"Development of Evaluation Method on Energy Efficiency and Conservation Policy (Marginal Abatement Cost Curve)"

(Project Research)

Final Report

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Japan International Cooperation Agency (JICA)

Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.

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ABBREVIATION

AC	Air Conditioner, Air Conditioning
ADB	Asian Development Bank
AfD	Agence Francaise de Development
APKENINDO	Indonesia ESCO Association
API	Indonesia Textile Association
APKI	Indonesia Pulp & Paper Association
APPI	Indonesia Fertilizer Producers Association
ASAKI	Indonesia Ceramic Industry Association
ASI	Indonesia Cement Association
BAPPENAS	The State Ministry of National Development Planning/National Development Planning Agency
BAU	Business as Usual
BEMS	Building Energy Management System
boe	Barrel of oil equivalent
BPPT	Agency for Assessment and Application of Technology
BTU	British Thermal Unit
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
CD	Capacity Development
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
COP	Co-efficient of Performance
COP	COP-FCCC: Conference of the Parties-Framework Convention on Climate Change
C/P	Counterparts
CPA	CDM Program Activity
DANIDA	Danish International Development Agency
DFID	Department for International Development, United Kingdom
DKI	Special Capital Region
DSM	Demand Side Management
EC	Energy Conservation
ECCJ	The Energy Conservation Center, Japan
EE	Energy Efficiency
EER	Energy Efficiency Ratio
EE&C	Energy Efficiency and Conservation
EMI	Energy Management Indonesia
ESCO	Energy Service Company
FGD	Focus Group Discussion
FPA	Fiscal Policy Agency
FIKI	Federation of the Indonesian Chemical Industry
FS	Feasibility Study
GAPMMI	Indonesia Food & Beverage Association
GBC	Green Building Council (Indonesia)
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIZ	Deutsche Gesell-schaft fur Inter-natio-nale Zusam-men-arbeit
GW	Gigawatt
HP	Horsepower
IDR	Indonesian Rupiah

IFC	International Finance Corporation
IISIA	Indonesia Iron and Steel Industry Association
ISO	International Organization for Standard
Jamali	Jawa, Madura and Bali
Jamkrindo	Credit Guarantee Corporation of Indonesia
JCM	Joint Crediting Mechanism
JERI	Japan Economic Research Institute Inc.
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JPOWER	Electric Power Development Co., Ltd.
JPY	Japanese Yen
KfW	Development Bank of the Federal Republic and Federal States
LIL	Low Interest Loan
MACC	Marginal Abatement Cost Curve
MASKEEI	Indonesian Energy Conservation and Efficiency Society
MEMR	Ministry of Energy and Mineral Resources
MEPS	Minimum Energy Performance Standard
METI	Ministry of Economy, Trade and Industry
MMBTU	Million Metric British Thermal Unit
MMSCF	Million Metric Standard Cubic Feet
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOE	Ministry of the Environment
MOF	Ministry of Finance
MOI	Ministry of Industry
MOPWPH	Ministry of Public Works and Public Housing
MUMSS	Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.
MW	Megawatt
NEDO	New Energy and Industrial Technology Development Organization
ODA	Official Development Assistance
OTTV	Overall Thermal Transfer Value
PIP	Pusat Investasi Pemerintah (Government Investment Unit)
PLN	Perusahaan Listik Negara (State Electricity Company)
PoA	Program of Activities
PPP	Public Private Partnership
PUSDATIN	MEMR Center for Data and Information
PV	Photovoltaic power generation
RAD-GRK	Rencana Aksi Daerah penurunan emisi Gas Rumah Kaca (Local Action Plan for GHG Emission Reduction)
RAN-GRK	Rencana Aksi Nasional penurunan emisi Gas Rumah Kaca (National Action Plan for GHG Emission Reduction)
RIKEN	Rencana Induk Konservasi Energi Nasional (National Energy Conservation Master Plan)
RIPIN	Rencana Induk Pembangunan Industri Nasional (Master Plan for National Industry Development)
RKP	Rencana Kerja Pemerintah (Government Annual Work Plan)
RM	Malaysian Ringgit
RPJMD	Rencana Pembangunan Jangka Menengah Daerah (Local Medium Term Development Plan)

RPJMN	Rencana Pembangunan Jangka Menengah Nasional (National Medium Term Development Plan)
RT	Refrigeration Ton
RTTV	Roof Thermal Transfer Value
RUKN	Rencana Umum Ketenagalistrikan Nasional (National General Plan for Electricity)
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik) (Electricity Supply Business Plan)
SME	Small-Medium Enterprises
TA	Technical Assistance
THB	Thai Baht
TOE	Ton of Oil Equivalent
TOR	Terms of Reference
TSL	Two-step Loan
TV	Television
UKCCU	UK Climate Change Unit
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USD	US Dollar
VAT	Value Added Tax
VND	Vietnamese Dong
WB	World Bank
WWF	World Wildlife Fund

Chapter 1

Outline of the Study

Chapter 1 Outline of the Study

1.1 Background, Purpose and Scope of the Study

One of the main issues in developing countries is lack of know-how in effective generation and distribution of energy. Though the demand-side management is a valid solution for the power and energy supply issue regardless of the economic development stage of countries, the needs are particularly strong in developing countries.

Through a policy-induced approach, Japan has achieved reduction of approximately 30% of primary energy consumption per GDP over 10 years after the first Oil Crisis of 1973, by introducing Energy Management System and high energy efficiency (hereinafter "EE") technologies and equipment. Using the knowledge, since early 1980s, JICA has been assisting developing countries on policy and system development related to energy efficiency and conservation (hereinafter "EE&C") over 32 countries.

However, many developing countries do not have the quantitative data to determine a priority of the implementation of various EE&C policies including fiscal support and lack the ground for their prioritized decisions. Considering these background, this Study aims to establish the methodology to evaluate priority of various EE&C policies by quantifying and visualizing the policy's effects, in order to promote the consensus formulation in EE&C policy decision. In addition, this Study utilizes Marginal Abatement Cost Curve (hereinafter "MACC"), which is generally used for analysis of greenhouse gas (hereinafter "GHG") emission reduction methodology, as an evaluation tool. The methodology for developing EE&C MACC is expected to be established using Indonesia as the model case. The expected outputs are described as follows:

(1) To propose the most relevant EE&C policy package by visualizing the EE&C policy's quantitative effects by EE&C MACC using Indonesia as the model case (The target sectors are the industrial, commercial and residential sectors; transportation sector is out of scope in this Study); and

(2) To make a proposal to facilitate in applying the EE&C MACC evaluation methodology to quantify the effects of EE&C to other countries.

In order to have a realistic EE&C MACC, it is essential to have good quality data. Due to time limitation and lack of harmonized national data on detailed energy consumption, MACC developed in this Study is built upon the previous JICA studies related to EE&C[1], which is reinforced by the information collected or compiled by other institutions and interviews with various associations and equipment suppliers. MACC can be an effective tool in developing and evaluating EE&C policies. However, MACC may distort the results, if wrong data are applied. In today's rapidly changing world, JICA Study Team highly recommends to double check the data

[1] The Study on Energy Conservation and Efficiency Improvement in Indonesia 2009, The Study for Promoting Practical Demand Side Management Program in Indonesia2012 and Technical Cooperation Project for Capacity Development for Green Economy Policy in Indonesia Research on Green Urban Development 2015.

applied and replace data with more appropriate ones, if available, when using MACC. Furthermore, MACC in this Study does not reflect the aspect related to the possible government's tax revenue increase from boost in industrial production triggered by energy efficiency improvement. Quantifying the revenue increase involves market demand forecast and requires a completely different set of information and data for analysis.

1.2 Activity Record

The Study is initiated from end of March 2015. Work flow and the schedule of the Study are shown in Figure 1.2-1 and Table 1.2-1 respectively.

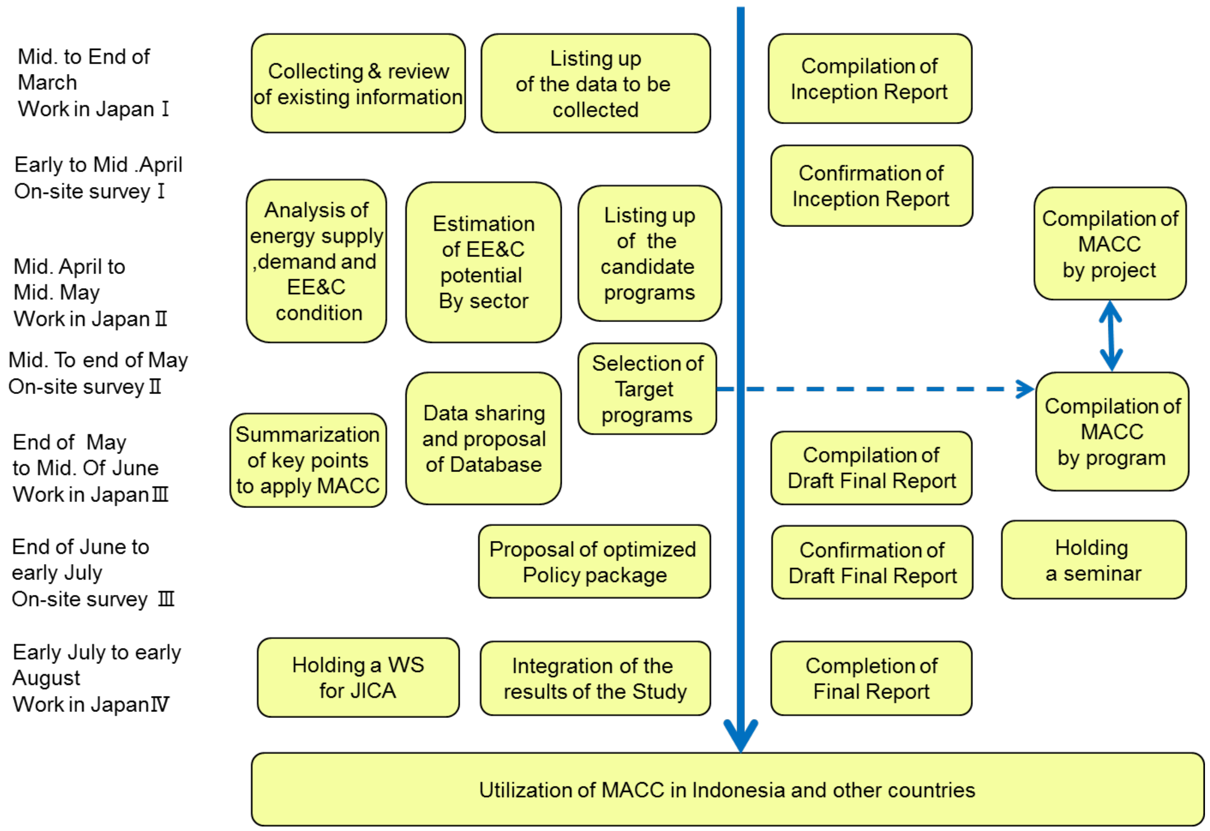


Figure 1.2-1 Study Work Flow

Table 1.2-1 Study Schedule

Items / Period	March	April	May	June	July	August
	2015					
Work in Japan I						
(1) Review and analyze existing information to promote EE&C in Indonesia						
(2) List up data and information to be collected in Indonesia						
(3) Compile and submit the Inception Report						
(4) Prepare fir on-site survey Ⅰ						
On-site Survey I & Work in Japan II						
(1) Explain the Inception Report to and consult with C/P for agreement						
(2) Interview for relative organizations in Jakarta						
(3) Analyse present condition of energy supply and demend, conditions and issues to promote EE&C						
(4) Estimate EE&C potential by sector and compile MACC by project						
(5) List up candidates of EE&C programs by sector						
(6) Prepare fir on-site survey II						
On-site Survey II & Work in Japan III						
(1) Select the EE&C programs to be evaluated						
(2) Compile MACC by project						
(3) Propose optimal EE&C program package						
(4) Integrate and share energy consumption data and propose to establish database						
(5) Have Focus Group Discussion						
(6) Propose measues to apply MACC to the other countries and summarize the key points to illustrate MACC						
(7) Compile and submit the Draft Final Report						
(8) Prepare fir on-site survey III						
On-site Survey III						
(1) Explain about major outputs of the study and consult with C/P for agreement						
(2) Hold FGDs in Jakarta						
(3) Hold a one day training for energy data management, technical transfer and advice for C/P						
Work in Japan IIII						
(1) Comlete the proposal to apply MACC to the other countries						
(2) Complete Final Report						

Legend: On-site survey period; Work period in Japan; △ Reporting

1.2.1 First Mission

Activity record of the first mission is shown in Table 1.2-2. In the first mission, the Study Team had meetings with Japan International Cooperation Agency (hereinafter "JICA"), Ministry of Energy and Mineral Resources (hereinafter "MEMR"), Ministry of Industry (hereinafter "MOI"), Ministry of Public Works and Public Housing (hereinafter "MOPWPH"), Ministry of Finance (hereinafter "MOF") and an international cooperation agency to discuss the direction, outline and outputs of the Study. In addition, the Study Team visited several local associations to interview and collect necessary data and information.

Through the first mission, the Study Team verified the latest published data for energy balance and energy consumption. The Study Team also collected useful market information from dominant equipment suppliers in Indonesia.

Table 1.2-2 First Mission Activity Record

Date		Issue	Content
April 2	Thu	General	Meeting with JICA Indonesia Office 1
		General	Meeting with MEMR 1
		General	Meeting with MOF 1
April 3	Fri	Preparation	Preparation for kick-off Focus Group Discussion
April 4	Sat		
April 5	Sun		
April 6	Mon	General	Meeting with JICA Indonesia Office 2
		General	Meeting with MEMR 2
		General	Meeting with Daikin
April 7	Tue	General	Meeting with Agency for Assessment and Application of Technology
		General	Meeting with MOPWPH
April 8	Wed	General	Kick-off Focus Group Discussion
		Preparation	Preparation for interviews
April 9	Thu	Survey	On-site survey at Best Denki
April 10	Fri	Interview	Interview with Energy Management Indonesia
		Interview	Interview with PLN 1
		Interview	Interview with Indonesia Cement Association
April 11	Sat		
April 12	Sun		
April 13	Mon	Interview	Interview with Food and Beverage Association
		Interview	Interview with Green Building Council Indonesia
		Interview	Interview with PLN 2 (Jakarta & Tangerang Distribution Center)
		Interview	Interview with Steel Association
April 14	Tue	Interview	Interview with Textile Association
		Interview	Interview with Indonesia Pulp and Paper Association
		Interview	Interview with MEMR Data Center
		General	Meeting with JICA Indonesia Office 3
April 15	Wed	General	Meeting with MEMR 3
		General	Meeting with Asia Development Bank
April 16	Thu	General	Meeting with MOF 2

1.2.2 Second Mission

The second mission was organized between May 17 and 30, 2015. The activity record is shown in Table 1.2-3. In the second mission, the Study Team organized a first Focus Group Discussion (hereinafter “FGD”) together with MEMR by inviting relevant ministries (MEMR Data Center (hereinafter “PUSDATIN”), MOF, MOI, MOPWPH, and Agency for Assessment and Application of Technology (hereinafter “BPPT”)), as well as industrial and building associations. Approximately 40 people participated and provided useful inputs to the study. The Study Team also collected further information and data to develop MACC and information sharing with Asia Development Bank (hereinafter “ADB”) and

International Finance Corporation (hereinafter "IFC") to avoid overlapping of assistance activities while enhancing each other by sharing the useful data.

Table 1.2-3 Second Mission Activity Record

Date		Issue	Content
May 18	Mon	General	Meeting with JICA Indonesia Office 1
		General	Meeting with MEMR 1
		General	Meeting with MOF 1
		Preparation	Meeting with a Hotel staff member for FGD preparation
May 19	Tue	General	Meeting with MEMR 2 (data collection)
		Interview	Interview with Hospital Association
		Interview	Interview with Ceramics Association
May 20	Wed	General	Meeting with IFC
		General	Meeting with MEMR 3 (data collection)
May 21	Thu	FGD	FGD 1
May 22	Fri	General	Meeting with MOI
May 23	Sat		
May 24	Sun		
May 25	Mon	Interview	Interview with Mayekawa
May 26	Tue	Interview	Interview with Indonesia Cement Association
		Interview	Interview with Daikin
May 27	Wed	Interview	Interview with Miura
		General	Meeting with Singaporean energy service company
		General	Meeting with PLN
		General	Meeting with ADB
May 28	Thu	Interview	Interview with Asahimas
May 29	Fri	General	Meeting with JICA Indonesia Office 2
		General	Meeting with MEMR 4

1.2.3 Third Mission

The third mission was organized between June 28 and July 9, 2015. The activity record is shown in Table 1.2-4. In the third mission, the Study Team organized a second FGD to discuss about the major outputs and issues of the Study among policymakers (PUSDATIN, MOF, MOI and MOPWPH). An extended FGD was also organized for other governmental and non-governmental stakeholders (including industrial and building associations) and international cooperation agencies to share the findings and receive further inputs for the study. Approximately 70 people participated in the event. In addition, JICA Study Team provided a training session for MEMR staff members in order for them to have a better understanding of MACC and the type of data utilized in developing MACC.

Table 1.2-4 Third Mission Activity Record

Date		Issue	Content
June 29	Mon	General	Meeting with JICA Indonesia Office 1
		General	Meeting with MEMR 1
June 30	Tue	General	Meeting with MOI
July 1	Wed	Training	Full-Day training for MACC and database
July 2	Thu	General	Meeting with IFC
		General	Meeting with JICA Indonesia Office 2
July 3	Fri	General	Meeting with Japanese Embassy
July 4	Sat		
July 5	Sun		
July 6	Mon	FGD	Extended FGD (for Other Stakeholders)
July 7	Tue	FGD	FGD 2 (for Policymakers)
July 8	Wed	General	Meeting with JICA Indonesia Office 3
		General	Meeting with MEMR 2

Chapter 2

Current Situation and Identification of Target Technologies

Chapter 2 Current Situation and Identification of Target Technologies

2.1 Recent Actions by the Government

2.1.1 Summary of Recent EE&C Regulations in Indonesia

(1) MEMR decree No 18 Year 2014 on Energy Labelling for Swaballast lamp

Indonesia has been having regulation on energy efficiency labelling for swaballast lamp (hereinafter "CFL") since 2011, under MEMR decree No 06 / 2011. Due to changes in the market for lighting equipment and to adjust to the current condition, MEMR decided to revise the regulation on labelling for CFL in 2014, through MEMR decree No 18 / 2014. The revisions of the new regulation covers the upper limit of luminous efficacy, categorization of type of lamps of warm light (< 4400 K) and cool daylight (> 4400 K), and a more detailed monitoring procedures and labelling criteria. Some points in the decree are as follows ("More stars, more efficient" – Maximum 4 stars):

- Paragraph 2 (1): mandatory application of energy saving labelling according to Indonesia National Standard (hereinafter "SNI") Number 04-6958-2003 (utilization of electricity for household and its kind – energy saving labelling for CFL).
- Paragraph 6: The Directorate General conducts the checking, verification, and monitoring on the application of energy saving labelling
- Paragraph 17: The decree becomes effective as of 18 June 2015.
- Attachment: on Criteria for Energy saving for CFL:

Table 2.1.1-1 Criteria of Energy Efficiency Labelling for CFL

Power (Watt)	Luminous efficacy (lumens / watt)							
	2,700 K – 4,400 K				4,400 K – 6,500 K			
	1 Star	2 Star	3 Star	4 star	1 Star	2 Star	3 Star	4 star
≤ 8	< 34	≥ 34	≥ 44	≥ 54	< 33	≥ 33	≥ 42	≥ 51
> 8 – 15	< 38	≥ 38	≥ 48	≥ 58	< 37	≥ 37	≥ 46	≥ 55
> 15 – 25	< 42	≥ 42	≥ 52	≥ 62	< 41	≥ 41	≥ 50	≥ 59
> 25 – 60	< 46	≥ 46	≥ 56	≥ 66	< 45	≥ 45	≥ 54	≥ 63

Source: Attachment of MEMR Decree No. 18 Year 2014

(2) MEMR decrees No. 19 Year 2014, No. 31 Year 2014, etc. on Electricity Tariff of National Electricity Company (hereinafter "PLN")

Historically, the energy price in Indonesia has been heavily subsidized by the government in the last few decades. Today, the subsidy coverage has reached to more than 20% of the state budget, which pushed the government to gradually reducing subsidies from 2013. Through MEMR decrees (Decrees No 19 and 31 / 2014), the government set up new electricity tariffs for each category as shown in Table 2.1.1-2.

Table 2.1.1-2 Current Pricing of Electricity Tariff Based on Category (2015)

Category	**Price (IDR / kWh)**	**Category**	**Price (IDR / kWh)**
Residential / Household		**Business / Commercial**	
R-1 / 450 VA	415	B-1 / 450 VA	535
R-1 / 900 VA	605	B-1 / 900 VA	630
R-1 / 1300 VA *2)	1,352	B-1 / 1300 VA	966
R-1 / 2200 VA *2)	1,352	B-1 / 2.2 – 5.5 kVA	1,100
R-2 / 3.5 – 5.5 kVA *2)	1,352	B-2 / 6.6 – 200 kVA *2)	1,352
R-3 / > 6.6 kVA *2)	1,352	B-3 / > 200 kVA *2)	1,020 *1)
Industry		**Government and Public**	
I-1 / 450 VA	485	P-1 / 450 VA	685
I-1 / 900 VA	600	P-1 / 900 VA	760
I-1 / 1300 VA	930	P-1 / 1300 VA	1,049
I-1 / 2200 VA	960	P-1 / 2.2 – 5.5 kVA	1,076
I-1 / 3.5 – 14 kVA	1,112	P-1 / 6.6 – 200 kVA *2)	1,352
I-2 / 14 – 200 kVA	972 *1)	P-2 / > 200 kVA **	1,115 *
I-3 / > 200 kVA *2)	1,115 *1)	P-3 (Street lighting)	1,352
I-4 / > 30 MVA *2)	1,191	-	-

* The price for these categories are for LWBP block (Off peak). For peak hours (6 – 10PM), the above price will be multiplied by K factor

** These electricity tariff categories are subjected to monthly tariff adjustment as regulated in MEMR decree No 09 / 2015. The tariff adjustment depends on the primary cost of electricity provision, i.e. a) USD to IDR exchange rate, b) Indonesia Crude Oil Price, and 3) inflation rate.

Source: Summarized by JICA Study Team based on the MEMR Decree Nos. 19 and 31/2014

(3) MEMR decree No. 07 Year 2015 on Energy Labelling and Minimum Energy Performance Standard for Split Air Conditioners[2]

Standards and labelling are applied to provide information to consumers about energy efficiency level of electric home appliances and to encourage manufacturers to increase their quality of products to be more efficient. The energy efficiency labelling was started for CFL lighting in 2011, and soon to be applied for split air conditioning (hereinafter “AC”), refrigerator, rice cooker, and electric motors.

The MEMR decree No 07/2015 regulates the labelling and Minimum Energy Performance Standard (hereinafter “MEPS”) for split air conditioning with the following main points in Table 2.1.1-3:

2 Typical model of room AC, consists of an indoor unit and an exterior unit. It is also known as “separate AC.”

Table 2.1.1-3 Main Points Related to EE Labeling and MEPS for Split ACs

<table>
<tr><th>Article</th><th>Item</th><th>Description</th></tr>
<tr><td>1.2</td><td>Labelling Standard</td><td>Energy Saving label follows SNI No 04-6958-2003</td></tr>
<tr><td>1.3</td><td>Scope of Air Conditioning Equipment</td><td>HS code ex 8415.10.10.00 of single split wall mounted type with maximum cooling capacity 27,000 BTU / hour for both inverter and non-inverter types</td></tr>
<tr><td>1.7</td><td>Product Certification Institution (LsPro)</td><td>Organization which conducts the certification of the AC equipment as per SNI ISO/IEC 17065:2012 and accredited by National Accreditation Committee or other accreditation agencies approved by Asia Pacific Laboratory Accreditation and International Laboratory Accreditation.</td></tr>
<tr><td>1.8</td><td>Testing Laboratory</td><td>The testing laboratory conducts the test and verification of the AC equipment according to SNI / IEC 17025:2008</td></tr>
<tr><td>10</td><td>Energy Saving Certification</td><td>Energy saving certificate is obtained through certification process 1a according to SNI / IEC 17067:2013</td></tr>
<tr><td>13</td><td>Performance Test</td><td>LsPro conducts the performance test of AC equipment with reference to SNI 19-6713-2002. For the energy efficiency ratio (hereinafter “EER”) value determination, non-inverter AC measurement is to be conducted at full load, while inverter AC measurement is to be conducted under both full load and half (50%) load, with calculation EERinverter = 0.4 x EER (full load) + 0.6 x EER (half load)</td></tr>
<tr><td>25</td><td>Applicability</td><td>The requirement for labelling and MEPS for AC equipment become mandatory effective from 01 August 2016.</td></tr>
<tr><td></td><td>Attachment 1</td><td>Criteria for Energy saving labelling for Air Conditioning equipment:
<table>
<tr><th>1 Star</th><th>2 Star</th><th>3 Star</th><th>4 Star</th></tr>
<tr><td>8.53 ≤ EER ≤ 9.01</td><td>9.01 ≤ EER ≤ 9.96</td><td>9.96 ≤ EER ≤ 10.41</td><td>10.41 ≤ EER</td></tr>
</table></td></tr>
<tr><td></td><td>Attachment 2</td><td>Procedures and Criteria for performance testing of Air Conditioning equipment</td></tr>
</table>

Note: EER = Energy Efficiency Ratio, which is the ratio of cooling capacity (BTU / hour) to amount of electricity consumed (Watt).

Source: Compiled by JICA Study Team based on MEMR Decree No. 07/2015 and its Attachment 1

(4) Government Decree No. 79 Year 2014 on National Energy Policy

National Energy Policy is the mandate of Law No 30 Year 2007 on Energy and is prepared by the National Energy Council to give direction of energy management to achieve energy independence and security for the nation. The decree regulates on all aspects of energy policy from energy availability, development priority, utilization, inventory, conservation and diversification, environment & safety, pricing, subsidy & incentives, infrastructure and accessibility, and R&D and application of the technology. The main points of this government decree are shown in Table 2.1.1-4:

Table 2.1.1-4 Main Points of Gov. Decree No. 79 Year 2014

Article	Item	Description
4	Validity	National Energy Policy is applied from year 2014 up to year 2050.
8	Target for provision and utilization of Primary and final energy	Accomplish the provisions of: ・ The primary energy in year 2025 about 400 MTOE* and in year 2050 of about 1,000 MTOE ・ The utilization of primary energy per capita in year 2025 about 1.4 TOE and in year 2050 about 3.2 TOE ・ The provision of power plant capacity in year 2025 about 115 GW and in year 2050 about 430 GW ・ The utilization of electricity per capita in year 2025 about 2,500 kWh and year 2050 about 7,000 kWh
9	National Energy Policy Target	・ Energy elasticity less than 1 by year 2025 aligned with the economic development ・ Reduction of final energy intensity of 1% per year until year 2025 ・ Electrification ratio of 85% in year 2015 and approaching 100% by year 2020 ・ Household gas use ratio of 85% in year 2015, and ・ Optimal primary energy mix : ➢ For New and Renewable Energy, in year 2025 for minimum 23% and in year 2050 for minimum 31% aligned with the economy ➢ For oil, in year 2025 less than 25% and in year 2050 less than 20% ➢ For coal, in year 2025 minimum 30% and in year 2050 minimum 25% ➢ For natural gas, in year 2025 minimum 22% and in year 2050 minimum 24%
17	Energy Conservation Policy	To increase energy efficiency on both supply and demand side, e.g. industry sector, transportation, household, and commercial
18	Energy Diversification Policy	To increase the share of new renewable energy use in the primary energy mix
22	Incentives	Both Central and Local Government will give incentives (fiscal and non-fiscal) to promote energy diversification and renewable energy development.

* MTOE = million ton of oil equivalent

Source: Compiled by JICA Study Team based on Government Decree No. 79 Year 2014

(5) Act /Law No. 3 Year 2014 on Industry

Act No. 3/2014 on Industry replaced No. 05/1984 with its objective to realize an independent, competitive and advanced industry, as well as ‘green industry’. The new Act regulates on the Master Plan for National Industry Development (hereinafter “RIPIN”) for the next 20 years (Government decree No. 14 Year 2015), including all the important and strategic programs. Green Industry development is mandated as part of the new Act No. 3/2014 (Article 77 to 83) and covers 1) the efforts on optimizing resource usage, 2) effectiveness and efficiency in production process, and 3) sustainable industry development.

The green industry concept is characterized with various efficiencies such as efficient material input usage, use of alternative raw materials, low energy and water intensity, waste minimization and low carbon technology. The government is currently preparing a draft regulation with regards to Green Industry and Ministry of Industry is also targeting the application of green industry standard in 4 commodities (steel, Portland cement, integrated pulp and paper, and ceramic tiles) through Ministerial decree.

(6) Presidential Decree No. 02 Year 2015 on National Medium Term Development Plan 2015-2019

The National Medium Term Development Plan (hereinafter “RPJMN”) is the guideline for ministries/institutions to prepare strategic plan, annual work plan (hereinafter “RKP”) and preparation materials for the local government to create Local Medium Term Development Plan (hereinafter “RPJMD”) for the next 5 years. In the RPJMN, the government prioritizes national development, of which energy resilience is identified as one of the strategic elements for sustainable development in RPJMN, including increase in production for energy resources (particularly gas and coal) and focus on domestic consumption, as well as improvement in basic energy infrastructure.

In terms of financing framework, the funds are sourced from State Budget (ministry/institutional budget, Specially Allocated Funds, assistance and grants from state budget), local/provincial budget, overseas grants, trust funds, and private sector/community.

(7) MEMR Decision No. 0074 K/21/MEM/2015 on Electricity Power Supply Business Plan

The Electricity Supply Business Plan (hereinafter “RUPTL”) is prepared to fulfill the mandate of Government Regulation No. 14 Year 2012 on Power Supply Operations and to serve as guidance for the development of power infrastructure to meet electricity demand within PLN business areas in an efficient and well-planned manner. RUPTL covers electricity demand load forecasts, generation capacity expansion plans, and the development plans related to transmission, substations, and distribution. Along with the government RPJMN plan, RUPTL also describes the 35 GW electricity development program between 2015 and 2019. The roles of private sector is expected to increase in terms of capacity contribution from currently 15% to 32% in year 2019 and 41% in year 2024.

(8) MOPWPH Decree No. 02/2015 on Green Building

Ministry of Public Works and Public Housing decree No 02/PRT/M/2015 on Green Building was issued in order to mainly support GHG emission reduction action from buildings and to materialize the form of sustainable buildings according to Act No. 28 2002 on Buildings. One of the requirements for Green Building is efficient use of energy to achieve optimal use of energy depending on the type of buildings, to reduce negative impact to the environment, and to reduce costs of excess energy use. The criteria for energy efficiency for green buildings include the building envelope (roof thermal transfer value (hereinafter “RTTV”) and overall thermal transfer value (hereinafter “OTTV”), maximum 35 W/m2), ventilation system, air conditioning system, lighting system, movement inside the building, and electricity system in accordance to their respective SNIs.

The implementation of this decree relies greatly on active roles of the stakeholders and participation of local governments. In year 2015, as part of its first milestone for nation-wide implementation of green building, MOPWPH has targeted its assistance to 3 pioneer metropolitan cities for capacity development, i.e. Bandung, Surabaya, and Makassar.

(9) MOPWPH Decree No. 05/2015 on General Guideline on Implementation of Sustainable Construction

Ministry of Public Works and Public Housing decree No 05/PRT/M/2015 on Implementation of Sustainable Construction was issued to apply sustainability principles to the infrastructure development process for public works and housing in respect to economic, social and environment aspects. The resources used at every step of the infrastructure development are required to follow the sustainability principles, which consist of land, energy, water, materials and ecosystem.

