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List of Abbreviations

ADB	Asian Development Bank
ALOS	Advanced Land Observing Satellite
AR-CDM	Afforestation/Reforestation Clean Development Mechanism
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
BM	Build Margin
BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CM	Combined Margin
COP	Conference of the Parties
COD	Chemical Oxygen Demand
CSP	Concentrated Solar Thermal Power
E10	Fuel containing 10% Ethanol
GEF	Global Environment Facility
GHG	Greenhouse Gas
GREEN	Global Action for Reconciling Economic Growth and Environmental Preservation (JBIC)
Green-e	Green-e
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPCC GPG	IPCC Good Practice Guidance
IPCC GPG for LULUCF	IPCC Good Practice Guidance for Land Use, Land Use Change, and Forestry
IPCC-GNGGI	IPCC Guidelines for National Greenhouse Gas Inventories
JBIC	Japan Bank for International Cooperation
J-MRV	Measurement, Reporting and Verification of GHG Emission Reductions in JBIC's GREEN
J-VER	Japan Verified Emission Reduction
LANDSAT	LANDSAT
LCA	Life Cycle Assessment
LFG	Landfill Gas
LRT	Light Rail Transit
MRT	Mass Rapid Transit
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
OM	Operational Margin
QuickBird	QuickBird
RDF	Refuse. Derived. Fuel
REDD	Reducing Emissions from Deforestation and Forest Degradation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SPOT	Satellite Pour l'Observation de la Terre
UNFCCC	United Nations Framework Convention on Climate Change
US-EPA	US Environmental Protection Agency
VCS	Verified Carbon Standard
VER	Verified Emission Reduction

Chapter 1 Outline of the Survey

1.1 Background and Objective

The 16th Conference of the Parties (COP16) of the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Cancun Agreements. The agreements clearly state the commitment by developed countries to provide financial support to developing countries in the field of climate change, which include i) collective commitment approaching USD 30 billion for three years from 2010 to 2012 (as Fast-start finance) and ii) joint mobilization of USD 100 billion per year by 2020 (as Long-term finance). The direction of future framework on climate change after 2013 is still under discussion. It is considered that Official Development Assistance (ODA) will continue to be actively utilized as part of the support for the developing countries in the field of climate change. The Cancun Agreements request implementation of measurement, reporting and verification (MRV) regarding quantitative evaluations of greenhouse gas (GHG) emission reduction (sequestration) through supported mitigation actions.

Taking into account the above situations, JICA is faced with the task to consider MRV regarding GHG emission reduction (sequestration) during the planning stages of country assistance strategies and individual projects to ensure its implementation. This survey presents a reference document providing estimation methodologies of quantitative evaluations of GHG emission reduction (sequestration), in order to facilitate consideration of MRV during the planning stages of country assistance strategies and individual projects. This survey is not intended to provide methodologies for estimating emission reduction credits, such as those generated by the Clean Development Mechanism (CDM). The purpose of this survey is to calculate the impacts of projects assisted by JICA. Therefore, this survey does not take into account additionality considerations required by the CDM.

This report contains survey on mitigation measures as part of the “Study on Mainstreaming Climate Change Considerations into JICA Operation”. The reports for survey on adaptation measures and national and regional climate impacts are prepared separately.

1.2 Selection of Target Sub-sectors and Review of Existing Methodologies

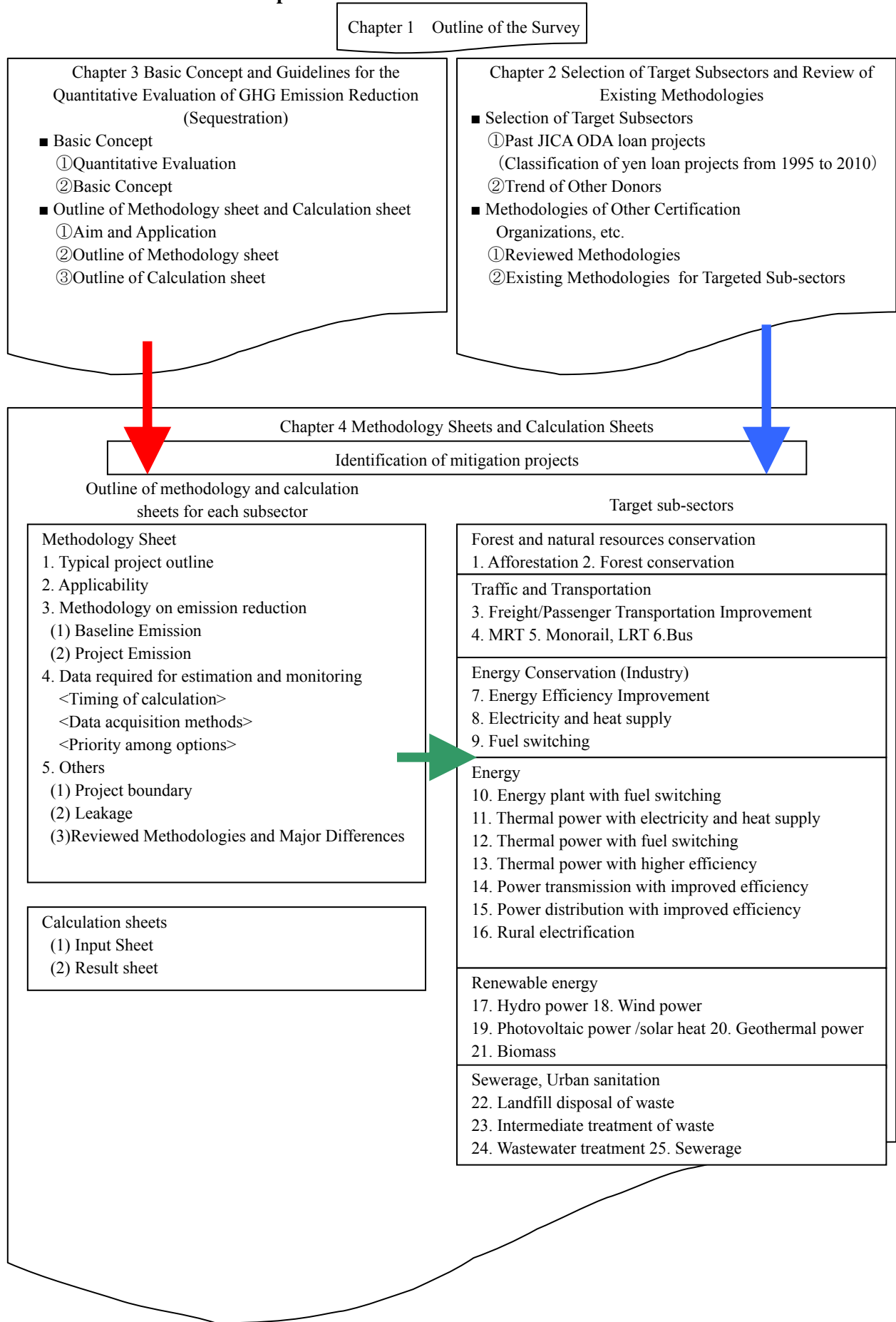
After reviewing past JICA ODA loan projects and the trend of other donors’ assistance, 25 sub-sectors were chosen as potential areas of future JICA ODA loan assistance. In order to establish the estimation methodologies for quantitative evaluation of GHG emission reduction (sequestration), the survey reviewed existing methodologies and tools including those used by other donors and by credit generating mechanisms like the CDM.

1.3 Basic Concept and Guidelines for the Quantitative Evaluation of GHG Emission Reduction (Sequestration)

For the selected 6 sectors and 25 sub-sectors, methodology sheets summarizing GHG emission reduction methodologies were prepared. The five items included in the methodology sheets are: i) typical project outline, ii) applicability, iii) methodology on emission reduction, iv) data required for

estimation and monitoring, and v) others. In developing countries, it can be easily anticipated that there exists great limitation in data availability. In order to overcome this limitation, the presented methodology allows flexibility by indicating several options when possible, along with the order of priority. Furthermore, excel sheets with embedded estimation formula were prepared to enable estimating actual GHG emission reductions (calculation sheets).

1.4 Framework of the Report



Chapter 2 Selection of Target Sub-sectors and Review of Existing Methodologies

2.1 Selection of Target Sub-sectors

In this section, target sub-sectors are selected for discussion in Chapters 3 and 4. The following items are considered for selection of the sub-sectors.

- Past JICA ODA loan projects
- Potential for formulating future mitigation projects

The process of selection is as follows:

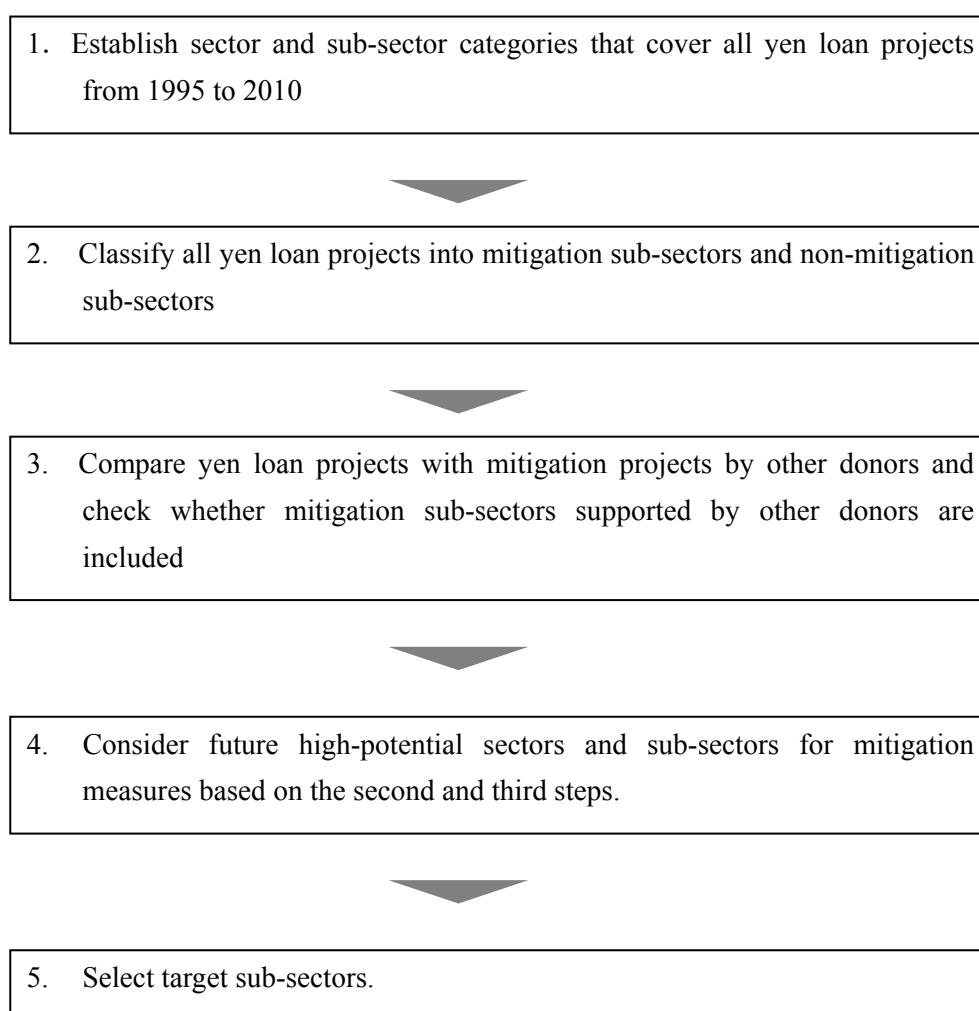


Figure 2.1.1 Process of Selecting Sub-sectors

2.1.1 Identification of Sectors and Sub-sectors Based on Past JICA ODA Loan Projects

First, in order to classify and identify sectors and sub-sectors based on past JICA ODA loan projects¹, projects classified in mitigation sub-sectors are extracted from all projects committed from 1995 to 2010 (1,139 projects). The mitigation and non-mitigation sub-sectors and the number of projects classified in each group are shown in Table 2.1.1.

There are 503 projects classified into 6 mitigation sectors (forestry/natural environment, disaster prevention, traffic and transportation, mining and industry, energy, and public utility) and 29 mitigation sub-sectors. On the other hand, there are 793 projects classified into 14 non-mitigation sectors (including miscellaneous sector) and 52 non-mitigation sub-sectors. Projects classified into more than one sub-sector are counted in their respective sub-sectors, resulting in a total of 1,296 counted projects.

