology.

Within the context of innovation system TTD process, root barriers correlate with maturing R&D chain and those of canopy barriers correlate with technology diffusion chain. In other words, the maturing R&D process deals with barriers to provide a reference project of viable, credible and reliable peatland water management project, whereas the chain of technology diffusion deals with barriers of adopting this technology in facilitating mitigation measures to establish a n effective peatland water management for "low Carbon" peatland management. To assess possible solutions for overcoming barriers, a hierarchical logical framework analysis was applied to objective trees, followed by a rapid benefit cost/consequence analysis, with special consideration of critical and difficult nature of "take off" – the initial phases when the reliability, practicality and financial feasibility of the technology is demonstrated. Furthermore, the results of such assessment were used to recommend the following overcoming barrier solutions:

Table A-9 Recommend overcoming barrier solutions

Recommended Solutions	
Maturing R&D Phase	**Technology Diffusion Phase**
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented peatland water management technology. **Mode of Action:** International Capacity Building for a national expert consultation workgroup through the development of an operational, reliable, credible, and feasible prototype of peatland water management carried out on national demonstrator R&D field stations.	**Policy Action:** Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of peatland water management technology. **Mode of Action:** On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain period of trial and adjustment in their areas. The program is designed and implement by national expert consultation workgroup

6 — Benefits

The ultimate benefit GHG mitigation measures are

- annual GHG net emission of will be 800 reduced to 496 MtCO2e by implementing KPH-HTI mitigation scenario within a time period of 2011 – 2020
- annual emission of 1700 MtCO2e will be reduced to 1230 MtCO2e by implementing "low carbon" peatland management (zero burning policy and water management best practice).

From the perspective of CO2 emission, the use of proper water management on such newly built landscapes is critical. Lack of proper water management would lead to over-drained condition of peatland, promoting rapid decomposition and peat fires. Peat decomposition and peat fire contribute annual emission of 300 MtCO2e and 472 MtCO2e in 2005 respectively. Under BAU conditions, they will increase up to 370 MtCO2e and 532 MtCO2e in 2020. Direct benefit of constructing regulated dams for water management strategies in timber and estate crops plantations located on peatlands will significantly reduce emissions. DNPI (2010) estimated technical abatement of more than 100 MtCO2e per year in 2030 from restoration of the hydrological functions of the peat by means of blocking drainage channels.

A qualitative assessment of specific benefits of TTD of peat water management technology by this report suggested the followings:

Table A-10 Goal: to achieve zero risk of peatland degradation, peatland fire, and peat forest fire

Goal: To Achieve Zero Risk of Peatland Degradation, peatland fire, and Peat Forest Fire							
Maturing R&D				Technology Diffusion			
Objective Establishment of reference project of viable, credible, and reliable peatland water management				Objective Provide effective water management for "Low Carbon" peat management on HTI, plantation estate, and irrigated farmland			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of peatland water management task Force	M	L	H	M5. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	M	L	H
M2. Establishment of expert workgroup for peatland water management	H	L	M	M6. Carry out on-site job training for development and implementation of peatland water management practices	H	H	H
M3. Establish international capacity building for peatland water management prototype development	H	H	H	M7. Develop and implement organization mechanism to establish peatland water management	L	M	M
M4. Provide adequate R&D field stations and facilities for peatland water management prototyping (hardware and software)	H	M	H				
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							

7 — Operations

Technology for water management strategy is the essential part of 'low carbon' peatland management. Two types of operations are recognized for the implementation of this technology.

Firstly, the regulated blocking canal structures applied to HTIs, HPHs, and plantation estates is a capital good technology type of operation and secondly, blocking canal structures applied to forest conservation areas and agriculture lands is a public good technology type of operation. The first type is operated by HTIs, HPHs, and plantation estates as a part of timber production or plant commodity production processes. Suggested operation and maintenance works are as follows (Hooijer et al, 2007):

- Oil palm plantations require frequent access over water, for maintenance and harvesting. This is done with relatively small boats, so weir/sluice structures can be small in size. Frequent access means that regular maintenance and operational water level control are possible, so constructions can be quite light.
- In pulp wood plantations, the canal system is partly dictated by transport, not only water management requirements. Canals must be about 8 to 10 metres wide to allow log transport with barges every crop rotation, approximately every 5 years. Dams must be removed to allow barges to pass. Such temporary dams are easily constructed from peat; in these plantations, excavators are available to construct and remove dams. As peat dams erode quickly if water flows over them, bypass channels and spillways need to be constructed that allow water level control. As water level control is very difficult in channels across contour lines (i.e. following the peat gradient), it is best to only have transport in canals along contour lines, and to use roads for further transport down the slope

The second type is operated by regional office of Ministry of Public Works and Ministry of Forestry. Suggested operation and maintenance are as follows (Hooijer et al, 2007):

Operational water level control with adjustable crests is neither required nor feasible: the aim is to keep water levels as high as possible at all times. In addition, boat access is usually not a priority; in fact an aim of structures should be to reduce accessibility. Consequently, permanent dams without bypass channels and requiring little maintenance are to be preferred; if possible, these should be backfilled with any remaining material that was excavated in the first place.
Further research and scientific assessment to improve current available knowledge on peatland water management strategy related to carbon emissions of peatlands need to be carried out continuously. National expert consultation workgroup need to do on site assessment of the results of ongoing peatland water management measures and best practices. In addition, various types of meetings in the forms of Focused group discussion, workshop, seminar, conference and the like at both regional and national levels of experts and practitioners for communicating and staying their ideas and experiences need to be established regularly.

8 — Costs

In a typical drained peatland area with an average surface gradient of 0.1m/km and a channel spacing of 1km, creating water level steps of 0.2m means that roughly 1 structure is required for every 200 hectares. Each structure costs hundreds to thousands of dollars, depending on type, location and implementing organization (Hooijer et al, 2007). Assuming that each plantation area or peatlands rehabilitation area having 10,000 hectares, a total number of 50 water management structures are required for each of them. With additional assumption, hundred dollars equal to USD 500 and thousands dollars equal USD 5,000 the construction of water management structures will need capital cost of USD 25,000 to 250,000. This implies that estimation of other costs (operation and maintenance, administration cost, and enabling environmental cost) of TTD process for this technology will be figuring a wide range of costs. Such an estimation costs, presented in low, medium, high estimate are as follows:

Table A-11 Estimation of other costs peat water management technology

Item	Estimated Cost (USD)		
	Low	Medium	High
A. Capital costs one unit of management area of 100,000 ha 6. Construction of 50 water management structures 7. Installation of automatic water level recorder	125,000	250,000	350,000
B. Annual operations and maintenance for each management unit 5. Operation cost 6. Maintenance of water management structure	15,000	75,000	125,000
C. Annual administration costs 5. field assessment by expert consultation workgroup	22,500	25,000	27,500
D. Annual costs for developing and enabling environment 3. National Workshops 2 times per year @15,000 4. National Seminar and Conference once per year@25,000		30,000 25,000	

9 — References and Additional Information

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Annex 1.2. Technology factsheets energy sector

Annex 1.2.1. Solar PV

Solar photovoltaic, or simply photovoltaic (SPV or PV), refers to the technology of using solar cells to convert solar radiation directly into electricity. A solar cell works based on the photovoltaic effect. R&D and practical experience with photovoltaic have led to the development of three generations of solar cells: Crystalline silicon based solar cells, thin film solar cells and third generation PV. Solar PV is very likely to play a significant role in climate change mitigation in the future. However, today, in spite of significance decreases in the cost for solar PV systems, the majority of PV deployment is still driven by substantial subsidy schemes.

As a tropical country, Indonesian potential of solar energy is large enough. Based on the solar radiation data collected from 18 locations in Indonesia, the solar radiation in Indonesia can be classified respectively as follows: for the Western Region of Indonesia (KBI) the solar radiation is about 4.5 kWh/m2/day with monthly variation of about 10% and in Eastern Region of Indonesia (KTI) is about 5.1 kWh/m2/day with a monthly variation of about 9%. Thus, the average wind potential in Indonesia is about 4.8 kWh/m2/day with a monthly variation of about 9%.

Annex 1.2.1.1. Introduction

The photovoltaic effect

The photovoltaic effect can be briefly summarised as sunlight striking a semiconductor and causing electrons to be excited due to energy in the sunlight (photons). The excited electrons become free of their atomic structure and, in moving away, they leave behind 'holes' of relative positive charge that can also migrate throughout the material. By placing two different semiconductors together in thin layers (or wafers) the free electrons and 'holes' can be separated at their interface/junction, creating a difference in charge, or voltage, across two materials. Sometimes, the term "p-n junction" is used which refers to the two different types of semiconductor used. A single such arrangement, or cell, creates only a modest voltage and current, but when arranged into larger arrays the cells can produce useful amounts of electricity which is known as solar PV electricity.

On the basis of their manufacturing process, solar cells consist basically of three main components - the semiconductor, which absorbs light and converts it into electron-hole pairs, the semiconductor junction, which separates the electrons and holes, and the electrical contacts on the front and back of the cell that allow the current to flow to the external circuit. R&D and practical experience with photovoltaic have led to the development of three generations of solar cells.

Crystalline silicon based solar cells

The first generation is represented by crystalline silicon based solar cells, which may be monocrystalline or multicrystalline depending on the manufacturing technique. It is the most mature technology and represents a market share of 80 to 90 percent (IEA, 2009; IPCC, 2010). Maximum recorded efficiencies (the percentage of the incoming energy that is converted to electricity) of roughly 20 and 25 percent have been achieved for multicrystalline and monocrystalline cells respectively, representing an approximate doubling of efficiency since 1990 (IPCC, 2010). These improvements in efficiency have been mirrored by improvements in manufacturing techniques including thinner cells (lower material costs), larger wafers, increased automation and other factors that likewise contribute to the significant cost reductions seen in the past decades (these are discussed further in the finance section below).

Thin film solar cells

Second generation technologies, so called thin film solar cells are based on alternative materials such as cadmium telluride (CdTe), copper indium gallium diselenide (CIGS), amorphous silicon and micromorphous silicon set as thin films. The layer that absorbs the sunlight is only a few micrometers thick and can be deposited onto relatively large smooth surfaces such as glass, metal or plastic. This PV type has the advantage of lower labor and energy intensity compared to crystalline silicon PV but a reduced efficiency in terms of electricity generation (10 to 16% depending on the film type, IPCC, 2010). The majority of the remaining share of the PV market is taken by thin film technologies. Selection of type of solar cells that will be developed in Indonesia has not been decided because the study is still ongoing and results will be known by the end of 2011. However, the trend of industrial development of crystalline silicon solar cell is due to raw material for making solar cell is very abundant.

Third generation PV

Third generation technologies were originally developed for use in space and have multiple junctions typically using more exotic semiconductors such as gallium and indium compounds. These types of cells have already crossed the maximum theoretical efficiency of single junction solar cells, and many laboratories have reported lab scale solar cells reaching efficiencies in the excess of 40%. Third generation cells are typically considered in combination with solar concentrator systems as described below and are currently being commercialised in this context. The use of concentrators allows much smaller cells to be used, which in turn reduces the cost associated with these more exotic materials.

Concentrated solar PV

Solar cells have been found to operate more efficiently under concentrated light, which has led to the development of a range of approaches using mirrors or lenses to focus light on a specific point of the PV cell, called concentrator systems. Specially designed cells use heat sinks, or active cooling, to dissipate the large amount of heat that is generated. This type of concentrating configuration requires a sun tracking system using either single axis or double axis tracking to make sure that the mirrors/lenses are always pointing at the correct orientation. Until recently, the use of concentrated solar PV does not exist in Indonesia.

Off-grid and grid connected PV

There is an obvious yet important qualification to the discussion above on efficiency, which is that solar panels are limited to only produce electricity in periods of sunlight, either direct light or diffuse sunlight on overcast days. During the night, they will not produce power. This means that solar cells, if used for remote/off-grid generation purposes, need to be implemented in conjunction with some kind of storage system such as a battery or as a hybrid system with some other type of generator. Where solar cells are grid connected this is less of a problem. They can be used during the day to reduce the local demand from the grid (or even to export back to the grid) and then at night, or during periods of low incident light, the grid can supply the necessary power. The former kind of application, as a remote or off-grid generator, is most commonly observed in developing countries and isolated areas, while grid-connected solar PV is more common in industrialised countries, which have a wider reaching grid.

Grid connected solar PV also can have differences in the approach used depending on the way in which customers purchase the electricity. If the solar array is distributed, for example over a larger number of residential houses, then the single installations are operated by the consumer directly. The advantage of this to the consumer is that the cost of electricity, that the consumer must compete with, is the distributed cost, i.e. the cost to purchase power at the location of demand which is normally significantly higher than the actual levelised production cost of electricity (that doesn't account for transmission/distribution charges/losses and profit margins along the value chain). Solar installations can also be large and centralised but this demands that the power is sold into the common grid at market prices and must compete directly with other technologies (bearing in mind any subsidies that might be applicable for solar generation).

Utilization of off-grid PV in Indonesia has been going in recent years combined (hybrid) with diesel, for example PLTHybrid Nurambela 6 units of 100 kw (25 kva, 8 kWp PV) in Southeast Sulawesi, 5 units in the province of South Sulawesi, 25 kVA 8 kWp PV in Gorontalo province, and the baron 24 kwpPV 35 kw wind and 25 kVA diesel NTB. Development of off-grid PV in Indonesia have the potential is quite promising, especially on remote islands in eastern Indonesia region. Today, PT PLN (Persero) has a program in 1000 the island, which is developing the use of off-grid PV on a desert island, and for the year 2011 has been budgeted for 100 electrify the remote island. This program can be a hybrid with a diesel and off-grid PV.

Solar Home System (SHS)

"A SHS typically includes a photovoltaic (PV) module, a battery, a charge controller, wiring, fluorescent DC (direct current) lights, and outlets for other DC appliances. A standard small SHS can operate several lights, a black-and-white television, a radio or cassette player, and a small fan. A SHS can eliminate or reduce the need for candles, kerosene, liquid propane gas, and/or battery charging, and provide increased convenience and safety, improved indoor air quality, and a higher quality of light than kerosene lamps for reading. The size of the system (typically 10 to 100Wp) determines the number of 'light-hours' or 'TV-hours' available. In general, the utilization of solar PV in Indonesia in the form of SHS and is largely a grant from the government. The total installed capacity of SHS in Indonesia until the year 2009 reached 12.1 MWp.

Annex 1.2.1.2. Feasibility of technology and operational necessities

Resource and Location

As presented in Figure Annex 1, locations closer to the tropics tend to have higher solar irradiation and hence a higher potential for solar PV electricity generation. There is a marked difference in resource levels geographically with northern Africa, for example, being exposed to more than twice the level of solar energy as northern Europe; implying that for the same size panel the electrical output could be doubled in the former location. Having said that, Germany has the largest installed capacity in the world due to domestic incentives there, illustrating that other factors related to cost greatly influence the current global distribution of solar PV installations. This is discussed further in the sections below on policy, markets and costs.

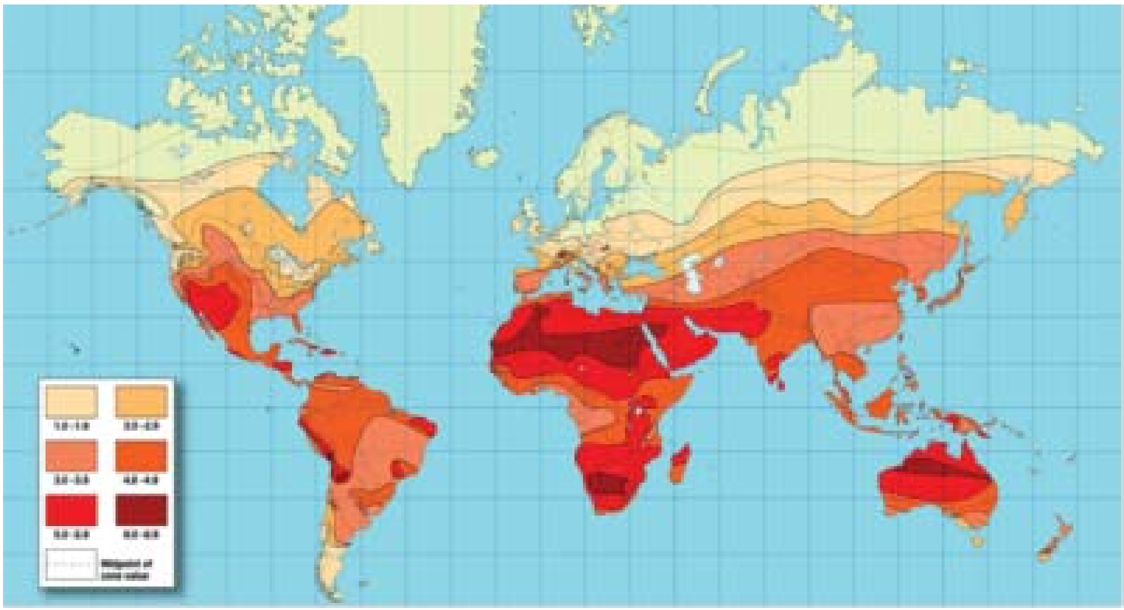

Figure A-4 Worldwide average solar irradiation (kWh/m2 per day)

Typically satellite data is used to determine the average yearly radiation level at a site for a number of reasons i) local ground based measurements are expensive and equipment must be cleaned to prevent soiling ii) satellites can provide up to 20 years of data for an average which is important given the large annual variation in solar irradiation levels iii) the accuracy of satellite data is found to be good in correlation with ground based measurements (Pitz-Paal et al., 2007).

Based on these estimates of resource and the associated time-series/seasonal-variation it is possible to estimate the power that would be generated throughout a typical year. This allows the economics of a project to be determined and allows other aspects of the system (for example battery size if it is an off-grid application) to be calculated.

Technical Requirements

The technical requirements for the installation of solar PV vary greatly depending on the size of the system and kind of technology used. Small off-grid systems in remote/rural areas using first generation technology, such as solar home systems (see Box 1), can be bought in what is effectively a 'kit' form and installed with relatively little local expertise. Maintenance is minimal and mainly requires the cleaning of the solar panel to ensure efficiencies are maintained. Alternately, the installation of grid scale concentrating solar power with third generation technology is a highly specialised field, requiring detailed calculations for the plant layout, expected yield and economics of the project. The equipment, with the required tracking mechanisms, requires maintenance and upkeep, and the power output must be forecast for export.

Legal/Regulatory

The legal and regulatory requirements for solar PV are relatively few compared to some other renewable technologies. They have a low local environmental impact and are not very visible (for small applications they are often mounted on the roofs of buildings) typically making public/permitting acceptance high. Grid connected systems require an appropriate licence or permit to export to the grid along with the necessary metering equipment, connected by a professional, to ensure that the level of export to the grid is measured for any subsequent compensation. Larger installations obviously require the appropriate planning permissions that would accompany any moderate to large infrastructure project.

Currently, the main policy instruments that have an impact on solar PV are incentives that subsidise its use and offset its currently uncompetitive cost; a handful of countries with strongly supportive policies account for 80% of global installed PV capacity (IEA, 2010). For the condition of Indonesia, incentive to the use of PV have not been there and selling price of PV grid-connected with a maximum of 1.506 USD / kWh. The selling price for PV off-grid in accordance with economic price (about 40 cents USD / kWh).

Annex 1.2.1.3. Status of the technology and its future market potential

While crystalline silicon based and thin film solar systems are in the early phases of rapid market deployment, third generation and concentrated solar PV are in the R&D and demonstration phase.

In the last two decades the global solar PV market has experienced rapid expansion, with an average annual growth rate of 40% (IEA, 2010) and 60% between 2004 and 2009 (REN21, 2010). A record 7GW of new grid-connected capacity was added in 2009, bringing total grid-connected capacity to 21GW with off-grid PV accounting for an additional 3 to 4 GW (Figure Annex 2). It can be observed that the majority of installations are in countries that have only moderate solar resource levels however their strong policy regimes and support mechanisms have allowed their domestic markets to flourish.

The largest solar PV producers, those that had an output of more than 500MW in 2009, were First Solar (USA), Q-cells (Germany), Sharp (Japan), JA Solar Holdings, Suntech and Yingli (all China). However, the market is relatively diversified with significant number of global manufacturers vying for market share and the top ten manufacturers occupying only 45 percent of production of solar cells (Hirshman, 2010).

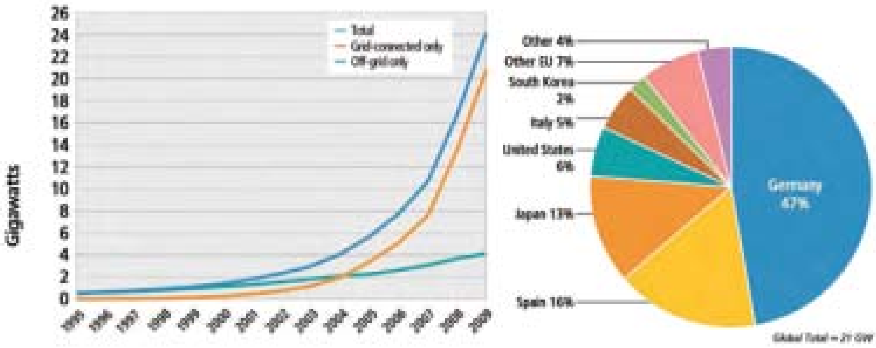

Figure A-5 Solar PV: Existing world capacity 1995 to 2009 (left) and top six countries by cumulative capacity 2009 (right) (REN21, 2010)

The IEA (2010) forecasts an average annual market growth rate of 17% in the next decade, leading to a global cumulative installed PV power capacity of 200 GW by 2020 and 3000GW by 2040 (with repowering of older systems). This would represent roughly 11 percent of global energy demand should this scenario play out. In terms of technology, the market share of thin films is expected to grow to 35% by 2013, due to constraints in the availability of high-grade silicon.

Photovoltaic Development Goals in Indonesia are:

- The more the role of photovoltaic solar energy utilization in providing energy in rural areas, so that in 2020 their installed capacity to 25 MW.
- The more the role of solar energy utilization in urban areas.
- The lowest price of solar photovoltaic energy, in order to reach the commercial stage.
- Implementation SESF production equipment and support equipment in the country that have a high quality and highly competitive.

Photovoltaic solar energy development strategies in Indonesia are:

- Encourage the use of PV in an integrated manner, i.e. for the purposes of illumination (consumptive) and SESF productive. Develop activities through two patterns, namely patterns of spread and centralized adapted to field conditions. The pattern of spread is applied when the location of houses spread a considerable distance, while the pattern is applied when the centralized location of houses centered.
- Develop the use of PV in rural and urban areas.
- Encourage the commercialization of PV by maximizing private sector involvement.
- Develop the domestic PV industry is export oriented.
- Encourage the creation of systems and efficient funding pattern involving the banking sector.

Photovoltaic Development Program in Indonesia are:

- Develop PV for rural electrification programs, particularly to meet the electricity needs in areas far from the reach of electricity.
- Increase the use of hybrid technology, particularly to meet the shortage of electricity supply from isolated diesel.
- Replace all or most of the electricity supply for customers Social Small and Small Households with SESF PLN.

The proposed patterns are:

- Fulfilling all electrical needs for customers S1 with 220 VA power limit;
- Meet all requirements for customers S2 with 450 VA power limit;
- Meet 50% of electricity needs to subscribers S2 with 900 VA power limit;
- Meeting the 50% requirement for R1 customers with 450 VA power limit.
- Encourage the use of PV in buildings, especially the Government House.
- Assess possibility of establishing a solar module factory to meet domestic and export possibilities.
- Encourage private sector participation in the utilization of photovoltaic solar energy.
- Carrying out cooperation with foreign countries to the construction of large-scale PV.

Annex 1.2.1.4. Contribution of the technology to protection of the environment

Solar PV systems, once manufactured, are closed systems; during operation and electricity production they require no inputs such as fuels, nor generate any outputs such as solids, liquids, or gases (apart from electricity). They are silent and vibration free and can broadly be considered, particularly when installed on brown field sites, as environmentally benign during operation. The main environmental impacts of solar cells are related to their production and decommissioning. In regards to pollutants released during manufacturing, IPCC (2010) summarises literature that indicates that solar PV has a very low lifecycle cost of pollution per kilowatt-hour (compared to other technologies). Furthermore, they predict that upwards of 80% of the bulk material in solar panels will be recyclable; recycling of solar panels is already economically viable. However, certain steps in the production chain of solar PV systems involve the use of toxic materials, e.g. the production of poly-silicon, and therefore require diligence in following environmental and safety guidelines. Careful decommissioning and recycling of PV system is especially important for cadmium telluride based thin-film solar cells as non-encapsulated Cadmium telluride is toxic if ingested or if its dust is inhaled, or in general the material is handled improperly. In terms of land use, the area required by PV is less than that of traditional fossil fuel cycles and does not involve any disturbance of the ground, fuel transport, or water contamination (IPCC, 2010).

