Energy Efficiency and Alternative Energy Task Force

Joint Team made by
EE&AE Task Force and JICA Experts in Energy Sector

Time line

- March: Preliminary Discussion before the project started
- May : JCC and the Steering Committee & 1st Task Force Meeting
  - Introduction of the current activities and near future plans of energy efficiency for BMA owned buildings, and introduction of energy efficiency technologies/institutions in Japan,
- July : 1st internal study session & 2nd Task Force Meeting
  - Discussion on the necessity and issues concerning “simple and sustainable” data/info collection system,
  - Introduction of energy efficiency technologies in Japan,
- August: Follow up
  - Follow up of the 2nd TF Meeting, including list of local consultant candidates

Policy Information & Data collection

- Major existing reports/materials which can be referred to establish “simple and sustainable information & data collection system
  - Project on study, survey, preparing preliminary report, energy analysis and value analysis for retrofitting of existing buildings under BMA towards energy-saving buildings
  - Report on Energy Management Year 2012

LEED for Green Building

The Leadership in Energy and Environment Design (LEED) standard consists of five categories :

Source : Dr.Pimpida Chanyaraksakul, P.E., LEED ®AP

The Energy Conservation Promotion Act B.E.2535

Energy Conservation in Buildings

Section 17 : Energy conservation inside the buildings means one of the following measures:

(1)Reduction of heat from the sunlight that enters the building.
(2)Efficient air-conditioning, including maintaining room temperature at an appropriate level.
(3)Use of energy-efficient construction materials and demonstration of qualities of such materials.
(4)Efficient use of light in the building.
(5)Use and installation of machinery, equipment, and materials that contribute to energy conservation in the building
(6)Use of operation control systems for machinery and equipment
(7)Other measures for energy conservation as prescribes in the Ministerial Regulations.

Source : Department of Alternative Energy Development and Efficiency, Ministry of Energy

Discussion at Task Force Meetings, and Workshop

Task Force Meetings and Informal Discussions

- TF members clearly understood the necessity of “simple and sustainable” data and information collection system,
- The system is essential for the continuous monitoring and management system of RE-EE related activities,
- They also understood that identification of data sources is important concerning emission sources which are not directly controlled by BMA,
- TF members also learned Information on new mitigation measures, such as energy efficiency technologies applied in Japan.

Emission estimations in the energy sector

Basic approach to calculate emissions in the energy sector are...

Future GHG emissions
= Emission without the Plan (BaU) - Emission with the Plan (WP)

To estimate the BaU emission, we need the "real data" of fossil fuel consumption.

Past real data	2003		....		2012		Total
Direct(D)/In-Direct(ID) control of BMA	D	I-D	D	I-D	D	I-D	
Electricity							
Oil							
Gas							
Coal							
Others							
Total							

- Last 10 years data is ideal but as much data as you can collect is enough (3years, 5years, or none).
- The existing reports can be used as reference materials.
- Confirming the "data source" is one of the most important process to collect data so that you can continue this kind of work easily in future.

Emission estimations in the energy sector

Basic approach to calculate emissions in the energy sector are...

Future GHG emissions
= Emission without the Plan (BaU) - Emission with the Plan (WP)

To estimate the emission reduction by projects, we need the data related to the project activity.

Emission reduction	2013		....		2022		Total
Introduction of renewable energy							
Hydro							
Solar							
.....							
Implementation of energy efficiency							
.....							
.....							
Total							

- Already "planed" projects by BMA (but not started yet) can be included in the project list, because they will not be implemented without the BMA's initiative.
- For the in-direct controlled projects, we can use appropriate estimation method to calculate the effect of emission reduction using existing references.

BMA City Hall 2

The Bangkok City Tower follows the six criteria for international green building standards.

BMA City Hall 2

The six criteria for international green building standards, which are:

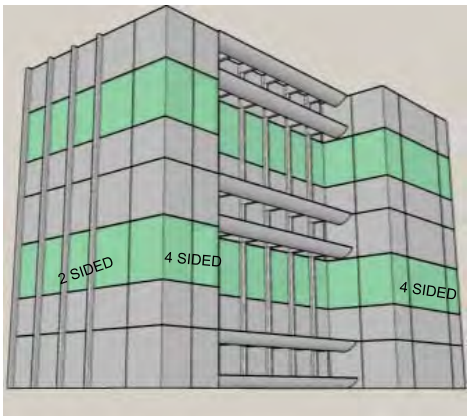
1. Good building management
2. Well-designed landscaping to reduce the urban heat effect
3. Effective use of water
4. Maximum cost-efficient use of energy
5. Use of environmentally friendly materials and construction methods
6. Creating comfort zones in the building to enhance people's quality of life and to encourage environmental concern

BMA City Hall 2

Building orientation

Design for orientation is a fundamental step to ensure that buildings work with the passage of the sun across the sky. Maximizing north and south façade exposure to let in light and passive solar gain.

BMA City Hall 2



Material selection

Curtain Walls

Vision area is equipped with *double*-panel insulated glass to lower the amount of heat penetration and enhance noise reduction.

Spandrel area utilizes aluminium composite panel which is *heat* resistant and waterproof. Fiber cement board is used to create a continuous surface suitable for most types of interior decoration. Sandwiched between aluminium composite panel and fiber cement board is rock wool which is an excellent heat insulator and sound absorber.

Retrofitting BMA's Existing Building

District Office

Office Building

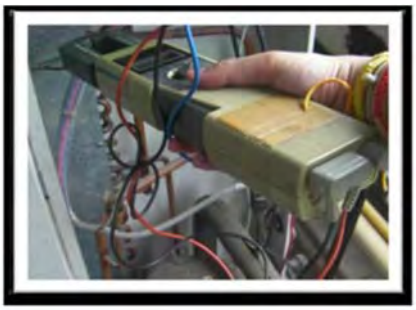
Hospital

Health Centre

School

Public Works Department Bangkok Metropolitan Administration

Preliminary energy analysis 12 Buildings



- Summary Result (not including building envelope measures) 512 buildings

Group Representative	Number of Building	SEC Reductions				Implemented Energy-Savings(kWh)	Money Savings (Baht)	Investment (Baht)	Pay-Back Period (Year)	CO2 Emission Reductions (tCO2/Year)
		kWh/m2	kWh/Person	MJ/m2	MJ/Bed					
Small School	278	20,555.32	66,450.34	-	-	20,147,357.78	72,548,467.38	244,403,700.00	3.37	11,709.36
Large School	98	4,275.74	903,656.27	-	-	8,881,430.81	31,376,772.21	119,080,290.00	3.80	4,952.43
				-	-					
Large District Office	13	774.41	-	-	-	2,079,883.85	6,819,662.66	23,014,550.00	3.37	1,343.81
			-	-	-					
Small District Office	15	1,915.80	15,027.30	-	-	1,069,036.50	3,495,749.40	24,384,000.00	6.98	316.05
Small Hospital	4	-	-	1746.76	117,313.48	3,887,842.88	13,024,273.64	21,105,000.00	1.62	2,259.60
Large Hospital	5	-	-	2,487.35	374,607.40	12,963,690.80	27,874,973.75	34,338,500.00	1.23	4,511.80
Small Health Care Center	47	4,163.73	33,922.25	-	-	1,546,669.89	5,428,811.14	25,278,010.00	4.66	899.11
Large Health Care Center	13	840.06	10,847.72	-	-	265,374.59	873,082.34	7,255,040.00	8.31	154.18
Small Other Office	29	142.68	-	-	-	1,573,370.93	5,821,472.47	63,939,200.00	10.98	914.37
Large Other Office	10	1,668.90	41,967.40	-	-	10,134,508.20	39,017,856.60	93,714,000.00	2.40	5,890.20
Total	512	34,336.64	1,071,871.28	4,234.11	491,920.88	62,549,166.23	206,281,121.59	656,512,290.00	3.18	32,950.91

Concept of Low Carbon City

ร้อย 1 และ 2 ดำเนินการแล้วจาก Action Plan 2007-2012

ระบบการสร้างกิจกรรมของการลด CO_2

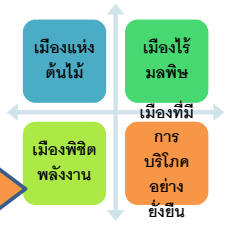
1. การวิเคราะห์การบริโภคของประชาชนจากการใช้
2. การวิเคราะห์ปริมาณของเสียที่ก่อให้เกิดก๊าซเรือนกระจก ได้แก่ น้ำเสีย และขยะ
3. *สร้างกิจกรรมมาตรการรองรับจากการวิเคราะห์การเกิดก๊าซเรือนกระจกโดยคิดจากปริมาณก๊าซคาร์บอนได้ออกไซที่เมืองผลิตขึ้น*
4. *สร้างกระแสความรับผิดชอบร่วมกันทุกภาคส่วน*

เมืองคาร์บอนต่ำ

เมืองลดคาร์บอน (Low Carbon City) : เมืองที่มีการคำนวณขนาดปริมาณก๊าซเรือนกระจกที่ปล่อยจากกิจกรรมทั้งหมดขององค์กรในรูปของ CO_{2eq} โดยเมืองนั้นต้องมีการพัฒนาแนวทางการลดการปล่อยก๊าซเรือนกระจกในกิจกรรมต่างๆ และมีเป้าหมายในการลดก๊าซเรือนกระจกในอนาคต

ตัวชี้วัด

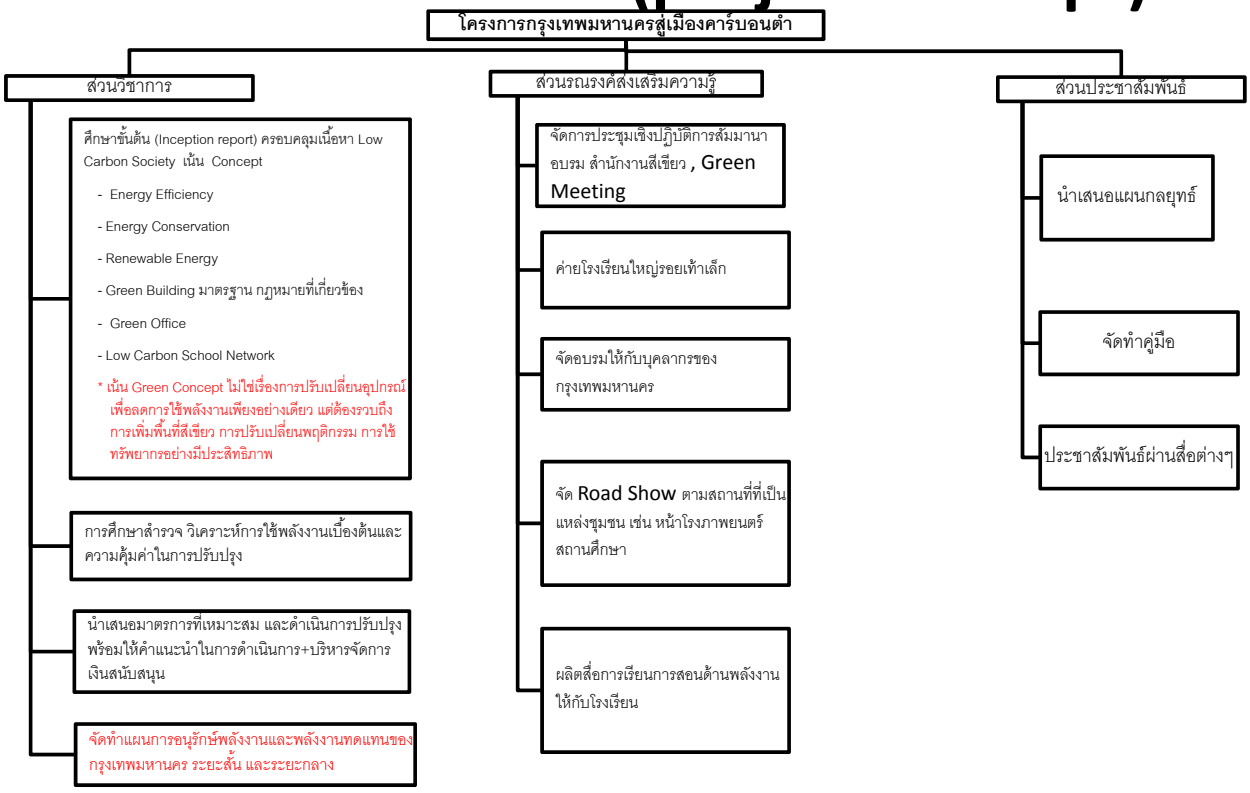
นโยบาย มาตรการ แผนงาน โครงการ หรือกิจกรรมเกี่ยวกับการลดหรือการส่งเสริมการลดการใช้พลังงานอย่างน้อย 1 นโยบาย/มาตรการ/แผนงาน/โครงการ/กิจกรรมต่อปี



โครงการกรุงเทพสู่สังคมคาร์บอนต่ำ

กรอบยุทธศาสตร์ ของสมาคมสันนิบาตเทศบาลแห่งประเทศไทย

กรอบแนวคิดโครงการฯ (project concept)



Achievements, Lessons learned & challenges, and expectation

- How to select necessary data and information for simple and sustainable monitoring and progress management of the Master Plan,
  - Direct control of BMA
  - In-direct control of BMA
- Discuss the BaU scenario based on the data and information which TF can collect easily and continuously,
- Consider possible mitigation measures and set the GHG emission reduction target, etc.

Challenges

Bangkok Master Plan on Climate Change 2013-2023

- BMA is formulating a 10-year Master Plan, 2013 – 2023, which covers adaptation and mitigation plan supported by JICA.

Creating Low Carbon Society in Bangkok

- BMA is going to launch more projects to additional target groups such as
  - Low Carbon School Networks in 2012.
  - Low Carbon Bangkok City Project in 2013 : target groups such as office buildings, schools, universities.

Improving Building Energy Consumption Efficiency

- The Establishment of BMA Building Energy Management Software to control of appliance utility in the building to work automatically and properly to curtail the electricity cost during peak load.
- Retrofitting of BMA Existing Building Towards Energy Saving Building.

Drafting a Plan of Energy Efficiency and Alternative Energy in a Bangkok Master Plan on Climate Change 2013-2023

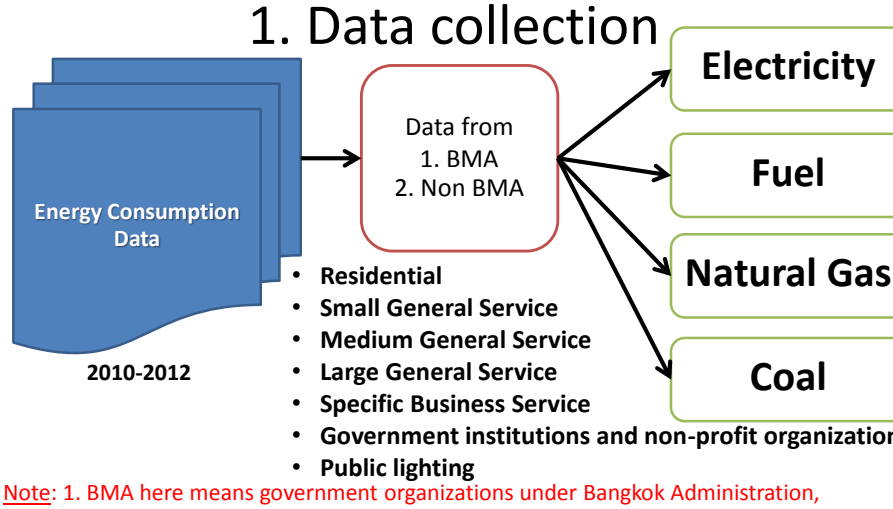
20th May

Energy Efficiency and Alternative Energy Task Force

TABLE OF CONTENTS

Ⅰ. Energy Consumption data in BMA district

1. Data collection



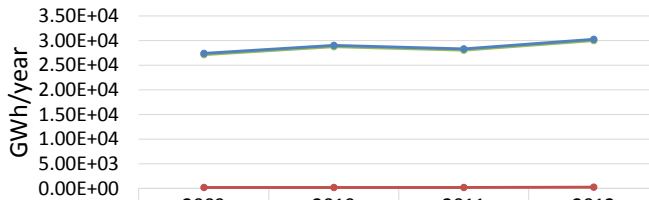
- **Residential**
- **Small General Service**
- **Medium General Service**
- **Large General Service**
- **Specific Business Service**
- **Government institutions and non-profit organization**
- **Public lighting**

Note: 1. BMA here means government organizations under Bangkok Administration, which exclude the central government organization in other Ministries

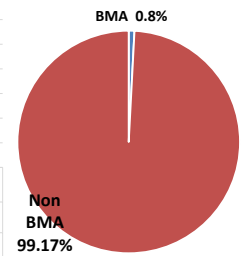
2. Non-BMA means other central government organizations and all other sectors (manufacturing, commercial buildings, transport, agriculture) in Bangkok entire area.

2. Calculate and Analyze Data

(1) Electricity consumption (million GWh/year)

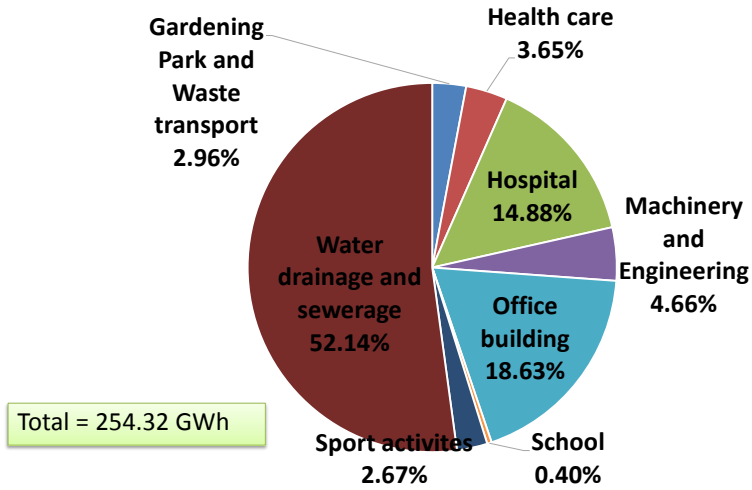


	2009	2010	2011	2012
BMA	231.75	243.15	220.52	254.31
Non BMA	27,156.71	28,775.18	28,072.59	29,983.05
Total	27,388.46	29,018.33	28,293.11	30,237.36



- Secondary data from Metropolitan Electricity Authority (MEA)
- BMA: Electricity has increased continuously by about 10% except in 2011 which due to the great flood.
- การใช้ไฟฟ้า BMA คือ ปริมาณการใช้ไฟฟ้าของอาคารราชการภายใต้สังกัดกรุงเทพมหานคร

Electricity Consumption proportion of BMA in 2012

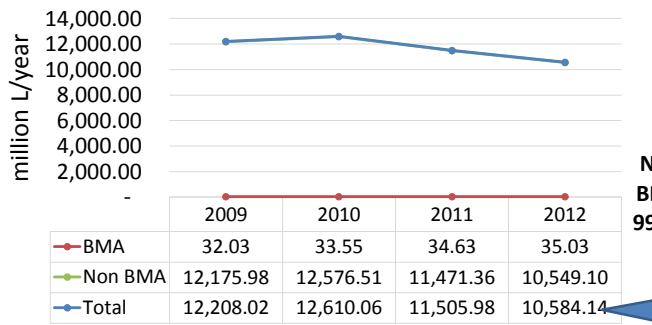


Total = 254.32 GWh

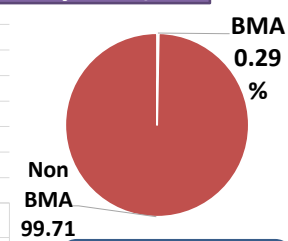
5

2. Calculate and Analyze Data

(2) Fuel consumption (million L/year)



	2009	2010	2011	2012
BMA	32.03	33.55	34.63	35.03
Non BMA	12,175.98	12,576.51	11,471.36	10,549.10
Total	12,208.02	12,610.06	11,505.98	10,584.14

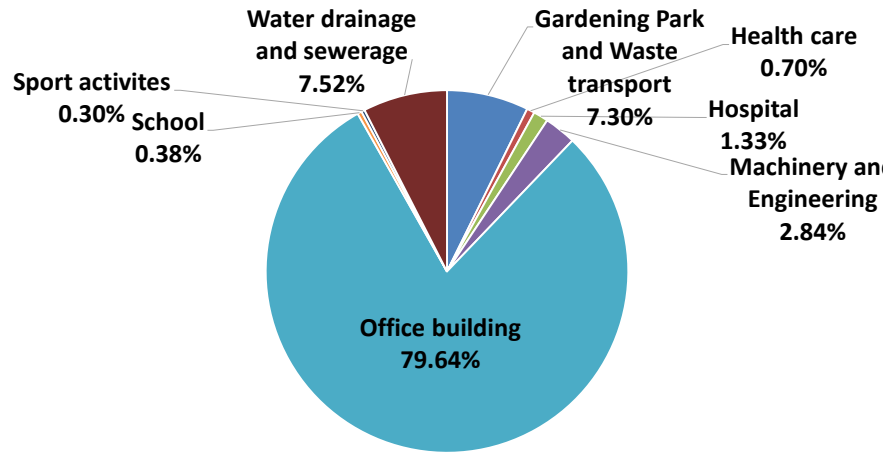


Decrease due to the decrease of LPG in transport sector in 2012

- Secondary data from Department of Energy Business, Ministry of Energy
- BMA: Fuel consumption has increased continuously about 5% except in 2011which due to the great flood.
- Fuel here consists of diesel, gasoline, gasohol, LPG and fuel oil, transport sector also included
- For easier understanding, the proportion here presents in physical unit (litre), not in heating value (Joule)

6

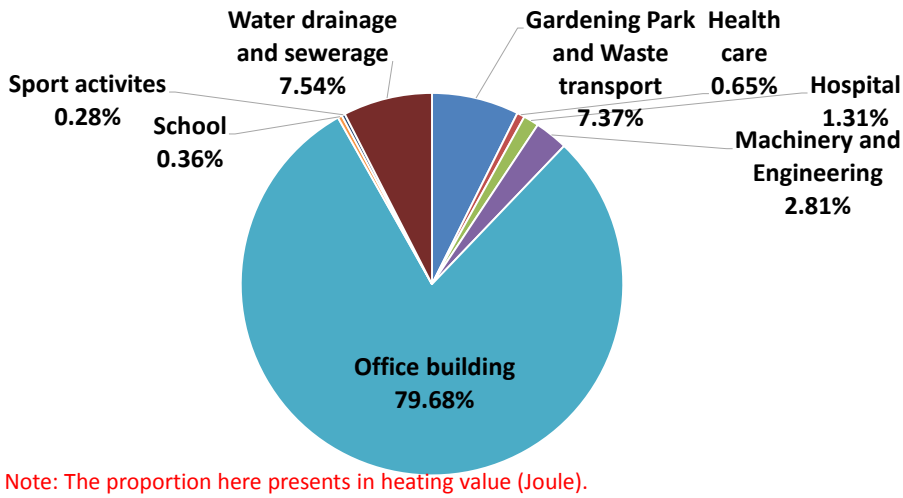
Fuel Consumption Ratio of BMA in 2012 (in physical units)



Note: For easier understanding, the proportion here presents in physical unit (litre), not in heating value (Joule)

7

Fuel Consumption Ratio of BMA in 2012 (in heating value)

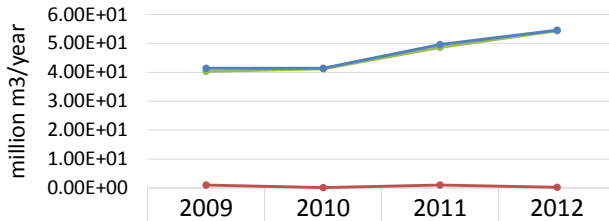


Note: The proportion here presents in heating value (Joule).
Heating value conversion factor from DEDE

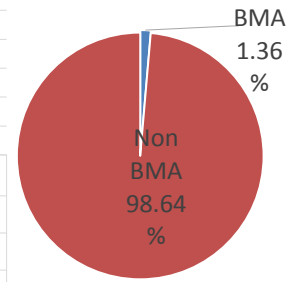
8

2. Calculate and Analyze Data

(3) Natural Gas consumption (million m^3/year)



	2009	2010	2011	2012
BMA	1.06	0.16	1.03	0.22
Non BMA	40.30	41.22	48.57	54.34
Total	41.36	41.39	49.60	54.56

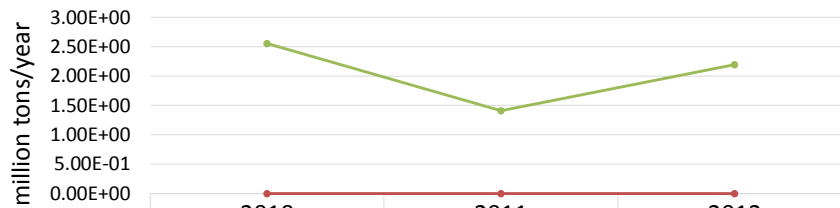


- Secondary data from PTT Public Company Limited
- BMA: NG consumption is slightly increased