Steps for infrastructure development covered in this decree includes programming, technical planning, construction process, utilization and demolition process.

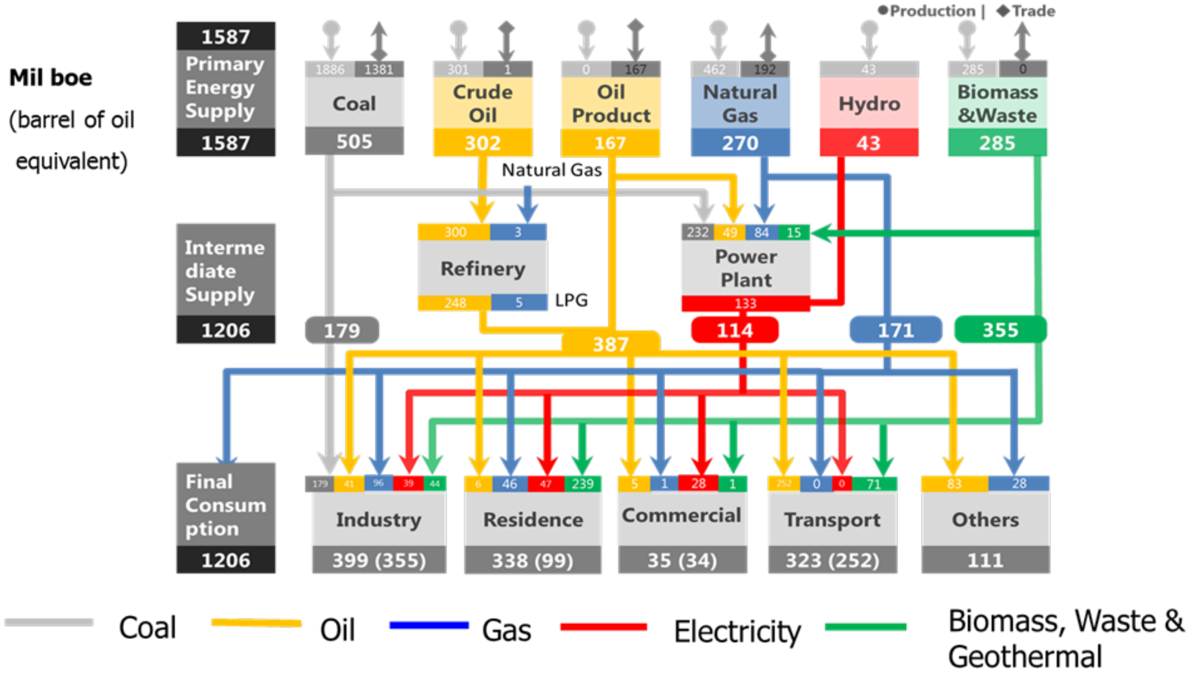
2.2 Environment Surrounding EE&C

2.2.1 Macro View

Figure 2.2.1-1 shows macro energy balance of Indonesia in 2013. It exhibits the country's high dependency on coal and oil import as well as high concentration of energy consumption in industry, residence and transportation sectors.

The energy consumption by sector in Indonesia in 2013 is shown on the primary energy basis[3] in Figure 2.2.1-2 (excluding biomass). As demonstrated in the figure, <u>the energy consumption in industrial, commercial and residential sectors account for 62% of the total consumption on the primary energy basis.</u>

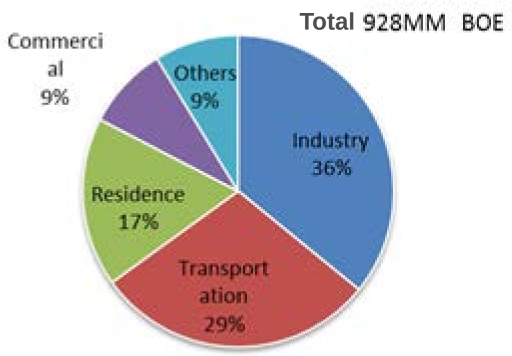
[3] The largest difference between primary energy base and secondary (final) energy base appears in energy equivalent figure in electricity. More specifically, the energy consumption on the secondary energy base is 1kWh=860kcal, while it is 1kWh=3185kcal in Indonesia where power supply is highly dependent on thermal power plants.



Source: Compiled by JICA Study Team based on PUSDATIN Handbook of Energy and Economics 2014

Figure 2.2.1-1 Macro Energy Balance in Indonesia

For energy demand forecast, (i) a forecast by MEMR, (ii) "Outlook Energi Indonesia 2014" compiled by BPPT and (iii) JICA's study "The study on energy conservation and efficiency improvement in the Republic of Indonesia" expect that the energy consumption in 2025 will approximately double from the amount observed between 2013 and 2015. This Study will take this into account.

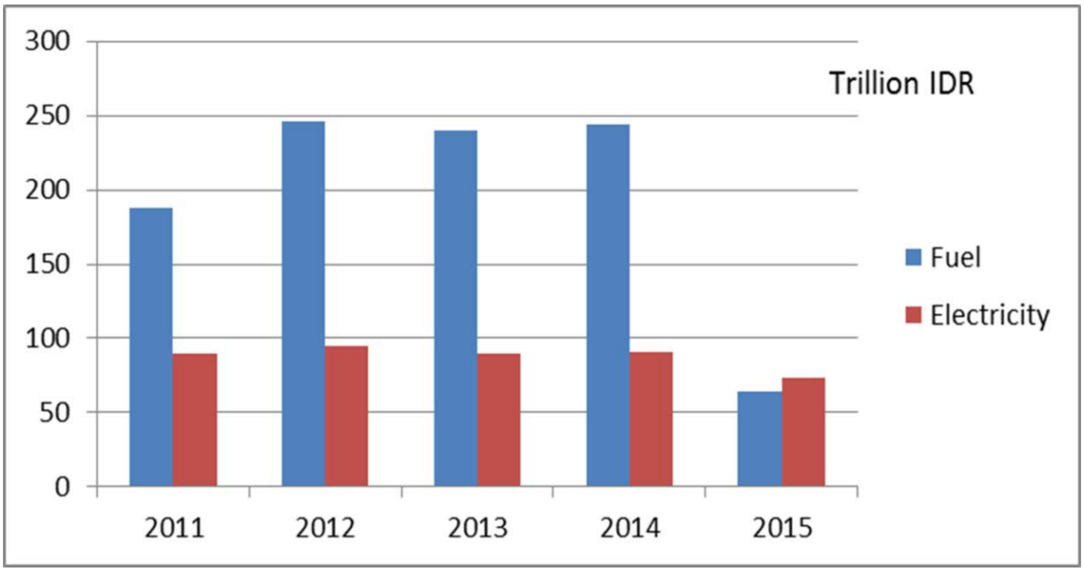


Source: Compiled by JICA Study Team based on 2014 Handbook of Energy & Economic Statistics of Indonesia
Conversion factor for grid electricity to primary energy；860kcal/kWh÷0.27 (generation efficiency） ＝3,185kcal/kWh, excluding biomass

Figure 2.2.1-2 Primary Energy Consumption by Sector in Indonesia

2.2.2 Energy Subsidy

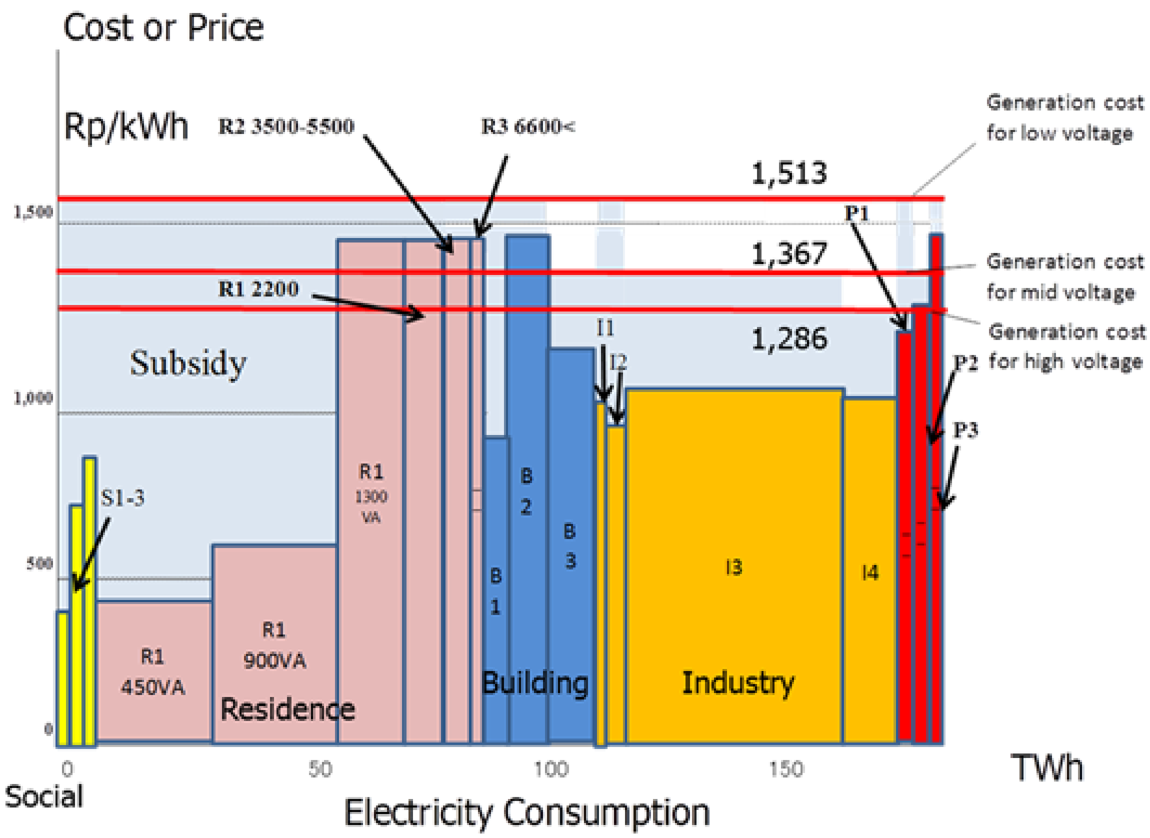
In Indonesia, energy price was historically kept low by the governmental policy, and it was observed as the biggest hurdle to promote EE&C. Under the new administration established in 2014, a bold subsidy reduction policy was put into effect to bring down the oil-based fuel and electricity subsidy to IDR 85 trillion in 2015, which is about a quarter of the previous year. Figure 2.2.2-1 shows the change in the fuel and electricity subsidies (the figure in 2015 is the forecast). Thus, year 2015 is the good timing to promote EE&C.



Source: Compiled by JICA Study Team, based on MOF, MEMR and PLN 2014 data

Figure 2.2.2-1 Trends of Fuel and Electricity Subsidy (2015: Gov. Estimates)

Figure 2.2.2-2 shows electricity consumption, electricity tariff and subsidy by sector (electricity contract) as of January 2015. The electricity tariff in small houses (below 900VA) is still kept extremely low and small houses account for most of the government subsidy. Therefore the people living in small houses are not conscious for EE&C. The largest beneficiary by improving EE&C in houses is the Government (electricity subsidy reduction). Thus in order to promote EE&C in houses, the Government should formulate an incentive measures for the target end-users. Besides the electricity price of mid-size industry is also kept lower than its supply cost.



Source: Compiled by JICA Study Team, based on PLN data (consumption: 2014 basis tariff as of May 2015)

Figure 2.2.2-2 Electricity Consumption, Price/Cost and Subsidy by Sector and Contract Type

Table 2.2.2-1 shows the characteristics of electricity consumption pattern in Jawa, Madura and Bali (hereinafter “Jamali”) and outside Jamali. The electricity consumption outside Jamali is smaller than that of Jamali, besides the electricity subsidy outside Jamali is larger than that of Jamali, because generation cost is quite higher in outside Jamali. Additionally 79% of electricity outside Jamali is consumed in low voltage consumers, and promoting small consumers EE&C can contribute electricity subsidy reduction.

Table 2.2.2-2 shows the raw data of electricity supply cost by region and contract voltage category provided by PLN. The highest electricity supply cost reaches almost 4,000IDR/kWh.

Table 2.2.2-1 Characteristics of Electricity Consumption in Jamali and Outside Jamali (Island Area)

District	Electricity Consumption A (MWh/y)	Average Supply Cost B (IDR/kWh)	Average Price C (IDR/kWh)	Amount of Subsidy A*(B - C) (billion IDR/y)	%
Jamali	141,868	1,094	818	39,039	38
	(Composition) High Voltage: 9%, Medium Voltage: 41%, Low Voltage : 50%				
Outside Jamali	43,478	2,272	818	63,181	**62**
	(Composition) High voltage: 3%, Medium Voltage: 18%, **Low Voltage: 79%**				
Total (ave.)	185,345	1,370	818	102,220*	100

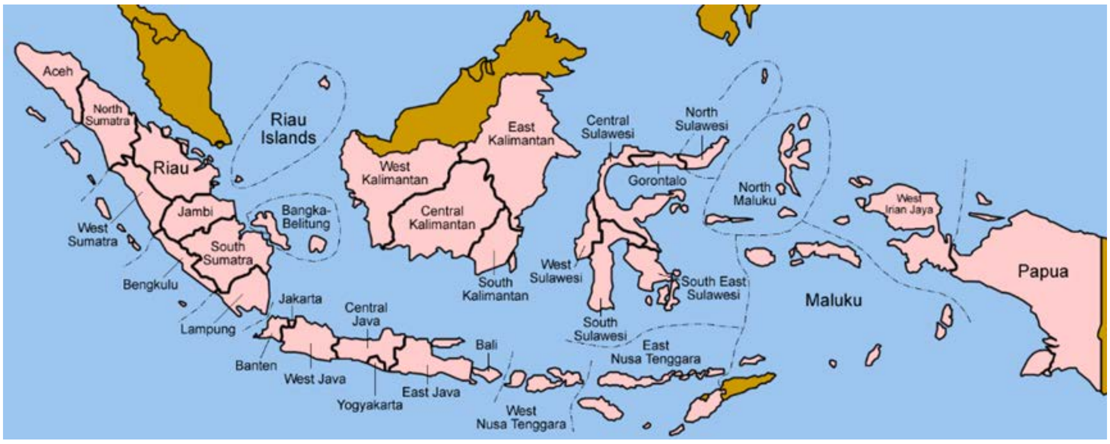
Note: Jamali is the abbreviation of Jawa, Madura and Bali. There exists about 10% discrepancy in subsidy valued between this calculation and MOF statistics.

Source: Compiled by JICA Study Team, based on PLN Statistics 2014 and PLN Generation Cost Data (2013)

Table 2.2.2-2 Electricity Supply Cost by Region and Contract Voltage Category

No	Uraian	BPP-TT (high V)	BPP-TM (medium V)	BPP-TR (low V)
1	ACEH	1,805	1,864	2,616
2	SUMUT	1,064	1,209	2,041
3	SUMBAR	1,598	1,650	2,003
4	RIAU	1,853	1,899	2,298
5	S2JB	1,504	1,572	1,950
6	LAMPUNG	1,408	1,494	1,855
7	BABEL	2,840	2,875	3,235
8	KALBAR	2,725	2,796	3,506
9	KALSELTENG	2,049	2,099	2,608
10	KALTIM	2,440	2,503	2,856
11	SULUTTENGGO	2,228	2,300	2,815
12	SULSELRABAR	1,627	1,685	1,967
13	MALUKU	3,064	3,116	3,842
14	PAPUA	2,919	2,954	3,452
15	NTT	2,792	2,848	3,290
16	NTB	3,169	3,253	3,898
17	BALI	918	976	1,196
18	JATIM	952	1,017	1,182
19	JATENG & DIY	934	991	1,165
20	JABAR	965	1,045	1,197
21	DKI	944	1,013	1,158

Source: PLN (2013)



Source: Wikipedia

Figure 2.2.2-3 Indonesian Provinces and Their Capitals, Listed by Region

2.2.3 Financial Incentive for Promoting Energy Efficiency

The structuring incentives to promote EE&C are currently stipulated by Government Regulation No.70/2009; however, as of today, it has not yet concretely implemented. Despite Indonesian MOF's lead in considering the introduction of a low-interest loan (for about 5 billion yen) program to attract investment in EE&C projects, it has not been materialized to date.

Meanwhile, MOF, in collaboration with MOI, allocated the budget of IDR 900 billion to provide VAT exemption for the industry sector from 2010. The priority was given to large GHG emission sectors, including iron and steel, cement, chemical, ceramics, palm oil, pulp and paper and textile. However, the first year was without a single application received, and MOF cut its budget to IDR 500 billion in the subsequent year. According to the interview with MOI, it appears that industries were hesitant to submit their application forms mainly due to complexity in its requirements. This shows that the economic sense alone cannot foster the EE&C; paper works need to be clear enough to encourage industries to use the scheme.

2.2.4 Energy Audit Program (for Industry and Large Buildings)

Enacted by the Government Regulation No.70/2009 concerning Energy Conservation, MEMR has been providing free energy auditing to both governmental and private buildings and factories. Over 680 facilities were audited between 2010 and 2013, and 120 buildings and 180 industries in 2014.

2.3 EE&C's Current Situation and Issues by Sector

Technologies (of equipment) which have high-potentials in EE&C are: 1) air-conditioning/ refrigerators/chillers, 2) heating, 3) motor, 4) energy management and 5) lighting. The energy-intensive industries identified by MOI are: iron & steel, textiles, fertilizers, pulp & paper, cement, ceramics, and food & beverage. This Study focuses on those energy-intensive industries, except for pulp & paper industry.

2.3.1 Industry

As shown in Table 2.3.1-1 below, iron & steel, textiles, fertilizers, cement, ceramics, food & beverage are heavily consuming energy in Indonesia.

Table 2.3.1-1 Energy Consumption by Energy Consuming Industrial Sub-sector

Sub-sector	Energy consumption (supply data)					
	Electricity	Coal	Diesel	Gas	Others*	Total*
	kBOE (yr)					
Iron&Steel	**10,000**	530	4,476	**30000**	338	45,344
Textile	**10,000**	**9,000**	**4,000**	448	686	24,134
Chemical/Fertilizer	8,419	5,978	12,469	**15,000**	2,119	43,985
Cement	3,703	**90,000**	3,054	2,111	117	98,985
Ceramics	**1000**			**20,000**		21,000
Food & beverage	5,233	3,168	**10,000**	1,211	1,433	21,045
Total	38,355	108,676	33,999	68,770	4,693	254,493

Note: The conversion factor applied by MOI (2012) is as follows: diesel (10.6996kWh/L); coal (5.9313kWh/kg); Gas(293kWh/MMBTU); 0.613boe= 1MWh (on the secondary energy base).

Source: Compiled by JICA Study Team, based on MOI "Needs for Energy Planning for the Industry Sector towards the Acceleration of Industrialization" (2012) and interviews with Indonesian Industrial Associations (Bold data were collected or estimated by JICA Study Team based on interviews).

(1) Cement

The Cement Association in Indonesia (hereinafter "ASI") does not have an energy saving target; however, the association encourages its members to achieve 1% of fuel change to renewable energy such as biomass. The target of CO2 emission reduction in the industry is 5% by 2020 from the 2009 level.

The operation rate of existing factories has continuously improved and is expected to be 63% in 2015 from 55% (2012), 58% (2013), and 60% (2014). The annual cement production is about 60 million ton with 40,000 thousand barrel of oil equivalent (hereinafter "kboe") of coal consumption (0.25 coal ton/clinker ton) and 3,600 kboe of power consumption (100kWh/cement ton).

Primary technologies for energy saving in the industry are (1) high efficient kiln, (2) waste heat recovery, (3) high quality (high calorific) coal and (4) variable frequency drive (hereinafter "VFD")/variable speed drive (hereinafter "VSD") motor. Among these four, the waste heat recovery is listed as the most effective EE&C technology in the field.

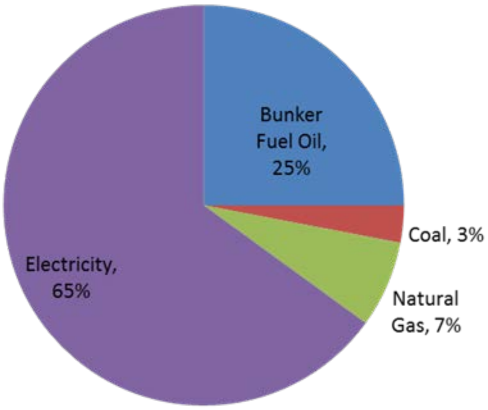
According to ASI, installation potential is about 119MW equivalent to 70% of total capacity (170MW). The investment cost is estimated about 20,000,000IDR/kW and its payback period is around 4 years.

The capacity of cost effective cement production line is above 3,000clinker ton/day and there are 11 existing companies (24 production lines) that are satisfied with this condition. Among them, only one line has so far installed the waste heat recovery technology using the Clean Development Mechanism (hereinafter "CDM") scheme.

Thus, incentive measure for promoting waste heat recovery is the most desirable in the field.

(2) Iron and Steel

Indonesia's iron and steel sector annually produces approximately 500 to 600 million tons of billets by mainly using electric furnaces, and only one company (Krakatau) owns an integrated steelworks. Indonesian Iron and Steel Industry Association (hereinafter "IISIA") currently has 70 member companies[4], of which 30 are of small melting shops using 100% scraps producing 250,000 ton of billets/year on average. Bar mills, wire-rod mills and rolling use reheating furnaces. As shown in Figure 2.3.1-1, electricity is the main energy source, followed by fuel oil and natural gas.



Source: MOI (2009 data)

Figure 2.3.1-1Energy Consumption at the Iron and Steel Sector by Energy Source

Today, Indonesian iron and steel sector faces a severe price competition with imported products. Although replacing the existing inefficient electric furnaces with high efficient ones may contribute to prominent energy consumption reduction and improving energy efficiency in production, investing in the main equipment like furnaces would be challenging according IISIA. According to recent reports by Japanese experts, there are few techniques to rehabilitate furnaces to improve energy efficiency by reducing air leakage; however, the costs would vary depending on the size and the condition of furnaces and their piping systems. One of the main and clear energy saving solutions to the Indonesia iron and steel sector is to replace banners with regenerative banners. Regenerative banners contribute in reducing fuel consumption by using recovered waste

4 http://www.steelindonesia.com/asosiasi/index.asp?Association_ID=ASS0000073

heat, and they are short life-time compared to furnaces, easy to replace within a short upgrading downtime and a short payback period.

(3) Food and Beverage

Around 400 companies belong to Indonesian Food and Beverage Association (hereinafter “GAPMMI”). Among which, about 40% is listed or not listed but large companies, about 45% is mid-sized and the remaining 15% is small companies. Besides them, there are around 5 million small companies in food and beverage sub-sector. Some of small restaurants are consuming electricity illegally. Thus food and beverage sub-sector mainly consists of mid and small companies, it is quite difficult to grasp total energy consumption in it.

The largest energy source is diesel oil, which is mainly consumed in heating and about 10% is consumed in captive power generation. Therefore, the most effective measure to conserve energy is improving the thermal efficiency of boilers.

The market price of diesel oil at gas stations, which are controlled and subsidized by the government, is approximately IDR 6,900/L today, while the diesel oil price of Pertamina for industries is IDR 12,000/L. Due to this price difference, some small companies purchase diesel oil not from Pertamina but from gas stations.

Some larger companies consume energy in cooling storage and chilling processes.

(4) Textile

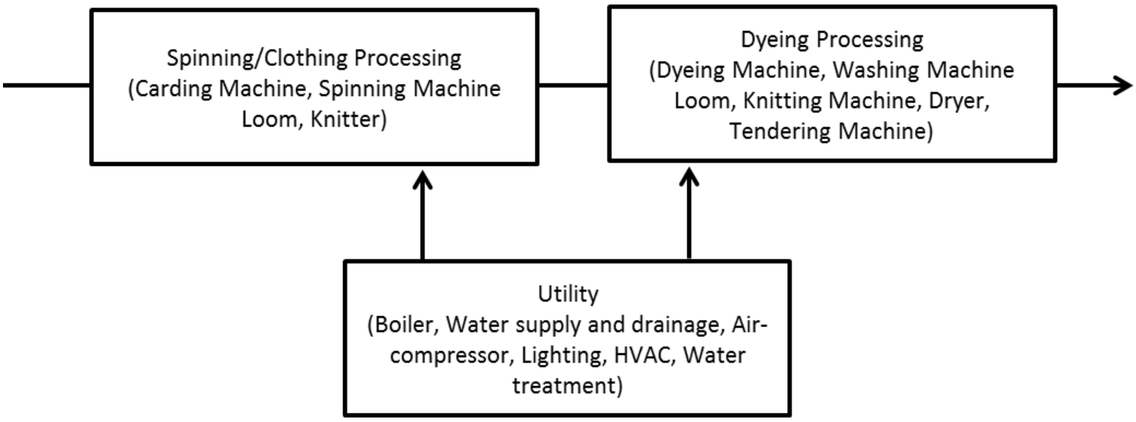
The textile industry is one of primary industries in Indonesia, and according to the Indonesian textile association (hereinafter “API”)’s information, the industry consists of approximately 22 yarn, 300 spinning, and 1,400 sewing companies. The industry is ranked as a second position in all industries, with respect to contribution to country’s Gross Domestic Product (hereinafter “GDP”) and export.

The breakdown of energy consumption by the industry is approximately 70% in electric power, 20% in gas, 5% in coal and 5% in petroleum for the most part. Due to an environment consideration requested by Europe and the Japanese customers, coal consumption has been switched to electricity in recent years.

The production process of textile industry can roughly be divided into spinner and dyeing. In addition to these two, a utility consisting of boilers and air-conditioners in both processes should be considered for analyzing energy consumption. Most of the old machineries are of Japanese, which were primarily introduced in 1970's. In recent years, these are replaced with Chinese machineries sold at reasonable prices. The incentive mechanism offered by the Chinese government contributes to lower the price of Chinese machineries, which is almost a half of Japanese ones. Since many existing machines are still not energy-efficient, there is a tremendous energy saving potential with the textile industry. According to Japanese specialists, efficiency of looming and yarning equipment is important in the industry. A replacement of loom can increase the productivity and achieve a high energy conservation as much as 70 % reduction by a unit production basis.

API has promoted Technology Development Program from 2005 and about 10% energy conservation of annual average has been achieved under the program. A related investment from 2007 to 2010 was 10 trillion IDR.

Like other industries, there is an energy saving potential with a waste heat recovery from the dyeing process. However, there is a technical challenge specific to the textile industry, e.g. clogging of fiber.



Source: Compiled by JICA Study Team based on hearing from Japanese expert

Figure 2.3.1-2 Energy Consumption in Textile Industry

(5) Fertilizer

The Fertilizer industry is one of the strategically important sub-sectors for the government, and the majority is the state-owned companies. Indonesian Fertilizer Association (hereinafter “APPI”) consists of state-owned PUPUK Indonesia and its subsidiary companies, and the function of Fertilizer Association belongs to PUPUK Indonesia. Annual production amount of fertilizer in Indonesia is around 9 million tons. The number of urea and ammonia factories is 15 and14, respectively.

Because of recent gas shortage, energy source is gradually shifting from gas to coal. Two coal-fired power plants have been constructed, and three additional coal-fired power plants are under construction now. About 97% of consumed energy source, mainly gas, is used as feedstock, and lest 3% is used as combustion energy.

Today, the fertilizer industry is under total system renovation, in which energy intensity by ton of product produced can be reduced from existing 40MMBTU/t (product) to 27MMBTU/t, or about 30％ saving. Fertilizer Association is discussing about their factories renovation with several engineering companies. Furthermore, the industry has a plan to operate a pilot coal gasification plant by 2018 to lower the gas dependency. There is several production data in PUPUK Indonesia's annual report on their web-site.

(6) Ceramics

Ceramic product can be roughly divided into 4 categories, (1) tile, (2) sanitary relation, (3) tableware, and (4) roof. According to the Ceramic Industry Association (hereinafter "ASAKI"), the annual production amount in 2014 was 550 million m2 on capacity basis and the actual production was 500 million m2 (40 - 42 million m2/month). The rate of operation was beyond the 90%. A slowdown in the domestic economy in 2015 has resulted in 20% down of sales from year 2014, and the industry is experiencing tight business environment.

The energy consumption is about 2.8 Nm3 /m2 (the range from 2.2 to 3.5 Nm3/m2) on average. The primary energy source is gas and its average consumption is about 140MMSCF/day (160MMSCF/day for special products such as tableware, roof material, and sanitary and 125 -130MMSCF/day for general ceramics). The energy consumption by the manufacturing process is roughly 40 - 45% by drying process and 55 - 60% by calcination process.

About 30% of production cost is gas consumption while 10% is electricity consumption. Thus, the energy cost occupies a significant weight in the ceramic industry. There is use of coal and oil products as other energy, but the consumption is limited. Coal is mainly used by the small-scale enterprise while oil products are used in heavy industry machinery for transportation at the site. A target of energy conservation can therefore be narrowed down to gas and electricity consumption.

As mentioned above, main production processes are drying and calcination. Since raw material of ceramics generally includes about 20 % of water, drying process requires heat at a steady level. One remarkable technology for energy conservation in the process is optimization of burning by controlling the amount of fuel spray and air volume. A measure by change in component of a raw material such as silicon mixture is also considered. However, the most effective energy-saving technology is the waste heat recovery from calcination process and its heat usage at the drying process. The energy conservation for introducing the technology can be estimated as about 10 % (about 4 or 5 % on a total energy consumed by a factory). The payback period is calculated as about 3 years. About 15 % of ceramic plants have already introduced the waste heat recovery system, while remaining 85% have not. The financial incentive such as subsidy is extremely effective in promoting energy conservation.

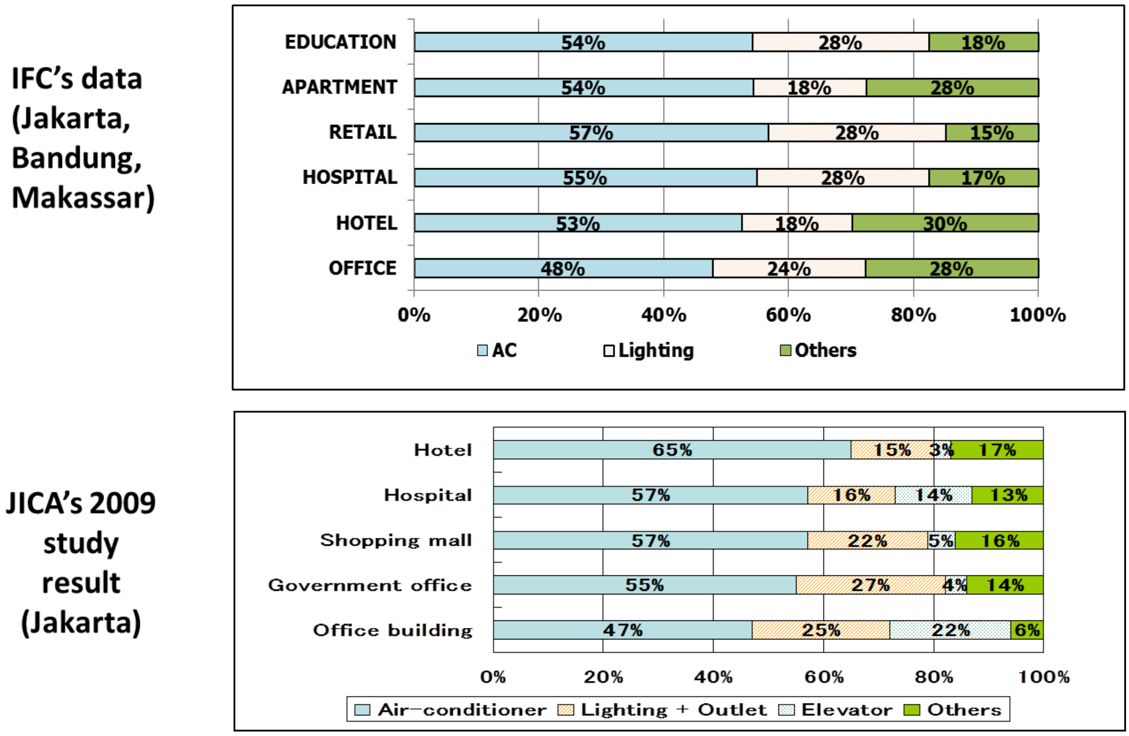
(7) Pulp and Paper

Ranked as the world top 10 producer countries, Indonesia's pulp and paper sector is one of the important exporting industries in the country. The sector consumes a variety of energy types, including coal, gas, oil products (diesel, kerosene, and lubricants), electricity and biomass/biogas., and few data collected by MOI reveals that the percentage share of fuel consumption changes over time with some factories possibly doing some fine adjustment of fuel switching based on energy prices. Waste heat recovery system and co-generation for in-house heat and power supply appear to be already well-part of the common practice in the pulp and paper plants in Indonesia. However, there still remains significant potential for energy savings by further recovering waste heat for heat and power usage. One case was observed using methane recovered from wastewater to use for steam generation for boilers. In the process, too, has a room of improvement with diverse options, according to MEMR's energy audits results.