Annex 1.2.1.5. Climate

Solar PV is very likely to play a significant role in climate change mitigation in the future. As described above solar PV is a rapidly growing market and forecasted by the IEA (2010) it will contribute more than 10 percent of global electricity supply by 2050. It has energy payback periods ranging from 2 to 5 years for good to moderate locations and life cycle of GHG emissions vary from 30 to 70 gCO2e/kWh (IPCC, 2010), depending on panel type, solar resource, manufacturing method and installation size. Comparing to emission factors for coal fired plants of more than 900 gCO2e/kWh and for gas fired power stations of more than 400 gCO2e/kWh (Sovacool, 2008) showing the large potential for solar PV to contribute to reductions in carbon emissions from the electricity sector.

Annex 1.2.1.6.Financial requirements and costs

There has been a large decrease in the cost of solar PV systems in recent decades. The average global PV module price dropped from about 22 USD/W in 1980 to less than 4 USD/W in 2009, while for the price of larger grid connected applications has dropped to roughly 2 USD/W in 2009 (IPCC, 2010). A review of the available literature on historical solar PV learning rates (the percentage reduction in price for every doubling of installed capacity) shows a range of estimates from 11 to 26 percent (IPCC, 2010).

Using a slightly different approach (based on a study of solar PV module and consumer electricity prices, i.e. a grid-parity study) Breyer et al. (2009) estimated that the "cost of PV electricity generation in regions of high solar irradiance will decrease from 17 to 7 €ct/kWh in the EU and from 20 to 8 $ct/kWh in the US in the years 2012 to 2020, respectively".

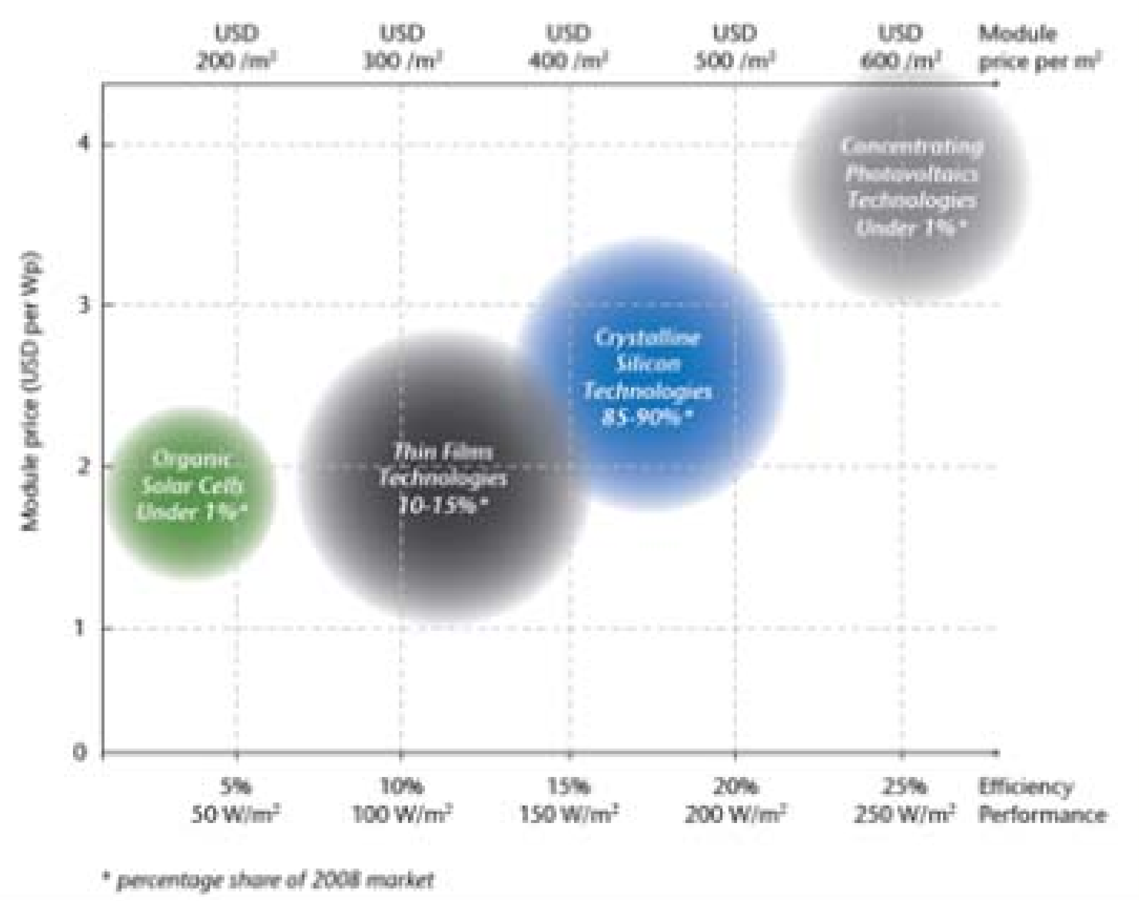

Figure A-6 Current performance and price of different PV module technologies in 2008 (source: IEA, 2010)

It is important to note that these prices only apply to those wishing to install large, utility scale, solar parks in industrialised countries. The costs of Solar Home Systems in developing countries have been shown to be orders of magnitude higher per kilowatt-hour. Wamukonya (2007) presents costs of SHS systems ranging from 1.51 to 1.75 US$/kWh in African countries using favourable discount rates and PV lifetimes. She concludes that on a simple cost basis petrol/diesel generators may be preferable which suggests that a thorough study of the economics of any planned solar PV deployment is advisable before proceeding.

Annex 1.2.2. Regenerative burner combustion system (RBCS)

Annex 1.2.2.1. Introduction

The high-performance industrial furnace contract for one of the steel industry in Indonesia, awarded to and executed by PMD as a New Energy & Industrial Technology Development Organization (NEDO) model project for increasing the efficient use of energy, was constructed on schedule, commissioned and, after a demonstration operation, inaugurated on May 29, 2006. This Japanese-Indonesian joint project was the first model project of its kind in Indonesia. The furnace equipment installed by this project efficiently recovers sensible heat of the combustion exhaust gas of the steel-slab reheating furnace, for preheating combustion air. When introduced, this equipment makes it possible to cut natural-gas consumption by about 4.44 million Nm3 a year (about 4,940 tons in crude-oil equivalent), a major contribution to the effective use of energy. At the same time, this equipment also permits a reduction in green house gas. Specifically, it can reduce carbon-dioxide emissions by about 15,000 tons a year, helping to prevent global warming. The spread of the energy-saving technology adopted for this model project will certainly contribute not only to energy savings, conservation of resources and environmental

Annex 1.2.2.2. Feasibility of technology and operational necessities

Regenerative burner is a high efficient heat recovery system by recovering waste heat of the furnace exhaust gas to heat-up combustion air at the furnace site by installing heat recovery regenerator. The key technology of RBCS is to set a pair of burner with regenerator at each burner. During combustion, one side of burner combusts fuel where another side of burner accumulates heat of exhaust gas into heat recovering regenerator.

Then combusting burner and its switch accumulated heat from exhaust gas to combust fuel at high temperature combustion air which takes heat out of heat recovering regenerator. The other side of burner accumulates heat of exhaust gas into another heat recovering regenerator, securing stable combustion and high-efficient combustion as well as low NOx.

Annex 1.2.2.3. Benefits of the RBCS

- Energy: approximately 20 to 50% of energy reduction is possible. The reduction range differ according to the types and condition of fuel
- Environment: maximum of 50% of NOx reduction is possible with high temperature combustion. The reduction range differ according to the types of furnace and condition of fuel
- Improve the quality of steel
- Increase the production of steel
- Reduce maintenance costs
- Reduce the production of crack

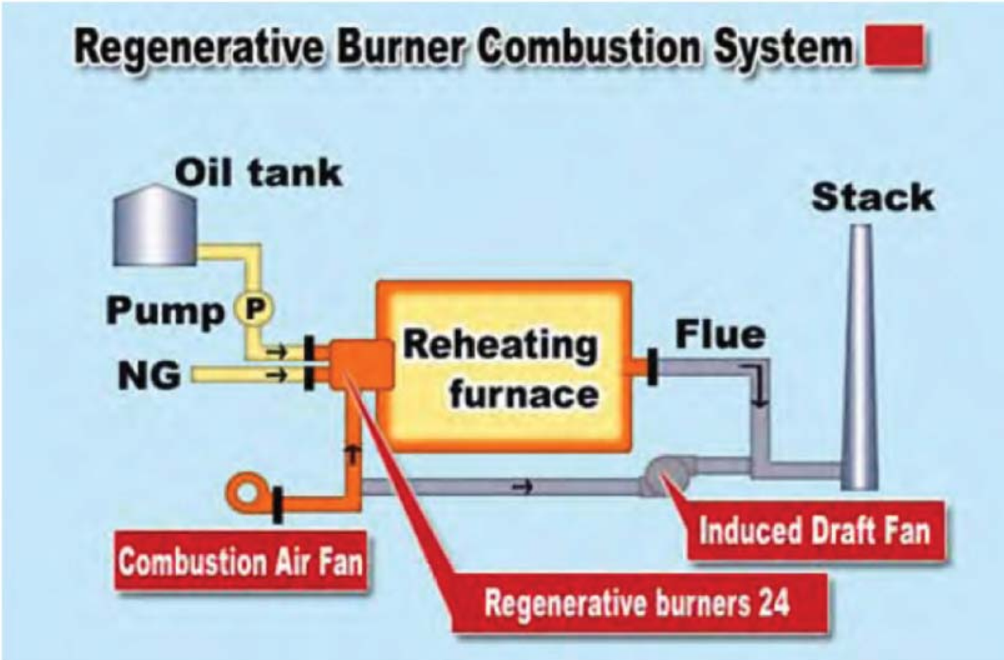

Figure A-7 Regenerative burner combustion system (Nippon Steel, 2006)

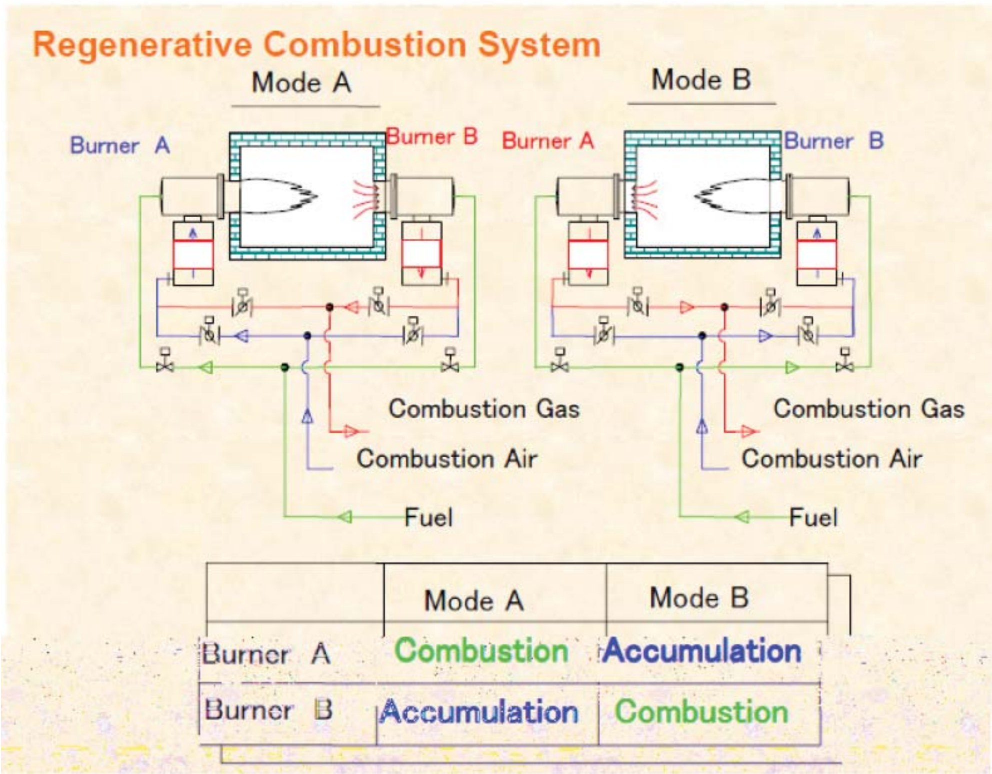

Figure A-8 Regenerative combustion system (Niga T, 2005)

Technical Requirements

The technical requirements for the installation of RBCS technology vary greatly depending on the size of the system and kind of technology used. Installation of this technology requires specialized technicians and operation of RBCs arranged computerize technology in the computer room, so it requires training and mentoring over a certain period before the local operators to operate their own equipment in the control room.

Legal/Regulatory

Utilization of RBCs in the related industries is not a constraint because the Indonesian government is trying to conserve energy in various sectors. Even for consumers who consume energy sector over the 6000 TOE per year shall be subject to energy conservation and disincentives if it does not do it. However, the rules about disincentives have not been established. However, installation of RBCs in the related industries has to have knowledge and permission of the authorized institution as mentioned by applicable regulations in Indonesia.

Annex 1.2.2.4. Status of the technology and its future market potential

RBCs technology developed since the early 1990s in several countries, including in Japan. Today, more than 540 furnaces have used RBCs in Japan and first commercial facility constructed in 1996. The technology is already mature and has been used in several countries.

The need for RBCs technology is expected to continue to increase along with increased world steel demand in 2005 reached about 1200 million tonnes (T. Ono, 2007). The case also for Indonesia, as a developing country, steel demand will continue to increase. In 2010, of 11 million tons of steel consumption, around 8 million tonnes are national product. National steel industrial products will increase as the development of new steel industry in Kalimantan is carried out. This technology is only used in the steel industry, also can be utilized in industries that require a furnace in the production process, such as ceramics industry, automobile, non-ferrous metals, and other sectors.

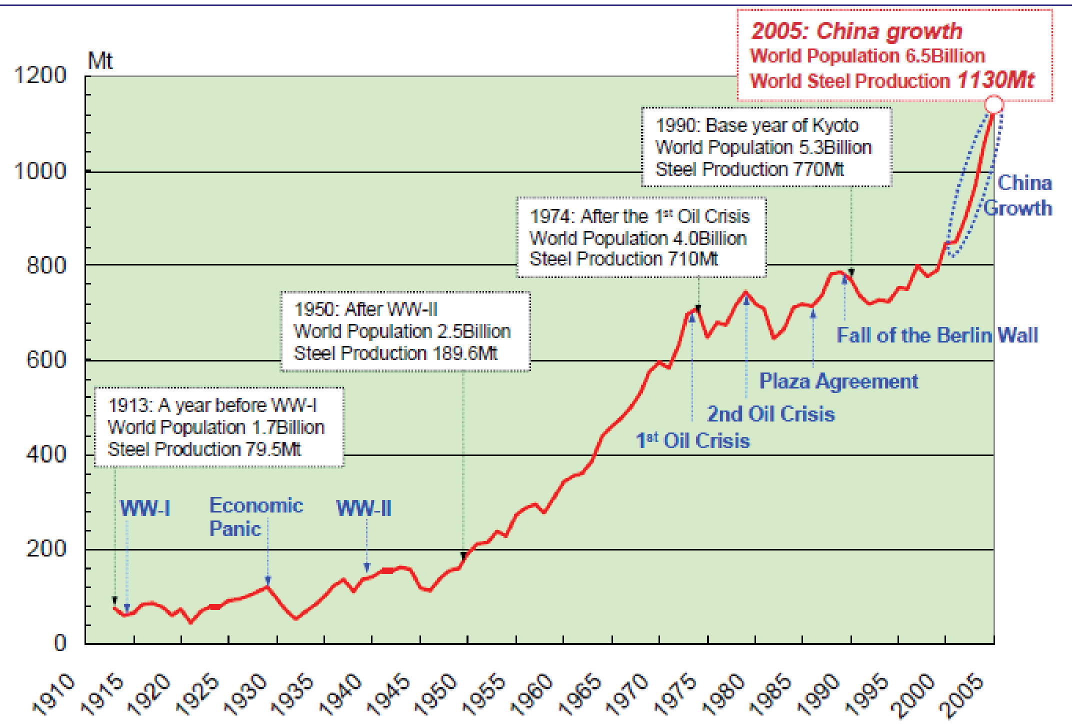

Figure A-9 Trend of world steel production (Nippon Steel Engineering, 2006)

Annex 1.2.2.5. Contribution of the technology to protection of the environment

The eco-friendly regenerative burner heating system emphasizes the highly preheated air combustion technology. This establishes energy savings resulting from the high heat recovery rate and ultimately low NOx emissions. Developing industrial burner that use highly preheated air emphasizes the suppression of NOx emissions generated by oxidation of nitrogen in the air, (thermal NOx). Studied the generation of thermal NOx and found that the generation of thermal NOx is determined by a function of temperature, oxygen concentration, and residence time. Accordingly, achieving low NOx combustion should result from: (1) the suppression of maximum flame temperature, and (2) the prevention of excess amounts of oxygen. The eco-friendly regenerative burner can be applied to any type of heating facility by simply adjusting the number of burners responding to the required heating capacity. Energy savings have reached an average of 30%, accounting for as much as 1212 TJ/y. NOx generation has significantly decreased by an average of 50%.

RBCs technology is a waste heat recovery technology that can be used in various industries that use the furnace in the production process. The use of RBCs in the steel industry technology can save the use of fossil energy, the amount depends upon the type of energy used and the conditions of the combustion chamber. RBCs equipment mounted on steel slab reheating furnace for preheating air for combustion. Based on operating experience in the steel industry RBCs one of the steel industry in Indonesia, then the fuel gas consumption can be reduced by 35% and steel production increased by 15%. Energy consumption to produce 1 kg of steel was 540 kcal, so that for steel production of 300,000 tonnes per year is expected to decline as much as 12,764 tons of CO2 per year.

Annex 1.2.2.6. Climate

RBCS technology is very likely to play a significant role in climate change mitigation in the future. As described above it is a rapidly growing market of iron and steel product and the RBCS can also be used in the ceramics industry, and others. It has energy payback periods ranging from 1.2 years for good to moderate industries and lifecycle GHG emission is about 38 gCO2e/kwh (fuel use and burner condition).

Annex 1.2.2.7. Financial requirements and costs

RBCs are mounted on the steel industry require investment in equipment around 4 jt USD. During the installation of equipment RBCs, the furnace should be discontinued and the cessation of operation of the furnace schedule tailored to the installation schedule. However, during the commissioning of the furnace about 2 months also had to be stopped and resulted in the loss of revenue due to the cessation of production during the commissioning within 2 months of 2.5 jt USD. With the decline in gas consumption of about 35%, steel production increased by 15%, and other benefits, the ROI of the investment and revenue losses during commissioning only about 13 months (K Setiawan, 2011).

Annex 1.3. Technology factsheets waste sector

Annex 1.3.1. Mechanical-biological treatment (MBT)

A. Introduction

A mechanical biological treatment system is a waste processing facility that combines a waste sorting facility with biological treatment methods e.g. anaerobic digestion and/or composting. MBT plants are designed to process mixed household waste as well as commercial and industrial waste. Therefore, MBT is neither a single technology nor a complete solution, since it combines a wide range of techniques and processing operations (mechanical and biological) dictated by the market needs of the end products. Thus, MBT systems vary greatly in their complexity and functionality.

The products of the Mechanical Biological Treatment technology are:

- Recyclable materials such as metals, paper, plastics, glass etc.
- Unusable materials (inert materials) safely disposed to sanitary landfill
- Biogas (anaerobic digestion)
- Organic stabilized end product
- refuse derived fuel - RDF (High calorific fraction).

MBT systems can form an integral part of a region's waste treatment infrastructure. These systems are typically integrated with curbside collection schemes. In the event that a derive fuel is produced as a by-product then a combustion facility would be required. Alternatively, MBT practices can diminish the need for home separation and curb side collection of recyclable elements of waste. This gives the ability of local authorities and councils to reduce the use of waste vehicles on the roads and keep recycling rates high (DEFRA, 2007).

A key advantage of MBT is that it can be configured to achieve several different aims. Some typical aims of MBT plants include the:

- Pre-treatment of waste going to landfill;
- Diversion of non-biodegradable and biodegradable MSW going to landfill through the mechanical sorting of MSW into materials for recycling and/or energy recovery as refuse derived fuel (RDF);

Diversion of biodegradable MSW going to landfill by:

  - Reducing the dry mass of organic waste prior to landfill;
  - Reducing the biodegradability of organic waste prior to landfill;

- Stabilisation into a compost-like output for use on land;
- Conversion into a combustible biogas for energy recovery; and/or
- Drying materials to produce a high calorific organic rich fraction for use as RDF

MBT plants may be configured in a variety of ways to achieve the required recycling, recovery and biodegradable municipal waste (BMW) diversion performance. Figure A-10 illustrates configurations for MBT and highlights the components within each.

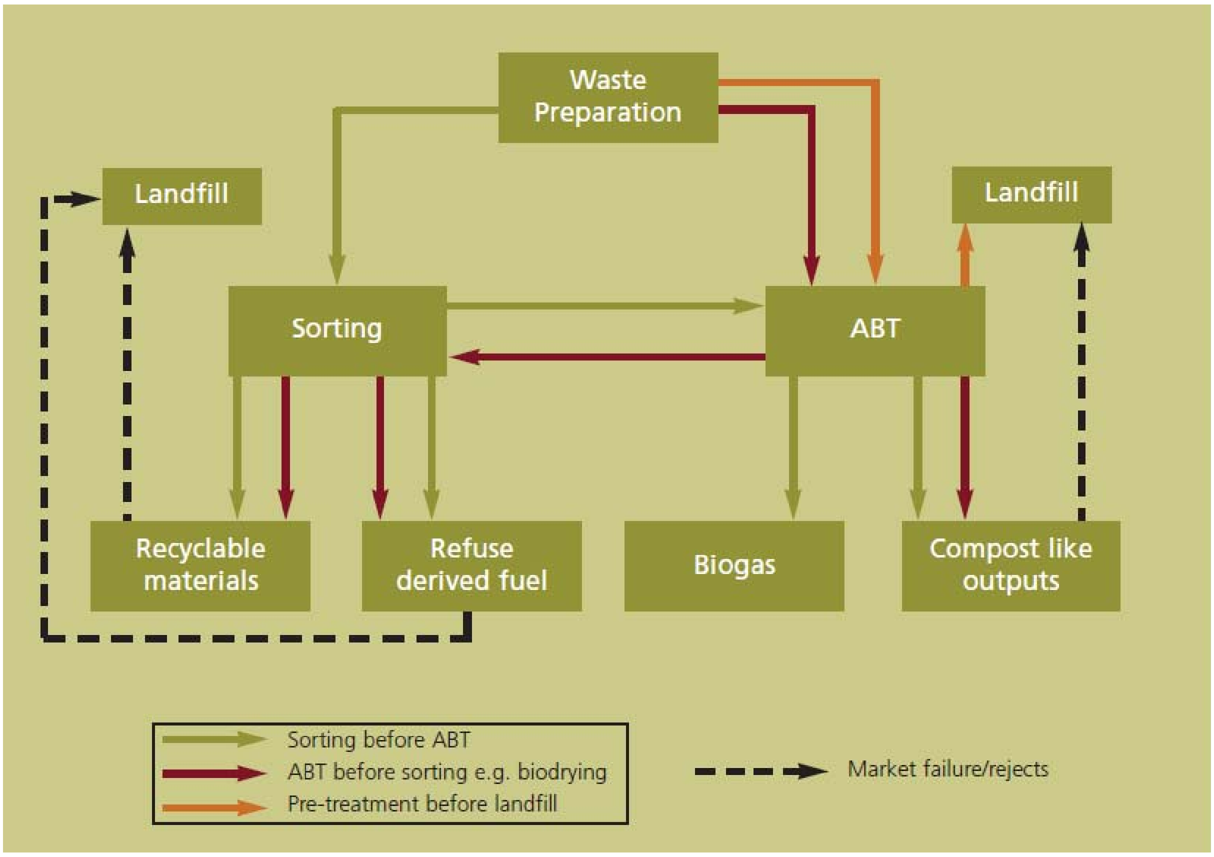

Figure A-10 An illustration of the potential mechanical biological treatment options (DEFRA, 2007)

Table A-12 Waste preparation techniques

Ref	Technique	Principle	Key Concerns
A	Hammer Mill	Material significantly reduced in size by swinging steel hammers	Wear on Hammers, pulverising and 'loss' of glass / aggregates, exclusion of pressurised containers
B	Shredder	Rotating knives or hooks rotate at a slow speed with high torque. The shearing action tears or cuts most materials	Large, strong objects can physically damage, exclusion of pressurised containers
C	Rotating Drum	Material is lifted up the sides of a rotating drum and then dropped back into the centre. Uses gravity to tumble, mix, and homogenize the wastes. Dense, abrasive items such as glass or metal will help break down the softer materials, resulting in considerable size reduction of paper and other biodegradable materials	Gentle action – high moisture of feedstock can be a problem
D	Ball Mill	Rotating drum using heavy balls to break up or pulverise the waste	Wear on balls, pulverising and 'loss' of glass / aggregates
E	Wet Rotating Drum with Knives	Waste is wetted, forming heavy lumps which break against the knives when tumbled in the drum	Relatively low size reduction. Potential for damage from large contraries
F	Bag Splitter	A more gentle shredder used to split plastic bags whilst leaving the majority of the waste intact	Not size reduction, may be damaged by large strong objects

Source: DEFRA, 2007

B. Technical requirements

Waste Preparation

MSW requires preparation before biological treatment or sorting of materials can be achieved. Initial waste preparation may take the form of simple removal of contrary objects, such as mattresses, carpets or other bulky wastes, which could cause problems with processing equipment downstream. Further mechanical waste preparation techniques may be used which aim to prepare the materials for subsequent separation stages. The objective of these techniques may be to split open refuse bags, thereby liberating the materials inside; or to shred and homogenise the waste into smaller particle sizes suitable for a variety of separation processes, or subsequent biological treatment depending on the MBT process employed (DEFRA, 2007).