9

2. Calculate and Analyze Data

(4) Coal consumption (ton/year)



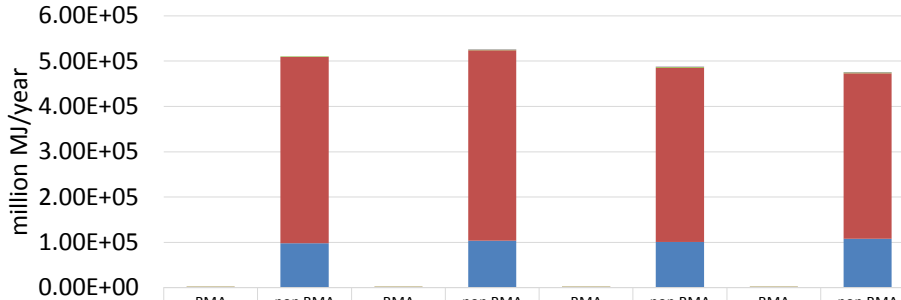
	2010	2011	2012
BMA	-	-	-
Non BMA	2.56	1.41	2.20

- Secondary data from Energy Database of Department of Alternative Energy Development and Efficiency, Ministry of Energy
- The consumption of coal has occurred only in the industrial

10

2. Calculate and Analyze Data

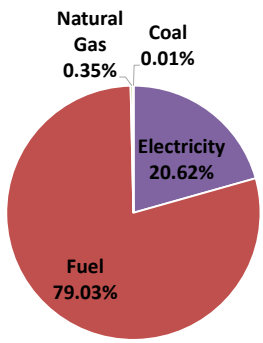
Total of Energy consumption (million MJ/year)

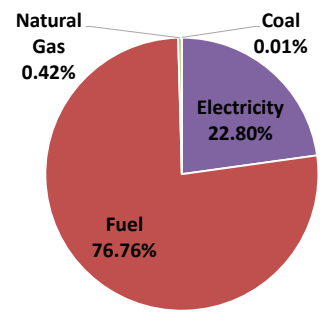


	2009		2010		2011		2012	
	BMA	non BMA	BMA	non BMA	BMA	non BMA	BMA	non BMA
Coal	-	-	-	62.62	-	34.54	-	57.95
Natural Gas	39.55	1,496.71	6.12	1,531.20	38.32	1,803.93	7.99	2,018.48
Fuel	1,164.16	411,069.45	1,219.34	420,295.50	1,258.77	384,210.28	1,273.51	365,179.61
Electricity	834.31	97,764.15	875.35	103,590.64	793.88	101,061.31	915.53	107,938.96
Total	**2,038.02**	**510,330.31**	**2,100.80**	**525,479.96**	**2,090.97**	**487,110.07**	**2,197.03**	**475,195.00**

11

2. Calculate and Analyze Data





Electricity Fuel Natural Gas Coal

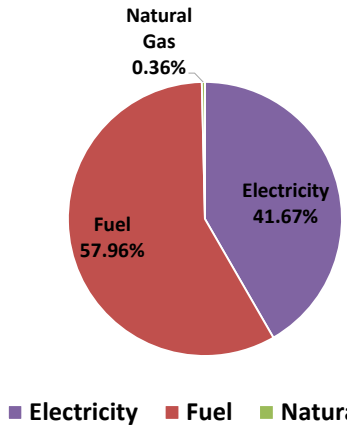
Consumption Ratio of In Bangkok entire area 2009-2012

Electricity Fuel Natural Gas Coal

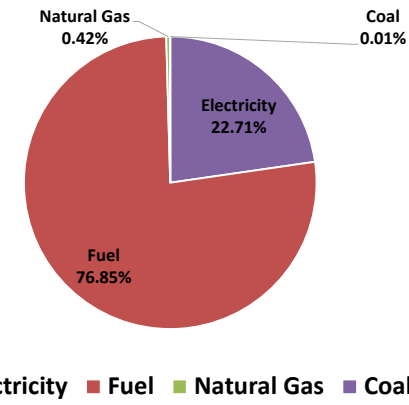
Consumption Ratio of In Bangkok entire area 2012

12

2. Calculate and Analyze Data



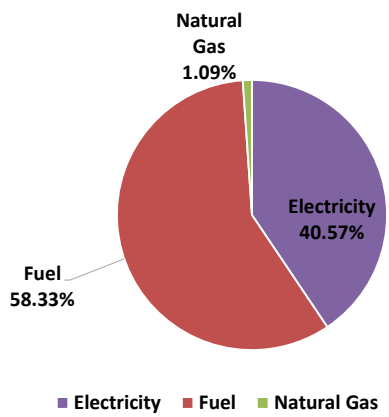
Consumption Ratio of BMA section Only 2012



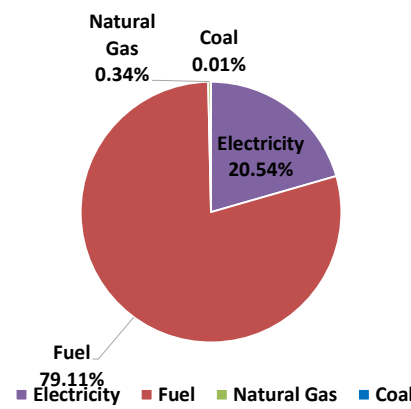
Consumption Ratio of Non BMA section Only 2012

13

2. Calculate and Analyze Data



Consumption Ratio of BMA section Average 2009-2012



Consumption Ratio of Non BMA section Average 2009-2012

14

Summary

- Energy Consumption data
  - The highest energy consumption is fuel (oil for transport)and tend to continuously increase.
  - Total amount of fuel consumption of Bangkok are decreased due to the decrease of LPG, but in BMA the overall consumption are increased
  - Coal consumption is only in industrial sector.
  - Great flood in 2011 makes impacts on the reduction in all energy consumption (except NG) in that year.

15

Ⅱ. Activities on Energy Efficiency and Alternative Energy

List of Activities(countermeasures)

Countermeasures on Energy Efficiency and Alternative Energy

No.	Countermeasure
1	Retrofitting BMA's Existing Building for appropriate management of energy
2	Renovation of BMA buildings(DPW building, etc.) for reducing energy consumption
3	BMA City Hall 2(follows international green building standards, contains district cooling project)
4	Public awareness campaign for energy saving behavior with DEDE
5	Promoting energy saving business style among city employees

16

Countermeasure 1
- Retrofitting BMA's Existing Building for appropriate management of energy -

Target		
Short-term (2015)	Target in Activity Level	Estimated Emission Reduction
Retrofitting BMA's Existing Building	Start retrofitting model project buildings	- CO2-t
Long-term (2023)	Target in Activity Level	Estimated Emission Reduction
Retrofitting BMA's Existing Building	Start retrofitting other buildings	- CO2-t
BMA Action to realize emission reduction	Promoting retrofit of model project building, and spread retrofitting other buildings of BMA.	
Related stakeholders	DPW	

17

Retrofitting BMA's Existing Building

District Office

Office Building

Hospital

Health Centre

School

18

- Summary Result (not including building envelope measures) 512 buildings

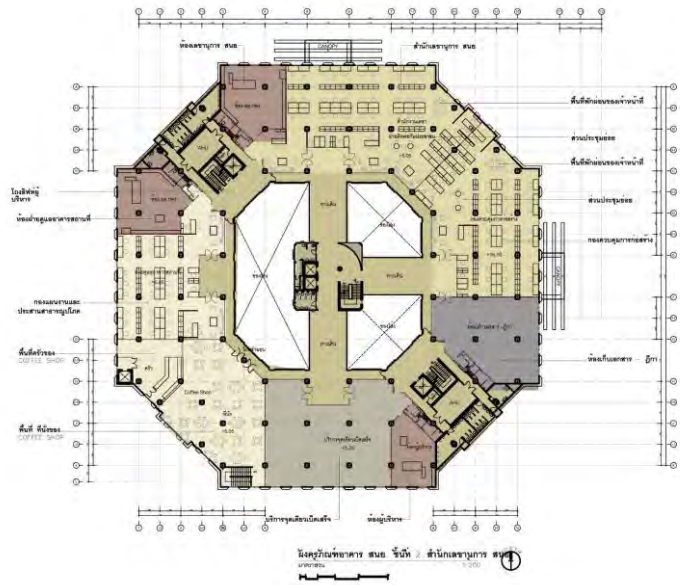
Group Representative	Number of Building	SEC Reductions				Implemented Energy-Savings(kWh)	Money Savings (Baht)	Investment (Baht)	Pay-Back Period (Year)	CO2 Emission Reductions (tCO2/Year)
		kWh/m2	kWh/Person	MJ/m2	MJ/Bed					
Small School	278	20,555.32	66,450.34	-	-	20,147,357.78	72,548,467.38	244,403,700.00	3.37	11,709.36
Large School	98	4,275.74	903,656.27	-	-	8,881,430.81	31,376,772.21	119,080,290.00	3.80	4,952.43
				-	-					
Large District Office	13	774.41	-	-	-	2,079,883.85	6,819,662.66	23,014,550.00	3.37	1,343.81
			-	-	-					
Small District Office	15	1,915.80	15,027.30	-	-	1,069,036.50	3,495,749.40	24,384,000.00	6.98	316.05
Small Hospital	4	-	-	1746.76	117,313.48	3,887,842.88	13,024,273.64	21,105,000.00	1.62	2,259.60
Large Hospital	5	-	-	2,487.35	374,607.40	12,963,690.80	27,874,973.75	34,338,500.00	1.23	4,511.80
Small Health Care Center	47	4,163.73	33,922.25	-	-	1,546,669.89	5,428,811.14	25,278,010.00	4.66	899.11
Large Health Care Center	13	840.06	10,847.72	-	-	265,374.59	873,082.34	7,255,040.00	8.31	154.18
Small Other Office	29	142.68	-	-	-	1,573,370.93	5,821,472.47	63,939,200.00	10.98	914.37
Large Other Office	10	1,668.90	41,967.40	-	-	10,134,508.20	39,017,856.60	93,714,000.00	2.40	5,890.20
Total	512	34,336.64	1,071,871.28	4,234.11	491,920.88	62,549,166.23	206,281,121.59	656,512,290.00	3.18	32,950.91

19

Countermeasure 2
-Renovation of BMA buildings(DPW building, etc.) for reducing energy consumption -

Target		
Short-term (2015)	Target in Activity Level	Estimated Emission Reduction
Renovation of BMA buildings	Start renovation of DPW	- CO2-t
Long-term (2023)	Target in Activity Level	Estimated Emission Reduction
Renovation of BMA buildings	Start renovation of other buildings	- CO2-t
BMA Action to realize emission reduction	Promoting renovation of BMA buildings.	
Related stakeholders	DPW	

20



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22

Scope of works

- Renovate 2 buildings (Department of drainage and department of public works) area 35,000 sq.m.
- Renovation consist of changing envelop of building by changing material to reduce radiation of heat to building.

23

24


อาคารสำนักการโยธา
25


อาคารสำนักการโยธา
อาคารปรับปรุงสำนักการโยธา
26

District Cooling Project

27

Scope of project

- District Cooling system can improve efficiency of electrical power usage by average demand on cooling power system close to actual demand.
- District Cooling system is much easier to maintenance because all machines are in proximity area.
- Cooling load 500 BTU/sq.m.
- Cooling area are 120,000 sq.m.

28

Countermeasure 3
-BMA City Hall 2(follows international green building standards, contains district cooling project)-

Target		
Short-term (2015) Long-term (2023)	Target in Activity Level Implement the Green building standard	Estimated Emission Reduction
Construction of BMA City Hall 2 (green building)	Completion of construction	- CO2-t
BMA Action to realize emission reduction	Complete the new green building and Appeal the merit for environment to citizens, private enterprises.	
Related stakeholders	DPW	

29

BMA City Hall 2

The Bangkok City Tower follows the six criteria for international green building standards.

30

BMA City Hall 2

The six criteria for international green building standards, which are:

1. Good building management
2. Well-designed landscaping to reduce the urban heat effect
3. Effective use of water
4. Maximum cost-efficient use of energy
5. Use of environmentally friendly materials and construction methods
6. Creating comfort zones in the building to enhance people's quality of life and to encourage environmental concern

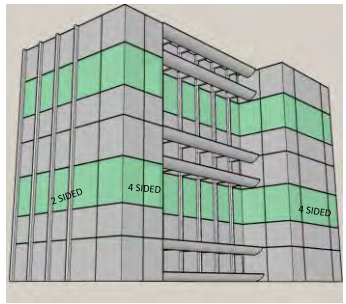
31

BMA City Hall 2

Building orientation

Design for orientation is a fundamental step to ensure that buildings work with the passage of the sun across the sky. Maximizing north and south façade exposure to let in light and passive solar gain.

BMA City Hall 2



Material selection

Curtain Walls

Vision area is equipped with *double*-panel insulated glass to lower the amount of heat penetration and enhance noise reduction.

Spandrel area utilizes aluminium composite panel which is *heat* resistant and waterproof. Fiber cement board is used to create a continuous surface suitable for most types of interior decoration. Sandwiched between aluminium composite panel and fiber cement board is rock wool which is an excellent heat insulator and sound absorber.

33

BMA City Hall 2

Roof

Reinforced concrete roof is laced with fireproofing fiberglass insulator to enhance thermal protection.

Air-conditioning and Ventilation Systems

Water cooled chillers, compared to air cooled chillers, have longer life, higher efficiency, large capacity and lower operational costs. It gives the precise response for required cooling load, and achieves energy-saving.

Domestic wastewater from the buildings in the complex will be collected and treated at *Din Daeng Wastewater Treatment* Plant. Recycled wastewater is used for landscaping and toilet flushing at the city hall complex.

34

Countermeasure 4
-Public awareness campaign for energy saving behavior with DEDE -

Target		
Short-term (2015) Long-term (2023)	Target in Activity Level	Estimated Emission Reduction
Public awareness campaign	Launching the campaign on Energy Conservation issue	-
BMA Action to realize emission reduction	Promoting campaign about energy-saving behavior to children, students, other younger generation.	
Related stakeholders	DOE, DEDE and private sectors	

35

36


Thank you

1st Drafting of Bangkok Master Plan on Climate Change 2013-2023 in The Kingdom of Thailand

Energy Efficiency and Alternative Energy Task Force

22nd October 2014

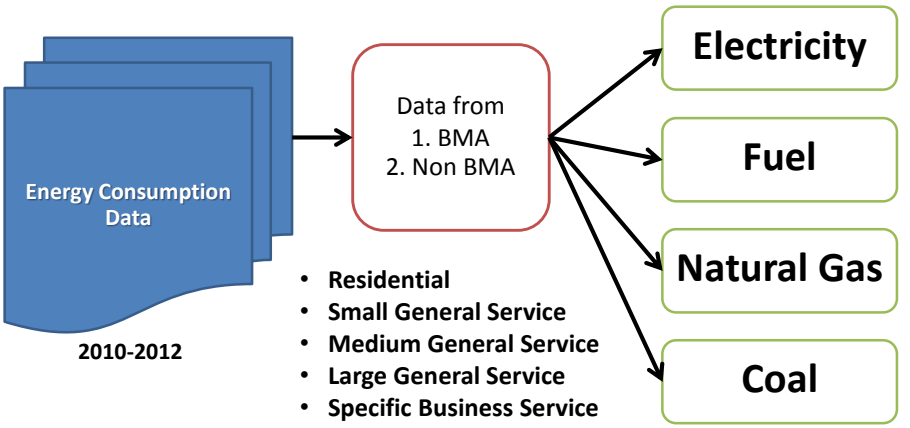
OUTLINES

Ⅰ. Energy Consumption data in BMA district

Ⅱ. 1st Draft of Master Plan on Energy Efficiency and Alternative Energy

Ⅰ. Energy Consumption data in BMA district

1.Collect Data

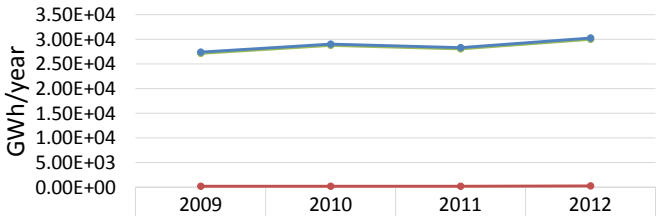


- **Residential**
- **Small General Service**
- **Medium General Service**
- **Large General Service**
- **Specific Business Service**
- **Government institutions and non-profit organization**
- **Public lighting**

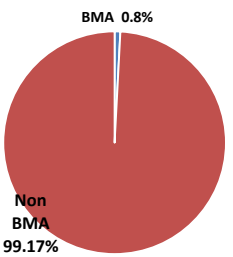
Note: BMA here means government organizations under Bangkok Administration, which exclude the central government organization in other Ministries

2. Calculate and Analyze Data

(1) Electricity consumption (million GWh/year)

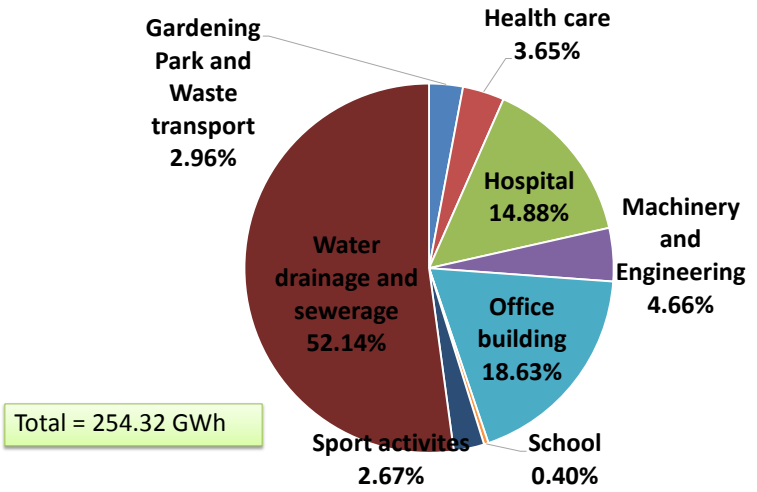


	2009	2010	2011	2012
BMA	231.75	243.15	220.52	254.31
Non BMA	27,156.71	28,775.18	28,072.59	29,983.05
Total	27,388.46	29,018.33	28,293.11	30,237.36



- Secondary data from Metropolitan Electricity Authority (MEA)
- BMA: Electricity has increased continuously by about 10%
- การใช้ไฟฟ้า BMA คือ ปริมาณการใช้ไฟฟ้าของอาคารราชการภายใต้สังกัดกรุงเทพมหานคร

Electricity Consumption proportion of BMA in 2012



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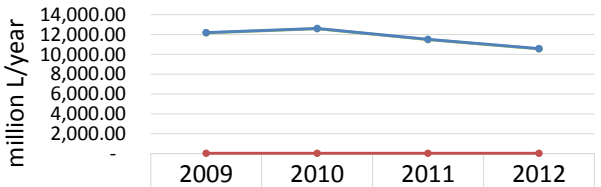
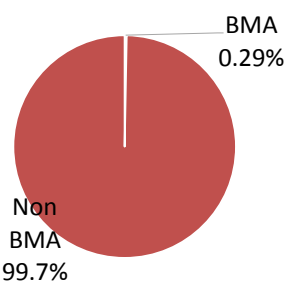
2. Calculate and Analyze Data

(2) Fuel consumption (million L/year)



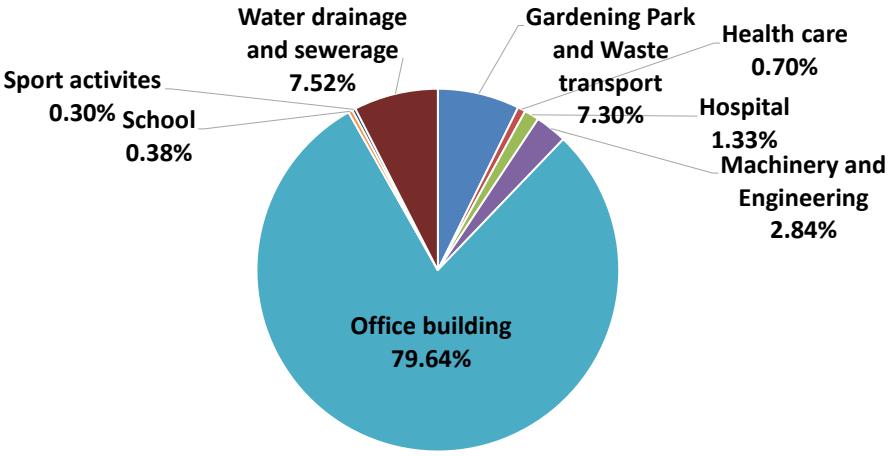
	2009	2010	2011	2012
BMA	32.03	33.55	34.63	35.03
Non BMA	12,175.	12,576.	11,471.	10,549.
Total	12,208.	12,610.	11,505.	10,584.



- Secondary data from Department of Energy Business, Ministry of Energy
- BMA: Fuel consumption has increased continuously about 5%
- For easier understanding, the proportion here presents in physical unit (litre), not in heating value (Joule)

6

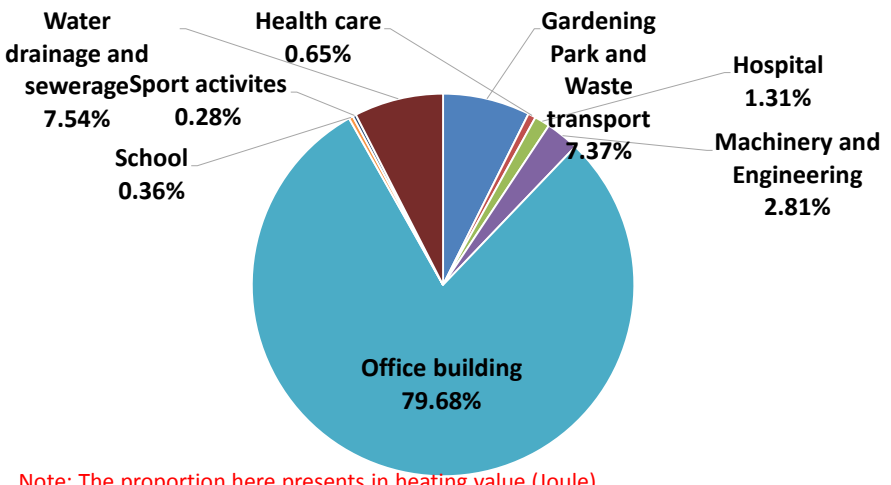
Fuel Consumption Ratio of BMA section in 2012



Note: For easier understanding, the proportion here presents in physical unit (litre), not in heating value (Joule)

7

Fuel Consumption Ratio of BMA section in 2012



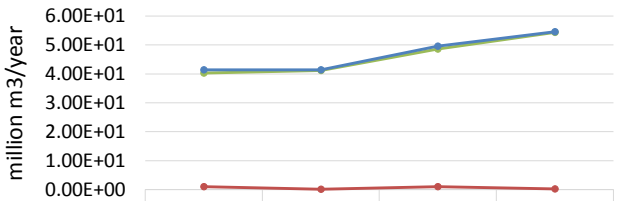
Note: The proportion here presents in heating value (Joule).