Based on (i) reviews of recommendations provided by the MEMR's energy audit programs, (ii) literature review, and (iii) interview with, the JICA Study Team concluded that there remains still many aspects to consider for prioritizing technology options for the pulp and paper sector. For this reason, JICA Study Team concluded that it is best to develop EE&C MACC for the sector after in-depth discussion with Indonesia Pulp & Paper Association (hereinafter "APKI") and member factories.

2.3.2 Commercial Buildings

This study conducted an update of the electricity consumption data measured in "The Study on Energy Conservation and Efficiency Improvement" (2009). Figure 2.3.2-1 compares the original data with the simulation model introduced by IFC in 2015 (conducted in 2012 from 2011 in 3 cities, Jakarta, Bandung and Makassar).



Source: Study to Promote EE&C (2009), JICA/J-POWER Compiled by JICA Study Team, based on the simulation data introduced by IFC in 2015 (conducted in 2012 from 2011 in 3 cities, Jakarta, Bandung and Makassar)

Figure 2.3.2-1 Electricity Consumption by Building Type

As a result of the comparison analyses, it can be concluded that the most energy-consuming equipment in the commercial/office buildings is an AC, accounting for more than 50% of the total electricity consumption, of which improvement of EE is the highest priority to promote energy conservation in buildings.

Along with the improvement of EE for ACs, to minimize AC demand from solar insolation, introduction of heat reflective glass or Low-E glass and optimization of renewable energy generation volume depending on reduction of electricity consumption (greening of buildings) is an important theme of this sector.

(1)Split ACs

In the 2009 EE&C promotion study conducted in Indonesia, it was estimated that the 40% of domestic energy consumption is dominated by ACs, refrigerators and chillers (primary energy base). Thus, improvement of EE in cooling process is the most important issue. Meanwhile, with the establishment of ISO16358 in 2013, the increasing introduction rate of inverter technology for split ACs is a global trend in efficiency improvement as it is shown in Table 2.3.2-1. However, the diffusion rate of ACs with inverters in Indonesia was 5% in 2013 and it is expected to drop to 4% in 2014. The field test performed by JICA/J-Power in Jakarta in 2010-2011 under the "Study for Promoting Practical Demand Side Management Program in Indonesia" (2012) confirmed that an AC with inverter showed 20% of EE&C improvement in one-year operation compared to a non-inverter AC. Therefore, this Study intensively addresses the impact analysis on the introduction of inverter technology to ACs for its promotion.

Table 2.3.2-1 Inverter Ratio of Split AC by Country

Country	Inverter ratio（%）
Japan	100
Singapore	78
China	50
Vietnam	30
Malaysia	(20)
Indonesia	5

Source: GfK (2014); Malaysia data is the estimation by JICA Study Team

(2) VRV and Chiller

The inverter is an effective technology in Indonesian energy conservation promotion of the building sector simultaneously with introduction of split inverter air conditioner. Known as Variable Refrigerant Volume (hereinafter, "VRV"), the technology controls the operation to generate the most suitable refrigerant amount according to the cooling load. It is also called Variable Refrigerant Flow (hereinafter "VRF") in general.

SNI 6390:2011 indicates the minimum efficiency (Coefficient of Performance (hereinafter “COP”) of AC. AC is classified by its cooling type into air-cooling and water cooling, and most spread equipment in Indonesia is air-cooling type.

Unlike small split ACs, for large scale chiller, the larger capacity unit tends to become higher-efficient. The SNI standard shown in Table 2.3.2-2 indicates that the efficiency of VRV equipment is about 40 %, or 20% higher than other air cooled chillers.

Table 2.3.2-2 SNI Standard for AC Efficiency

INDONESIAN STANDARD SNI 6390:2011

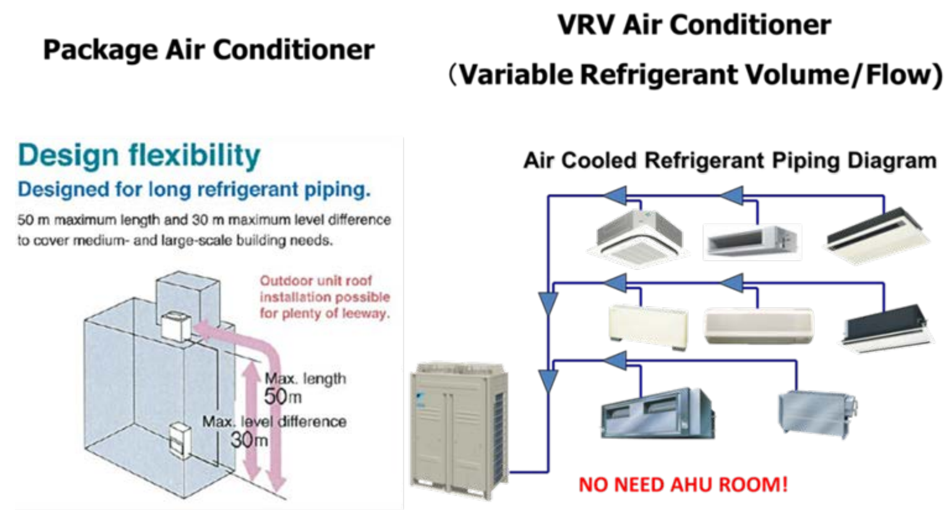
Type of Air Conditioning	Minimum Energy Efficiency	
	COP	kW/TR
Split < 65,000 BTU/h	2.70	1.303
Variable Refrigerant Volume	3.70	0.951
Split Duct	2.60	1.353
Air Cooled Chiller < 150 TR (recip)	2.80	1.256
Air Cooled Chiller < 150 TR (screw)	2.90	1.213
Air Cooled Chiller > 150 TR (recip)	2.80	1.256
Air Cooled Chiller > 150 TR (screw)	3.00	1.172
Water Cooled Chiller < 150 TR (recip)	4.00	0.879
Water Cooled Chiller < 150 TR (screw)	4.10	0.858
Water Cooled Chiller > 150 TR (recip)	4.26	0.826
Water Cooled Chiller > 150 TR (screw)	4.40	0.799
Water Cooled Chiller > 300 TR (Centrifugal)	6.05	0.581

- Energy Efficient are measure at Outdoor temperature 33 °C in case of air cooled condenser , or 30 °C cooling water inlet temperature for water cooled condenser
- TR = Ton Refrigeration, 1 TR = 12,000
- For chille the EE are measured at 100 % load.

Source: Compiled by JICA Study Team from SNI (Institute Technology of Bandung’s presentation)

In addition to high efficiency level, VRV equipment has the design flexibility. As opposed to duct-type AC system, no space is required for AC machine room and ducting, contributing to architectural design flexibility. Since one outdoor unit can be connected with up to ten different types of indoor units, flexibility of AC system design is also considerably high.

The recent technology innovation increases available laying length of refrigerant pipe, contributing to increase in the degree of freedom on outdoor unit installation place. Figure 2.3.2-2 shows the comparison between VRV system and traditional package AC system.

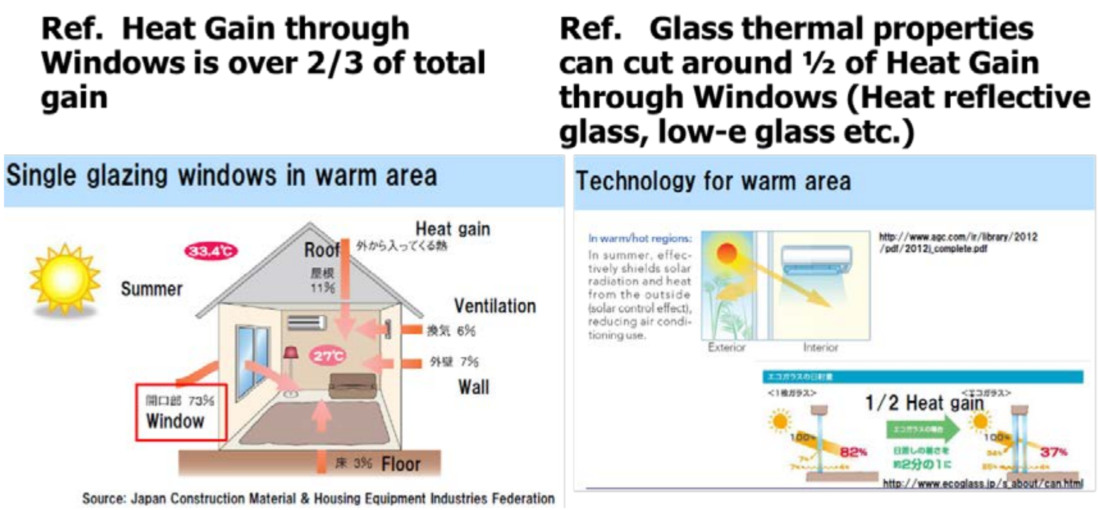


Source: Daikin

Figure 2.3.2-2 Characteristics off Multi VRV Air-conditioner

(3) Heat reflective glass

In addition to improving the efficiency of AC equipment itself, it is important to consider improvement of OTTV for building energy conservation. Two third of heat gain is thermal transfer through windows. Replacement from single glazed standard glass to high efficiency glass, such as heat reflective glass or double glazing Low-e is effective for energy saving, achieving to reduce 20 to 50% of heat gain. Low energy building can also be designed with well insulated roofs and walls (See Figure 2.3.2-3). OTTV for standard buildings in Indonesia is around 60-100W/m2. Furthermore, SNI and the Green Building Regulation in Jakarta City recommend keeping OTTV below 35W/m2 and 45W/m2 respectively.



Source: Compiled by JICA Study Team, based on the information from Japan Construction Material & Housing Equipment Industries Federation

Figure 2.3.2-3 Reduction of Heat Gain through Windows

(4) Energy Auditing and Conservation

Energy efficiency improvement in commercial buildings based on recommendations provided by appropriate energy auditing can save approximately 20 to 30% of energy compared with existing conditions. Behavioral and hardware (see Figure 2.3.2-4) approaches summarized in Table 2.3.2-3 can be considered for EE&C in commercial buildings: the former is categorized into operational/maintenance measures and the latter system renovation. Software approach (or ‘zero cost approach’ by managing suitable operation) is relatively effective for building occupants who have low interest in energy conservation.

Source: Compiled by JICA Study Team, based on the information in the energy audit reports under the MEMR’s program

Figure 2.3.2-4 Hardware Approach Image for EE&C

Table 2.3.2-3 Energy Saving Measures

Energy Saving Measures	
Operational/Maintenance (Behavioral Approach)	System Renovation (Hardware Approach)
Turning off unnecessary lightings	Replacement to high efficient equipment (AC, Light, Boiler, etc)
Higher temperature setting for air-conditioning	Replacement of refrigerant for air-conditioner
Filter cleaning for air-conditioner	Insulation pipes, ducts, and glasses
Energy saving advertisement	Optimizing capacity of air conditioner
Energy saving reward	Shading roof and window

Source: Compiled by JICA Study Team, based on the information in the energy audit reports under the MEMR’s program

(5) LED

The development of an LED lamp is a revolution in energy conservation for illumination. Approximately 50% of energy can be saved for introducing LED compared with conventional fluorescent light type. A payback period is from 5 to 9 years.

The main feature of the LED lamp is its longevity of around 40,000 to 60,000 hours, and it requires no replacement for longer than 10-20 years. When also considering the maintenance cost, the investment for LED technology can be highly effective. Figure 2.3.2-5 shows LED lightings.

Source: JICA Study Team

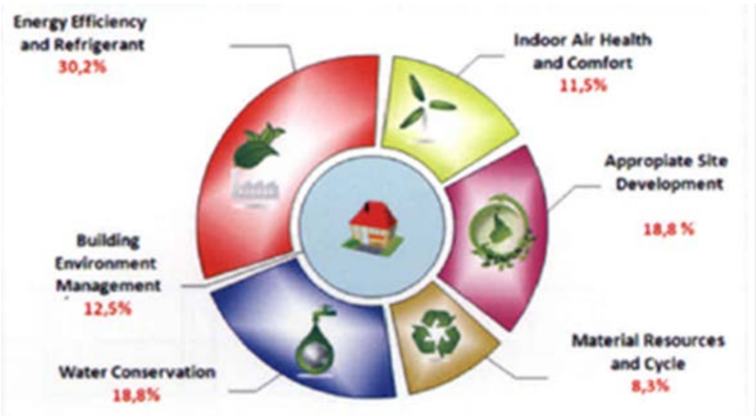
Figure 2.3.2-5 LED Lightings

(6) Green Building

Green Building Council Indonesia (hereinafter "GBC Indonesia") was established in 2009 and became a sole organization accredited to certify green buildings as per the Ministry of Environment Decree on Green Building Certification Organization No. 8/2012.

GBCI Indonesia has developed a rating system called "Greenship" for both new and existing buildings based on their sets of standards and evaluation methods. Greenship rating system evaluates 6 different items as shown in Table 2.3.2-6 and ranks the target facility into 4 categories: bronze, silver, gold and platinum.

Unlike EE&C measures for buildings mentioned above, the Greenship is utilized only for evaluating building quality and their functions. It mainly targets newly constructed buildings and has an objective for saving energy from the lifecycle perspective for buildings expected to consume energy for a long time period.



Source: GBC Indonesia

Figure 2.3.2-6 Component of Greenship Rating System

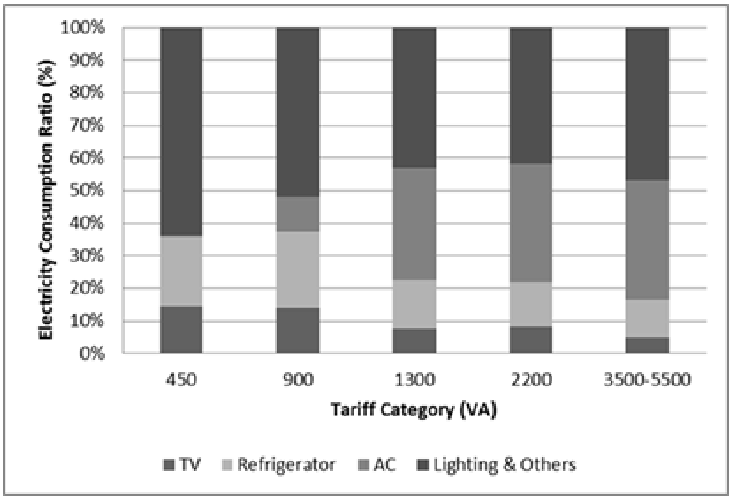
Compared with standard buildings, about 50kWh/m2 or higher performance rate of energy conservation has been recorded in green buildings in Indonesia.

2.3.3 Residential Sector

(1) Current situation

The tariff in the residential sector (R1, R2 and R3) is kept low and huge amount of subsidy is provided to this segment, as discussed in 2.2.2.

Composition of energy consumption in the today's residential sector is illustrated in Figure 2.3.3-1. In houses with small contracts (450VA, 900VA), ACs, refrigerator and TV account for high ratio in the consumption (i.e. refrigerators and ACs account for 20- 50% of the consumption).



Source: Study for Promoting Practical Demand Side Management Program in Indonesia (2012), surveyed in Jakarta, Palembang, Balikpapan, Manado and Denpasar, JICA/J-POWER

Figure 2.3.3-1 Electricity Consumption Ratio by Electricity Contract Size and Electrical Appliances in Houses

A similar tendency is shown for the area outside of Jakarta where the consumption ratio of AC and refrigerator is prominently high. Furthermore, Table 2.3.3-1 reveals that the electricity consumption of lighting is relatively high. Therefore, refrigerator, AC and lighting will be the effective target to reduce electricity consumption in the residential sector.

Table 2.3.3-1 Electricity Consumption Ratio in Houses by Regional Area and Electricity Appliances

City (Number of Study Targets)	Electricity Consumption Rates of Home Appliances for Total in Household (%)						
	Lighting	Refrigerator	TV	AC	Wash Machine	Rice Cooker	Dispenser
Jakarta (48)	13.1%	17.9%	12.3%	19.0%	2.4%	9.3%	0.6%
Palembang (50)	18.2%	22.4%	11.5%	10.5%	3.1%	11.7%	1.9%
Balik papan (52)	14.8%	21.4%	15.4%	22.4%	3.1%	5.6%	2.4%
Manado (50)	14.7%	16.4%	15.1%	19.7%	1.9%	8.0%	6.3%
Denpasar (46)	20.0%	18.3%	9.4%	16.0%	3.5%	11.5%	2.5%
All	16.1%	19.5%	13.2%	17.2%	2.8%	9.5%	2.6%
	Elec. Kitchen	Water Pump	Computer	Water Heater	Elec. Iron	Fan	Others
Jakarta (48)	0.0%	0.2%	0.6%	0.2%	5.7%	5.1%	0.9%
Palembang (50)	0.0%	0.1%	2.7%	0.1%	6.3%	6.7%	1.3%
Balik papan (52)	0.1%	0.0%	3.2%	0.0%	5.3%	3.9%	1.0%
Manado (50)	0.2%	0.1%	3.1%	0.1%	5.5%	1.9%	1.1%
Denpasar (46)	0.0%	1.3%	2.3%	1.3%	6.9%	1.9%	1.1%
All	0.1%	5.6%	2.4%	0.2%	5.9%	3.9%	1.1%

Source: Study for Promoting Practical Demand Side Management Program in Indonesia (2012), JICA/J-POWER

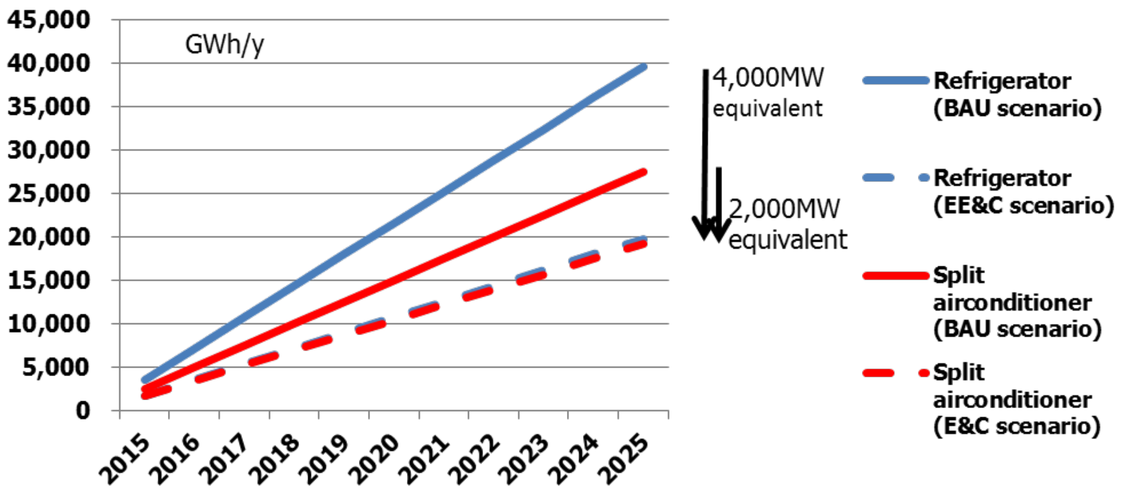
For the lighting system, the measures such as awareness raising and EE Labeling Program by the government and PLN are already taken, and CFL is in widespread use in all over Indonesia. Therefore, the effects to EE&C can be expected through similar awareness raising and EE Labeling Program for ACs and refrigerators.

Table2.3.3-2 shows the number of annual sales amounts, average electricity consumption per an appliance and expected EE&C potential, estimated by JICA Study Team and UN Development Program (hereinafter “UNDP”). The EE&C potential to introduce high efficient refrigerators and split ACs is estimated to be the largest in the residential sector. Moreover, Figure 2.3.3-2 shows the cumulative annual electricity consumption of high efficient appliances and business-as-usual (hereinafter “BAU”) appliances up to 2025. For refrigerators and split ACs, EE&C introduction scenario is approximately 6000MW less compared with BAU scenario in terms of the accumulated energy demand

Table 2.3.3-2 EE&C Potentials by Electric Appliance in Indonesia

	Market Size (u/y)	Average consumption (kWh/u/y)	(%) of Total electricity *1 in Household	EE&C Potential
Refrigerator	4,500,000 *3 6,200,000 *2	800 *3 470 *2	19.5%	50%*3 16%*2
Air Conditioner	2,500,000 *3 1,400,000 *2	1,000 *3 1,400 *2	17.2%	30%*1,*2.*3
Lighting	-	-	16.1%	50% *3 (LED)
Ballast	To be replaced by LED			
TV	-	-	13.2%	
Rice cooker	-	-	9.5%	5%*2
Iron	-	-	5.9%	-
Fan	500,000 *2	150 *2	3.9%	50%*2

Source: *1 Study for Promoting Practical Demand Side Management Program in Indonesia (2012), JICA/J-POWER
*2 Study on cost-effective development and implementation of energy efficiency standards and labeling program in Indonesia (2014), UNDP
*3 This Study (2015)



Note: The difference in cumulative annual electricity consumption between the introduction of high efficient appliances and BAU scenarios is calculated up to 2025 using the data in Table 2.3.3-2. Contribution to reducing the evening peak hour's consumption is estimated to be twice as large as the annual average.
Source: JICA Study Team

Figure 2.3.3-2 Accumulated Electricity Reduction Effect by Introducing High Efficient Refrigerators and ACs

The introduction situation of electrical appliances by the contract size (AC and refrigerator) in Table 2.3.3-3 shows the households with 450VA, which are heavily subsidized, use refrigerators only and cannot use ACs due to the constrain from the electricity contract capacity. The households with 900 VA can use refrigerator and AC of 500W (7000Btu). This result also shows that EE&C promotion for ACs and refrigerators is effective if electricity consumption in the houses with 450VA and 900VA is expected to be reduced.

Table 2.3.3-3 Electrical Appliances Which Can Be Installed: By the Electricity Contract Size in Residential Sector (AC Size and Refrigerator)

	Contract Size		
	450VA	900VA	1,300VA
Refrigerator	○	○	○
AC 5,000Btu (350W)	×	○	○
AC 7,000Btu (500W)	×	○	○
AC 9,000Btu (700W)	×	×	○

Source: Composed by JICA Study Team, based on market surveys and hearing from manufacturers

About EE&C promotion of AC, please refer to Table 2.1.1-3 “Main Points Related to EE Labeling and MEPS for Split Air Conditioners” in 2.1.1 and “Building Sector” in 2.3.2. EER of almost all ACs of 5,000Btu and 7,000Btu in the present market exceeds over the threshold value of EER of 4 stars of planed EE labeling program, and this need to be considered when designing the incentive mechanism for split ACs.

For EE&C of refrigerator, the labeling mechanism under consideration in Indonesia is effective. The government’s final draft of refrigerator’s EE&C labeling standard is summarized in Table 2.3.3-4. Under this mechanism, 4 star is the appropriate target for EE&C promotion.

Table 2.3.3-4 EE&C Labelling Standard for Refrigerator

Without ice makers	
Star rate	Formula
1 Star	≤ 465 + 1.378 x V_{adj} x 1.15
2 Star	≤ 1 Star x 0.77
3 Star	≤ 2 Star x 0.77
4 Star	≤ 3 Star x 0.77
With ice makers	
Star rate	Formula
1 Star	≤ 465 + 1.378 x V_{adj} x 1.55
2 Star	≤ 1 Star x 0.77
3 Star	≤ 2 Star x 0.77
4 Star	≤ 3 Star x 0.77

Source: MEMR (2015)

Performance test is based on SNI-ISO 04-15502-2008 or IEC 62552-2007. Here,

Adjusted Volume (V_{adj}),

$$V_{\mathrm{adj}} = \Sigma V_{\mathrm{i}} \cdot \Omega$$

Vi = storage volume in each compartment

Ω = Load factor

$$\Omega = \frac{T_a - T_i}{T_a - T_r}$$

Ta = T class ambience temperature (32 °C based on SNI/ ISO 15502)

Ti = Rated temperature in each tested compartment

Tr = Rated temperature in fresh food compartment (5°C)

(2) Issues

As discussed above, reduction of electricity consumption in the residential sector, especially with small contractors (450VA and 900VA), will lead to a significant subsidy reduction. In particular, EE&C of AC and refrigerator is important in this aspect. The price difference between the ordinary equipment and EE&C equipment is 20 to 50% for AC and refrigerator and 20 to 30% for TV, according to JICA study in 2012, and thus, EE&C equipment is more expensive. The incentive to purchase more expensive EE&C equipment hardly works for the consumers, since the electricity tariff is kept low with small contractors and the investment recovery takes time even with the electricity cost saving by switching to EE&C equipment. According to the interviews in the previous JICA study ("Study for Promoting Practical Demand Side Management Program in Indonesia (2012)"), the consumers in Indonesia tend to be price sensitive and purchase cheaper products with 15% price difference. It is hard to predict the case of 10% price difference, but the consumers answered to purchase more expensive products with 5% price difference.

Based on the situation above, the incentive provision from the government may be effective to reduce this price gap in order to promote EE&C of ACs and refrigerators. For the quantitative analysis, please refer to 4.2.

2.3.4 Summary

The target technologies/programs in each sector/sub-sector are summarized in Table 2.3.4-1. It will be used in preparing EE&C MACC:

Table 2.3.4-1 Target Technologies/Programs in Each Sector/Sub-sector

Sector	Sub-sector	Target technologies/programs
Residential sector		Split AC
		Refrigerator
Commercial sector		Split AC
		Packaged AC (VRV)
		High efficient chiller
		Heat reflective glass (Solar insulation)
		LED*
		Green buildings

Sector	Sub-sector	Target technologies/programs
Industry sector	Cement	Heat recovery power generation
	Iron & Steel	Regenerative burner
	Food & Beverage	Industrial chilling compressor unit High efficient boilers
	Textile	High efficient weaving machine
	Fertilizer	Renewal of equipment
	Ceramics	Heat recovery

* For lighting in the residential sector, CFL with comparatively high efficiency has been widely distributed throughout Indonesia. Thus, the additional improvement in EE and cost-benefit performance by replacing with LED is considered to be relatively small.

Source: JICA Study Team

In order to accelerate EE&C, governmental financial supports for implementing important programs and projects are indispensable. The technologies/measures to promote EE&C are identified in this section. In the following section, the cost-benefit impact by 2025 (the target year of RIKEN) will be quantitatively analyzed and illustrated by MACC. The quantitative analysis and MACC will help the government prioritize its action toward EE&C and evaluate EE&C's impacts on the government and end-users, respectively.

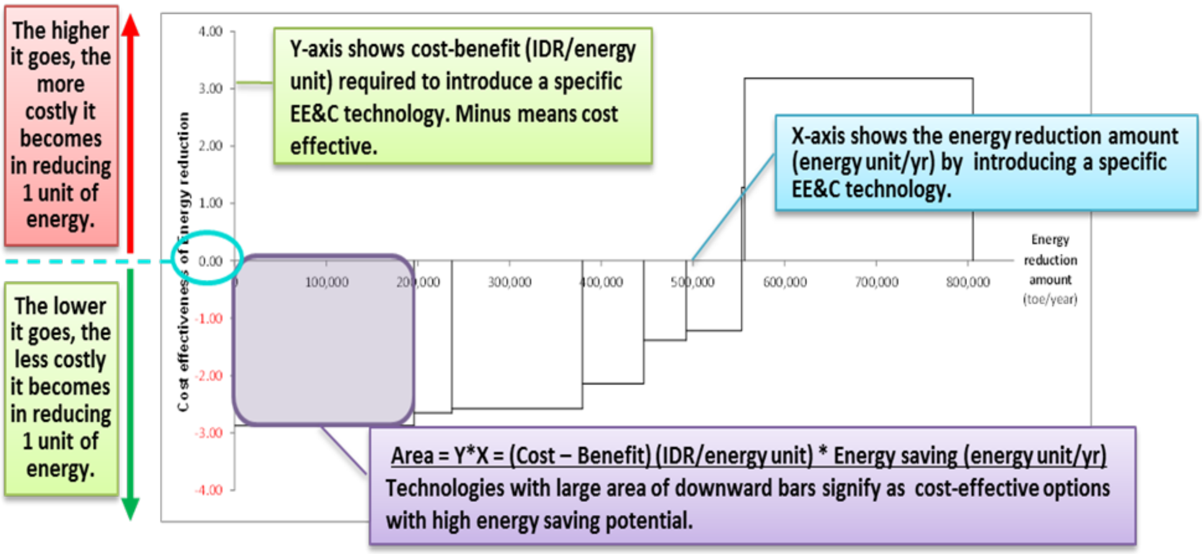
Chapter 3

General Guideline for EE&C MACC Development

Chapter 3 General Guideline for EE&C MACC Development

3.1 What is MACC?

EE&C MACC is a graph to show cost-effectiveness and energy saving volume by each EE&C measure, and can be primarily used to prioritize the cost effective projects/program to promote EE&C for policy making. As shown on Figure 3.1-1, low abatement cost measures per unit of energy (boe) are shown below a horizontal axis, and high abatement cost measures are shown above the horizontal axis on MACC. As the transverse indicates the reduction amount of energy, a program shown by a downward bar with larger area (boe/year × (cost-benefit)/boe) has the higher priority in implementation. The estimation was separately calculated into two parts, one demonstrating the government's benefit and the other demonstrating the end-users' benefit. Figure 3.1-2 shows the formulae for combined evaluation.



Source: JICA Study Team

Figure 3.1-1 EE&C MACC

Formula of Cost effectiveness of Energy reduction in MACC
{(A+B)-(C+D)}/E

A: Cost for government: Annual gov't expenditure to operate EE&C regulatory measures (IDR/year)

B: Cost for private sector: Annual investment and maintenance cost for EE&C (IDR/year)

C: Expected benefit for government: Annual reduction of energy subsidy by EE&C implementation (IDR/year)

D: Expected benefit for Private sector: Annual cost reduction by EE&C investment (IDR/year)

E: Expected Annual EE&C amount (BOE/year)

Source: JICA Study Team

Figure 3.1-2 Formula for MACC

3.2 Drafting MACC

Before preparing MACC, it is important to have a full-understanding on overall pictures related to EE&C. For that purpose, the following information needs to be collected. Data collection methods are discussed in detail in Chapter 5.