Waste Separation

A common aspect of many MBT plant used for MSW management in the sorting of mixed waste into different fractions using mechanical means. The sorting of material may be achieved before or after biological treatment. No sorting is required if the objective of the MBT process is to pre-treat all the residual MSW to produce a stabilised output for disposal to landfill. Sorting the waste allows an MBT process to separate different materials, which are suitable for different end uses. Potential end uses include material recycling, biological treatment, energy recovery through the production of RDF, and landfill. A variety of different techniques can be employed, and most MBT facilities use a series of several different techniques in combination to achieve specific end use requirements for different materials. Separation technologies exploit varying properties of the different materials in the waste. These properties include the size and shape of different objects, their density, weight, magnetism, and electrical (DEFRA, 2007).

Table A-13 Waste separation techniques

	Separation Technique	Separation Property	Materials targeted	Key Concerns
1	Trommels and Screens	Size	Oversize – paper, plastic Small – organics, glass, fines	Air containment and cleaning
2	Manual Separation	Visual examination	Plastics, contaminants, oversize	Ethics of role, Health & Safety issues
3	Magnetic Separation	Magnetic Properties	Ferrous metals	Proven technique
4	Eddy Current Separation	Electrical Conductivity	Non ferrous metals	Proven technique
5	Wet Separation Technology	Differential Densities	Floats - Plastics, organics Sinks - stones, glass	Produces wet waste streams
6	Air Classification	Weight	Light – plastics, paper Heavy – stones, glass	Air cleaning
7	Ballistic Separation	Density and Elasticity	Light – plastics, paper Heavy – stones, glass	Rates of throughput
8	Optical Separation	Diffraction	Specific plastic polymers	Rates of throughput

Source: DEFRA, 2007

Biological Treatment
The biological element of an MBT process can take place prior to or after mechanical sorting of the waste. In some processes, all the residual MSW is biologically treated to produce a stabilised output for disposal to landfill and no sorting is required. The biological processes used are either:

- Aerobic Bio-drying
- Aerobic In-vessel composting
- Anaerobic digestion

There are varieties of different biological treatment techniques, which are used in MBT plant. Table A-14 below outlines the key categories of biological treatment (DEFRA, 2007).

Table A-14 Biological treatment options

Options	Biological Treatment
I	Aerobic - Bio-drying / Biostabilisation: partial composting of the (usually) whole waste
II	Aerobic - In-Vessel Composting: may be used to either biostabilise the waste or process a segregated organic rich fraction
III	Anaerobic Digestion: used to process an segregated organic rich fraction

Source: DEFRA, 2007

c. Status of the technology and its future market potential

The concept of MBT originated in Germany where it is an established waste treatment method. Regulatory restrictions on landfill space, the search for alternatives to incineration and increased costs of landfill disposal have been the major drivers for the development of these technologies. The largest European markets for established MBT plant include Germany, Austria, Italy, Switzerland and the Netherlands, with others such as the UK growing fast. Furthermore, other countries outside Europe are also using this technology.

Since the early 1990s, MBT processes have changed significantly, so today, numerous configurations of plant have developed, and these are provided by a variety of companies. There are over 70 MBT facilities in operation in Europe, with over 40 MBT facilities operating in Germany.

The Mechanical-Biological-Treatment (MBT) methodologies are more compatible with the demanding management requirements coming into effect in the E.U. and this explains the recent significant impetus on their development and use. By 2005, 80 plants with capacities ranging from 20.000 to 480.000 t/y and a cumulative capacity of 8.500.000 t/y had been constructed by 27 companies. By 2006, 123 plants are expected to be operating with an installed capacity of 13.000.000 t/y.

Most of these plants (and the largest) use Mechanical treatment and aerobic composting, followed by plants with mechanical treatment and anaerobic digestion and by a limited number of plants with aerobic drying followed by mechanical separation. The latter is only a pre-treatment of MSW yielding a Solid Recovered Fuel (SRF).

Among the MBT alternatives, the mechanical treatment and aerobic composting is by far the most proven and economic technology. This is well suited for source separated biodegradable wastes, as is the case with most plants in Germany, as well as for un-segregated MSW, as is the case with all plants in Italy and Spain. This flexibility is important for Greece, since source separation is not currently practiced and, even if it is adopted, it will take several years to be widely implemented. The above features make the MBT technology with MRF and aerobic composting particularly suitable for Greece. An additional reason is the particular suitability of this technology for MSW wastes rich in biodegradable materials.

d. Contribution of the technology to protection of the environment

The primary goal of MBT is to minimize the environmental burdens of waste disposal by way of extensive stabilization. MBT can also help to recover valuable materials.

In the mechanical stage, the first step is to sort out the disturbances (e.g. large pieces of metal), unwanted materials and - optionally - recyclables. Next, the residual waste is prepared for biological treatment by combination, mixing and, if necessary, moistening. Then comes the biological stage, the purpose of which is to effect extensive biological stabilization of the waste. There are two basic methods of biological decomposition: aerobic decomposition, i.e. decomposition in the presence of atmospheric oxygen, and anaerobic digestion, i.e. decomposition the absence of atmospheric oxygen, also referred to as fermenting.

The biological decomposition and conversion of organic matter by microorganisms (bacterial, protozoa, and fungi) is a natural form of recycling that takes place in landfilled waste. As biological decomposition progresses in a landfill, anaerobic digestion generates a combustible, explosive gas referred to as sanitary landfill gas. This gas escapes from the landfill and contributes to global warming and hence to climate degradation. Water seeping into the landfill, together with water contained in the waste, becomes contaminated by the products of decomposition and by the leaching out of pollutants. To keep the leachate and the landfill gas from escaping to the environment, the landfill needs to be sealed so that they can be collected and treated systematically (Dilewski, G. and Stretz, J. 2003).

Through the controlled decomposition of organic substances, mechanical-biological waste treatment substantially reduces both the gas and water emissions, which would otherwise be subsequently generated at the landfill and the volume of the residual waste requiring emplacement. Waste containing a large share of biodegradable organic material is most suitable for such treatment. This is generally the case for household and commercial waste. However, contaminated waste, e.g. hazardous industrial waste; infectious waste, e.g. waste from hospitals and slaughterhouses; and construction site waste are inherently unsuitable. The suitability of industrial waste needs to be determined in advance, e.g. by analyzing, on a case-by-case basis, its pollutant concentrations and biomass fractions (Dilewski, G. and Stretz, J. 2003).

e. Climate

Human activities have caused a considerable increase in the greenhouse-gas contents of the earth's atmosphere. Consequently, the earth's surface is expected to become gradually warmer over the coming decades (global warming), in turn giving rise to attendant climatic changes. The greenhouse gases that are contributing most to the greenhouse effect are carbon dioxide (CO2), methane (CH4) and nitrous oxide or laughing gas (N2O). All three of them occur internal in connection with waste disposal.

Most of the greenhouse effect attributable to waste management can be ascribed to methane, which is produced by the anaerobic digestion of biodegradable waste in landfills. Approximately one-third of all anthropogenic CH4 emissions within the EU derive from that source. By contrast, only 1 % of the N2O emissions and less than 0.5 % of the CO2 emissions can be traced to land filled waste. Hence, reducing CH4 emissions from landfills holds the greatest potential for reducing greenhouse gas emissions in the waste-management context. MBT allows methane generation to be greatly reduced. Well-ventilated, long-term aerobic decomposition emits only about 1 % of the methane generated by a comparably sized landfill full of untreated waste. Anaerobic processes offer certain advantages over aerobic processes with regard to climatic effects because the biogas they produce contains a large proportion of methane and is therefore a useful energy vehicle, and they produce only small amounts of exhaust air, i.e. off-gas, that can scrubbed before it is released to the atmosphere.

The net greenhouse gas flux from MBT (Smith et al, 2001):

- The net greenhouse gas flux -403 kg CO2 eq/tonne of MSW (high stabilize +landfill)
- The net greenhouse gas flux -329 kg CO2 eq/tonne of MSW (less stabilize +landfill)
- The net greenhouse gas flux -137 kg CO2 eq/tonne of MSW (high stabilize +landfill)

f. Financial requirements and costs

There are a wide range of costs dependent upon the complexity of the technology and the degree of mechanisation and automation employed (DEFRA, 2007). The table below shows indicative capital expenditure (Capex) and operational expenditure (Opex) for aerobic and anaerobic MBT facilities. These costs provided are predominantly based on European examples. Costs in the Indonesia will involve differing site specific issues such as permitting, labour, emission controls and other requirements.

Table A-15 Typical MBT cost using anaerobic and aerobic processes

	Aerobic processes		AD processes	
Capacity	Capex £/t/yr	Opex £/t	Capex £/t/yr	Opex £/t
<50,000	70 – 150	up to 140	160 – 420	From 23
>50,000	28 – 225	20 – 69	107 – 278	16 – 69

Source: DEFRA, 2007

Information from Germany suggests that MBT costs are around 87 Euro/t, including landfill disposal fees. However, since waste management charges in Germany are usually at the upper end of the range for other member states, it has adopted lower figures for the EU as a whole. It has selected figures of 60 Euro/t for MBT with landfill and 75 Euro/t for MBT with incineration. These figures are slightly higher than the composting, AD and incineration figures to reflect the extra processing (separation) stages necessary for MBT (Smith et al, 2001).

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Annex 1.3.2. In vessel composting

a. Introduction

Composting is a biological degradation process in which microorganisms transform organic materials into a soil-like material called compost under controlled conditions. Organic materials that can be used to produce compost include food wastes, leaves, wood, manure, paper, and sewage sludge. The decomposition of organic materials is a dynamic, natural process. The difference between natural decay and composting is that during the composting process people control the conditions under which the decomposition takes place (Ripley, S., and Mackenzie, K. 2008).

The primary objectives of composting organic materials are the following:

- Convert biodegradable organic waste into a biologically stable product and reduce the original volume of the waste;
- Retain the nutrient content of the original waste (nitrogen, phosphorus, potassium and micronutrients);
- Produce a product that can support plant growth and improve soil structure; and
- Destroy pathogens or unwanted microorganisms, insect eggs and weed seeds.

All composting systems, regardless of their scale, are designed to provide an environment in which the natural process of aerobic degradation of organic waste is optimized to produce a stable end product of compost. There are four main types of composting methods:

- Turned windrows
- Aerated static piles
- Enclosed channel system
- In-vessel system

In-vessel composting is accomplished inside an enclosed container or vessel. Type of vessel has been used include vertical tower, horizontal rectangular and circular tanks, and circular rotating tanks. In-vessel composting system can be divided into plug flow and agitated bed. In plug flow system, the relationship between particles in the composting mass stays the same throughout the process and the system operates on the first-in, first-out principle. In an agitated bed system, the composting material is mixed mechanically during the processing. Mechanical systems are designed to minimized odor and process time by controlling environmental conditions such as airflow, temperature, and oxygen concentration. The popularity of in vessel system become increase because of odor control, faster, lower labor cost, and small area requirements. The detention time in vessel varies from 1 to 2 weeks, but virtually system employ a 4- to 12- week curing period after the active composting period (Tchobanoglous et al, 1993).

Carried out in the absence of oxygen, the anaerobic stabilization process or conversion of the organic material in MSW occurs in three step. The first step involves the enzyme-mediated transformation (hydrolysis) of higher molecular mass compounds into compounds suitable for use as of energy and cell tissue. The second step involves the bacterial conversion of the compound s resulting from the first step into identifiable lower-molecular mass intermediate compounds. The third step involves the bacterial conversion of the intermediate compounds into simpler end products, principally methane and carbon dioxide (Tchobanoglous et al, 1993).

B. Technical requirements

With in-vessel systems, the composting process takes place in a confined space, which is usually a highly controlled, sealed chamber. Access is normally restricted; even facility personnel usually do not enter. Composting is an intensive aerobic conversion process in a tunnel with forced air. Organic materials can be processed as a batch, or can be moved progressively through a structure by the pressure of incoming new material. There are many different types of in-vessel systems, including fixed, portable and non-rigid vessels. In-vessel systems can involve channels, tunnels or other types of containers. All in vessel systems involve proprietary knowledge or technology and are thus relatively expensive compared with other composting systems. Windrows are needed to cure the compost once it has been processed within the composting vessel.

In-vessel systems require the least amount of space of all composting systems, and most are installed inside a building. However, almost all in-vessel systems require windrows or aerated static piles to finish the composting process after the material has moved through the vessel. In-vessel systems are usually used in locations with relatively high volumes of organic waste generation, and space and/or odour concerns, such as in larger communities. Although in-vessel systems can be designed to process quantities of organic waste as low as 365 tonnes per year, in vessel systems are often not economically feasible at such low processing rates. In-vessel composting facilities in Germany and the Netherlands have demonstrated that container in-vessel systems can treat from 3,000 to 20,000 tonnes of vegetable, fruit, and garden waste per year (Ripley, S., and Mackenzie, K. 2008).

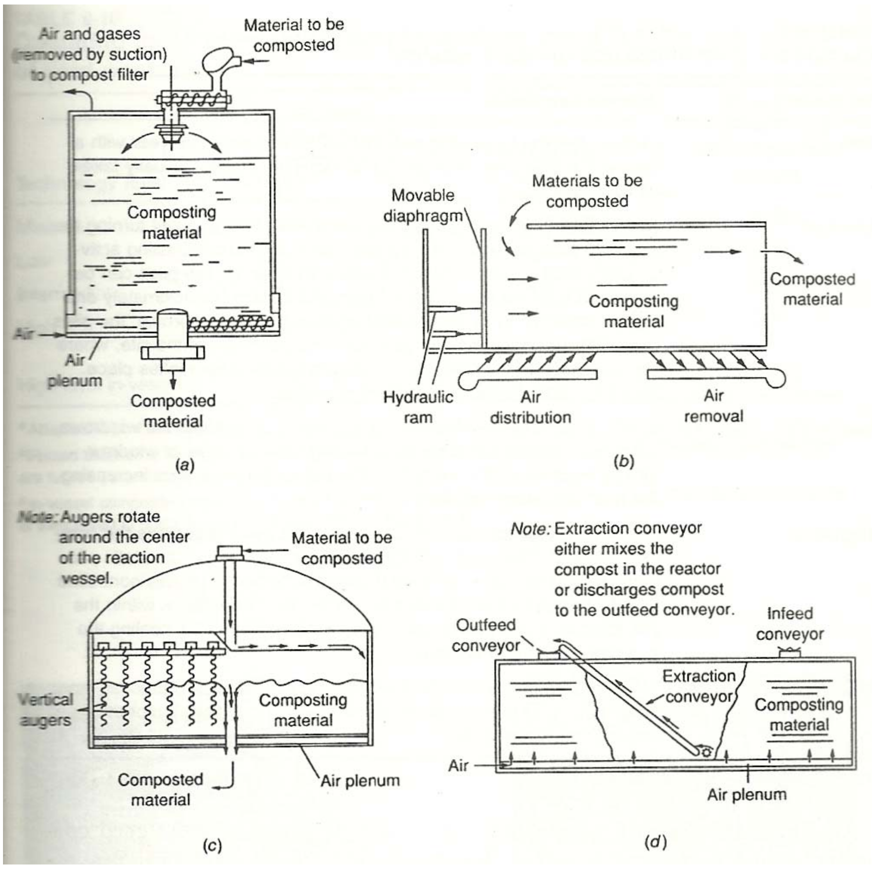

Figure A-11 In-Vessel Composting units: (a) unmixed verticalplug flow reactor, (b) unmixed horizontal plug flow reactor, (c) mixed (dynamic) vertical reactor, (d) mixed (dynamic) horizontal reactor (Source: Tchobanoglous et al, 1993).

In-vessel systems produce compost in the shortest amount of time. For some systems, organic materials remain in the vessel for one to two weeks, and then must be cured for at least a month in optimal conditions.

In-vessel composting systems provide the highest amount of process control and involve the most intensive use of equipment and technology. As a result, these systems also tend to be the most expensive centralized composting method. For example, tunnel systems use compartments made of concrete or another material that can be closed with an insulated door. Each compartment has ventilation equipment, recirculation ducts and a mechanism to heat or cool the recirculated air.

Table A-16 Advantages and disadvantages of in-vessel composting

Advantages	Disadvantages
• Require the least amount of land • Most rapid production of compost – highest control of composting parameters. • Odours can be controlled reasonably well inside a building in most cases. • Control release of leachate.	• Most capital intensive. • Requires extensive training of personnel. • Higher maintenance and operational costs.

(Source: Ripley, S., and Mackenzie, K. 2008).

C. Status of the technology and its future market potential

In vessel, composting generally widely applied in various states in the USA and Canada. Vessel is used typically shaped tunnel or drum. As has been mentioned in-vessel composting systems reserve the bioreactor for the active stage of the composting process and rely upon windrow systems for the curing and maturation phase of the organic matter. The rationale of these systems is to maintain conditions at optimum levels during the active stage of the process and thus accelerating the microbial activity rate and consequently shortening the active phase.

The economic gain of in-vessel systems in comparison to windrow composting is the reduction of residence time and the increase of its processing capacity as well as the better quality of the end product, since the conditions during the process are usually optimized and controlled at all times. However, the economics of some mechanized systems are more unfavourable than those of windrow systems.

D. Contribution of the technology to protection of the environment

In-vessel composting (IVC) just means that the composting process takes place within an enclosed environment. This allows for the temperature levels to be strictly monitored and controlled. Like any composting process the material relies on natural bacteria to rot the material down. With in-vessel composting the process is much hotter - up to 70 degrees which kills off pathogenic bacteria and weeds.

Environmental Advantages of In-Vessel Composting are;

- Reduces volume of organic waste going to landfills.
- Reduces odor and vermin attraction
- Compost is slow- release and will not leach out.
- Compost conserves water
- Reduces greenhouse emissions (production of landfill methane also produces C02 which is more harmful than methane)
- Compost has valuable nutritional value and has a ready market.
- Provides additional recycling credits.

e. Climate

Most of the greenhouse effect attributable to waste management can be ascribed to methane, which is produced by the anaerobic digestion of biodegradable waste in landfills. Approximately one-third of all anthropogenic CH_4 emissions within the EU derive from that source. By contrast, only 1 % of the N_2O emissions and less than 0.5 % of the CO_2 emissions can be traced to landfilled waste. Hence, reducing CH_4 emissions from landfills holds the greatest potential for reducing greenhouse gas emissions in the waste-management context. In-Vessel Composting can reduce the organic waste going to landfill, so that landfill gas production can be reduced.

The net greenhouse gas flux from In-Vessel Composting (Smith et al, 2001):

- The net greenhouse gas flux about -10 kg CO_2 eq/tonne of MSW
- The net greenhouse gas flux about -461 kg CO_2 eq/tonne of MSW (compost, recycling, landfill residue) include sequestration

f. Financial requirements and costs

There are a wide range of costs dependent upon the complexity of the technology and the degree of mechanisation and automation employed. The table below shows indicative capital and O&M for In-Vessel Composting facilities. These costs provided are predominantly based on US examples. Costs in the Indonesia will involve differing site specific issues such as permitting, labour, emission controls and other requirements.

Table A-17 Typical capital, O&M costs for in-vessel composting facilities

Costs	M System Components	Cost Basis	Cost (US dollars)
Capital Costs	Feedstock derived from processing of commingled waste; enclosed building with concrete floors, MRF processing equipment, and in-vessel composting; enclosed building for curing of compost product	$/ton of capacity per day	25,000 – 50,000

Source: Tchobanoglous, G and Kreith, F (2002)

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Annex 1.3.3. Low solid anaerobic digestion

A. Introduction

Low-solid anaerobic digestion is a biological process in which organic wastes are fermented at solid concentration equal to or less than 4-8 percent. The low solid fermentation process is used in many part of the world to generate methane gas from human, animal and agricultural wastes, and from the organic fraction of MSW. One of the disadvantages of LSAD is that considerable water must be added to waste to bring the solid content to the required range of 4 to 8 percent. The addition of water results in a very dilute digested sludge, which must be dewatered prior to disposal. The disposal of the liquid stream resulting from the dewatering step is an important consideration in the selection of the low solids digestion process (Tchobanoglous et al, 1993).

There are three basic steps involved whenever the low-solid anaerobic digestion process is used to produce methane from the organic fraction of MSW. The first step, involves the preparation of the organic wastes such as sorting and separation, and size reduction. The second step involves the addition of moisture and nutrient, blending, pH adjustment to about 6.8, and heating of the slurry to between 55 and 60 oC, and the anaerobic digestion is carried out in a continuous-flow reactor whose contents are mixed completely. The third step in the process involves the capture, storage, and, if necessary, separation of the gas component. The dewatering of the digested sludge is an additional task that must be accomplished. In general, the processing of the digested sludge is so expensive that the process has seldom been used (Tchobanoglous et al, 1993).

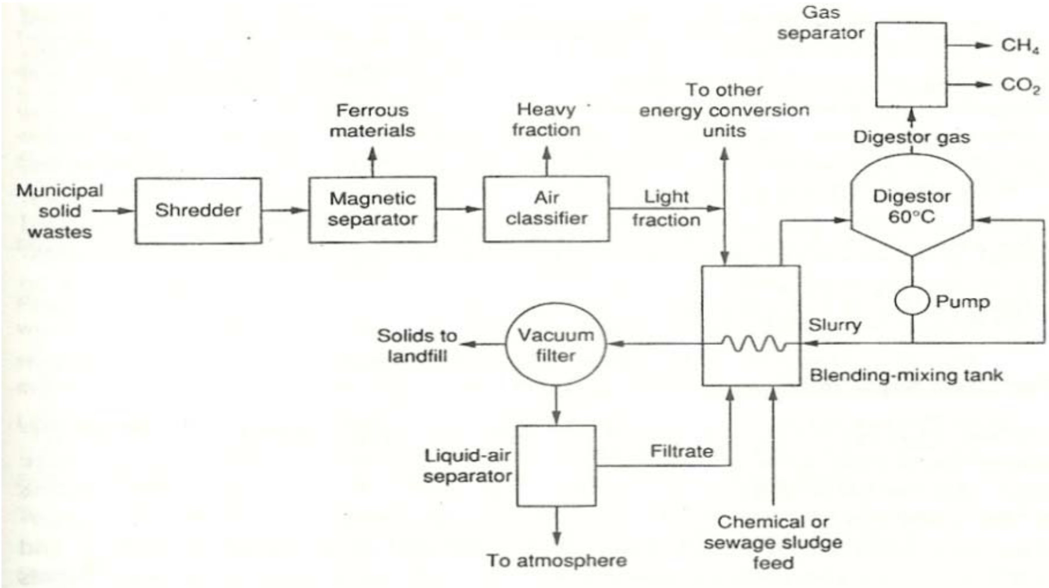

Figure A-12 Flow diagram for low solid anaerobic digestion process (Source: Tchobanoglous et al, 1993)

B. Technical requirements

Carried out in the absence of oxygen, the anaerobic stabilization process or conversion of the organic material in MSW occurs in three step. The first step involves the enzyme-mediated transformation (hydrolysis) of higher molecular mass compounds into compounds suitable for use as of energy and cell tissue. The second step involves the bacterial conversion of the compound s resulting from the first step into identifiable lower-molecular mass intermediate compounds. The third step involves the bacterial conversion of the intermediate compounds into simpler end products, principally methane and carbon dioxide.

Table A-18 Important technical requirement for low solid anaerobic digestion process

Waste component	Comment
Size of material	Wastes to be digested should be shredded to a size that will not interfere with the efficient functioning of pumping and mixing operations.
Mixing equipment	To achieve optimum results and to avoid scum buildup, mechanical mixing is recommended.
Percentage of solid wastes mixed with sludge	Although amounts of waste varying from 50 to 90+ percent have been used, 60 percent appears to be a reasonable compromise.
Hydraulic and mean cell-residence time	Washout time is in the range of 3 to 4 d. Use 10 to 20 d for design, or base design on results of pilot plant studies.
Loading rate	0.04 to 0.10 lb/ft^3 · d (0.6 to 1.6 kg/m^3 · d). Not well defined at present time. Significantly higher rates have been reported.
Solids concentration	Equal to or less than 8 to 10% (4 to 8% typical).
Temperature	Between 85 and 100°F (30 to 38°C) for mesophilic and between 131 and 140°F (55 and 60°C) for thermophilic reactor.
Destruction of volatile solid wastes	Depends on the nature of the waste characteristics. Varies from about 60 to 80 percent; 70 percent can be used for estimating purposes.
Total solids destroyed	Varies from 40 to 60 percent, depending on amount of inert material present originally.
Gas production	8 to 12 ft^3/lb (0.5 to 0.75 m^3/kg) of volatile solids destroyed (CH_4 = 55 percent; CO_2 = 45 percent).