สัดส่วนในหน้านี้ แสดงสัดส่วนโดยแปลงหน่วยลิตรน้ำมันของดีเซลและ Gasohol เป็นค่าความร้อน (joule) แล้ว

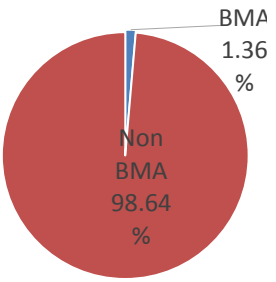
8

2. Calculate and Analyze Data

(3) Natural Gas consumption (million m^3/year)



	2009	2010	2011	2012
BMA	1.06	0.16	1.03	0.22
Non BMA	40.30	41.22	48.57	54.34
Total	41.36	41.39	49.60	54.56

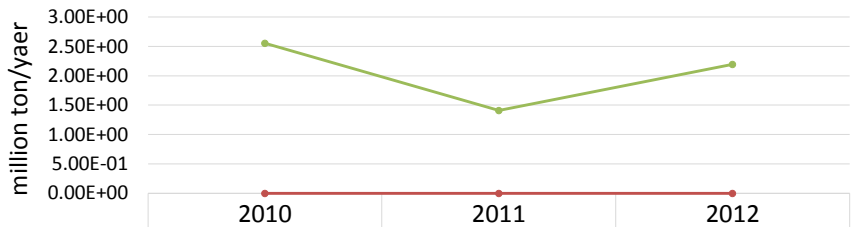


- Secondary data from PTT Public Company Limited
- BMA: NG consumption is slightly increased

9

2. Calculate and Analyze Data

(4) Coal consumption (ton/year)

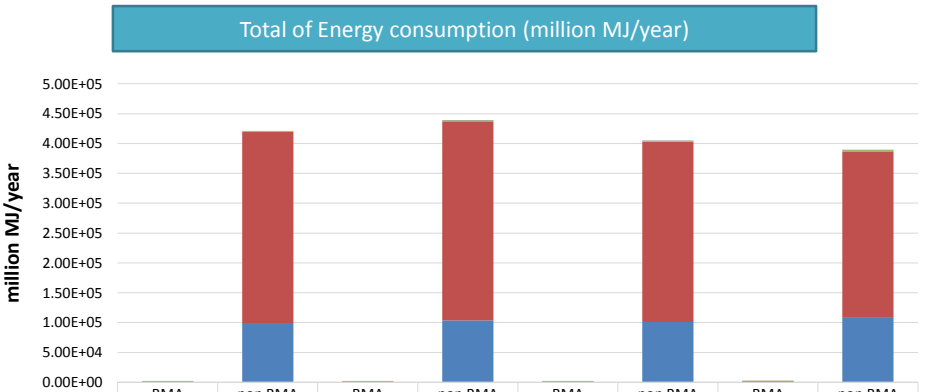


	2010	2011	2012
BMA	-	-	-
Non BMA	2.56	1.41	2.20

- Secondary data from Energy Database of Department of Alternative Energy Development and Efficiency, Ministry of Energy
- The consumption of coal has occurred only in the industrial

10

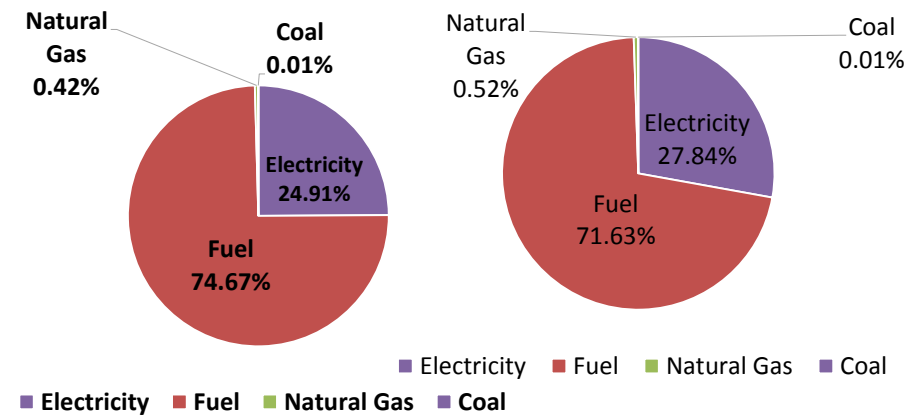
2. Calculate and Analyze Data



	2009		2010		2011		2012	
	BMA	non BMA	BMA	non BMA	BMA	non BMA	BMA	non BMA
Coal	-	-	-	62.62	-	34.54	-	57.95
Natural Gas	39.55	1,496.71	6.12	1,531.20	38.32	1,803.93	7.99	2,018.48
Fuel	1,135.68	321,552.25	1,192.61	333,486.93	1,231.63	301,779.50	1,246.89	278,874.68
Electricity	834.31	97,764.15	875.35	103,590.64	793.88	101,061.31	915.53	107,938.96

Total	2,009.55	420,813.11	2,074.07	438,671.39	2,063.83	404,679.29	2,170.41	388,890.08

2. Calculate and Analyze Data

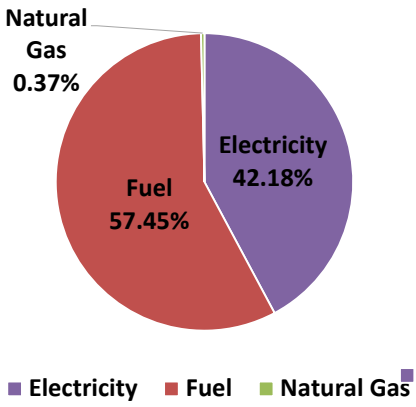


Consumption Ratio of In Bangkok entire area 2009-2012

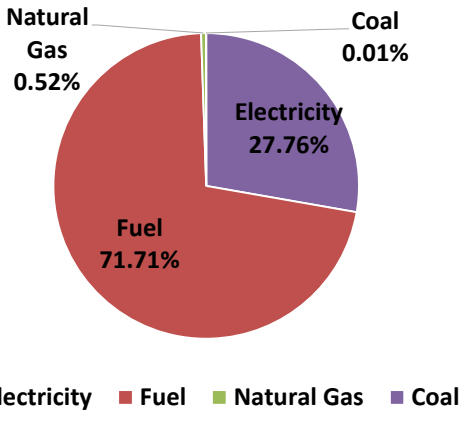
Consumption Ratio of In Bangkok entire area 2012

12

2. Calculate and Analyze Data



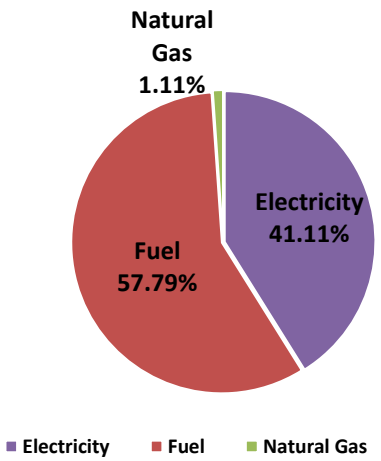
Consumption Ratio of BMA section Only 2012



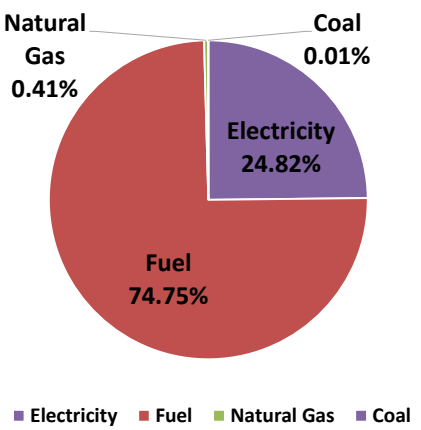
Consumption Ratio of Non BMA section Only 2012

13

2. Calculate and Analyze Data



Consumption Ratio of BMA section Average 2009-2012



Consumption Ratio of Non BMA section Average 2009-2012

14

Summary

- Energy Consumption data
  - The highest energy consumption is fuel (oil for transport)and tend to use it increasingly.
  - Electricity, fuel and natural gas consumption are increasing both in BMA and Non BMA
  - Coal consumption is only in industrial sector and increase due to the growth of the industry in Thailand.

15

Ⅱ. 1st Draft of Master Plan on Energy Efficiency and Alternative Energy

1. List of Possible Countermeasures on Energy Efficiency and Alternative Energy (Tentative)

No.	Categories
1	BMA Government Buildings and Facilities
2	Civil Categories (Residential, Commercial, and Industrial Part)

16

BMA's Existing Building

District Office

Office Building

Hospital

Health Centre

School

17

Public Works Department Bangkok Metropolitan Administration

- Summary Result (not including building envelope measures) 512 buildings

Group Representative	Number of Building	SEC Reductions				Implemented Energy-Savings(kWh)	Money Savings (Baht)	Investment (Baht)	Pay-Back Period (Year)	CO2 Emission Reductions (tCO2/Year)
		kWh/m2	kWh/Person	MJ/m2	MJ/Bed					
Small School	278	20,555.32	66,450.34	-	-	20,147,357.78	72,548,467.38	244,403,700.00	3.37	11,709.36
Large School	98	4,275.74	903,656.27	-	-	8,881,430.81	31,376,772.21	119,080,290.00	3.80	4,952.43
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			-	-	-					
Small District Office	15	1,915.80	15,027.30	-	-	1,069,036.50	3,495,749.40	24,384,000.00	6.98	316.05
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Category 1
- BMA Government Buildings and Facilities

1-1 Energy saving renovation/repair work for existing facilities	
1-1-1 General tasks	Form the systematic schedule of retrofitting BMA's existing building for appropriate management of energy
Main Responsibilities - DPW	Systematic implementation of energy saving retrofitting works of BMA's existing building
	Selection of model project for energy saving renovation work. Intensive adoption of top-runner appliances
	Energy saving requirements for retrofitting works of BMA facilities and setting of high-level of energy efficiency Acquisition of certification for energy saving renovation work (CASBEE or LEED etc.)
	Consideration of renovation work, extension work, conversion at the time of facilities update (maximum utilization of existing stocks)
	Efficient retrofitting/renovation work for energy saving by introducing private capital know-how (ESCO business etc.)

Category 1 (continued)
- BMA Government Buildings and Facilities

1-1 Energy saving renovation/repair work for existing facilities	
1-1-2 Improve insulation performance (renovation technique)	Introduce thermal barrier roof coatings
Main Responsibilities - DPW - DOE (Roof greening only)	Improve external insulation and waterproofing
	Introduce roof greening
	Improve heat insulating window (high heat insulating glass such as low-e pair glass)
	Improve heat insulating window (thermal barrier film)
	Controlling solar radiation heat by installing louver or eaves

Category 1 (continued)
- BMA Government Buildings and Facilities

1-1 Energy saving renovation/repair work for existing facilities	
1-1-3 Cut down air conditioning/ ventilation load (retrofitting technique)	Replace existing air-conditioning equipment by high-efficiency one
Main Responsibilities - DPW	Introduce variable flow controller
	Introduce task ambient air conditioning system - controlled by motion/temperature sensor, timer etc.
	Introduce high-efficiency fan (total heat exchanger)
	Introduce cogeneration system

Category 1 (continued)
- BMA Government Buildings and Facilities

1-1 Energy saving renovation/repair work for existing facilities	
1-1-4 Cut down lighting load (retrofitting technique)	Introduce LED lighting or hf fluorescent lamp
Main Responsibilities - DPW	Introduce task ambient lighting
	Install motion sensor lighting to bathroom, corridor or staircase
	Daytime energy reduction by daylight sensor

Category 1 (continued)
- BMA Government Buildings and Facilities

1-1 Energy saving renovation/repair work for existing facilities	
1-1-5 Energy reduction by water saving	Upgrade to water saving sanitary appliances
Main Responsibilities - DPW	Introduce rainwater recycling system
	Introduce wastewater recycling system (reuse as toilet bowl flushing water)
1-1-6 Others	Solar power generation systems
	Introduce BEMS, building energy management systems
	Replacing street lighting to LED

Category 1 (continued)
- BMA Government Buildings and Facilities

1-2 Energy saving consideration for new construction	
1-2-1 General tasks	Construct high energy efficiency building
Main Responsibilities - DPW	Requirements of certificate acquisition for new construction of BMA facilities (CASBEE or LEED etc.)

Category 1 (continued)
- BMA Government Buildings and Facilities

1-3 Information campaign	
1-3-1 Conduct campaign to citizens	Promote environmental education at school
Main Responsibilities - DOE - DPW (Hold workshop… only)	Support opening exhibition of energy saving merchandise for BMA facility
	Visualization of energy saving of BMA facility Notify saving energy activities by panel or monitor
	Promote "Green Curtain" installation at school to reduce air conditioning load
	Hold workshop on energy saving repair work for public participation (schoolchild, public facilities)

Category 1 (continued)
- BMA Government Buildings and Facilities

1-3 Information campaign	
1-3-2 Conduct campaign to the officials	Raise preset cooling temperature
Main Responsibilities - ALL	Commendation for saving energy activity
	Turn off lightings during lunch break
	Thorough power saving setting on PC or OA equipment

Category 1 (continued)
- BMA Government Buildings and Facilities

1-4 Promotion of low carbon city	
1-4-1 Model areas	Setup low-carbon model area, each fields top runner measure, intensive equipment investment
Main Responsibilities - DOE - DPW	

Category 2
- Civil Categories

2-1 Residential part	
2-1-1 Promotion of energy saving house	Promotion of low-carbon/energy saving detached house (Publicity of cost benefit from the viewpoint of LCC, backup exhibition, provide advertising spaces at BMA facilities)
BMA Responsibilities - Support	Facility equipment introduction promotion of energy saving house (LED lights, energy-saving air conditioning system or hot-water apparatus etc.)
2-1-2 Promotion of energy saving repair work	Publicity of cost benefit by repair work for energy saving
BMA Responsibilities - Support	Promotion of repair work for energy saving: insulation upgrade by double glazing, heat barrier film, renew air conditioning device (subsidy system etc.)

Category 2 (continued)
- Civil Categories

2-1 Residential part	
2-1-3 Promotion of energy saving home appliance	Purchase promotion of energy saving home electric appliances (air conditioning, fridge, TV etc.)
BMA Responsibilities - Support	
2-1-4 Promotion of energy saving action	Promote better understanding of air conditioner maintenance (conduct free cleaning)
BMA Responsibilities - Support	
2-1-5 Others	Promote solar panel installation (subsidy system or mediating installable roof)
BMA Responsibilities - Support	

Category 2 (continued)
- Civil Categories

2-2 Commercial/Business part	
2-2-1 Promotion of energy saving building	Incentive for constructing/repairing saving energy factory (tax reduction, subsidy, zero-interest financial etc.)
BMA Responsibilities - Support	

Category 2 (continued)
- Civil Categories

2-2 Commercial/Business part	
2-2-2 Promotion of energy saving repair work for existing building	Conduct energy saving inspection of public buildings
BMA Responsibilities - Support	Promotion of ESCO business for existing buildings (Educate ESCO business, advertisement promotion support, subsidy system for energy saving diagnostic)
	Promotion of repair work for energy saving: insulation upgrade by double glazing, heat barrier film, renew air conditioning device (subsidy system etc.)
	Publicity of cost benefit by Electricity Peak-Cut Introduction support for automatic control facility of Electricity Peak-Cut

Category 2 (continued)
- Civil Categories

2-2 Commercial/Business part	
2-2-3 Promotion of energy saving action	Promote saving energy activity (publicity of cost benefit etc.)
BMA Responsibilities - Support	Raise preset cooling temperature at public buildings Turn off lightings during lunch break
	Thorough power saving setting on PC or OA equipment
	Commendation for saving energy activity

Category 2 (continued)
- Civil Categories

2-2 Commercial/Business part	
2-2-4 Others	Promote solar panel installation (subsidy system or mediating installable roof)
BMA Responsibilities - Support	

Category 2 (continued)
- Civil Categories

2-3 Industrial part	
2-3-1 Promotion of energy saving factory	Incentive for constructing/retrofitting saving energy factory (tax reduction, subsidy, zero-interest financial etc.)
BMA Responsibilities - Support	
2-3-2 Promotion of energy saving repair work for existing factory	Conduct energy saving inspection of public factories
BMA Responsibilities - Support	Promotion of repair work for energy saving (subsidy system etc.)
	Publicity of cost benefit by Electricity Peak-Cut Introduction support for automatic control facility of Electricity Peak-Cut

Category 2 (continued)
- Civil Categories

2-3 Industrial part	
2-3-3 Promotion of energy saving action	Promotion activity for factory's energy saving technique (for SMEs)
BMA Responsibilities - Support	Commendation for saving energy activity
2-3-4 Others	Promote Solar Energy (subsidy system or mediating installable roof)
BMA Responsibilities - Support	Promote beneficial use of factory exhaust heat

Ⅱ. 1st Draft of Master Plan on Energy Efficiency and Alternative Energy

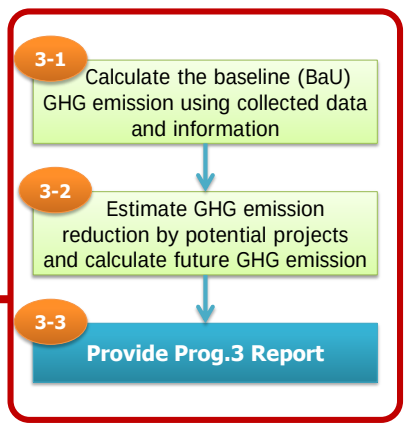
2. Scope (Work plan for Progress 3)

(P1) Understanding and confirming existing reports about energy in Bangkok (Jan 2014)

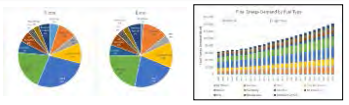
(P2) Collection of data/information for the formulation of the Master Plan (May 2014)

(P3) Quantification of Greenhouse Gas (GHG) (November 2014)

(P4) Regular Advices to the JICA Expert Team and follow up support of the activities (Feb 2015)



3-1 Calculate the baseline (BaU) GHG emission using collected data and information



July 2014

From energy consumption data (both BMA and Bangkok entire area) by using 2006 IPCC GHG inventory emission factor and apply 2010 as the base year; by fuel types, by sector, and by year

คำนวณการปล่อย GHG (ใช้ปี พ.ศ.2553 เป็นปีฐาน) โดยใช้ข้อมูลจากการใช้พลังงานของ กทม. และ ทั้งกรุงเทพ คำนวณแยกรายเชื้อเพลิง แยกการใช้ และแยกรายปี

3-2 Estimate GHG emission reduction by potential projects and calculate future GHG emission

Oct 2014

From planned energy projects in both BMA and Bangkok entire area; by fuel types, by sector, and by year

- Both energy efficiency and renewable energy project
- Both public and private sector (only official project/data/policies/plans would be considered)
- Estimate the future GHG emission (2010-2020)
- Scope for only Bangkok entire area including BMA

คำนวณศักยภาพการลดการปล่อย GHG โดยใช้ข้อมูลของ กทม. และ ทั้งกรุงเทพ ที่มีการวางแผนไว้ คำนวณแยกรายเชื้อเพลิง แยกลักษณะการใช้ และแยกรายปี

- ทั้งด้านการอนุรักษ์พลังงานและพลังงานทดแทน
- ทั้งภาครัฐและเอกชน โดยใช้ข้อมูล แผน นโยบายและกิจกรรมที่เป็นทางการเท่านั้น
- คำนวณการปล่อยในอนาคตหลังมีมาตรการ (2553-2563)

3-3 Provide Prog.3 Report

Nov 2014

Submit Prog. Report 3 ส่งรายงานก้าวหน้าฉบับ 3

Ⅱ. 1st Draft of Master Plan on Energy Efficiency and Alternative Energy

3. Results

3-1

Calculate the baseline (BaU) GHG emission using collected data and information

Sept 2014

From energy consumption data (both BMA and Bangkok entire area) by using revised 2006 IPCC GHG inventory emission factor and apply 2010 as the base year; by fuel types, by sector, and by year

คำนวณการปล่อย GHG (ใช้ปี พ.ศ.2553 เป็นปีฐาน) โดยใช้ข้อมูลจากการใช้พลังงานของ กทม. และ ทั้งกรุงเทพ คำนวณแยกรายเชื้อเพลิง แยกการใช้ และแยกรายปี

Data structure & Baseline setting → **Data collection** → **Data review & aggrega-tion** → **Data analysis** → **Convert from energy to GHG** → **GHG BaU Baseline**

Current status: 100%

- Apply 2010 as base year due to the comparability with national EEDP and NAMAs,
- Structure BMA/non-BMA sector: manufacturing, commercial and household sector
- Fuel type: electricity, oil, NG and coal

Street lighting is under considering btw transport sector or commercial sector

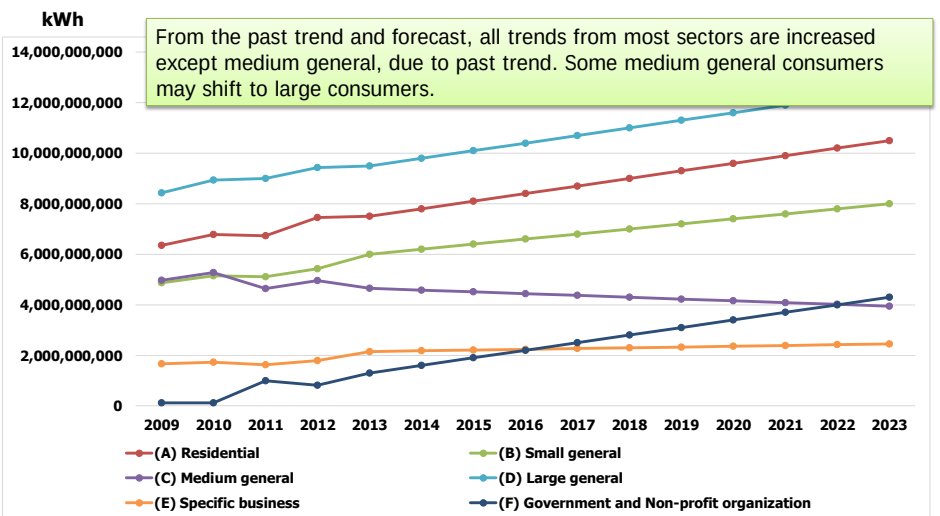
- Data availability: 2009-2013
- BMA → direct from BMA working team
- Non-BMA sector → Electricity (MEA) , oil (DOEB), NG (PTT) and coal (DEDE), RE (DEDE)

- Data review: comparability, unit conversion to MJ or toe
- Data analysis and QC under working team

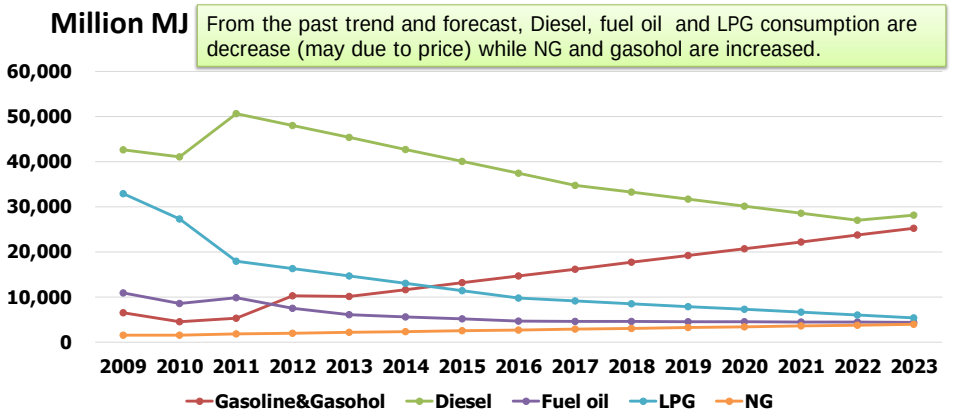
- Using emission factors from 2006 IPCC Guidelines to convert energy to GHG, covering CO2, CH4 and N2O and represent into CO2-eq
- Tables and graphs illustrate for the baseline emission including the most recent fact data from 2010 to 2013

Electricity: BAU & Demand forecast in Bkk

From the past trend and forecast, all trends from most sectors are increased except medium general, due to past trend. Some medium general consumers may shift to large consumers.