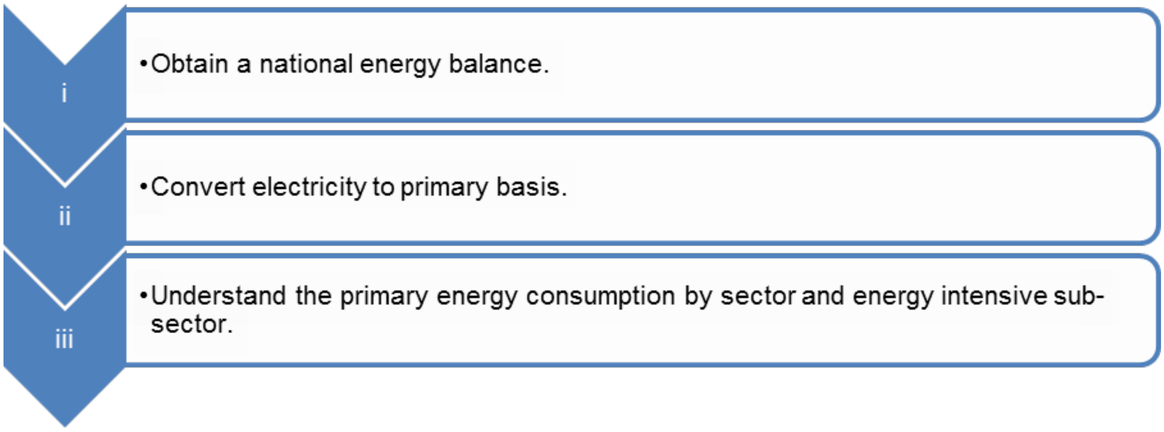
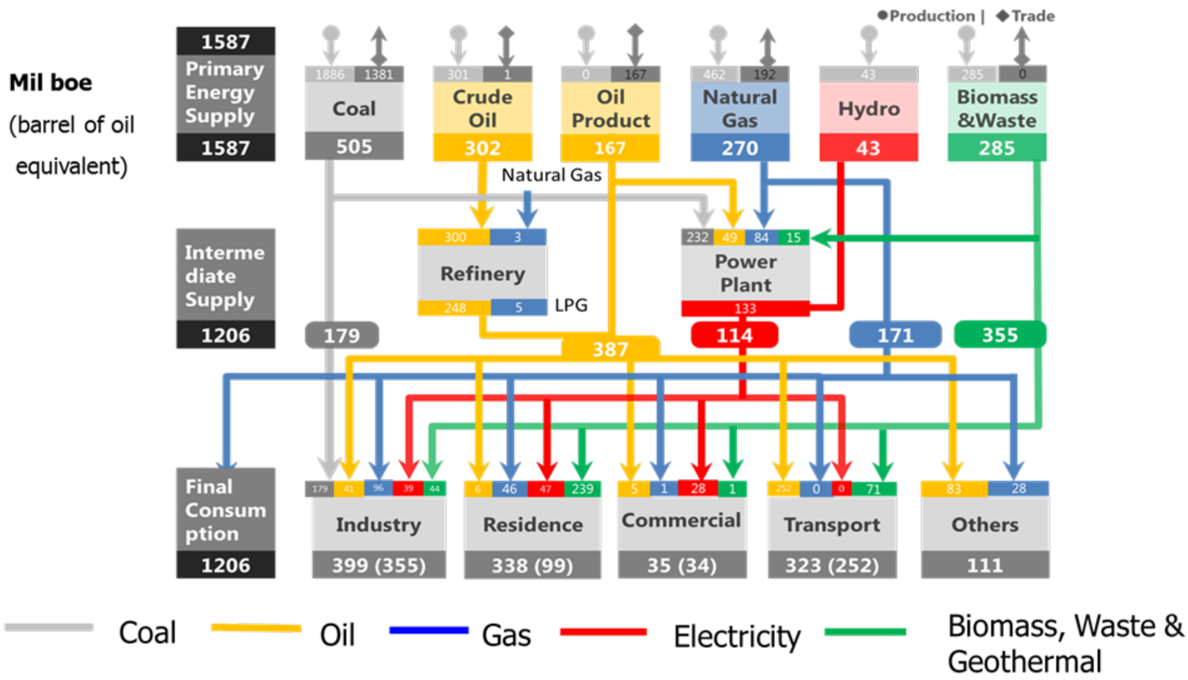


Figure 3.2-1 Analysis Flow for Overall Pictures of the Country's Energy Situation

i) Obtain a national energy balance.

The final image of a national energy balance in Indonesia is shown in Figure 3.2-2.



Source: Indonesia Energy Balance 2013, compiled by JICA Study Team, based on Global Act based on Handbook of Energy & Economic Statistics of Indonesia, MEMR (million boe)

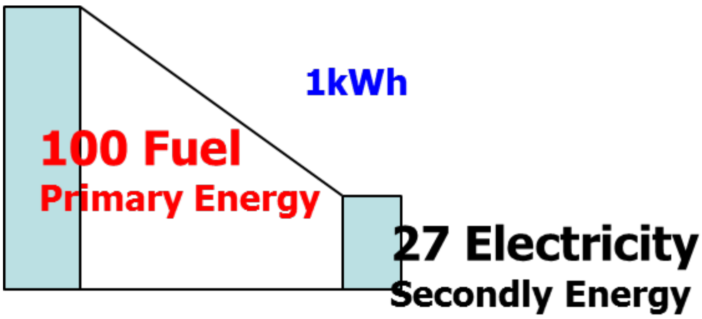
Figure 3.2-2 National Energy Balance in Indonesia

ii) Convert electricity to primary basis.

In Indonesia, 88% of electricity is generated by fossil fuel. Under this circumstance, the country's EE&C should be assessed by not secondary energy basis but by primary energy basis. Otherwise, the analysis based on secondary energy is misleading, as it does not take the fuel consumed by the intermediate supply into account. The primary energy based analysis can directly contribute to achieving effective energy use.

Where:

Secondary energy for the electricity grid consumed by end-users: 860kcal/kWh
Primary energy for the grid consumed by a thermal power plant: 3185kcal/kWh (860kcal/ 0.27)
0.27: representing a thermal efficiency, which is calculated as 0.30 (30%) *(1.0 - network loss of 0.1 (10%))



Source: JICA Study Team

Figure 3.2-3 Primary and Secondary Energy for Electricity

iii) Understand the primary energy consumption by sector and energy intensive sub-sector.

Part of the section 2.3 corresponds to this analysis.

After having a full-understanding of the above, MACC can be drafted as in Figure 3.2-4.

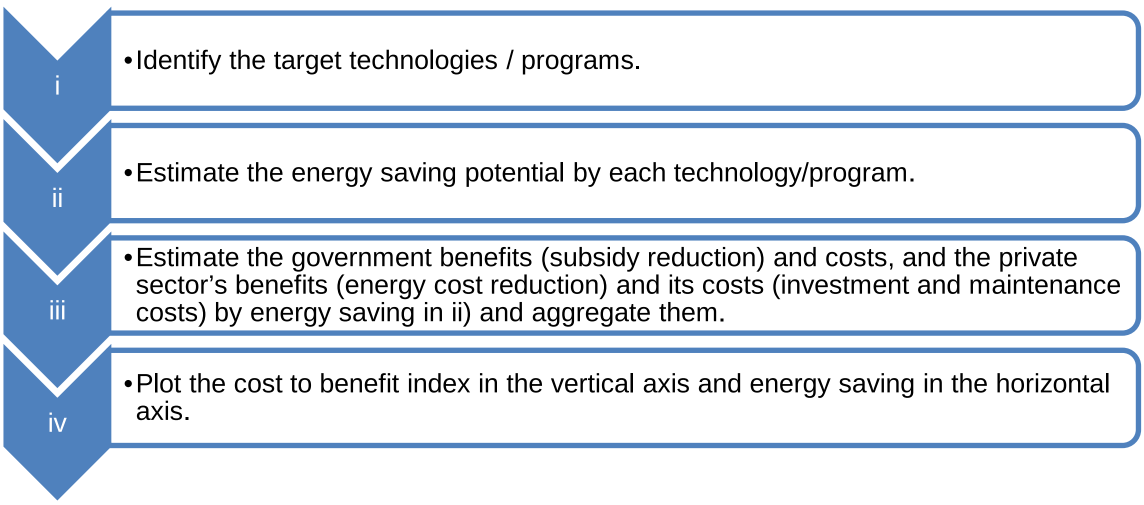


Figure 3.2-4 Procedures to Draw MACC

The detailed explanation of each step is as below:

i) Identify the target technologies / programs.

Energy consumption of each target sector (industry, commercial and residential sector) is analyzed and technologies/programs, which will greatly contribute to EE&C, will be extracted. In this report, the section of 2.3 corresponds to this analysis.

ii) Estimation of energy saving potential by each technology/program.

After the target technologies/programs are identified, the energy saving potential is estimated using the following information. The information is collected from the statistics and the interviews with private companies / industry association.

For energy saving potential over several years, we need to take into consideration of the effects of precedent year's energy saving effects. For example, if we assume that 10 new equipment is installed every year over next 10 years and 10 equipment is installed at this moment, the number of equipment in the country over next 10 years will be as in Figure 3.2-5:

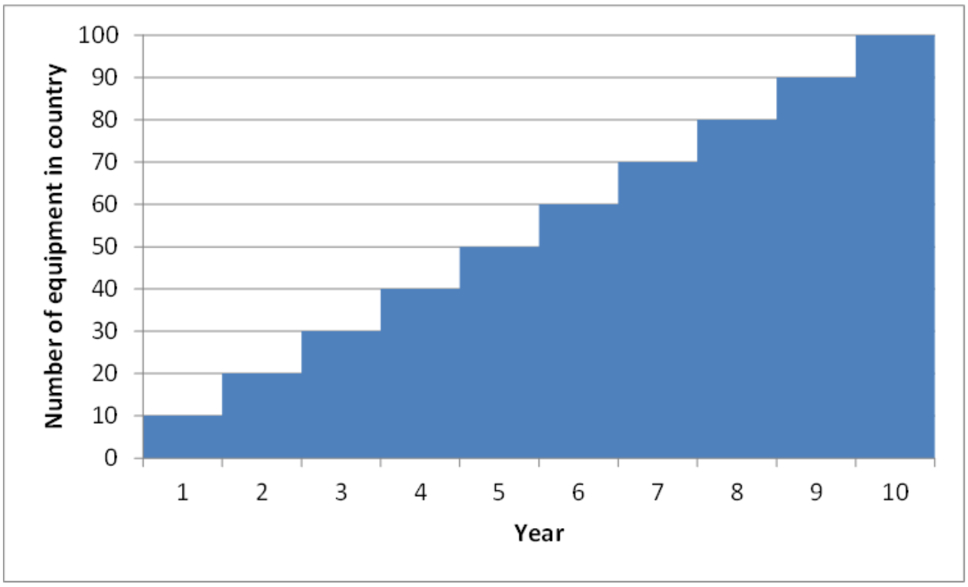


Figure 3.2-5 Example of Annual EE&C Investment Implementation

Each equipment produce energy saving effects. In order to estimate the accumulated effects, the total effects of accumulated equipment need to be taken into consideration. If energy saving per equipment is "A", energy saving potential in the country for next 10 years can be calculated as follows:

$$(\text{Energy saving potential over 10 years})$$

$$= \text{A} \times 10 + \text{A} \times 20 + \text{A} \times 30 + \text{A} \times 40 + \text{A} \times 50 + \text{A} \times 60 + \text{A} \times 70 + \text{A} \times 80 + \text{A} \times 90 + \text{A} \times 100$$

$$= \text{A} \times \left\{ \frac{100 - 10}{2} + 10 \right\} \times 10$$

This “number of equipment” in the first year” (10 in this example) and in 10th year (100 in this example) represents “the current number of the equipment in the country” and “the target number in the country after 10 years”, respectively. To simplify the calculation, the median of these two figures $\{ \frac{100-10}{2} + 10 \}$ in the formula above can be used.

To generalize the formula above, “energy saving potential over 10 years” is:

$$(\text{Energy saving potential over 10 years})$$

$$= \text{Energy saving per equipment} \times \left\{ \frac{\text{Target (total number of equipment in country)in 2025} - \text{Current number of equipment in country}}{2} + \text{Current number of equipment in country} \right\} \times 10$$

This logic above is common across the technologies/programs below. The formula to estimate each technology/program is described below.

(a) AC (split type, mid/large sized AC), refrigerator
(Energy saving potential/year) =

(Sales volume of the equipment/year) * (Penetration rate of EE&C equipment/year) * (Electricity consumption of standard type/year) * (Energy saving rate)

(b) Heat reflective glass (Solar insulation)
(Energy saving potential/year) =

(Floor area of newly constructed buildings/year) * (Penetration rate of energy efficient glass) * (Electricity consumption with standard glass/year) * (Energy saving rate)

(c) Green buildings
(Energy saving potential/year) =

(Floor area of newly constructed buildings/year) * (Penetration rate of green buildings) * (Energy saving rate)

(d) High efficient boiler
(Energy saving potential/year) =

(Sales volume of the EE&C equipment/year) * (Energy saving volume per equipment)

(e) Industrial chilling compressor unit
(Energy saving potential/year) =

(Sales volume of the equipment/year) * (Penetration rate of EE&C equipment/year) * (Electricity consumption of standard type/year) * (Energy saving rate)

(f) Fertilizer
(Energy saving potential/year) =

(Number of plants to renew equipment) * (Production volume per plant) * (Energy saving volume)

(g) Textile
(Energy saving potential/year) =

(Number of equipment/year) * (Energy saving per equipment/year)

(h) Ceramic / Cement
(Energy saving potential/year) =

(Number of heat recovery equipment/year) * (Energy saving per equipment/year)

iii) Estimate the government benefits (subsidy reduction) and costs and the private sector's benefits (energy cost reduction) and its costs (investment and maintenance costs) by energy saving in ii) and aggregate them.

(a) Government benefit (here, it is defined as "subsidy reduction")
(Subsidy reduction) = (Energy saving potential/year) * (Subsidy per unit) (e.g. per kWh)

(b) Government cost
If the expense is required to implement the policies, its estimation needs to be included. However, it is not included for the initial analysis to identify the incentive needs. Once the necessity is identified, this cost is added and MACC is re-drafted to see the incentive program's impact.

(c) Private sector's benefit (here, it is defined as "energy cost saving")
(Energy cost saving potential) = (Energy saving potential/year) * (Energy cost per unit)

For LED, the opportunity costs (the costs which users have to bear if the standard bulbs are used instead of LED) are also added. Likewise, for fertilizer, production increase (=sales increase) by facility renewal was also taken into consideration.

(d) Private sector's costs
(Private sector's cost) = (Capital cost for investment/ economic life) + (Maintenance cost / year)
(For low interest loan scheme, the interest payment is also included as the costs)

In order to keep the consistency with energy saving potential (what produces energy saving), the capital costs are applied based on the following rules:

- The new installment: Price difference between the standard type of equipment and EE&C (high efficient) equipment
- Upgrade of equipment: The total costs for upgrade
- Installment of heat recovery facilities: The total costs for heat recovery facilities

iv) Plot the data

Vertical axis: Using the figure of ii) and iii), the index to show “cost to benefit impacts of each target technology/program” (hereinafter called “Cost to benefit index”) is calculated using the formula below. This index number is plotted in the vertical axis.

$$\text{Cost to benefit index per 1 boe} = \frac{(\mathrm{A}+\mathrm{B})-(\mathrm{C}+\mathrm{D})}{\mathrm{E}}$$

A: Government (policy) costs ((b) in iii) above)

B: Private sector’s costs ((d) in iii) above)

C: Government’s benefits ((a) in iii) above)

D: Private sector’s benefits ((c) in iii) above)

E: Energy saving potential (ii) above)

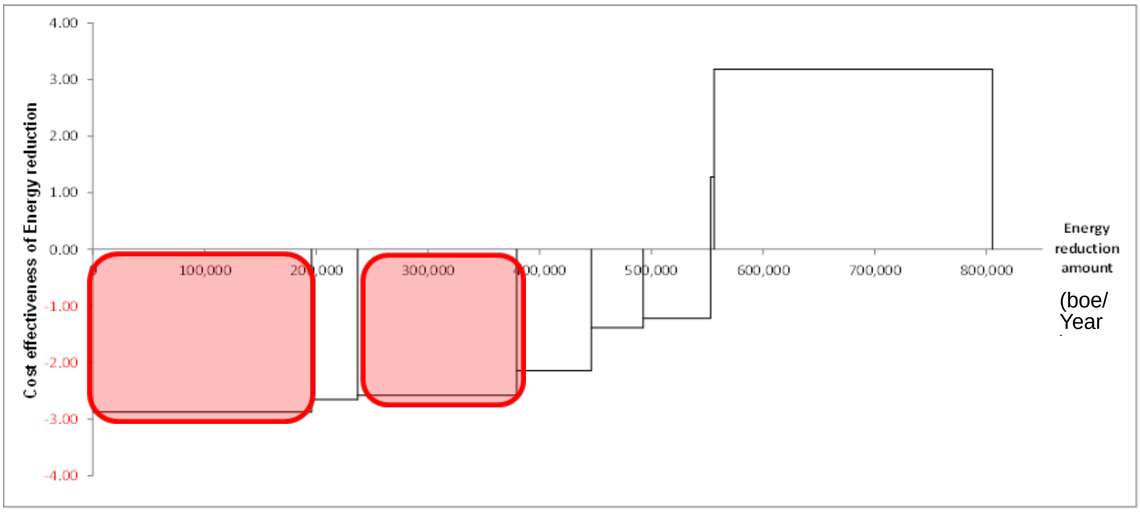
Horizontal axis: Plot the figure in ii).

3.3 Utilization of MACC

MACC drafted following 3.2 above can be used in the following way:

(1) MACC can be used to identify the targets to be focused in the policy and prioritize them, by visualizing the impacts by the target equipment introduction.

The technologies/programs occupying wide area in the negative direction, i.e. high cost-to-benefit technologies/program, are deemed to be higher priority (Area = Net benefit per 1 boe * Energy saving (boe)) than others. For example, the technologies/programs surrounded by red line in MACC (sample) shown in Figure 3.3-1 can be considered as a high priority.



Source: JICA Study Team

Figure 3.3-1 Example of Priority Program Shown by MACC

However, this is the priority shown only from quantifiable costs and benefits; therefore, it is necessary for the government to take into consideration of the unquantifiable factors when the priority in policies is determined.

(2) Draft MACC by the government and private sector separately and identify the technologies/program prioritized to provide incentives.

MACC can be used to identify priority target for incentive provision in policy making. In this case, MACC needs to be decomposed into the government and private sector, while MACC explained in 3.2 is based on the sum of net benefits of the government and private sector. The process to draft decomposed graphs are explained below:

1) To identify the target technologies/programs (the same as the sum of the government and private sector in 3.2 (p.3-6)).

2) Estimation of energy saving quantity by the target technologies/programs (the same as the sum of the government and private sector in 3.2 (p.3-6)).

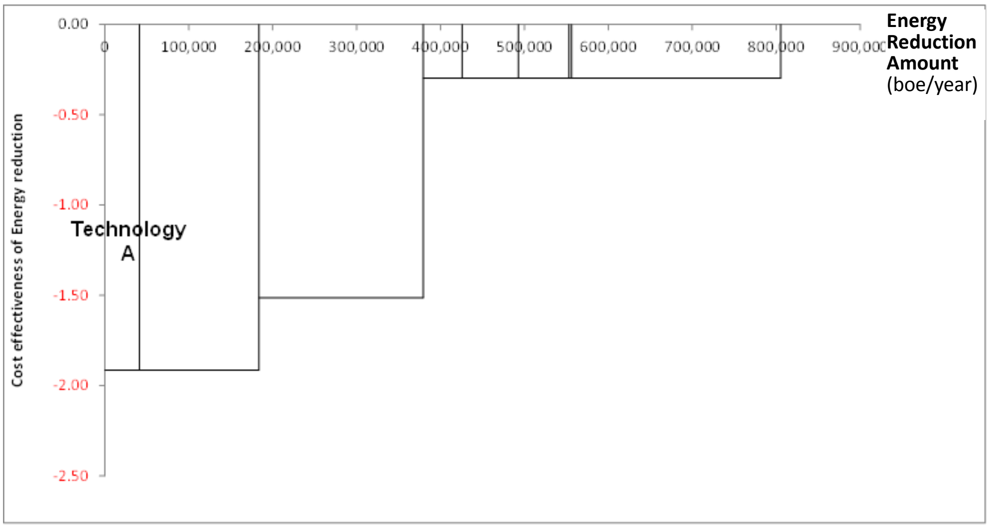
3) Draft MACC of the government component.

Estimate the government's benefit (subsidy reduction) by energy saving in 2), calculate the index number below by this figure and the figure in 2) and plot this index number in the vertical axis. For the horizontal axis, plot the energy saving figure in 2).

$$\text{Cost benefit index per 1 boe (for government)} = \frac{A}{B}$$

A: Government's benefit, B: Energy saving quantity in 2) above

For the identification of incentive target, it is important to note that the estimation should be conducted based on the costs excluding the incentive related costs. This government's benefits and costs are the same figure used as the one used in the sum of the government and private sector's net benefits.



Source: JICA Study Team

Figure 3.3-2 MACC (Example) of the Government Only

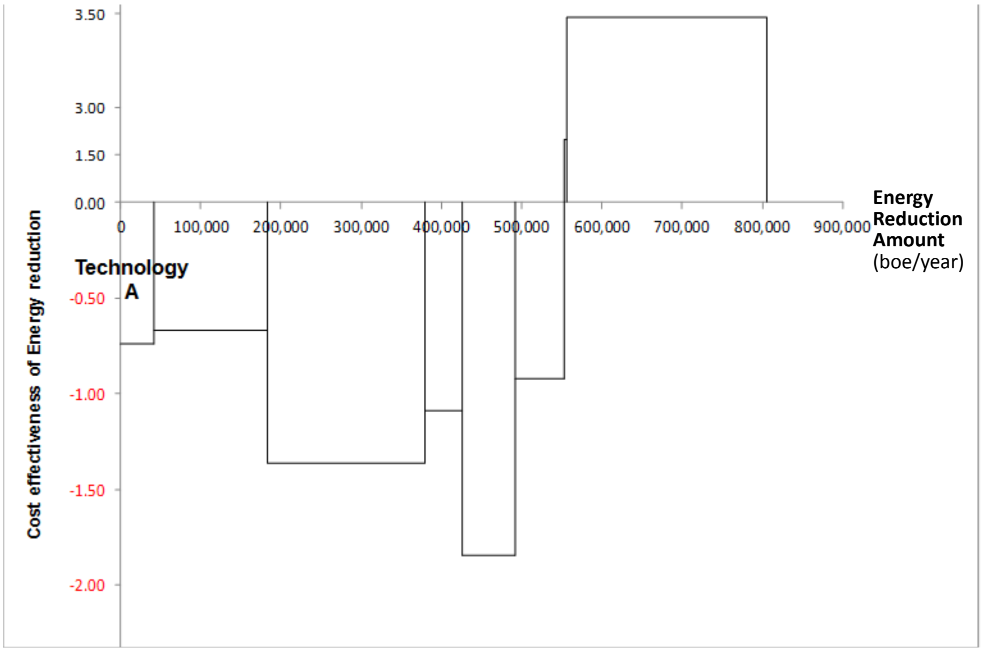
4) Draft MACC of the private sector component.

Estimate the benefits (reduction of energy costs) and costs (investment and maintenance costs, for some of technologies/programs, interest payment), calculate the index number below by this figure and the figure in 2) and plot this figure in the vertical axis. For the horizontal axis, plot the energy saving figure in 2).

$$\text{Cost benefit index per 1 boe (for private sector)} = \frac{(A - B)}{C}$$

A: Cost for private sector, B: Benefits for private sector, C: Energy saving quantity in ii) above

This private sector's benefits and costs are the same figure used as the one used in the sum of the government and private sector's net benefits.



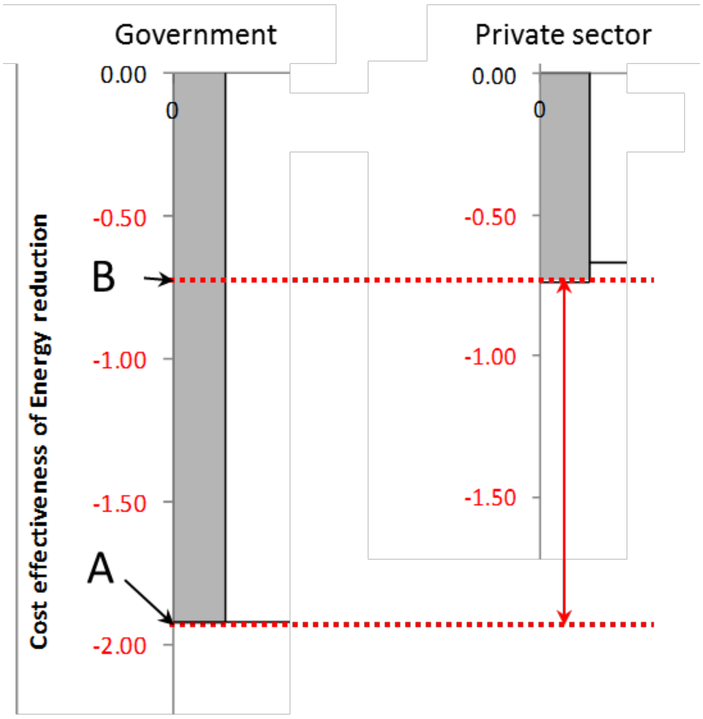
Source: JICA Study Team

Figure 3.3-3 MACC (Example) of the Private Sector Only

The aggregated figure in the vertical axis (cost to benefit index) of 3) and 4) is supposed to be the same as the aggregated figure of the government and private sector in 3.2 in case of the same technologies/programs. On the other hand, the figures in the horizontal axis are the all same in the aggregated figure of the government and private sector in 3.2, as the decomposed MACC, the government only and the private sector only.

5) Compare the decomposed MACCs in 3) and 4) and identify the potential incentive target technologies/programs.

Compare the cost to benefit index (the vertical axis) of MACC of the government in 3) and the private sector in 4) for the same technologies/programs. If the cost to benefit index in the government is higher than the one in the private sector (the absolute figure is bigger in the negative direction), the government's net benefit is higher than the private one for the introduction of this technology/program. It signifies that there is room for transferring the benefit from the government to the private sector (i.e. provision of the incentives). For example, the figure below shows that the cost to benefit index for the government (signified as "A") is greater than the one for the private sector (signified as "B") and a part of {(A) minus (B)} can be transferred from the government to the private sector to partially use the government's benefits as a funding source for an incentive for the private sector.



Source: JICA Study Team

Figure 3.3-4 Comparison of MACC of Government and Private Sector

(3) Estimate the Incentive Size and Reflect in MACC.

1) Estimation of government cost

Based on the interviews with private companies and industry associations and the price difference between the ordinary equipment etc., the incentive level is temporarily assumed. Furthermore, the penetration rate to be targeted in the incentive program is assumed by the similar interviews and statistics. Using these figures, the government costs are estimated:

[Targeted number for the incentive program] X [Incentive amount] = [Government cost by incentive program]

2) Estimate Energy Saving Quantity by the Target Technologies/Programs (Same as 2) in (2)).

3) Draft MACC of the Government.

The government benefit is the same as (2)-3), and 1) above is used for the government cost. Together with 2) above, the cost to benefit index of the government with an incentive provision is calculated and is plotted in the vertical axis.

$$\text{Cost to benefit index per 1boe (for Government with incentive)} = \frac{A - B}{C}$$

A: Government cost 1) above, B: Government benefit (same as (2)), C: Energy saving quantity 2) above

For the horizontal axis, plot the figure in 2).

4) Draft MACC of the private sector.

The incentive amount in 1) is added to the private sector's benefit in (2)-4). The private sector's cost and the energy saving quantity are the same as (2)-4) and (3)-2) above, respectively. Using these figures, the index below is calculated and is plotted in the vertical axis.

$$\text{Cost to benefit indecx per boe (Private sector, with incentive)} = \frac{(A - B)}{C}$$

A: Private sector's cost; B: Private sector's benefit (Energy cost saving + Incentive received); C: Energy saving quantity 2) above)

Plot the figure in 2) in the horizontal axis.

5) Compare MACC of the government and private sector.

Theoretically, there is room to provide the incentives from the government until the cost to benefit indexes of the government and the private sector reach the same level. However, the balance with the investment costs and the unquantifiable benefits/costs (i.e. not reflected in MACC) need to be taken into consideration, so the comprehensive judgment is necessary in order to decide the incentive level.

Chapter 4

EE&C MACC for Indonesia

Chapter 4 EE&C MACC for Indonesia

4.1 Assumption for EE&C MACC in Indonesia

In Indonesia, prevailing unit of IDR/boe should be used rather than USD/toe in calculating cost-benefit performance for establishing MACC in order to facilitate the understanding among stakeholders. In making international comparison, USD/toe is recommended.

The following target technologies were identified based on the analysis in section 2.3 and the data was collected from the following source:

Table 4.1-1 Target Technologies and Data Source: Residential and Commercial Sector

Sector	EE&C Technology	Source / Note
Residence	**Refrigerator**	Market Data, Manufacturer Previous JICA Study UNDP Study
	Inverter AC	Market Data, Manufacturer Previous JICA Study
Building	**Inverter AC**	Market Data, Manufacturer Previous JICA Study
	Chiller, VRV	SNI, Manufacturer
	Heat Reflective Glass	SNI, Manufacturer
	LED	PLN Data, Previous JICA Study
	Reconditioning and Behavioral Change	MEMR Audit Reports
	Green Building	GBC Indonesia etc.

Source: JICA Study Team

Table 4.1-2 Target Technologies and Data Source: Industrial Sector

Sub-sector	EE&C Technology			Source / Note
	1	2	3	
Cement	**Waste Heat Recovery Power Generation**	Mill	Inverter	Association
Food & beverage	**Boiler**	**Chilling**		Manufacturer
Iron & steel	**Re-generative Burner**			Other Research
Textile	**Weaving**	Lighting	Heat Recovery	Other Research
Fertilizer	**Total System Renovation**			Association
Ceramic	**Heat Recovery**			Association, Other Research
Glass	Heat Recovery	Lighting (LED)	Inverter	Factory, Other Research

Source: JICA Study Team

4.1.1 Industry Sector

The assumptions for technologies/measures in industry sector are summarized in Table 4.1.1-1 and 4.1.1-2.