¹ http://www2.jica.go.jp/ja/yen_loan/index.php

Table 2.1.1 Projects in Mitigation Sub-sectors among Japan's Yen Loan Projects

(Target: Committed Projects from 1995 to 2010)¹

Mitigation Sub-sectors			Non-mitigation Sub-sectors		
Sector	Sub-sector	projects	Sector	Sub-sector	projects
3 Forestry/natural resources conservation	01 Forestry	37	1 Water resources	01 Proper management of water resources	2
	02 Forest conservation, Slope conservation/Soil conservation	15		02 Water resources development, facility upgrade	14
	03 Mangrove conservation	0		03 Utilization of water resources	2
	05 Ecosystem (biodiversity)	5		04 Water and sanitary reform	0
4 Disaster management	07 Forest disaster prevention	0	2 Agriculture, Food ²	01 Irrigation, drainage	56
	08 Landslide disaster management	0		02 Cultivation management (Assistance of agricultural management), enhancement of irrigation association	13
6 Transportation	04 Railway			03 Crop development	3
	001 Freight (a new railway double track)	21		04 Information system	0
	002 Passenger (a new railway, a double track railway, or a quadruple track railway)	9		05 Livestock	1
	003 MRT (City and suburb rapid railway; Subway, Elevated railway)	46		06 Fisheries	4
	004 Monorail, LRT	2		07 Agro- economy	1
	005 Improvement of rails, High standardization, Rehabilitation of railway	10		08 Sustainable agriculture	2
	006 Rehabilitation of train cars and railway facilities	8		09 Development/improvement of farmland	1
9 Mining and manufacturing industries	01 Industry	4		10 Agricultural process	1
	02 Factory, Plant	16	3 Forestry/natural resource conservation	04 Coastal/lakefront protection/restoration	3
	03 Mining industry	3	4 Disaster management	01 Coastal protection	3
11 Energy	01 Energy conservation	2		02 River prevention (flood control)	35
	02 Intensive heat-supply system with fuel switching	26		03 Disaster-relief	1
	03 Thermal power plants with electricity and heat supply	4		04 Information system	1
	04 Thermal power plants with fuel switching	12		05 Development of human resources, Environmental control ability	4
	05 Thermal power plants with higher energy efficiency	39		06 Urban disaster prevention	0
	06 Transmission and distribution	64	09 Land-use management	0	
	07 Hydro power plants (except for small hydropower and pumped and storage hydropower...)	42	5 Urban-regional development	01 Rural development	38
	08 Renewable energy	12	02 Urban community improvement	2	
	09 Rural electrification	17	6 Transportation	01 Road, bridge	164
	10 Energy facilities (construction of new natural gas pipelines)	2		02 Airport	35
13 Public utilities	02 Urban health (waste disposal)	16		03 Port	36
	03 Sewerage	56		05 Marine transportation	7
	03 Wastewater treatment	35		06 TDM and other soft measures	1
Total	503	07 Logistic facilities		1	
		08 ICT		0	
		7 Health		01 Adaptation capacity development	0
			02 Adaptations for high risk area	0	
			03 Heat prevention	0	
			04 Malaria control	0	
			05 Waterborne (infectious) disease control	1	
			06 Medical care	15	
		8 Architect	01 Architect	31	
		10 Government administration	01 Finance, monetary	25	
			02 Environmental-related issues	21	
			03 Survey/cartography	1	
			04 General government	5	
			05 Assistance in policy-making system	57	
			06 Assistance for rehabilitation and reconstruction	0	
		12 Human resources	01 Education	42	
		02 Healthcare education	13		
		13 Public Utility	01 Water Supply	96	
		14 Commerce	01 Tourism	7	
		15 Communications and broadcasting	01 Telecommunications	17	
			02 Broadcasting	11	
		99 Others	01 Instauration	1	
			02 Poverty program	19	
		Total	793		

¹ 1,139 projects are extracted from JICA's database of Japan's ODA loan projects from 1995 to 2010, and classified into sectors.

² As for agricultural and food sectors, countermeasures and utilization for "methane emissions from paddy fields", "domestic animals' waste", "loss of soil organic material due to surface soil runoff", "nitrous oxide originated from fertilizers", and "methane emissions from paddy fields" are expected as promising projects in the future.

2.1.2 Trend of Projects by Other Donors

The trend of mitigation projects implemented by other donors is as follows:

(1) World Bank (WB)

Projects whose major theme is climate change are extracted from WB database² and classified into project fields. Project fields are divided into major sectors and sectors. The WB database system allows projects to be classified into more than one major sector and/or sector as shown in Figure 2.1.2. The figure summarizes the result for 193 projects classified into major sectors and sectors. Among the major sectors, energy has 124 projects, which is overwhelmingly greater than that of other major sectors. Sectors with a larger number of projects include, power generation, renewable energy, agriculture, forestry, and public utility (sewerage, etc.).

(2) Global Environment Facility (GEF)

From GEF's database³, 645 projects whose focal area is climate change and implemented after year 2000 are extracted. 385 projects are classified as mitigation projects. These projects are further classified into project fields and implementing international organizations (Figure 2.1.3). 298 of the total 385 projects are energy projects.

(3) Asian Development Bank (ADB)

From ADB's database⁴, 38 loan projects related to mitigation measures are extracted. ADB's project classification system allows selection of multiple sectors and sub-sectors for one project (Figure 2.1.4). It is noted that there are more mitigation projects in the energy sector than other sectors.

² <http://www.worldbank.org/>

³ <http://www.gefonline.org/>

⁴ <http://www.adb.org/Climate-Change/projects.asp#promoting>

Table 2.1.2 Sector Classification of World Bank Mitigation Projects

Major Sector	Sector	count					
		only	1st	2nd	3rd	4th	Total
Agriculture, Fishing, and Forestry	AB Agricultural extension and research	1	1	3	0	0	5
	AJ Animal production	0	1	0	0	0	1
	AH Crops	2	0	0	0	0	2
	AI Irrigation and drainage	2	4	0	0	0	6
	AT Forestry	12	2	10	0	0	24
	AZ General agriculture, fishing and forestry	19	3	9	4	0	35
	BC Central government administration	7	3	5	0	0	15
Public Administration, Law and Justice	BE Compulsory pension and unemployment insurance	0	0	0	0	0	0
	BG Law and justice	0	0	0	0	0	0
	BH Sub-national government administration	6	3	0	0	0	9
	BK Compulsory health finance	0	0	0	0	0	0
	BZ General public administration	2	3	5	0	0	10
	BL Public administration – Agriculture, fishing and forestry	0	0	0	0	0	0
	BM Public administration – Information and communications	0	0	0	0	0	0
	BN Public administration – Education	0	0	0	0	0	0
	BO Public administration – Finance	0	0	0	0	0	0
	BQ Public administration – Health	0	0	0	0	0	0
	BS Public administration – Other social services	0	0	0	0	0	0
	BT Public administration – Industry and trade	0	0	0	0	0	0
	BU Public administration – Energy and mining	0	0	3	0	0	3
	BV Public administration – Transportation	0	1	0	0	0	1
	BW Public administration – Water, sanitation and flood protection	0	1	1	0	0	2
Information and Communications	CA Information technology	0	0	0	0	0	0
	CB Media	0	0	0	0	0	0
	CT Telecommunications	0	0	0	0	0	0
	CZ General information and communications	0	0	0	0	0	0
Education	EL Adult literacy/non-formal education	0	0	0	0	0	0
	EC Pre-primary education	0	0	0	0	0	0
	EP Primary education	0	1	0	0	0	1
	ES Secondary education	0	0	0	0	0	0
	ET Tertiary education	0	0	0	0	0	0
	EV Vocational training	0	0	0	0	0	0
	EZ General education	0	0	0	0	0	0
Finance	FA Banking	0	0	0	0	0	0
	FB Non-compulsory health finance	0	0	0	0	0	0
	FC Housing finance and real estate markets	0	0	0	0	0	0
	FD Non-compulsory pensions, insurance, and contractual savings	0	2	0	0	0	2
	FE Micro- and SME finance	0	0	0	0	0	0
	FG Payment systems, securities clearance, and settlement	0	0	0	0	0	0
	FK Capital markets	0	0	0	0	0	0
FZ General finance	0	0	0	0	0	0	
Health and Other Social Services	JA Health	0	0	0	1	0	1
	JB Other social services	0	0	2	2	0	4
Industry and Trade	YA Agricultural marketing and trade	0	0	0	0	0	0
	YB Agro-industry	0	0	1	0	0	1
	YC Housing construction	0	0	0	0	0	0
	YD Petrochemicals and fertilizers	0	1	0	0	0	1
	YW Other industry	2	0	4	3	0	9
	YY Other domestic and international trade	0	0	0	0	0	0
	YZ General industry and trade	0	0	0	8	0	8
Energy and Mining	LA District heating and energy efficiency services	12	7	0	0	0	19
	LB Mining and other extractive	1	5	0	0	0	6
	LC Oil and gas	2	0	0	0	0	2
	LD Power	29	6	0	0	0	35
	LE Renewable energy	23	16	0	0	0	39
LZ General energy	6	17	0	0	0	23	
Transportation	TA Roads and highways	1	0	0	0	0	1
	TV Aviation	0	0	0	0	0	0
	TP Ports, waterways and shipping	0	0	0	0	0	0
	TW Railways	2	0	0	0	0	2
	TZ General transportation	3	0	5	4	1	13
Water, Sanitation, and Flood Protection	WD Flood protection	3	0	5	3	0	11
	WA Sanitation	0	0	0	0	0	0
	WS Sewerage	1	0	0	0	0	1
	WB Solid waste management	8	0	1	0	2	11
	WC Water supply	0	0	2	1	0	3
	WZ General water, sanitation and flood protection	8	0	13	5	1	27
Project Total						193	

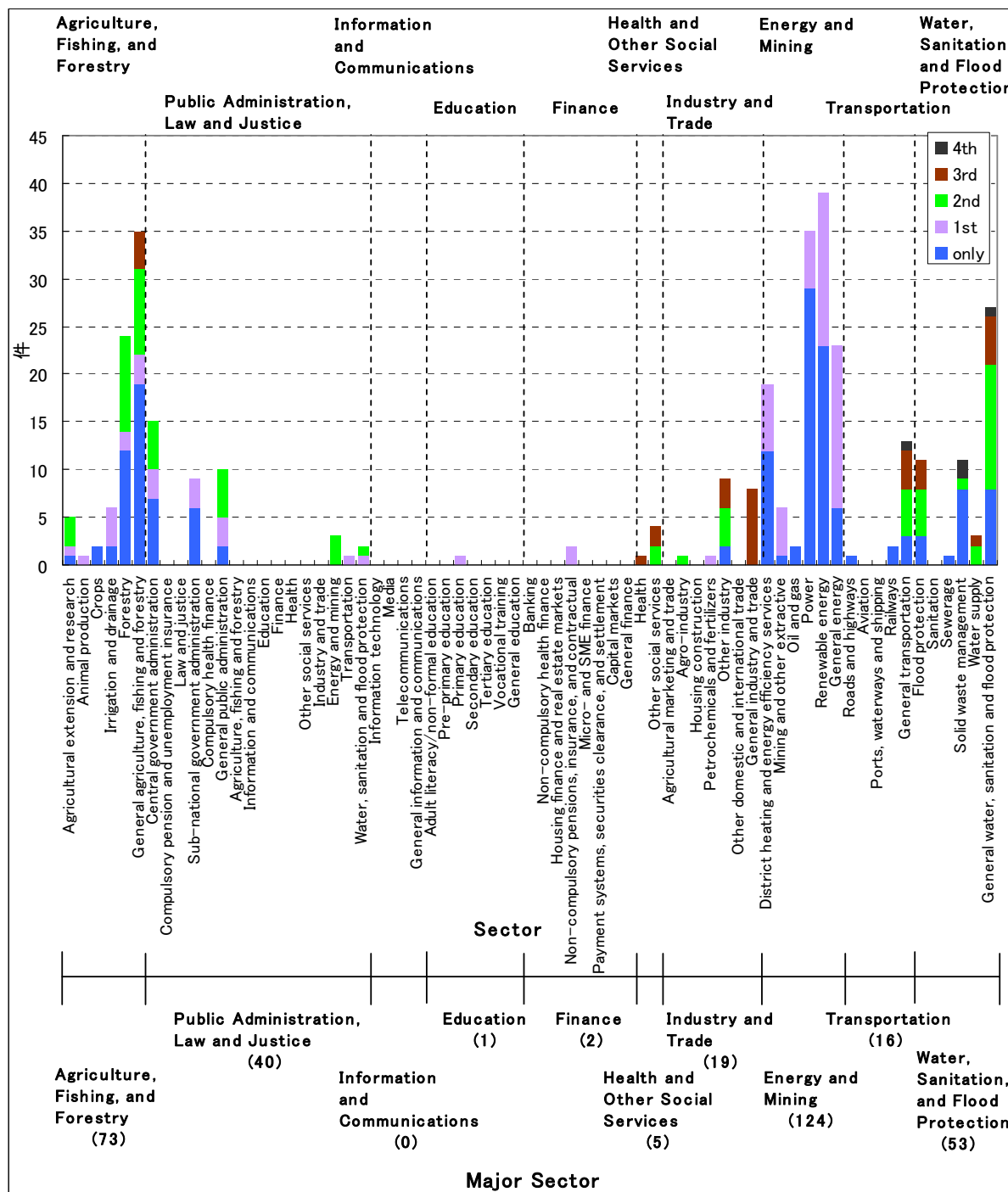
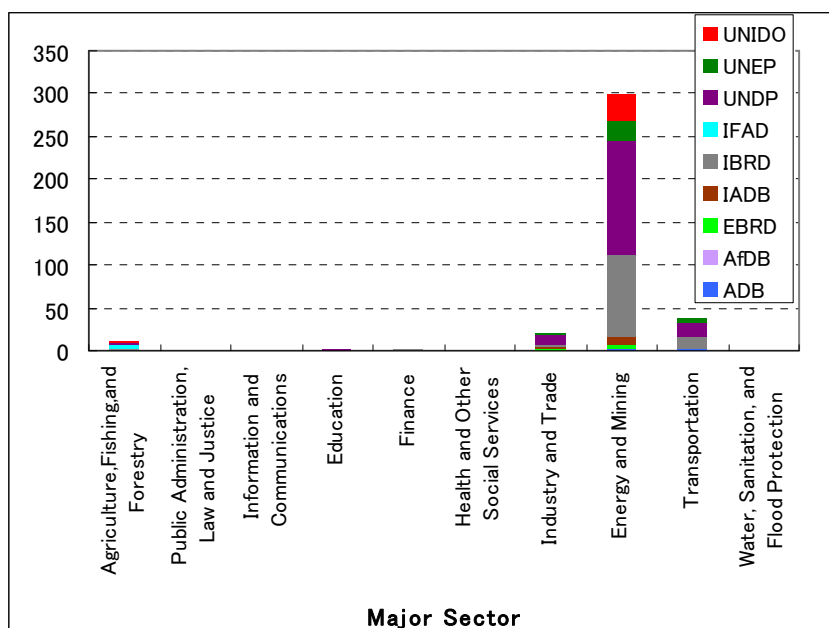