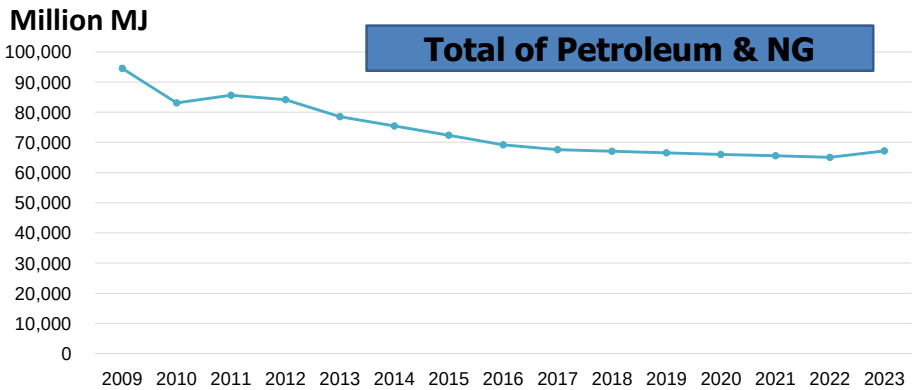


All petroleum products and NG:
BAU & Demand forecast in Bkk; by types



Note: Exclude energy in transport sector

All petroleum products and NG:
BAU & Demand forecast in Bkk



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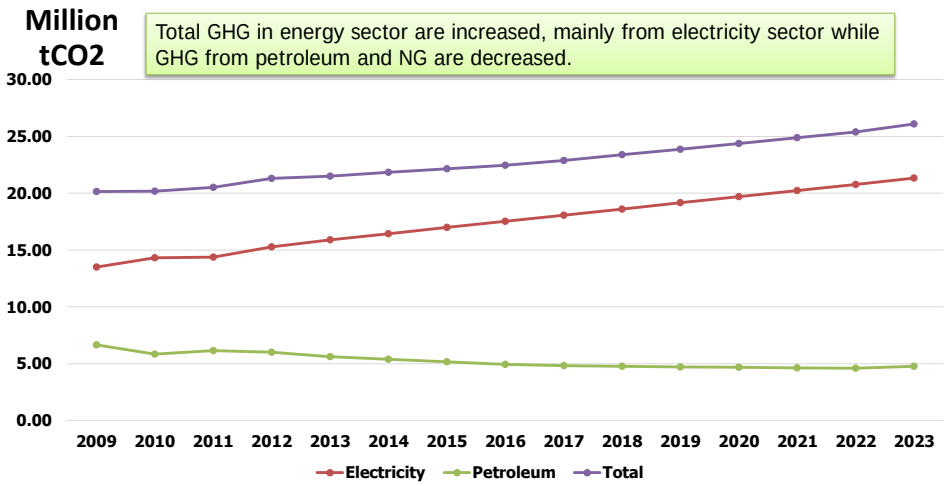
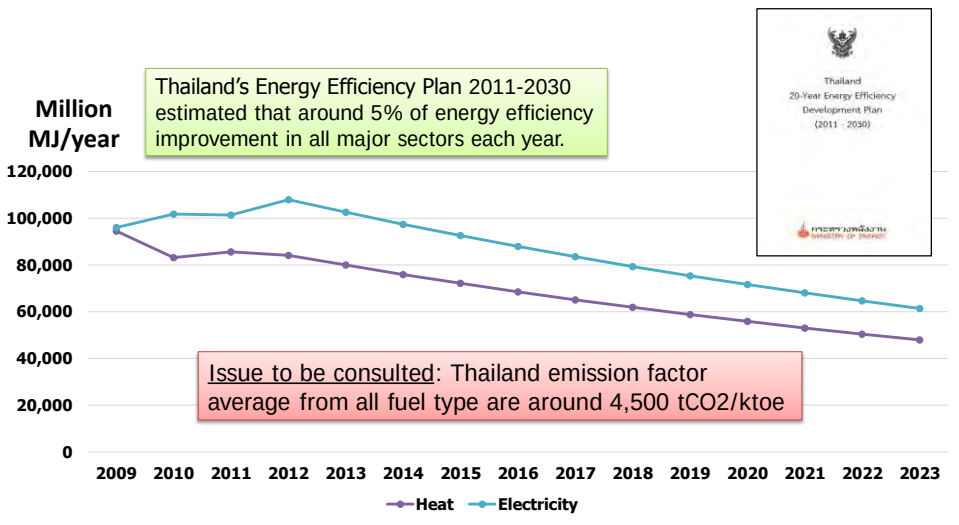
GHG: BAU & forecast in Bkk



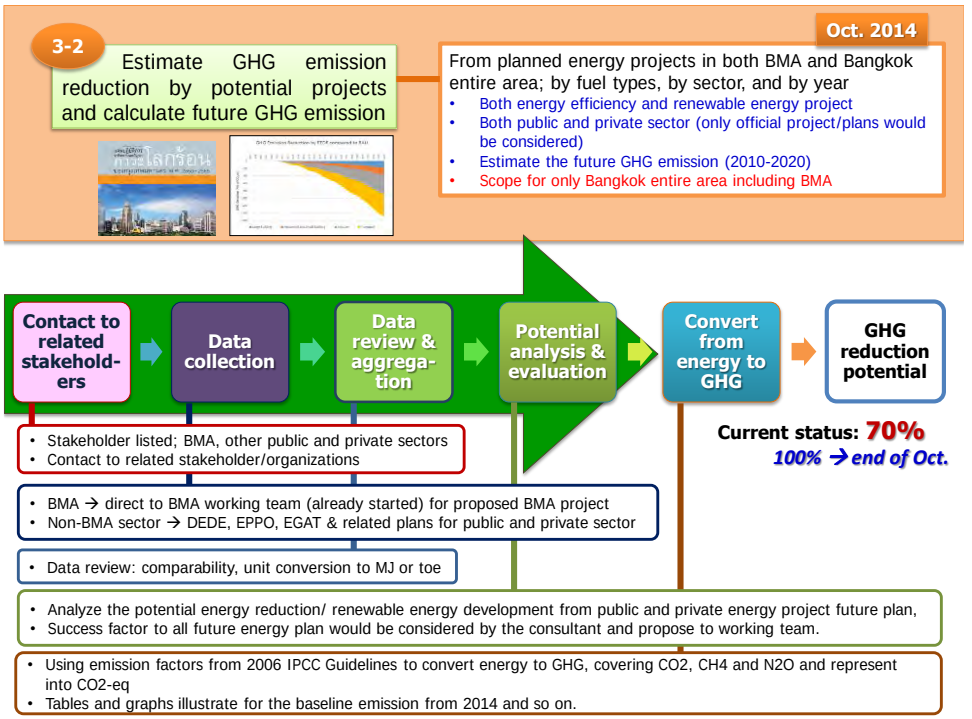
Note: Exclude energy in transport sector

EE Plan : Decrease 5% per year



Issue to be consulted: Thailand emission factor average from all fuel type are around 4,500 tCO2/ktoe

Note: Exclude energy in transport sector



Energy conservation measures: Bkk entire area

- Data investigation for potential energy reduction and renewable energy project in Bangkok, from DEDE and EPPO plan and also from national EEDP and AEDP (which cover Bangkok area target),
- Convert energy data to GHG unit,
- Estimate the GHG reduction potential from Bangkok entire area.

Results

- Energy conservation measures (real) from designated factories and buildings in Bangkok have been collected and analyzed
- Disaggregate into 3 main methods;
  - Housekeeping
  - Process improvement
  - Major change equipment
- Energy conservation from household sector is now under evaluation,
- Renewable energy project in Bangkok have limited data and may in limited potential.

Energy conservation measures: BMA area

- Data investigation is also completed from BMA staff,
- Under estimating the "descriptive" energy conservation measures (most of them are applied in BMA office) to numeric results
- Convert energy data to GHG unit,
- Estimate the GHG reduction potential from BMA area.

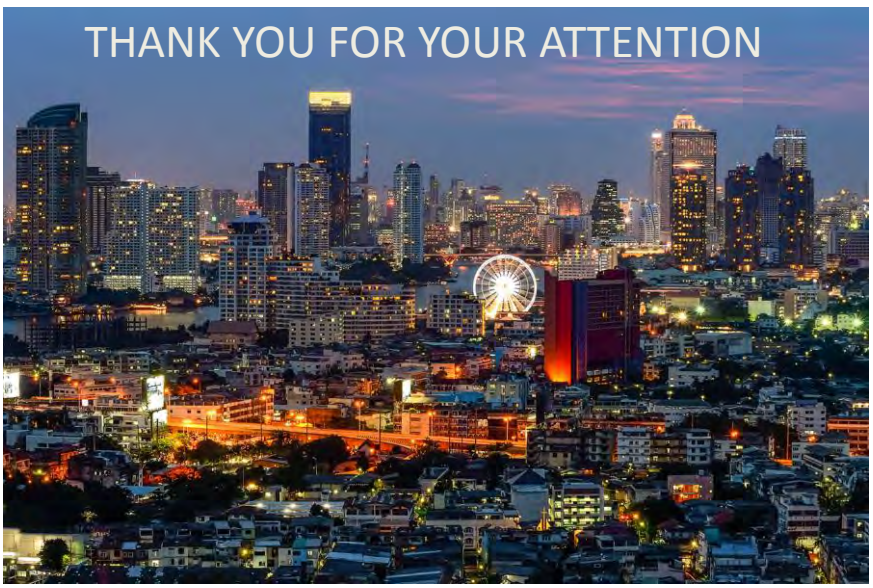
Conclusions

- Overall countermeasures template have been developed,
- BAU of energy, electricity and GHG in energy sector have been developed,
- Potential of energy efficiency improvement measures under Bangkok entire area, in industry and commercial building sector have been estimated.

Next steps (Oct-Nov 2014)

- **For BMA potential energy project**
  - Confirm the potential and calculate the expected CO_2 mitigation,
  - Estimate energy conservation measures to energy unit
  - Estimate the GHG reduction potential under BMA authorization.

- **Submit the Progress 3 report**



50

DRAFTING A PLAN OF ENERGY EFFICIENCY AND ALTERNATIVE ENERGY IN A BANGKOK MASTER PLAN ON CLIMATE CHANGE 2013-2023

21st January, 2015

Energy Efficiency and Alternative Energy Task Force

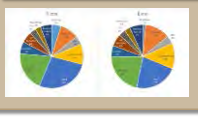
Outline

2

1. GHG BaU Baseline Calculation
2. List of countermeasures
3. Energy conservation Plan
   - *Bkk entire area*
   - *BMA Buildings*
4. M&E(Monitoring and Evaluation) /MRV(Measurement, Report, and Verification)
5. Ideas about Outreach activities

1. GHG BaU Baseline Calculation

Calculate the baseline (BaU) GHG emission using collected data and information



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Data structure & Baseline setting → **Data collection** → **Data review & aggrega-tion** → **Data analysis** → **Convert from energy to GHG** → **GHG BaU Baseline**

Current status: 100%

- Apply 2010 as base year due to the comparability with national EEDP and NAMAs,
- Structure BMA/non-BMA sector: manufacturing, commercial and household sector
- Fuel type: electricity, oil, NG and coal

Street lighting is under considering btw transport sector or commercial sector

- Data availability: 2009-2013
- BMA → direct from BMA working team
- Non-BMA sector → Electricity (MEA) , oil (DOEB), NG (PTT) and coal (DEDE), RE (DEDE)

- Data review: comparability, unit conversion to MJ or toe
- Data analysis and QC under working team

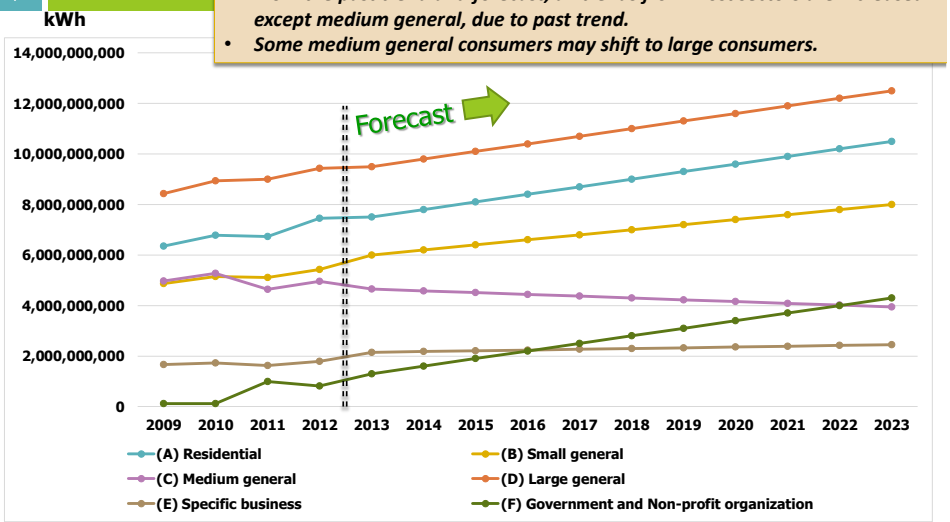
- Using emission factors from 2006 IPCC Guidelines to convert energy to GHG, covering CO2, CH4 and N2O and represent into CO2-eq
- Tables and graphs illustrate for the baseline emission including the most recent fact data from 2010 to 2013

3

Electricity: BAU & Demand forecast in Bkk

4

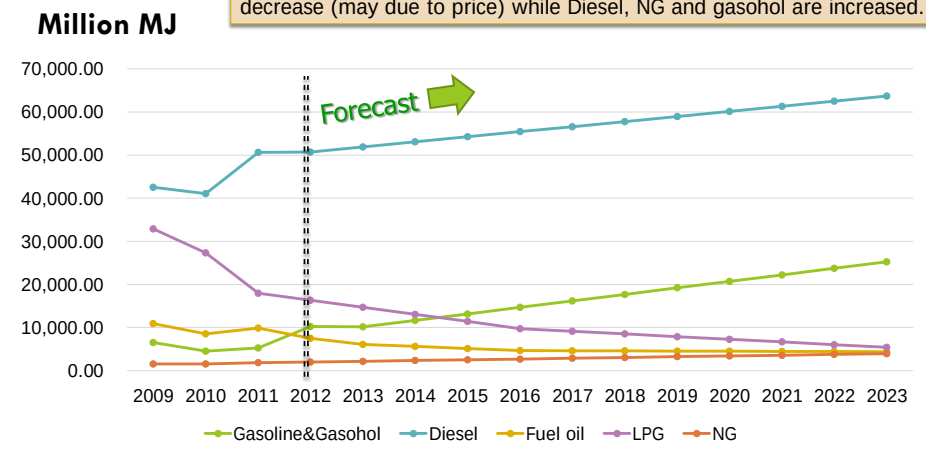
- ***From the past trend and forecast, all trends from most sectors are increased except medium general, due to past trend.***
- ***Some medium general consumers may shift to large consumers.***



All petroleum products and NG:
BAU & Demand forecast in Bkk; by types

5

From the past trend and forecast, Fuel oil and LPG consumption are decrease (may due to price) while Diesel, NG and gasohol are increased.

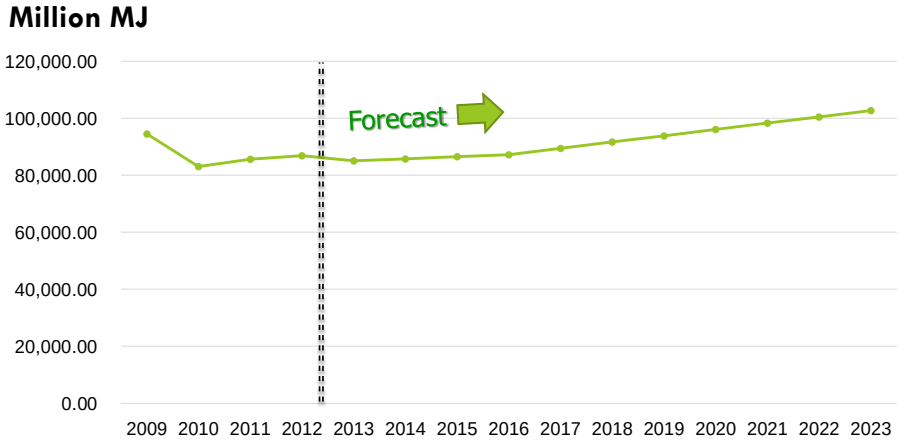


Note: Exclude energy in transport sector

All petroleum products and NG:
BAU & Demand forecast in Bkk

6

Total of Petroleum & NG



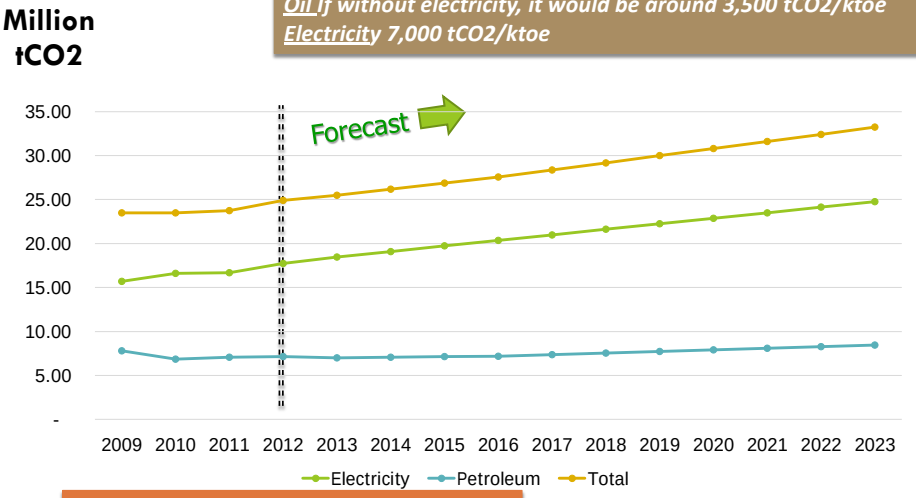
Note: Exclude energy in transport sector

GHG: BAU & forecast in Bkk area

Total GHG in energy sector are increased, mainly from electricity sector while GHG from petroleum and NG are decreased.

7

Thailand emission factor (Suggested by TGO)
Oil If without electricity, it would be around 3,500 tCO2/ktoe
Electricity 7,000 tCO2/ktoe

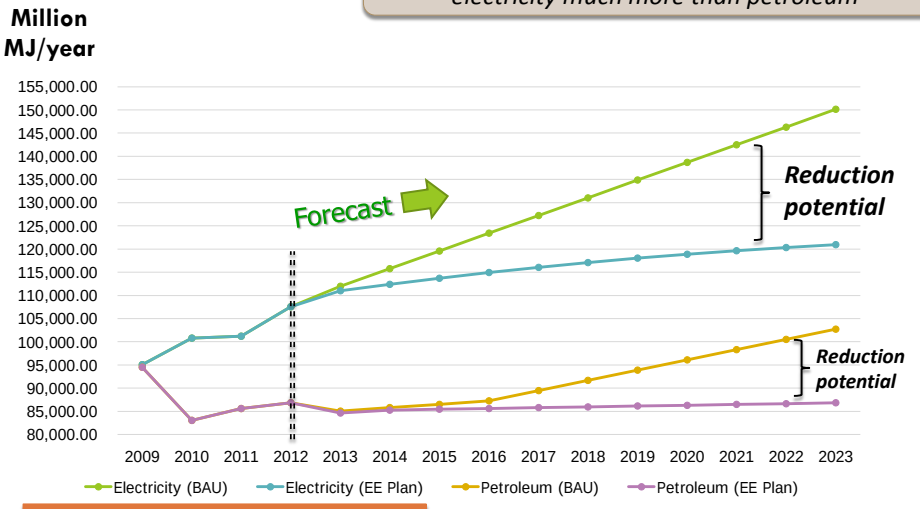


Note: Exclude energy in transport sector

EE Plan: Bangkok area

8

From past data till now, Bangkok area consumes electricity much more than petroleum

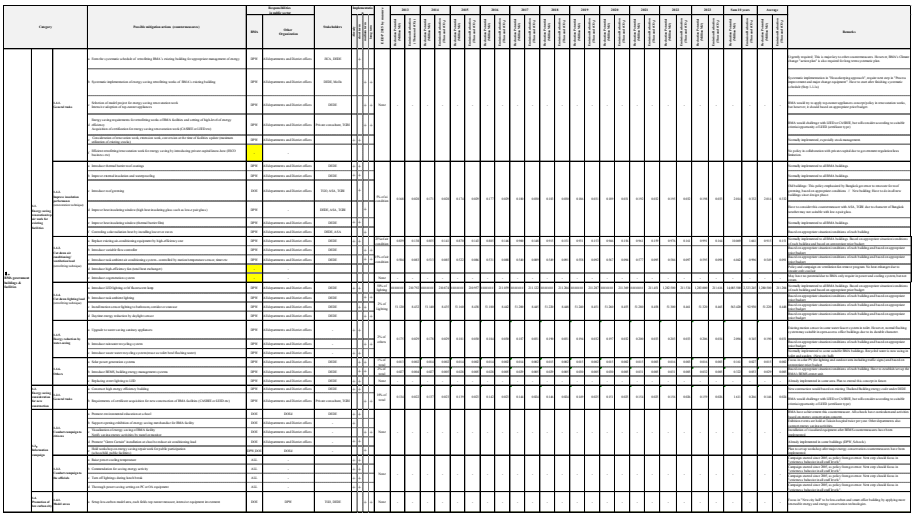


Note: Exclude energy in transport sector

2. List of countermeasures

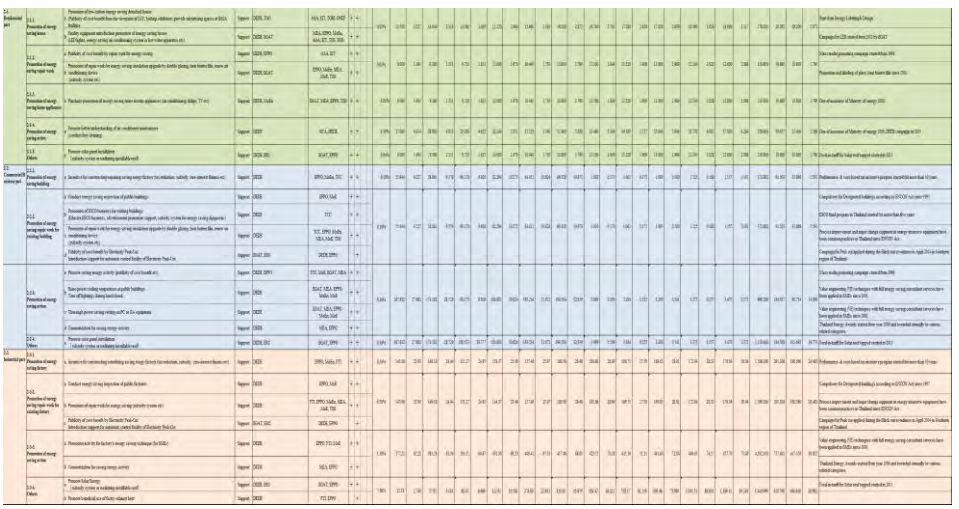
Countermeasure: Category 1 (BMA)

9



Countermeasure: Category 2 (Bkk entire area)

10



3. Energy conservation Plan

Estimate GHG emission reduction by potential projects and calculate future GHG emission

From planned energy projects in both BMA and Bangkok entire area; by fuel types, by sector, and by year

- Both energy efficiency and renewable energy project
- Both public and private sector (only official project/plans would be considered)
- Estimate the future GHG emission (2010-2020)
- Scope for only Bangkok entire area including BMA

Contact to related stakehold-ers → **Data collection** → **Data review & aggrega-tion** → **Potential analysis & evaluation** → **Convert from energy to GHG** → **GHG reduction potential**

- Stakeholder listed; BMA, other public and private sectors
- Contact to related stakeholder/organizations

Current status: 100%

- BMA → direct to BMA working team (already started) for proposed BMA project
- Bkk area sector → DEDE, EPPO, EGAT & related plans for public and private sector

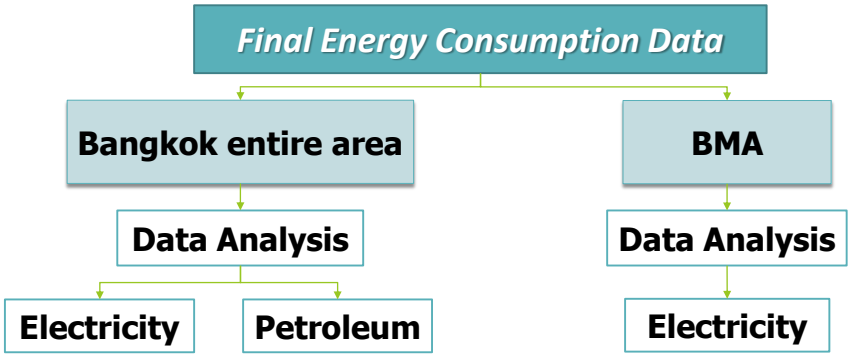
- Data review: comparability, unit conversion to MJ or toe

- Analyze the potential energy reduction/ renewable energy development from public and private energy project future plan,
- EE Plan for Thailand have been analyzed and applies in this study.

- Using emission factors from 2006 IPCC Guidelines to convert energy to GHG, covering CO2, CH4 and N2O and represent 11 into CO2-eq
- Tables and graphs illustrate for the baseline emission from 2014 and so on.

Energy conservation Plan: Data Analysis

12



Note: 1. Exclude Transport sector in this study
2.Neglect petroleum in BMA due to most of petroleum consumption in BMA are for transport

Energy conservation measures: Bkk entire area

13

- Data investigation for potential energy reduction and renewable energy project in Bangkok, from DEDE and EPPO plan and also from national EEDP and AEDP (which cover Bangkok area target),
- Convert energy data to GHG unit,
- Estimate the GHG reduction potential from Bangkok entire area.

Results

- Energy conservation measures (real) from designated factories and buildings in Bangkok have been collected and analyzed
- Disaggregate into 3 main methods;
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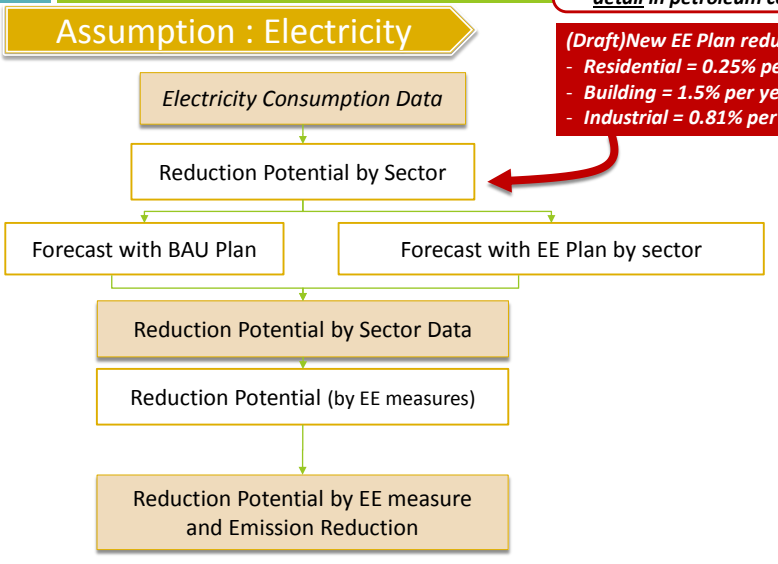
- Energy conservation from household sector is now under evaluation,
- Renewable energy project in Bangkok have limited data and may in limited potential.