(Source: Tchobanoglous et al, 1993)

C. Status of the technology and its future market potential

Over the past 20 years, LSAD of MSW technology has advanced in Europe because of waste management policies enacted to reduce the long-term health and environmental impacts of landfill disposal. This has led to relatively high landfill tipping fees (compared with the U.S.), which, in combination with generous prices paid for renewable energy, has created an active commercial market for LSAD and other MSW treatment technologies in Europe. Installed AD capacity in Europe is more than 4 million tons per year (Mark, 2008).

In some parts of Europe, source separation of the organic fraction of municipal solid waste is common and even mandatory, which contributes to the growth of biological treatment industries. Regions outside of Europe are also enacting more stringent waste disposal regulations, leading to the development of new LSAD and other MSW conversion plants.

The treatment of solid wastes using LSAD adds several new challenges because of the variety in the feedstock and the space limitations where such facilities would be located. The organic fraction of MSW may contain food, yard waste or paper in varying concentrations, sizes, and composition. Furthermore, MSW is contaminated with non-organics, such as glass and metal, and therefore requires pre-treatment to separate the feedstock. Though the ideal waste stream for an LSAD plant would be source-separated organics, the reality is that there is always a small degree of contamination that must be handled on site.

Despite these challenges, European nations have led the way to expanding LSAD to be a significant part of MSW management. Over 70 plants process MSW either alone or with sewage in Germany, Denmark, France, Spain, Austria, Holland, England, Belgium, and other European nations. Additionally, Israel, Australia and Canada have at least one LSAD plant treating MSW. The typical plant processes between 50,000 and 80,000 tons of organic waste per year, with the largest treating 100,000 tons annually. Some plants accept mixed MSW, for example the Vagron plant that treats 232,000 tons of mixed waste per year, 92,000 tons of which are organics. The expansion to the American market has been stalled by failed attempts, such as that in Los Angeles, as well as by lack of government incentives (Ostrem, 2004).

The future of LSAD as a MSW management strategy depends on several factors ranging from environmental concerns to economic considerations. Some of these include increased process efficiency, reduced construction and operation costs, expanding markets for products and decrease in the availability of landfills. It seems that AD will continue to play a role in MSW, but to what extent is unknown.

D. Contribution of the technology to protection of the environment

LSAD facilities are capable of producing energy and reducing the biodegradable content of the organic waste prior to composting, which reduces emissions of pollutants and greenhouse gases. LSAD has the potential to minimize the environmental impact of waste disposal by reducing the amount of biodegradable materials in landfills.

LSAD of municipal solid waste (MSW) is used in different regions worldwide to:

- Reduce the amount of material being landfilled
- Stabilize organic material before disposal in order to reduce future environmental impacts from air and water emissions
- Recover energy

E. Climate

LSAD has the advantage of generating energy, which reduces emissions of climate hange gases by offsetting emissions from fossil-fuelled power stations. It therefore gives higher net carbon savings than composting. If 5.5 million tonnes of waste was treated by LSAD it could generate between 477 and 761 GWh of electricity each year. Compared to composting the same amount of food waste, treating it with LSAD would save between 0.22 and 0.35 million tonnes of CO2 equivalent, assuming the displaced source is gas-fired electricity generation. Using the soil improver also brings climate benefits through storing up some carbon in the soil and by displacing the use of mineral fertiliser, which requires significant energy input to produce (Friend of the Earth, 2007).

The net greenhouse gas flux from LSAD (Smith et al, 2001):

- The net greenhouse gas flux about -33 kg CO2 eq/tonne of MSW
- The net greenhouse gas flux about -461 kg CO2 eq/tonne of MSW (AD, recycling, landfill residue) include sequestration

F. Financial requirements and costs

One comprehensive cost analysis extracted cost data on 16 different MSW AD facilities from the literature and adjusted the data for consistency. The capital costs considered included all predevelopment and construction costs. Operating costs included labor, maintenance, materials, testing, insurance, overheads, and training costs, but not the costs of transporting residuals to disposal sites or any revenues. A second study also published capital and operating costs for a handful of European MSW digesters, but did not adjust the cost data for consistency. The capital and operating costs, originally reported in 2003 Euros, were converted to 2007 dollars. Then the data were multiplied by the consumer price index for 2003 to convert to 2007 dollars and the cost curves were plotted (Mark, 2008).

Although separated by 10 years, the capital cost curves from the two studies were very similar. Differences could be due in part to differences in the cost items included in the different studies. There was an economy of scale of about 0.5 for both studies. The operating cost curves were different for the two studies; however, the earlier data did not fit the curve well, indicating that they may not include the same cost items. The data that fit the cost curve had an economy of scale of 0.6. researchers, the estimated capital cost for a 70,000 MT/y (76,000 tons/y) digester proposed for the CSU Channel Islands campus was $17 million. According to the above cost curve, the predicted cost for such a plant is about $19 million. A feasibility study for a similarly sized 63,000 MT/y (69.00 tons/y) digester in Iowa estimated the capital and operating costs to be $14.2 million and $11.14 per MT ($10.11 per ton), respectively. The study found the project to be economically marginal and highly dependent on the amount of heat sold (Mark, 2008).

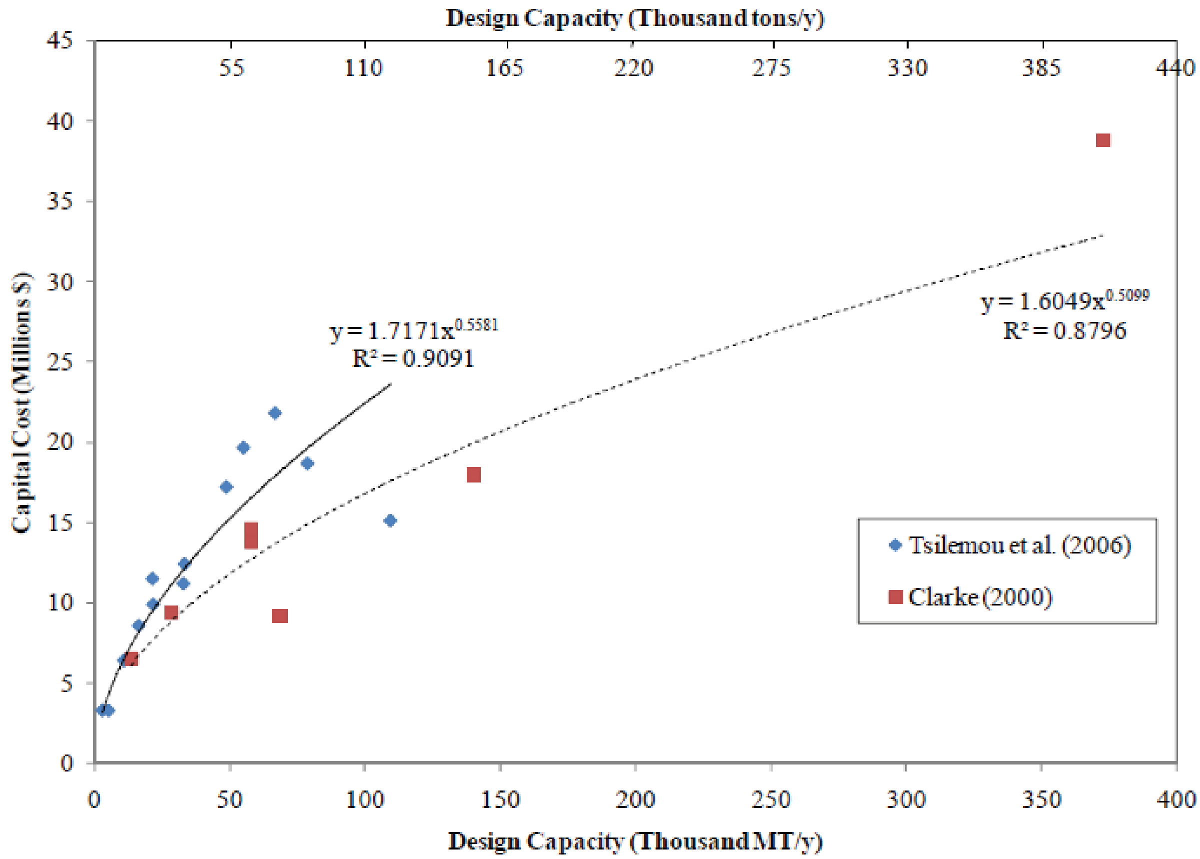

Figure A-13 Capital cost curves for European MSW digesters

(Source: Mark, 2008)

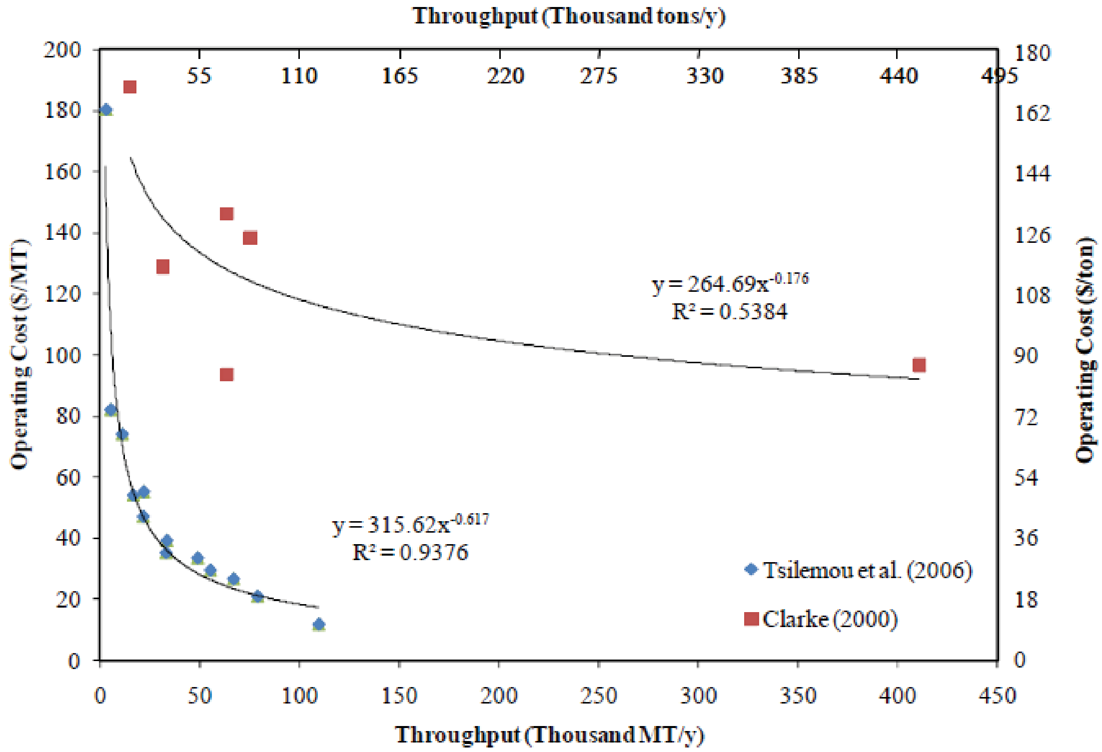

Figure A-14 Operating cost curves for European MSW digesters (Source: Mark, 2008)

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Annex 2: Market maps for technologies

Annex 2.1. Market maps for forestry and peat technologies

Annex 2.2. Market maps for energy

Annex 2.2.1. Market maps for PV

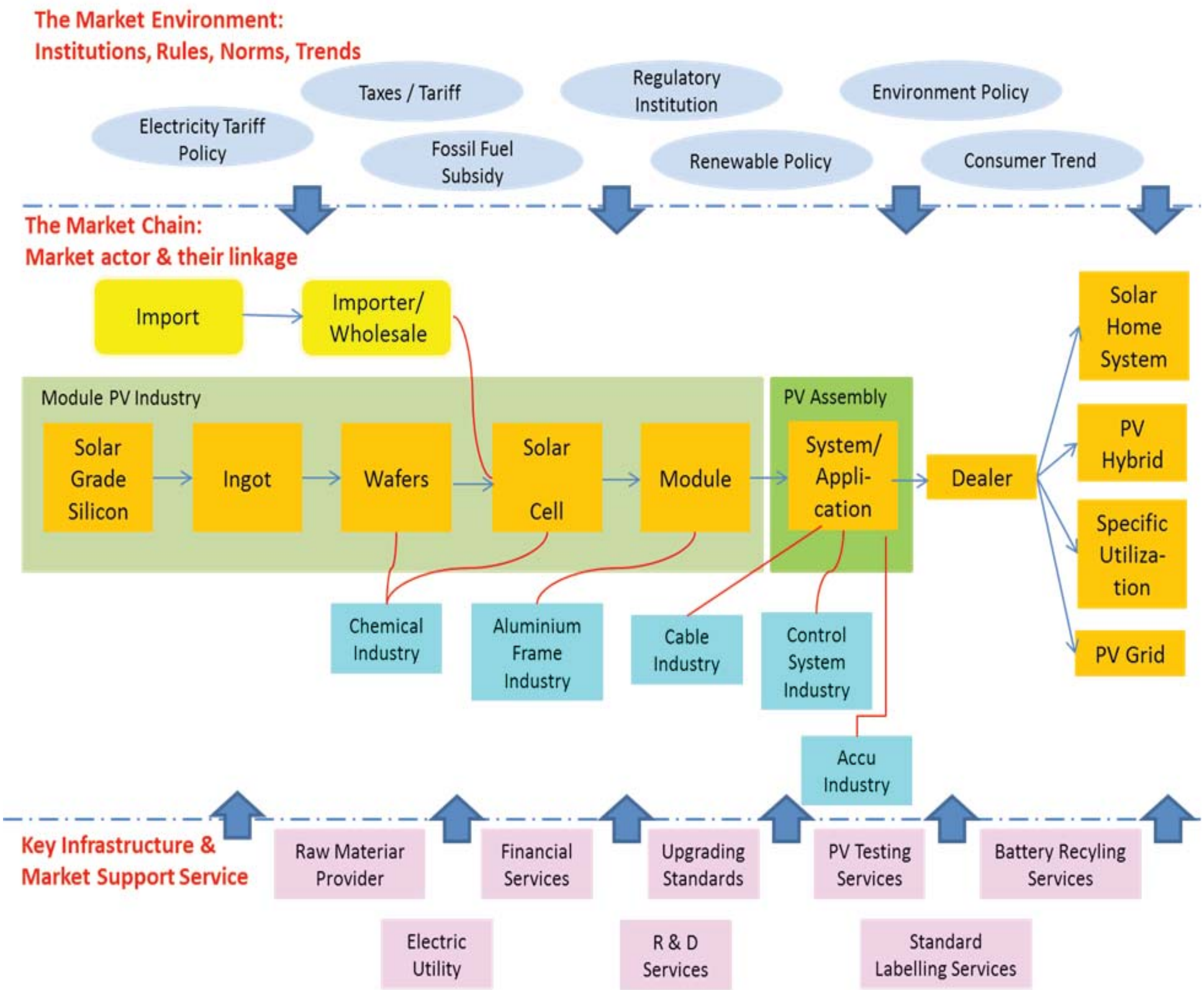


Figure A-15 Market map for PV

Annex 2.2.2. Market maps for RBCS

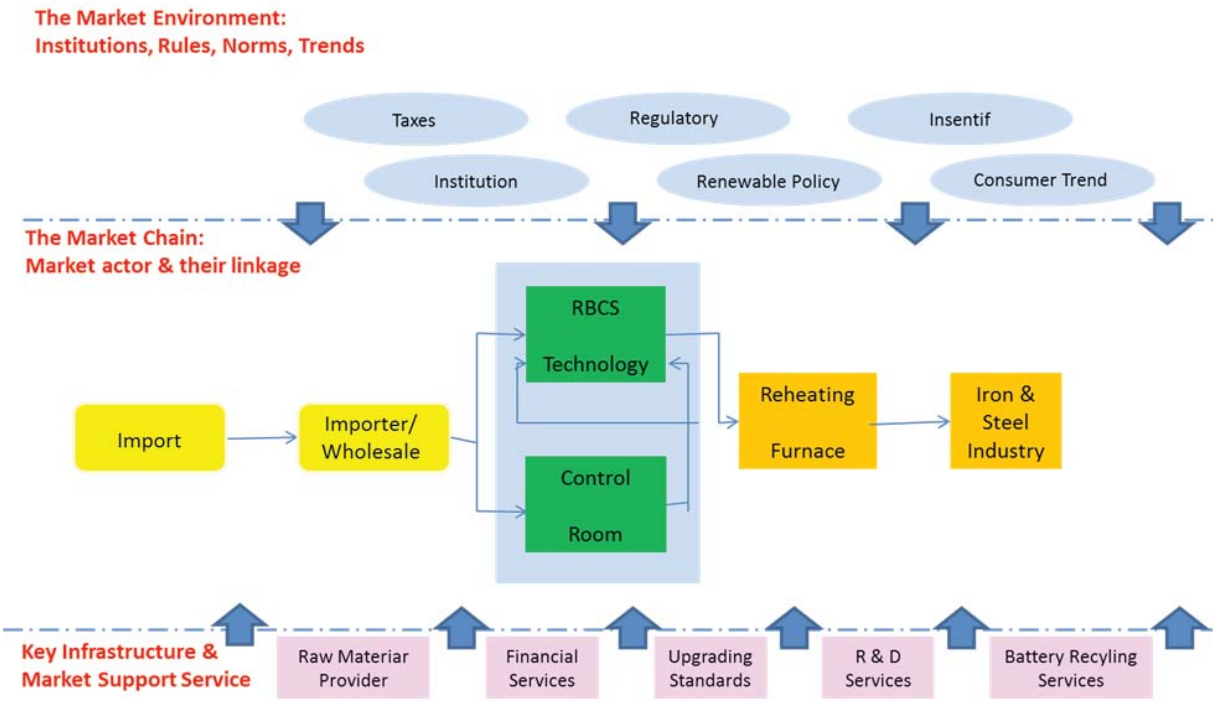


Figure A-16 Market Map for RBCS

Annex 2.3. Market maps for Waste

Annex 2.3.1. Mechanical biological treatment (MBT)

A mechanical biological treatment system is a waste processing facility that combines a waste sorting facility with biological treatment methods e.g. anaerobic digestion and/or composting. MBT plants are designed to process mixed household waste as well as commercial and industrial waste. Therefore, MBT is neither a single technology nor a complete solution, since it combines a wide range of techniques and processing operations (mechanical and biological) dictated by the market needs of the end products. Thus, MBT systems vary greatly in their complexity and functionality. Figure A-17` below present a process diagram of a Mechanical Biological Treatment facility.

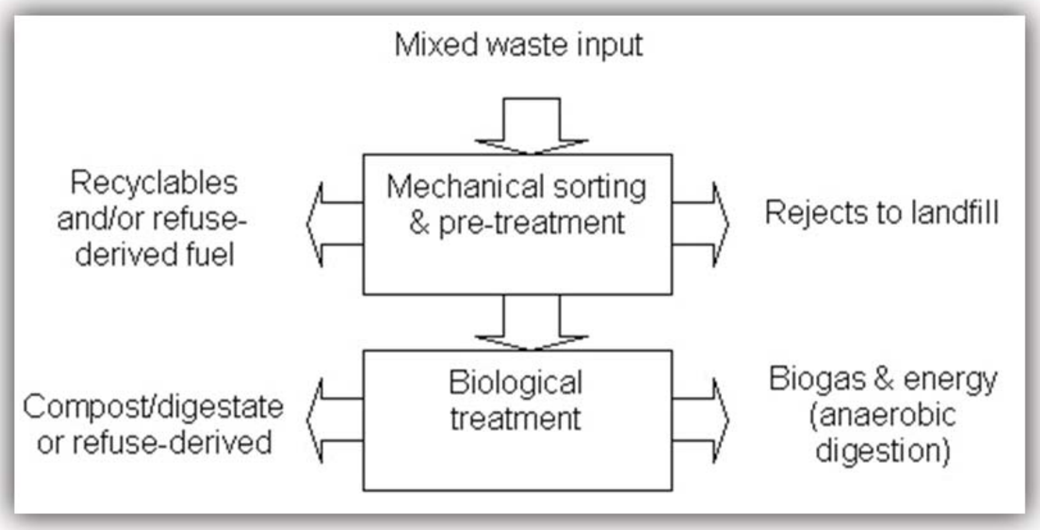


Figure A-17 Process diagram of a mechanical biological treatment facility

The products of the Mechanical Biological Treatment technology are:

- Recyclable materials such as metals, paper, plastics, glass etc.
- Unusable materials (inert materials) safely disposed to sanitary landfill
- Biogas (anaerobic digestion)
- Organic stabilized end product
- Refuse derived fuel - RDF (High calorific fraction).

MBT systems can form an integral part of a region's waste treatment infrastructure. These systems are typically integrated with curbside collection schemes. In the event that a DF is produced as a by-product then a combustion facility would be required. Alternatively, MBT practices can diminish the need for home separation and curb side collection of recyclable elements of waste. This gives the ability of local authorities and councils to reduce the use of waste vehicles on the roads and keep recycling rates high.

The use of mechanical – biological treatment is for the management of municipal waste is a choice with a large number of applications around Europe. The crucial point about the feasibility of such schemes should take into account the fact that market should be available for the utilization of the produced RDF / SRF. Otherwise, in the case that there is also significant cost for the utilization of the produced SRF / RDF, then the total cost of this management option could be even higher than that of a thermal management option.

For decades, MBT has competed with incineration in the more industrialized countries of the world. Although incineration has generally been favoured by the politicians, uptake of MBT in these developed countries nevertheless continues. For example, in the UK and Italy at present, more MBT than conventional thermal treatment capacity is being installed. And in less developed environments, cost comparisons alone make the MBT option attractive.

In Switzerland, the construction of the MSW compost plant at Schaffhausen (which has been recognized internationally but not in Switzerland) set the trend in the material-flow-specific treatment of residual waste back in the early 1990s. This technique consisted of shredding the waste and sieving off the fraction with a high calorific value for intermediate storage; in winter, this fraction was used as a fuel in some of the adjacent waste-to-energy (WtE) plants for the production of heat in the district. The fraction with a low calorific value was mixed with sewage sludge and composted; after separating insignificant quantities for use in landscape design, it was eventually land filled. Except for this one-off achievement, Switzerland has remained a 'blank space' on the European MBT map. On account of a 2000 national ban on the landfilling of MSW (as well as other combustible wastes that cannot be recovered), all residual waste in Switzerland is thermally processed.

Austria remains far in advance of the upper time limits established by European legislation regarding the reduction of biodegradable waste fractions. Since 2004, the country's Landfill Ordinance has included a ban on the landfilling of untreated wastes. Currently 15 MBT facilities are in operation. Exclusively aerobic systems are in use - which is what distinguishes Austria from the German position and is a consequence of Austria's considerable experience with MSW composting between the mid 1970s and 1990. Six of these MBT facilities are converted MSW compost plants using certain components of the previous structure.

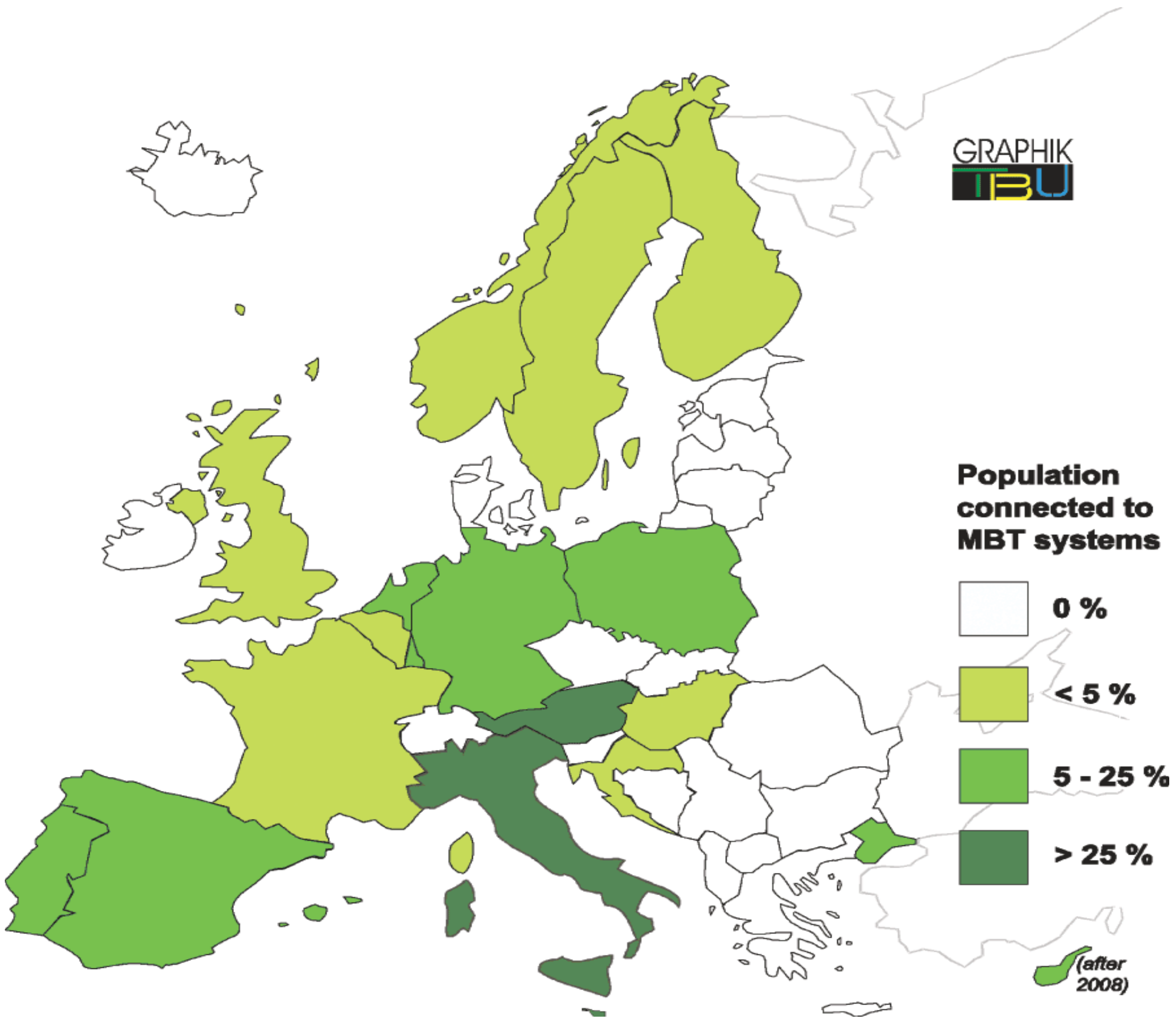


Figure A-18 Estimated percentage of MBT systems users in europe

Annex 2.3.2. In vessel composting

In-vessel composting (IVC) just means that the composting process takes place within an enclosed environment. There are many different systems, including containers, silos, agitated bays, tunnels, rotating drums and enclosed halls. This allows the temperature levels to be strictly monitored and controlled. Like any composting process the material relies on natural bacteria to rot the material down. With in-vessel, composting the process is much hotter - up to 70 degrees which kills off any harmful bugs.