Table 4.1.1-1 Assumptions for Technologies/Measures in Industry Sector (1)

	Industrial chilling compressor unit	**Heat recovery power generation in cement industry**	**Textile: high efficient weaving machine**
Energy saving potential	**Average number of units in operation:** 1310 units ➢ Major manufacturers' annual sales as of 2016: 100 → The target in 2025: 300 units: average # of units: 200 ➢ Market share: 70%, i.e. the market as a whole, 2000/70% units/yr **Energy saving per unit:** 91,980kWh ➢ Capacity 100kW ➢ Operation: 8769hours * 70% ➢ Energy saving rate: 15%	**Power generation potential** ➢ 0 as of 2016 ➢ Expected total capacity in 2025: 119,000kW ➢ Operation: 8760hours * 70% ➢ Power generation efficiency: 27%	**Average number of units in operation:** 2000 units **Energy saving potential per unit:** 45MWh
Government benefits	Electricity subsidy IDR200/kWh	Electricity subsidy IDR200/kWh	Electricity subsidy IDR200/kWh
Private sector's benefits and costs	**Benefits** ➢ Average electricity tariff: IDR1100/kWh **Costs** ➢ Initial investment: IDR20 million/unit ➢ Maintenance costs: n/a ➢ Interest: 12%	**Benefits** ➢ Average electricity tariff: IDR1100/kWh **Costs** ➢ Initial investment cost/unit: IDR 500 billion/unit ➢ Economic life: 15 yr ➢ Maintenance costs: IDR 15 billion/unit ➢ Interest: 12%	**Benefits** ➢ Average electricity tariff: IDR1100/kWh **Costs** ➢ Initial investment cost/unit: IDR 250 million/unit ➢ Economic life: 20 yr ➢ Maintenance costs: IDR7.5million/unit ➢ Interest: 12%

Source: JICA Study Team

Table 4.1.1-2 Assumptions for Technologies/Measures in Industry Sector (2)

	High efficient boiler	Heat recovery in ceramic industry	Renewal of fertilizer facility (incl. material use reduction)	Regenerative burner (Iron & steel)
Energy saving potential	**Annual sales:** 300 units sold every year ➢ 0 as of 2016 ➢ 3000 in 2025 **Energy saving per unit:** 70,000m3/yr	**Heat recovery potential** ➢ 0 as of 2016 ➢ Total heat recovery in 2025: 8.6million boe gas ➢ Ratio of factories not implementing heat recovery facility: 85% ➢ Heat recovery rate: 15%	➢ Production volume per plant: 300,000 ton ➢ EE&C improvement by renewal: 10 MMBTU/ton ➢ Number of plants: 2.5	➢ Energy consumption: 264.0Mcal/ton ➢ Iron production: 300,000ton/yr ➢ Number of plants (0 as of2016 → 30 in 2025) ➢ Energy saving: 5%
Government benefits	n/a	n/a	n/a	n/a
Private sector's benefits and costs	**Benefits** ➢ Cost for gas: IDR4500/m3 **Costs** ➢ Initial investment cost: IDR 447 million/unit ➢ Maintenance cost: IDR 18 million/unit ➢ Interest: 12%	**Benefits** ➢ Energy cost saved: 5,725,722,420 IDR/yr **Costs** ➢ Initial investment costs: 17,177,167,260 IDR/yr ➢ Useful life: 15 yrs ➢ Maintenance costs: 342,207,900 IDR/yr ➢ Interest: 12%	**Benefits** ➢ Average fuel price: IDR4000/m^3 (Coal: Gas = 3:1, coal is expected to be increased.) ➢ Production (sales) increase: by 10%, USD400/ton **Costs** ➢ Initial investment costs: 200 million USD/plant ➢ Useful life: 30 yrs ➢ Maintenance costs 6 million USD/yr/plant ➢ Interest: 12%	Exchange rate: 13,000IDR/USD **Benefits** ➢ Natural gas and bunker oil consumption: 50% each ➢ Energy saving: 5% ➢ Production per plant: 300,000ton/yr ➢ Natural gas cost: 0.132Gcal/ton 3.968 MMBTU/Gcal Price: 7.9USD/MMBTU ➢ Banker oil cost: 1GJ/238.8 1 to-MFO/41.57GJ 1000L/0.9634ton-MFO 8000IDR/L **Costs** ➢ 600,000USD/plant ➢ Useful life: 10 yrs ➢ Maintenance cost: 8400USD/yr/plant ➢ Interest: 12%

Source: JICA Study Team

4.1.2 Commercial Sector

The assumptions for technologies/measures in commercial sector are summarized in Table 4.1.2-1 and 4.1.2-2.

Table 4.1.2-1 Assumptions for Technologies/Measures in Commercial Sector (1)

	Chiller: Conversion to high efficient chiller	Conversion to VRV	Introduction of heat reflective glass
Energy saving potential	- **Sales volume:** 1800unit/yr (actual) - **Penetration rate of high efficient chiller:** # of high efficient chillers/total # of chillers sold = 5% in 2016 => expanding to 50% in 2025 (Conversion ratio to EE products: 22.5% (average till 2025) (BAU of 5% is deducted), 19.17% (average till 2020 (over incentive period)) - **Energy consumption** ➢ Electric capacity (average) 0.8kW/RT ➢ 200RT (average, mainly air cooling) ➢ Operation: 10hrs/day, 300days/yr **Energy saving by conversion to high efficient chiller:** 20%	- **Sales volume:** 26,000units sold/yr (Actual base) - **Penetration rate of VRV:** # of package ACs (VRV)/total # of package AC sold = 20% in 2016 => expanding to 50% in 2025 (Conversion ratio by incentive to VRV: 15.0% (Average till 2025) (i.e. BAU of 20% is deducted) - **Energy consumption** ➢ Electric capacity (average) 12kW(12HP) ➢ Operation: 10hrs/day, 300days/yr - **Energy saving by conversion to package AC (VRV):** 25%	- **Penetration rate:** Heat reflective glass / total glass sold (= 5% in 2016 => expanding to 50% in 2025)(Conversion ratio to heat reflective glass 22.5%/yr (average till 2025, excluding BAU)/15.0%/yr(average till 2020, over incentive period)) - **Energy saving rate by conversion to heat reflective glass**: 20%*35W/m2/3.5 (AC COP) ➢ New construction for large building 20million m2 - Operation: 10hrs/day, 300days/yr
Government benefits	Electricity subsidy IDR 102/kWh (B-class average in 2013)	Electricity subsidy IDR 102/kWh	Electricity subsidy (B-class average) IDR 102/kWh
Private sector's benefits and costs	- **Benefits** ➢ Electricity tariff: IDR 1,333/kWh (B-class average in 2013) - **Costs** ➢ EE chiller's cost: IDR 1,000million (plus value added tax (hereinafter "VAT") ➢ Cost increase by conversion to EE products: IDR200million/unit (plus VAT) ➢ Interest: 12%	- **Benefits** ➢ Electricity tariff: IDR 1,333/kWh (B-class average in 2013) - **Costs** ➢ Investment cost: IDR 80million/unit (plus VAT) ➢ Cost increase by conversion to package AC (VRV): IDR 40million/unit (plus VAT) ➢ Interest: 12%	- **Benefits** ➢ Electricity tariff of building IDR1,333/kWh (B-class average) - **Costs** ➢ New construction cost for building: IDR10million/ m2 ➢ Cost increase by conversion to heat reflective glass 1% - Useful life of glass 40 yrs

Source: JICA Study Team

Table 4.1.2-2 Assumptions for Technologies/Measures in Commercial Sector (2)

	Introduction of Green buildings	**Introduction of LED**	**Building: Reconditioning and behavior change**
Energy saving potential	- **Penetration rate:** Green buildings/Total buildings built: =1% in 2016 expanding to 30% in 2025 (Green building increase by incentive: 14.5%/yr (average till 2025) (excluding BAU) /7.44 %(average till 2020, over incentive period) - **Energy saving:**50kWh/ m2 ➢ New construction for large building 20million m2 ➢ Operation: 10hrs/day, 300days/yr	**Energy saving by LED** Total electricity consumption in 2013 (167,486,000MWh) * Commercial facilities (9%) * Electricity used by lighting (20%) * LED penetration (5% as of 2016 → 33% in 2025) * Electricity saving (50%)	**Energy saving by reconditioning and behavior change** - Total electricity consumption in 2013 (167,486,000MWh) * % of buildings for reconditioning and behavior change (0% as of 2016 → 20% in 2025)* Electricity saving (25%)
Government benefits	Electricity subsidy IDR102/kWh (B2&B3 weighted average)	Electricity subsidy IDR102/kWh (B2&B3 weighted average)	Electricity subsidy IDR102/kWh (B2&B3 weighted average)
Private sector's benefits and costs	- **Benefits** ➢ Average electricity tariff: IDR1,333/kWh (B2&B3 weighted average) ➢ Electricity tariff*Energy saving potential*1.2 ("Cost saving by water saving" is taken into consideration by this 20%.) - **Costs** ➢ New construction cost for building: IDR10million/ m2 (plus VAT) ➢ Cost increase by conversion to green building: 3% ➢ Average useful life of green buildings: 20 yrs	- **Benefits** ➢ Average electricity tariff: IDR1,333/kWh (B2&B3 weighted average) ➢ Opportunity costs (in case of using the standard bulbs): 1/10 of LED price, change 4 times over 10 yrs - **Costs** ➢ Rating capacity in country: 924MW ➢ 40W * 2 bulbs: IDR13,303 ➢ Useful life: 20 yrs	- **Benefits** ➢ Average electricity tariff: IDR1,333/kWh (B2&B3 weighted average) - **Costs** ➢ Initial investment: 8,097,956,650IDR (Based on MEMR energy audits (20 cases)) ➢ Useful life: 10 yrs

Source: JICA Study Team

4.1.3 Residential/Commercial Sector Mixed

The assumptions for technologies/measures in residential/commercial sectors mixed are summarized in Table 4.1.3-1:

Table 4.1.3-1 Assumptions for Technologies/Measures in Residential/Commercial Sectors Mixed

	Split AC: Conversion to inverter type	Refrigerator: Conversion to high efficient refrigerator
Energy saving potential	- **Sales volume:** 2.5 million units sold/yr 50% for commercial sector, 50% for residential sector - **Penetration rate:** # of inverter ACs/total # of AC sold = 5% in 2016 => expanding to 30% in 2025 (Conversion ratio by incentive to inverter AC: average till 2025, 12.5% (excluding BAU), average till 2020 (over incentive period): 10.56%) - **Energy saving by conversion to AC with inverters:** 30% - **Energy consumption:** <u>For household portion</u>: ➢ Operating hours: 7 hrs/day, 365days/per yr ➢ Capacity: 0.7 kW <u>For commercial portion</u>: ➢ Operating hours: 7 hrs/day, 300days/per yr ➢ Capacity: 0.7 kW	- **Sales volume:** 4.5 million units/yr, 1/3 for commercial sector, 2/3 for residential sector - **Penetration rate:** # of refrigerators with 4 star level specification/total # of refrigerators sold = 40% in 2016 => expanding to 100% in 2025 (Conversion ratio to a refrigerator with high EE label by incentive: 30%/yr (average till 2025) (excluding BAU) /53.33%/yr(average till 2020, over incentive period)) - **Energy saving by conversion to a refrigerator** with high EE label: 23% - **Energy consumption:** ➢ Electric consumption (Average): 800kWh/unit/yr
Government benefits	- **For commercial portion:** Electricity subsidy: 171.72IDR/kWh (Weighted average of B-1 to B-3) - **For household portion:** Electricity subsidy: 659IDR/kWh (Weighted average of R-1 to R-3)	- **For commercial portion:** Electricity subsidy: 171.72IDR/kWh (Weighted average of B-1 to B-3) - **For household portion:** Electricity subsidy: 659IDR/kWh (Weighted average of R-1 to R-3)
Private sector's benefits and costs	- **Benefits: Electricity tariff** For commercial portion: 1,275.87IDR/kWh (Weighted average of B-1 to B-3) For household portion: 854IDR/kWh (Weighted average of R-1 to R-3) - **Costs** ➢ Price for AC with inverters: IDR3.5million (without VAT) ➢ Price difference between with/without inverters: IDR 1million/unit (plus VAT) ➢ Maintenance over 10 yrs: 15% of investment	- **Benefits** For commercial portion: 1,275.87IDR/kWh (Weighted average of B-1 to B-3) For household portion: 854IDR/kWh (Weighted average of R-1 to R-3) - **Costs** ➢ Price for high efficient refrigerator: IDR2million (without VAT) ➢ Price difference between standard and high efficient refrigerator: IDR 0.5million/unit (plus VAT) ➢ Maintenance cost over 10 yrs: 15% of investment cost ➢ Useful life: 10 yrs

Source: JICA Study Team

4.1.4 Other EE&C Technologies for Residential Sector

In residential sector, there are other energy consuming appliances, such as rice cooker, electric fan etc. In our MACC, the appliances with larger EE&C potential (split air conditioners and refrigerators) were sorted and the others with less potential and less energy consumption data were excluded from the calculation.

Table 4.1.4-1 shows the estimated overall energy consumption and EE&C potential in residential sector. ACs and Refrigerators have the largest EE&C potential, followed by lighting (LED) and TV.

Table 4.1.4-1 Estimated Overall Energy Consumption and EE&C Potential in Residential Sector

	Market Size (u/y)	Average Consumption (kWh/u/y)	(%) of Total Electricity *1 in Household	EE&C Potential
Refrigerator	4,500,000 *3 6,200,000 *2	800 *3 470 *2	19.5%	50%*3 16%*2
Air Conditioner	2,500,000 *3 1,400,000 *2	1,000 *3 1,400 *2	17.2%	30%*1,*2.*3
Lighting	-	-	16.1%	50% *3 (LED)
Ballast	To be replaced by LED			
TV	-	-	13.2%	
Rice Cooker	-	-	9.5%	5%*2
Iron	-	-	5.9%	-
Fan	500,000 *2	150 *2	3.9%	50%*2

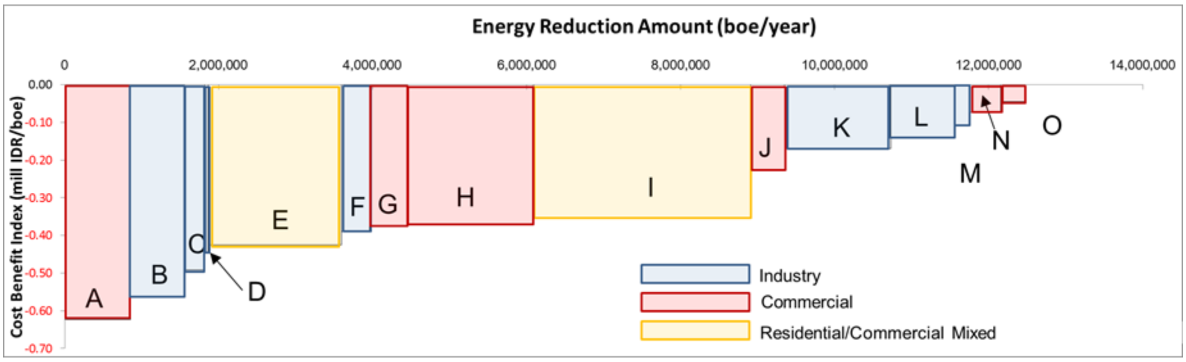
Source: *1 JICA, Study on Promoting Practical Demand Side Management in Indonesia,2012
*2 UNDP, Study on cost-effective development and implementation of energy efficiency standards and labeling program in Indonesia, 2014
*3 JICA Study 2015

4.2 EE&C MACC for Indonesia

4.2.1 EE&C MACC

(1) Combined version of EE&C MACC (cross-sector, government and private sector combined)

The combined version of EE&C MACC is in Figure 4.2.1-1. To promote national EE&C effectively, all sectors --industries, commercial buildings and residence--should be attended in parallel. For economic performance per unit boe, reconditioning and behavior change in buildings appears to be most effective. The total economic benefits gained by changing refrigerators and split ACs to high efficient ones is the largest.



A	Commercial-Building: Reconditioning & behavior change*
B	Industry-High efficient boiler
C	Industry-Industrial chilling compressor unit
D	Industry-Iron and steel: Regenerative burner
E	Residential/Commercial mix-Split AC: Conversion to inverter type
F	Industry-Heat recovery in ceramic industry
G	Commercial-Introduction of LED
H	Commercial-Introduction of Green buildings
I	Residential/Commercial mix-Refrigerator
J	Commercial-Chiller: Conversion to high efficient chiller
K	Industry-Renewal of fertilizer facility (incl. material use reduction)
L	Industry-Heat recovery power generation in cement industry
M	Industry-Textile: high efficient weaving machine
N	Commercial-Package AC: Conversion to VRV
O	Commercial-Introduction of heat reflective glass

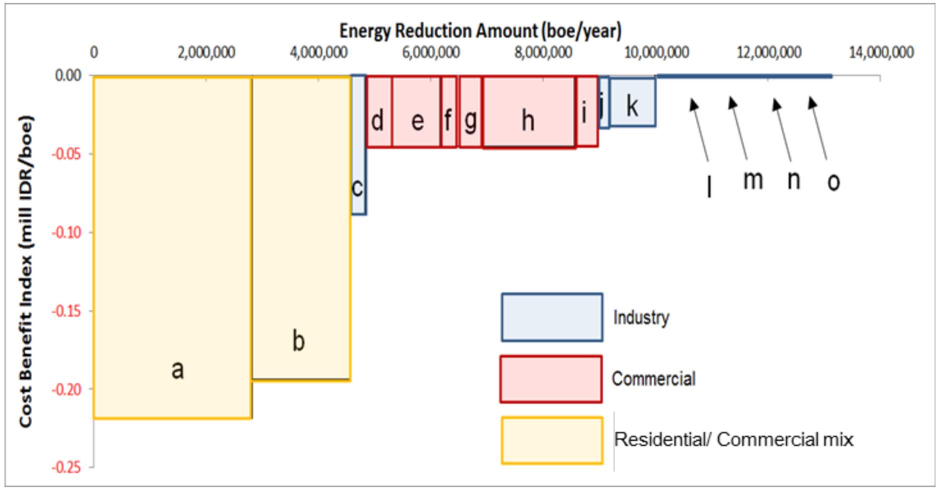
*The assumption is based on MEMR's energy audit reports (20 cases).
Source: JICA Study Team

Figure 4.2.1-1 EE&C MACC in Indonesia (Cross-sector, Government and Private Sector Combined)

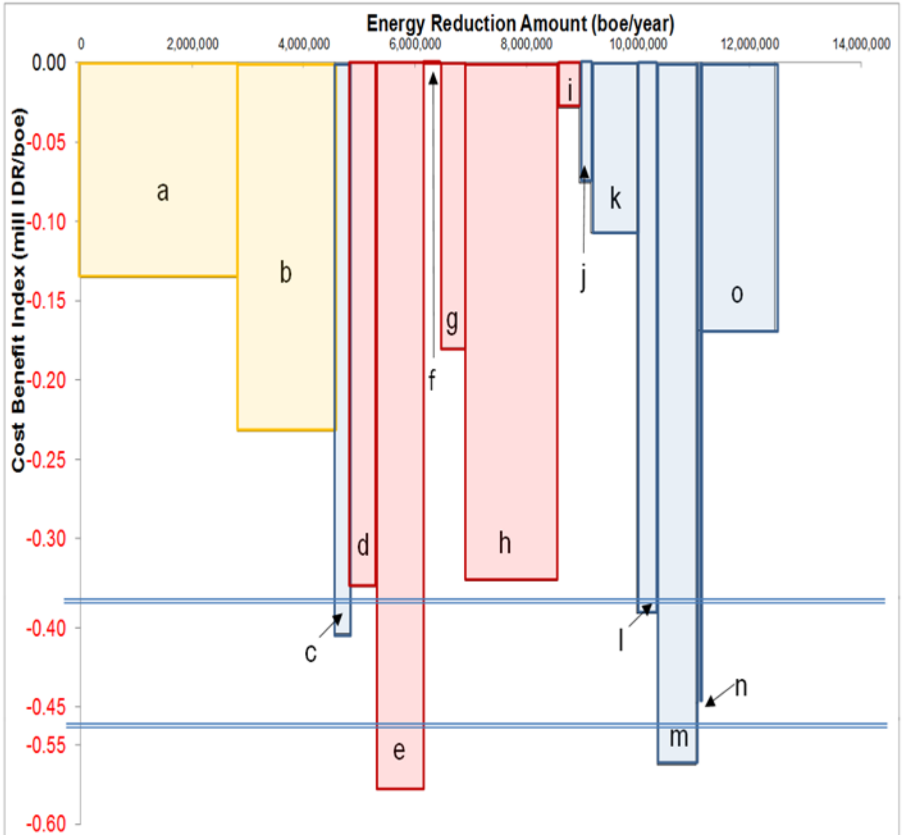
(2) Separate MACC (Government and Private Sector)

The assumptions are the same as the one used for MACC in 4.2.1 (1). Based on these assumptions, the separated MACC from Government and private sector is in Figure 4.2.1-2. It is suggested that the government benefit is the largest by changing refrigerators and split ACs into high efficient ones (electricity subsidy reduction). For all private sectors, the benefit gained by introducing suitable EE&C measures appears to be promising.

Government



Private Sector



a	Residential/Commercial mix-Refrigerator
b	Residential/Commercial mix-Split AC: Conversion to inverter type
c	Industry-Industrial chilling compressor unit
d	Commercial-Introduction of LED
e	Commercial-Building: Reconditioning & behavior change*
f	Commercial-Introduction of heat reflective glass
g	Commercial-Chiller: Conversion to high efficient chiller
h	Commercial-Introduction of Green buildings
i	Commercial-Package AC: Conversion to VRV
j	Industry-Textile: high efficient weaving machine
k	Industry-Heat recovery power generation in cement industry
l	Industry-Heat recovery in ceramic industry
m	Industry-High efficient boiler
n	Industry-Iron and steel: Regenerative burner
o	Industry-Renewal of fertilizer facility (incl. material use reduction)

*The assumption is based on MEMR's energy audit reports (20 cases).

Source: JICA Study Team

Figure 4.2.1-2 EE&C MACC Decomposed by Government and Private Sector

4.2.2 Priority Shown by MACC

The priority implied by MACC, based on the impacts estimated by [“Cost to benefit index” (vertical axis) multiplied by “energy reduction amount” (horizontal axis)], is listed in Table 4.2.2-1. The higher the ranking is, the larger the cost-benefit impact is. Especially, the impact by changing refrigerators and split ACs into high efficient ones, introduction of green buildings, reconditioning / behavior change for buildings and introduction of high efficient boilers are estimated to be significantly large.

Table 4.2.2-1 Impacts on the Society as a Whole

Ranking	In graph	EE technologies/programs	Energy reduction amount (boe/year) (A)	Cost to benefit index (IDR/boe) (B)	Impact -(A)*(B)
1	I	Residential/Commercial mix-Refrigerator	2,819,800	-0.35	998,191
2	E	Residential/Commercial mix-Split AC: Conversion to inverter type	1,733,907	-0.43	737,646
3	H	Commercial-Introduction of Green buildings	1,646,019	-0.37	611,471
4	A	Commercial-Building: Reconditioning & behavior change	855,574	-0.62	532,616
5	B	Industry-High efficient boiler	689,850	-0.56	387,837
6	K	Industry-Renewal of fertilizer facility (incl. material use reduction)	1,379,700	-0.17	233,333
7	G	Commercial-Introduction of LED	479,122	-0.38	179,833
8	F	Industry-Heat recovery in ceramic industry	365,500	-0.39	142,706
9	C	Industry-Industrial chilling compressor unit	273,466	-0.49	134,498
10	L	Industry-Heat recovery power generation in cement industry	828,354	-0.14	116,435
11	J	Commercial-Chiller: Conversion to high efficient chiller	441,360	-0.22	99,250
12	N	Commercial-Package AC: Conversion to VRV	398,450	-0.07	29,308
13	M	Industry-Textile: high efficient weaving machine	204,333	-0.11	22,170
14	D	Industry-Iron and steel: Regenerative burner	43,362	-0.45	19,397
15	O	Commercial-Introduction of heat reflective glass	306,500	-0.04	13,705

Source: JICA Study Team

Table 4.2.2-2 Impacts on the Government

Ranking	In graph	EE technologies/programs	Energy reduction amount (boe/year) (A)	Cost to benefit index (IDR/boe) (B)	Impact -(A)*(B)
1	a	Residential/Commercial mix-Refrigerator	2,819,800	-0.22	616,653
2	b	Residential/Commercial mix-Split AC: Conversion to inverter type	1,733,907	-0.19	335,356
3	h	Commercial-Introduction of Green buildings	1,646,019	-0.04	73,990
4	e	Commercial-Building: Reconditioning & behavior change	855,574	-0.04	38,459
5	k	Industry-Heat recovery power generation in cement industry	828,354	-0.03	27,420
6	c	Industry-Industrial chilling compressor unit	273,466	-0.09	24,090
7	d	Commercial-Introduction of LED	479,122	-0.04	21,537
8	g	Commercial-Chiller: Conversion to high efficient chiller	441,360	-0.04	19,840
9	i	Commercial-Package AC: Conversion to VRV	398,450	-0.04	17,911
10	f	Commercial-Introduction of heat reflective glass	306,500	-0.04	13,778
11	j	Industry-Textile: high efficient weaving machine	204,333	-0.03	6,764

Source: JICA Study Team

Table 4.2.2-3 Impacts on the Private Sector

Ranking	In graph	EE technologies/programs	Energy reduction amount (boe/year) (A)	Cost to benefit index (IDR/boe) (B)	Impact -(A)*(B)
1	h	Commercial-Introduction of Green buildings	1,646,019	-0.33	537,480
2	e	Commercial-Building: Reconditioning & behavior change	855,574	-0.58	494,157
3	b	Residential/Commercial mix-Split AC: Conversion to inverter type	1,733,907	-0.23	402,290
4	m	Industry-High efficient boiler	689,850	-0.56	387,837
5	a	Residential/Commercial mix-Refrigerator	2,819,800	-0.14	381,538
6	o	Industry-Renewal of fertilizer facility (incl. material use reduction)	1,379,700	-0.17	233,333
7	d	Commercial-Introduction of LED	479,122	-0.33	158,296
8	l	Industry-Heat recovery in ceramic industry	365,500	-0.39	142,706

9	c	Industry-Industrial chilling compressor unit	273,466	-0.40	110,408
10	k	Industry-Heat recovery power generation in cement industry	828,354	-0.11	89,015
11	g	Commercial-Chiller: Conversion to high efficient chiller	441,360	-0.18	79,410
12	n	Industry-Iron and steel: Regenerative burner	43,362	-0.45	19,397
13	j	Industry-Textile: high efficient weaving machine	204,333	-0.08	15,407
14	i	Commercial-Package AC: Conversion to VRV	398,450	-0.03	11,397
15	f	Commercial-Introduction of heat reflective glass	306,500	0.00	0

Source: JICA Study Team

In summary, the priorities shown by MACC are shown in Table 4.2.2-4. From the point of EE&C, subsidy reduction amount and overall economic benefit (covering both the government's and the private sector's), the net benefit gained by changing refrigerators and split ACs into high efficient ones stands first among the recommend EE&C measures. From the point of increasing the private sector's economic benefit, reconditioning and behavior change for buildings stand first.

Table 4.2.2-4 Summary of Priority Shown by MACC

<table>
<tr><th rowspan="2">Ranking</th><th colspan="4">Ranking by different conditions</th></tr>
<tr><th>(1) By the amount of EE&C</th><th>(2) By the Gov't Benefits (electricity subsidy reduction)</th><th>(3) By the Private Sector's net benefits</th><th>(4) By the overall net benefits</th></tr>
<tr><td>1</td><td colspan="2">Residential/commercial mix-Refrigerator</td><td>Introduction of Green buildings</td><td>Residential/commercial mix-Refrigerator</td></tr>
<tr><td>2</td><td colspan="2">Residential/commercial mix-Split AC: Conversion to invertor type</td><td>Building: Reconditioning & behavior change</td><td>Residential/commercial mix-Split AC: Conversion to invertor type</td></tr>
<tr><td>3</td><td colspan="2">Introduction of Green buildings</td><td>Residential/commercial mix-Split AC: Conversion to invertor type</td><td>Introduction of Green buildings</td></tr>
<tr><td>4</td><td>Renewal of fertilizer facility</td><td>Building: Reconditioning & behavior change</td><td>High efficient boiler</td><td>Building: Reconditioning & behavior change</td></tr>
<tr><td>5</td><td>Building: Reconditioning & behavior change</td><td>Heat recovery power generation in cement industry</td><td>Residential/commercial mix-Refrigerator</td><td>High efficient boiler</td></tr>
<tr><td>6</td><td>Industry-Heat recovery power generation in cement industry</td><td>Industrial chilling compressor unit</td><td>Renewal of fertilizer facility (incl. material use reduction)</td><td>Renewal of fertilizer facility (incl. material use reduction)</td></tr>
</table>

Source: JICA Study Team

4.2.3 Concept of Negawatt

Indonesian government and PLN set a target to secure 35GW power by 2019. However, it is a significant challenge to have all 35 GW power plants under operation within a given time frame. On the other hand, 10GW of electricity may be saved in 2025 by implementing above mentioned EE&C measures. Compared with the construction of new thermal power plants, EE&C solution is faster, cheaper and CO2-free[5]. A theoretical unit of electricity saved by EE&C measures (in wattage) is considered as a substitute of 1 wattage of a power plant to be constructed, and this amount of energy is referred to as "Negawatt" power.

Table 4.2.3-1 Electricity Reduction Effect by Introducing the Proposed EE&C Measures at 2025

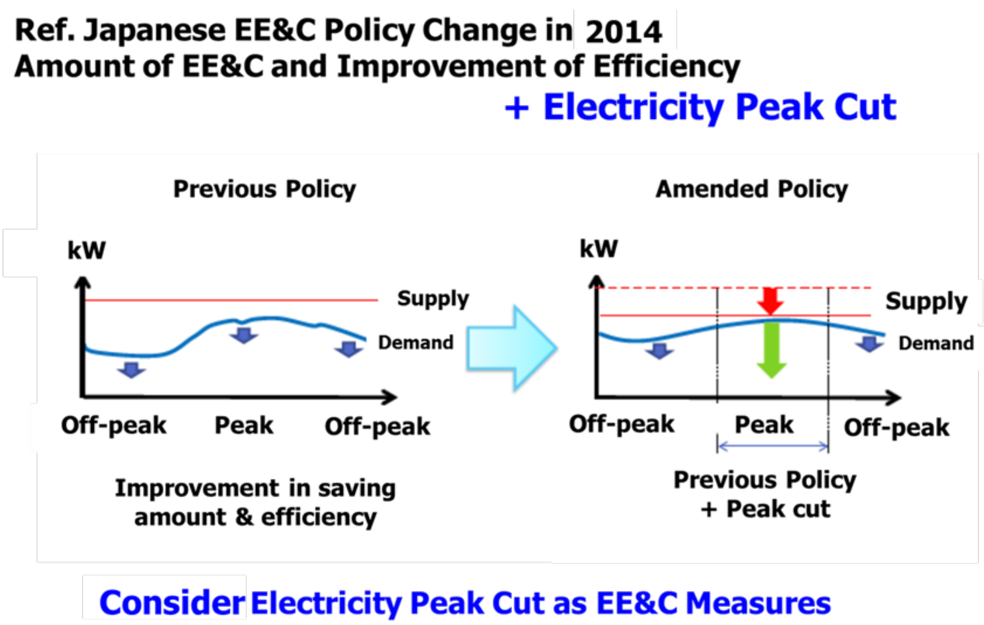
	EE projects	Annual energy reduction amount	(Unit)	Average MW added/ year	MW saved in 2025
Residential/ Commercial mix	Residential/ Commercial mix-Split AC: Conversion to inverter type	764	GWh	192	1,918
	Residential/ Commercial mix-Refrigerator	1,242	GWh	312	3,119
Commercial	Commercial-Package AC: Conversion to VRV	176	GWh	44	441
	Commercial-Chiller: Conversion to high efficient chiller	194	GWh	49	488
	Commercial-Introduction of solar insulated glass	135	GWh	34	339
	Commercial-Introduction of Green buildings	725	GWh	182	1,821
	Commercial-Introduction of LED	211	GWh	53	530
	Commercial-Building: Reconditioning & behavior change	377	GWh	95	946
Industry	Industry-Heat recovery power generation in cement industry	365	GWh	92	916
	Industry-Industrial chilling compressor unit	120	GWh	30	303
	Industry-Textile: high efficient weaving machine	90	GWh	23	226
	Industry-Heat recovery in ceramic industry	Heat only		0	0
	Industry-High efficient boiler	Gas only		0	0
	Industry-Renewal of fertilizer facility (incl. material use reduction)	Gas/Coal only		0	0
	Industry-Iron and steel: Regenerative burner	Gas and oil only		0	0
Total		4,399	GWh		11,047

Note: Conditions of calculation: MW reduction at 2025=Annual average electricity saving amount/8,760h/y/0.5 (Average/Peak factor)*1.1 (transmission and distribution loss)*10 years (cumulative)

Source: JICA Study Team

In this context, Figure 4 shows the major point of the amendment in Japanese Energy Conservation (hereinafter "EC") Law in 2014. Not only the improvement of saving amount and efficiency but also electricity peak cut effect was included in the amended EC Law.

[5] Through MACC, it is suggested that the economic benefit gained from introducing suitable EE&C measures is large. On the other hand, construction of power plants needs a significant investment. By introducing EE&C measures, CO2 emission can be reduced compared to the conventional measures. In addition, CO2 will be further emitted throughout the life time of newly constructed power plants.