Figure 2.1.2 Summary of Sector Classification of World Bank Mitigation Projects



ADB	Asian Development Bank
AfDB	African Development Bank
EBRD	European Bank for Reconstruction and Development
IADB	Inter-American Development Bank
IBRD	International Bank for Reconstruction and Development
IFAD	International Fund for Agricultural Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization

Figure 2.1.3 Sector Classification of GEF Registered Mitigation Projects Implemented by Various International Organizations

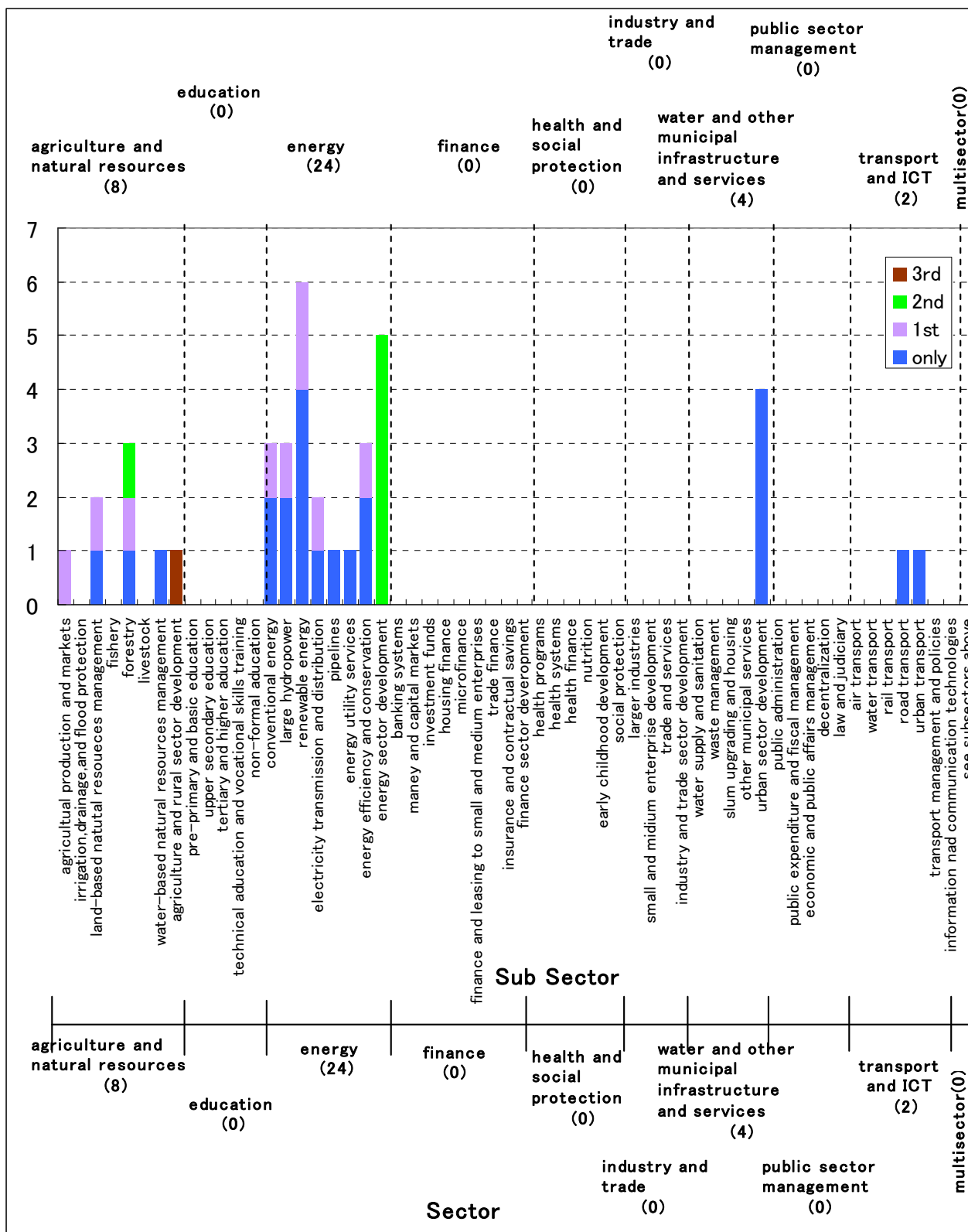


Figure 2.1.4 Summary of Sector Classification of ADB Mitigation Projects

(4) Selection of Target Sub-sectors

Based on the above investigation, the potential of mitigation actions in each sub-sector are re-classified. As a result, the following 6 sectors and 25 sub-sectors shown in Table 2.1.3 are selected.

Table 2.1.3 Sub-sectors for Mitigation Measures

Sector	Sub-sector	Examples of mitigation measures
Forest/natural resource conservation	1.Afforestation	Afforestation , reforestation
	2.Forest conservation	Forest conservation
Transportation	3.Passenger/Freight transportation improvement	Passenger (a new railway, a double track railway, or a quadruple track railway)
		Freight (a new railway , double track railway)
		Improvement of rails, High standardization
	4.MRT(Mass Rapid Transit)	City and suburb rapid railway (Subway, Elevated railway)
	5.Monorail, LRT	Monorail and Light Rail Transits
	6.Bus (BRT,Trunk bus)	BRT , Trunk bus
Energy conservation (Industry)	7.Energy efficiency improvement in industrial facilities	Introduction of high efficiency facilities and technology
	8.Electricity and heat supply in industrial facilities	Effective utilization of waste heat and waste gas
	9.Fuel switching in industry facilities	Fuel switching from coal or petroleum to natural gas
Energy	10.Energy plant construction with fuel switching	Natural gas pipeline
		Natural gas supply system
		Intensive heat-supply facilities
	11.Thermal power with electricity and heat supply	Cogeneration(waste heat and waste gas use)
	12.Thermal power with fuel switching	Natural gas plants
		Natural gas pipeline
	13.Thermal power with high efficiency	Fuel switching from coal or petroleum to natural gas for existing thermal power plants
		Combined-cycle electric generation
		High efficient coal thermal power plants
	14.Power transmission with improved efficiency	Thermal power plants improvement
15.Power distribution with improved efficiency	Decreasing of electrical loss due to improved power transmission systems	
16.Rural electrification	Decreasing of electrical loss due to improved power distribution systems	
	Rural electrification project by renewable energy use	
Renewable energy	17.Hydro power	Small hydro power , river-runoff hydro power
		Reservoir hydro power (except for pumped and storage hydro power)
	18.Wind power	Wind power plants
	19.Photovoltaic power/Solar heat	Solar power plants
	20.Geothermal	Geothermal plants
21.Biomass	Biomass power generation and heat-supply	
Sewerage, Urban sanitation	22.Landfill disposal of waste	Landfill LFG power generation
	23.Intermediate treatment of waste	Waste power plants , waste composition
	24.Wastewater treatment	Methane emission reduction by improving wastewater treatment
	25.Sewerage	Biomass generation and composting sewage sludge

2.2 Methodologies of Other Certification Organizations, etc.

Existing methodologies and tools are reviewed in order to clarify the basic concept and guidelines to be provided under this survey.

2.2.1 Reviewed Methodologies

This survey mainly reviews CDM methodologies. Other methodologies, including domestic and international Voluntary Emissions Trading methodologies, GHG emission reduction calculation manual or tool used by international organization for assistance to developing countries, and VER certification organization methodologies are also considered.

Table 2.2.1 below shows the surveyed methodologies and their outlines.

Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies (1)

Survey Targets		Overview
CDM Methodology	Approved methodologies, Approved consolidated methodologies, Small-scale CDM methodology, Afforestation/reforestation CDM methodology Approved consolidated afforestation/reforestation CDM methodology, Small-scale approved consolidated afforestation/reforestation CDM methodology	International standard method for project-based GHG emission reductions as a method to quantify. Covering all sectors, there are 179 methodologies applied to more than 2,400 projects, as of April 28, 2011. ¹
Domestic Voluntary Emissions Trading methodologies	J-VER (offset-credit system: Ministry of the Environment, Japan)	This is the methodology for calculation and certification of project-based voluntary GHG emission reduction (sequestration). ² Energy:24 , Forestry:3 , Waste:1
	Domestic Credit System (Domestic emission certification system) (Ministry of the Environment, Ministry of the Environment, Ministry of Agriculture, Forestry and Fisheries, Japan)	This is the methodology for authentication and GHG estimation done by small businesses ³ Energy, Waste, etc.:34
	J-MRV (Japan Finance Corporation, Japan Bank For International Cooperation)	This is JBIC's tool for MRV for environmental protection activities (GREEN: Global action for Reconciling Economic growth and ENvironmental preservation) ⁴ Energy Sector: 4, as of February 28, 2011.
Manual or tool to estimate GHG emission reduction by international organization(Developing country support)	WB (The World Bank/Carbon Finance Unit)	The handbook has been published. CDM projects are in accordance with the CDM methodology while other projects conform to the GEF manual. ⁵
	IFC (International Finance corporation)	IFC offers project-GHG calculation sheet for sectors such as forestry, water supply and sewerage and drainage, urban sanitation, others) ⁶
	OECD Organization for Economic Co-operation and Development)	Published a power sector manual for calculating GHG. ⁷
	ADB(Asian Development Bank)	Released a transportation and energy sector manual on basic concept for GHG estimation. ⁸

Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies (2)

Survey Targets		Overview
Manual or tool to estimate GHG emission reduction by international organization (Developing country support)	UNEP (United Nations Environment Program)	Released energy, transportation and industrial processes GHG calculation sheets. ⁹
	GEF (Global Environment Facility)	In the published manual, CDM-like approach is used to quantify GHG. ¹⁰
	GHG protocol (the Greenhouse Gas Protocol Initiative)	Released energy consumption, transportation and industrial processes GHG calculation sheets. ¹¹
	USAID (United States Agency for International Development)	Released forestry and transportation sectors GHG calculation sheets (outline). ¹²
	CIDA (Canadian International Development Agency)	GHG calculations are conducted under a fund targeting climate change operations. Details of the program are unknown.
	GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) (*Now GIZ : The Deutsche Gesellschaft für Internationale Zusammenarbeit)	GHG calculator is released in the waste sector. ¹³
	KfW (Kreditanstalt für Wiederaufbau)	Released tool for GHG calculation for landfill. ¹⁴
	PROPARCO (single pour Promotion et Participation pour la Coopération économique)	Estimates GHG of the project they assist. Information on the program is unknown. ¹⁵
Methodology of VER Certification agency	Gold Standard	In addition to the verification and certification of CDM projects, the following criteria is used to determine the quality of CDM /JI projects. ¹⁶ i) Project Eligibility, ii) Additionality and baseline iii) Contribution to sustainable development
	VER+	Certification audit is basically being done using the same methodology as with CDM and JI projects. ¹⁷
	CCB Standards (The Climate, Community and Biodiversity Project Design Standards)	Assessment of biodiversity, climate change mitigation effects and impact to the local community. ¹⁸
	Green-e	Green Power Certification Program (Green-e) is aimed at consumer protection when power credits are sold, verifying whether the goods satisfy environmental standards. ¹⁹
	VOS (Voluntary Offset Standard)	Certification system equivalent to the standard of the Kyoto credits. Target countries are mainly countries that did not ratify the Kyoto Protocol, and in particular, the U.S. and Australia (Australia ratified the Protocol). ²⁰
	CCX (Chicago Climate Exchange)	System has its own validation criteria. Provides manuals for calculation of GHG in multiple sectors. ²¹
	CCAR (California Climate Action Registry)	The methodology of California NPO. Provides manuals for calculation of GHG in multiple sectors. ²²
	Plan Vivo	Grass root criteria that offer high standard for environmental protection and local benefits. The methodology is an expensive option compared to those used in the global carbon market. ²³

Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies (3)

Survey Targets		Overview
Methodology of VER Certification agency	Social Carbon	The feature of the methodology is to evaluate and verify the long-term impact assessment of sustainable development. ²⁴
	NCOS(National Carbon Offset Standard)	Efforts by the Australian Government started in July 2010, replacing Greenhouse Friendly™. The targets are Australian companies. ²⁵

¹ <http://www.kyomecha.org/cdm.html#method>

² http://www.4cj.org/jver/system_doc/methodology.html

³ <http://jcdm.jp/process/methodology.html>

⁴ <http://www.jbic.go.jp/ja/about/environment/j-mrv/pdf/jmrv-guideline.pdf>

⁵ <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTCARBONFINANCE/0,,contentMDK:22366206~pagePK:64168445~piPK:64168309~theSitePK:4125853,00.html>

⁶ <http://www.ifc.org/ifcext/climatebusiness.nsf/Content/GHGaccou>

⁷ <http://www.oecd.org/dataoecd/45/43/1943333.pdf>

⁸ <http://www.adb.org/documents/papers/adb-working-paper-series/ADB-WP09-Transport-CO2-Emissions.pdf>

⁹ <http://www.unemg.org/MeetingsDocuments/IssueManagementGroups/SustainabilityManagement/UnitedNationsGreenhouseGasCalculator/tabid/3975/Default.aspx>

¹⁰ <http://www.thegef.org/gef/node/313>

¹¹ <http://www.ghgprotocol.org/calculation-tools>

¹² http://www.usaid.gov/our_work/environment/climate/docs/forest_carbon_calculator_jan10.pdf

¹³ <http://www.gtz.de/en/themen/umwelt-infrastruktur/abfall/30026.htm>

¹⁴ http://www.kfw-entwicklungsbank.de/EN_Home/Sectors/Waste_management/Solid_Waste_Management_Greenhouse_Gas_Calculator/index.jsp

¹⁵ <http://www.proparco.fr/jahia/webdav/site/afd/shared/PUBLICATIONS/INSTITUTIONNEL/plaquettes-presentation/AFD-Brochure-english-2008.pdf>

¹⁶ <http://www.cdmgoldstandard.org/Current-GS-Rules.102.0.html>

¹⁷ http://www.netinform.de/KE/Beratung/Service_Ver.aspx

¹⁸ http://www.climate-standards.org/standards/pdf/second_edition/CCB_Standards_2nd_Edition_JAPANESE.pdf

¹⁹ http://www.green-e.org/getcert_ghg_products.shtml

²⁰ <http://www.carboninvestors.org/ECISVoluntaryOffsetStandardFINALJune.pdf>

²¹ <https://registry.chicagoclimatex.com/public/projectsReport.jsp>

²² <http://www.climateregistry.org/>

²³ <http://planvivo.org.34spreview.com/documents/standards.pdf>

²⁴ <http://www.socialcarbon.org/>

²⁵ <http://www.climatechange.gov.au/en/government/initiatives/national-carbon-offset-standard.aspx>

2.2.2 Existing Methodologies for Targeted Sub-sectors

The existing methodologies and tools are classified into each of the mitigation sub-sectors chosen in the earlier section “Selection of Targeted Sub-sectors” and served as basic data for discussion of this survey. Some of the applied methodologies in past projects were introduced. (All existing methodologies and tools are shown in Table 2.2.2, including those in sectors with a relatively small number of or no past applications.)