Environmental Advantages of In-Vessel Composting are;

- Reduces volume of organic waste going to landfills.
- Reduces odor and vermin attraction
- Compost is slow- release and will not leach out.
- Compost conserves water

- Reduces greenhouse emissions (production of landfill methane also produces C02 which is more harmful than methane)
- Compost has valuable nutritional value and has a ready market.
- Provides additional recycling credits.

Economic Advantages of In-Vessel Composting are;

- Re- use of organic waste on site saves producer on fertilizer costs
- Sale of excess compost to local farmers
- Reduction of waste disposal fees

In vessel, composting generally widely applied in various states in the USA and Canada. Vessel is used typically shaped tunnel or drum. As has been mentioned in-vessel composting systems reserve the bioreactor for the active stage of the composting process and rely upon windrow systems for the curing and maturation phase of the organic matter. The rationale of these systems is to maintain conditions at optimum levels during the active stage of the process and thus accelerating the microbial activity rate and consequently shortening the active phase. The economic gain of in-vessel systems in comparison to windrow composting is the reduction of residence time and the increase of its processing capacity as well as the better quality of the end product, since the conditions during the process are usually optimized and controlled at all times. However, the economics of some mechanized systems are more unfavorable than those of windrow systems. In the early 1970s, capital costs for compost plants in the USA were of the order of $15,000–20,000 per tonne of daily capacity. The operational costs were about $10–15 per tonne processed. Present day costs range from about $25,000 to about $80,000 per tonne of daily capacity weeks. Upon investigating the costs and the effort involved with a particular mechanized system, it should be borne in mind that a common failing in some of the promotional literature is the tendency to hold down apparent cost through the devices of under-designing the equipment needed and in under-estimating operational requirements.

Annex 2.3.3. Low solid anaerobic digestion (LSAD)

This process has been used for decades in the stabilization of sludge from the treatment of wastewater. The advantages offered by LSAD are operational simplicity and technology that has been developed for a much longer time than high solid systems. Cheaper equipments (pumps, pipe) can also be used for handling slurries, relative to solid materials. This advantage is however balanced by the higher investment costs resulting from larger reactor with internal mixing, larger dewatering and necessary pre-treatment steps.

Many MSW anaerobic treatment plants are in operation throughout the world. Many of the plants are situated in Europe, with the majority of the companies who design and construct the plants being European. Germany and Denmark lead the world in the number of plants operating by a significant margin. There are many companies involved in the design and construction of AD systems for processing MSW. The data is Table Annex 4 shows the companies involved in providing AD systems and the number of plants in operation, or under construction. It also gives the nationality of the company.

Table A-19 Companies supplying AD plants with capacity

Company & Nationality	No. Of Plants in Operation	No. Of Plants Under Construction
Arge Biogas (Austrian)	2	0
Entech (Austrian)	7	4
Kompogas (Swiss)	10	0
OWS-Dranco (Belgian)	4	1
BTA (German)	11	0
Steinmuller Valorga, Sarl (French)	2	4
Ecotec (Finish)	1	7
C.G.Jensen (Danish)	1	0
BWSC (Danish)	3	0
NNR (Danish)	6	0
Kruger (Danish)	12	2
Bioscan (Danish)	1	1
Prikom/HKV (Danish)	2	0
Jysk (Danish)	1	0
CiTEC (Finish)	1	1
Linde-KCA (German)	1	0
Schwarting UHDE (German)	1	0
ANM (German)	1	0
Haase Energietechnik (German)	1	1
DSD Gas und Tankanlagenbau (German)	2	0
IMK BEG Bioenergie (German)	0	1
Bioplan (Danish)	1	0
TBW (German)	1	0
BRV Technologie Systeme (German)	2	0
D.U.T (German)	1	0
Paques Solid Waste Systems (Dutch)	3	1
Unisyn Biowaste Technology (USA)	1	0
Duke Engineering (USA)	0	2
WMC Resource Recovery (UK)	0	1
R.O.M (Swiss)	1	1
Purac (Swedish)	1	0
SWECO/VBB (Swedish)	0	1
NSR (Swedish)	1	0
BKS Nordic (Swedish)	1	0
Projektror (Swedish)	2	0
Biocel/Heidemij Realisatie (Dutch)	1	0
Ionics Italba (Italian)	1	0
Kiklos (Italian)	1	0
SPI (Italian)	1	0
RPA (Italian)	1	0

Annex 3. Project ideas

Annex 3.1. Project ideas for forestry and peat sector

National Capacity Building on Technology for Forest-Peat Carbon Measurement and Monitoring

Introduction/Background

Carbon measurement and monitoring technology, in the context of CHG mitigation of Forest and Peat Sectors, deals with integrating knowledge, tools, and institutional framework aimed at facilitating two in one measurements: timber standing stock inventory and peat deposit survey. This integrated measurement technology would facilitate proper estimation of carbon stock by combining the results of conventional forest inventory (above ground biomass) and the result of peat survey (below ground biomass). Within the context of TTD (Technology Transfer and Diffusion) facilitated by 'Innovation System' approach, the above-mentioned technologies need to be integrated in the form of technology prototype. This marks the completion of the first chain of innovation process –research and development (R&D) – continuing to move into the initial phase of the second innovation chain –technology diffusion. This initial phase of diffusion – referred to as 'take-off' – is marked by transfer of technology from 'innovators' to 'early adopters'. Within this phase the reliability, practicality and financial feasibility of the technology is demonstrated and is recognized as phases of very difficult and critical to overcome.

The results of problem tree analysis revealed that the starter problem for TTD process of carbon measurement and monitoring technology is lack reference project of viable, credible and reliable integrated forest—peat carbon measurement. To assess possible solutions for overcoming barriers, a logical framework analysis was applied to objective trees. The results of logical framework solution are presented in Table A-20.

Table A-20 Recommended solution based on logical framework analysis for overcoming barriers of technology transfer and diffusion (TTD) of carbon measurement and monitoring technology.

Technology Transfer and Diffusion of Carbon Measurement and Monitoring Technology Goal: To make data and information available for Forest—Peat carbon accounting	
Maturing R&D	**Technology Diffusion**
Objective To establish a reference TTD project of Forest—Peat carbon measurement and monitoring	Objective To provide complete and updated information system on forest carbon stock covering sub-national level
Recommended Solutions	
Maturing R&D Phase	Technology Diffusion Phase
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented integrated peat-forest carbon measurement and monitoring technology. **Mode of Action:** International Capacity Building for a national expert consultation workgroup through the development of an operational, reliable, credible, and feasible prototype of integrated peat-forest carbon measurement and monitoring carried out on national demonstrator R&D field stations.	**Policy Action:** Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of integrated peat-forest carbon measurement and monitoring technology. **Mode of Action:** On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D field stations followed by a certain time period of trial and adjustment in their areas. The program is designed and implement by national expert consultation workgroup

The results suggest two inseparable key actions: (1) establish national demonstrator supported by (2) an international capacity building program be the solutions to overcome the difficult nature of "take off", i.e., from the phase of maturing R&D to the phase of technology diffusion. These key actions are in separable to each other. The first key action is an infrastructure for performing the second key action by which a newly invented technology is developed from a prototype development program.

Recognizing the critical nature of "take off" phase of TTD and considering the two inseparable key actions, an international capacity building project aimed to facilitate the success of "take off" phases from "innovators" to "early adopters" shall be developed and implemented, supported by adequate and proper international resources.

Purpose and Objectives

The purpose of this project is to build and improve capability of national innovation system to perform TTD of carbon measurement and monitoring technology, which is specifically aimed to facilitate the 'innovators' and the 'early adopters' to perform "take off" successfully and be achieved through a framework of International Capacity Building program comprises two pathways: bilateral/multilateral R&D arrangements and an international training program.

Recognizing the purpose of the project, this project idea should facilitate the achievement of the following objectives:

Ultimate Objective: development and establishment of a Reference Project dedicated for the demonstration of reliability, practicality and financial feasibility of newly invented peat-forest carbon measurement and monitoring technology.

Specific Objectives:

1) Development and establishment of "National Demonstrator" in the forms of a network of sub national TTD reference stations, demonstrating reliability, practicality and financial feasibility of newly invented integrated peat-forest carbon measurement and monitoring technology.
2) Arrangement and Implementation of an International Capacity Building program for in the form of "innovators" as well as "early adopters" in the form of cooperation on the modelling and prototype development of reliable, credible, and feasible integrated peat-forest carbon measurement and monitoring technology carried out on the "national demonstrator".

Relationship to the country's sustainable development priorities

In the context of climate change, forests are recognized as a source or a sink of greenhouse gases, particularly CO2. Such recognition is documented in the Indonesia Climate Change Sectoral Roadmap – ICCSR (BAPPENAS 2009). In this document, Ministry of Forestry proposed several key mitigation measures by implementing some selected BMPs (Best Management Practice) of SFM (Sustainable Forest Management) aimed for sink enhancement and emission reduction from forestry sector. The summary of the key mitigation measures are as follows:

Sink enhancement: Forest rehabilitation activities mostly on protection forest and watershed; Development of industrial plantations (HTI), plantations with private entrepreneurs and communities (HTR) on production forest; Stimulate plantations outside forestlands for rehabilitation or wood production; Management of natural secondary forests in production, protection and conservation forests.

Emission reduction: Improved sylviculture and logging activities in productive natural forest; reducing emissions form forestland conversion particularly on peat forestland; reducing emissions from illegal logging and fire.

The ICCSR document also revealed that the key mitigation measures are implemented by so-called KPH-HTI-SFM scenario. This scenario is characterized by heavy investments on the establishment of hundreds of newly developed Forest Management Units (KPH) in order to guarantee significant improvement of sustainable forest management (SFM) of all state forests: natural forests, rehabilitated forest, and productive plantation. Within the first period of Forestry Sector's roadmap, (2010 – 2019) 244 newly developed KPHs will be established and by the end of second period (2020-2029) a total number of 344 KPHs will be established. Mitigation efforts in this scenario are based on a mix of activities:

1) Industrial forest plantations (HTI) established on dry land, where KPH have been developed;
2) Emission reduction enhancement comes from better sustainable forest management (SFM) of production, conservation and protection forests under the KPHs; and
3) Some modest REDD activities during the first period of 2010-2014.

Carbon Measurement and Monitoring (CMM) Technology is expected to support better SFM, in terms of providing key mitigation measures with method, manual, tools, and skill for both integrated measurement and monitoring of above and below ground biomass (Table A-21). Such supports will be implemented in this International Capacity Building program, specifically by building and improving capability of national innovation system to perform TTD of CMM technology. And such a capacity building program will facilitate the 'innovators' and the 'early adopters' to perform "take off" successfully led the CMM technology operational in all of the newly established KPH.

Project Deliverables

The main deliverable of this project would be an operational "National Demonstrator" to demonstrate the reliability, practicality and financial feasibility of newly invented integrated peat-forest CMM technology. This National Demonstrator for CMM technology comprises three technology components as follows:
1) Hardware: a network of sub national TTD reference stations
2) Software: CMM models and prototypes, regulation for CMM
3) Org-ware: Inter-Institutional national task force and expert workgroup

Table A-21 Key mitigation measures as prioritized SFM (Sustainable Forest Management) and expected support from carbon measurement and monitoring (CMM) technology.

<table>
<tr><th colspan="3">Key Mitigation Measures</th><th>Expected Support of CMM Technology</th></tr>
<tr><td rowspan="3">Sink Enhancement</td><td colspan="2">A forestation/Reforestation:</td><td rowspan="9">Integrated method, manual, tools, and skill for measurement and monitoring of above and below ground biomass on:
■ newly planted area
■ improved degraded areas by better SFM
■ Protection and conservation forest using better SFM
■ Prevention and reduction of forest fire
■ Low carbon peatland management</td></tr>
<tr><td>• Gerhan/RHL
• One Mill tree program
• HTI
• HTR</td><td>• HR
• Community Forest
• Village Forest
• Natural Forest</td></tr>
<tr><td colspan="2">Improve Sustainable Forest Management (SFM) to Increase stock on degraded forest:
■ Stock enhancement on protected forest
■ Stock enhancement on conservation forest</td></tr>
<tr><td rowspan="6">Emission Reduction</td><td colspan="2">Increase of Protection forest land under SFM</td></tr>
<tr><td colspan="2">Increase of Conservation forest land under SFM</td></tr>
<tr><td colspan="2">Prevention of forest fire</td></tr>
<tr><td colspan="2">Management of productive natural forest</td></tr>
<tr><td colspan="2">Reduction of forest fire</td></tr>
<tr><td colspan="2">Low Carbon Peatland Management
■ Enforce strict compliance by existing forest and plantation concessions on >3m peat
■ zero burning for land clearing
■ water management to reduce subsidence and carbon emissions from oxidation</td></tr>
</table>

Project Scope and Possible Implementation

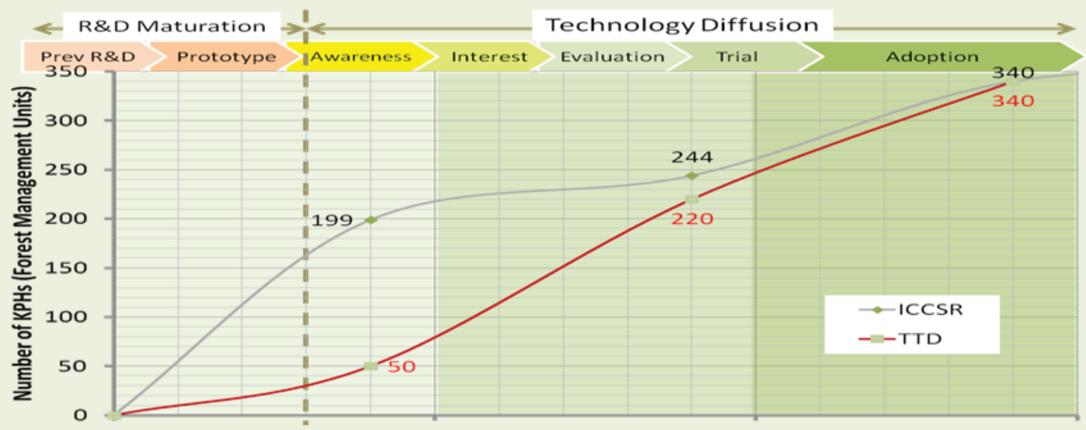
By inferring the purpose of this project, the scope of this project can be defined as follows:

1. Build and improve capability of national innovation system to perform TTD
2. Facilitate the ‘innovators’ and the ‘early adopters’ to perform “take off”
3. International Capacity Building program in modelling and prototyping by means of

- bilateral/multilateral R&D arrangements and
- international training program

By this definition, the scope of this project shall be structured and implemented according to logical framework of purpose, outcome, program, work breakdown structure (WBS) and work package confined by measures and incentives of the R&D maturation up to early phases of technology diffusion of the TTD-curved as graphically illustrated in Figure A-19.

Purpose	Build and improve capability of national innovation system to perform TTD		
Outcome	Facilitate the 'innovators' and the 'early adopters' to perform "take off"		
Program	International Capacity Building in Modelling and Prototyping of Forest – Peat Carbon Measurement and Monitoring		
WBS, Work Package,	Forest-peat carbon modelling	Forest-peat carbon measurement and monitoring prototyping	
Measure, and	M1,M2,M3,M4	M1,M2,M3, M5	
Incentive	I1, I2, I4	I3, I4	



Measures	Incentives
M1 Establishment of Forest—Peat carbon measurement national task Force M2 Establishment of expert workgroup for growth modelling biomass measurement M3 Establishment of expert workgroup for peat biomass measurement modelling M4 Prototype Development of Forest—Peat carbon measurement by means of international capacity building for Forest—Peat biomass and carbon modelling M5 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement	I1 Development of inter ministerial task force and expert workgroups I2 Self capacity building arrangement for inter ministerial expert workgroups I3 Regulation for facilitation of TTD reference stations and supporting facilities I4 Financial schemes for M1,M2,M3,M4,M5

Figure A-19 Logical framework and scope of project

Timelines and Geographical Extent

This project is designed as a national multiyear program, whose timeline and geographical extent for the achievement of its WBS and work packages are presented in Table A-22.

Viewing from a broader scope of the whole objective tree of TTD processes of forest-pest carbon measurement and monitoring technology, the scope of this project shall be related and perfectly matched with the scope of Sub-National Collaborative Learning Project (Figure A-20).

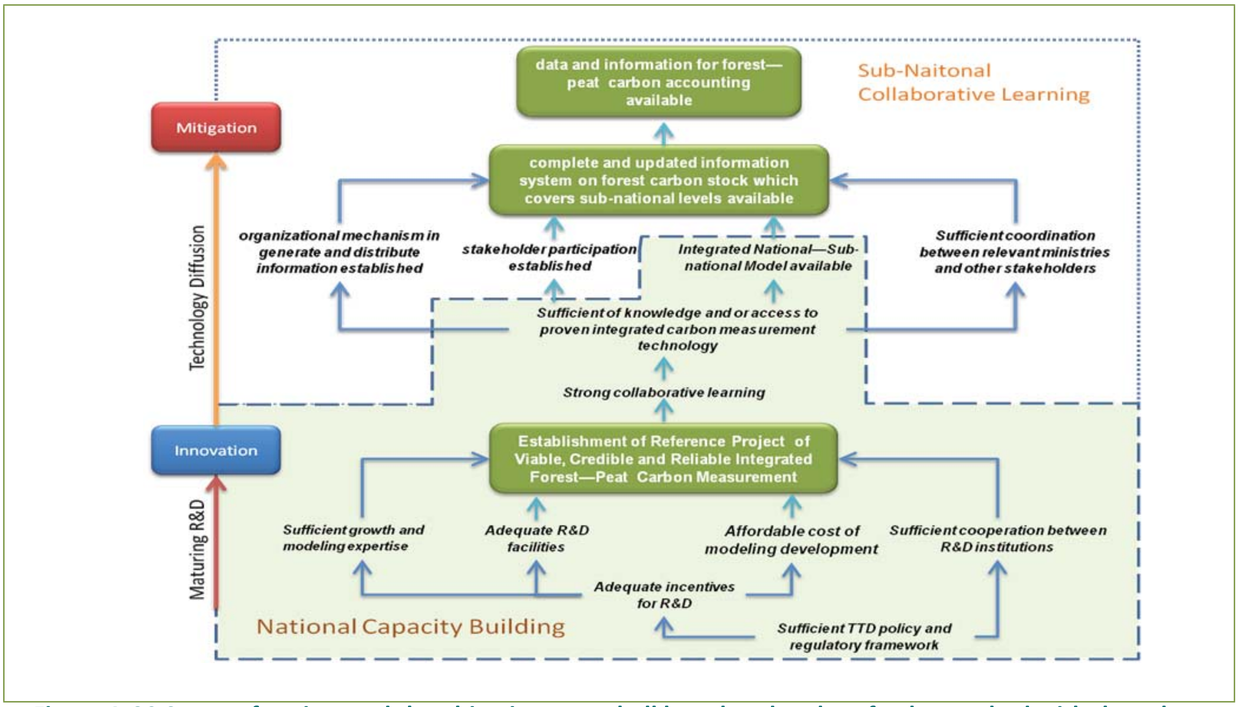


Figure A-20 Scope of project and the objective tree: shall be related and perfectly matched with the sub-national collaborative learning project

Table A-22 Timeline and geographical extent

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Time Line			
	Year 1	Year 2	Year 3	Year 4
Development of national task force and expert workgroup				
M1 Establishment of Forest—Peat carbon measurement national task Force	>>>>			
M2 Establishment of expert workgroup for growth modelling biomass measurement	>>>>			
M3 Establishment of expert workgroup for peat biomass measurement modelling	>>>>			
I1 Development of inter ministerial task force and expert workgroups	>>>>			
I2 Self capacity building arrangement for inter ministerial expert workgroups	>>>>			
I4 Financial schemes for M1,M2,M3	>>>>			
Development of CMM models and prototypes				
M4 Prototype Development of Forest—Peat carbon measurement by means of international capacity building for Forest—Peat biomass and carbon modelling	sumatra	sumatra	kalimantan	papua
		kalimantan	papua	sulawesi
I4 Financial schemes for M4	>>>>	>>>>	>>>>	>>>>
Development of network of sub national TTD reference stations				
M5 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping	sumatra	sumatra	kalimantan	papua
		kalimantan	papua	sulawesi
I3 Regulation for facilitation of TTD reference stations and supporting facilities	>>>>			
I4 Financial schemes for,M4	>>>>	>>>>	>>>>	>>>>

Resource and Budget Requirements

Resources and budget required for the achievement of WBS and work packages of this project of both national and international sources are listed in Table A-23.

Table A-23 Resources and budget

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Resources	Budget	
		National	International
Development of national task force and expert workgroup			Hundred thousands of USD
M1 Establishment of Forest—Peat carbon measurement national task Force	National expert, meeting, workshop, seminar	PM	
M2 Establishment of expert workgroup for growth modelling biomass measurement	National and International expert, meeting, training course, and workshop	PM	PM
M3 Establishment of expert workgroup for peat biomass measurement modelling	National and International expert, meeting, training course, and workshop	PM	PM
I1 Development of inter ministerial task force and expert workgroups	Policy and regulation, meeting, workshop, and seminar	PM	
I2 Self capacity building arrangement for inter ministerial expert workgroups	Policy and regulation, meeting, workshop, and seminar	PM	PM
I4 Financial schemes for M1,M2,M3	Policy and Regulation, meeting, workshop, international cooperation	PM	
Development of CMM models and prototypes			Mill of USD
M4 Prototype Development of Forest—Peat carbon measurement by means of international capacity building for Forest—Peat biomass and carbon modelling	National and international experts, International and national training course, on the shelve and previous R&D models and prototypes	PM	PM
I4 Financial schemes for M4	Policy and regulation, meeting, seminar, international cooperation	PM	
Development of network of sub national TTD reference stations			Mill of USD
M5 Establish a network of TTD reference stations and provide them with adequate facilities for prototyping carbon measurement	Field station, building, equipments, computer hardware, modelling software, workshops, seminar	PM	PM
I 3 Regulation for facilitation of TTD reference stations and supporting facilities	Policy and regulation, meeting, seminar, international cooperation	PM	PM
I4 Financial schemes for,M4	Policy and regulation, meeting, seminar, international cooperation	PM	PM
TOTAL BUDGET			Ten Mill of USD

Measurement/Evaluation

To measure whether the purpose of this project is accomplished and the objectives of this project are accomplished, evaluations of accomplishment of each work package shall be carried out accordingly. The evaluations are proposed to be carried out in two phases: intermediate and final program reviews.

The intermediate review shall be carried out in three steps as follows:

1. Initial review: evaluation of conditions of work packages ready to start
2. Detail review: evaluation of a work packages complied with technical requirements
3. Critical review: evaluation of work packages are timely delivered or need rescheduling

The final review shall be carried out at the end of completion of each work package to evaluate the accomplishment of the purpose and the objectives of this project. The scheme of this review is presented in Table A-24.