Energy conservation Plan: Bkk entire area

14

Draft New EE Plan start focus in electricity conservation, but still not in detail in petroleum conservation

(Draft)New EE Plan reduction (2015-2036)
- ***Residential = 0.25% per year***
- ***Building = 1.5% per year***
- ***Industrial = 0.81% per year***



Energy conservation Plan: Bkk entire area

15

Assumption : Petroleum

Petroleum consumption Data

Reduction Potential by Sector

Forecast with BAU Plan

Forecast with EEDP Plan by sector

For Petroleum
- **Building = 0.3% per year**
- **Industrial = 0.5% per year**

Reduction Potential by Sector Data

Reduction Potential by EE measures

Reduction Potential by EE measures Data and Emission Reduction

Energy Conservation Measure in petroleum (data avr from DFBs)
- *Building = 0.13%*
- *Industrial = 7.68%*

From previous Ppt page

*DFB- Designated factories & Buildings

Energy conservation Plan: BMA (Electricity)

16

Assumption :

Electricity Consumption Data

Reduction Potential by Sector

Forecast with BAU Plan

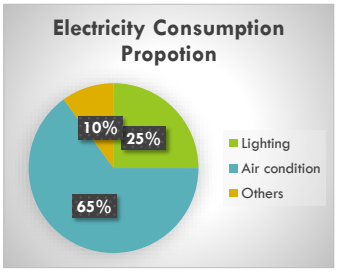
Forecast with EEDP Plan by sector

For Electricity
- Government Building = 1.5%

Reduction Potential by Sector Data

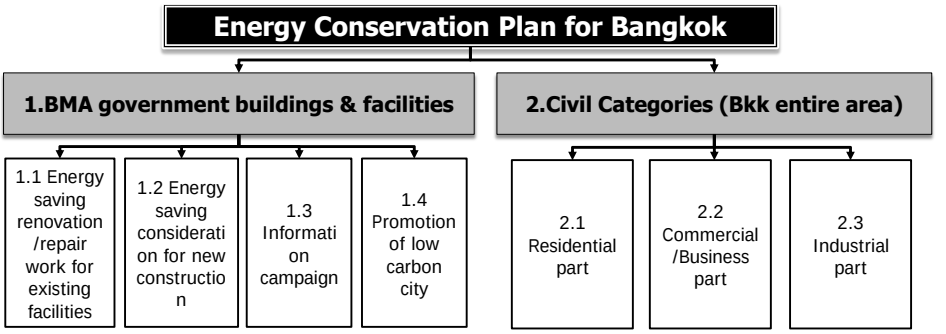
Expert Judgment (based on past DEDE projects)

Reduction Potential by Measure Data and Emission Reduction



Results: Energy conservation measures

17



Energy consumption of BAU

Unit : Million MJ

Item	2013	2018	2023
Electricity	111,960.00	131,040.00	150,120.00
Petroleum	85,057.11	91,665.53	102,699.59
Total	**197,017.11**	**222,705.53**	**252,819.59**

GHG Emission of BAU

Unit : Million tCO_2-eq

Item	2013	2018	2023
Electricity	18.55	21.71	24.88
Petroleum	7.05	7.59	8.51
Total	**25.60**	**29.31**	**33.38**

Energy Consumption Reduction of BKK

Unit : Million MJ

Item	2013	2018	2023
Electricity	985.79	13,940.89	29,209.39
Petroleum	106.93	5,869.96	15,869.22
Total	**1,092.72**	**19,810.85**	**45,078.61**

GHG Mitigation of BKK

Unit : thousand tCO_2-eq

Item	2013	2018	2023
Electricity	152.17	2,236.24	4,692.47
Petroleum	8.86	486.34	1,314.80
Total	**161.02**	**2,722.58**	**6,007.27**

Results:

Energy Consumption Reduction of BMA

Unit : Million MJ

Item	2013	2018	2023
Electricity	13.43	84.23	161.11

GHG Mitigation of BMA

Unit : thousand tCO_2-eq

Item	2013	2018	2023
Electricity	2.22	13.89	26.57

Energy Reduction Proportion of BKK compare with BKK

Item	2013	2018	2023
Electricity	0.89%	11.91%	24.16%
Petroleum	0.52%	6.63%	18.28%
Total	**0.73%**	**9.67%**	**21.70%**

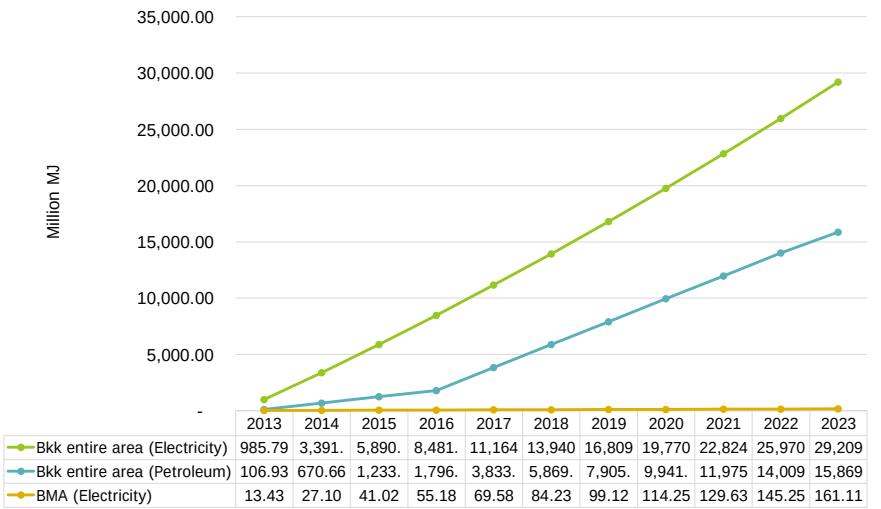
Energy Reduction Proportion of BMA compare with BKK

Item	2013	2018	2023
Electricity	0.79%	0.76%	0.74%

Energy Reduction Proportion of BMA compare with BMA

Item	2013	2018	2023
Electricity	1.52%	9.44%	17.97%

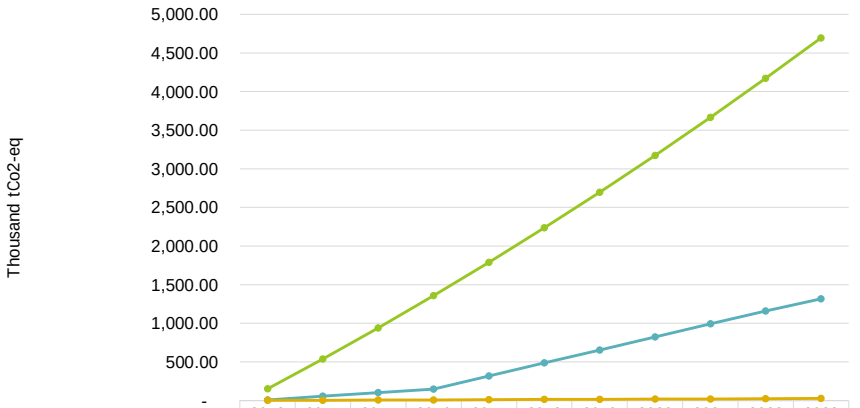
Overall: Energy Reduction Potential



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bkk entire area (Electricity)	985.79	3,391.	5,890.	8,481.	11,164	13,940	16,809	19,770	22,824	25,970	29,209
Bkk entire area (Petroleum)	106.93	670.66	1,233.	1,796.	3,833.	5,869.	7,905.	9,941.	11,975	14,009	15,869
BMA (Electricity)	13.43	27.10	41.02	55.18	69.58	84.23	99.12	114.25	129.63	145.25	161.11

Overall: GHG Mitigation Potential

23



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bkk entire area (Electricity)	152.17	539.21	941.14	1,357.	1,789.	2,236.	2,697.	3,174.	3,665.	4,171.	4,692.
Bkk entire area (Petroleum)	8.86	55.57	102.22	148.83	317.61	486.34	655.02	823.64	992.22	1,160.	1,314.
BMA (Electricity)	2.22	4.47	6.77	9.10	11.48	13.89	16.35	18.84	21.38	23.96	26.57

4. M&E(Monitoring and Evaluation) MRV(Measurement, Report, and Verification)

1-1 Energy saving renovation/repair work for existing facilities (BMA)

24

M&E/MRV		Baseline indicator	End of Project/Action indicator	Data/Information	Data/Information Provider	Reporting cycle	Other remark
M&E	M&E of activities	• Architecture or/and Engineering design	• With the construction plan to the Governor, and BMA Council for budget	• Construction plan	• DPW	• 3 months	
		• Budgetary arrangement is not yet decided.	• Budgetary arrangement is decide.	• BMA council decision (Budget xxx Bath)	• BMA council, DPW, DOB	• 3 months	
		• Tender is not yet done	• Tender				
		• Construction is not yet done.	• Construction Existing facilities are renovated/repaired and operated.				
		• There is no existing facilities renovation/repair yet.					
	MRV of GHG emissions	• GHG reduction from existing facilities renovation/repair is not yet in place	• GHG reduction from existing facilities renovation/repair is in place	• Electricity consumption of existing facilities (kWh/year) • CO2 emission factor of Energy sector (tCO2-eq)	• MEA, BMA	• Annually	

1-2 Energy saving consideration for new construction (BMA)

M&E/MRV		Baseline indicator	End of Project/Action indicator	Data/Information	Data/Information Provider	Reporting cycle	Other remark
M&E	M&E of activities	• Architecture and Engineering design	• With the construction plan to the Governor, and BMA Council for budget	• Construction plan	• DPW	• 3 months	
		• Budgetary arrangement is not yet decided.	• Budgetary arrangement is decide.	• BMA council decision (Budget xxx Bath)	• BMA council, DPW, DOB	• 3 months	
		• Tender is not yet done	• Tender				
		• Construction is not yet done.	• Construction New energy saving buildings are constructed and operated.				
		• There is no new energy saving buildings are constructed yet.					
	MRV of GHG emissions	• GHG reduction from new energy saving buildings is not yet in place	• GHG reduction from new energy saving buildings is in place	• Electricity consumption of new energy saving buildings (kWh/year) • CO2 emission factor of energy sector (tCO2-eq)	• MEA, BMA	• Annually	

2. Civil categories (Residential, Commercial/Business and Industrial part) (BKK entire area)

26

M&E/MRV		Baseline indicator	End of Project/Action indicator	Data/Information	Data/Information Provider	Reporting cycle	Other remark
M&E	M&E of activities	• Public relations campaign planning	• With the public relation campaign plan to the Governor, and BMA Council for budget	• Public relations campaign plan	• DOE,DPW	• 3 months	
		• Budgetary arrangement is not yet decided.	• Budgetary arrangement is decide.	• BMA council decision (Budget xxx Bath)	• BMA council, DOE,DPW, DOB	• 3 months	
		• Launch campaign about energy saving in Residential, Commercial/Business and Industrial part is not yet done	• Launch campaign about energy saving in Residential, Commercial/Business and Industrial part	• Frequency of the campaign is x • The number of participants is x • Questionnaire for impact evaluation of campaign (Pre-test and Post-test)	• DOE,DPW	• Annually	
	MRV of GHG emissions	• GHG emission do not calculate	• GHG emission do not calculate	-	-	-	

5. Ideas about Outreach activities Exhibition of Eco product

27

Background

・At Taksin hospital, Exhibitions of Eco product are already hold twice a year.

Event

・Exhibition of Eco product

Target

・Citizens of Bkk area

Implementation

・BMA increases a number of exhibitions

・Exhibitions shall be hold at various places for various citizens (e.g. other hospital, health care center, sport center

Promotion of Eco incentives (1)

28

Background

・ DEDE has various plan of promotion, incentive measures

Event

・Advertisement of these incentive measures

Target

・Citizens and private sector of Bkk area

Implementation

・BMA promotes that these measures be well known by citizens

・Advertisement at exhibitions, meetings

・BMA supports the widespread use of these measures

Promotion of Eco incentives (2)

29

Background

・ There are pure private (no subsidy) eco approach examples in BKK area (e.g. ESCO, BEMS of Amarin Plaza)

Event

・Advertisement of these approach examples

Target

・Private sector (especially building owners, real estate companies of Bkk area)

Implementation

・BMA supports the widespread use of these measures

・BMA host the prize of superior eco building company

・Advertisement at exhibitions, meetings

30

THANK YOU FOR YOUR ATTENTION

BANGKOK MASTER PLAN ON CLIMATE CHANGE 2013-2023 IN THE KINGDOM OF THAILAND
List of possible mitigation actions(countermeasures) for Energy Efficiency and Alternative Energy (tentative)

Category		Possible mitigation actions (countermeasures)	Responsibilities in public sector: BMA	Responsibilities in public sector: Other Organization	Stakeholders	Implementation: Already	Implementation: short term	Implementation: medium term	Implementation: long term	EEDP 2015 by measure	2013 Reduction Potential (Million MJ)	2013 Emission Reduction (Thousand tCO_2)	2014 Reduction Potential (Million MJ)	2014 Emission Reduction (Thousand tCO_2)	2015 Reduction Potential (Million MJ)	2015 Emission Reduction (Thousand tCO_2)	2016 Reduction Potential (Million MJ)	2016 Emission Reduction (Thousand tCO_2)	2017 Reduction Potential (Million MJ)	2017 Emission Reduction (Thousand tCO_2)	2018 Reduction Potential (Million MJ)	2018 Emission Reduction (Thousand tCO_2)	2019 Reduction Potential (Million MJ)	2019 Emission Reduction (Thousand tCO_2)	2020 Reduction Potential (Million MJ)	2020 Emission Reduction (Thousand tCO_2)	2021 Reduction Potential (Million MJ)	2021 Emission Reduction (Thousand tCO_2)	2022 Reduction Potential (Million MJ)	2022 Emission Reduction (Thousand tCO_2)	2023 Reduction Potential (Million MJ)	2023 Emission Reduction (Thousand tCO_2)	Remarks
1-1. Energy saving renovation/repair work for existing facilities	1-1-1. General tasks	a Form the systematic schedule of retrofitting BMA's existing building for appropriate management of energy	DPW	All departments and District offices	JICA, DEDE		+			None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Urgently required; This is major key to other countermeasures. However, BMA's Climate change "action plan" is also required for long term systematic plan.
		b Systematic implementation of energy saving retrofitting works of BMA's existing building	DPW	All departments and District offices	DEDE, MoEn			+	+																									Systematic implementation in "Housekeeping approach", require next step in "Process improvement and major change equipment". Have to start after finishing systematic schedule (Step 1-1-1a)
		c Selection of model project for energy saving renovation work Intensive adoption of top-runner appliances	DPW	All departments and District offices	DEDE			+	+																									BMA would try to apply top-runner appliances concept/policy in renovation works, but however, it should based on appropriate price/budget.
		d Energy saving requirements for retrofitting works of BMA facilities and setting of high-level of energy efficiency Acquisition of certification for energy saving renovatation work (CASBEE or LEED etc)	DPW	All departments and District offices	Private consultant, TGBI			+	+																									BMA would challenge with LEED or CASBEE, but will consider according to suitable criteria/opportunity of LEED (certificate type)
		e Consideration of renovation work, extension work, conversion at the time of facilities update (maximum utilization of existing stocks)	DPW	All departments and District offices		+	+																											Normally implemented, especially stock management.
		f Efficient retrofitting/renovatation work for energy saving by introducing private capital know-how (ESCO business etc)	-	-																														No policy in collaboration with private capital due to government regulation/laws limitation.
	1-1-2. Improve insulation performance (renovatation technique)	a Introduce thermal barrier roof coatings	DPW	All departments and District offices	DEDE	+	+			5% of air condition	0.436	0.072	0.881	0.145	1.333	0.220	1.793	0.296	2.261	0.373	2.737	0.452	3.221	0.531	3.713	0.612	4.213	0.695	4.721	0.779	5.236	0.864	Normally implemented to all BMA buildings.
		b Improve external insulation and waterproofing	DPW	All departments and District offices	DEDE	+	+																											Normally implemented to all BMA buildings.
		c Introduce roof greening	DOE	All departments and District offices	TGO, ASA, TGBI		+																											Old buildings: This policy emphasized by Bangkok governor to renovate for roof greening, based on appropriate conditions // New building: Have to do in all new buildings since design phase.
		d Improve heat insulating window (high heat insulating glass such as low-e pair glass)	DPW	-	DEDE, ASA, TGBI			+																									Have to consider this countermeasure with ASA, TGBI due to character of Bangkok weather may not suitable with low e-pair glass.
		e Improve heat insulating window (thermal barrier film)	DPW	All departments and District offices	DEDE	+	+																											Normally implemented to all BMA buildings.
		f Controling solar radiation heat by installing louver or eaves	DPW	All departments and District offices	DEDE, ASA			+																										Based on appropriate situation/conditions of each building
	1-1-3. Cut down air conditioning/ ventilation load (retrofitting technique)	a Replace existing air-conditioning equipment by high-efficiency one	DPW	All departments and District offices	DEDE	+	+			25%of air condition	2.182	0.360	6.587	1.086	13.252	2.186	22.219	3.665	33.526	5.530	47.213	7.787	63.320	10.444	81.885	13.506	102.950	16.980	126.552	20.873	152.733	25.192	Normally implemented to all BMA buildings. Based on appropriate situation/conditions of each building and based on appropriate price/budget
		b Introduce variable flow controller	DPW	All departments and District offices	DEDE			+	+																									Based on appropriate situation/conditions of each building and based on appropriate price/budget
		c Introduce task ambient air conditioning system - controlled by motion/temperature sensor, timer etc	DPW	All departments and District offices	DEDE			+	+	15% of air condition	1.309	0.216	3.952	0.652	7.951	1.311	13.331	2.199	20.116	3.318	28.328	4.672	37.992	6.266	49.131	8.104	61.770	10.188	75.931	12.524	91.640	15.115	Based on appropriate situation/conditions of each building and based on appropriate price/budget
		d Introduce high-efficiency fan (total heat exchanger)	-	-																														Policy and campaign on ventilation fan remove program. No heat exhanger due to require only cool air
		e Introduce cogeneration system	-	-						None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	May have no potential due to BMA only require in power and cooling system, but not steam.
	1-1-4. Cut down lighting load (retrofitting technique)	a Introduce LED lighting or hf fluorescent lamp	DPW	All departments and District offices	DEDE	+	+			50% of lighting	1.679	0.277	5.067	0.836	10.194	1.681	17.091	2.819	25.789	4.254	36.318	5.990	48.707	8.034	62.989	10.389	79.192	13.062	97.348	16.056	117.487	19.378	Normally implemented to all BMA buildings. Based on appropriate situation/conditions of each building and based on appropriate price/budget
		b Introduce task ambient lighting	DPW	All departments and District offices	DEDE			+	+																									Based on appropriate situation/conditions of each building and based on appropriate price/budget
		c Install motion sensor lighting to bathroom, corridor or starcase	DPW	All departments and District offices	DEDE		+	+		2% of Lighting	0.067	0.011	0.203	0.033	0.408	0.067	0.684	0.113	1.032	0.170	1.453	0.240	1.948	0.321	2.520	0.416	3.168	0.522	3.894	0.642	4.699	0.775	Based on appropriate situation/conditions of each building and based on appropriate price/budget
		d Daytime energy reduction by daylight sensor	DPW	All departments and District offices	DEDE			+	+																									Based on appropriate situation/conditions of each building and based on appropriate price/budget
	1-1-5. Energy reduction by water-saving	a Upgrade to water saving sanitary appliances	DPW	All departments and District offices	-	+	+			2% of others	0.067	0.011	0.203	0.033	0.408	0.067	0.684	0.113	1.032	0.170	1.453	0.240	1.948	0.321	2.520	0.416	3.168	0.522	3.894	0.642	4.699	0.775	Existing motion sensor in some water faucet system in toilet. However, normal flushing system may suitable in open-access office buildings due to its durable character.
		b Introduce rainwater recycling system	DPW	All departments and District offices	-			+	+																									Based on appropriate situation/conditions of each building and based on appropriate price/budget
		c Introduce waste water recycling system (reuse as toilet bowl flushing water)	DPW	All departments and District offices	-	+	+																											Normally implemented to some suitable BMA buildings. Recycled water is now using in toilet and garden. (New city hall)
	1-1-6. Others	a Solar power generation systems	DPW	All departments and District offices	DEDE		+	+		1% of total	0.134	0.022	0.405	0.067	0.816	0.135	1.367	0.226	2.063	0.340	2.905	0.479	3.897	0.643	5.039	0.831	6.335	1.045	7.788	1.285	9.399	1.550	Focus in solar PV (for lighting and outdoor area including traffic signs) and based on appropriate price/budget
		b Introduce BEMS, building energy management systems	DPW	All departments and District offices	DEDE		+	+		2% of total	0.269	0.044	0.811	0.134	1.631	0.269	2.735	0.451	4.126	0.681	5.811	0.958	7.793	1.285	10.078	1.662	12.671	2.090	15.576	2.569	18.798	3.100	Based on appropriate situation/conditions of each building. Have to establish/set up the BMA's BEMS center unit.
		c Replacing street lighting to LED	DPW	All departments and District offices	DEDE	+	+			None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Already implemented in some area. Plan to extend this concept in future.
1-2. Energy saving consideration for new construction	1-2-1. General tasks	a Construct high energy efficiency building	DPW	All departments and District offices	DEDE	+	+			10% of total	1.343	0.222	4.053	0.669	8.155	1.345	13.673	2.255	20.631	3.403	29.054	4.792	38.966	6.427	50.391	8.311	63.354	10.449	77.878	12.845	93.989	15.502	New contruction would based on existing Thailand Building energy code under DEDE
		b Requirements of certificate acquisition for new construction of BMA facilities (CASBEE or LEED etc)	DPW	All departments and District offices	Private consultant, TGBI			+	+																									BMA would challenge with LEED or CASBEE, but will consider according to suitable criteria/opportunity of LEED (certificate type)
1-3. Information campaign	1-3-1. Conduct campaign to citizens	a Promote environmental education at school	DOE	DOEd	DEDE	+	+			None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	BMA have achievement this countermeasure. All schools have curriculum and activities based on energy conservation concept.
		b Support opening exhibition of energy saving merchandise for BMA facility	DOE	All departments and District offices	-	+																												Exibition events are hold at Taksin hospital twice per year. Other departments also support energy saving activities.
		c Visualization of energy saving of BMA facility Notify saving energy activities by panel or monitor	DOE	All departments and District offices	-			+	+																									Installation of visualized equipment after BEMS countermeasures have been implemented.
		d Promote "Green Curtain" installation at shool to reduce air conditioning load	DOE	All departments and District offices	-	+	+																											Already implemented in some buildings (DPW, Schools).
		e Hold workshop on energy saving repair work for public participation (schoochild, public facilities)	DPW,DOE	DOEd	-			+																										Plan to set up workshop after major energy conservation countermeasures have been implemented.
	1-3-2. Conduct campaign to the officials	a Raise preset cooling temperature	ALL	-		+	+			None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Campaign started since 2005, as policy from governor. Next step should focus in "strictness bahavior in all staff levels".
		b Commendation for saving energy activity	ALL	-		+	+																											Campaign started since 2005, as policy from governor. Next step should focus in "strictness bahavior in all staff levels".
		c Turn off lightings during lunch break	ALL	-		+	+																											Campaign started since 2005, as policy from governor. Next step should focus in "strictness bahavior in all staff levels".
		d Thorough power saving setting on PC or OA equipment	ALL	-		+	+																											Campaign started since 2005, as policy from governor. Next step should focus in "strictness bahavior in all staff levels".
1-4. Promotion of low carbon city	1-4-1. Model areas	a Setup low-carbon model area, each fields top runner measure, intensive equipment investment	DOE	DPW	TGO, DEDE			+	+	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Focus in "New city hall" to be low-carbon and smart office building by applying more renewable energy and energy conservation technologies.