(1) Forest and Natural Resources Conservation Sector

Some of the methodologies of CDM and J-VER are applied in the forestry sector. CDM is only applicable for afforestation and reforestation in the first commitment period (2008~2012), excluding forest management (REDD) or farmland management. Application of CDM to afforestation projects is limited. AR-AM003 has the most applied numbers, with only 4 approved projects. On the other hand, there is progress in application of Japan’s J-VER methodologies to domestic forest management projects. There are two methodologies on increase of CO₂ sequestration through forest management activities, with 51 applications for one of the methodologies (Thinning Promotion R001).

The ‘forest conservation’ explained here means the “Reduced Emission from Deforestation and Forest Degradation (REDD)”. The VCS guideline is referred to because the United Nations has not approved any of the REDD methodologies at the timing of the survey.

Table 2.2.2 Existing Methodologies in Forest and Natural Resources Conservation Sector

Sub-sector	CDM			J-VER			VCS			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
Afforestation	AR-AM0003	Afforestation and reforestation of degraded land through tree planting, assisted natural regeneration and control of animal grazing	4	—	—	—	—	—	—	Forestation	37
	AR-AM0002	Restoration of degraded lands through afforestation/reforestation	1								
	AR-AM0001	Reforestation of degraded land	2								
	AR-ACM0001	Afforestation and reforestation of degraded land	2								
	AR-AM0004	Reforestation or afforestation of land currently under agricultural use	1								
	AR-AM0005	Afforestation and reforestation project activities implemented for industrial and/or commercial uses	1								
	AR-AM0010	Afforestation and reforestation project activities implemented on unmanaged grassland in reserve/protected areas	1								
Forest conservation	—	—	—	R001	Increase in CO ₂ sequestration through forest management activity (Thinning Promotion Project)	51	VM0003	Methodology for Improved Forest Management through Extension of Rotation Age, v1.0	Unknown	Forest Conservation, Slope Conservation/ Soil Conservation, Mangrove Conservation, Ecosystem (Biodiversity) conservation, Restoration, Forest disaster prevention	31
							VM0004	Methodology for Conservation Projects that Avoid Planned Land Use Conversion in Peat Swamp Forests, v1.0			
							VM0005	Methodology for Conversion of Low-productive Forest to High-productive Forest			
							VM0006	Methodology for Carbon Accounting in Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation			

Sub-sector	CDM			J-VER			VCS			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
				R002	Increase in CO ₂ sequestration through forest management activity (Thinning Promotion Project)	9	VM0007	REDD Methodology Modules (REDD-MF)			
							VM0009	Methodology for Avoiding Mosaic Deforestation of Tropical Forests			
							VM0010	Methodology for Improved Forest Management: Conversion from Logged to Protected Forest			
							VM0003	Methodology for Improved Forest Management through Extension of Rotation Age, v1.0			

Note : Application number is indicated in the approved real ones. In () indicate the number of cases pending projects. (as of March 31, 2011)

(2) Traffic and Transportation Sector

Some methodologies are currently available for CDM and J-VER in traffic and transportation sector. However, only CDM methodologies have been applied to actual project activities. There are only 6 projects because of the geographically large project boundary and difficulties in estimating/verification/monitoring of GHG emission reductions effect. As shown in Table 2.2.3, there are 5 modal shift projects applied, including 2 for bus rapid transit or BRT projects, 1 for railway, 1 for rolling stock cars for subways, 1 for cable cars, and 1 for bio-diesel production projects.

Table2.2.3 Existing Methodologies in Traffic and Transportation Sector

Sub-sector	CDM			ODA Loan Projects	
	Method No.	Title	Project	Classification	Project
Freight/Passenger Transportation Improvement	AM0090	Modal shift in transportation of cargo from road transportation to water or rail transportation	0	Freight (a new railway , double track railway)	48
	AMS-III.C.	Emission reductions by electric and hybrid vehicles	1	Passenger (a new railway, a double track railway, or a quadruple track railway) Improvement of railway facilities, High standardization , Rehabilitation of railway bridges	
MRT (Mass Rapid Transit)	ACM0016	Baseline and monitoring methodology for Mass Rapid Transit Projects	0	MRT (City and suburb rapid railway: Subway, Elevated railway)	46
	AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS)	1		
Monorail, LRT	ACM0016	Baseline and monitoring methodology for Mass Rapid Transit Projects	0	Monorail, LRT	2
	AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS)	1		
Bus(BRT , Trunk bus)	ACM0016	Baseline and monitoring methodology for Mass Rapid Transit Projects	0		
	AM0031	Cable Cars for Mass Rapid Transit System (MRTS)	2		0

(3) Energy Conservation (Industry) Sector

Energy conservation (Industry) sector has methodologies and actual application examples in the CDM, J-VER, Domestic Credit System and J-MRV. Domestic Credit System 001 is ranked highest at 248 applications in the sub-sector of energy efficiency improvement for industrial facilities. Also, the small-scale approved methodologies, AMS-II.D, ranked highest at 42 among other methodologies for the CDM. These are projects that include upgrading of boilers in industrial facilities.

The CDM-approved consolidated methodology, ACM0012, ranked highest at 22 in cogeneration (supply of electricity and heat) for industrial facilities. There are many scenarios in approved consolidated methodologies; however, cogeneration (supply of electricity and heat) by effective utilization of waste energy (waste gas, waste heat, waste pressure) is the target.

Small-scale CDM methodology AMS-III.B and consolidated methodology ACM0003, both with 13 applications each, rank the highest among the methodologies in the sub-sector of fossil fuel switching measure for industrial facilities. These involve fuel switching to low-carbon fuel, from fossil fuel to natural gas, etc..

Table 2.2.4 Existing Methodologies in Energy Conservation (Industry) Sector (1)

	CDM			J-VER			Domestic Credit System			J-MRV			ODA Loan Projects			
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project		
Energy Efficiency Improvement	AMS-II.D.	Energy efficiency and fuel switching measures for industrial facilities	42	E011	Upgrade • fuel switch of boiler equipment	Update of boiler.	001	Upgrading of boiler.	248	J-MRV002	Methodology for Energy conservation project	Unknown	Energy conservation	2		
	AMS-II.C.	Demand-side energy efficiency activities for specific technologies Baseline Methodology for steam optimization systems	11				004	Upgrading of air-conditioning equipment.	109							
	AM0018	Energy efficiency measures through centralization of utility provisions of an industrial facility	10				001-A	Installing a new boiler.	33							
	AMS-II.H.	Methodology for improved electrical energy efficiency of an existing submerged electric arc furnace used for the production of SiMn	1				002	Upgrading of heat source equipment by introducing a heat pump.	28							
	AM0038	Energy efficiency and fuel switching measures for industrial facilities; Demand-side energy efficiency activities for specific technologies	1				002-A	Upgrading of heat source equipment by introducing a heat pump. (Heat-collecting type)	8							
							002-B	Installing a new heat source equipment by introducing a heat pump	3							
							003	Upgrading of industrial furnace	14							
							005	Intermittent operational control, Inverter control, or Install of regulating equipments for pumps and fans	43							

	CDM			J-VER			Domestic Credit System			J-MRV			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
	AM0059	Baseline methodology for steam optimization systems	1				010	Upgrading of transformer	5					
							022	Upgrading of refrigeration equipment	2					
Electricity and heat supply	ACM0012	Consolidated baseline methodology for GHG emission reductions for waste gas or waste heat or waste pressure based energy system	22(1)	E006	Recovery and utilization of waste heat	2	014	Introduction of a small steam generator by utilizing excess steam	5	J-MRV003	Recovery and utilization of waste energy project	Unknown	Industry	15
	AMS-III.Q.	Waste gas based energy systems	11(1)				009	Energy utilization of hot spring heat and waste heat	2				Factory, plant	
	AM0024	Methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants	9				—	013	Switching to thermal applications from the external high-efficiency heating equipment					
	AMS-III.P	Recovery and utilization of waste gas in refinery facilities	4											

Table 2.2.5 Existing Methodologies in Energy Conservation (Industry) Sector (2)

	CDM			J-VER			Domestic Credit System			J-MRV			ODA Loan Projects				
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project			
Fuel switching	AMS-III.B	Supply side energy efficiency improvements – generation	13(1)	E001	Switch from fossil fuel to unused woody biomass for boiler fuel	8	012	Switch from coke to biocoke in melting furnace	1				Factory, plant Mining industry	8			
	AMS-II.D.	Methodology for conversion from single cycle to combined cycle power generation	42	E002	Switch from fossil fuel to unused wood pellets for boiler fuel	5											
	ACM0003	Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology	13(1)														
	ACM0009	Supply side energy efficiency improvements – transmission and distribution	5		–												
	AM0036	Methodology for installation of energy efficient transformers in a power distribution grid	3														
	AMS-II.G.	Supply side energy efficiency improvements – transmission and distribution	1														

Note : Application number is indicated in the approved real ones. Values in () indicate the number of cases of pending projects. (as of March 31, 2011)

(4) Energy Sector

The energy sector has methodologies and actual application examples in the CDM and VCS. Projects under CDM-approved methodology AM0029 ranked highest at 31 in the sub-sector of plant supplying energy maintenance with fuel switching, targeting projects that supply natural gas originated electricity to a grid.

Projects under CDM-approved consolidated methodology ACM0012 ranked second at 22 in the sub-sector of fossil fuel fired power plants for supplying electricity. Projects under CDM small-scale methodology MS-III.B ranked third at 13 in the sub-sector of fossil fuel-fired power plants for fuel switching.

10 projects have applied CDM small-scale methodology AMS-II.B in the sub-sector of fossil fuel-fired power plants for efficiency improvement, targeting projects that replace plants such as boilers in fossil fuel-fired power plants.

Table 2.2.6 Existing Methodologies in the Energy Sector

Sub-sector	CDM			ODA Loan Projects	
	Method No.	Title	Project	Classification	Project
Energy plant with fuel switching	AM0029	Baseline Methodology for Grid-Connected Electricity Generation Plants using Natural Gas	31	Intensive heat-supply system with fuel switching Energy facilities(Establishment of natural gas pipeline)	28
	AM0014	Natural gas-based package cogeneration	5		
	AM0058	Introduction of a new primary district heating system	0(1)		
Thermal power with electricity and heat supply	ACM0012	Consolidated baseline methodology for GHG emission reductions for waste gas or waste heat or waste pressure based energy system	22(1)	Thermal power with electricity and heat supply	4
	AM0055	Baseline and Monitoring Methodology for the recovery and utilization of waste gas in refinery facilities	1		
Thermal power with fuel switching	AMS-III.B.	Switching fossil fuels	13(1)	Intensive heat-supply system with fuel switching	12
	ACM0011	Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation	1		
Thermal power with higher efficiency	AMS-II.B.	Supply side energy efficiency improvements – generation	10	Thermal power with high efficiency	39
	ACM0007	Methodology for conversion from single cycle to combined cycle power generation	4		
	ACM0013	Consolidated baseline and monitoring methodology for new grid-connected fossil fuel-fired power plants using a less GHG-intensive technology	3		
Power transmission with improved efficiency	AMS-II.A.	Supply side energy efficiency improvements – transmission and distribution	0	Transmission and distribution	53
	AM0067	Methodology for installation of energy efficient transformers in a power distribution grid	0		
Power distribution with improved efficiency	AMS-II.A.	Supply side energy efficiency improvements – transmission and distribution	0	Transmission and distribution	11
	AM0067	Methodology for installation of energy efficient transformers in a power distribution grid	0		
Rural electrification	AMS-I.F.	Renewable electricity generation for captive use and mini-grid	0	Renewable energy Rural electrification	31

Note : Application number is indicated in the approved real ones. Values in () indicate the number of cases of pending projects. (as of March 31, 2011)

(5) Renewable Energy Sector

The renewable energy sector has some methodologies available with the CDM, J-VER, and Domestic Credit System. However, only the CDM and Domestic Credit System exhibit actual application examples. Most CDM methodologies fall into two sub-sectors. One group is categorized into hydro, wind, photovoltaic and geothermal. The other is biomass.

Projects under approved consolidated methodology ACM0002 ranked highest at 900, while projects under small-scale approved methodology AMS-I.C ranked second at 846 in the sub-sector group of hydro, wind, photovoltaic and geothermal. These are all projects for grid-connected electricity generation from renewable sources. The above 2 methodologies account for about half of the current CDM approved projects.

Bio-diesel production and use for transportation applications are referred separately in the fuel switching methodologies. In this chapter, approved consolidated methodology for electricity generation with biomass residues under ACM0006 is regarded as the highest ranking methodology with 93 application cases.