Table A-24 Scheme of final program review

Work Breakdown Structure and Work Package of Measures and Incentives	Indicator of achievement
Development of national task force and expert workgroup	
M1 Establishment of Forest—Peat carbon measurement national task force	Strategic agenda implemented
M2 Establishment of expert workgroup for growth modelling biomass measurement	Working agenda implemented
M3 Establishment of expert workgroup for peat biomass measurement modelling	Working agenda implemented
I1 Development of inter ministerial task force and expert workgroups	Formal regulation implemented
I2 Self capacity building arrangement for inter ministerial expert workgroups	Formal regulation implemented
I4 Financial schemes for M1,M2,M3	Formal regulation implemented
Development of CMM models and prototypes	
M4 Prototype Development of Forest—Peat carbon measurement by means of international capacity building for Forest—Peat biomass and carbon modelling	Model implemented Prototype demonstrated
I4 Financial schemes for M4	Formal regulation implemented
Development of network of sub national TTD reference stations	
M5 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement	Network of reference station are in operation
I3 Policy and regulation, meeting, seminar, international cooperation	Formal regulation implemented
I4 Financial schemes for,M4	Formal regulation implemented

Possible Complications/Challenges

The idea of this project assumes that the barriers of TTD processes are overcame within current framework of condition in favorable current enabling environments. Any alterations on the current framework condition and enabling environments will lead to possible complication of the implementation of this project. A risk analysis on the following possible threads of complication needs to be carried out prior to the implementation of this project.

A. National Policy Action and Priorities

1. Change of priorities in national development plan
2. Change of priorities in related sectors strategic plan:
   - Ministry of Forestry
   - Ministry of environment
   - Ministry of Agriculture
   - Ministry of Research and Technology
3. Current status and projected trend of the implementation of Climate Change action plan and recommendations:
   - Indonesia Second National Communication (Ministry of Environment)
   - Indonesia Climate Change Sectoral Roadmap (Bappenes)
   - Indonesia's greenhouse gas abatement cost curve (DNPI)

B. International Support
   - Status, implementation, and implication of REDD program for Indonesia
   - Status, results, and implications of previous and current International projects associated with climate change and carbon trade

Responsibilities and Coordination

The purpose of this project is obvious, i.e., building and improving national capability of innovation system to perform TTD of carbon measurement and monitoring technology. This implies strong coordination of among involving related national institutions. The coordination model coordinating, implementing, and contributing institutions, based on the structure logical frameworks of WBS and work packages may be defined as follows (Table A-25.)

Table A-25 Responsibility and coordination

Work Breakdown Structure and Work Package of Measures and Incentives	Responsibility and Coordination		
	Coordinating	Implementing	Contributing
Development of national task force and expert workgroup M1 Establishment of Forest—Peat carbon measurement national task force M2 Establishment of expert workgroup for growth modelling biomass measurement M3 Establishment of expert workgroup for peat biomass measurement modelling I1 Development of inter ministerial task force and expert workgroups I2 Self capacity building arrangement for inter ministerial expert workgroups I4 Financial schemes for M1,M2,M3	Ministry of Forestry	DG of Forest Planning of Ministry of forestry	Ministry of Finance BPPT LIPI Soil Research Institute Forest Research Institute CIFOR Universities
Development of CMM models and prototypes M4 Prototype Development of Forest—Peat carbon measurement by means of international capacity building for Forest—Peat biomass and carbon modelling I4 Financial schemes for M4			
Development of network of sub national TTD reference stations M5 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement I3 Formal regulation implemented I4 Financial schemes for,M4			

National Capacity Building on Unified Peat Re-Mapping Technology (PROJECT IDEA)

Introduction/Background

Carbon measurement and monitoring technology, in the context of CHG mitigation of Forest and Peat Sectors, deals with integrating knowledge, tools, and institutional framework aimed at facilitating two in one measurements: timber standing stock inventory and peat deposit survey. This integrated measurement technology would facilitate proper estimation of carbon stock by combining the results of conventional forest inventory (above ground biomass) and the result of peat survey (below ground biomass). Within the context of TTD (Technology Transfer and Diffusion) facilitated by 'Innovation System' approach, the above-mentioned technologies need to be integrated in the form of technology prototype. This marks the completion of the first chain of innovation process –research and development (R&D) – continuing to move into the initial phase of the second innovation chain –technology diffusion. This initial phase of diffusion – referred to as 'take-off' – is marked by transfer of technology from 'innovators' to 'early adopters'. Within this phase the reliability, practicality and financial feasibility of the technology is demonstrated and is recognized as phases of very difficult and critical to overcome.

The results of problem tree analysis revealed that the starter problem for TTD process of unified peat re-mapping technology is lack reference project of viable, credible and reliable Unified Peat Mapping. To assess possible solutions for overcoming barriers, a logical framework analysis was applied to objective trees. The results of logical framework solution are presented in Table A-26.

Table A-26 Recommended solution based on logical framework analysis for overcoming barriers of technology transfer and diffusion (TTD) of unified peat re-mapping technology

Technology Transfer and Diffusion of Unified Peat Re-Mapping Technology Goal: To make data and spatial information available for "Low Carbon" Peatland Management	
Maturing R&D	Technology Diffusion
Objective Establishment of a TTD reference project of viable, credible, and reliable unified peat mapping	Objective To provide complete and updated information system on forest carbon stock covering sub-national level
Recommended Solutions	
Maturing R&D Phase	Technology Diffusion Phase
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented unified peat mapping system technology. **Mode of Action:** International Capacity Building for a national expert consultation workgroup through the development of an operational, reliable, credible, and feasible prototype of unified peat mapping system carried out on national demonstrator TTD reference stations.	**Policy Action:** Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of unified peat mapping system technology. **Mode of Action:** On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator TTD reference stations followed by a certain period of trial and adjustment in their areas. The program is designed and implement by national expert consultation workgroup

The results suggest two inseparable key actions: (1) establish national demonstrator supported by (2) an international capacity building program be the solutions to overcome the difficulty nature of "take off", i.e., from the phase of maturing R&D to the phase of technology diffusion. These key actions are in separable to each other. The first key action is an infrastructure for performing the second key action by which a newly invented technology is developed from a prototype development program.

Recognizing the critical nature of "take off" phase of TTD and considering the two inseparable key actions, an international capacity building project aimed to facilitate the success of "take off" phases from "innovators" to "early adopters" shall be developed and implemented, supported by adequate and proper international resources.

Purpose and Objectives

The purpose of this project is to build and improve capability of national innovation system to perform TTD of unified peat re-mapping technology, which is specifically aimed to facilitate the 'innovators' and the 'early adopters' to perform "take off" successfully and be achieved through a framework of International Capacity Building program comprises two pathways: bilateral/multilateral R&D arrangements and an international training program.

Recognizing the purpose of the project, this project idea should facilitate the achievement of the following objectives:

Ultimate Objective: development and establishment of a Reference Project dedicated for the demonstration of reliability, practicality and financial feasibility of newly invented unified peat re-mapping technology.

Specific Objectives:

1) Development and establishment of "National Demonstrator" in the forms of a network of sub national TTD reference stations, demonstrating reliability, practicality and financial feasibility of newly invented unified peat re-mapping technology.

2) Arrangement and Implementation of an International Capacity Building program for in the form of "innovators" as well as "early adopters" in the form of cooperation on the modelling and prototype development of reliable, credible, and feasible unified peat re-remapping technology carried out on the "national demonstrator".

Relationship to the country's sustainable development priorities

In the context of climate change, forests are recognized as a source or a sink of greenhouse gases, particularly CO2. Such recognition is documented in the Indonesia Climate Change Sectoral Roadmap – ICCSR (BAPPENAS 2009). In this document, Ministry of Forestry proposed several key mitigation measures by implementing some selected BMPs (Best Management Practice) of SFM (Sustainable Forest Management) aimed for sink enhancement and emission reduction from forestry sector. The summary of the key mitigation measures are as follows:
Sink enhancement: Forest rehabilitation activities mostly on protection forest and watershed; Development of industrial plantations (HTI), plantations with private entrepreneurs and communities (HTR) on production forest; Stimulate plantations outside forest lands for rehabilitation or wood production; Management of natural secondary forests in production, protection and conservation forests.

Emission reduction: Improved sylviculture and logging activities in productive natural forest; reducing emissions form forestland conversion particularly on peat forestland; reducing emissions from illegal logging and fire.

The ICCSR document also revealed that the key mitigation measures are implemented by so-called KPH-HTI-SFM scenario. This scenario is characterized by heavy investments on the establishment of hundreds of newly developed Forest Management Units (KPH) in order to guarantee significant improvement of sustainable forest management (SFM) of all state forests: natural forests, rehabilitated forest, and productive plantation. Within the first period of Forestry Sector's roadmap (2010 – 2019) 244 newly developed KPHs will be established and by the end of second period (2020-2029) a total number of 344 KPHs will be established. Mitigation efforts in this scenario are based on a mix of activities:

1) Industrial forest plantations (HTI) established on dry land, where KPH have been developed;
2) Emission reduction enhancement comes from better sustainable forest management (SFM) of production, conservation and protection forests under the KPHs; and
3) Some modest REDD activities during the first period of 2010-2014.

Unified Peat Re-Mapping (PRM) Technology is expected to support better SFM, in terms of providing key mitigation measures with method, manual, tools, and skill for both integrated unified peat re-mapping (Table A-27). Such supports will be implemented in this International Capacity Building program, specifically by building and improving capability of national innovation system to perform TTD of PRM technology. And such a capacity building program will facilitate the 'innovators' and the 'early adopters' to perform "take off" successfully led the PRM technology operational in all of the newly established KPH.

Table A-27 Key Mitigation Measures as prioritized SFM (Sustainable Forest Management) and Expected support from Peat Re-Mapping (PRM) Technology.

<table>
<tr><th colspan="3">Key Mitigation Measures</th><th>Expected Support of CMM Technology</th></tr>
<tr><td rowspan="3">Sink Enhancement</td><td colspan="2">Aforestation/Reforestation:</td><td rowspan="9">Newly invented unified peat re-mapping method, manual, tools, and skills to facilitate key mitigation measures:
■ Aforestation/ reforestation of peat swamp forest and peatland
■ Improvement of SFM of degraded protection and conservation forest on peat swamp
■ Forest fire prevention and reduction on peat
■ Low carbon peatland management</td></tr>
<tr><td>• Gerhan/RHL
• One Mill tree program
• HTI
• HTR</td><td>• HR
• Community Forest
• Village Forest
• Natural Forest</td></tr>
<tr><td colspan="2">Improve Sustainable Forest Management (SFM) to Increase stock on degraded forest:
■ Stock enhancement on protected forest
■ Stock enhancement on conservation forest</td></tr>
<tr><td rowspan="6">Emission Reduction</td><td colspan="2">Increase of Protection forest land under SFM</td></tr>
<tr><td colspan="2">Increase of Conservation forest land under SFM</td></tr>
<tr><td colspan="2">Prevention of forest fire</td></tr>
<tr><td colspan="2">Management of productive natural forest</td></tr>
<tr><td colspan="2">Reduction of forest fire</td></tr>
<tr><td colspan="2">Low Carbon Peatland Management
■ Enforce strict compliance by existing forest and plantation concessions on >3m peat
■ zero burning for land clearing
■ water management to reduce subsidence and carbon emissions from oxidation</td></tr>
</table>

Project Deliverables

The main deliverable of this project would be an operational "National Demonstrator" to demonstrate the reliability, practicality and financial feasibility of newly invented unified PRM technology. This National Demonstrator for unified PRM technology comprises three technology components as follows:

1) Hardware: a network of sub national TTD reference stations
2) Software: unified PRM models and prototypes, regulation for PRM
3) Org-ware: Inter-Institutional national task force and expert workgroup

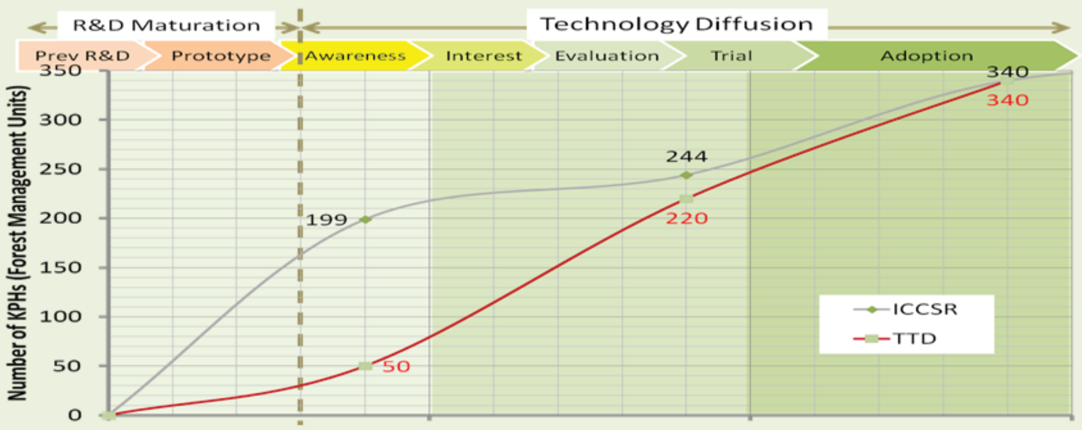
Project Scope and Possible Implementation

By inferring the purpose of this project, the scope of this project can be defined as follows:

1. Build and improve capability of national innovation system to perform TTD
2. Facilitate the 'innovators' and the 'early adopters' to perform "take off"
3. International Capacity Building program in modelling and prototyping by means of
   - bilateral/multilateral R&D arrangements and
   - international training program

By this definition, the scope of this project shall be structured and implemented according to logical framework of purpose, outcome, program, work breakdown structure (WBS) and work package confined by measures and incentives of the R&D maturation up to early phases of technology diffusion of the TTD-curved as graphically illustrated in Figure A-21.

Purpose	**Build and improve capability of national innovation system to perform TTD**		
Outcome	Facilitate the 'innovators' and the 'early adopters' to perform "take off"		
Program	International Capacity Building in Modelling and Prototyping of Unified Peat Re-Mapping		
WBS, Work Package,	Unified Peat Re-Mapping modelling	Unified Peat Re-Mapping prototyping	
Measure, and	M1,M2,M3,M4	M1,M2,M3, M5	
Incentive	I1, I2, I4	I3, I4	



Measures	Incentives
M1. Establishment of unified peat re-mapping national task Force M2. Establishment of expert workgroup for unified peat re-mapping M3. Establish national capacity building for unified peat mapping prototype development M4.Provide adequate TTD reference stations and facilities for unified peat mapping prototyping (hardware and software)	I1: Development of inter ministerial task force and expert workgroups I2: Self capacity building arrangement for inter ministerial expert workgroups I3: Regulation for facilitation of TTD Reference stations and supporting facilities I4: Financial schemes for M1,M2,M3,M4

Figure A-21 Logical framework and scope of project.

Viewing from a broader scope of the whole objective tree of TTD processes of unified peat re-mapping technology, the scope of this project shall be related and perfectly matched with the scope of Sub-National Collaborative Learning Project (Figure A-22).

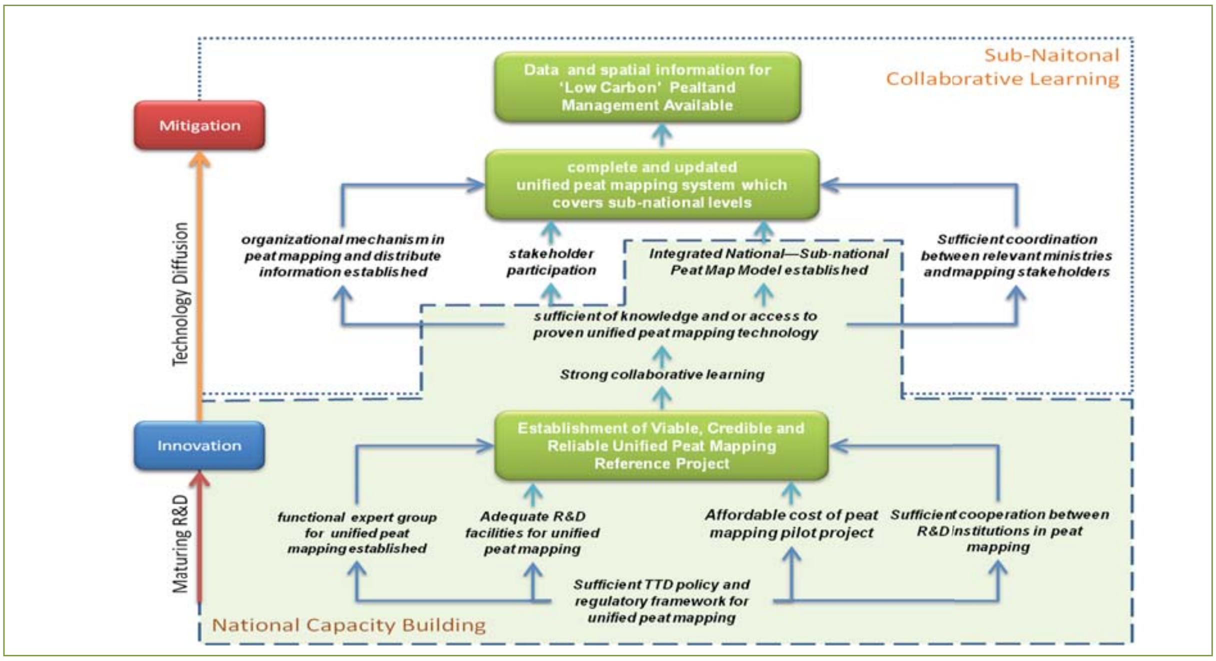


Figure A-22 Scope of project and the objective tree: shall be related and perfectly matched with the sub-national collaborative learning project

Timelines and Geographical Extent

This project is designed as a national multiyear program, whose timeline and geographical extent for the achievement of its WBS and work packages are presented in Table A-28.

Table A-28 Timeline and Geographical Extent

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Time Line			
	Year 1	Year 2	Year 3	Yea 4
Development of national task force and expert workgroup				
M1 Establishment of united peat re-mapping national task Force	>>>>			
M2 Establishment of expert workgroup for unified peat re-mapping	>>>>			
I1 Development of inter ministerial task force and expert workgroups	>>>>			
I2 Self capacity building arrangement for inter ministerial expert workgroups	>>>>			
I4 Financial schemes for M1,M2,M3	>>>>			
Development of CMM models and prototypes				
M3 Prototype Development of unified peat mapping by means of international capacity building	sumatra	sumatra	kalimantan	papua
		kalimantan	papua	sulawesi
I4 Financial schemes for M4	>>>>	>>>>	>>>>	>>>>

Table A-28 (Continued)

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Time Line			
	Year 1	Year 2	Year 3	Yea 4
Development of network of sub national TTD reference stations				
M4 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping unified peat re-mapping	sumatra	sumatra	kalimantan	papua
		kalimantan	papua	sulawesi
I3 Regulation for facilitation of TTD Reference stations and supporting facilities	>>>>	>>>>	>>>>	>>>>
I4 Financial schemes for,M4	>>>>			

Resource and Budget Requirements

Resources and budget required for the achievement of WBS and work packages of this project of both national and international sources are listed in Table A-29.

Measurement/Evaluation

To measure whether the purpose of this project is accomplished and the objectives of this project are accomplished, evaluations of accomplishment of each work package shall be carried out accordingly. The evaluations are proposed to be carried out in two phases: intermediate and final program reviews.

The intermediate review shall be carried out in three steps as follows:
1. Initial review: evaluation of conditions of work packages ready to start
2. Detail review: evaluation of a work packages complied with technical requirements
3. Critical review: evaluation of work packages are timely delivered or need rescheduling

The final review shall be carried out at the end of completion of each work package to evaluate the accomplishment of the purpose and the objectives of this project. The scheme of this review is presented in Table A-30.

Table A-29 Resources and budget

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Resources	Budget	
		National	International
Development of national task force and expert workgroup			Hundred thousands of USD
M1 Establishment of Unified Peat Re-Mapping national task Force	National expert, meeting, workshop, seminar	PM	
M2 Establishment of expert workgroup for Unified Peat Re-Mapping	National and International expert, meeting, training course, and workshop	PM	PM
I1 Development of inter ministerial task force and expert workgroups	Policy and regulation, meeting, workshop, and seminar	PM	
I2 Self capacity building arrangement for inter ministerial expert workgroups	Policy and regulation, meeting, workshop, and seminar	PM	PM
I4 Financial schemes for M1,M2	Policy and Regulation, meeting, workshop, international cooperation	PM	

Development of CMM models and prototypes			Mill of USD
M3 Prototype Development of unified Peat Re-Mapping by means of international capacity building	National and international experts, International and national training course, on the shelve and previous R&D models and prototypes	PM	PM
I4 Financial schemes for M3	Policy and regulation, meeting, seminar, international cooperation	PM	
Development of network of sub national TTD reference stations			Mill of USD
M4 Establish a network of TTD reference stations and provide them with adequate facilities for prototyping carbon measurement	Field station, building, equipments, computer hardware, modelling software, workshops, seminar	PM	PM
I3 Regulation for facilitation of TTD Reference stations and supporting facilities	Policy and regulation, meeting, seminar, international cooperation	PM	PM
I4 Financial schemes for,M4	Policy and regulation, meeting, seminar, international cooperation	PM	PM
TOTAL BUDGET			Ten Mill of USD

Table A-30 Scheme of final program review

Work Breakdown Structure and Work Package of Measures and Incentives	Indicator of achievement
Development of national task force and expert workgroup	
M1 Establishment of Unified Peat Re-Mapping national task force	Strategic agenda implemented
M2 Establishment of expert workgroup for Unified Peat Re-Mapping national task force	Working agenda implemented
I1 Development of inter ministerial task force and expert workgroups	Formal regulation implemented
I2 Self capacity building arrangement for inter ministerial expert workgroups	Formal regulation implemented
I4 Financial schemes for M1,M2,M3	Formal regulation implemented
Development of CMM models and prototypes	
M3 Prototype Development of Unified Peat Re-Mapping by means of international capacity building	Model implemented
I4 Financial schemes for M3	Formal regulation implemented
Development of network of sub national TTD reference stations	
M4 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement	Network of reference station are in operation
I3 Regulation for facilitation of TTD Reference stations and supporting facilities	Formal regulation implemented
I4 Financial schemes for,M4	Formal regulation implemented

Possible Complications/Challenges

The idea of this project assumes that the barriers of TTD processes are overcame within current framework of condition in favorable current enabling environments. Any alterations on the current framework condition and enabling environments will lead to possible complication of the implementation of this project. A risk analysis on the following possible threads of complication needs to be carried out prior to the implementation of this project.

A. National Policy Action and Priorities

4. Change of priorities in national development plan

5. Change of priorities in related sectors strategic plan:

- Ministry of Forestry
- Ministry of environment
- Ministry of Agriculture
- Ministry of Research and Technology

6. Current status and projected trend of the implementation of Climate Change action plan and recommendations:

- Indonesia Second National Communication (Ministry of Environment)
- Indonesia Climate Change Sectoral Roadmap (Bappenes)
- Indonesia's greenhouse gas abatement cost curve (DNPI)

B. International Support

- Status, implementation, and implication of REDD program for Indonesia
- Status, results, and implications of previous and current International projects associated with climate change and carbon trade

Responsibilities and Coordination

The purpose of this project is obvious, i.e., building and improving national capability of innovation system to perform TTD of carbon measurement and monitoring technology. This implies strong coordination of among involving related national institutions. The coordination model coordinating, implementing, and contributing institutions, based on the structure logical frameworks of WBS and work packages may be defined as follows (Table A-31).

Table A-31 Responsibility and coordination

Work Breakdown Structure and Work Package of Measures and Incentives	Responsibility and Coordination		
	Coordinating	Implementing	Contributing
Development of national task force and expert workgroup M1 Establishment of Unified Peat Re-Mapping national task force M2 Establishment of expert workgroup for Unified Peat Re-Mapping I1 Development of inter ministerial task force and expert workgroups I2 Self capacity building arrangement for inter ministerial expert workgroups I4 Financial schemes for M1,M2,M3	Ministry of Forestry	DG of Forest Planning of Ministry of forestry Bakosurtanal	■ Ministry of Finance ■ BPPT ■ Soil Research Institute ■ Forest Research Institute ■ CIFOR ■ Universities
Development of CMM models and prototypes M3 Prototype Development of Unified Peat Re-Mapping by means of international capacity building I4 Financial schemes for M4			
Development of network of sub national TTD reference stations M5 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement I3 Regulation for facilitation of TTD Reference stations and supporting facilities I4 Financial schemes for,M4			

National Capacity Building on Technology for Carbon measurement and monitoring (PROJECT IDEA)

Introduction/Background

Carbon measurement and monitoring technology, in the context of CHG mitigation of Forest and Peat Sectors, deals with integrating knowledge, tools, and institutional framework aimed at facilitating two in one measurements: timber standing stock inventory and peat deposit survey. This integrated measurement technology would facilitate proper estimation of carbon stock by combining the results of conventional forest inventory (above ground biomass) and the result of peat survey (below ground biomass). Within the context of TTD (Technology Transfer and Diffusion) facilitated by 'Innovation System' approach, the above-mentioned technologies need to be integrated in the form of technology prototype. This marks the completion of the first chain of innovation process –research and development (R&D) – continuing to move into the initial phase of the second innovation chain –technology diffusion. This initial phase of diffusion – referred to as 'take-off' – is marked by transfer of technology from 'innovators' to 'early adopters'. Within this phase the reliability, practicality and financial feasibility of the technology is demonstrated and is recognized as phases of very difficult and critical to overcome.