Source: METI HP, Japan

Figure 4.2.3-1 Amendment of Japanese EC Law in 2014 (Considering the Effect of Electricity Peak Cut)

4.3 Suggested Incentives for Priority Projects and Programs

4.3.1 Incentive Options

As the incentive options, there are various options and each option has pros and cons. Table 4.3.1-1 summarizes these characteristics.

Table 4.3.1-1 General Characteristics of Incentives to Promote EE&C

Incentives	Pros	Cons
Direct subsidies	Strong attractiveness to all users	- High fiscal burden - High administration costs to avoid misuse
Import Duty Exemption Reduction	Relatively easy to implement, compared with direct subsidy.	These tax for some products (e.g. AC) are already exempted.
VAT Exemption/Reduction	Relatively easy to implement, compared with direct subsidy.	Max. incentive is the level of VAT.
Low Interest Loan Guarantee	- Limited fiscal burden (only part of interests) - Possible to use bank's (guarantee institution's) appraisal skills to avoid misuse	- Benefits are limited to investments which requires bank loans. - Mechanism for bankers/guarantee institutions to distinguish EE&C is necessary.
Promotion of Lease	No fiscal burden, but high attractiveness for users (tax incentive for lease is already in place.)	Environment to promote lease needs to be in place.

Source: JICA Study Team

4.3.2 Recommended Incentives

(1) Recommended Incentives by Technologies/Programs

1) Industry Sector

MACC results reveal that benefits for the government from promoting EE&C in the industry sector is small in terms of energy subsidy reduction compared to residential and commercial sectors. However, acceleration of EE&C may have a substantial positive impact to the Indonesian economy, as improvement in energy efficiency will contribute to boost in productivity, which will lead to increase in GDP and tax revenue, and possibly generates employment needs.

Comments received from the industrial associations at the first FGD as well as separate interviews with the private sector show that the industry sector is summarized in Table 4.3.2-1.

Table 4.3.2-1 Summary of the Comments Collected from the Industry Sector

Industries	Comments
1) Interest in EE&C measures and current situation of the sector	
Export-oriented sub-sectors or sub-sectors with significant share in export	・ Some are keen in replacing their old (second-hand) equipment with a ‘new’ and ‘high-efficient’ equipment to increase productivity and meet customers’ increasing demands in the level of product quality. ・ Large companies in some sub-sectors may be able to invest in the high-efficient equipment, provided that the payback period is short. ・ However, for some sub-sectors, the cost of high-efficient new equipment is nearly double of the cost of the low-efficient one, and without substantial incentives from the government, it is difficult to upgrade their equipment with the high-efficient ones. ・ Regardless, SMEs need special support from the government.
Domestic demand-oriented sub-sectors	・ Some are interested in reducing costs by introducing EE&C measures. ・ However, they are challenged by the imported products, and their prime interest is to safeguard their market (hence, difficult to make any additional investment at this moment). ・ Some are dominated by state-owned companies and have a strategic plan to retrofit existing plants to increase the productivity while reducing the energy consumption. ・ Some sub-sectors have a wide variety of company size and industrial types that it is a herculean task to have a consensus as a sub-sector in terms of EE&C strategies and incentives required to achieve the targets. ・ For large investment like introduction of waste heat recovery system, the industries need low interest loan at the rate of 0% to 3%, with government guarantee, and tax incentives as a package. ・ SMEs need all types of governmental assistance.

Source: Compiled by JICA Study Team, based on the Interviews with various industrial associations and companies (April - May 2015)

Industries’ common consensus is that they will positively consider switching to EE&C equipment, if (i) it does not hamper the current production level or take longer time than originally scheduled equipment replacement period, (ii) sufficient government incentives are given, and iii) easy to apply for the government incentives. Table 4.3.2-2 shows JICA Study Team’s initial response.

Table 4.3.2-2 Initial Responses to Industries' Requests

	Issues	JICA Study Team's Initial Response
(i)	Not to affect the current production or take longer installation time than scheduled	This could be a challenge, because it may increase the construction costs to keep the effect at minimum. The higher the costs for installation, the more reluctant industries become to install effective EE&C equipment even at the time of scheduled replacement.
(ii)	Sufficient government incentives are given	This could be a challenge, due to the following reasons: - Regardless the company's size, all industries are currently facing severe competition in both domestic (against imported goods) and foreign (against cheaper commodities than what Indonesian industries can offer) markets and difficult to make any investment if it does not give a short-term result. - Potentials for EE&C are different among the sub-sectors; some sub-sectors have already done many improvement with one or two year payback period and the remaining potential requires a long-term investment (e.g. the case of Cement Sector); some sub-sectors have not yet started in introducing EE&C equipment and still have a wide range of options with short-payback period. - Credit rating and the level of investment required for installing EE&C are different (e.g. difficult to compare a loan scheme for a cement factory introducing a waste heat recovery system with a food factory introducing a EE&C boiler). If a flat rate of loan interest rates reduction (e.g. minus 2%) are introduced, reaction from industries may differ. - Some medium-size industries and SMEs need additional guarantee from the government to pass the bank's evaluation for loan application.
(iii)	Easy to apply for the government incentives	This could be solved by introducing following schemes: - A soft loan provided through commercial banks, which will submit all the documentations required for obtaining the governmental assistance (banks will be the intermediary to facilitate industries to opt for more EE&C equipment - A leasing promotion

Other countries in Asia have already introduced low interest loans and import tax exemptions. Table 4.3.2-3 summarizes the incentive schemes provided in other countries in Asia.

Table 4.3.2-3 Incentive Schemes for EE&C in Other Countries in Asia

Country	Soft loan (with/without guarantee)	Guarantee	Tax exemptions	Others
Japan	- Interest subsidies to loans for capital investment provided by both central and provincial governments -(Provincial scheme: Interest subsidies to provide a loan at the rate of 1.2% with 10 years of tenure (Max 70 million JPY)		--	- 3-5% lease fee subsidy for low-carbon equipment
Malaysia	- 2% interest subsidy with 60% government guarantee with 10 years max. repayment		- Import duty and sales tax exemption for equipment	--

Country	Soft loan (with/without guarantee)	Guarantee	Tax exemptions	Others
			manufacturers - Investment tax allowance, import & export tax exemptions	
Thailand	- 10- 50% of total equity covered up to THB 50 million for 5-7 years (for venture capital, the rate is 10-30%) - (Revolving Fund) Low interest loans from commercial banks (capped at 4%) to EE&C projects at a maximum of THB 50 million with the investment term of 7 years loan period.	- THB 10 million with a charge of 1.75% per annum of the guarantee amount; guarantee term no more than 5 years. -Grants for SMEs: 20% of the costs for EE products	- Exemption from import duty for machinery regardless of zone and 3 year corporate income tax exemption on the revenue of existing project accounting for 50% of investment, excluding land cost and working capital.	- [Already ended in December 2012] 25% of Corporate income tax (hereinafter “CIT”) rate deduction
Vietnam	-30% of investment to the maximum of VND 70 million - Subsidy up to 30% or VND 5 billion per project		- Preferential rate between 0%-150% of the cost, insurance and freight price of the imported goods - Exemption and reduction for domestically unavailable EE&C and Renewable energy devices and equipment and parts - Exemption and reduction for parts and components for the manufacture of energy-efficient lighting devices and equipment; devices and equipment using solar and wind power.	- Preferential rate for CIT at 17% or 20% for 10 years - CIT exemption for 2 years - CIT at 2% if located in industrial park until 4th years

Source: JICA Study Team

Looking at the order of initial investment costs of each recommended equipment, as well as the feedback received during the Study and other countries’ examples, JICA Study Team concludes that it is more appropriate to have a different menu of the incentive schemes, than providing just one single menu of the incentive scheme. For instance, following combinations may be considered as part of the menu:

a) Soft loan + guarantee package
b) Soft loan + guarantee + import tax reduction package
c) Leasing promotion
d) Leasing promotion + guarantee

Guarantee scheme may be provided from the public facilities, while tax reduction (especially for the import tax) for EE&C equipment may be added to the existing list of preferential tax rate. However, the case of soft loan and leasing promotion require extensive cooperation from commercial banks and leasing companies. From the experiences in other countries, this would require a substantial capacity building activities, particularly with the leasing scheme, as leasing EE&C equipment has not yet been a widely-spread practice in Indonesia[6]. The benefit of using leasing scheme is that the lease fee is treated as a deductible expense in the Indonesian taxation system when calculating the corporate tax (25%). The merit of using leasing companies for the promotion of EE&C is promising. For instance, in Japan, engineering companies incapable of assuming any credit risks of their clients, tag with leasing companies to provide Energy Service Company (hereinafter “ESCO”) services. However, interviews with leasing companies in other study[7] indicate that leasing companies are hesitant to take risks involved with leasing EE&C equipment. Thus, prior to the introduction of any incentive scheme with leasing, it is prerequisite to have solutions for issues hindering the local leasing companies to move into EE&C equipment leasing and have them well prepared to be part of the scheme. As the local leasing market is still premature to handle EE&C equipment, this Study focuses on soft loan incentives and their different combinations of the incentive package.

Incentive menu may be useful; however, it requires an extensive trial calculation and comparison. Examples of the menu and some sample calculations as well as their energy saving impact from the government support will be summarized in the final report, after further consultation with the stakeholders at the JICA Study Team’s third visit to Indonesia.

2) Commercial Sector

The recommended incentives for commercial sector are summarized in the following table.

[6] In the past, there were some heavy equipment leasing in the country; however, leasing companies shifted to consumers' market after the Asian Financial Crisis in 1997. The heavy equipment leasing is gradually coming back to the Indonesia market, including the power generation equipment. However, its application is still limited.

[7] Mitsubishi Research Institute, et al. (March 2015). “Financial Scheme Development Project for Promoting Energy Saving in Jakarta, Indonesia.”

Table 4.3.2-4 Recommended Incentives for Commercial Sector

	AC (split)	**Packaged AC (VRV, high efficient chiller)**	**Heat reflective glass (Solar insulation)**	**Green building**
Recom-mended incentives	VAT exemption/ reduction	Low interest loan and credit guarantee	VAT exemption/ reduction	Land/ building tax reduction/exemption
Reason	Relatively easy to implement and high impact on consumer's purchasing behavior.	- LIL: Attractive for companies, despite limited gov't fiscal burden. - Guarantee: Attractive for companies, if it could work as a substitute of collateral.	Relatively easy to implement and high impact on consumer's purchasing behavior.	The simplest and most effective way to reinforce the Green Building Regulation, once introduced.
Other country's experience	Malaysia: Sales tax exempted for EE electrical appliance such as AC certified by Energy Commission.	- Malaysia: Green Technology Financing Scheme 2% of interest subsidy and 60% gov't guarantee, up to RM 500 million, maximum 15 year repayment period - Thailand: Revolving Fund: low interest loans up to 50 million THB with tenure up to 7 years. ESCO Fund: loan guarantee up to 10 million THB+1.75%/yr charge for max. 5 years	Malaysia: Sales tax exempted for EE electrical appliance including insulation material, certified by Energy Commission. Vietnam: Tax exemption for domestically unavailable EE devices and equipment products not produced in the country.	Malaysia: Corporate tax reduction to companies with green building certificates
Issue to consider	The mechanism to avoid misuse is essential.	If implemented, eligible equipment needs to be clearly specified. (e.g. through eligible equipment list)	VAT needs to be exempted at the stage where a glass is sold to companies to frame a glass, in order to strictly ensure the quality.	- Like the case of Malaysia, need some evidence such as certificates to receive the incentive. - Need an extensive capacity building for local governments to be involved.

Source: JICA Study Team

3) Residential/Commercial Sector

The recommended incentives for residential/commercial sector are summarized in the following table.

Table 4.3.2-5 Recommended Incentives for Residential/Commercial Sector

	AC (split)	Refrigerator
Recommended incentives	VAT exemption/reduction	VAT exemption/reduction
Reason	Relatively easy to implement and high impact on consumer's purchasing behavior.	Relatively easy to implement and high impact on consumer's purchasing behavior.
Other country's experience	Malaysia: Sales tax exempted for EE electrical appliance such as AC certified by Energy Commission.	Malaysia: Sales tax exempted for EE electrical appliance such as refrigerator certified by Energy Commission
Issue to consider	The mechanism to avoid misuse is essential.	The mechanism to avoid misuse is essential.

Source: JICA Study Team

(2) Summary of Incentive Options by Technologies

The incentive options are compared by technologies in Table 4.3.2-6 and Table 4.3.2-7. In those tables, the most and second recommended incentive are marked as ★ and ○ respectively, while strongly not to recommended is marked as Δ. For small and widely-spread appliances, VAT and/or another tax reduction/exemption are to be recommended. For large equipment/projects, law interest loan, government guarantee mechanism and/or import tax reduction/exemption are to be recommended.

Table 4.3.2-6 Comparison of Incentive Options by Technologies: Residential and Commercial Sectors

In MACC	Technologies	Direct Subsidy (rebate)	Import Duty Ex/Re*	VAT/Other tax Ex/Re*	Low Interest Loan	Guarantee	Lease
a	Commercial/Residential mix-Split AC: Conversion to invertor type	Δ/O	--/--	★/★	Δ/--	Δ/--	O/--
		Commercial: Difficult to attract SMEs without subsidies and loans + guarantee, while VAT exemption/reduction may be good enough to attract big companies					
		Residential: VAT(VAT reduction is easier to handle administratively than rebate) (possibly, give rebate only to 450 VA/900VA contractors) ; loan and guarantee are out of scope					
b	Commercial/Residential mix-Refrigerator	Δ/O	--	★/★	Δ/--	Δ/--	O/--
		Commercial: Difficult to attract SMEs without subsidies and loans + guarantee, while VAT exemption/reduction may be good enough to attract big companies					
		Residential: Recommend to VAT reduction (VAT reduction is easier to handle administratively than rebate) (possibly, give rebate only to 450 VA/900VA contractors)					
E	Chiller: Conversion to high efficient chiller	Δ	★	★	★	O	O
I	Package AC: Conversion to VRV	Package of 3 incentives are highly recommended (tax incentive alone may not instigate the commercial owners); not to recommend subsidies (too heavy fiscal burden)					
H	Introduction of solar insulated glass	Δ	X	★	Δ	Δ	x
		Not to recommend the reduction in import duty (too difficult to check the quality at custom); not to recommend loan or guarantee for glasses (too small for loan)					
g	Introduction of Green buildings	Δ	Depending on items	★	O	O	Δ
		Land/Building tax reduction/exemption + allowing extra floor permits are recommended; not to recommend subsidies (too heavy fiscal burden)					

*Ex/Re: Exemption or Reduction

Legend: ★=first recommendation; O = second recommendation or together with other incentives; Δ = not highly recommended.

Source: JICA Study Team

Table 4.3.2-7 Comparison of Incentive Options by Technologies: Industrial Sector

<table>
<tr><th>In MACC</th><th>Technologies</th><th>Direct Subsidy (rebate)</th><th>Import Duty Ex/Re*</th><th>VAT/Other tax Ex/Re*</th><th>Low Interest Loan</th><th>Guarantee</th><th>Lease</th></tr>
<tr><td>c</td><td>Cross-Sectoral: Industrial chilling compressor unit</td><td>Δ</td><td>★</td><td>O</td><td>★</td><td>★</td><td>Δ/x</td></tr>
<tr><td>m</td><td>Cross-Sectoral: High efficient boiler</td><td colspan="6" rowspan="6">- Highly recommended to provide low interest loan and guarantee scheme as a package for the expensive equipment (e.g. heat recovery system).
- Recommended to introduce import duty exemption/reduction to highly efficient equipment (as in the case of other Southeast Asian countries), if the EE&C equipment is not manufactured in Indonesia.
- Although leasing a potentially effective scheme due to the Indonesian accounting system which allows leasing fees as deductible expenses, it is still premature for the local leasing market to assume risks related to industrial equipment leasing; hence not recommended for now.
- Not to recommended introducing the direct subsidy scheme as it will be a heavy fiscal burden</td></tr>
<tr><td>k</td><td>Cement: Heat recovery power generation</td></tr>
<tr><td>j</td><td>Textile: high efficient weaving machine</td></tr>
<tr><td>l</td><td>Ceramics: Heat recovery</td></tr>
<tr><td>o</td><td>Fertilizer: Renewal of fertilizer facility (incl. material use reduction)</td></tr>
<tr><td>n</td><td>Iron and steel: Regenerative burner</td></tr>
</table>

*Ex/Re: Exemption or Reduction

Legend: ★=first recommendation; O = second recommendation or together with other incentives; Δ = not highly recommended;
x = not recommended; -- = not applicable or incentives already given

Source: JICA Study Team

(3) MACC after incentive implementation

When the incentive programs are implemented, the form of MACC will be changed. MACC with the incentive was drawn based on the following assumptions for each technology:

Table 4.3.2-8 Proposed Incentives and Assumptions for MACC

Legend in MACC in Figure 4.3.2-1	Technologies	Proposed incentive programs & Assumptions
B'/ C'/ D'/ F'/ K'/ L'/ M'	Industry- - High efficient boiler - Industrial chilling compressor unit - Iron and steel: Regenerative burner - Heat recovery in ceramic industry - Renewal of fertilizer facility (incl. material use reduction) - Heat recovery power generation in cement industry - Textile: high efficient weaving machine	Low interest loan - 5 years repayment - 2% interest subsidy - 5-year annual principal equal repayment - Incentive provision to the new loans over 5 years
E'	Residential/Commercial mix-Split AC: Conversion to inverter type	VAT reduction (10%) Incentive program over 5 years

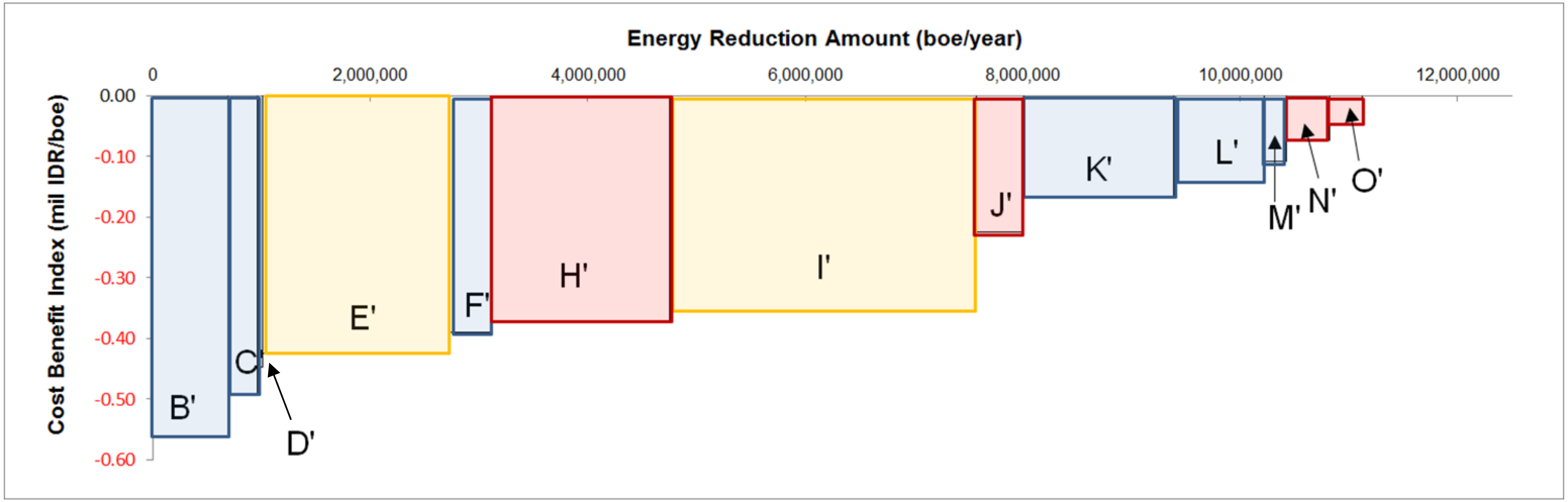
Legend in MACC in Figure 4.3.2-1	Technologies	Proposed incentive programs & Assumptions
I'	Residential/Commercial mix-Refrigerator	VAT reduction (10%) Incentive program over 5 years
J'	Commercial-Chiller: Conversion to high efficient chiller	Low interest loan - 3 years repayment - 2% interest subsidy - 3-year annual principal equal repayment - Incentive provision to the new loans over 3 years
O'	Commercial-Introduction of heat reflective glass	VAT reduction (9%) Incentive program over 5 years
H'	Commercial-Introduction of Green buildings	Land & building tax reduction (0.16% reduction over 3 years) Land sales price: IDR 20 million/m2 (Bank Indonesia, Commercial property survey) Incentive program over 5 years
N'	Commercial-Package AC: Conversion to VRV	Low interest loan - 3 years repayment - 2% interest subsidy - 3-year annual principal equal repayment - Incentive provision to the new loans over 3 years

Source: JICA Study Team

Through Figure 4.3.2-1 and4.3.2-3, following points are observed:

1) The combined net benefits of the government and the private sector are almost the same between with and without the incentive cases. This is due to the fact that the government's net benefits can be used to finance the incentives for the private sector.

2) Even in the case of implementing a suitable incentive program for the private sector, the government can still enjoy some economic benefits by promoting EE&C measures. MACC can indicate the threshold amount of subsidy to avoid net loss.



B'	Industry-High efficient boiler
C'	Industry-Industrial chilling compressor unit
D'	Industry-Iron and steel: Regenerative burner
E'	Residential/Commercial mix-Split AC: Conversion to inverter type
F'	Industry-Heat recovery in ceramic industry
H'	Commercial-Introduction of Green buildings
I'	Residential/Commercial mix-Refrigerator
J'	Commercial-Chiller: Conversion to high efficient chiller
K'	Industry-Renewal of fertilizer facility (incl. material use reduction)
L'	Industry-Heat recovery power generation in cement industry
M'	Industry-Textile: high efficient weaving machine
N'	Commercial-Package AC: Conversion to VRV
O'	Commercial-Introduction of heat reflective glass

The data label above corresponds to the data label for technologies/programs without incentives in Figure 4.2.1-1. The ones with apostrophe (‘) signifies that the technologies/programs are with incentives.

“Building: reconditioning and behavior change” (A) and “LED” (G) are excluded from MACC above, since they are not included in the proposed incentive programs.

Source: JICA Study Team

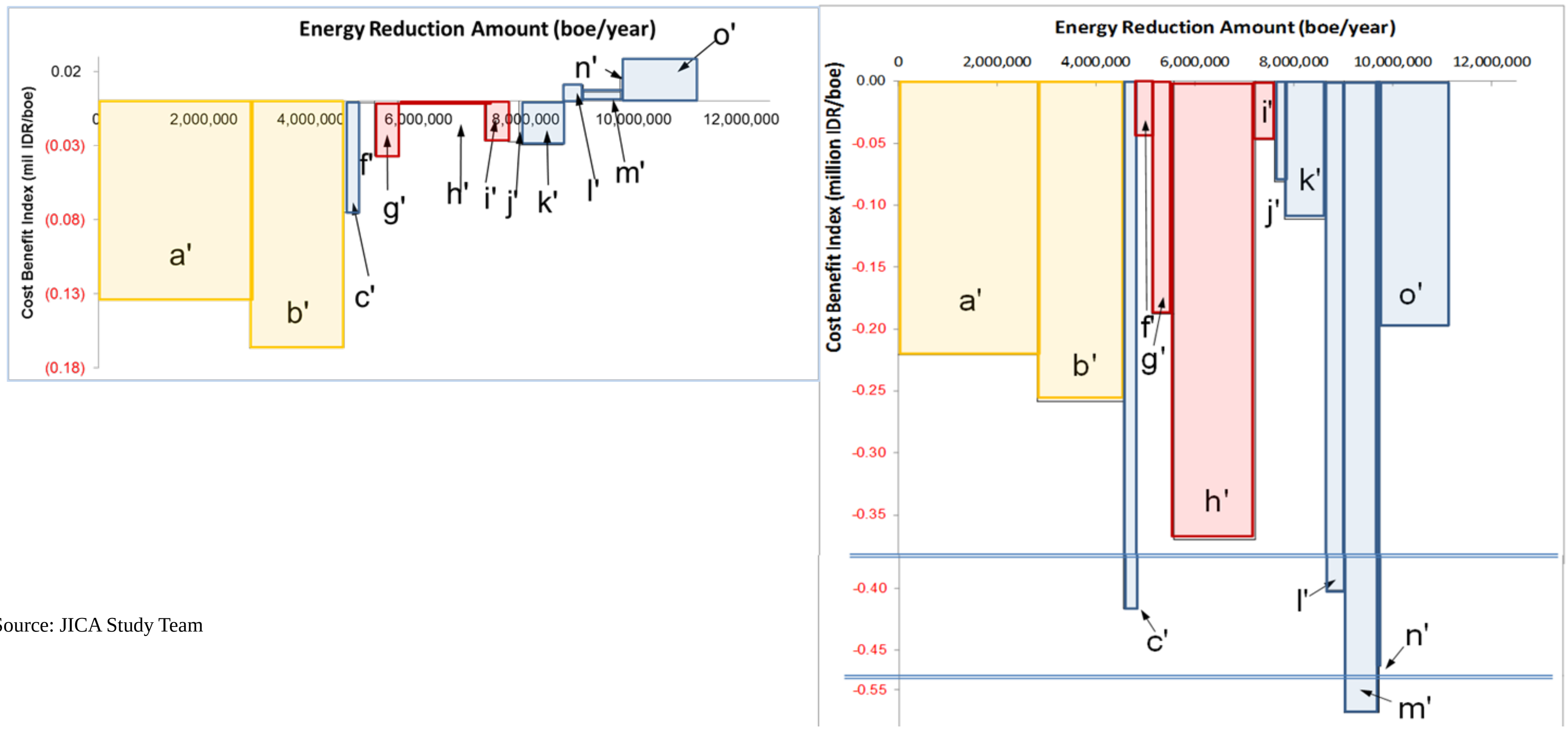
Figure 4.3.2-1 EE&C MACC in Indonesia (with Incentive)
(Cross-sector, Government and Private Sector Combined)

The form of the total MACC (government and private sector combined) above will not be changed from the one without incentives, unless the transaction costs are required for the implementation of the incentive programs. Such transaction costs are not assumed in MACC in this study. By implementing incentive program, the incentive portion of the benefits will be transferred from the government cost to the private sector's benefit. As a result, the forms of MACC decomposed into the government and private sector will be changed by incentive program implementation.

Data label in MACC in Figure 4.3.2-2 and 4.3.2-3	**Technologies**
a'	Residential/Commercial mix-Refrigerator
b'	Residential/Commercial mix-Split AC: Conversion to inverter type
c'	Industry-Industrial chilling compressor unit
f'	Commercial-Introduction of heat reflective glass
g'	Commercial-Chiller: Conversion to high efficient chiller
h'	Commercial-Introduction of Green buildings
i'	Commercial-Package AC: Conversion to VRV
j'	Industry-Textile: high efficient weaving machine
k'	Industry-Heat recovery power generation in cement industry
l'	Industry-Heat recovery in ceramic industry
m'	Industry-High efficient boiler
n'	Industry-Iron and steel: Regenerative burner
o'	Industry-Renewal of fertilizer facility (incl. material use reduction)

The legend above without ‘corresponds to the legend in MACC without incentive.
“EE&C building including reconditioning and behavior change” and “LED” are excluded from MACC above, since they are not included in proposed incentive programs.

Government | **Private Sector**

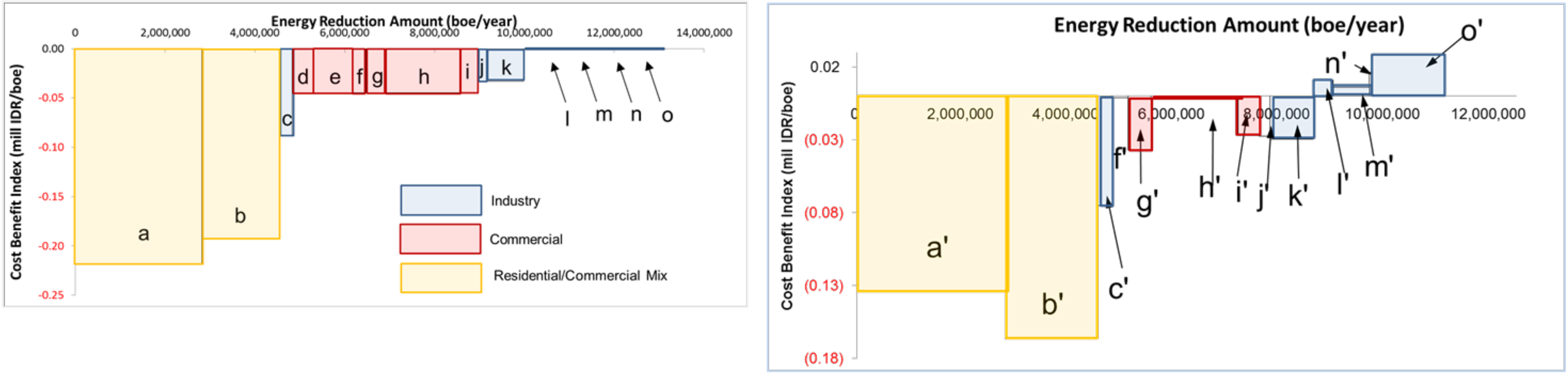


Source: JICA Study Team

Figure 4.3.2-2 EE&C MACC with Incentive Program, Decomposed by Government and Private Sector

The reduced portion in the government MACC is transferred to private sector in order to promote each technology/program.

Without Incentive Program **With Incentive Program**



"Building: reconditioning and behavior change" (e) and "LED" (d) are excluded from MACC above, since they are not included in proposed incentive programs.
The data label above corresponds to the data label for technologies/programs without incentives in Figure 4.2.1-2. The ones with apostrophe (') signifies that the technologies/programs are with incentives.

Source: JICA Study Team

Figure 4.3.2-3 Comparison of MACC for Government with/without Incentive Program

(4) Comparison of Different Scenarios

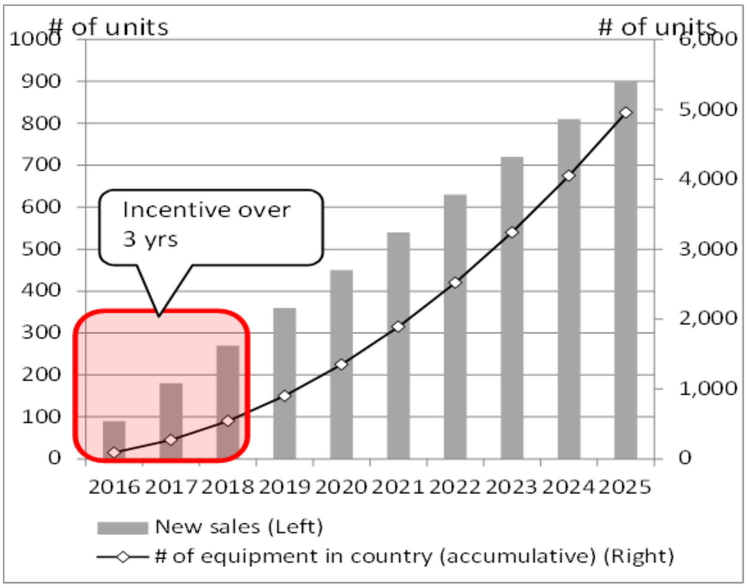
1) Comparison of Incentive Scheme

The quantitative comparison of incentive schemes (low interest loan with 2%/4% interest subsidy vs subsidy) was conducted by taking high efficient chiller and high efficient boiler as examples.

a) High Efficient Chiller

<Assumption>

- Low interest loan (2% or 4% interest subsidy) (same as the assumption used for MACC) vs Subsidy (20% of capital cost) (consumer behavior is assumed to be same for both incentives)
- Three incentive schemes are assumed to be provided over 3 years (same as the assumption used for MACC)
- Same energy saving potential/year assumed for three incentive schemes: 451,990 boe/year (same as the assumption used for MACC)
- New sales in each year (same as the assumption for MACC): the number of high efficient chillers/total number of chillers sold in 2016 is assumed to be 5% and will be increased to 50% in 2025. Total sales is assumed as 1800 units/year.