Table 2.2.7 Existing Methodologies in Renewable Energy Sector

Sub-sector	CDM			Domestic Credit System			Yen Loan Aid Projects	
	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
Hydro power, Wind power, Photovoltaic power /solar heat, Geothermal power	ACM0002	Consolidated baseline methodology for grid-connected electricity generation from renewable sources	900(29)	008	Methodology for grid-connected electricity generation from photovoltaic power system	21	Hydro power plants (except for small hydropower and pumped and storage hydropower) Renewable energy	54
	AMS-I.D.	Grid-connected renewable electricity generation	846(21)					
	AMS-I.C.	Thermal energy production with or without electricity	114(4)					
	AM0026	Methodology for zero emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid	4					
Biomass	ACM0006	Consolidated methodology for electricity and heat generation from biomass residues	93(1)		—		Renewable energy	0

Note : Application number is indicated in the approved real ones. Values in () indicate the number of cases of pending projects. (as of March 31, 2011)

(6) Sewerage and Urban Sanitation Sector

Sewerage and urban sanitation sector have methodologies, but only the CDM has actual application examples. In the sub-sector of waste management, projects under approved consolidated methodology ACM0001 ranked highest at 129. These include the methodologies for landfill gas capture projects.

In the 2 sub-sectors of treatment of wastewater and sewerage, 93 projects have applied small-scale approved methodology, targeting projects for methane recovery in wastewater treatment.

Table 2.2.8 Existing Methodologies in Sewerage and Urban Sanitation Sector

Sub-sector	CDM			Yen Loan Aid Projects	
	Method No.	Title	Project	Classification	Project
Landfill disposal of waste	ACM0001	Consolidated baseline and monitoring methodology for landfill gas project activities	129	Urban sanitation (waste disposal)	7
	AMS-III.E.	Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment	27		
	AMS-III.G.	Landfill methane recovery	13		
	AM0083	Avoidance of landfill gas emissions by in-situ aeration of landfills	1		
	AM0025	Avoided emissions from organic waste through alternative waste treatment processes	17		
Intermediate treatment of waste	AMS-III.F.	Avoidance of methane emissions through composting	36	Urban sanitation (waste disposal)	9
	AM0039	Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting	2		
Wastewater treatment	AMS-III.H.	Methane recovery in wastewater treatment	93(5)	Drainage	35
	AMS-III.I.	Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems	7		
	AMS-III.Y.	Methane avoidance through separation of solids from wastewater or manure treatment systems	1		
Sewerage	AMS-III.H.	Methane recovery in wastewater treatment	93(5)	Sewerage	56
	AMS-III.I.	Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems	7		
	AMS-III.Y.	Methane avoidance through separation of solids from wastewater or manure treatment systems	1		
	ACM0014	Mitigation of greenhouse gas emissions from treatment of industrial wastewater	2		

Note : Application number is indicated in the approved real ones. Values in () indicate the number of cases of pending projects. (as of March 31, 2011)

Reference-1 Comparison of Methodologies (1)

Sector	Sub-Sector	CDM			J-VER			VCS			Domestic Credit System			J-MRV			Yen loan aid projects		
		Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project	
Forest and natural resources conservation	Afforestation	AR-AM0003	Afforestation and reforestation of degraded land through tree planting, assisted natural regeneration and control of animal grazing	4													Afforestation	37	
		AR-AM0002	Restoration of degraded lands through	1															
		AR-AM0001	Reforestation of degraded land	2															
		AR-ACM0001	Afforestation and reforestation of degraded land	2															
		AR-AM0004	Reforestation or afforestation of land currently under agricultural use	1															
		AR-AM0005	Afforestation and reforestation project activities implemented for industrial and/or commercial uses	1															
		AR-AM0010	Afforestation and reforestation project activities implemented on unmanaged grassland in reserve/protected areas	1															
	Forest conservation					R001	Increase in CO2 sequestration through forest management activity (Thinning Promotion Project)	51	VM0003	Methodology for Improved Forest Management through Extension of Rotation Age, v1.0	Unknown							•Forest conservation , Slope conservation/Soil conservation •Mangrove conservation •Ecosystem (biodiversity) integrity/restoration •Forest disaster prevention	20
						R002	Increase in CO2 sequestration through forest management activity (Thinning Promotion Project)	9	VM0004	Methodology for Conservation Projects that Avoid Planned Land Use Conversion in Peat Swamp Forests, v1.0	Unknown								
										VM0005	Methodology for Conversion of Low-productive Forest to High-productive Forest	Unknown							
									VM0006	Methodology for Carbon Accounting in Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation	Unknown								
									VM0007	REDD Methodology Modules (REDD-MF)	Unknown								
									VM0009	Methodology for Avoided Mosaic Deforestation of Tropical Forests	Unknown								
Traffic and Transportation	Freight/Passenger Transportation Improvement	AM0090	Modal shift in transportation of cargo from road transportation to water or rail transportation	0	E023	Eco-drive with mounted digital tachographs	0										•Freight (a new railway double track railway) •Passenger (a new railway, a double track railway, a quadruple track railway) •Improvement of rails, High standardization , Rehabilitation of railway bridges •Rehabilitation of train cars and railway facilities	48	
		AMS-III.C.	Emission reductions by electric and hybrid vehicles	1															
	MRT	AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS)	1													MRT (City and suburb rapid railway :Subway, Elevated	46	
		ACM0016	Baseline Methodology for Mass Rapid Transit Projects	0															
	Mono-rail,LRT	AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS)	1													Monorail, LRT	2	
		ACM0016	Baseline Methodology for Mass Rapid Transit Projects	0															
	Bus	ACM0016	Baseline Methodology for Mass Rapid Transit Projects	0													BRT,Trunk Bus	0	
		AM0031	Baseline Methodology for Bus Rapid Transit Projects	2															
	Energy Conservation (Industry)	Energy Efficiency Improvement	AMS-II.D.	Energy efficiency and fuel switching measures for industrial facilities	42	E011	Upgrade fuel switch of boiler equipment	5				001	Upgrading of boiler.	248	J-MRV002	Methodology for Energy conservation project	Unknown	Energy Conservation	2
				Demand-side energy efficiency activities for specific technologies	11								004	Upgrading of air-conditioning equipment.	109				
AM0018			Baseline methodology for steam optimization systems	10								001-A	Installing a new boiler.	33					
AMS-II.H.			Energy efficiency measures through centralization of utility provisions of an industrial facility	1								002	Upgrading of heat source equipment by introducing a heat pump.	28					
AM0038			Methodology for improved electrical energy efficiency of an existing submerged electric arc furnace used for the production of SiMn	1								002-A	Upgrading of heat source equipment by introducing a heat pump.	8					
AM0059			Reduction in GHGs emission from primary aluminium smelters	1								002-B	Installing a new heat source equipment by introducing a heat pump.	3					
												003	Upgrading of industrial furnace	14					
												005	Intermittent operational control, Inverter control, or Install of regulating equipments for pumps and fans	43					
											010	Upgrading of transformer	5						
											022	Upgrading of refrigeration equipment	2						
Electricity and heat supply		ACM0012	Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects	22(1)	E006	Recovery and utilization of waste heat	2					014	Introduction of a small steam generator by utilizing excess steam	5	J-MRV003	Recovery and utilization of waste energy project	Unknown	•Factory, Plant •Mining	15
		AMS-III.Q.	Waste energy recovery (gas/heat/pressure) projects	11(1)								009	Energy utilization of hot spring heat and waste heat	2					
		AM0024	Baseline methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants	9								013	Switching to thermal applications from the external high-efficiency heating equipment	1					
		AMS-III.P.	Recovery and utilization of waste gas in refinery facilities	4															
Fuel switching	AMS-III.B.	Switching fossil fuels	13(1)	E001	Switch from fossil fuel to unused woody biomass for boiler fuel	8					012	Switch from coke to biocoke in melting furnace	1			•Factory, Plant •Mining	8		
	AMS-II.D.	Energy efficiency and fuel switching measures for industrial facilities	42	E002	Switch from fossil fuel to unused wood pellets for boiler fuel	5													
	ACM0003	Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement or quicklime manufacture	13(1)																
	ACM0009	Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas	5																
	AM0036	Fuel switch from fossil fuels to biomass residues in heat generation equipment	3																
	AMS-II.G.	Energy efficiency measures in thermal applications of non-renewable biomass	1																

Reference-2 Comparison of Methodologies (2)

Sector	Sub-Sector	CDM			J-VER			VCS			Domestic Credit System			J-MRV			Yen loan aid projects		
		Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project	
Energy	Energy plant with fuel switching	AM0029	Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas	31													Intensive heat-supply system with fuel switching Energy Facilities (Construction of Natural gas pipelines)	28	
		AM0014	Natural gas-based package cogeneration	5															
		AM0058	Introduction of a new primary district heating system	0(1)															
	Thermal power electricity	ACM0012	Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects	22(1)														Thermal power plants with electricity and heat supply	4
		AM0055	Recovery and utilization of waste gas in refinery	1															
	Thermal power with fuel switching	AMS-III.B.	Switching fossil fuels	13(1)														Thermal power plants with fuel switching	12
		ACM0011	Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation	1															
	Thermal power with higher efficiency	AMS-II.B.	Supply side energy efficiency improvements – generation	10										J-MRV004	Methodology for fossil fuel fired power plants using a less GHG intensive technology	Unknown	Thermal power plants with higher energy efficiency	39	
		ACM0007	Conversion from single cycle to combined cycle power generation	4															
		ACM0013	Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology	3															
	Power transmission with improved efficiency	AMS-II.A.	Supply side energy efficiency improvements – transmission and distribution	0													Electricity Transmission	53	
		AM0067	Methodology for installation of energy efficient transformers in a power distribution grid	0															
Power distribution with improved efficiency	AMS-II.A.	Supply side energy efficiency improvements – transmission and distribution	0													Electrical Distribution	11		
	AM0067	Methodology for installation of energy efficient transformers in a power distribution grid	0																
Rural electrification	AMS-I.F.	Renewable electricity generation for captive use and mini-grid	0													Renewable energy Rural electrification	31		
Renewable energy	Hydro power, Wind Power, Photovoltaic power / solar heat, Geothermal	ACM0002	Consolidated baseline methodology for grid-connected electricity generation from renewable sources	900(29)							008	Methodology for grid-connected electricity generation from photovoltaic power system	21			Hydro power plants (except for small hydropower and pumped and storage hydropower) Renewable energy	54		
		AMS-I.D.	Grid connected renewable electricity generation	846(21)															
		AMS-I.C.	Thermal energy production with or without electricity	114(4)															
		AM0026	Methodology for zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid	4															
	Biomass	ACM0006	Consolidated methodology for electricity and heat generation from biomass	93(1)									J-MRV0001	Methodology for electricity and heat generation from biomass residues	Unknown	Renewable energy	0		
Sewerage, Urban sanitation	Landfill disposal of waste	ACM0001	Consolidated baseline and monitoring methodology for landfill gas project activities	129												Urban Sanitation (Disposal of waste)	7		
		AMS-III.E.	Avoidance of methane production from decay of biomass through controlled combustion, gasification or	27															
		AMS-III.G.	Landfill methane recovery	13															
		AM0083	Avoidance of landfill gas emissions by in-situ aeration of landfills	1															
		AM0025	Avoided emissions from organic waste through alternative waste treatment processes	17															
	Intermediate treatment of waste	AMS-III.F.	Avoidance of methane emissions through composting	36												Urban Sanitation (Disposal of waste)	9		
		AM0039	Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting	2															
	Wastewater treatment	AMS-III.H.	Methane recovery in wastewater treatment	93(5)												Wastewater	35		
		AMS-III.L.	Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems	7															
		AMS-III.Y.	Methane avoidance through separation of solids from wastewater or manure treatment systems	1															
Sewerage	AMS-III.H.	Methane recovery in wastewater treatment	93(5)												Sewerage	56			
	AMS-III.I.	Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems	7																
	AMS-III.Y.	Methane avoidance through separation of solids from wastewater or manure treatment systems	1																
		ACM0014	Natural gas-based package cogeneration	2															

Note: Application number is indicated in the approved real ones. Values in () indicate the number of cases of pending projects. (March 31, 2011)

Reference-3 Methodologies of International Organization (1)