The results of problem tree analysis revealed that the starter problem for TTD process of Peatland Water Management Technology is lack reference project of viable, credible and reliable Peatland Water Management. To assess possible solutions for overcoming barriers, a logical framework analysis was applied to objective trees. The results of logical framework solution are presented in Table A-32.

Table A-32 Recommended solution based on logical framework analysis for overcoming barriers of technology transfer and diffusion (TTD) of peatland water management technology

Technology Transfer and Diffusion of Peatland Water Management Technology Goal: To Achieve Zero Risk of Peatland Degradation, peatland fire, and Peat Forest Fire	
Maturing R&D	**Technology Diffusion**
Objective Establishment of reference project of viable, credible, and reliable peatland water management	Objective Provide effective water management for "Low Carbon" peat management on HTI, plantation estate, and irrigated farmland
Recommended Solutions	
Maturing R&D Phase	Technology Diffusion Phase
Policy Action: Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented peat water management technology. **Mode of Action:** International Capacity Building for a national expert consultation workgroup through the development of an operational, reliable, credible, and feasible prototype of peat water management carried out on national demonstrator TTD Reference stations.	**Policy Action:** Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of peatland water management technology. **Mode of Action:** On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator TTD reference stations followed by a certain time period of trial and adjustment in their areas. The program is designed and implement by national expert consultation workgroup

The results suggest two inseparable key actions: (1) establish national demonstrator supported by (2) an international capacity building program be the solutions to overcome the difficulty nature of "take off", i.e., from the phase of maturing R&D to the phase of technology diffusion. These key actions are in separable to each other. The first key action is an infrastructure for performing the second key action by which a newly invented technology is developed from a prototype development program.

Recognizing the critical nature of "take off" phase of TTD and considering the two inseparable key actions, an international capacity building project aimed to facilitate the success of "take off" phases from "innovators" to "early adopters" shall be developed and implemented, supported by adequate and proper international resources.

Purpose and Objectives

The purpose of this project is to build and improve capability of national innovation system to perform TTD of peatland water management technology, which is specifically aimed to facilitate the 'innovators' and the 'early adopters' to perform "take off" successfully and be achieved through a framework of International Capacity Building program comprises two pathways: bilateral/multilateral R&D arrangements and an international training program.

Recognizing the purpose of the project, this project idea should facilitate the achievement of the following objectives:

Ultimate Objective: development and establishment of a Reference Project dedicated for the demonstration of reliability, practicality and financial feasibility of newly invented peatland water management technology

Specific Objectives:

5) Development and establishment of "National Demonstrator" in the forms of a network of sub national TTD reference stations, demonstrating reliability, practicality and financial feasibility of newly invented peatland water management technology.
6) Arrangement and Implementation of an International Capacity Building program for in the form of "innovators" as well as "early adopters" in the form of cooperation on the modelling and prototype development of reliable, credible, and feasible peatland water management technology carried out on the "national demonstrator".

Relationship to the country's sustainable development priorities

In the context of climate change, forests are recognized as a source or a sink of greenhouse gases, particularly CO2. Such recognition is documented in the Indonesia Climate Change Sectoral Roadmap – ICCSR (BAPPENAS 2009). In this document, Ministry of Forestry proposed several key mitigation measures by implementing some selected BMPs (Best Management Practice) of SFM (Sustainable Forest Management) aimed for sink enhancement and emission reduction from forestry sector. The summary of the key mitigation measures are as follows:

Sink enhancement: Forest rehabilitation activities mostly on protection forest and watershed; Development of industrial plantations (HTI), plantations with private entrepreneurs and communities (HTR) on production forest; Stimulate plantations outside forest lands for rehabilitation or wood production; Management of natural secondary forests in production, protection and conservation forests.

Emission reduction: Improved sylviculture and logging activities in productive natural forest; reducing emissions form forest land conversion particularly on peat forest land; Reducing emissions from illegal logging and fire.

The ICCSR document also revealed that the key mitigation measures are implemented by so-called KPH-HTI-SFM scenario. This scenario is characterized by heavy investments on the establishment of hundreds of newly developed Forest Management Units (KPH) in order to guarantee significant improvement of sustainable forest management (SFM) of all state forests: natural forests, rehabilitated forest, and productive plantation. Within the first period of Forestry Sector's roadmap (2010 – 2019) 244 newly developed KPHs will be established and by the end of second period (2020-2029) a total number of 344 KPHs will be established. Mitigation efforts in this scenario are based on a mix of activities:

4) Industrial forest plantations (HTI) established on dry land, where KPH have been developed;
5) Emission reduction enhancement comes from better sustainable forest management (SFM) of production, conservation and protection forests under the KPHs; and
6) Some modest REDD activities during the first period of 2010-2014.

Peatland Water Management (PWM) Technology is expected to support better SFM, in terms of providing key mitigation measures with method, manual, tools, and skill for regulated irrigation and or drainage channel to avoid over drainage condition to happen (Table A-33). Such supports will be implemented in this International Capacity Building program, specifically by building and improving capability of national innovation system to perform TTD of PWM technology. And such a capacity building program will facilitate the 'innovators' and the 'early adopters' to perform "take off" successfully led the PWM technology operational in all of the newly established KPH.

Table A-33 Key Mitigation Measures as prioritized SFM (Sustainable Forest Management) and Expected support from Peatland Water Management (PRM) Technology.

<table>
<tr><th colspan="3">Key Mitigation Measures</th><th>Expected Support of CMM Technology</th></tr>
<tr><td rowspan="3">Sink Enhancement</td><td colspan="2">Aforestation/Reforestation:</td><td rowspan="3">Regulated irrigation/ drain-age/ channel networks and or vegetation belts to avoid over-drainage of HTI areas, facilitating sink enhancement of peat swamp</td></tr>
<tr><td>• Gerhan/RHL
• One Mill tree program
• HTI
• HTR</td><td>• HR
• Community Forest
• Village Forest
• Natural Forest</td></tr>
<tr><td colspan="2">Improve Sustainable Forest Management (SFM) to Increase stock on degraded forest:
• Stock enhancement on protected forest
• Stock enhancement on conservation forest</td></tr>
<tr><td rowspan="6">Emission Reduction</td><td colspan="2">Increase of Protection forest land under SFM</td><td rowspan="6">Regulated channel networks and or vegetation belts to avoid over-drainage of agriculture land and plantation estate areas, facilitating emission reduction of peatlands</td></tr>
<tr><td colspan="2">Increase of Conservation forest land under SFM</td></tr>
<tr><td colspan="2">Prevention of forest fire</td></tr>
<tr><td colspan="2">Management of productive natural forest</td></tr>
<tr><td colspan="2">Reduction of forest fire</td></tr>
<tr><td colspan="2">Low Carbon Peatland Management
• Enforce strict compliance by existing forest and plantation concessions on >3m peat
• zero burning for land clearing
• water management to reduce subsidence and carbon emissions from oxidation</td></tr>
</table>

Project Deliverables

The main deliverable of this project would be an operational "National Demonstrator" to demonstrate the reliability, practicality and financial feasibility of newly invented peatland water management (PWM) technology. This National Demonstrator for PWM technology comprises three technology components as follows:

1. Hardware: a network of sub national TTD reference stations
2. Software: PWM models and prototypes, regulation for PWM
3. Org-ware: Inter-Institutional national task force and expert workgroup

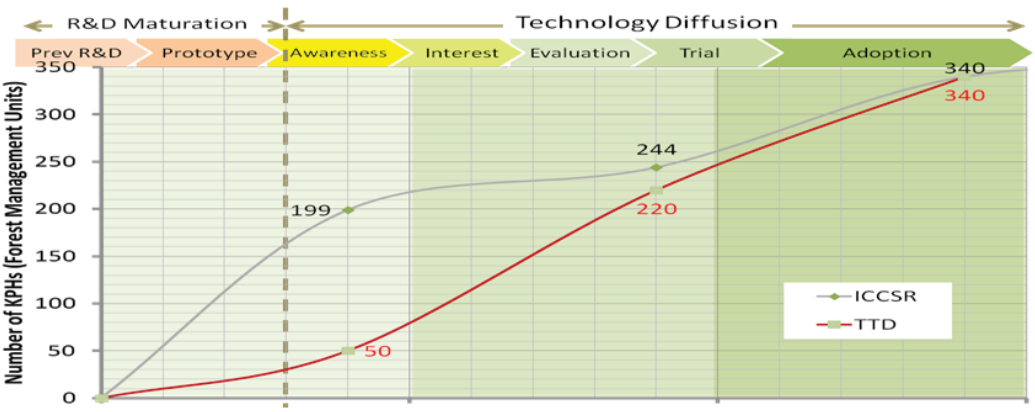
Project Scope and Possible Implementation

By inferring the purpose of this project, the scope of this project can be defined as follows:

1. Build and improve capability of national innovation system to perform TTD
2. Facilitate the ‘innovators’ and the ‘early adopters’ to perform “take off”
3. International Capacity Building program in modelling and prototyping by means of Bilateral/multilateral R&D arrangements and international training program

By this definition, the scope of this project shall be structured and implemented according to logical framework of purpose, outcome, program, work breakdown structure (WBS) and work package confined by measures and incentives of the R&D maturation up to early phases of technology diffusion of the TTD-curved as graphically illustrated in Figure A-23.

Purpose	Build and improve capability of national innovation system to perform TTD			
Outcome	Facilitate the ‘innovators’ and the ‘early adopters’ to perform “take off”			
Program	International Capacity Building in Modelling and Prototyping of Peatland Water Management			
WBS, Work Package,	Unified Peatland Water Management modelling		Unified Peatland Water Management prototyping	
Measure, and	M1,M2,M3		M1,M2 , M4	
Incentive	I1, I2, I4		I3, I4	



Measures	Incentives
M1. Establishment of peatland water management national task Force M2. Establishment of expert workgroup for peatland water management technology M3. Establish national capacity building for peatland water management prototype development M4.Provide adequate TTD reference stations and facilities for peatland water management (hardware and software)	I1: Development of inter ministerial task force and expert workgroups I2: Self capacity building arrangement for inter ministerial expert workgroups I3: Regulation for facilitation of TTD Reference stations and supporting facilities I4: Financial schemes for M1,M2,M3,M4

Figure A-23 Logical framework and scope of project.

Viewing from a broader scope of the whole objective tree of TTD processes of peatland water management technology, the scope of this project shall be related and perfectly matched with the scope of Sub-National Collaborative Learning Project (Figure A-24.).

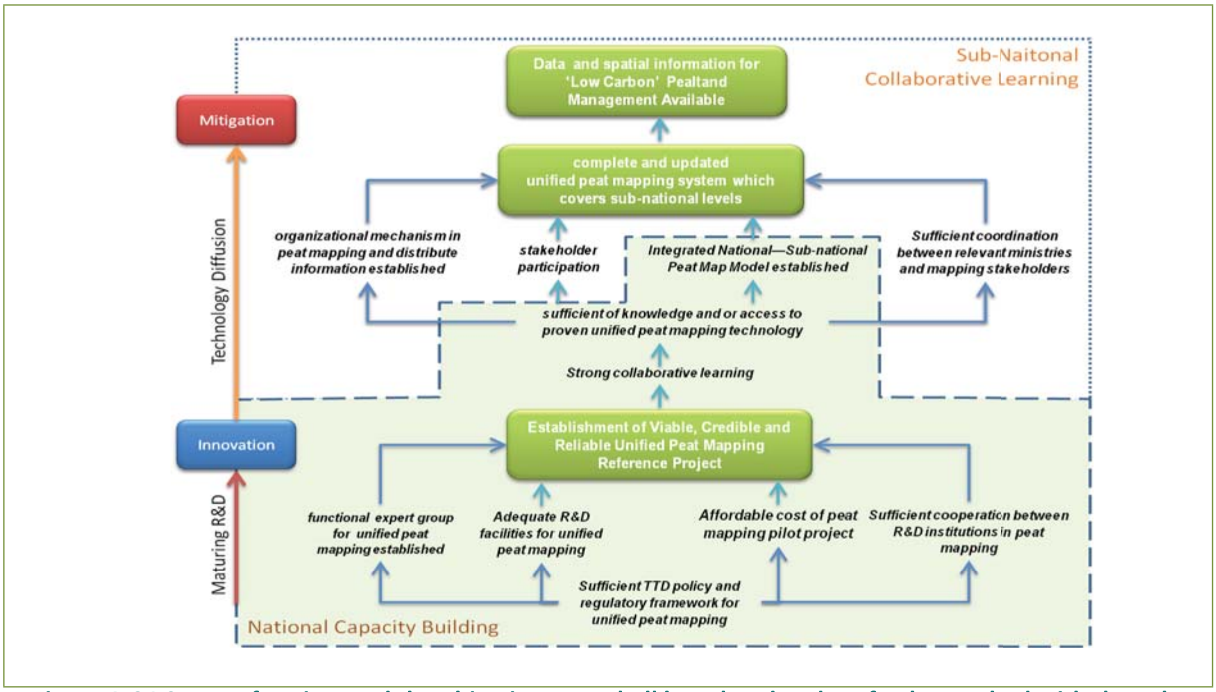


Figure A-24 Scope of project and the objective tree: shall be related and perfectly matched with the sub-national collaborative learning project

Timelines and Geographical Extent

This project is designed as a national multiyear program, whose timeline and geographical extent for the achievement of its WBS and work packages are presented in Table A-34.

Table A-34 Timeline and geographical extent

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Time Line			
	Year 1	Year 2	Year 3	Year 4
Development of national task force and expert workgroup				
M1 Establishment of peatland water management technology national task Force	>>>>			
M2 Establishment of expert workgroup of peatland water management technology	>>>>			
I1 Development of inter ministerial task force and expert workgroups	>>>>			
I2 Self capacity building arrangement for inter ministerial expert workgroups	>>>>			
I4 Financial schemes for M1,M2,M3	>>>>			
Development of CMM models and prototypes				
M3 Prototype Development of peatland water management technology by means of international capacity building	sumatra	sumatra	kalimantan	papua
		kalimantan	papua	
I4 Financial schemes for M4	>>>>	>>>>	>>>>	>>>>
Development of network of sub national TTD reference stations				
M4 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping unified peat re-mapping	sumatra	sumatra	kalimantan	papua
		kalimantan	papua	
I3 Regulation for facilitation of TTD Reference stations and supporting facilities	>>>>	>>>>	>>>>	>>>>
I4 Financial schemes for,M4	>>>>			

Resource and Budget Requirements

Resources and budget required for the achievement of WBS and work packages of this project of both national and international sources are listed in Table A-35.

Measurement/Evaluation

To measure whether the purpose of this project is accomplished and the objectives of this project are accomplished, evaluations of accomplishment of each work package shall be carried out accordingly. The evaluations are proposed to be carried out in two phases: intermediate and final program reviews.

The intermediate review shall be carried out in three steps as follows:
1. Initial review: evaluation of conditions of work packages ready to start
2. Detail review: evaluation of a work packages complied with technical requirements
3. Critical review: evaluation of work packages are timely delivered or need rescheduling

Table A-35 Resources and budget

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Resources	Budget	
		National	International
Development of national task force and expert workgroup			Hundred thousands of USD
M1 Establishment of Peatland Water Management Technology national task Force	National expert, meeting, workshop, seminar	PM	
M2 Establishment of expert workgroup for Peatland Water Management Technology	National and International expert, meeting, training course, and workshop	PM	PM
I1 Development of inter ministerial task force and expert workgroups	Policy and regulation, meeting, workshop, and seminar	PM	
I2 Self capacity building arrangement for inter ministerial expert workgroups	Policy and regulation, meeting, workshop, and seminar	PM	PM
I4 Financial schemes for M1,M2	Policy and Regulation, meeting, workshop, international cooperation	PM	
Development of CMM models and prototypes			Mill of USD
M3 Prototype Development of Peatland Water Management Technology by means of international capacity building	National and international experts, International and national training course, on the shelve and previous R&D models and prototypes	PM	PM
I4 Financial schemes for M3	Policy and regulation, meeting, seminar, international cooperation	PM	

Table A-35 (Continued)

Work Breakdown Structure (WBS) and Work Package of Measures and Incentives	Resources	Budget	
		National	International
Development of network of sub national TTD reference stations			Mill of USD
M4 Establish a network of TTD reference stations and provide them with adequate facilities for prototyping carbon measurement	Field station, building, equipments, computer hardware, modelling software, workshops, seminar	PM	PM
I3 Regulation for facilitation of TTD Reference stations and supporting facilities	Policy and regulation, meeting, seminar, international cooperation	PM	PM
I4 Financial schemes for,M4	Policy and regulation, meeting, seminar, international cooperation	PM	PM
TOTAL BUDGET			Ten Mill of USD

The final review shall be carried out at the end of completion of each work package to evaluate the accomplishment of the purpose and the objectives of this project. The scheme of this review is presented in Table A-36.

Table A-36 Scheme of final program review

Work Breakdown Structure and Work Package of Measures and Incentives	Indicator of achievement
Development of national task force and expert workgroup	Strategic agenda implemented
M1 Establishment of Peatland Water Management Technology national task force	Working agenda implemented
M2 Establishment of expert workgroup for Peatland Water Management national task force	Formal regulation implemented
I1 Development of inter ministerial task force and expert workgroups	Formal regulation implemented
I2 Self capacity building arrangement for inter ministerial expert workgroups	Formal regulation implemented
I4 Financial schemes for M1,M2,M3	
Development of CMM models and prototypes	
M3 Prototype Development of Peatland Water Management technology by means of international capacity building	Model implemented
I4 Financial schemes for M3	Formal regulation implemented
Development of network of sub national TTD reference stations	
M4 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement	Network of reference station are in operation
I3 Regulation for facilitation of TTD Reference stations and supporting facilities	Formal regulation implemented
I4 Financial schemes for,M4	Formal regulation implemented

Possible Complications/Challenges

The idea of this project assumes that the barriers of TTD processes are overcame within current framework of condition in favorable current enabling environments. Any alterations on the current framework condition and enabling environments will lead to possible complication of the implementation of this project. A risk analysis on the following possible threads of complication needs to be carried out prior to the implementation of this project.

A. National Policy Action and Priorities
1. Change of priorities in national development plan
2. Change of priorities in related sectors strategic plan:
   a. Ministry of Forestry
   b. Ministry of environment
   c. Ministry of Agriculture
   d. Ministry of Research and Technology
3. Current status and projected trend of the implementation of Climate Change action plan and recommendations:
   a. Indonesia Second National Communication (Ministry of Environment)
   b. Indonesia Climate Change Sectoral Roadmap (Bappenes)
   c. Indonesia's greenhouse gas abatement cost curve (DNPI)

B. International Support
- Status, implementation, and implication of REDD program for Indonesia
- Status, results, and implications of previous and current International projects associated with climate change and carbon trade

Responsibilities and Coordination

The purpose of this project is obvious, i.e., building and improving national capability of innovation system to perform TTD of carbon measurement and monitoring technology. This implies strong coordination of among involving related national institutions. The coordination model coordinating, implementing, and contributing institutions, based on the structure logical frameworks of WBS and work packages may be defined as follows (Table A-37).

Table A-37 Responsibility and coordination

Work Breakdown Structure and Work Package of Measures and Incentives	Responsibility and Coordination		
	Coordinating	Implementing	Contributing
Development of national task force and expert workgroup M1 Establishment of Unified Peat Re-Mapping national task force M2 Establishment of expert workgroup for Unified Peat Re-Mapping I1 Development of inter ministerial task force and expert workgroups I2 Self capacity building arrangement for inter ministerial expert workgroups I4 Financial schemes for M1,M2,M3	Ministry of Forestry	Ministry of forestry Ministry of Public Work	■ Water Resources Research Institute ■ Ministry of Finance ■ BPPT ■ Soil Research Institute ■ Forest Research Institute ■ CIFOR ■ Universities
Development of CMM models and prototypes M3 Prototype Development of Unified Peat Re-Mapping by means of international capacity building I4 Financial schemes for M4			
Development of network of sub national TTD reference stations M5 Establish a network of TTD reference stations and provide them with adequate facilities (Field station, building, equipments, software, and the like) for prototyping carbon measurement I3 Regulation for facilitation of TTD Reference stations and supporting facilities I4 Financial schemes for,M4			

Annex 3.2. Project ideas for energy sector

Annex 3.2.1. PV technology

Annex 3.2.1.1. Construction of PV cell industry

A. Introduction/background

As a tropical country, Indonesia has considerable potential for solar energy. Based on the solar radiation data collected from 18 locations in Indonesia, the Indonesia solar radiation differs between eastern and western Indonesia. The distribution of radiation in the Western Region of Indonesia (KBI) approximately 4.5 kWh/m2/day with a monthly variation of about 10% and in Eastern of Indonesia (KTI) about 5.1 kWh/m2/day with a monthly variation of about 9%. Thus, the potential average of Indonesian solar energy is about 4.8 kWh/m2/day with a monthly variation of about 9%.

The potential use of solar power that is promising is followed by the fact that the ratio of the national electrification by 2010 only around 67% which means that many households still had no electricity nationwide, especially in areas difficult to reach by the grid. Therefore, in order to meet the national target of electrification ratio by 72% in 2011, the government relies on program PLTS, both as SHS, PV hybrid, as well as off-grid PV as a means for providing electric power, especially in remote areas in Indonesia. In the year 2011 is expected to have about 30,000 new customers based PV on the 100 national remote island. Crash program on a remote island will be forwarded to reach 1,000 islands.

The high level of PV requirement is not followed by improvement of national capabilities in providing the PV cell. During this time, the national PV industry just as the industrial fabricators throughout the PV module PV cell is an import component. PV module industry nationwide conducted by the state and private industry. Ironically, many imported PV cell is produced from the processing of quartz sand derived from Indonesia. As it is known that Indonesia has the potential of quartz sand in the year 2010 reached 18.3 billion tons with production levels in 2009 as many as 29.2 million tons. Quartz sand of the largest reserves are in West Sumatra, another potential found in West Kalimantan, West Java, South Sumatra, South Kalimantan, and the island of Bangka and Billiton.

B. Purpose and objectives

The purpose of this activity is to develop a national industry-based crystalline PV cell with a minimum capacity of 50 MWp. PV cell industry can be built on the PT LEN Industry (Persero) which is a state enterprise which is engaged in laminating and packaging PLTS system. The company is located in Bandung West Java Province.

The objectives and the development of national PV cell industry is to lower the cost of PV investments and strengthen the resilience of the national PV industry. With the PV cell industry is expected to encourage the growth needs of PLTS and gradually the capacity of the PV cell industry will be increased according to his needs.

C. Relationship to the country's sustainable development

Development of national PV cell industry will encourage the use of PV that in turn supports the national sustainable development. President of the Republic of Indonesia has committed to reduce greenhouse gas emissions by 2020 by 26% in his own abilities and can be increased to 41% if it gets state aid donors. One of the mitigation technologies that encouraged its use to achieve the GHG reduction target is through the use of PLTS for various purposes.

D. Project deliverables

Development of national PV cell industry is very strategic because it would reduce imports and increase PV cell industry supporting national PV cell. Until 2011, the entire requirement of PV cells supplied from abroad while Indonesia has the potential resources are abundant quartz sand. Imports of PV cells will continue to increase as the mainstay of government in accelerating the electrification ratio is through the utilization of PV, both as SHS, hybrid, and off-grid. To that end, the government plans to build a national PV industry and the support through activities / program will accelerate the achievement of the plan.

E. Project scope and possible implementation

Seeing the need for PLTS high enough, then the development of national PV cell industry is highly prospective because no one in Indonesia. It is just that this industry needs to be protected because the PV cell import price of about $ 1.8 / Wp is not subject to import tax. Protection can be done by reducing the VAT and tax the various components of the PV cell supporting industries, including industrial solar grade silicon, ingots, and wafers.

F. Project Activities

Time lines

PV cell industry development can begin as soon as possible.

G. Budget/Resource requirements

Industrial development includes industrial PV solar cell grade silicon, ingots, wafers, PV cells and PV modules. PV cell import price is currently around 1.8 $ / Wp, and if construction of the national PV cell industry uses these figures, the total costs required for industrial development capacity of 50 MWp of PV cells about 90 million USD. The cost of this investment does not include the investment costs for PV module manufacturing.

It is hoped this industry is built in Indonesia with the help of soft loans from donor countries with a maximum co-funding by 30%. Partnership in the development of the PV cell industry is PT LEN Industry.