BANGKOK MASTER PLAN ON CLIMATE CHANGE 2013-2023 IN THE KINGDOM OF THAILAND
List of possible mitigation actions(countermeasures) for Energy Efficiency and Alternative Energy (tentative)

Category		Possible mitigation actions (countermeasures)	Responsibilities in public sector		Stakeholders	Implementation				EEDP 2015 by measure	2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023		Remarks
			BMA	Other Organization		Already	short term	medium term	long term		Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	Reduction Potential (Million MJ)	Emission Reduction (Thousand tCO2)	
2-1. Residensital part	**2-1-1. Promotion of energy saving house**	a Promotion of low-carbon/energy saving detached house (Publicity of cost benefit from the viewpoint of LCC, backup exhibition, provide advertising spaces at BMA facilities	Support	DEDE, TGO	ASA, EIT, TGBI, ONEP	+	+			0.05%	13.500	2.227	27.540	4.542	42.120	6.947	57.240	9.441	72.900	12.024	89.100	14.696	105.840	17.457	123.120	20.307	140.940	23.246	159.300	26.275	178.200	29.392	Start from Energy Labeling& Design
		b Facility equipment introduction promotion of energy saving house (LED lights, energy-saving air conditioning system or hot - water apparatus etc)	Support	DEDE, EGAT	MEA, EPPO, MoEn, ASA, EIT, TISI, TGO	+	+																									Campaign for LED started from 2012 by EGAT
	2-1-2. Promotion of energy saving repair work	a Publicity of cost benefit by repair work for energy saving	Support	DEDE, EPPO	ASA, EIT	+	+			0.03%	9.000	1.484	18.360	3.028	28.080	4.631	38.160	6.294	48.600	8.016	59.400	9.797	70.560	11.638	82.080	13.538	93.960	15.498	106.200	17.516	118.800	19.595	Mass media promoting campaign started from 1996
		b Promotion of repair work for energy saving: insulation upgrade by double glazing, heat barrier film, renew air conditioning device (subsidy system etc)	Support	DEDE, EGAT	EPPO, MoEn, MEA, MoE, TISI	+	+																									Promotion and labeling of glass, heat barrier film since 2010
	2-1-3. Promotion of energy saving home appliances	a Purchase promotion of energy saving home electric appliances (air conditioning, fridge, TV etc)	Support	DEDE, MoEn	EGAT, MEA, EPPO, TISI	+	+			0.03%	9.000	1.491	18.360	3.042	28.080	4.653	38.160	6.323	48.600	8.053	59.400	9.843	70.560	11.692	82.080	13.601	93.960	15.570	106.200	17.598	118.800	19.686	One of measures of Ministry of energy 2008.
	2-1-4. Promotion of energy saving action	a Promote better understanding of air conditioner maintenance (conduct free cleaning)	Support	DEDE	JICA, DEDE	+	+			0.10%	27.000	4.474	55.080	9.127	84.240	13.959	114.480	18.970	145.800	24.160	178.200	29.528	211.680	35.076	246.240	40.803	281.880	46.709	318.600	52.793	356.400	59.057	One of measures of Ministry of energy 2008. DEDE campaign in 2013
	2-1-5. Others	a Promote solar panel installation (subsidy system or mediating installable roof)	Support	DEDE, ERC	EGAT, EPPO	+	+			0.03%	9.000	1.491	18.360	3.042	28.080	4.653	38.160	6.323	48.600	8.053	59.400	9.843	70.560	11.692	82.080	13.601	93.960	15.570	106.200	17.598	118.800	19.686	Feed-in-tariff for Solar roof topped started in 2013
2-2. Commercial/Business part	**2-2-1. Promotion of energy saving building**	a Incentive for constructing/repairing saving enegy factory (tax reduction, subsidy, zero-interest financi etc)	Support	DEDE	EPPO, MoEn, TCC	+	+			0.10%	55.944	9.270	114.005	18.891	174.182	28.863	236.477	39.185	300.888	49.858	367.416	60.882	436.061	72.257	506.822	83.983	579.701	96.059	654.696	108.486	731.808	121.264	Performance- & cost-based tax incentive program started for more than 10 years
	2-2-2. Promotion of energy saving repair work for existing building	a Conduct energy saving inspection of public buildings	Support	DEDE	EPPO, MoE	+	+			0.10%	55.944	9.270	114.005	18.891	174.182	28.863	236.477	39.185	300.888	49.858	367.416	60.882	436.061	72.257	506.822	83.983	579.701	96.059	654.696	108.486	731.808	121.264	Compulsory for Designated buildings according to ENCON Act since 1995
		b Promotion of ESCO business for existing buildings (Educate ESCO business, advertisement promotion support, subsidy system for energy saving diagnostic)	Support	DEDE	TCC	+	+																									ESCO fund program in Thailand started for motre than five years
		c Promotion of repair work for energy saving: insulation upgrade by double glazing, heat barrier film, renew air conditioning device (subsidy system etc)	Support	DEDE	TCC, EPPO, MoEn, MEA, MoE, TISI	+	+																									Process improvement and major change eqipment in energy intensive equipment have been common practices in Thailand since ENCON Act.
		d Publicity of cost benefit by Electricity Peak-Cut Introduction support for automatic control facility of Electricity Peak-Cut	Support	EGAT, ERC	DEDE, EPPO		+																									Campaign for Peak cut applied during the Black out avoidance in April 2014 in Southern region of Thailand
	2-2-3. Promotion of energy saving action	a Promote saving energy activity (publicity of cost benefit etc)	Support	DEDE, EPPO	TCC, MoE, EGAT, MEA	+	+			0.30%	167.832	27.810	342.014	56.673	522.547	86.588	709.430	117.555	902.664	149.575	########	182.647	1,308.182	216.771	1,520.467	251.948	1,739.102	288.176	1,964.088	325.457	2,195.424	363.791	Mass media promoting campaign started from 1996
		b Raise preset cooling temperature at public buildings Turn off lightings during lunch break	Support	DEDE	EGAT, MEA, EPPO, MoEn, MoE	+	+																									Value engineering (VE) techniques with full energy saving consultant services have been applied in SMEs since 2001.
		c Thorough power saving setting on PC or OA equipment	Support	DEDE	EGAT, MEA, EPPO, MoEn, MoE	+	+																									Value engineering (VE) techniques with full energy saving consultant services have been applied in SMEs since 2001.
		d Commendation for saving energy activity	Support	DEDE	MEA, EPPO	+	+																									Thailand Energy Awards started from year 2000 and rewarded annually to various related categories.
	2-2-4. Others	a Promote solar panel installation (subsidy system or mediating installable roof)	Support	DEDE, ERC	EGAT, EPPO	+	+			0.30%	167.832	27.810	342.014	56.673	522.547	86.588	709.430	117.555	902.664	149.575	########	182.647	1,308.182	216.771	1,520.467	251.948	1,739.102	288.176	1,964.088	325.457	2,195.424	363.791	Feed-in-tariff for Solar roof topped started in 2013
2-3. Industrial part	**2-3-1. Promotion of energy saving factory**	a Incentive for constructing/retrofitting saving enegy factory (tax reduction, subsidy, zero-interest financi etc)	Support	DEDE	EPPO, MoEn, FTI	+	+			0.50%	145.08	24.04	293.26	48.59	444.53	73.66	598.90	99.24	756.36	125.33	916.92	151.94	1,080.58	179.06	1,247.33	206.69	1,417.18	234.83	1,590.12	263.49	1,766.16	292.66	Performance- & cost-based tax incentive program started for more than 10 years
	2-3-2. Promotion of energy saving repair work for existing factory	a Conduct energy saving inspection of public factories	Support	DEDE	EPPO, MoE	+	+			0.50%	145.08	24.04	293.26	48.59	444.53	73.66	598.90	99.24	756.36	125.33	916.92	151.94	1,080.58	179.06	1,247.33	206.69	1,417.18	234.83	1,590.12	263.49	1,766.16	292.66	Compulsory for Designated buildings according to ENCON Act since 1997
		b Promotion of repair work for energy saving (subsidy system etc)	Support	DEDE	FTI, EPPO, MoEn, MEA, MoE, TISI	+	+																									Process improvement and major change eqipment in energy intensive equipment have been common practices in Thailand since ENCON Act.
		c Publicity of cost benefit by Electricity Peak-Cut Introduction support for automatic control facility of Electricity Peak-Cut	Support	EGAT, ERC	DEDE, EPPO		+																									Campaign for Peak cut applied during the Black out avoidance in April 2014 in Southern region of Thailand
	2-3-3. Promotion of energy saving action	a Promotion activity for factory's energy saving technique (for SMEs)	Support	DEDE	EPPO, FTI, MoE	+	+			1.30%	377.21	62.50	762.47	126.34	1,155.77	191.52	1,557.13	258.02	1,966.54	325.86	2,383.99	395.04	2,809.50	465.55	3,243.05	537.39	3,684.66	610.56	4,134.31	685.07	4,592.02	760.92	Value engineering (VE) techniques with full energy saving consultant services have been applied in SMEs since 2001.
		b Commendation for saving energy activity	Support	DEDE	MEA, EPPO	+	+																									Thailand Energy Awards started from year 2000 and rewarded annually to various related categories.
	2-3-4. Others	a Promote Solar Energy (subsidy system or mediating installable roof)	Support	DEDE, ERC	EGAT, EPPO	+	+			7.68%	33.18	2.749	37.95	3.144	80.45	6.666	122.91	10.184	276.80	22.933	430.63	35.679	584.42	48.421	738.17	61.159	891.86	73.893	1,045.51	86.623	1,199.11	99.349	Feed-in-tariff for Solar roof topped started in 2013
		b Promote beneficial use of factry exhaust heat	Support	DEDE	FTI, EPPO		+																									

Presentation on the BAU and Mitigation Target in the Energy Efficiency and Alternative Energy Sector

The Stakeholder Meeting on the Bangkok Master Plan on Climate Change 2013-2023
-- July 9th, 2015

Jointly by The Energy Efficiency and Alternative Energy Task Force and Wongkot Wongsapai (Chiang Mai University)

Table of Contents

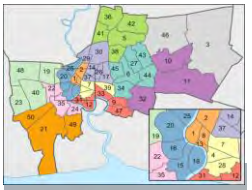
I Current status of GHG emission

1.Scope and coverage of the GHG emission

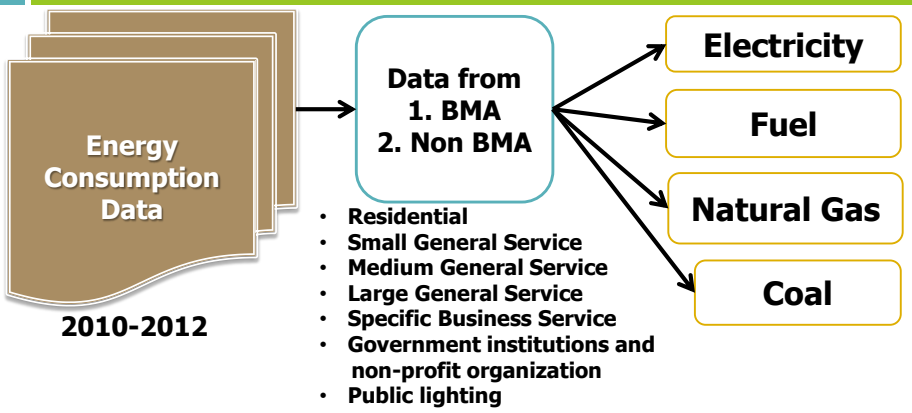
- Focus mainly in GHG mitigation through Energy efficiency and renewable energy.
- Fuel exclude transport sector.
- From energy data to GHG data.
- Focus in two level;

  (i) Entire Bangkok area (hereafter, Bkk)

  (ii) Only building under BMA office authorization (hereafter, BMA)



I Current status of GHG emission



Note: 1. BMA here means government organizations under Bangkok Administration, which exclude the central government organization in other Ministries

2. Non-BMA means other central government organizations and all other sectors (manufacturing, commercial buildings, transport, agriculture) in Bangkok entire area.

I Current status of GHG emission

2 .Basic methodologies for GHG calculation

- GHG emission is calculated by multiplying activity data such as amount of energy consumption in industry sector by emission factor.

$$GHG \quad Emission = Activity\,Data \times EmissionFactor$$

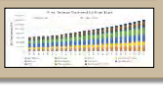
- **Fuel type: electricity, oil, NG and coal**
- **Sector: Industry, Commercial building, residential**

BAU: use 2006 IPCC Guideline for each energy types.
GHG mitigation potential: Due to this study focus in the long-term; future energy consumption proportion would be flexible. We then applied one universal figure of emission factor, average from various fuel types in Thai energy market.
Oil If without electricity, it would be around 3,500 tCO2/ktoe
Electricity 0.59 tCO2/MWh (or 7,000 tCO2/ktoe)

II BAU of GHG emission

1.BAU Scenario & 2.Methodologies for Calculation

Calculate the baseline (BaU) GHG emission using collected data and information



From energy consumption data (both BMA and Bangkok entire area) by using revised 2006 IPCC GHG inventory emission factor and apply 2010 as the base year; by fuel types, by sector, and by year

ค่านวณการปล่อย GHG (ใช้ปี พ.ศ.2553 เป็นปีฐาน) โดยใช้ข้อมูลจากการใช้พลังงานของ กทม. และ ทั้งกรุงเทพ ค่านวณแยกรายเชื้อเพลิง แยกการใช้ และแยกรายปี

Data structure & Baseline setting → **Data collection** → **Data review & aggrega-tion** → **Data analysis** → **Convert from energy to GHG** → **GHG BaU Baseline**

- Apply 2010 as base year due to the comparability with national EEDP and NAMAs,
- Structure BMA/non-BMA sector: manufacturing, commercial and household sector
- Fuel type: electricity, oil, NG and coal

- Data availability: 2009-2013
- BMA → data direct from BMA working team, energy consumption in BMA buildings
- Non-BMA sector → Electricity (MEA) , oil (DOEB), NG (PTT) and coal (DEDE), RE (DEDE)

- Data review: comparability, unit conversion to MJ or toe
- Data analysis and QC under working team

- Using emission factors from 2006 IPCC Guidelines to convert energy to GHG, covering CO2, CH4 and N2O and represent into CO2-eq for the BAU calculation
- Tables and graphs illustrate for the baseline emission including the most recent fact data from 2010 to 2013

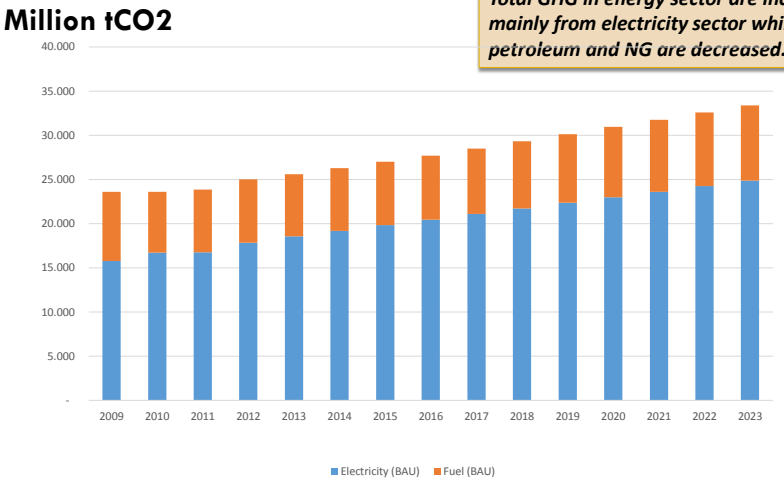
II BAU of GHG emission

3.Results of Calculation

GHG: BAU & forecast in Bkk area

7

Total GHG in energy sector are increased, mainly from electricity sector while GHG from petroleum and NG are decreased.



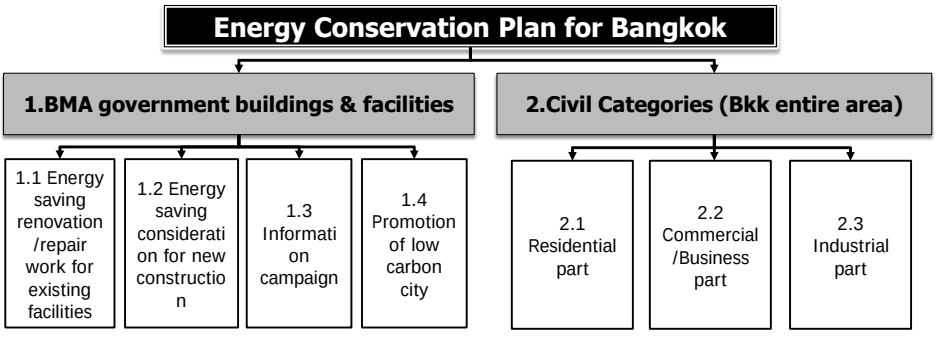
Note: Exclude energy in transport sector

III Mitigation target in the Energy Sector

8

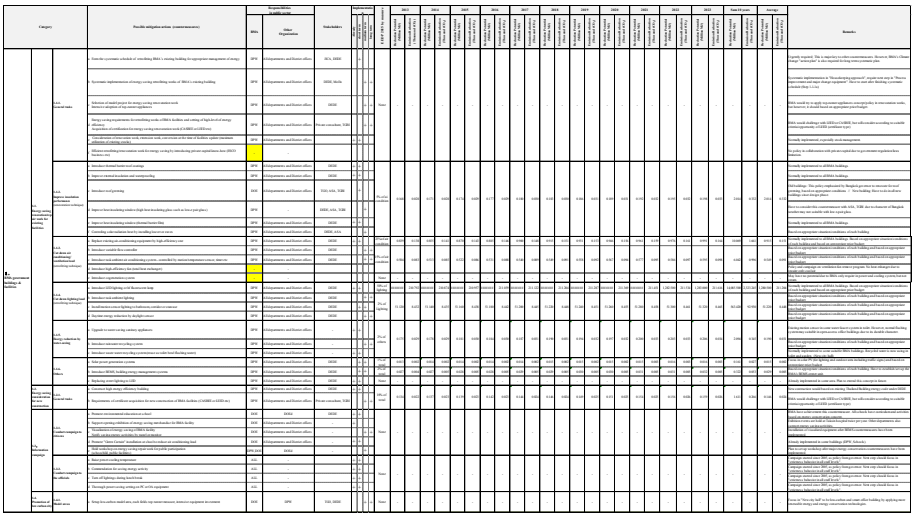
1.Mitigation Scenario

(Energy conservation measures)



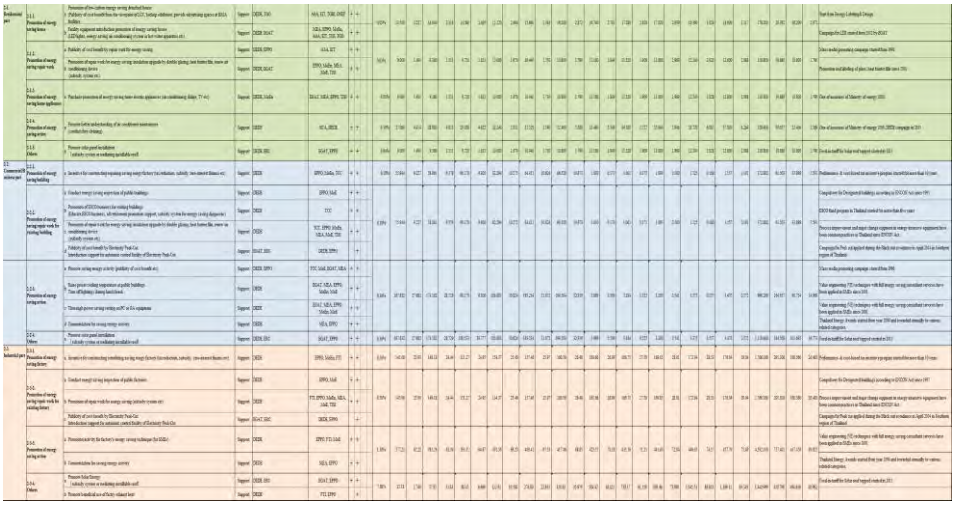
III Mitigation target in the Energy Sector
Countermeasure: Category 1 (BMA)

9



III Mitigation target in the Energy Sector
Countermeasure: Category 2 (Bkk area)

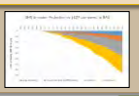
10



III Mitigation target in the Energy Sector

2.Methodologies for Calculation

Estimate GHG emission reduction by potential projects and calculate future GHG emission



From planned energy projects in both BMA and Bangkok entire area; by fuel types, by sector, and by year

- Both energy efficiency and renewable energy project
- Both public and private sector (only official project/plans would be considered)
- Estimate the future GHG emission (2013-2023)
- Scope for Bangkok entire area and BMA

Contact to related stakehold-ers → **Data collection** → **Data review & aggrega-tion** → **Potential analysis & evaluation** → **Convert from energy to GHG** → **GHG reduction potential**

- Stakeholder listed; BMA, other public and private sectors
- Contact to related stakeholder/organizations

- BMA → direct to BMA working team (already started) for proposed BMA project
- Bkk area sector → DEDE, EPPO, EGAT & related plans for public and private sector

- Data review: comparability, unit conversion to MJ or toe

- Analyze the potential energy reduction/ renewable energy development from public and private energy project future plan,
- EE Plan for Thailand have been analyzed and applies in this study.

- Using emission factors from 2006 IPCC Guidelines to convert energy to GHG, covering CO2, CH4 and N2O and represent into CO2-eq
- Tables and graphs illustrate for the baseline emission from 2014 and so on.

11

III Mitigation target in the Energy Sector

2.Methodologies for Calculation

Energy conservation Plan: Data Analysis

12

Final Energy Consumption Data

Bangkok entire area → **Data Analysis** → **Electricity**, **Petroleum**

BMA → **Data Analysis** → **Electricity**

Note: 1. Exclude Transport sector in this study
2.Neglect petroleum in BMA due to most of petroleum consumption in BMA are for transport

III Mitigation target in the Energy Sector

2.Methodologies for Calculation

Energy conservation Plan:Bkk entire area

13

Assumption : Electricity

Electricity Consumption Data

Reduction Potential by Sector

Forecast with BAU Plan

Forecast with EE Plan by sector

Reduction Potential by Sector Data

Reduction Potential (by EE measures)

Reduction Potential by EE measure and Emission Reduction

(Draft)New EE Plan reduction (2015-2036)
- ***Residential = 0.25% per year***
- ***Building = 1.5% per year***
- ***Industrial = 0.81% per year***

Based on the energy conservation measures from EE Plan

III Mitigation target in the Energy Sector

2.Methodologies for Calculation

Energy conservation Plan:Bkk entire area

14

Assumption : Petroleum

Petroleum consumption Data

Reduction Potential by Sector

Forecast with BAU Plan

Forecast with EEDP Plan by sector

Reduction Potential by Sector Data

Reduction Potential by EE measures

Reduction Potential by EE measures Data and Emission Reduction

(Draft)New EE Plan reduction (2015-2036)
- ***Building = reduce 0.3% per year = "A"***
- ***Industrial = reduce 0.5% per year = "B"***

Energy Conservation Measure in petroleum (data avr from DFBs)
- ***Building = 0.13% of "A"***
- ***Industrial = 7.68% of "B"***

*DFB- Designated factories & Buildings

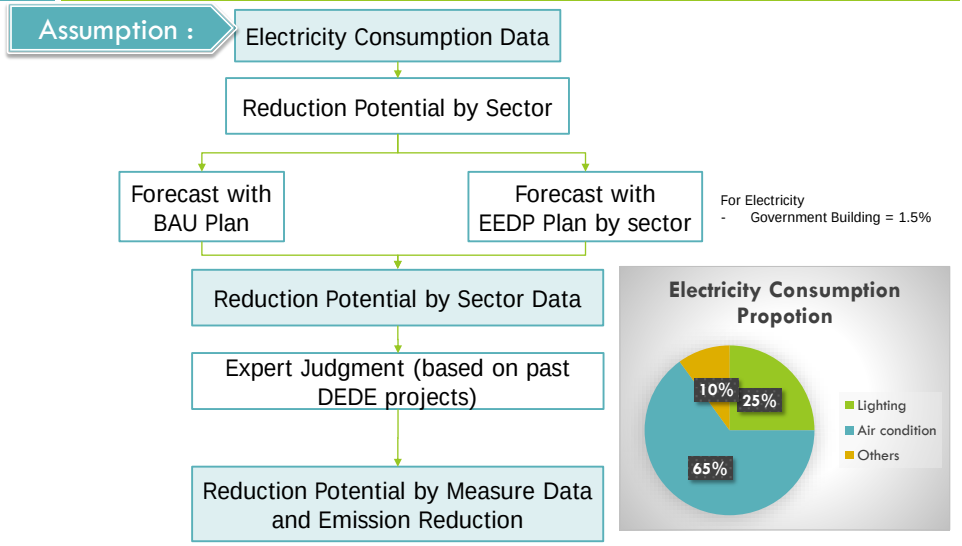
III Mitigation target in the Energy Sector

2.Methodologies for Calculation

Energy conservation Plan:BMA (Electricity)

15

Assumption :



For Electricity
- Government Building = 1.5%

III Mitigation target in the Energy Sector

3. Results of Calculation

16

Energy consumption of BAU

Unit : Million MJ

Item	2013	2018	2023
Electricity	111,960.00	131,040.00	150,120.00
Petroleum	85,057.11	91,665.53	102,699.59
Total	**197,017.11**	**222,705.53**	**252,819.59**

GHG Emission of BAU

Unit : Million tCO_2-eq

Item	2013	2018	2023
Electricity	18.55	21.71	24.88
Petroleum	7.05	7.59	8.51
Total	**25.60**	**29.31**	**33.38**

III Mitigation target in the Energy Sector
3. Results of Calculation

17

Energy Consumption Reduction of BKK

Unit : Million MJ

Item	2013	2018	2023
Electricity	985.79	13,940.89	29,209.39
Petroleum	106.93	5,869.96	15,869.22
Total	**1,092.72**	**19,810.85**	**45,078.61**

GHG Mitigation of BKK

Unit : thousand tCO_2-eq

Item	2013	2018	2023
Electricity	152.17	2,236.24	4,692.47
Petroleum	8.86	486.34	1,314.80
Total	**161.02**	**2,722.58**	**6,007.27**