Established agency / Institution	WB (The World Bank/Carbon Finance Unit)	IFC (International Finance corporation)	OECD (Organization for Economic Co-operation and Development)	ADB (Asian Development Bank)	UNEP (United Nations Environment Programme)	GEF (Global Environment facility)	GHG protocol (The Greenhouse Gas Protocol Initiative)	USAID (United States Agency for International Development)	CIDA (Canadian International Development Agency)
Multi/Bilateral	Multi	Multi	Multi	Multi	Multi	Multi	Multi	Bi	Bi
Outline	The handbook has been published. CDM projects are in accordance with the CDM methodology while other projects conform to the GEF manual.	IFC offers project-GHG calculation sheet for sectors such as forestry, water supply and sewerage and drainage, urban sanitation, others)	Published a power sector manual for calculating GHG.	Released a transportation and energy sector manual on basic concept for GHG estimation.	Released energy, transportation and industrial processes GHG calculation sheets.	In the published manual, CDM-like approach is used to quantify GHG.	Released energy consumption, transportation and industrial processes GHG calculation sheets.	Released forestry and transportation sectors GHG calculation sheets (outline).	Canada Climate Change Development Fund estimates GHG, but the details including an estimation program are unknown.
Forest and natural resources conservation	•Forestry	•Forestry •Land use	•Provide estimation methodology for GHG emission reductions in Agriculture sector •EX-ACT, EX-ante					•Carbon estimation tool FOREST CARBON CALCULATOR	
Traffic and Transportation	•Transport (modal shift) •Infrastructures (Construction of Port, Bridge, etc.)			•Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation		Others: MANUAL FOR CALCULATING GREENHOUSE GAS BENEFITS FOR GLOBAL ENVIRONMENT FACILITY TRANSPORTATION PROJECTS	•GHG estimation sheet for traffic and transportation •WR1_Transport_Tool		
Energy Conservation (Industry)	•Cement •Fertilizer	•Cement •Metal •Chemistry •Glasses •Lime production •Oil, Mining				•Energy conservation in general	•GHG estimation sheet for industry •GHG emissions from the production of aluminum •CO2 emissions from the production of lime •CO2 emissions from the production of iron and steel •CO2 emissions from the production of cement (US EPA) •CO2 emissions from the production of ammonia		
Energy	•Fuel switch from fossil fuel •Cogeneration •Updating of refinery •Updating of electricity transmission •Updating of electric power substation •Construction of natural gas pipeline		•PRACTICAL BASELINE RECOMMENDATIONS FOR GREENHOUSE GAS MITIGATION PROJECTS IN THE ELECTRIC POWER SECTOR	•EVALUATION KNOWLEDGE BRIEF ON GREENHOUSE GAS IMPLICATIONS OF ADB'S ENERGY SECTOR OPERATIONS		•Higher efficiency of energy			
Renewable energy	•• Fuel switch from fossil fuel					•Renewable energy in general			
Sewerage, Urban sanitation	•Landfill •wetland reclamation •Reservoir Others: Evaluation tool for GHG emissions reduction in the field of waste •Simplified Toolkit for Manure Management Processes •Simplified toolkit for wastewater treatment projects •Simplified toolkit for solid waste management projects •Simplified toolkit for landfill gas capture projects	•Waste disposal •Waste water treatment							
all	•Greenhouse Gas Assessment Handbook(1998)	•GHG estimation sheet IFC Carbon Emissions Estimation Tool (CEET) •Fuel consumption •Electricity consumption •Refrigerator, Air conditioner	•GHG Mitigation actions: MRV issues and options		•GHG estimation sheet •Spreadsheet for calculating greenhouse gas (GHG) emissions based on the UNEP GHG Calculator •United Nations Greenhouse Gas Calculator	•Manual for Calculating GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects Others: GHG estimation tool for GEF project GHG Benefits of GEF Projects: Carbon Dioxide Calculator	•GHG estimation tool for fixed sources •Stationary_combustion_tool •GHG estimation tool using electrical consumption •GHG emissions from purchased electricity •OHFC, PFC emissions tool •hfc-pfc		
Source	http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTCARBONFINANCE/0,,contentMDK:22366206-pagePK:64168445-piPK:64168309-theSitePK:4125853,00.html	http://www.ifc.org/ifcext/climatebusiness.nsf/Content/GHGaccou	http://www.oecd.org/dataoecd/45/43/194333.pdf	http://www.adb.org/documents/papers/adb-working-paper-series/ADB-WP09-Transport-CO2-Emissions.pdf	http://www.unep.org/MeetingsDocuments/IssueManagementGroups/SustainabilityManagement/UnitedNationsGreenhouseGasCalculator/tabid/3975/Default.aspx	http://www.thegef.org/gef/node/313	http://www.ghgprotocol.org/calculation-tools	http://www.usaid.gov/our_work/environment/climate/docs/forest_carbon_calculator_jan10.pdf	
			http://www.oecd.org/dataoecd/26/44/42474623.pdf	http://www.adb.org/Documents/Evaluation/Knowledge-Briefs/REG/EKB-REG-2009-38.pdf	http://www.energyefficiencyasia.org/docs/SimplifiedGHGCalculator.xls	http://www.thegef.org/gef/GEF_C39_Inf.16_Manual_Greenhouse_Gas_Benefits	http://www.ghgprotocol.org/calculation-tools/all-tools		

Reference-4 Methodologies of International Organization (2)

Established agency / Institution	KFW (Kreditanstalt für Wiederaufbau)	PROPARCO (sigle pour Promotion et Participation pour la Coopération économique)	U.S. Department of Commerce	US Environmental Protection Agency	U.S. Department of Transportation	Defra: Department for Environment, Food and Rural Affairs	Co-Benefit Manual of Quantitative evaluation (Ministry of Environment, JAPAN)
Multi/Bilateral Outline	Bi Released tool for GHG calculation for landfill.	Bi Estimates GHG of the project they assist. Information on the program is unknown.	— GHG calculation tool for Landuse, Traffic Sector has been released.	— GHG calculation tool for Traffic Sector and Climate Change has been released.	— GHG Model for Traffic Sector has been released.	— GHG calculation Guideline for Traffic and Energy Sector has been released.	Bi The conditions required to organize a quantitative assessment of global warming co-benefits.
Forest and natural resources conservation							
Traffic and Transportation			Calculation sheets for Simulation of Traffic Network • VMT Spreadsheet • Trip Generation with 4Ds Spreadsheet • TDF Model • Enhanced TDF Model GHG Calculation software • URBEMIS Software • ICLEI CACP Software • Place3s Software • INDEX Software	Optimization Model for Reducing Emissions of Greenhouse Gases from Automobiles (OMEGA)	GHG Calculation Model for traffic Sector • MOBILE6 • NONROAD • NMIM • COMMUTER • SIT • SIPT • CLIP etc. 17 Models.	Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations	Air quality improvement (Calculation formula by mobile sources)
Energy Conservation (Industry)							
Energy						2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting	
Renewable energy							
Sewerage, Urban sanitation	SWM Greenhouse Gas Calculator (the solid waste and wastewater management sector)			Waste Reduction Model (WARM) Recycled Content (ReCon) Tool			Water Pollution Control (GHG emission reduction from Wastewater treatment system : small scale CDM AMSIII-1) Air quality improvement (Calculation formula by fixed sources) Waste Management (Landfill methane recovery tool)
all		Calculation of GHG emission program for each project • Bilan Carbone					
Source	http://www.kfw-entwicklungsbank.de/EN/Home/Sectors/Waste_management/Solid_Waste_Management_Greenhouse_Gas_Calculator/index.jsp	http://www.proparco.fr/jahia/webdav/site/afd/shared/PUBLICATIONS/INSTITUTIONNEL/plaquettes-presentation/AFD-Brochure-english-2008.pdf	http://www.commerce.wa.gov/DesktopModules/OTEDPublications/OTEDPublicationsView.aspx?tabID=0&ItemID=7797&Mid=944&version=Staging	http://www.epa.gov/otaq/climate/models.htm	http://climate.dot.gov/methodologies/analysis-resources.html	http://www.defra.gov.uk/environment/business/reporting/pdf/ghg-freight-guide.pdf	http://www.env.go.jp/press/file_view.php?serial=13728&hou_id=11242
			http://www.newpartners.org/2010/docs/presentations/thursday/np10_samdahl.pdf	http://www.epa.gov/climatechange/wyacd/waste/calculators/Warm_home.html		http://www.defra.gov.uk/environment/business/reporting/pdf/100805-guidelines-ghg-conversion-factors.pdf	

VMT: Vehicle-Miles Traveled
TDF: Travel Demand Forecasting

Reference-5 Methodologies of VER Certification Organization

VER Certification agency	Gold Standard	VER+	CCB Standards (The Climate, Community and Biodiversity Project Design Standards)	Green-e	VOS (Voluntary Offset Standard)	CCX (Chicago Climate Exchange)	CCAR (California Climate Action Registry)	Plan Vivo	Social Carbon	NCOS (National Carbon Offset Standard)
Established Institutions	WWF (World Wide Fund for Nature) , SSN (SouthSouthNorth) , Helio International etc.	TÜV SÜD Group, 3C Group	CCBA (Company, NGO etc.)	CRS (Center for Resource Solution, NPOs in US)	International Carbon Investors and Services (INCIS) , Morgan Stanley ※ INCIS was established by financial institutions for the development of emissions trading markets GHG.	CCX(Private Sector)	California	ECCM(Edinburgh Centre for Carbon Management) , BR&D (BioClimate Research & Development)	NGO of Brazil: Ecologica Institute (IE)	Australian Government
Multi/Bilateral	-	-	-	-	-	-	-	-	-	-
Outline	In addition to the verification and certification of CDM projects, the following criteria is used to determine the quality of CDM /JI projects: i) Project Eligibility, ii) Additionality and baseline iii) Contribution to sustainable development	Certification audit is basically being done using the same methodology as with CDM and JI projects.	Assessment of biodiversity, climate change mitigation effects and impact to the local community.	Green Power Certification Program (Green-e) is aimed at consumer protection when electric credits are sold, verifying whether the goods satisfy environmental standards.	Certification system equivalent to the standard of the Kyoto credits. Target countries are mainly countries that did not ratify the Kyoto Protocol, and in particular, the U.S. and Australia (Australia ratified the Protocol).	System has its own validation criteria. Provides manuals for calculation of GHG in multiple sectors.	The methodology of California NPO. Provides manuals for calculation of GHG in multiple sectors.	Grass root criteria that offer high standard for environmental protection and local benefits. The methodology is an expensive option compared to those used in the global carbon market.	The feature of the methodology is to evaluate and verify the long-term impact assessment of sustainable development.	Efforts by the Australian Government started in July 2010, replacing Greenhouse Friendly*. The targets are Australian companies.
S e c t o r s	Forest and natural resources conservation	*Afforestation	*Forest Conservation, Forest Management *Afforestation *Nature Restoration			*Forest Conservation, Forest Management *Afforestation	*Forest Conservation, Forest Management *Afforestation	*Forest Conservation, Forest Management *Afforestation *Agroforestry	*Afforestation/reafforestation	*Forest management (forests established before 1990) *Revegetation (establishment of woody biomass that does not meet forest criteria)
	Traffic and Transportation	*Energy efficiency Target:Industry* Residential * Transportation*Public* Agricultural *Business Sector	Suppression of methane emission in Area circulation							
	Energy Conservation (Industry)	*Energy efficiency Target:Industry* Residential * Transportation*Public* Agricultural *Business Sector								
	Energy	*Energy efficiency Target:Industry* Residential * Transportation*Public* Agricultural *Business Sector	*Energy efficiency				*Energy efficiency *Fuel Switching		*Water power	
	Renewable energy	*Renewable Energy photovoltaic/Solar Heat(Electricity/Heat),Biomass, Biogas /Liquid biofuels,Wind power,Geothermal power,Water power	*Renewable Energy Biomass,Water power,Wind power etc.		*Renewable Energy photovoltaic,Wind power,Geothermal power,Small Water power,Biomass,Bio Diesel,Hydrogen battery		*Renewable Energy Wind power,Biomass,Biogas, etc.			
	Sewerage, Urban sanitation		*Landfill methane recovery				*Landfill methane recovery *Proper disposal of ozone- depleting substances *Effective use of methane in the organic waste treatment	*Landfill methane utilization *Composting of organic refuse *Decomposition of organic refuse (proper disposal) *Proper disposal of ozone- depleting substances	*Landfill	
all										
Source	http://www.cdmgoldstandard.org/Current-GS-Rules.102.0.html	http://www.netinform.de/KE/Beiratung/Service_Ver.aspx	http://www.climate-standards.org/standards/pdf/second_edition/CCB_Standards_2nd_Edition_JAPANESE.pdf	http://www.green-e.org/getcert_ghg_products.shtml	http://www.carboninvestors.org/ECISVoluntaryOffsetStandardFINALJune.pdf	https://registry.chicagoclimatex.com/public/projectsReport.jsp	http://www.climateregistry.org/	http://planvivo.org/34spreview.com/documents/standards.pdf	http://www.socialcarbon.org/	http://www.climatechange.gov.au/en/government/initiatives/national-carbon-offset-standard.aspx
	http://www.wwf.or.jp/activities/climate/cat1297/cat1299/index.html	http://www.netinform.de/KE/Weisener/Ebene1_Projekte2.aspx?Ebene1_ID=49&mode=4	http://www.climate-standards.org/projects/index.html			http://www.chicagoclimatex.com/docs/offsets/CCX_Rulebook_Chapter09_OffsetsAndEarlyActionCredits.pdf			http://www.socialcarbon.org/uploadDocs/Documents/SOCIALCARBON_STANDARD.v4.1.pdf	
	http://goldstandard.apx.com/resources/AccessReports.asp									

Chapter 3 Basic Concept and Guidelines for the Quantitative Evaluation of GHG Emission Reduction (Sequestration)

3.1 Basic Concept

3.1.1 Quantitative Evaluation

Mitigation measures against global warming are intended to stop the progress of global warming by reducing (or sequestering) GHG emissions and stabilize the concentrations of GHG in the atmosphere. The mitigation measures need time to show their effects but are the fundamental solutions. Actual mitigation measures such as effective use of energy and energy conservation, carbon dioxide capture and storage, and increasing carbon sinks are being implemented.

Quantification of GHG emission reduction (sequestration) aims to calculate the impact of mitigation through individual measures.

3.1.2 Basic Concept of Estimation

- (1) Traffic and Transportation, Energy Conservation, Energy, Renewable Energy, Sewerage and Urban Sanitation Sectors

The effects of GHG emission reductions through a mitigation measure (ER_y) can be estimated as the difference between the GHG emissions without the mitigation measure (baseline emissions: BE_y) and those with the mitigation measure (project emission: PE_y). For example, the mitigation measure involving implementation of mass rapid transportation (MRT) is as follows:

$$ER_y = BE_y - PE_y$$

Basically, the baseline emission is the GHG emission in case present conditions would continue without project implementation (other concepts can be adopted depending on individual circumstances in each project). To compare between 'with' and 'without' mitigation measure, GHG is estimated based on the assumption that the level of activities is equivalent to the 'with' mitigation measure case (such as the amount of electricity used or the volume of production).

On the other hand, the project emission is determined as the GHG emission by implementing the project. Generally, the volume of project emission is smaller than that of the baseline emission. Also, the project emission of a renewal energy project activity becomes zero.