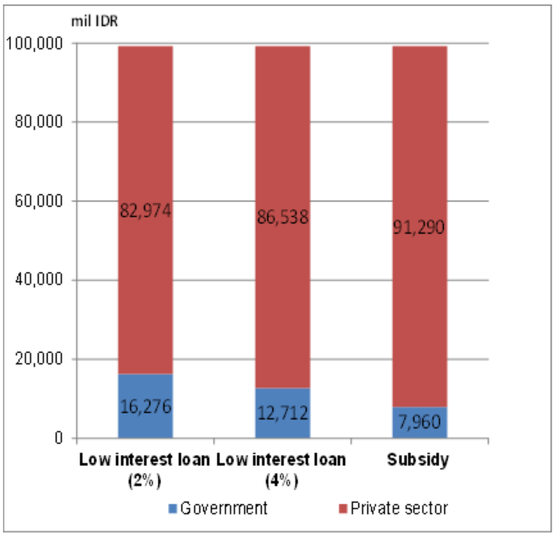


Source: JICA Study Team

Figure 4.3.2-4 Assumption of New Sales in Each Year and Incentive Target

<The results>

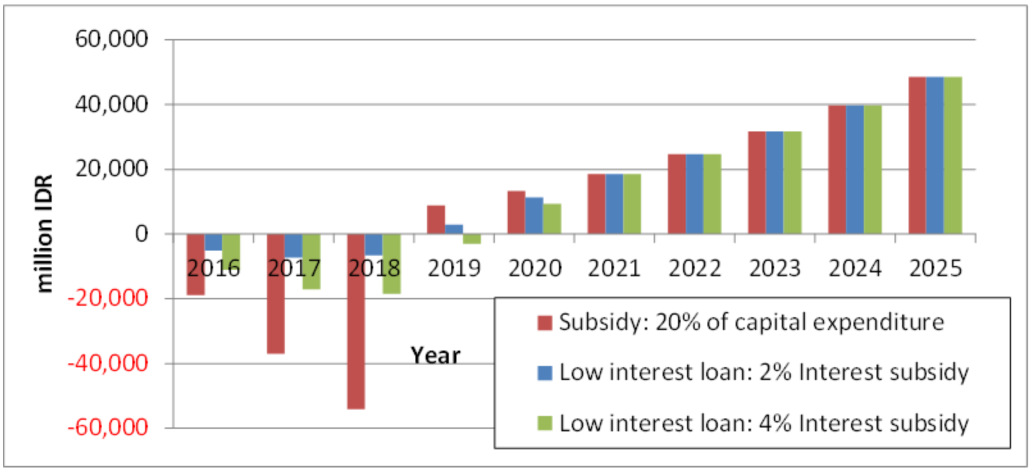
The 10 year average of net benefit as the entire society is the same regardless of incentive schemes. However, the government’s net benefit is lower for “subsidy” than “low interest loan”, while the private sector’s net benefit is higher for “subsidy”. In terms of interest subsidy level, the government’s net benefit is lower for “interest subsidy (4%)” than “interest subsidy (2%)”, but the private sector’s net benefit is higher for “interest subsidy (4%)” than the one of 2%.



Source: JICA Study Team

Figure 4.3.2-5 Comparison of 10 Year Average Net Benefit

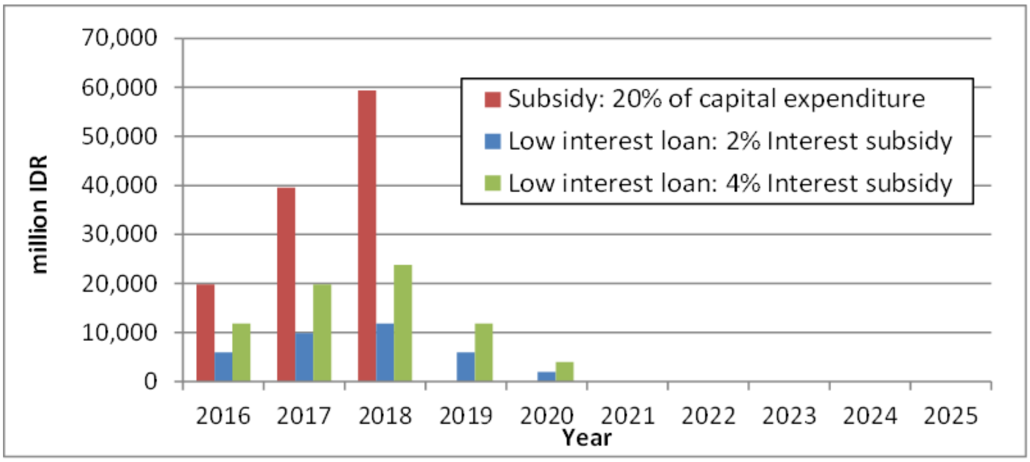
When net benefit by year is compared, the net benefit over the initial 3 years is largely negative for “subsidy”. However, after these 3 years, the net benefit for “low interest loan (2%)” becomes lower than “subsidy”, but the difference is small compared with the initial 3 years. The net benefit of “4% low interest loan” falls between the net benefits of “2% low interest loan” and “subsidy”.



Source: JICA Study Team

Figure 4.3.2-6 Comparison of Net Benefit Over 10 Years

In terms of government expenditure, the fiscal burden is much heavier for “subsidy” over the initial 3 years, while it will continue for longer period in case of “low interest loan”.



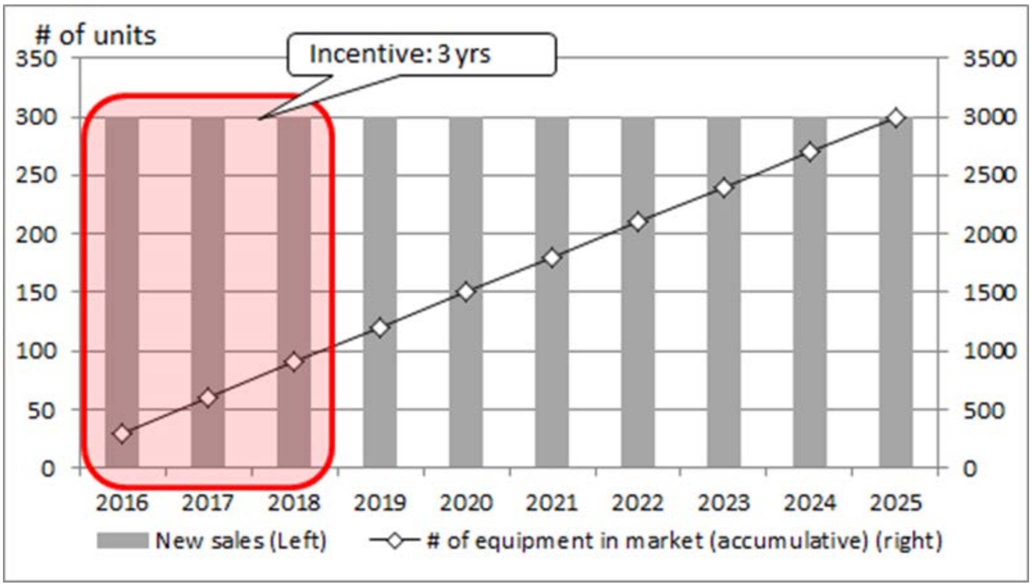
Source: JICA Study Team

Figure 4.3.2-7 Comparison of Government Expenditure for Incentives Over 10 Years

b) High Efficient Boiler

<Assumption>

- Low interest loan (2% or 4% interest subsidy) (same as the assumption used for MACC) vs Subsidy (20% of capital cost) (consumer behavior is assumed to be same for both incentives)
- Three incentive schemes are assumed to be provided over 3 years (same as the assumption used for MACC)
- Same energy saving potential/year assumed:886,950boe/year (same as the assumption used for MACC)
- The new sales in each year (same as the assumption for MACC): New boiler is assumed to be sold 300 units every year until 2025

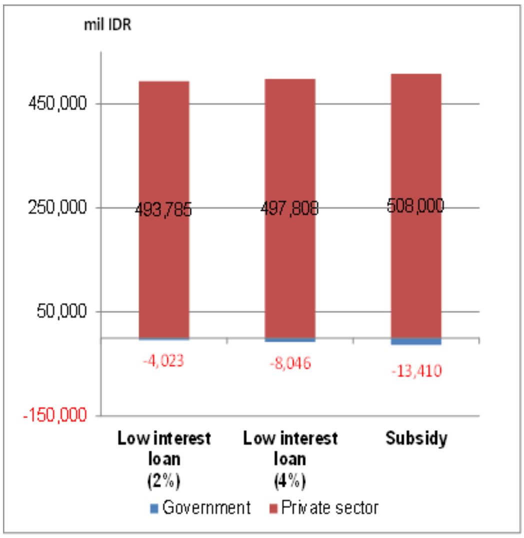


Source: JICA Study Team

Figure 4.3.2-8 Assumption of New Sales and Accumulative Unit Number in Each Year and Incentive Target

<The results>

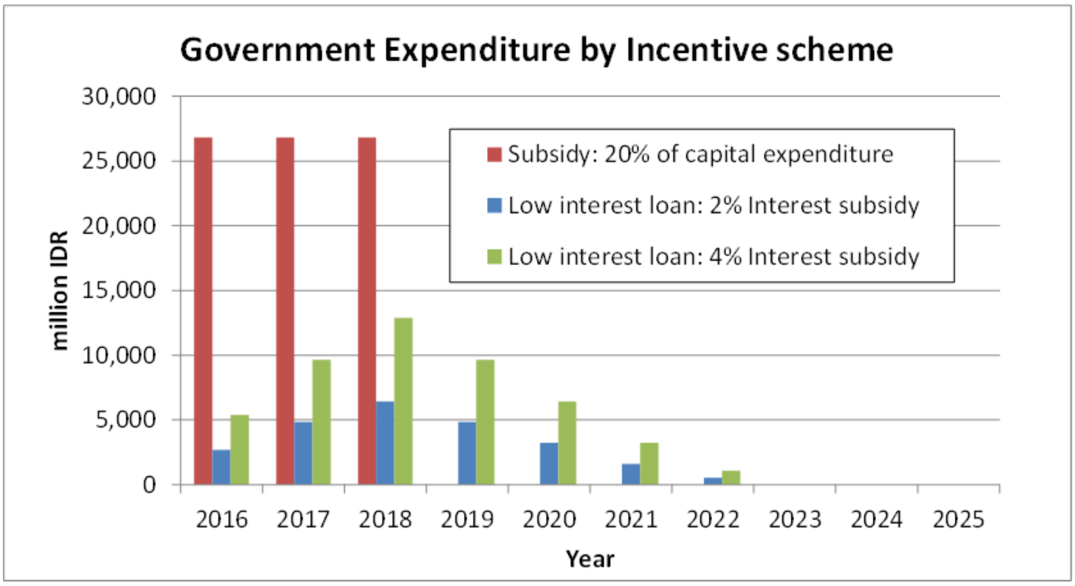
The 10 year average of net benefit as the entire society is the same for three incentive schemes. Government's net benefit is lower with subsidy than "low interest loan (2%/4%)", while it is opposite for private sector's net benefit. It is important to note that the government's net benefit by incentive provision appears negative, since the government benefit is estimated only by electricity subsidy reduction and the boiler is not assumed to reduce electricity consumption. However, EE&C by high efficient boiler could produce benefit which cannot be captured by electricity subsidy reduction and the negative net benefit in government does not mean that there are no points providing incentives to high efficient boiler.



Source: JICA Study Team

Figure 4.3.2-9 Comparison of 10 Year Average Net Benefit

In terms of government expenditure, the fiscal burden is much heavier for “subsidy” over the initial 3 years, while it will continue for longer period in case of “low interest loan (2%/4%)”.



Source: JICA Study Team

Figure 4.3.2-10 Comparison of Government Expenditure by Incentives Over 10 Years

4.4 Stakeholders' Comments through FGDs

Together with MEMR, the JICA Study Team hosted 3 FGDs as shown below:

Table 4.4-1 FGDs

Event	Organized Date	Participants	Contents
FGD 1	May 21, 2015	- Other ministries - Building and industrial associations	- Explanation of the objective and study content - Input gathering
FGD 2	July 7, 2015	- Policymakers	- Sharing the findings of the study - Discussing issues related to core data problem and needs for harmonized data source - Input gathering
Extended FGD	July 6, 2015	- Other ministries - Building and industrial associations	- Sharing the findings of the study - Input gathering

At the FGD 2, the participants shared the view that all the core data should be handled by MEMR’s PUSDATIN. However, PUSDATIN does not have access to many demand-side data that are essential for MACC development. JICA Study Team encouraged MEMR and MOI to cooperation with PUSDATIN for data sharing and harmonization.

Through the Extended FGD, JICA Study Team gathered additional comments from the participants, as summarized in Table 4.4-2:

Table 4.4-2 Comments Obtained Through FGDs

Topics	Comments
General	・ EE&C in supply-side should receive more attention than EE&C in demand-side, as it requires relatively few players to achieve a significant result. ・ Although the Study focuses on MOI's 8 target industries for EE&C for MACC development, the impact of the palm oil industries' contribution to EE&C should also be revisited, as it uses recovered methane for power or heat generation. ・ Fuel change using biofuel could contribute in reducing import of oil and oil productions, and it should also be considered as a technology to foster EE&C. ・ The Study should include the EE&C potential by introducing co-generation, combined heat and power (hereinafter "CHP") and trigeneration, especially in the food & beverage (sugar manufacturing), refining and smelting industries in the future. ・ Establishing co-generation and other power facilities established near demand (e.g. industrial zones) require multi-sector planning and local/government initiatives.
Data-related	・ Demand-side data are scarce. Promoting EE&C is important; however, the policymakers should also be careful with its 'rebound effect', that is, energy consumption level increases by shifting to energy-efficient equipment. ・ Some industries do not have the most recent detailed information and data. Though published, using old data to develop MACC is not appropriate and misleading, especially for the industrial sector. It is recommended not to include those sub-sectors until the comprehensive data are available.
Incentives and ESCO	・ The government should provide a clear message in the expected role for incentives. ・ It is important to show an overall picture including the government's costs for introducing incentives (e.g. subsidies) and the cost saving achieved. ・ Providing clarification for (or justification of) any recommended figures, such as 2% of soft loan, is important. ・ Looking back the history, VAT reduction of 10% may be highly difficult to implement. It may be most useful to introduce income tax reduction. ・ EE&C measures using efficient equipment require high upfront investment cost. In one of the international assistance program, 11 facilities received energy audit; however, none on of them could implement the recommendations due to not only high investment costs and low electricity price, but also technology not exactly matching the needs and low capacity or knowledge of the engineers or the sub-sector. ・ EE&C can be promoted using ESCO scheme. ESCO companies need incentives, special interest loan, collateral mechanisms, import duty reduction, tax holiday, etc. ・ ESCO is still a new concept for facility managers, and capacity building is essential in promoting ESCO. ・ Peak cut caused by behavior change (e.g. set government offices' room temperature at 23 degree C) will significantly reduce consumption.

4.5 Application of EE&C MACC to Other Countries

As mentioned before with the Indonesian case, MACC can be one of useful tools to evaluate the candidates for EE&C technologies and programs. Basic procedures to collect data (macro- and micro-level) and evaluate the candidate technologies and programs applied to the Indonesian case can be duplicated in other countries. In addition, following points should be customized for the target countries:

(1) In the case of Indonesia, boe (barrel of oil equivalent), a widely applied unit in Indonesia, is applied as the unit to evaluate the EE&C volume. However, in the other countries, it is recommended to apply toe (ton of oil equivalent), an internationally popular unit, instead of boe. By applying toe, comparison among the countries can become easier.

(2) Electricity and other energy should be evaluated in primary energy basis. The conversion factor of primary energy for electricity should be decided based on the target country's power generation mix.

(3) In case of no subsidy for energy, it is no need to calculate the cost and benefit of the government and consumers separately.

(4) The evaluation target of should be commercial energy (excluding biomass).

Chapter 5

Integrated Database

Chapter 5 Integrated Database

5.1 Proposal of Database to Structure and Evaluate EE&C Policies

As mentioned in MACC Chapter, it is needed to grasp and maintain the macro and micro energy consumption data in the country. Hereinafter, it is described what kind of data is to be collected and how to collect the data. Figure 5.1-1shows the overall framework of a database to structure and evaluate EE&C policies.

- ✓ **Essential to have both macro and micro views related to EE&C**
- ✓ **Collect the most recent information and data on the following aspects:**

Macro View:	**Micro View:**
Energy Production and Import	**Energy Consuming Devices**
End Use by Sector	**Eligible EE&C Technologies**
Electricity is converted from fuel	**Energy Consumption by Sub-sector and Technology**
	Energy Price Information

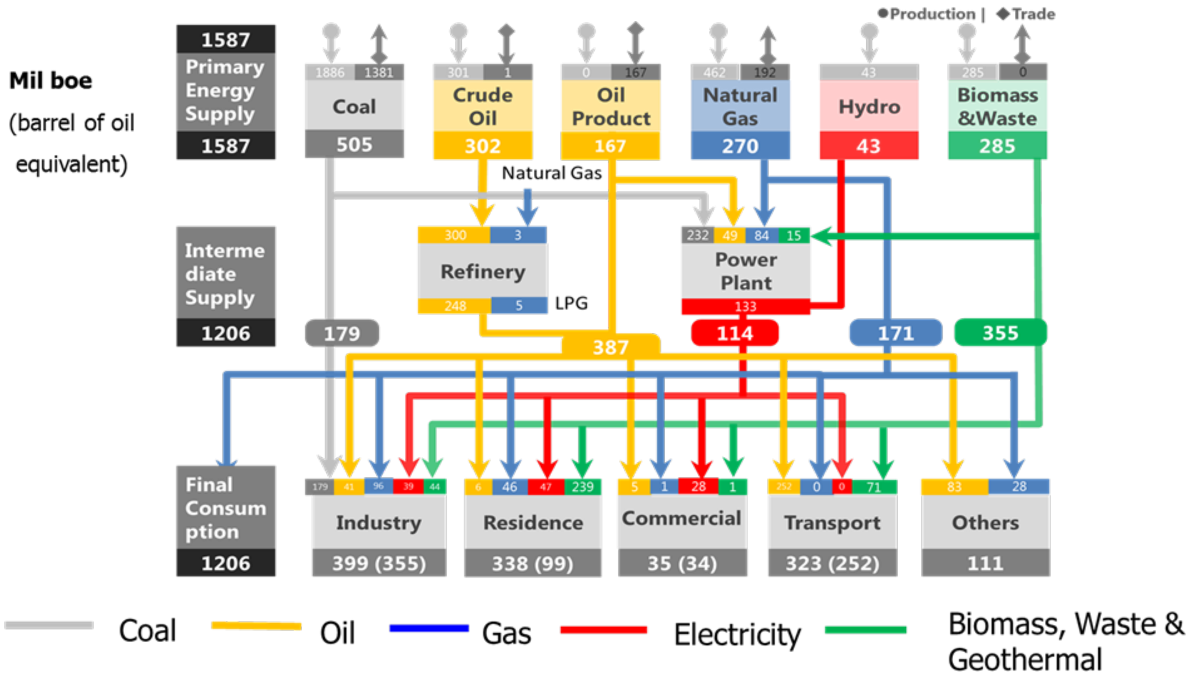
Source: JICA Study Team

Figure 5.1-1 Total Framework of a Database to Structure and Evaluate EE&C Policies

5.2 Macro Energy Balance

(1) Macro Energy Balance

Referring to PUSDATIN Handbook of Energy and Economics, Figure 5.2-1 and Table 5.2-1 were constructed. National macro energy balance needs to be understood at first.



Source: Compiled by JICA Study Team, based on PUSDATIN Handbook of energy and Economics

Figure 5.2-1 Indonesia Macro Energy Balance (2013)

Table 5.2-1 Indonesia Macro Energy Balance (2013) Raw Data in PUSDATIN Handbook

(Thousand BOE)

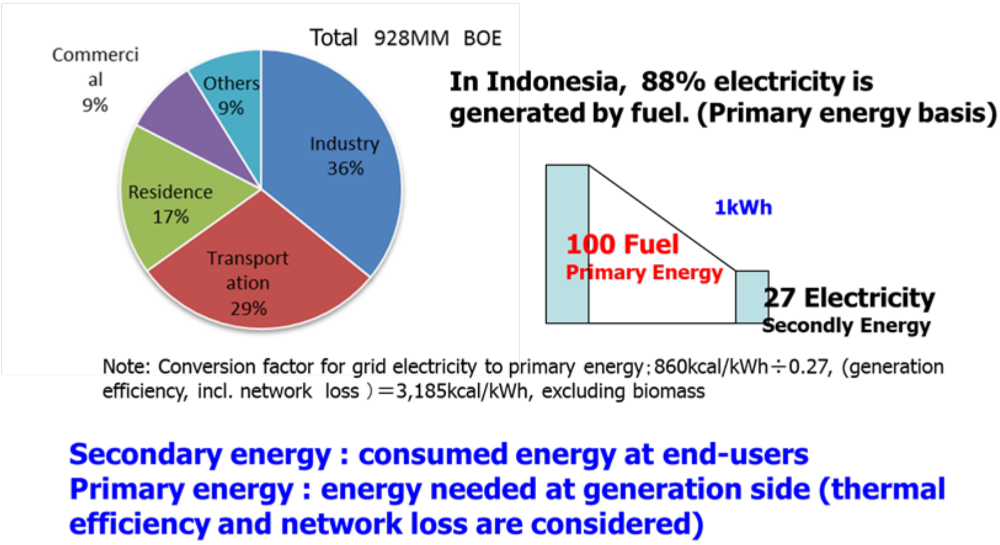
		Hydro Power	Geothermal	Biomass	Coal	Briquette	Natural Gas	Crude Oil	Fuel	Biofuel	LPG	Other Petroleum Product	Electricity	LNG	Total
1	**Primary Energy Supply**	42,627	15,245	285,120	410,567	0	402,121	306,137	209,569	71,074	30,658	-20,335	1,857	-159,509	1,595,131
	a. Production	42,627	15,245	285,120	1,886,137	0	462,317	300,830	0	71,074	0	0	0	0	3,063,350
	b. Import	0	0	0	463	0	0	118,334	192,656	0	28,130	6,509	1,857	0	347,949
	c. Export	0	0	0	-1,380,724	0	-60,195	-117,380	-6,339	0	0	-26,845	0	-159,509	-1,750,993
	d. Stock Change	0	0	0	-95,309	0	0	4,353	23,253	0	2,529	0	0	0	-65,175
2	**Energy Transformation**	-42,627	-15,245	-140	-231,662	130	-278,871	-300,134	119,366	0	17,143	80,094	132,522	181,963	-337,550
	a. Refinery	0	0	0	0	0	-3,490	-300,134	168,447	0	4,807	80,094	0	0	-50,276
	b. Gas Processing	0	0	0	0	0	-191,748	0	0	0	12,336	0	0	181,963	2,551
	c. Coal Processing Plant	0	0	0	-153	130	0	0	0	0	0	0	0	0	-23
	d. Power Plant	-42,627	-15,245	-140	-231,596	0	-83,633	0	-49,081	0	0	0	132,522	0	-289,802
	- State Own Utility (PLN)	-32,767	-6,334	0	-166,324	0	-73,616	0	-49,047	0	0	0	100,511	0	-227,578
	- Independent Power Producer (Non-PLN)	-9,860	-8,912	-140	-65,272	0	-10,017	0	-34	0	0	0	32,011	0	-62,224
3	**Own Use and Losses**	0	0	0	0	0	-42,538	-6,003	-608	-142	0	0	-17,453	-22,454	-89,198
	a. During Transformation	0	0	0	0	0	-3,490	-6,003	0	0	0	0	-4,763	0	-14,256
	b. Energy Use/Own Use	0	0	0	0	0	-39,048	0	0	0	0	0	0	0	-39,048
	c. Transmission & Distribution	0	0	0	0	0	0	0	-608	-142	0	0	-12,690	-22,454	-35,894
4	**Final Energy Supply**	0	0	284,980	178,817	130	80,712	0	328,327	70,932	47,801	59,758	116,926	0	1,168,384
5	**Statistic Discrepancy**	0	0	0	0	0	-44,818	0	0	0	0	0	1,964	0	-42,854
6	**Final Energy Consumption**	0	0	284,980	178,817	130	125,529	0	328,327	70,932	47,801	59,758	114,962	0	1,211,237
	a. Industry	0	0	44,374	178,817	130	95,431	0	40,778	0	693	0	39,466	0	399,688
	b. Transportation	0	0	0	0	0	185	0	252,411	70,932	0	0	79	0	323,607
	c. Household	0	0	239,246	0	0	122	0	6,396	0	45,839	0	47,330	0	338,934
	d. Commercial	0	0	1,360	0	0	1,422	0	5,195	0	1,269	0	28,088	0	37,334
	e. Other Sector	0	0	0	0	0	0	0	23,546	0	0	0	0	0	23,546
7	**Non Energy Use**	0	0	0	0	0	28,370	0	0	0	0	59,758	0	0	88,128

Source: PUSDATIN Handbook of Energy and Economic Statistics 2014

(2) Conversion Factor of Electricity to Primary Energy

Electricity demand should be evaluated in primary energy basis (actual amount of energy required). See Figure 5.2-2.

The data needed to calculate the conversion factor of electricity primary energy, generation sources, thermal efficiency and transmission& distribution loss, is to be supplied by PLN Sustainable Report and Statistics, etc..



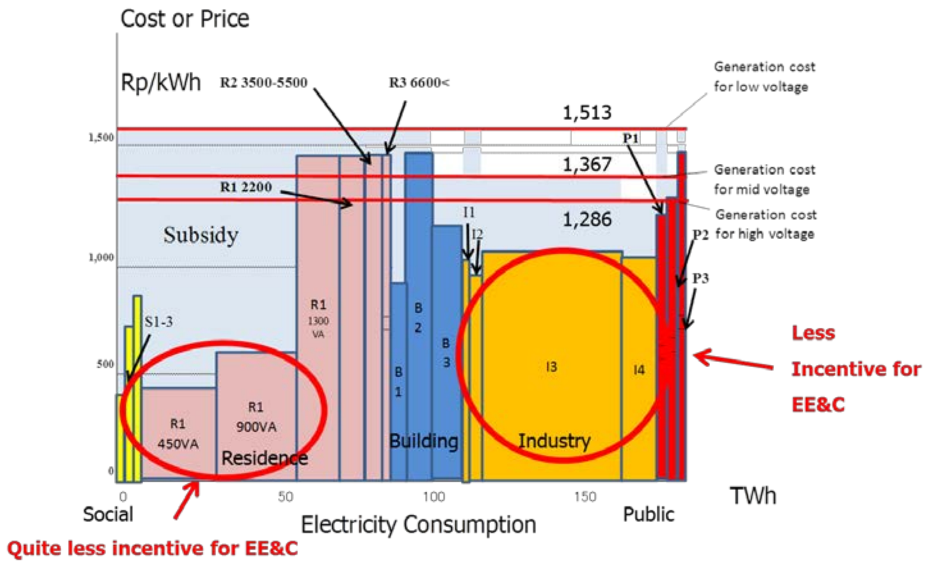
Source: Compiled by JICA Study Team, based on 2014 Handbook of Energy & Economic Statistics of Indonesia

Figure 5.2-2 Conversion Factor of Electricity to Primary Energy in Indonesia

(3) Electricity and Energy Subsidy

The amount of electricity subsidy (distribution) will be collected by PLN Statistics and tariff table at that time. See Figure 5.2-3.

In the process of evaluating and reviewing EE&C policies, the effect of energy subsidy should be considered.



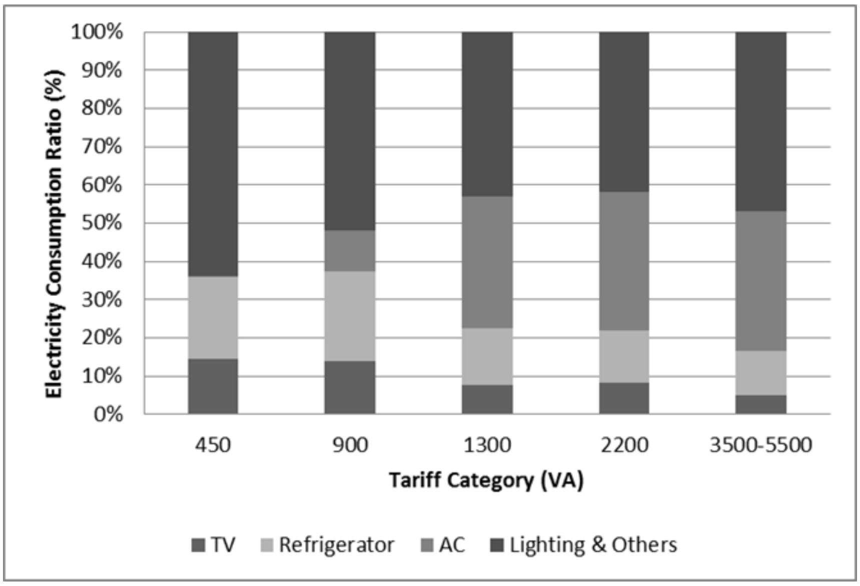
Source: Compiled by JICA Study Team based on PLN electricity consumption data (2014) and tariff table as of May 2015

Figure 5.2-3 Electricity Price/Cost and Consumption by Sector

(4) Sectoral Information

1) Residence: Electricity Consumption by Major Appliance

Figure 5.2-4 shows the measured electricity consumption data by major appliance in residential sector. This kind of survey is recommended to be conducted every several years in order to update the data, possibly with the support of international cooperation agencies.



Source: The Study for Promoting Practical Demand Side Management Program in Indonesia (2012), Surveyed in Jakarta, Palembang, Balikpapan, Manado and Denpasar, JICA/J-POWER

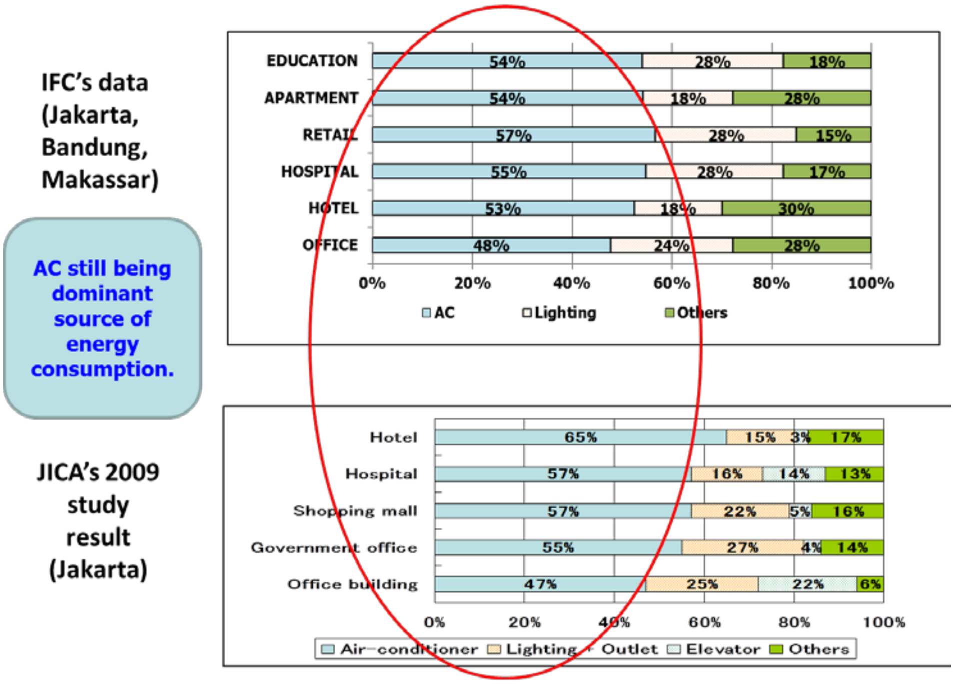
Figure 5.2-4 Electricity Consumption by Major Appliance and Contract Size in Residential Sector

2) Building：Electricity Consumption by Purpose

Figure 5.2-5 shows the measured electricity consumption data of buildings. This kind of survey is recommended to be conducted every several years in order to update the data possibly with the support of international cooperation agencies. For the case of Indonesia, it is also useful to use the summary of audit report and submitted data from large energy consumers.