III Mitigation target in the Energy Sector
3. Results of Calculation

Energy Consumption Reduction of BMA

Unit : Million MJ

Item	2013	2018	2023
Electricity	13.43	84.23	161.11

GHG Mitigation of BMA

Unit : thousand tCO_2-eq

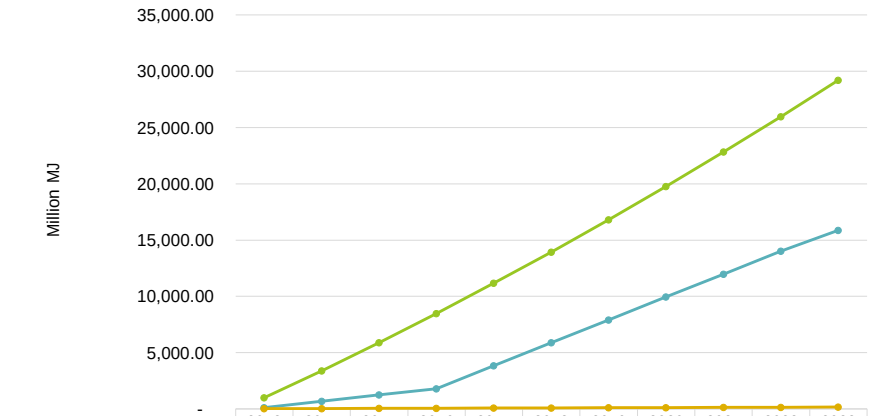
Item	2013	2018	2023
Electricity	2.22	13.89	26.57

Mitigation target in the Energy Sector

3. Results of Calculation

Overall: Energy Reduction Potential

19



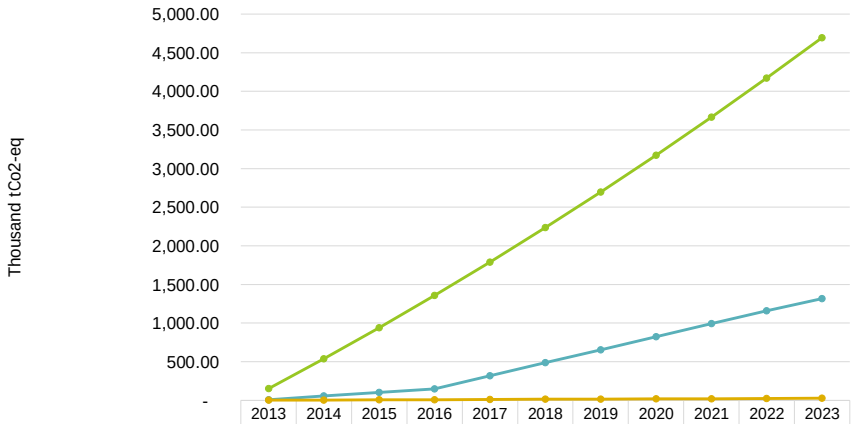
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bkk entire area (Electricity)	985.79	3,391.	5,890.	8,481.	11,164	13,940	16,809	19,770	22,824	25,970	29,209
Bkk entire area (Petroleum)	106.93	670.66	1,233.	1,796.	3,833.	5,869.	7,905.	9,941.	11,975	14,009	15,869
BMA (Electricity)	13.43	27.10	41.02	55.18	69.58	84.23	99.12	114.25	129.63	145.25	161.11

Mitigation target in the Energy Sector

3. Results of Calculation

Overall: GHG Mitigation Potential

20



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bkk entire area (Electricity)	152.17	539.21	941.14	1,357.	1,789.	2,236.	2,697.	3,174.	3,665.	4,171.	4,692.
Bkk entire area (Petroleum)	8.86	55.57	102.22	148.83	317.61	486.34	655.02	823.64	992.22	1,160.	1,314.
BMA (Electricity)	2.22	4.47	6.77	9.10	11.48	13.89	16.35	18.84	21.38	23.96	26.57

III Mitigation target in the Energy Sector

3. Results of Calculation

Mitigation Target in2020 (& 2023)

21

	Base Year (2010)	2020	(2023)
BAU Emission	23.580 million ton-CO2e	30.939 million ton-CO2e	33.384 million ton-CO2e
Emission with Mitigation Actions		26.853 million ton-CO2e 13.2 % (Reduction against BAU emission in 2020)	27.229 million ton-CO2e 18.44 % (Reduction against BAU emission in 2023)

22

THANK YOU FOR YOUR ATTENTION

Efficient Solid Waste Management and Wastewater Treatment Task Force

Joint Team made by
BMA Task Force members and JICA Experts

Time line

- 3 Task Force meetings (8 May, 26 July and 19 Sept)
  - Basic approach of the Project
  - Barriers of BMA climate change Action Plan
  - Current/ future projects of waste management and wastewater treatment in BMA
  - Possible mitigation measures (e.g. energy efficiency improvement in wastewater treatment plants, etc.)
  - Good practices in Japan (waste and wastewater management)
- Discussion with related entities
  - Wastewater treatment plant operators, waste management center, landfill site

Policy Information & data collection and analysis

[Waste]

- "Feasibility Study for Municipal Solid Waste Management in Bangkok" (Kasetsart Univ., 2012)
- Presentation: "Bangkok towards Sustainable Waste Management" (DOE, 2013), "Current/ future projects of solid waste management" (DOE, 2013)
- Data: solid waste amount

[Wastewater]

- "Preparation Survey for the Bangkok Sewerage Development Project in Thailand " (BMA/JICA, 2011)
- Presentation: "Water Quality Management in Bangkok" (DDS, 2013)
- Data: monthly wastewater volume, electricity consumption, BOD treated at each treatment plant, etc.

Discussion at Task Force meetings

Task Force Meetings

- TF members have a clearer understanding on the basic approach for climate change master plan formulation.
- TF members pointed out key barriers related to preparation and implementation of BMA climate change action plan, including:
  - lack of necessary data,
  - difficulty in evaluation, e.g. methodology of GHG emission reduction calculation, and
  - lack of coordination with consultants during the stage of mitigation measure selection and target setting.
- TF members have deepened their knowledge about possible mitigation measures in the sector, referring to several good practices in Japan.

Estimation of GHG emissions in waste and wastewater sector

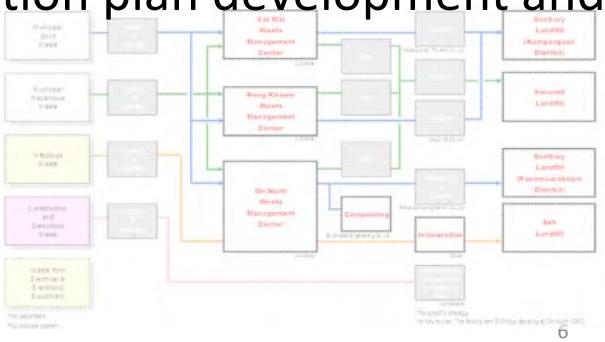
Basic approach to quantify GHG emissions from waste management and wastewater treatment

$$GHG\ Emission = Activity\ Data * Emission\ Factor$$

Option 1	Energy (fuel, electricity) consumption at WWTP [liter, ton, kWh]	EF [kg-CO_{2e}/liter, kg-CO_{2e}/liter, kg-CO_{2e}/kWh]
Option 2	Total amount of solid/ organic waste collected/ landfilled [ton]	EF [kg-CO_{2e}/ton]
Option 3	Total volume of wastewater treated at WWPT [m^3]	EF [kg-CO_{2e}/m^3]
Option 4	Travel distance of waste collection trucks [km]	EF [kg-CO_{2e}/km] = EF[kg-CO_{2e}/liter] FE[kg-CO_{2e}/liter]
Option xx		

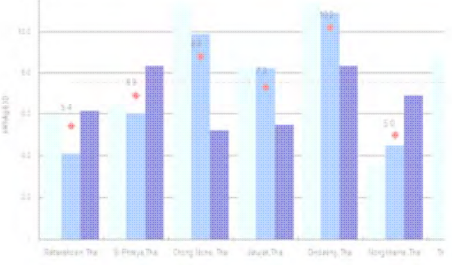
Achievements, lessons learned & challenges, and expectation (1)

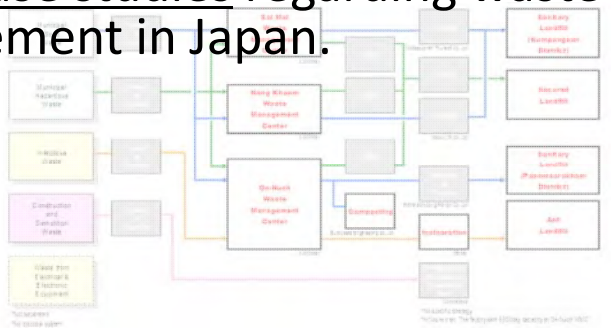
- **Achievement**: enhanced understanding on basic approach for climate change master plan formulation by TF members.
- **Achievement**: analyzed current status of the sector to move toward next step of M/P formulation.
- **Lesson learned**: identified barriers and lessons learned through BMA action plan development and evaluation.



Achievements, lessons learned & challenges, and expectation (2)

- **Challenge**: data collection and projection; identifying appropriate GHG calculation methodology; identifying GHG reduction activities in the sector
- **Expectation/ need**: Basic concept and example of MRV method, including GHG emission reduction calculation; successful case studies regarding waste and wastewater management in Japan.





Draft framework of

Bangkok Climate Change Master Plan of

Efficient Solid Waste Management and Waste Water Treatment Sector

20 May, 2014
BMA

1. Approach to action plan identification & selection

a. Preparation of Long List of mitigation actions (please see ***Attachment***)

b. Formulation of 6 evaluation criteria

- Consistency with existing policies, starting date within '13-'23, GHG reduction/ control, data availability, appropriate financial performance, MRV-ability

c. Selection of priority mitigation actions

- Application of evaluation criteria (as a reference)
- Actions that do not comply with all selection criteria will still be selected taking into account their contribution to sustainable development in Bangkok, etc.

2. Selected priority mitigation actions (waste management)

Action (waste management)	Ref No.	Stakeholders	2013-2016	2017-2023
1. Promote people's participation on waste reduction and separation by using principle of 3Rs	1,2,3, 4	Dept. of Environment, district offices, community, private sector	→	→
2. Reduce food waste at supermarket (for example grade B campaign, after 8 p.m. discount campaign)	5,6	Dept. of Environment, district offices, supermarket	→	→
3. Promote reduction/ recycle of plastic waste	10	Dept. of Environment, district offices, community, private sector, scavengers	→	→
4. Improve fuel efficiency of waste collection and transportation system (environmentally friendly trucks, efficient routes, eco-driver awards program)	14,15, 16,17	Dept. of Environment, district offices truck rental companies		→
5. Utilization of night soil, sludge, and yard waste for fertilizer	18	Dept. of Environment, district offices, Various BMA departments, government agencies	→	→
6. Waste-to-energy incineration facility	20	Dept. of Environment Private sector	→	→
7. Construct new composting plants	22,23	Dept. of Environment Private sector	→	→
8. Introduction of environment-friendly landfill system such as methane collection from landfill	25,27	Dept. of Environment Private sector	→	→
9. Utilization of biogas from community	18	Dept. of Environment district offices, Community	→	→

2. Selected priority mitigation actions (wastewater management)

Action (wastewater treatment)	Ref No.	Stakeholders	2013-2016	2017-2023
1. Promote reduction of water usage at house	30	Sewage Dept., Env. Sanitation dept. of district offices Community	→	→
2. Promote conversion of sludge to fertilizer	38	Sewage Dept., Public Park Office, (farmers) Academic and research institutions	→	→
3. Implement new energy efficient treatment system (such as DHS)	35, 44,47	Sewage Dept. Academic and research institutions	→	→
4. Improve operation of WWTP through adjusting contract between BMA and operator or BMA recommendation	35, 45	Sewage Dept., Private WWTP operators	→	→
5. Replace existing inefficient equipment to efficient equipment such as pumps and blowers	35,46	Sewage Dept., Private WWTP operators	→	→
6. Introduce energy efficient equipment such as pumps and blowers at new WWTPs	35,47	Sewage Dept., Private WWTP constructors	→	→
7. Promote water reuse such as application to agricultural and community	32,48, 51	Sewage Dept., Farmers and community (private sector) Academic and research institutions	→	→
8. Construct new WWTPs: Minburi, Thonburi, Klongtoey, Nongbon	42	Sewage Dept., Ministry of Interior		→

First Draft of Climate Change Master Plan :

Waste management and Wastewater treatment Sector

22 October 2014

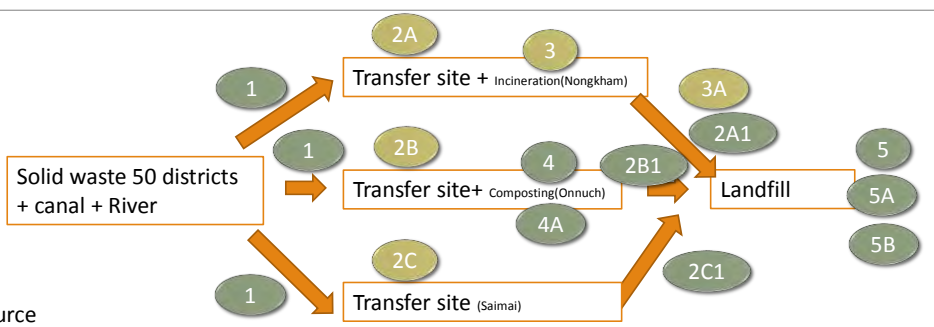
Ms. Sirilak Leerasiri
Ms. Wontana Wuttiyingyong

Structure for the table of contents

1. Emission calculation from Solid Waste
2. Mitigation Actions for Waste management
3. Emission calculation from Wastewater
4. Mitigation Actions for Wastewater treatment
5. Suggestion

1.Emission from Solid Waste

Scenario



GHG emission source
1 Transportation of solid waste
2 A, 2B, 2C Emission from transfer site (Electricity)
2A1, 2B1, 2C1 Emission from oil consumption
3. Emission from incineration (CO_2+N_2O+CH4)
3A Transportation of ash from incinerator to LF
Fossil fuel&Elec. consumption for process

4 CH_4, CO_2, N_2O Emission from composting
4A Electricity+Oil consumption at composting
5 CH_4 Emission from LF
5A Electricity consumption at LF
5B Electricity consumption at LF

Total emission from waste sector

	Source	Emission	Unite
1	CO2 emission from transportation of solid waste	42,078	Ton CO_2/year
2 A, 2B, 2C	Emission from transfer site (Electricity)	1,922	
2A1, 2B1, 2C1	Emission from oil consumption	32,951	Ton CO_2/year
3	Emission from incineration (CO_2+N_2O+CH4)	172,613	Ton CO_2/year
3A	Transportation of ash from incinerator to LF, Fossil fuel&Elec. consumption for process		Ton CO_2/year
4	CH_4, CO_2, N_2O Emission from composting	70,926	Ton CO_2/year
4A	Electricity + Oil consumption at composting	3,130	Ton CO_2/year
5	CH_4 Emission from LF	1,013,596	Ton CO_2/year
5A	Electricity consumption at LF	1,360	Ton CO_2/year
5B	Oil consumption at LF		Ton CO_2/year

Total emission = 1,338,567 Ton CO_2/year

Data is not verified, please do not use as a reference

BAU calculation

Sub sector		GHG emission source	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566
			Estimate BAU GHG Emission (Ton/year)										
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Solid waste	1	CO2 emission from transportation of solid waste	42,078	42,793	43,521	44,261	45,013	45,778	46,557	47,348	48,153	48,972	49,804
	2 A, 2B, 2C	Emission from transfer site (Electricity)	1,922	1,955	1,988	2,022	2,056	2,091	2,127	2,163	2,199	2,237	2,275
	2A1, 2B1, 2C1	Emission from oil consumption (Transfer to LF)	32,951	33,511	34,081	34,660	35,249	35,849	36,458	37,078	37,708	38,349	39,001
	3	Emission from incineration (CO2+N2O+CH4)	0	0	0	172,613	172,613	172,613	287,688	287,688	287,688	287,688	287,688
	3A	Transportation of ash from incinerator to LF, Fossil fuel&Elec. consumption for process											
	4	CH4, CO2, N2O Emission from composting	70,926	70,926	70,926	109,612	109,612	109,612	109,612	109,612	109,612	109,612	109,612
	4A	Electricity + Oil consumption at composting	3,130	3,130	3,130	4,837	4,837	4,837	4,837	4,837	4,837	4,837	4,837
	5	CH4 Emission from LF	1,013,596	1,080,286	1,142,458	1,200,448	1,254,567	1,305,101	1,352,314	1,396,451	1,437,736	1,476,376	1,512,562
	5A	Electricity consumption at LF	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360	1,360
	5B	Oil consumption at LF											
		Total	1,165,963	1,233,962	1,297,464	1,569,813	1,625,307	1,677,241	1,840,953	1,886,537	1,929,294	1,969,431	2,007,140

Data is not verified, please do not use as a reference

2. Mitigation Actions for Waste Management

Mitigation Actions by Waste Management

Category	Measure
Waste generation	1. Promote people's participation on waste reduction and separation
	2. Encourage utilization of organic waste at source
	3. Promote reduction/ recycle of plastic waste
Waste collection & Transportation	4. Improve fuel efficiency of waste collection and transportation system
Intermediate treatment	5. Utilize organic waste
	6. Construct waste-to-energy incineration facility
	7. Construct new composting plant
Final disposal	8. Construct waste segregation plant
	9. Install environment-friendly landfill system

Waste generation

1) Promote people's participation on waste reduction and separation
2) Encourage utilization of organic waste at source
3) Promote reduction/ recycle of plastic waste

1) " Promote people's participation on waste reduction and separation"

Title	1.Promote people's participation on waste reduction and separation
Details	1.1 Enhance public awareness and partnership on waste management from waste reduction and separation at source to final disposal through Public Relation , giving knowledge, implement the projects, etc.
	1.2) Develop waste management system in District offices
	1.3) Expand community based solid waste management (CBM)
	1.4) Study and develop waste management model in BMA's school, BMA hall 1, BMA hall 2, BMA's health center service, community and all BMA's offices
	1.5) Create a mascot for the symbol on waste reduction and separation
	1.6) Promote junk shop in environmentally friendly waste management
	1.7) Promote partnership with the private sector in the management of solid waste at source
	1.8) Waste reduction and separation at source in household, accommodation, apartment and commercial
	1.9) Campaign reuse project

1) " Promote people's participation on waste reduction and separation"

Title	1. Promote people's participation on waste reduction and separation
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept.of Environment, district offices, community, schools, university, private sector and etc.
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

2) "Encourage utilization of organic waste at source"

Title	2. Encourage utilization of organic waste at source
Detail	2.1) Grade B campaign, after 8 p.m. discount campaign at supermarket
	2.2) Utilize biogas from community
	2.3) Encourage utilization of biogas in BMA's school,market,hotel and restaurant
	2.4) Promote home composting
	2.5) Promote liquid organic fertilizer and Bio fertilizer use in community
BMA's Responsibility	BMA (Indirectly implemented)
Stakeholders	Dept.of Environment, district offices, supermarket
Implementation schedule	Mid to long term(2016-2023)
Estimated GHG emission reduction	XXXX ton /year

3) "Promote reduction /recycle of plastic waste."

Title	3. Promote reduction/ recycle of plastic waste
Details	3.1) Promote bio-packing use in order to reduce plastic
	3.2) Promote manufactures and trader to reduce packaging and use decomposed materials
	3.3) Reduce the amount of plastic waste incineration - Encourage cloth bags use instead of plastic bags - Promote plastic waste separation for recycling - Reduce foam use
BMA's Responsibility	BMA (Indirectly implemented)
Stakeholders	Dept.of Environment, district offices, community, private sector, scavenger
Implementation schedule	Mid to long term(2016-2023)
Estimated GHG emission reduction	XXXX ton /year

4) Improve fuel efficiency of waste collection and transportation system

4) “Improve fuel efficiency of waste collection and transportation system”

Title	4. Improve fuel efficiency of waste collection and transportation system
Details	4.1) environmentally friendly trucks, efficient routes, eco-driver awards program 4.2) Determine the indicator for District offices that use efficient truck 4.3) Determine the frequency of waste collection by type
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, district offices, truck rental companies
Implementation schedule	Long term(2019-2023)
Estimated GHG emission reduction	XXXX ton /year

5) Utilize organic waste
6) Construct waste-to-energy incineration facility
7) Construct new composting plant
8) Construct waste segregation plant

5) “Utilize organic waste”

Title	5. Utilize of organic waste
Details	5.1) Utilization of Organic Waste and Yard Waste 5.2) Nightsoil, sludge and yard waste for fertilizer
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, district offices, Various BMA departments, government agencies, Agricultural sector, Community
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

6) “Construct waste-to-energy incineration facility”

Title	6. Construct waste-to-energy incineration facility
Details	6.1) Under-construction the incinerator with 300 tons/day at Nong Khaem Transfer Station 6.2) Generate electricity through waste incineration
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

7) “Construct new composting plants”

Title	7. Construct new composting plants
Details	7.1) Construct composting plant with 600 tons/day at On-Nuch Transfer station (within 2015) 7.2) Reduce the amount of landfill organic waste
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Mid to long term(2016-2023)
Estimated GHG emission reduction	XXXX ton /year

8) “Construct Waste segregation Plant”

Title	8. Construct Waste segregation Plant
Details	Construct waste segregation Plant with 300 tons/day at On nuch Transfer station
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

Final disposal

9) Install environment-friendly landfill system

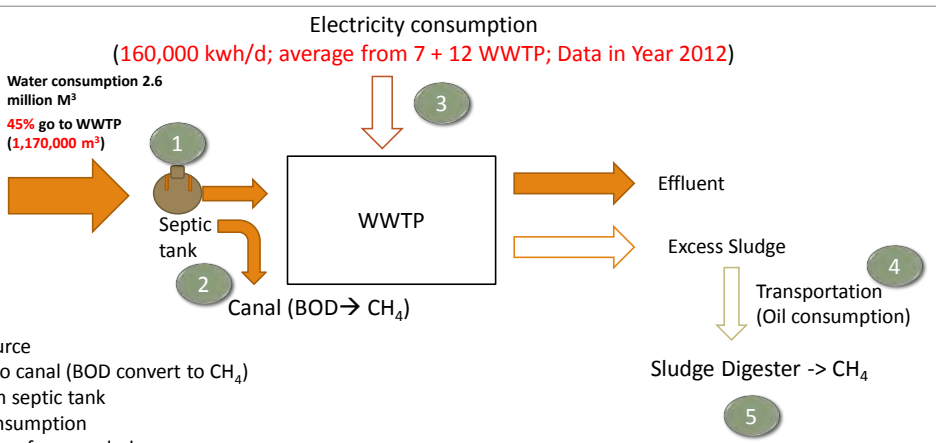
9)“Install environment-friendly landfill system”

Title	9. Install environment-friendly landfill system
Details	methane collection from landfill
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

3.Emission from Wastewater

Data is not verified, please do not use as a reference 23

Scenario



GHG emission source

1. Wastewater to canal (BOD convert to CH_4)
2. Emission from septic tank
3. Electricity consumption
4. Transportation of excess sludge
5. Anaerobic digestion of excess sludge

Data is not verified, please do not use as a reference 24

Total emission from WW sector

	Source	Emission	Unit
1	Septic tank	524,286	Ton CO_2/year
2	Untreated ww(sediment)	93,060	Ton CO_2/year
3	Electricity consumption	31,870	Ton CO_2/year
4	Transportation of excess sludge	142.781	Ton CO_2/year
5	Sludge digestion	360	Ton CO_2/year

Total Emission 649,719 Ton CO_2/year

Data is not verified, please do not use as a reference

BAU calculation

			2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566
Sub sector		GHG emission source	Estimate BAU GHG Emission (Ton/year)										
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Wastewater	1	Septic tank	524,286	533,199	542,263	551,482	560,857	570,391	580,088	589,950	599,979	610,178	620,551
	2	Untreated wastewater	93,060	94,642	96,251	97,887	99,551	101,244	102,965	104,715	106,495	108,306	110,147
	3	Electricity consumption at slude treatment plant	31,870	31,870	31,870	31,870	31,870	31,870	31,870	31,870	31,870	31,870	31,870
	4	Sludge digestion	360	360	360	360	360	360	360	360	360	360	360
	5	Transportation of excess sludge	143	143	143	143	143	143	143	143	143	143	143
	6	New Wastewater Treatment Plant		4375.62	4375.62	4375.62	4375.62	4375.62	4813.182	4813.182	4813.182	5294.5002	5294.5002
		Total	649,719	664,589	675,263	686,117	697,157	708,384	720,239	731,851	743,660	756,151	768,366

Data is not verified, please do not use as a reference

4. Mitigation Actions for the Wastewater Treatment

Mitigation Actions for Wastewater treatment

Category	Measure
Wastewater generation	1. Promote reduction of water usage at house
	2. Promote collection of wastewater tariff
Wastewater Collection	3. Expand sewage area
	4. Implement separate collection system
Wastewater treatment	5. Improve operation of WWTP
	6. Replace existing inefficient equipment to efficient equipment
	7. Implement energy efficient equipment at new WWTPs
	8. Construct new WWTPs
Sludge treatment	9. Promote utilization of sludge
Water reuse	10. Promote water reuse

Wastewater generation

1) Promote reduction of water usage at house
2) Promote collection of wastewater tariff

1) "Promote reduction of water usage at house"