H. Responsibilities and coordination

Industrial development of national PV cell can last for the cooperation between the ministries of industry owned by the ministry. This is necessary because the PT LEN Industry is a state enterprise under the coordination of the Ministry of SOEs, while the PV cell industry is under the authority of the Ministry of Industry. To carry out this activity can first contact PT LEN Industry as state enterprises engaged in the national assembly of PV modules

Annex 3.2.1.2. Capacity building system testing laboratory PLTS

A. Introduction/background

Increased use of PLTS requires a reliable support system so that its utilization required meeting various criteria. Currently, Indonesia has had a testing laboratory PLTS system. This laboratory is the only laboratory in Indonesia that has been accredited with ISO / IEC 17025. This laboratory is located in the Energy Technology Center (B2TE), which is a unit under the Agency for the Assessment and Application of Technology (BPPT), located in Tangerang, Banten province. Various B2TE-owned facilities such BPPT includes Components PV Modules, Components Batteries, Components Battery Charge Regulator (BCR), and the DC component of the inverter lights. Component PLTS test equipment and components in B2TE relatively limited the sun simulator, cycle test equipment, and electronic equipment. PLTS test equipment and components need to be improved so that the testing laboratory in B2TE-BPPT can comply with international standards for photovoltaic modules IEC 61215, plus the addition of other components of equipment such as testing batteries, inverters, and others.

Table A-38 Types of equipment and parameters measured at B2TE-BPPT

	Equipment	Measurement Parameter
Module Photovoltaic	Sun simulator	IV characteristic curve on the standard test condition (STC)
Battery	Cycle Test equipment	Test cycles and knowing battery capacity
BCR	Electronic equipment (power supply, electronic dummy load etc)	Function Test, power consumption, functionality and efficiency control
Inverter DC lamp	Electronic equipment (power supply, electronic dummy load etc) Ball integrator	Function Test, power consumption and efficiency, lumen

In fiscal year 2011, PTKKE-BPPT will conduct design studies and laboratory testing of system components and power electronics PLTS which comply to IEC 61215, expected outputs of this study will generate the output layout of the building design, necessary equipment, laboratory organization, number and qualifications of personnel. To that end, the expansion of PLTS testing laboratory building will be built in 2012 to support PLTS laboratory facilities to international standards.

B. Purpose and objectives

The purpose of this activity is to conduct laboratory testing equipment and power electronics PLTS system in accordance with IEC 61215 standard. Procurement of laboratory equipment PLTS system is provided to B2TE-BPPT because the institution is the only institution that has obtained the ISO / IEC 17025. B2TE-BPPT located in Tangerang, Banten province.

The purpose of the procurement of laboratory testing equipment and power electronics PLTS system is to support the growing use of PLTS. With the PLTS system testing laboratory equipment and power electronics is expected to improve the quality of the PLTS system so it does not harm consumers nationwide.

C. Relationship to the country's sustainable development

Procurement of laboratory testing equipment and power electronics PLTS system as a means to support the increased use of PLTS in Indonesia that is being promoted by the government. So far, many components of PLTS circulating in Indonesia and has not fully pass the test at a local laboratory. Expected with increased testing capabilities in B2TE then all of the outstanding components can be given that SNI consumers are protected.

D. Project deliverables

Deliverables of this activity is the availability of laboratory testing equipment and power electronics PLTS system that includes the following components:

Table A-39 PV test laboratory supplies equipment and power electronics

Item	Unit	USD Price	Total
a) IV Checker (outdoor measurement)	1	9861	9861
b) IV Checker set (indoor mearurement)	1	38656	38656
1. Module cable, 10 m	10	30	300
2. T-type Thermocouple, 10 m	4	205	820
3. PV module Selector, 12 channel	1	10729	10729
4. Pyranometer Selector, 5 channel	1	8678	8678
5. TC Selector, 12 channel	1	10098	10098
6. High Precision Pyranometer	1	4181	4181
7. Pyranometer	1	2200	2200
c) Spi-Sun Simulator	1	233333	233333
d) UV Exposure Chamber for PV Modules	1	227778	227778
e) Continuous Solar Simulator & Light Soaking Chamber for PV Modules	1	227778	227778
f) Climate Chamber	1	227778	227778
			1002190

E. Time lines

Procurement of laboratory testing equipment and power electronics PLTS system can be started as soon as possible because B2TE building expansion will be done in 2012, so that laboratory equipment can be performed simultaneously, i.e. by the end of 2012. With this equipment, then the module PLTS test results may be requested certification to the international or national certification body (if it exists).

F. Budget/resource requirements

The costs of laboratory testing equipment and power electronics PLTS system is estimated about 1 million USD. Cost does not include tax and benefits suppliers. The costs of laboratory testing equipment and power electronics PLTS system is expected in the form of grants from donor countries.

G. Responsibilities and coordination

Procurement of laboratory testing equipment and power electronics PLTS system can take place in cooperation with the Agency for the Assessment and Application of Technology (BPPT), which is the parent organization of B2TE. To carry out this activity can first contact B2TE as a unit under BPPT laboratory engaged in testing PLTS system.

Annex 3.2.1.3. Manufacturing capacity laboratory cell PV

A. Introduction/Background

Increased use of PLTS requires laboratory support PV cell manufacture of reliable and economic efficiency in order to obtain an effective PV cell. Currently, Indonesia has had a laboratory type crystalline PV cell manufacture. But still very simple laboratory facilities and some equipment is still an equipment loan from PT LEN Industry (Persero). Manufacture of laboratory type crystalline PV cell is contained in the laboratory of Electronics and Telecommunications Research Centre (PPET) - Indonesian Institute of Sciences (LIPI) in Bandung, West Java Province. The ability of PV cells laboratories PPET-LIPI for polycrystalline solar cells / multi-crystalline new maximum efficiency of 8% -10% for the dimensions of 5x5 cm2 and 5% -6% for the dimensions of 10x10 cm2. The low efficiency is due to the limited facilities available and the tools that have been aged between 20-25 years, performed in a laboratory cell processes that are not "clean-room", as well as some equipment status as a loan. Silicon wafers (Si) used are imported from Germany with dimensions of 10x10 cm2 and a minimum of 270 microns thick. Currently thick Si wafers on the market of about 200 microns so that the facilities available equipment is no longer sufficient. As for human resources in the laboratory PPIT-LIPI as many as 8 people and partially retire.

Table A-40 List of equipment preparation cell (crystalline) in the laboratory of PPET-LIPI

No.	Description	Tools	Power (kw)	Capacity	Process
1.	Texturing	- Wet bench	1	25 waf. / 15 min	B
	Rinse	- DI H2O System	2,2	25 waf. / 3 min	
2.	Dry	Dryer *		100 waf. / 2 min	B
3.	Spray Phosphor	Sprayer	0,5	2 waf. / min	C
4.	Diffusion	Conveyor furnace – 1	30	20 waf. / jam	C
5.	Measurement ?S	4 - point probe *		20 waf. / jam	
6.	Deglazing	- Wet bench	1	20 waf. / 5 min	B
	Rinse	- DI H2O System	2,2	25 waf. / 3 min	
7.	Dry	Dryer *	2	100 waf. / 2 min	B
8.	Screen printing ARC	Screen printer *	2,2	5 waf. / min	C
	- **Drying**	Oven	3,1	60 waf. / 10 min	B
	- Firing	Conveyor furnace -2*	10	2 waf. / 5 min	C
9.	Screen printing AgAl	Screen printer *	2.,2	5 waf. / min	C
	- **Drying**	Dryer conveyor *	9	5 waf. / min	C
10.	Screen printing Al	Screen printer *	2,2	5 waf. / min	C
	- **Drying**	Dryer conveyor *	9	5 waf. / min	C
11.	Screen printing Ag	Screen printer *	2,2	5 waf. / min	C
	- **Drying**	Dryer conveyor *	9	5 waf. / min	C
	- **Co-firing**	Conveyor furnace– 2*	10	5 waf. / min	C
12.	Testing	Sun simulator *	2,5	4 waf. / min	C
		Cell tester			

Note: B = Batch, C = Continuous, * = equipment on loan from PT. Len Industries, which can extend every year

B. Purpose and objectives

The purpose of this activity is to conduct laboratory equipment manufacture PV cells from infection until the incoming wafer testing & sorting. Procurement of laboratory equipment was delivered to the PV cell-LIPI PPIT because the institution is the only institution engaged in the type of PV cell testing crystalline. The purpose of the procurement of laboratory equipment manufacture PV cells is to support industrial development of the National PV Cell.

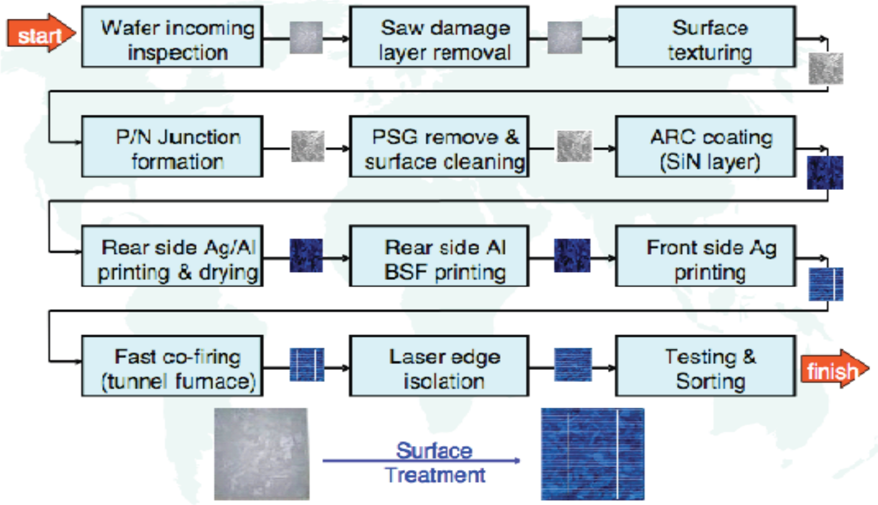


Figure A-25 PV cells is to support industrial development of the national PV Cell

C. Relationship to the country's sustainable development

Procurement of laboratory equipment manufacture PV cells as a means to support the development of the national PV industry which has an open outlook in line with demand and raw material potential is great. Expected to increase PV cell testing capabilities in PPIT LIPI PV cells then developed an efficient and economical.

D. Project deliverables

Estimated PV cell laboratory facilities with a capacity of about 2 MWp / yr, which can be used for laboratory facilities, as well as the pilot plan, and also for small-scale production. Currently, the capacity of the solar cell industry in the world's most minimum is 50 MWp / yr. To obtain the facility equipment 2 MWp / yr may be difficult if they get it from 1 (one) supplier (based on turn-key), but can be obtained from several suppliers and incorporate their own machines as needed. This is because the supplier of machines for industrial solar cells today are no longer designing small-scale inefficient since.

Table A-41 Machines for industrial solar cells

Process Tool	Quantity	Sourcing	Throughput/EA
Saw Damage remove and Alkaline Texturing	1	BR	300
N Type formation (diffusion furnace)	1	BR	300
PSG remove and surface clean (main frame share with saw damage remove)	1	TW	300
ARC Coating furnace (controller share with diffusion furnace)	1	BR	300
Printer	3	TW	240
Dryer (for Printing use)	1	TW	900
Fast Firing furnace	1	US	300
Laser isolation (semi-automation)	1	TW	300
Solar Cell efficiency Tester	1	DE	300

Capacity design of the laboratory are the design throughput :> 300pcs/hr, assumption: 125x125mm mono-Si cells using alkaline process, Eta = 16.0% (2.37W/cell) and utilization = 75%, the working time/day = 12 hrs, If line yield is 90%, the capacity Will be larger than 2.10MW/yr.

- POCl3 phosphorous doping is adopted for the drive-in. Licence of using POCl3 is required due to it's a controlled specialty gases
- Process tools are all in the manual type tools except for laser isolation is a semi-auto
- The overall throughput of all the tools are Greater Than 300pcs/hr except for the printer. (it needs more working time)

E. Time lines

Procurement of laboratory equipment manufacture PV cells can be started as soon as possible in line with national PV cell industry development.

F. Budget/resource requirements

One complete set of manual tools for mini solar cell line (main cell process including tools, metrology tools and facility tools) cost is € 3,000,000. The cost includes the basic solar cell efficiency (15.0%) offer at the beginning of tool installation (the design efficiency of the tool is 16.0%). All materials (e.g. solar wafers and all consumer materials etc) should be prepared by the customer, and should which meet the specified specifications provided seller. One-week training course is optional. During the installation tool and process tuning period, the local boarding / lodging and transportation fees and expenses will be covered by the customer.

G. Responsibilities and coordination

Procurement of laboratory equipment lab PV cell manufacturing can take place in cooperation with the Indonesian Institute of Sciences (LIPI), which is the parent organization of PPIT. To carry out this activity can first contact PPIT as a unit under LIPI laboratory engaged in testing of the PV cell.

Annex 3.2.2. RBCS technology

A. Introduction/Background

The steel industry is energy-intensive industries. Saving energy consumption in the steel industry is one of the GHG mitigation efforts that can be done in order to encourage the use of clean technology in the steel industry. As it is known that the national steel industry has not been effective and efficient because of national steel production capacity has not been sufficient so that most steel demand is still in the import and consumption of energy to produce steel is still wasteful. This is because the addition of a relatively limited production capacity amid the rapid demand for steel and lifetime national steel industry generally has been a long time.

B. Purpose and Objectives

The purpose of this activity is the installation of regenerative burner combustion system technology (RBCs) in the steel industry was selected. The purpose of mounting technology selected RBCs in the steel industry is to reduce energy consumption while increasing the production of steel in the steel industry was selected.

C. Relationship to the country's sustainable development

Installation of regenerative burner combustion system technology (RBCs) in the steel industry was selected as a means to support the reduction of GHG emissions that are being promoted by the government. As it is known that the current Indonesian government is conducting a program reduction of GHG emissions by 26% in 2020 in his own abilities and can be increased to 41% if they received aid from donor countries. GHG emission reductions of 26% is including the reduction of GHG emissions in the industrial sector. On the other hand, the installation of technology RBCs in selected industries to increase production of steel in the industry concerned.

D. Project deliverables

Deliverables of this activity is the installation of one unit of RBCs including control room technology on selected steel industry. The steel industry was selected may be determined jointly by the Ministry of Industry, taking into account the advice of Steel and Iron Industry Association of Indonesia or other steel association

E. Time lines

Installation of RBCs and control room technology on selected steel industry can be started in the medium term (1-5) years.

F. Budget/Resource requirements

The costs of installation of RBCs in the reheating furnace technology in the steel industry with a production capacity of 300,000 tons per year is about 6.5 million USD. The fee includes the cost of development and loss of income due to installation of equipment around 2.5 million USD and the cost of procurement of equipment and control room RBCs around 4 million USD. All fees are proposed to be borne by the donor countries with grants or soft loans, but if not possible then the procurement of RBCs and control room technologies borne by donor countries in the form of grants or soft loans.

G. Responsibilities and coordination

Procurement and installation of RBCs and control room technologies may be accomplished in cooperation with the Ministry of Industry.

B2 TRAINING DESIGN AND CONTROL ROOM RBCs

A. Introduction/Background

RBCS is one of the technological options for reducing energy consumption in the steel industry and some other industries. Given the importance of the role of technology RBCs, then BPPT in fiscal year 2011 trying to create a prototype technology RBCs. RBCs prototype design is done simply by the researchers / engineers at the Directorate of Energy Conversion and Conservation BPPT to understand the performance of these technologies. In fact, as is well known that the use of RBCs is controlled in the control room so that the utilization of flue gas can be arranged in such a way as to be able to reduce fuel consumption to the maximum.

B. Purpose and Objectives

The purpose of this activity is the training and control room design RBCs. The purpose of the training and control room design RBCs is to enhance the ability of researchers / engineers BPPT or other institutions that are interested in RBCs and control room design. Expected to increase the ability of researchers / engineers BPPT, then the use of RBCs in Indonesia in the future can be designed by Indonesia itself by force, to accelerate the development and utilization of RBCs, while reducing investment costs RBCs.

C. Project deliverables

Deliverables of this activity is the increased Traffic to the researchers / engineers in particular and BPPT researchers / engineers from other institutions in general and in making RBCS and control room design for different capacities and different types of industries that have the potential to use RBCS.

D. Time lines

Training RBCs and control room design can be initiated in the medium term (1-5) years.

E. Budget/Resource requirements

The cost of training and control room design RBCs fully expected from donor countries. Place of training can be done in Jakarta or elsewhere are desired by the donor countries.

F. Responsibilities and coordination

Training of control room design and room RBCs may be accomplished in cooperation with the Center for Conversion and Conservation Technology, Agency for the Assessment and Application of Technology

Annex 3.3. Project ideas for waste sector

A. Technology Transfer

Increasingly difficult to find land for landfill and meet the obligations of Act no. 18/2008, then the application of technology for intermediate treatment plant (ITP) becomes very relevant. The basic idea is to make the MBT plant at a typology of cities are where the biological process in which there is a low-solid anaerobic digestion or others. Some equipment in the MBT can be made in Indonesia, but as a technological system still needs to transfer technology from countries that have experienced operating MBT. Form of transfer of knowledge may include training of researchers and users from Indonesia to the producing countries and also sending experts to Indonesia in order to practice directly in the plant is built. Interactive learning, involving experts from the maker countries with the users MBT will minimize some of the problems that usually arise in the application of advanced technologies to developing countries. In this model of cooperation, the innovations MBT that may arise should be set in the agreement, especially related Intellectual Property Rights (IPR).

B. Capacity Building

In order for the application of MBT to be sustainable in its operations, the ability of local engineers and the operators must be improved. Capacity building should be part of the transfer of technology. In the case in Indonesia, ITP in the form of MBT should collaborate with the institution of city cleaning services and local community groups including scavengers. In order for the application of MBT successful, would be better if it sought ITP plant that is already running and a high level of community participation so that the human resources and technological capacity is upgraded. Minimum number of personnel for the operation of an MBT plant to be prepared and need to cooperate with the private company.

C. Financing

In the construction of MBT in Indonesia as a pilot project, need financial assistance from abroad. In addition, it is also necessary co-financing funds from the national budget. Component of funding also includes the cost of making the feasibility study (FS), detail-engineering design (DED), construction and training. In detail are as follows;

Source of financial:
- Grant with low interest rate
- National budget planning (APBN) for co-financing

Pre-Instalment cost:
- Planning cost
- Feasibility Study
- DED

Capital cost:
- Construction (parking, unloading area, sorting area, digestion area, screening area, machine garage, compost storage, recyclables storage)
- Installation (belt conveyor for sorting, shredder, magnetic separator, digester, screener)

Operation and maintenance cost:
- Salaries (supervisors, staff, workers, consultant)
- Utility bills (electricity, water, telephone)
- Tools and supplies (shovel, bag, uniforms)
- Fuels of machines
- Disposal reject to final disposal
- Maintenance of machines and building

D. Resources Requirement

MBT development also requires some resources that should be prepared in the country, in general these needs include;
- Local industries producing mechanical machinery (belt conveyor, magnetic separator, shredder, mobile rotary screen, in-vessel composter, etc.)
- Waste transportation and transfer stations supporting
- Land allocation for waste treatment in city planning (landfill site)
- Expert and professional workers
- Professional institution or private company
- Community participation

E. Timeline (multiple years)

Implementation of MBT plant requires a period of 3 years with the following stages;

First Year:

- Planning and coordination
- Feasibility Study
- DED

Second Year:

- Construction and Installation
- Running test
- Evaluation and improvement

Third Year:

- Full Operation

F. Indicators of Success

- Good cooperation and networking between stakeholders (foreign partner/donors, Public Work Department, Ministry of Environment, Municipality, community based organization)
- Community supporting with source separation
- Demo plant running well and continuously
- Significant waste reduction by demo plant

G. Domestic Partners

- BPPT
- Ministry of Public Work
- Ministry of Environment
- Municipality Cleaning Department
- Indonesia Solid Waste Association (InSwa)

Annex 4: List of Stakeholders Involved and Their Contacts

National Consultant:
Program Coordinator : Kardono
Chief Engineer : Agung Riyadi
Group Leader : M. Sidik Boedoyo
Supporting Team : Feddy Suryanto and Saraswati Diah

Table A-42 List of stakeholders involved and their contacts for forestry

Sector Leader : Agus Kristijono (BPPT)

No	Name	Institution	Sector selection and technologies	Identification of barriers and development of enabling framework	Technology Action Plans (TAPs), IPR issues	Project Ideas
1	Dr. Ir. Yetty Rusli	Advisor to the Minister Field of Environment & Climate Change Ministry of Forestry			✔	
2	Dr. Nur Masripatin	The Center for Environmental Standardization of Forestry Ministry of Forestry			✔	
3	Ir. Yuyu Rahayu, MSc	Director Forest Resources Inventory & Mapping Directorate General of Forestry Planning Ministry of Forestry	✔	✔	✔	✔
4	Prof. Dr. Didik Ardi	Soil Research - Bogor	✔	✔	✔	✔
5	Prof. Dr. Supiandi Sabiham	Faculty of Agriculture, IPB	✔	✔	✔	✔
6	Ir. Nana Sudiana, Msi	PTLWB – BPPT	✔	✔	✔	✔
7	Hasmono Soewandito, MSc	PURIGATRO - BPPT	✔	✔	✔	✔
8	Kristifianti Ginoga	Ministry of Forestry	✔	✔	✔	
9	Ari Wibowo	Ministry of Forestry		✔	✔	
10	Handayani	Premanet Indonesia	✔	✔	✔	

Table A-43 List of stakeholders involved and their contacts for energy sector

Sector Leader : La Ode Muhammad Abdul Wahid (BPPT)

No	Name	Institution	Sector selection and technologies	Identification of barriers and development of enabling framework	Technology Action Plans (TAPs), IPR issues	Project Ideas
1	Djajang Sukarna	Head of Planning and Cooperation, Secretariat General Ministry of Energy and Mineral Resources	✔	✔		
2	H. Laksamana Azaday	Director of the New Energy and Renewable Energy Directorate General of EBTKE Ministry of Energy and Mineral Resources	✔	✔		
3	Maritje Hutapea	Director of Bio Energy Directorate General of EBTKE Ministry of Energy and Mineral Resources	✔	✔		
4	Cucuk Suryo Suprojo	Advisor to the Minister of Transportation	✔	✔	✔	
5	Pariatmono	Ministry of Research and Technology (KemenRISTEK)	✔	✔	✔	✔
6	Lolo M. Panggabean	Environmental Foundation for Business Development	✔	✔		
7	Sugiharto Harsoprayitno	Director of Geothermal Directorate General of EBTKE Ministry of Energy and Mineral Resources		✔	✔	
8	Hardiv Situmeang	KNI-WEC	✔	✔		
9	Endang Supraptini	Head of the Center for Resources, Environment and Energy, Assessment Agency, Climate, and Quality of Industry - Ministry of Industry	✔			
10	Fabby Tumiwa	IESR	✔	✔	✔	
11	Idwan Suhardi	Chairman of the Workgroup on Technology Transfer, National Council on Climate Change.	✔	✔	✔	✔

12	Direktur Industri Logam	Dit Jen. ILMTA Ministry of Industry			✔	✔
13	Adjat Sudrajat	Center for Industrial Technology – BPPT		✔	✔	✔
14	Ida Nuryatin	Directorate General of New Energy, Renewable Energy and Conservation - Energy and Mineral Resources		✔	✔	✔
15	Eddy Rivai	Directorate General of New Energy, Renewable Energy and Conservation - Energy and Mineral Resources		✔	✔	
16	Hendriyanko	Directorate General of New Energy, Renewable Energy and Conservation - Energy and Mineral Resources		✔	✔	
17	Suci Wulandari	Ministry of Research and Technology	✔	✔	✔	✔
18	Satriyo Hadipurwo	Directorate General of New Energy, Renewable Energy and Conservation - Energy and Mineral Resources		✔	✔	✔
19	Junifer Simanjuntak	Directorate General of Electricity – ESDM		✔		
20	Job Supangkat	PT Permanent	✔	✔		
21	Haryanto Sagala	Director General of Metal – Kemendustrian			✔	✔
22	Martin Djamin	Center for Energy – BPPT	✔	✔	✔	✔
23	Andhika Prastawa	Center for Energy – BPPT	✔	✔	✔	✔
24	Sonny S Wirawan	Center for Energy Technology, Puspiptek Serpong			✔	✔
25	Ketut Setiawan IWE	Steel Industry Association of Indonesia	✔	✔	✔	✔
26	MAM.Oktaufik	Director Energy Resources Development Technology Center – BPPT			✔	✔

Table A-44 List of Stakeholders Involved and Their Contacts for Waste Sector

Sector Leader : Sri Wahyono (Centre for Environmental Technology – BPPT)

No	Name	Institution	Sector selection and technologies	Identification of barriers and development of enabling framework	Technology Action Plans (TAPs), IPR issues	Project Ideas
1	Aldy Mardikanto	Directorate of Settlement Agency		✔		
2	Syukrul Amin	Director of the Directorate of Development & Environmental Settlements (PLP) - Directorate General of Human Settlements Ministry of Public			✔	✔
3	Sri Bebassari	Indonesian Solid Waste Association (INSWA)	✔	✔		
4	Dini Trisyanti	Indonesian Solid Waste Association (INSWA)	✔	✔		
5	Emma Rachmawaty	Deputy Assistant on Climate Change Adaptation, Deputy III, Ministry of Environment		✔	✔	
6	Joko Heru Martono	Pusat Teknologi Lingkungan (PTL), Deputi Bidang Pengembangan Sumberdaya Alam (TPSA) – BPPT	✔	✔	✔	

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