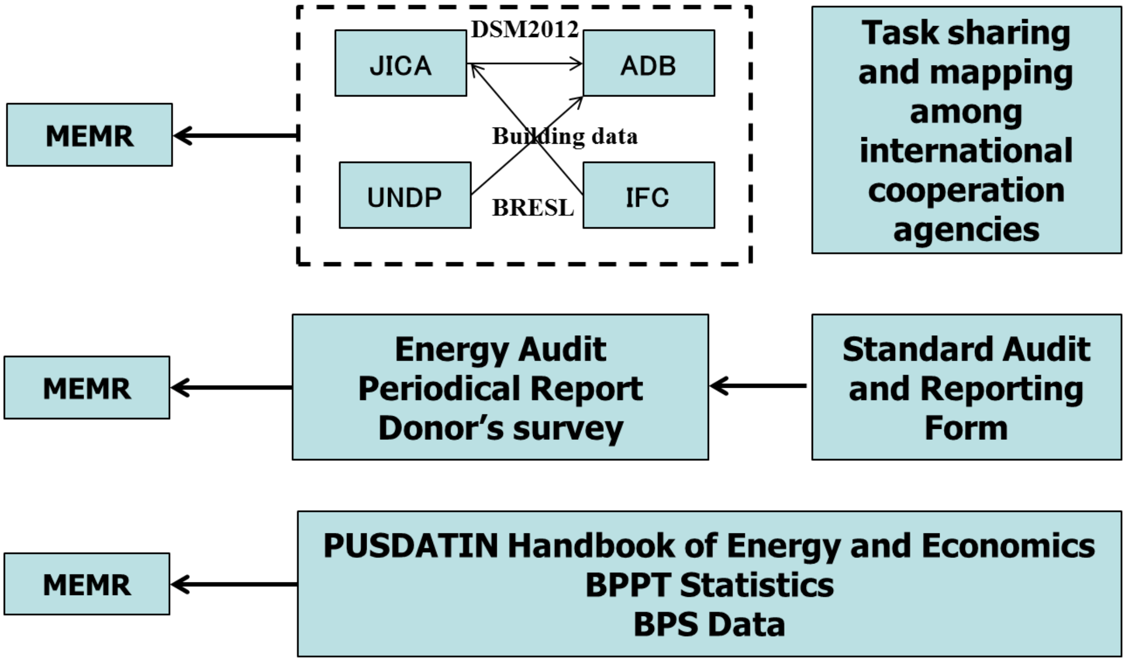
The followings are the figures, which JICA Study Team compiled, based on the data from Japan International Cooperation Agency and audit reports from MEMR.

As shown in Figure 5.2-6, in order to utilize and compare the collected data effectively, the coordination structure to collect, share, storage and utilize the energy consumption data should be formulated.



Source: IFC (2015), simulation model results from the selected sample data collected from 3 cities between 2011-2012; JICA Study (2009), data measured in facilities in Jakarta between 2007 and 2008

Figure 5.2-5 Electricity Consumption by Purpose in Buildings



Source: JICA Study Team

Figure 5.2-6 Structural Coordination of Energy Consumption Data Usage

The format of executive summary for annual energy audits should be standardized to collect and utilize the useful data obtained by the audits. See Table5.2-2. This table is common in buildings and factories.

Several examples of useful information derived from the MEMR audit reports are shown in Figure 5.2-7.

Table 5.2-2 Example of the Format of Executive Summary of Energy Audit Report

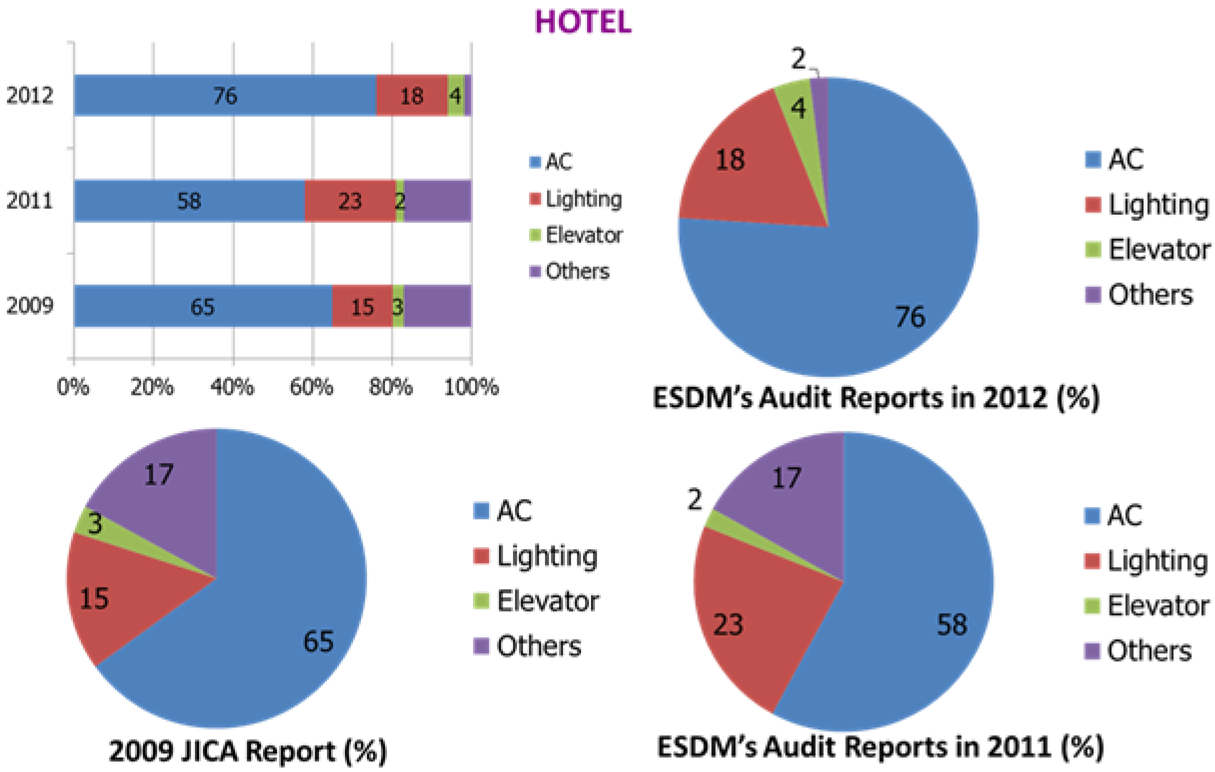
Building/factory Outline		
Building/ Factory Name		
Address		
Total Floor Space/ Production amount		M2 ton
Building Use/ main product		
Completion Day		
Facilities		
	AC	**Central Chiller (Rt), Heat Pump (HP),**
	Lighting	**LED Installation (Yes or Not), If yes, percentage (%)**
	Transport	**Elevator, Escalator**
	Hot water	**Boiler (L), Electric heater (kW)**

	Generator	**Generator Installation (Yes or Not), If yes, capacity (kW)**

Year ( )	**Annual Energy Consumption by energy type**				
	Electricity	Coal	Diesel	Gas	Others
	GWh	kt	'000kL	MMBTU	GWh

Year ( )	**Annual Electricity Consumption (GWh) by purpose**				
	Total	Air-conditioner	Lighting/Outlet	Elevator	Others

Source: JICA Study Team



Source: Compiled by JICA Study Team

Figure 5.2-7 Useful Information from MEMR Energy Audit

3) Industry sector

First of all, the discrepancy among several national statistics should be adjusted for the industry sector. Based on this adjustment, unified energy consumption data by sub-sector should be established to design EE&C policies. See Figure 5.2-8.

Existing Discrepancy in Industrial Energy Consumption Data

	Electricity	Coal	Fue l+ Petroleum	Gas	Others	Total
PUSDATIN Handbook Energy Balance 2013	39,466	178,817	40,778	96,124	44,504	399,689
BPPT Energy Statistcs 2012	36,900	123,100	49,500	123,700	43,300	376,500
MOI Total (Major sub-sectors) 2012	33,742	44,308	44,936	6,630	4,962	134,577

Comments from related organizations
BPPT: It is difficult to know accurate figures
MOI: ditto
Industrial Associations: ditto

Note: MOI data covers only energy consuming sub-sectors
Source: JICA Study Team

Figure 5.2-8 Discrepancy among National Energy Consumption Statistics in Industry Sector

In order to grasp the most likely energy consumption outline in industrial sub-sector, tentative measures is introduced to fill the gap in the above mentioned discrepancy of industrial energy consumption data as shown below:

a) Base Data: Energy Consumption Data by Sub-sector Compiled by MOI

As a basis, energy consumption data by sub-sector compiled by MOI should be understood. See Table 5.2-3.

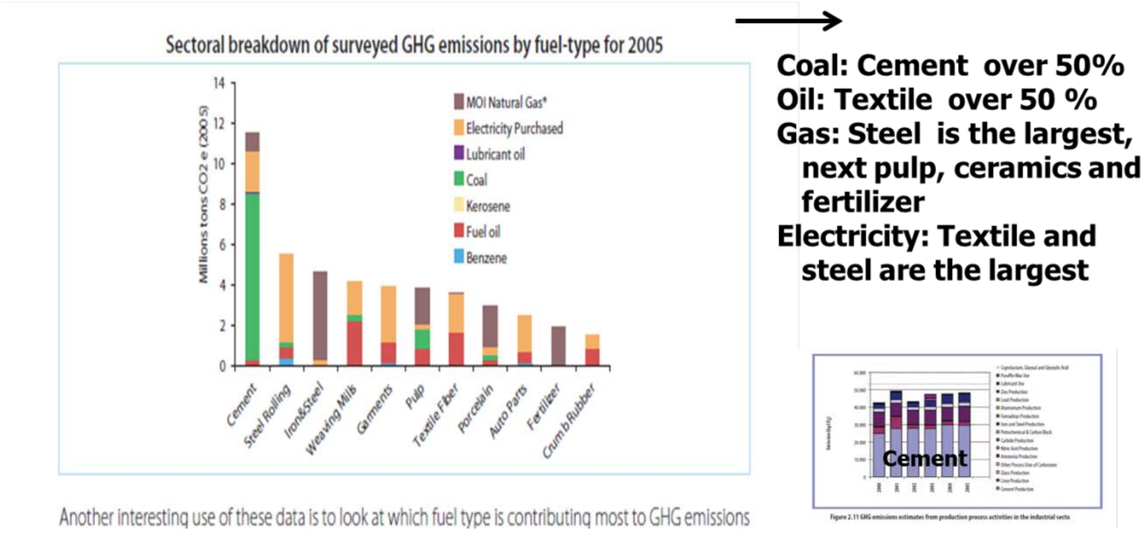
Table 5.2-3 Energy Consumption by Energy Consuming Sub-sector and Energy Type (MOI)

Sub-sector	Energy consumption (supply data)				
	Electricity	Coal	Diesel	Gas	Others
	GWh	kt	'000kL	MMBTU	GWh
Iron&Steel	2,784	55	256	1,756,314	23
Textile	5,351	1,107	353	938,225	47
Chemical/Fertilizer	5,161	618	714	2,350,512	144
Cement	2,270	2,318	175	4,415,700	72
Ceramics	--	--	--	--	--
Food & Beverage	3,208	327	984	2,534,130	97

Source: MOI Needs for Energy Planning for the Industry Sector towards the acceleration of Industrialization (2012), interview with Indonesia Cement Association and Indonesian Iron & Steel Industry Association

b) Cross-Checking with CO2 Emission Data by Sub-sector

With CO2 emission data, the macro view of energy consumption by sub-sector can be cross-checked.



Source: AfD Research (left); MOE, 2010 (right)

Figure 5.2-9 CO2 Emission by Industrial Sub-sector

c) Interviews from Relevant Industrial Associations and Stakeholders

With the collected information and data, several part of MOI data can be revised reflecting the present condition. Especially, the data from PLN and Gas Forum are useful, which is summarized by sub-sector.

Example)
1. Indonesia Cement Association (ASI)
2. Food and Beverages Association (GAPMMI)
3. Iron and Steel Association (IISIA)
4. Textile Association (API)
5. Pulp and Paper Association (APKI)
6. Fertilizer Association (APPI)
7. Indonesia Ceramic Industry Association (ASAKI)
8. Gas Forum
9. Green Building Council Indonesia (GBCI)
10. Indonesia Hospital Association
11. PLN

Source: JICA Study Team

Figure 5.2-10 List of Major Industrial Associations

d) Amended Energy Consumption Data by Sub-sector

By integrating the above mentioned three approaches, we can compile Table 5.2-4.

Table 5.2-4 Amended Energy Consumption by Energy Consuming Industrial Sub-sector (by energy type)

Sub-sector		Energy consumption (supply data)					
		Electricity	Coal	Diesel	Gas	Others*	Total*
		kBOE (yr)					
Iron&Steel	Original	4,542	530	4,476	839	338	10,724
	JICA rivision	**10,000**	530	4,476	**30000**	338	45,344
Textile	Original	8,728	10,713	6,170	448	686	26,745
	JICA rivision	**10,000**	**9,000**	**4,000**	448	686	24,134
Chemical/Fertilizer	Original	8,419	5,978	12,469	1,123	2,119	30,108
	JICA rivision	8,419	5,978	12,469	**15,000**	2,119	43,985
Cement	Original	3,703	22,430	3,054	2,111	117	31,415
	JICA rivision	3,703	**90,000**	3,054	2,111	117	98,985
Ceramics	Original						
	JICA rivision	**1000**			**20,000**		21,000
Food & beverage	Original	5,233	3,168	17,171	1,211	1,433	28,216
	JICA rivision	5,233	3,168	**10,000**	1,211	1,433	21,045
Total	Original	18,872	118,766	33,279	26,644	3,100	200,661
	JICA rivision	64,438	150,965	72,863	73,663	9,048	370,977

Source: JICA Study Team, based on MOI's "Needs for Energy Planning for the Industry Sector towards the Acceleration of Industrialization" (2012), interviews with Indonesian related Associations (Bold data were collected or estimated by JICA Study Team based on interviews).

e) Eligible EE&C Technologies

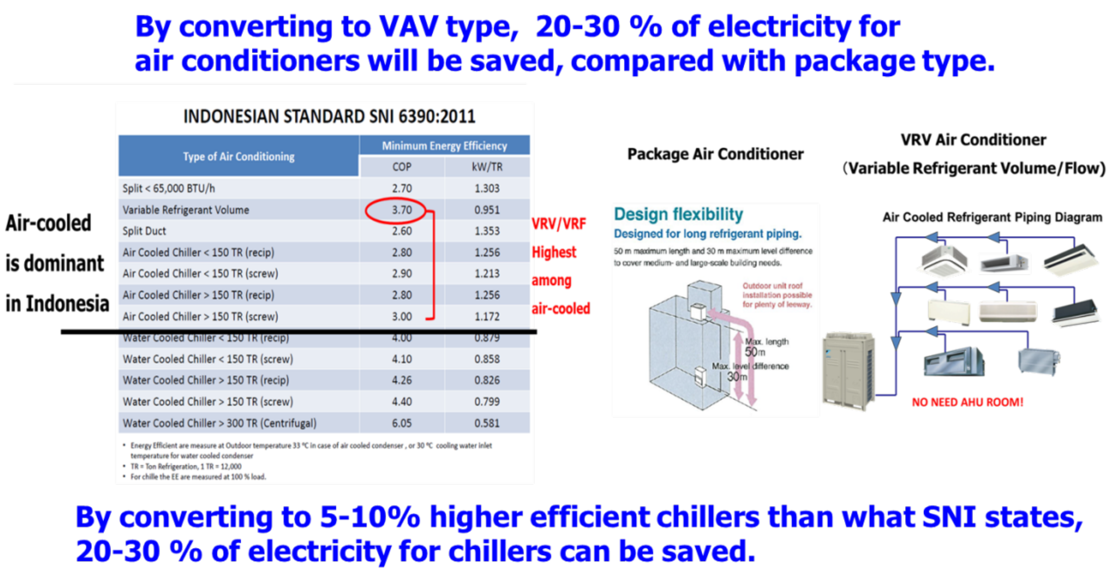
Eligible EE&C technologies, which contribute to EE&C promotion in Indonesia, should be selected and basic information for the technologies should be sorted as a database. These data will be collected by representatives of eligible technology manufacturers, retail shops of appliances and market research reports etc.

As for split air conditioners, by converting into inverter type, 20-30% electricity will be saved (See Table 5.2-5).

Table 5.2-5 Penetration Ratio of Inverter Air Conditioners by Reference Country

Country	Inverter ratio （%）
Japan	100
Singapore	78
China	50
Vietnam	30
Malaysia	(20)
Indonesia	5

Source: GfK (2014), ratio for Malaysia is the estimation by JICA Study Team



Source: SNI: Institute Technology of Bandung (below left); Daikin (below right)

Figure 5.2-11 SNI for AC

f) Market Survey

Conducting market surveys help to understand the present market condition, the penetration ratio of EE&C types and price ranges. It is recommended to conduct a sample market surveys every 2 years. The followings are room air conditioners market survey result conducted by JICA Study Team in 2014. From those tables, one can have a general idea of the level of energy efficiency and price range of the target technologies.

(Air conditioner)

Around 2,500,000 split air conditioners are sold in Indonesia annually. In 2014, the sales numbers decreased about 10% due to economic slowdown.

EER of air conditioners with 5,000Btu and 7,000Btu ranges from 9.0 to 17.3. Almost all the air conditioners' EER exceeds 10.415, which is a threshold of 4 stars in the market and the ones below 10.41 are highly limited. (For 5,000, 7,000Btu)

EER of 9,000Btu air conditioners ranges from 8.9 to 13.1. Standard type's EER is less than 10.41. (Generally EER of larger sized air conditioners is lower than that of smaller sized ones.)

Table 5.2-6 LG AC Line-up

	5000Btu (350W)		7000Btu (500W)		9000Btu (700W)	
	EER (Btu/Wh)	Cost (IDR)	EER (Btu/Wh)	Cost (IDR)	EER (Btu/Wh)	Cost (IDR)
HERCULES	17.3	4,419,000	14.3	—	13.0	4,599,000
Skincare	15.0	—	12.8	—	13.1	—
Standard	10.9/11.0	3,719,000	10.4	3.829,000	9.3/8.9	3,919,000

Source: JICA Study Team, based on market survey in 2014 in Jakarta

Table 5.2-7 POLYTRON AC Line-up

	5,000Btu		9,000Btu	
	EER (Btu/Wh)	Cost (IDR)	EER (Btu/Wh)	Cost (IDR)
LC	—	—	13.0	3,199,000
LA	15.6	2,779,000	13.0	3,089,000

Source: JICA Study Team, based on market survey in 2014 in Jakarta

Table 5.2-8 CHANGHONG AC Line-up

	5,000Btu		7,000Btu		9,000Btu	
	EER (Btu/Wh)	Cost (IDR)	EER (Btu/Wh)	Cost (IDR)	EER (Btu/Wh)	Cost (IDR)
CSC-TI	14.9	3,199,000	—	—	13.8	3,149,000
CSC-K	14.9	3,029,000	—	—	13.8	3,259,000
CSC-K/C	12.5	2,899,000	13.7	2,999,000	10.2	3,090,000
CSC-JZ	9.0	2,799,000	—	—	—	—

Source: JICA Study Team, based on market survey in 2014 in Jakarta

Table 5.2-9 shows potential technologies that are expected to be effective to promote EE&C in the target sub-sectors. This information was collected by energy audit reports, interviews with industrial associations and representatives of EE&C equipment manufacturers and international cooperation agencies' report.

Table 5.2-9 Potential EE&C Technologies by Industrial Sub-sector

Sub-sector	EE&C Technology			Source / Note
	1	2	3	
Cement	**Waste Heat Recovery Power Generation**	Mill	Inverter	Association
Food & beverage	**Boiler**	**Chilling**		Manufacturer
Iron & steel	**Re-generative Burner**			Other Research
Textile	**Weaving**	Lighting	Heat Recovery	Other Research
Fertilizer	**Total System Renovation**			Association
Ceramic	**Heat Recovery**			Association, Other Research
Glass	Heat Recovery	Lighting (LED)	Inverter	Factory, Other Research

Source: Compiled by JICA Study Team based on the information from Energy Audit Report

5.3 Input data for EE&C MACC

The measures to collect data for EE&C MACC are described below. Data should be collected from several different sources and integrated and analyzed.

(1) Data Collecting Measures 1: Industrial and Commercial Association

Example)
1. Indonesia Cement Association (ASI)
2. Food and Beverages Association (GAPMMI)
3. Iron and Steel Association (IISIA)
4. Textile Association (API)
5. Pulp and Paper Association (APKI)
6. Fertilizer Association (APPI)
7. Indonesia Ceramic Industry Association (ASAKI)
8. Gas Forum
9. Green Building Council Indonesia (GBCI)
10. Indonesia Hospital Association
11. PLN

Source: JICA Study Team

Figure 5.3-1 Data from Manufacturers with Larger Market Share

(2) Data Collecting Measures 2: Manufacturers with Larger Market Share

Example)

1. **Room air conditioner (Daikin, Panasonic/Gobel, LG, Samson, Polytron, Sharp)**
2. **Refrigerator(Sharp, Polytron, LG, Samson, Panasonic)**
3. **VRV air conditioner (Daikin, LG)**
4. **Chiller (Hitachi, Career, York, Daikin)**
5. **Industrial chilling compressor (MYCOM)**
6. **Boiler (Miura)**
7. **Glass (Asahimas)**

Source: JICA Study Team

Figure 5.3-2 Data from Manufacturers with Larger Market Share

(3) Data Collecting Measures 3: Surveys Conducted by International Cooperation Agencies

Example)

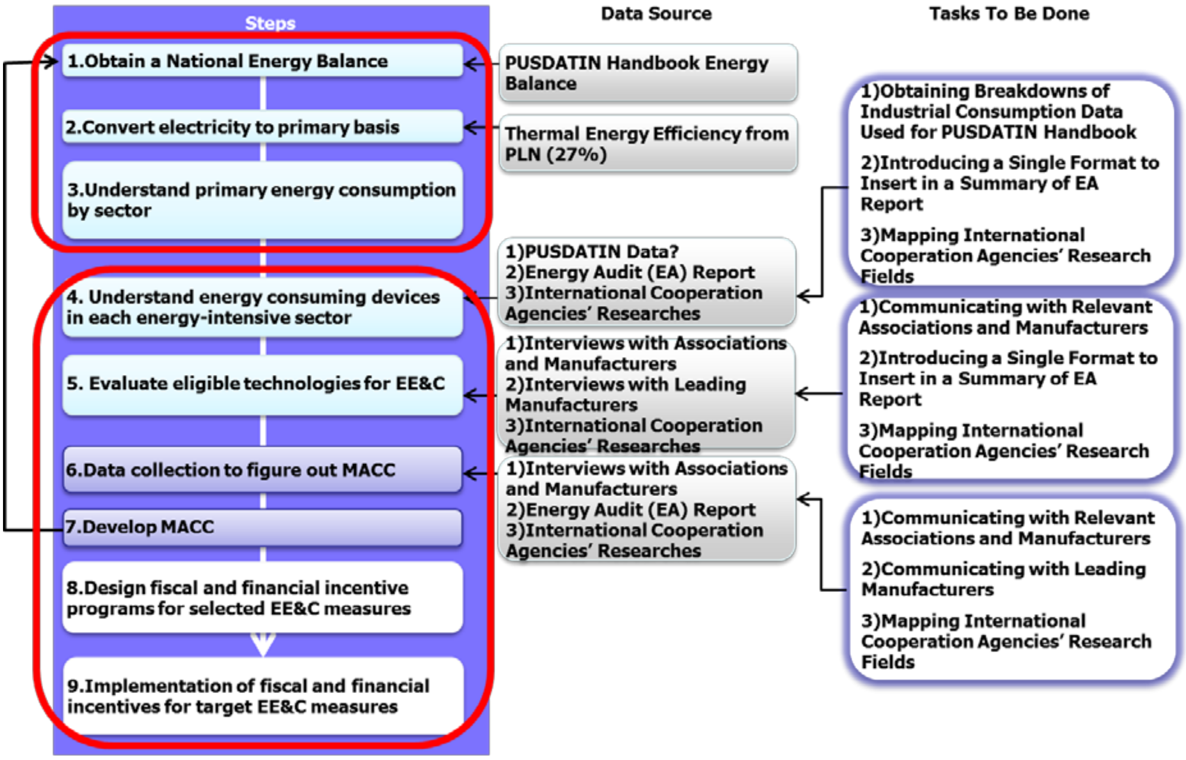
1. **UNDP (BRESL), 2014 for appliances**
2. **IFC for buildings, from 2010 to 2014**
3. **JICA , 2012 for appliances**

Source: JICA Study Team

Figure 5.3-3 Data from International Cooperation Agencies

5.4 Summary

Figure 5.4-1 shows the summary of data collection and utilization procedures to develop EE&C MACC. The left row provides the steps for data handling, while the mid row indicates the data required for analyzing each step's work. The right row shows preparations needed to structure and accumulate effective database for energy conservation.



Source: JICA Study Team

Figure 5.4-1 Summary of Procedures to Figure out EE&C MACC

Chapter 6

Key Findings and Recommendations for Future Cooperation

Chapter 6 Key Findings and Recommendations for Future Cooperation

6.1 Observations and Recommendations

The implications from EE&C MACC are as follows:

(1) To promote national EE&C effectively, all sectors of industries, commercial buildings and residences should be focused in parallel.

(2) To reduce government's energy subsidy, promoting EE&C for refrigerators and split air conditioners are promising.

(3) Electricity subsidy is larger outside Jamali than inside Jamali. In those outside Jamali areas of the country (mainly islands), about 80% of electricity is consumed in low voltage consumers. Promoting EE&C for refrigerators and split air conditioners are especially effective for these areas.

The impact of the implementation of (2) and (3) will increase by introducing the following policy package:

Table 6.1-1 Recommended Approach for Government's Electricity Subsidy Reduction

Target:	Promising solution:	Package policy	
To reduce the gov't subsidy	EE&C with split air conditioner Refrigerator	Enactment of Labeling & MEPS regulation in 2015 and 2016	Fiscal & Financial incentives to accelerate the promotion

Source: JICA Study Team

(4) By implementing all of the proposed EE&C projects in Chapter 4 of this study, approximately 10,000MW of electricity will be saved at year 2025. It may be faster, cheaper and less CO2 emission than constructing new power plants.

(5) Recommendation for incentive measures:

- Residential sector: tax reduction
- Industrial and some commercial sectors: low interest loan with government guarantee. A new policy to encourage the Indonesian local manufacturers to produce EE&C equipment may also need to be formulated. Though promoting EE&C in the industry sector may not always be connected to energy subsidy reduction for the government, there are some hidden benefits--increase in GDP (productivity) and employment opportunity, import reduction and export expansion--resulted in increase in tax revenue.
- For commercial buildings, awareness raising campaign to change peoples' behavior and incentives for design advantage (economic options) may be useful.

By introducing the following policy package, impact will increase.

Table 6.1-2 Recommended Approach for Fostering Low Cost EE&C Solutions

Target:	Promising solution:	Package policy	
To implement the low cost solution	Commercial building reconditioning & behavioral change	Enactment of the ESCO (Energy Service Company) Regulation (in a near future)	Fiscal & Financial incentives to accelerate the promotion

Source: JICA Study Team

(6) EE&C MACC is a useful tool to evaluate the priority of different EE&C measures. However, under the circumstances of poor availability of energy consumption data, it may not work as effectively as it should or/and is expected to be.

(7) In order to utilize EE&C MACC as a tool for policy making, the government needs to collect, update and accumulate the detailed energy consumption data to develop a practical EE&C MACC.

Table 6.1-3 summarizes a quantitative analysis result for the case with the incentives.

Table 6.1-3 Summary of Quantitative Analysis of Recommended EE&C Solutions (with Incentives)

Sector	EE Projects	Type of Incentive	Annual energy reduction amount	Gov't + Private	Government			Private			Negawatt Effect
				Net Benefits	Net Benefits	Costs for introducing incentives	Benefits from Subsidy Reduction	Net Benefits	Investment and Maintenance Costs	Benefits from Energy Savings and Incentives	MW saved in 2025
	Units		boe/yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	MW
Residential/ Commercial mix	Residential/ Commercial mix-Split AC: Conversion to inverter type	VAT reduction	1,733,907	737,646	289,175	46,181	335,356	448,471	395,313	843,783	1,918
	Residential/ Commercial mix-Refrigerator	VAT reduction	2,819,800	998,191	376,653	240,000	616,653	621,538	853,875	1,475,413	3,119
Commercial	Commercial-Package AC: Conversion to VRV	Low interest loan	398,450	29,308	10,589	7,322	17,911	18,719	222,508	241,227	441
	Commercial-Chiller: Conversion to high efficient chiller	Low interest loan	441,360	99,250	16,276	3,564	19,840	82,974	179,685	262,659	488
	Commercial-Introduction of solar insulated glass	VAT reduction	306,500	13,705	278	13,500	13,778	13,427	180,000	193,427	339
	Commercial-Introduction of Green buildings	Land&building tax reduction	1,646,019	611,471	2,524	71,467	73,990	608,947	622,050	1,230,997	1,821
	Commercial-Introduction of LED		479,122	179,833	21,537	0	21,537	158,296	614,833	773,129	530
	Commercial-Building: Reconditioning & behavior change		855,574	532,616	38,459	0	38,459	494,157	8,098	502,255	946

Sector	EE Projects	Type of Incentive	Annual energy reduction amount	Gov't + Private	Government			Private			Negawatt Effect
				Net Benefits	Net Benefits	Costs for introducing incentives	Benefits from Subsidy Reduction	Net Benefits	Investment and Maintenance Costs	Benefits from Energy Savings and Incentives	MW saved in 2025
	Units		boe/yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	mil Rp./yr	MW
Industry	Industry-Heat recovery power generation in cement industry	Low interest loan	828,354	116,435	24,625	2,795	27,420	91,810	61,796	153,606	916
	Industry-Industrial chilling compressor unit	Low interest loan	273,466	134,498	20,554	3,536	24,090	113,943	22,087	136,031	303
	Industry-Textile: high efficient weaving machine	Low interest loan	204,333	22,170	5,637	1,127	6,764	16,534	21,795	38,328	226
	Industry-Heat recovery in ceramic industry	Low interest loan	365,500	142,706	-4,063	4,063	0	146,768	83,011	229,779	0
	Industry-High efficient boiler	Low interest loan	689,850	387,837	-4,023	4,023	0	391,860	84,663	476,523	0
	Industry-Renewal of fertilizer facility (incl. material use reduction)	Low interest loan	1,379,700	233,333	-39,000	39,000	0	272,333	645,667	918,000	0
	Industry-Iron and steel: Regenerative burner	Low interest loan	43,362	19,397	-702	702	0	20,099	17,550	37,649	0
Total		--	12,465,296	4,258,395	758,519	437,279	1,195,797	3,499,877	4,012,930	7,512,806	11,047

Source: JICA Study Team

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