For financial intermediary loans (two-step loans) which provide assistance to numerous small-scale or medium-scale projects through intermediate financial organizations, etc., a simplified methodology based on the methodologies presented in this report can be applied to estimate the effects of GHG emission reductions, considering the availability of the required data and work volume.

BE_y : Baseline Emission (Without project)

PE_y : Project Emission (With Project)



Ex. MRT Project

(2) Forestry and Natural Resources Conservation Sectors

Because trees grow by sequestering carbon dioxide from the air through photosynthesis and capturing of carbon, a forested site can be considered as a sink of carbon dioxide (or carbon). According to IPCC guidelines, net anthropogenic GHG removals by sinks ($ER_{AR,y}$) can be estimated by extracting the increase (or the decrease) without the forestry (baseline absorptions: $\Delta C_{BSL,y}$). Meanwhile, GHG emissions at the initial stage of the forestry project (project emissions: $GHG_{PRJ,y}$) can be estimated from the increase of carbon dioxide sink after the forestry project progresses over a certain period (or the decrease by thinning and harvesting) (project absorptions: $\Delta C_{PRJ,y}$).

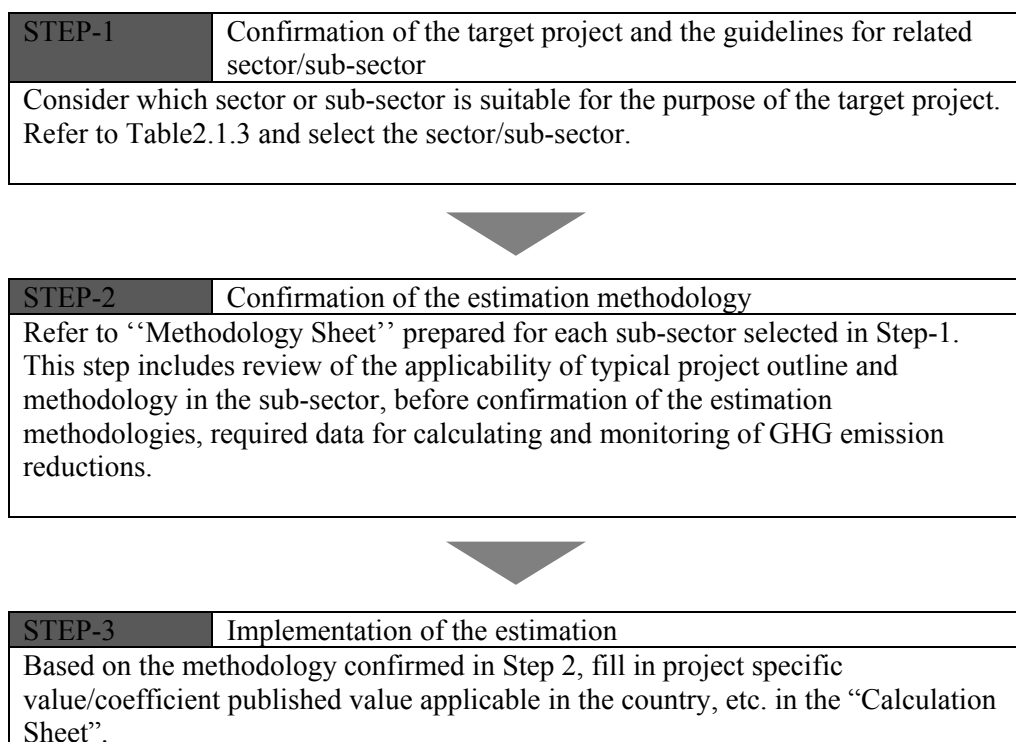
The details are also shown in the explanatory sheets for forestry and natural resources conservation sub-sectors in Chapter 4.

$$ER_{AR,y} = \Delta C_{PRJ,y} - \Delta C_{BSL,y} - GHG_{PRJ,y}$$

3.2 Framework of Methodology Sheet and Calculation Sheet (Excel)

3.2.1 Aim and Application of Methodology Sheet and Calculation Sheet (Excel)

Methodology sheets are prepared to simply estimate the quantitative effects of the GHG emission reduction at the pre-project and post-project stages on the individual project. Workflow and utilization of the methodology sheet and calculation sheets are shown in the figure below.



3.2.2 Outline of Methodology Sheet

Outline of the methodology sheet is described as follows:

13. Energy/ Thermal Power with higher efficiency

1. Typical Project Outline
The project intends to suppress the greenhouse gas (GHG) from fossil fuel combustion in the fossil fired plants by reducing the fuel consumption per electric supply through the new construction of high efficient fossil fired plants or improvement of the existing power plants (upgrading to the combined cycle power plants, efficiency improvement by the improvement/upgrading of the power plants or upgrading to the higher efficiency power plants)

2. Applicability
 For new facility: new facility construction equipped with highly efficient facilities through the project activity
 For existing facility: replacement, upgrading, and improvement of facilities using conventional fuel
 For the new and the existing facility: i) fossil fuel fired plants connecting the grid and ii) non-cogeneration facilities

3. Methodology on Emission Reduction
GHG emission reduction through energy efficiency improvement shall be determined as the difference between baseline emissions (from facilities with low efficiency) and project emission (after improvement). In order to compute emission, the amount of electricity power supply is multiplied by its CO₂ emission factor. GHG emission factor is computed from the respective efficiency in power generation before and after the project starts. Compute the emission from generating the same amount of power supply (after the project starts) and compare them. For the existing facilities, baseline emission is computed with the monitored emission factor before the improvement of the power plants.

$$ER_y = BE_y - PE_y \quad (t-CO_2/y)$$

ER_y : GHG emissions reduction in year y achieved by the project (t-CO₂/y)
 BE_y : GHG emission from low efficiency facilities in year y (t-CO₂/y) (Baseline emission)
 PE_y : GHG emission from improved efficiency facilities in year y (t-CO₂/y) (Project emission)

[New facilities] BE_y : Baseline emission PE_y : Project emission

[Existing facilities]

1. Typical project outline
Outline of the typical mitigation project for the sub-sector

2. Applicability
Applicability of the methodology of GHG reduction calculation shown in this sheet

3. Methodology on emission reduction
Description of the basic concept and formula of the estimation method

Image figure of baseline emission and project emission of typical mitigation project for the sub-sector

(1) Baseline Emission
Baseline emission is the emission calculated based on the assumption that the current condition continues in the absence of the mitigation measure. (However, a different assumption can be made according to individual circumstances in each project.) To compare between ‘with’ and ‘without’ mitigation measure, GHG is estimated based on the assumption that the level of activities is equivalent to the ‘with’ mitigation measure case (such as the amount of electricity used or the volume of production)
Here, basic calculation formula and explanation on the required parameters or figures, including the sub-formula for calculating the required parameters or figures, are described.

13. Energy/ Thermal Power with higher efficiency

3. Methodology on Emission Reduction (Continuation)

(1) Determination of Baseline emission
CO₂ emission factor is computed from the power generation efficiency without replacement, upgrading and improvement of power generator before the project starts. GHG emission necessary to generate the amount of electricity supply, equivalent to the existing power generators after the project starts.

$$BE_y = EG_{P1,y} \times EF_{BL,y}$$

Type	Parameter	Description
Output	BE_y	Baseline emission: GHG emission from low efficiency power generators (t-CO ₂ /y)
Input	$EG_{P1,y}$	annual energy production after the project starts (transmission edge)(MWh)
	$EF_{BL,y}$	CO ₂ emission factor per electric power supply (t-CO ₂ /MWh)

Determination of $EF_{BL,y}$
 [New facilities]
 Baseline CO₂ emissions factor in the new facilities is defined as the average emission factor of all power plants supplying the grid where the project activity is implemented. (Refer to Appendix C-1). The national default emission factor, data adopted by Kyoto Mechanisms or data based on IED are used for calculation. However, if the national default is not available, it should be calculated using the net electrical output of all plants, fuel used, net fuel consumption, net calorific value and CO₂ emission factor in addition to the interview subject from the management entities of the target facilities. (Refer to Appendix C-1).

13. Energy/ Thermal Power with higher efficiency

(2) Determination of project emission
To calculate project GHG emission, monitor CO₂ emission from the power generation efficiency what the power generator that are replaced, upgraded and improved after project activity.

$$PE_y = EG_{P2,y} \times EF_{P2,y}$$

Type	Parameter	Description
Output	PE_y	Project emission: GHG emission after the project starts (t-CO ₂ /y)
Input	$EG_{P2,y}$	Annual energy production after the project starts (transmission edge)(MWh)
	$EF_{P2,y}$	CO ₂ emission factor per electric power supply (t-CO ₂ /MWh)

Determination of $EF_{P2,y}$
 [New facilities] [Existing facilities]
 CO₂ emission factor per electric power supply after the project starts is computed using the efficiency after improvement. In order to compute $EF_{P2,y}$ please use the planned data before the project starts and the monitoring data after the project starts.

$$EF_{P2,y} = \frac{COEF_f}{\eta_{P2,y}} \times 3.6 \left(\frac{GJ}{MWh} \right)$$

$COEF_f$: CO₂ emission factor of fuel if (t-CO₂/TJ)
 $\eta_{P2,y}$: Planned or monitoring efficiency data after the efficiency improvement of the power generation
 3.6 : Electrical output per electric energy (1MWh=3.6GJ)

(2) Project Emission
Project emission is the emission calculated based on the result of the mitigation measure.
Here, basic calculation formula and explanation on the required parameters or figures, including the sub-formula for calculating the parameters or figures, are described.

13. Energy / Thermal Power with Higher Efficiency

Data Type	Description of Data	Data Acquisition Methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Quantity of power supply (After : $EG_{P2,p}$)	Quantity of power supply of the fossil fuel fired plants by the project activity (MWh/y)	Planned data	Measured data	Planned data	Measured data
Efficiency of power generation (Before : $\eta_{B,C}$) (After : $\eta_{P,C}$)	Efficiency of power generation in the fossil fuel-fired plants	Measured data of one or two old and typical power plants existing in the area		Planned data	Measured data
CO ₂ emission factor of each fuel type (COEF _F)	CO ₂ emissions factor of each fuel type (t-CO ₂ /TJ)	Data availability is validated in the following order because it is preferable to calculate using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)			

Data Type	Description of Data	Data Acquisition Methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Quantity of power supply (After : $EG_{P2,p}$)	Quantity of power supply of the fossil fuel fired plants by the project activity (MWh/y)	Planned data	Measured data	Planned data	Measured data
Efficiency of power generation (Before : $\eta_{B,C}$)	Efficiency of power generation in the	Measured data Before the Project		Planned data	Measured data

4. Data required for estimation and monitoring
Description of the data to be collected

<Timing of calculation>
Before the project starts:
During preparatory survey
After project completion:
During monitoring after project completion.

<Data acquisition methods>
Planned data: Planned data during the preparatory survey before the project starts
Actual data: Data measured (monitored) at power plants and factories after project completion

<Data type>
Description of the terms in formula.

<Priority among options>
If there are options, such as publicly available country specific value and default values issued by international organizations, the sheet presents options plus priority, based on the recognition that calculation based on project / country specific data is more desirable. If other appropriate data can be collected, users can apply a more suitable data for calculation.

13. Energy/ Thermal Power with higher efficiency

5. Others	(1) Project boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented.
(2) Leakage Project activity could lead to the following leakages: Plant replacement, the indirect emissions potentially lead to leakage due to activities such as product manufacturing or materials transport. This respective emission is temporary and negligible considering the project scale. Therefore it can be ignored.	
(3) Reference methodology and differences 1)AM0061(ver02) Methodology for rehabilitation and/or energy efficiency improvement in existing power plants. [Differences] · Though the reference methodology excludes new facilities as element, new facilities are used in this formula. · Power plants which run over 10 years and the last 5 year data is available is used in the reference methodology. This formula excludes these conditions. · Different calculation method is used for baseline emission when it exceeds the average electric power supply or not. It is determined using the efficiency in power supply with the specific formula. However, it is determined simply using the net power supply or the amount of power supply of the representative year in this formula. · The reference methodology excludes the leakage potential unless there are great influences. This formula also excludes the leakage in the same manner.	
2)AM0062(ver.1): Energy efficiency improvements of a power plant through retrofitting turbines [Differences] · Though the reference methodology excludes new facilities as element, new facilities are used in this formula. · The reference methodology is applied to the steam turbine and gas turbine. The amount of steam supply and the amount of power supply of the steam turbine should be able to be measured in the turbine improved under the project activities. This formula excludes these conditions. · The reference methodology excludes the leakage potential unless there are great influences. This formula also excludes the leakage in the same manner.	
3)ACM0013(ver02): Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology [Differences] · Though the reference methodology excludes new facilities as element, new facilities are used in this formula. · Regarding the baseline fuel based on the reference methodology, applicability of the formula is for fossil fuel used in the absence of the project, which is more than 50% of the net electricity power supply in the last three years. This formula excludes these conditions. This formula excludes these conditions.	
4)AMS-ILB(ver09) Supply side energy efficiency improvements – generation [Differences] · The reference methodology is applied to reduction of the electric power at 60GWh or less or fuel consumption reduction from thermal application through improvement of existing facilities, however, the formula here has no restrictions with quantity of electricity nor excludes heat supply. · The reference methodology applies to the cogeneration facilities however, in this formula cogeneration	

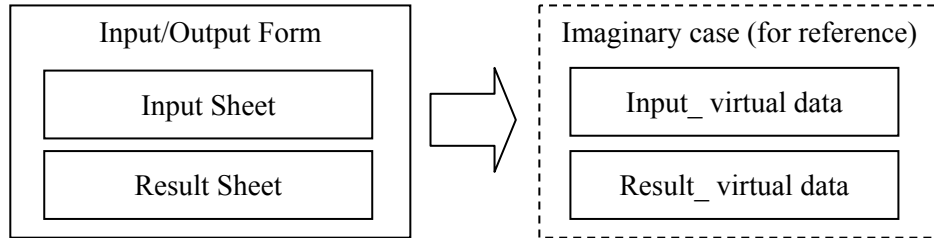
5. Others
(1) Project boundary
Basically, the project boundary is the project area itself. However, if special considerations are necessary for the sub-sector, it is described in this column.

(2) Leakage
Leakage means the possibility of GHG emission outside the boundary due to the project activities. Expected leakage and how leakage is dealt with is described for each sub-sector.

(3) Reviewed Methodologies and Major Differences
Brief description of major differences between reviewed methodologies and the methodology presented in this sheet is shown

3.2.3 Outline of Calculation Sheet (Excel)

Calculation sheet is composed of two sheets: "Input Sheet" and "Result Sheet.". For each sub-sector, an imaginary case using virtual data is attached to help users understand how the sheets can be utilized.



(1) Input Sheet

The contents of the "Data required for monitoring and estimation" indicated in the "Methodology Sheet " serve as inputs to the "Input Sheet".

Input Sheet: New facilities

Project Name: [Yellow Cell]

1. Quantity of power supply (of the target facilities after the project starts) (MWh/y)
Input the planned data for the calculation before the project start and the measured data for the calculation after the project start.

Item	Entry field	Unit
Quantity of power supply of the fossil fuel fired facilities after the project start	[Yellow Cell]	MWh/y

2. Efficiency of power generation
Input the monitoring data for the efficiency of the target facilities in absence of the project. Input the planned data for the calculation of the efficiency of the target facilities before the project start and the monitoring data for the calculation of the efficiency of the target facilities after the project start.

Item	Entry field
Before project: Monitoring data before start of the project from the target facilities	[Yellow Cell]
After project: Efficiency of power generation from the target facilities	[Yellow Cell]

4. CO₂ emission factor according to fuel type (t-CO₂/TJ)
Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project.
i) The unique data of the project obtained from the interview with power management entity
ii) National default
iii) IPCC Guideline default data

[The fuel used in the target facilities]

Input item	Entry field	Unit
[The fuel used in the target facilities]	[Yellow Cell]	t-CO ₂ /TJ

Legend:
[Yellow Cell] Entry field
[Light Yellow Cell] Entry field of the reference documents

(2) Result Sheet

The calculation results are shown in the "Result Sheet".

Calculation result sheet: New facilities

0

GHG emission reduction with the project (t-CO₂/y) $ER_p = BE_p - PE_p$ (t-CO₂/y)

1. Baseline emission $BE_p = EG_{RD} \times EF_{RD}$

BE_p	Baseline emission: GHG emission from low efficiency power generators	0	t-CO ₂ /y
EG_{RD}	Annual energy production after the project starts (transmission edge)	0	MWh
EF_{RD}	CO ₂ emission factor of electric power	0	t-CO ₂ /MWh

2. Project emission $PE_p = EG_{RD} \times EF_{RD}$

PE_p	Project emission: GHG emission after the project	0	t-CO ₂ /y
EG_{RD}	Annual energy production after the project starts (transmission edge)	0	MWh
EF_{RD}	CO ₂ emission factor of electric power	0	t-CO ₂ /MWh

3. GHG emission reduction with the project $ER_p = BE_p - PE_p$ (t-CO₂/y)

ER_p	GHG emission reduction with the project	0	t-CO ₂ /y
BE_p	Baseline emission: GHG emission from low efficiency power generators	0	t-CO ₂ /y
PE_p	Project emission: GHG emission after the project	0	t-CO ₂ /y

Chapter 4 Methodology Sheets and Calculation Sheets

This chapter shows how to formulate the mitigation measures.

In Figure 4.1, a workflow shows how to identify a mitigation project, and how corresponding information should be provided to the partner nation at the preparatory survey.

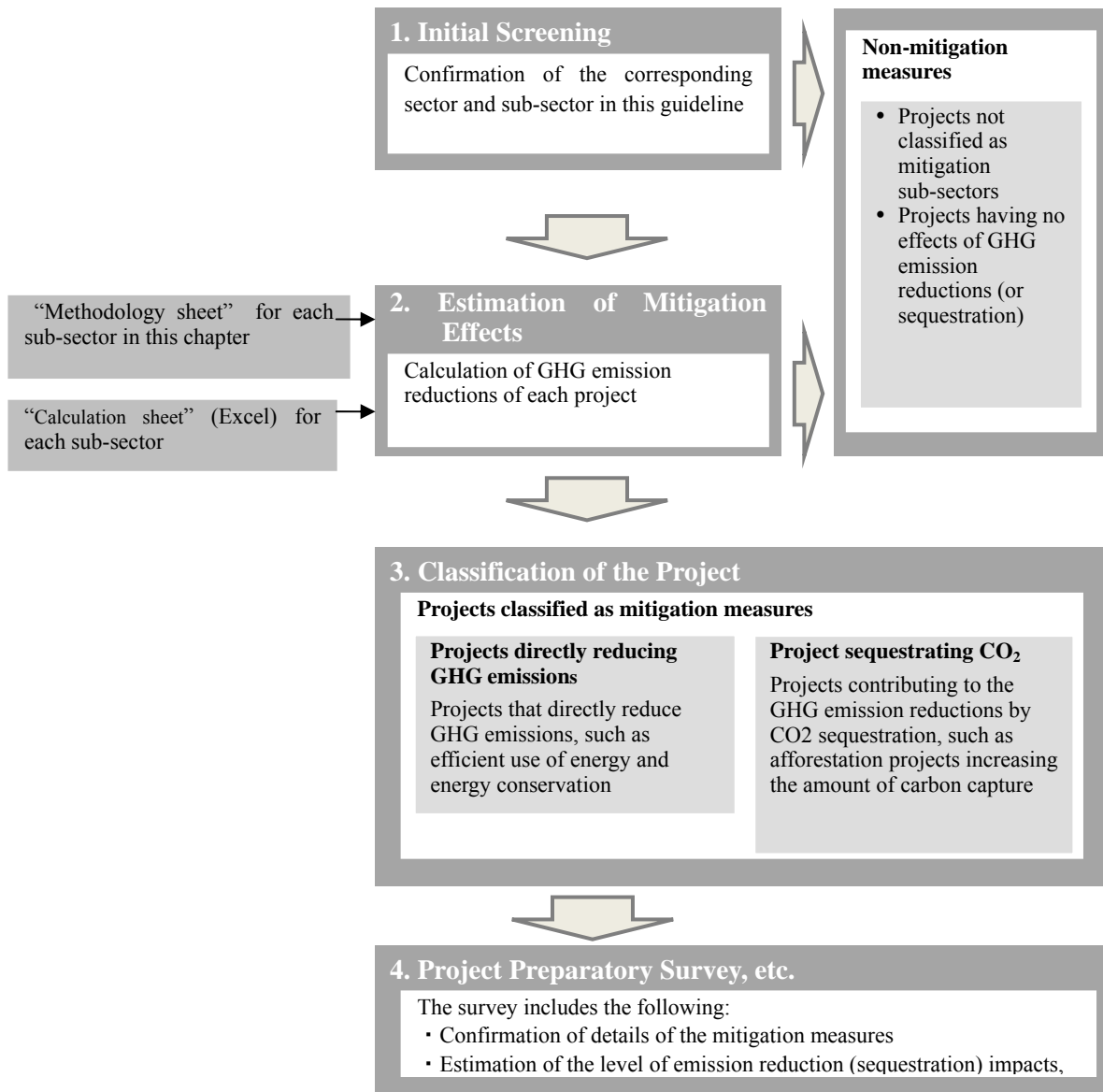


Figure 4.1 Process for Formulating Mitigation Projects

4.1 Typical Project Outlines in Targeted Sub-sectors

A typical project is outlined before preparing a guideline for each sub-sector, based on past JICA ODA loan project information. The outlines of the typical projects are shown in Table 4.1.1.

Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector(1)

Sub-sector		Typical Project Outline
1. Afforestation		The project intends to expand CO ₂ sink through afforestation in non-forest lands including degraded, pasture or agricultural lands. For reducing emissions from deforestation and forest degradation (REDD), refer to “2. Forest Conservation”.
2. Forest conservation		The project intends to reduce GHG emission through prevention of deforestation such as unregulated logging in developing countries (REDD). Refer to “1. Afforestation” for CO ₂ sinks increase through afforestation.
3. Passenger /Freight transportation improvement	3.1 Railway ,passengers	The project intends to reduce GHG emissions by realizing “modal shift” from existing passenger transport systems (i.e., conventional buses, passenger cars, taxis and bikes) to passenger railway systems such as a new railway, a double track railway, or a quadruple track railway. In addition, “electrification” of passenger railway systems will reduce GHG emissions.
	3.2 Railway , freight	The project intends to reduce GHG emissions by realizing “modal shift” from existing freight transport systems (i.e., conventional trucks and trailers) to freight railway systems such as a new railway, a double track railway. In addition, “electrification” of freight railway systems will reduce GHG emissions.
4.MRT(Mass Rapid Transit)		The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxis and bikes) to a Mass Rapid Transit (MRT) system.
5.Monorail, LRT		The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxis and bikes) to a light or medium transport system such as monorail and LRT (Light Rail Transit).
6.Bus (BRT, Trunk bus)		The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxis and bikes) to Bus Rapid Transit (BRT) or trunk bus systems.
7.Energy efficiency improvement		The project intends to inhibit greenhouse gas (GHG) emissions by reducing fuel consumption in industrial facilities through energy efficiency improvements such as efficient motors adoption.
8. Electricity and heat supply		The project intends to directly suppress electricity/fuel consumption and reduce GHG emissions in industrial facilities, such as steel plants and cement plants, through recovery and utilization from waste energy (waste heat, waste gas pressure).
9.Fuel switching		The project intends to inhibit GHG emissions through switching from high carbon content heavy oil fuel in order to lower carbon content fuel in new and existing industrial facilities.
10.Energy plant with fuel switching		The project intends to inhibit GHG emissions by switching from high carbon content heavy oil fuel in order to lower carbon content fuel of new and existing intensive heat-supply facilities.
11.Thermal power with electricity and heat supply		The project intends to directly reduce GHG emissions and suppress fuel consumption for electricity generation through recovery and utilization (new construction of combined cycle power plants etc.) from waste energy (waste heat, waste) at fossil fuel fired power plants.

Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector(2)

Sub-sector		Typical Project Outline
12. Thermal power with fuel switching		The project intends to inhibit GHG emissions by switching from high carbon content heavy oil fuel to lower carbon content fuel at new and existing intensive heat supply facilities.
13. Thermal power with higher efficiency		The project intends to suppress the greenhouse gas (GHG) from fossil fuel combustion in the fossil fired plants by reducing the fuel consumption per electric supply through the new construction of high efficient fossil fired plants or improvement of the existing power plants (upgrading to the combined cycle power plants, efficiency improvement by the improvement/upgrading of the power plants or upgrading to the higher efficiency power plants)
14. Power transmission with improved efficiency		The project intends to directly suppress GHG emissions associated with transmission loss, through reducing power loss in the transmission grid or through maintenance of high voltage substation at new and existing facilities for electric energy transmission-transformation.
15. Power distribution with improved efficiency		The project intends to directly suppress GHG emissions associated with distribution loss, through reducing power loss in the distribution grid or efficiency improvements of distribution equipment at new and existing facilities for electric energy distribution.
16. Rural electrification		The project intends to directly reduce greenhouse gas (GHG) emissions by generating power from renewable energy sources, which generate limited amounts of GHG. This is realized through the implementation of renewable energy utilization project in the area where there is no connection to the main electricity transmission grid, or diesel power generation or kerosene lamp is not applied.
17. Hydro power		The project intends to directly contribute to GHG emission reduction through hydropower plants construction aiming to generate renewable energy, which does not emit GHG at flaring, with the use of natural resources such as hydro power.
18. Wind power		The project intends to directly contribute to GHG emission reduction through the use of wind power plants in generating power. Thus, no GHG is generated with the use of natural resources such as wind power.
19. Photovoltaic power /Solar heat	19.1 Photovoltaic power	The project intends to directly contribute to GHG emission reduction through generation of power from photovoltaic power plants. Thus there is reduction in GHG emission with the use of non-fossil fuel source such as photovoltaic power.
	19.2 Solar heat	The project intends to directly reduce GHG emissions by generating power from solar power plants, which generate limited amounts of GHG. The requirement for flaring of GHGs to reduce emissions, with the use of natural resources such as concentrated solar power, is eliminated.
20. Geothermal power		The project intends to directly reduce GHG emissions by generating power from geothermal power plants, which generate limited amounts of GHG. The requirement for flaring of GHGs to reduce emissions with the use of natural resources such as geothermal power is eliminated.
21. Biomass		The project intends to directly reduce GHG emissions through electricity generation or heat generation from biomass residues instead of fossil fuel fired at power plants or factories which leads to reduce consumption of electricity or fossil fuel.

Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector(3)

Sub-sector	Typical Project Outline
22.Landfill disposal of waste	The project intends to reduce GHG emission through recovery and utilization of landfill gas (LFG) generated from landfill after the completion of reclamation and from active landfill.
23.Intermediate treatment of waste	The project intends to reduce the GHG emissions without disposing in landfill but by waste treatment such as composting or anaerobic digestion etc.
24.Wastewater treatment	The project intends to reduce the GHG emissions by suppressing CH ₄ from the sewage sludge decay through composting the sewage sludge.
25.Sewerage	The project intends to reduce GHG emission through improving the living condition and reducing CH ₄ from sewer water with wastewater treatment from the houses or factories.

4.2 Methodology Sheets and Calculation Sheets (Excel) for Each Sub-sector

Methodology sheets are shown below and calculation sheets are attached in Appendix “Calculation Sheet”.