Title	**1. Promote reduction of water usage at house**
Details	1.1 Conduct campaigns for Bangkok citizens to reduce water usage at house by using Water saving devices and facilities. 1.2 Giving Knowledge and raising awareness and consciousness in value of water resources and reducing water usage efficiently and properly. 1.3 Reduce the wastewater volume by charging wastewater treatment cost to users. (service area)
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, ENV, Sanitation Dept. of District Offices, Community, Private sector (water saving devices manufacture, Advertising), NGO ,(private WWTP operators)
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

2) “Promote collection of wastewater tariff”

Title	2. Promote collection of wastewater tariff
Details	2.1 Giving Knowledge, raising awareness, consciousness and acceptance in the field of legislative on wastewater tariff 2.2 Providing and developing the database of water user, legislation computer (hardware and software) system and manpower for wastewater tariff collection 2.3 Setting up the wastewater tariff collection service center in order to implement the tariff collection successfully JICA Expert team would like to conform the meaning of this action.
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Dept of Finance, Dept of strategies and Evaluation Env, Sanitation Dept of District Office Community (service area) MWA (Metropolitan water Authority), NGO, Private Sector
Implementation schedule	XXXX
Estimated GHG emission reduction	XXXX ton /year

Wastewater Collection

3) Expand sewage area
4) Implement separate collection system

3) “Expand sewage area”

Title	3. Expand sewage area
Details	3.1 Expand collection system in order to receive and collect inlet wastewater to WWTP and rearrangement of the existing treatment area 3.2 Expand of WWTP-connected area 3.3 Improvement of the interceptor sewerage system (BMA Combined type sewerage system) 3.4 Improvement of storm water drainage in parallel with improvement of water quality in canals and public watercourses 3.5 Improvement of scattering discharge point by rehabilitation of collection system.
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Env, Sanitation Dept of District Offices, private sector (wastewater facilities construction manufacture), community
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction	XXXX ton /year

4) “Implement separate collection system”

Title	4. Implement separate collection system
Details	4.1 separate Sewerage system pilot project • New urban development area with residential/commercial area (Individual WWTP) • Ongoing new urban development area and existing treatment area where it is possible to receive wastewater in public sewerage system (Flow into existing interceptor) • Exemplary area where people fully understand role/function of sewerage system, do not discharge garbage/oil into sewer and pay sewerage tariff
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Env, Sanitation Dept of District Offices, community, Private sector(establishments, manufactures, company ,etc)
Implementation schedule	Mid to long term (2016-2023)
Estimated GHG emission reduction	XXXX ton /year

Wastewater treatment

5) Improve operation of WWTP
6) Replace existing inefficient equipment to efficient equipment
7) Implement energy efficient equipment at new WWTPs
8) Construct new WWTPs

5) "Improve operation of WWTP"

Title	**5. Improve operation of WWTP**
Details	5.1 Improve operation of WWTP, based on adjusted contract between BMA and WWTP operator, or based on recommendation by BMA 5.2 Prevention of N_2O generation by setting anaerobic and aerobic operation adequately in the aeration tank 5.3 Increase efficiency of wastewater treatment process in order to decrease energy consumption,((oil and fuel) 5.4 Reduction of energy/electricity consumption by campaign to public reduce environmental load such as edible oil or discharged wastewater 5.5 Energy saving operation like air control of reaction tank
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Academic and Research Institutions, Private sector (Private WWTP operators)
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

6) "Replace existing inefficient equipment to efficient equipment"

Title	6. Replace existing inefficient equipment to efficient equipment
Details	6.1 Replace existing inefficient with more energy efficient equipment, such as pumps and blowers. 6.2 Adoption of the energy saving machinery
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Private WWTP operators
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

7) "Implement energy efficient equipment at new WWTPs"

Title	7. Implement energy efficient equipment at new WWTPs
Details	7.1 Implement energy efficient equipment, such as pumps and blowers at a new WWTP 7.2 Construct a new treatment system which can reduce the energy cost and reduce the excess sludge generation 7.3 Adoption of compact and energy saving technology for treatment system 7.4 Energy saving design by setting lift head of lifting pump adequately
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Private WWTP contractors.
Implementation schedule	Mid to long term(2016-2023)
Estimated GHG emission reduction	XXXX ton /year

8) “Construct new WWTPs”

Title	8. Construct new WWTPs
Details	8.1 New Central WWTPS of capacity 670,000 m3/d Minburi (10,000 m3/d), Thonburi (165,000 m3/d) , Klongtoey (360,000 m3/d), Nongbon (135,000 m3/d)
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Ministry of Interior, Ministry of Finance, The Nation of Economics development and Social
Implementation schedule	Long term(2019-2023)
Estimated GHG emission reduction	XXXX ton /year

Sludge treatment

9) Promote utilization of sludge
10) Promote water reuse

9) “Promote utilization of sludge”

Title	9. Promote utilization of sludge
Details	9.1 Conversion to fertilizer 9.2 Energy creation by digestion gas 9.3 Reduction of fuel by using sewage sludge as solid fuel 9.4 Considering warming coefficient (CH_4/CO_2=21), replacing CH4 generation at sludge disposal site to CO_2, of Solid fuel.
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Public Park Office, farmers Academic and Research institutions, Private contractors.
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

10) “Promote water reuse”

Title	10. Promote water reuse
Details	10.1 Increase quantity of treated wastewater reclamation from Central WWTP 10.2 Increase the reuse of treated wastewater for agricultural and community application 10.3 Reduction of water supply by using treated wastewater 10.4 Reduction of heat exchange energy by using treated wastewater for cooling
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Farmers, Community, private sectors, Academic and research institutions
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction	XXXX ton /year

Suggestion

1. Provide the waste and wastewater mitigation activities should be related to the implementation plan of BMA
2. Good cooperation for every taskforce and department of BMA as well as the other organization is important for proceed the master plan successfully

THANK YOU

Bangkok Climate Change of Master Plan Efficient Solid Waste Management and Wastewater Treatment Sector

Structure for the table of contents

1. **Mitigation Actions for Wastewater Treatment**
2. **Monitoring and Evaluation for Wastewater**
3. **Mitigation Actions for Waste Management**
4. **Monitoring and Evaluation for Waste Management**
5. **Outreach Activities**

1. Mitigation Actions for the Wastewater Treatment

Mitigation Actions for Wastewater treatment

Category	Measure
Wastewater generation	1. Promote reduction of water usage at house
	2. Promote collection of wastewater tariff
Wastewater Collection	3. Expand and improve sewage system
	4. Implement separate collection system
Wastewater treatment	5. Improve operation and equipment of existing WWTPS
	6. Construct new energy efficient WWTPS
Sludge treatment	7. Promote utilization of sludge
Water reuse	8. Promote water reuse

Wastewater generation

1) Promote reduction of water usage at house
2) Promote collection of wastewater tariff

1) "Promote reduction of water usage at house"

Title	1. Promote reduction of water usage at house
Details	1.1 Promote use of water saving device 1.2 Raise awareness of water saving
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, ENV, Sanitation Dept. of District Offices, Community, Private sector (water saving devices manufacture, Advertising), NGO ,(private WWTP operators)
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

2) “Promote collection of wastewater tariff”

Title	2. Promote collection of wastewater tariff
Details	2.1 Prepare and implement the tariff collection
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Dept of Finance, Dept of strategies and Evaluation Env, Sanitation Dept of District Office Community (service area) MWA (Metropolitan water Authority), NGO, Private Sector
Implementation schedule	XXXX
Estimated GHG emission reduction	XXXX ton /year

Wastewater Collection

3) Expand sewage area
4) Implement separate collection system

3) “Expand sewage area”

Title	3. Expand sewage area
Details	3.1 Expand and improve sewage system 3.2 Rearrange existing treatment area 3.3 Improvement of the interceptor sewerage system (BMA Combined type sewerage 3.4 Improvement of scattering discharge point by cellection system.
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Env, Sanitation Dept of District Offices, private sector (wastewater facilities construction manufacture), community
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction	XXXX ton /year

4) “Implement separate collection system”

Title	4. Implement separate collection system
Details	4.1 Implement separate Sewerage system pilot project at new urban residential/commercial area 4.2 Implement separate Sewerage system pilot project at existing treatment area
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Env, Sanitation Dept of District Offices, community, Private sector(establishments, manufactures, company ,etc)
Implementation schedule	Mid to long term (2016-2023)
Estimated GHG emission reduction	XXXX ton /year

Wastewater treatment

5)Improve operation and equipment of existing WWTPS
6. Construct new energy efficient WWTPS

5) "Improve operation and equpment of existing of WWTP"

Title	5. Improve operationand equpment of existing of WWTP
Details	5.1 Increase efficiency of wastewater treatment process such as air control of reaction tank 5.2 Replace existing inefficient equipment with more energy efficient equipment, such as pumps and blowers. 5.3 Generation by setting anaerobic and aerobic operation adequately in the aeration tank 5.4 Improve operation of WWTPs, Based on adjusted between BMA and WWTPs operator, or based on recommendation by BMA 5.5 Compaign to public environmental load as edible or discharged wastewater
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Academic and Research Institutions, Private sector (Private WWTP operators)
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

6) “Construct new energy efficient WWTPs”

Title	8. Construct new WWTPs
Details	6.1 Construct New Central WWTPs; Minburi WWTP (10,000 m3/d), Thonburi WWTP (165,000 m3/d), Klongtoey WWTP (360,000 m3/d), Nongbon WWTP (135,000 m3/d), 6.2 Install energy efficient equipment, such as pumps and blowers at new new WWTP 6.3 Construct a new treatment system which can reduce the excess sludge generation 6.4 Adoption of compact and energy saving technology for treatment system 6.5 Energy saving design by setting lift head of lifting pump adequately
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Ministry of Interior, Ministry of Finance, The Nation of Economics development and Social
Implementation schedule	Long term(2019-2023)
Estimated GHG emission reduction	XXXX ton /year

Sludge treatment

7) Promote utilization of sludge
8) Promote water reuse

7) “Promote utilization of sludge”

Title	7. Promote utilization of sludge
Details	7 Promote utillization of sludge 7.1 promote conversion to fertilizer 7.2 Encourage energy creation by digestion gas 7.3 Reduction of fuel by using sewage sludge as solid fuel
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Public Park Office, farmers Academic and Research institutions, Private contractors.
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

8) “Promote water reuse”

Title	8. Promote water reuse
Details	8.1 Increase quantity of treated wastewater use for agricultural and community application 8.2 Reduction of water supply by using treated wastewater 8.3 Reduction of heat exchange by using treated wastewater for cooling
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Farmers, Community, private sectors, Academic and research institutions
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction	XXXX ton /year

2. Monitoring and Evaluation for Wastewater Treatment

Monitoring and Evaluation for Wastewater Treatment
Construct new energy efficient system

Baseline indicator	End of Project/ Action indicator	Data/ Information source	Data/ Information Provider	Reporting Cycle
• Target areas are not connected to wastewater treatment service • 15% of BMA area is connected to WWTPs • 56% of BMA population is connected to WWTPs service area • 46% of wastewater generation is treated	Construction of new central WWTPs is completed	Monthly progress report of construction	Consultant	DDS collects data from consultant and send to DOE
	Operation of new WWTPs starts	Operation and maintenance monthly report	Consultant	DDS collects data from consultant and send to DOE
	Water quality of effluent meets national and BMA standard	Operation monthly report	WWTPs operator	DDS collect data from WWTPs operator and send to DOE
	Water quality of canal in wastewater treatment service area is improved	Water quality monitoring monthly report	DDS	DDS collect data and send to DOE

Monitoring and Evaluation for Wastewater Treatment
Promote reduction of water usage at house

Baseline indicator	End of Project/ Action indicator	Data/ Information source	Data/ Information Provider	Reporting Cycle
. Citizens in Bangkok area ' s water supply usage increase every year	. Water use at household decreases	. MWA report	. MWA	.DDs collect Data from MWA and send to DOE
. BMA has implemented Campaign about the water usage at house	. Campaigns or public relation/workshop regarding water use reduction issue are implemented	. DDs report . Number of participants/ People attend this project	.DDS	. DDS collect data and send to DOE

19

3. Mitigation Actions for Waste Management

Mitigation Actions for Waste Management

Category	Measure
Waste generation	1.Promote participation on waste reduction and separation at source (household, accommodation, apartment, commercial)
	2. Reduce the amount of plastic waste
Waste collection and transportation	3. Improve fuel efficiency of waste collection and transportation system
Intermediate treatment	4. Promote utilization of organic waste
	5. Construct waste-to-energy incineration facility
	6. Construct Waste segregation Plant
Final disposal	7. Install environment-friendly landfill system

Waste generation

1.Promote participation on waste reduction and separation at source (household, accommodation, apartment, commercial)
2. Reduce the amount of plastic waste

1) “Promote participation on waste reduction and separation at source (household, accommodation, apartment, commercial)”

Title	1.Promote participation on waste reduction and separation at source (household, accommodation, apartment, commercial
Details	1.1) Enhance public awareness and partnership on waste management from waste generation to final disposal through public relation, campaign (mascot campaign, Grade B campaign at supermarket, after 8 p.m. discount campaign at supermarket), project implementations etc. 1.2) Develop waste management model in district offices, BMA’s school, BMA hall 1 & 2, BMA’s health center service and all BMA’s offices 1.3) Expand CBM(Community Based solid waste Management) 1.4) Promote partnership with the private sector in the management of solid waste at source
BMA’s Responsibility	BMA (Directly implemented)
Stakeholders	Dept.of Environment, district offices, community, schools, university, private sector and etc.
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

2) “Reduce the amount of plastic waste ”

Title	2. Reduce the amount of plastic waste
Details	2.1) Encourage cloth bags and bio-packing use instead of plastic bags 2.2) Promote plastic waste separation for recycling 2.3) Promote manufactures and trader to reduce packaging and foam
BMA’s Responsibility	BMA (Indirectly implemented)
Stakeholders	Dept.of Environment, district offices, community, private sector, scavenger
Implementation schedule	Mid to long term(2016-2023)
Estimated GHG emission reduction	XXXX ton /year

Waste collection and transportation

3. Improve fuel efficiency of waste collection and transportation system

3. Improve fuel efficiency of waste collection and transportation system

Title	**3. Improve fuel efficiency of waste collection and transportation system**
Details	3.1) Implement environmentally friendly trucks 3.2) Select efficient routes 3.3) Develop Eco-driver awards program
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, district offices, truck rental companies
Implementation schedule	Long term(2019-2023)
Estimated GHG emission reduction	XXXX ton /year

Intermediate treatment

4. Promote utilization of organic waste
5. Construct waste-to-energy incineration facility
6. Construct waste segregation plant

4. Promote utilization of organic waste

Title	4. Promote utilization of organic waste
Details	4.1) Promote composting and utilization of organic waste, nightsoil, sludge and yard waste. 4.2) Construct composting plant with 600 tons/day at On-Nuch Transfer station (within 2015) 4.3) Encourage production of biogas in BMA's school, market, hotel, restaurant and community.
BMA (Indirectly implemented)	BMA (Indirectly implemented)
Dept.of Environment, district offices, supermarket	Dept.of Environment, district offices, supermarket
Mid to long term(2016-2023)	Mid to long term(2016-2023)
XXXX ton /year	XXXX ton /year

5. Construct waste-to-energy incineration facility

Title	5. Construct waste-to-energy incineration facility
Details	5.1) Construct waste-to-energy incinerator with 300 tons/day at Nong Khaem Transfer Station
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Academic and Research Institutions, Private sector (Private WWTP operators)
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

6. Construct Waste segregation Plant

Title	6. Construct Waste segregation Plant
Details	6.1) Construct waste segregation Plant with 300 tons/day at On nuch Transfer station
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

Final disposal

7. Install environment-friendly landfill system

7. Install environment-friendly landfill system

Title	7. Install environment-friendly landfill system
Details	7.1) Methane collection from landfill 7.2) Reduce GHG from landfill
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Short to long term(2013-2023)
Estimated GHG emission reduction	XXXX ton /year

4. Monitoring and Evaluation for Waste management

Monitoring and Evaluation for Waste: Construction
Construct new composting plant

Baseline indicator	End of Project/ Action indicator	Data/ Information source	Data/ Information Provider	Reporting Cycle
• A lot of organic waste is unused • BMA has policy to expand and construct new composting plant • BMA has a composting plant with 1,000 ton/day • Fill the target …% for reduce	Construction of new composting plant is completed	Monthly progress report of construction	DOE	Solid waste disposal division send to DOE
	Operation of new composting plan starts	Operation and maintenance monthly report	DOE	Solid waste disposal division send to DOE
	Organic waste is sent to composting plant instead of landfill	Amount of treated organic waste that is sent to new composting plant	Composting plant operator	Solid waste disposal division receive data from operator and send to DOE
	Composition of compost is suitable for fertilizer	Composition of compost monitoring report	Composting plant operator	Solid waste disposal division receive data from operator and send to DOE

Monitoring and Evaluation for Waste: Non-Construction promote participation on waste reduction and separation at source (Encourage participation on waste separation and collection by types)

Baseline indicator	End of Project/ Action indicator	Data/ Information source	Data/ Information Provider	Reporting Cycle
• Volume of solid waste in BKK increase every year about 9,900 ton/day • Solid waste composition consist of 50.34% compostable waste, 11.81% recyclable waste and 37.85% • BMA has implemented campaign on waste reduction and separation	.Campaigns or public relations/ workshop regarding the issue will be implemented	.Number of campaigns or public relations/workshop /people attend this project report	.DOE and Districts	.DOE collect data from districts and others send to DOE (Secretariat)
	.Route of solid waste collection by types will be defined by date and time	.Report of all routes from 50 districts	Districts	DOE collect data from districts send to DOE (Secretariat)
	. Amount of waste separation and utilization will be collected	Amount of waste by types report	DOE, Districts and Transfer station	DOE collect data from districts and others send to DOE (Secretariat

35

Outreach Activities

CBM (Community Base Solid Waste Management)

Background:

- The BMA has implemented campaigns and activities according to 3R principles. This has result in public cooperation on reduction and sorting of waste at source. In particularly, the concept of Community Based Solid Waste Management : CBM.
- Nowadays, there are almost 314 communities to participate this project.
- The DOE has expanded the mention project to other target groups (eg. Education Institutes, Department stores, Hotels, Hospitals, and Villages).

Event: Best Practice Award

Implementation: CBM Contest in Bangkok 's Community
: Training course or workshop for leader of communities, school etc.

THANK YOU

The 5th Working Group on the Bangkok Master Plan on Climate Change 2013-2023
May 20, 2015

Presentation on the BAU and Mitigation Target in Efficient Solid Waste Management and Wastewater Treatment Sector

Jointly by
The Waste and Wastewater Task Force,
JICA Experts and Dr. Wilasinee

Table of Contents

I. Current status of GHG emission

1. Scope and coverage of the GHG emission

- GHG emissions related to municipal solid waste generated in the administrative boundary of BMA and various activities related to handling of such waste
- GHG emissions related to domestic and commercial wastewater generated in the administrative boundary of BMA and various activities related to treatment of such wastewater
- GHG emitted from the waste and wastewater that is originally generated in the administrative boundary of BMA but is transported to outside of its boundary
  - Emissions from landfill sites located outside of Bangkok that accept municipal solid waste generated in Bangkok
  - Emissions from sludge sediment in canals located outside of Bangkok that is contained in wastewater from residential and commercial units and wastewater treatment plants in Bangkok

I. Current status of GHG emission

2. Basic methodologies for GHG calculation

[Waste]

- CH_4 emission from disposed wastes is calculated by applying First Order Decay (FOD) model specified in 2006 IPCC Guidelines.
- Data of municipal solid waste generated in Bangkok such as waste amount and composition is taken from "Bangkok State of Environment 2013."
- IPCC default values are applied for some parameters except those values where Thailand's country-specific value or BMA's actual data is available.

[Wastewater]

- CH_4 emission from wastewater sludge accumulated at the bottom of canal is calculated by multiplying "volume of wastewater discharged into canal" by CH_4 emission factor per BOD.
- CH_4 emission from septic tanks is calculated by multiplying BOD concentration of wastewater discharged from septic tanks installed in selected residential and commercial units by IPCC default emission factors.

I. Current status of GHG emission

2. Basic methodologies for GHG calculation

[Electricity consumption]

- All GHG emissions due to electricity consumption (at waste transfer centers, composting plant, wastewater treatment plants) are calculated by recorded or estimated electricity consumption data multiplied by CO_2 emission factor of the national electricity grid.

[Transportation of waste/ sludge]

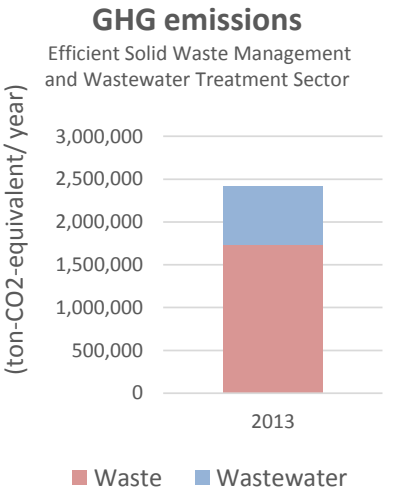
- Amount of fuel consumption by transportation trucks is multiplied by fuel emission factor provided by Ministry of Energy and IPCC Guidelines.
- Truck fuel consumption datais taken from 48 BMA districts.

I. Current status of GHG emission

3. Results of Calculation

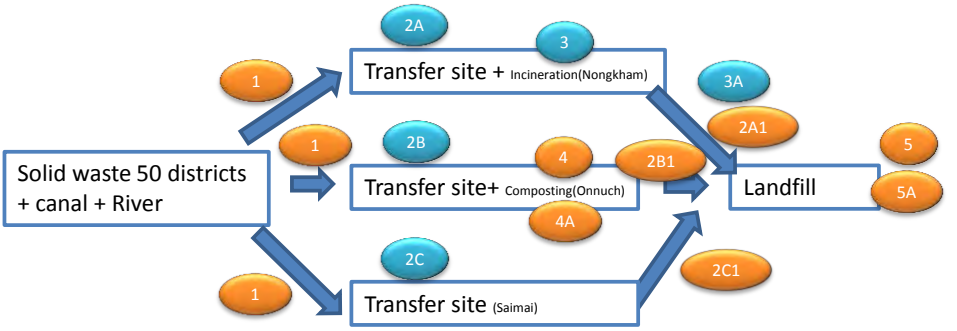
Table Current GHG emissions

Sub-sector	GHG emissions ($tCO_{2\text{-}e}$/year) (2013)
Waste	1,733,972
Wastewater	685,679
Total	2,392,972



II. BAU of GHG emission

I. BAU Scenario ; **Waste**

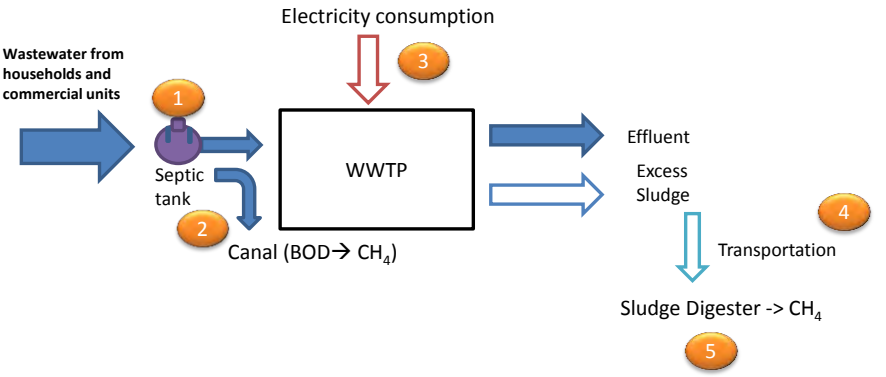


GHG emission source

1 Transportation of solid waste
2A, 2B , 2C Emission from transfer site (Electricity)
2A1,2B1,2C1 Emission from oil consumption
3 Emission from incineration (CO_2+N_2O+CH4)
3A Transportation of ash from incinerator to LF
4 CH_4, CO_2, N_2O Emission from composting
4A Electricity+Oil consumption at composting
5 CH_4 Emission from LF
5A Electricity consumption at LF

II. BAU of GHG emission

I. BAU Scenario; **Wastewater**



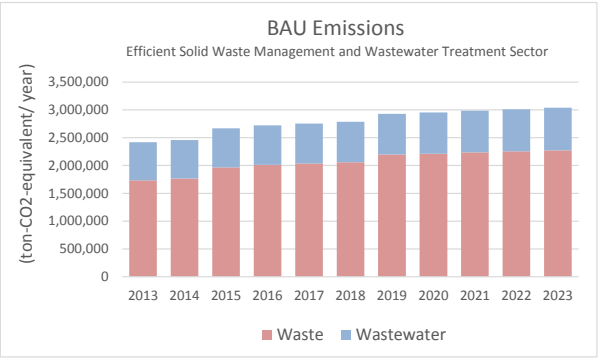
GHG emission source

1 Emission from septic tank
2 Wastewater to canal (BOD convert to CH_4)
3 Electricity consumption
4 Transportation of excess sludge
5 Anaerobic digestion of excess sludge

II. BAU of GHG emission

2. Methodologies for Calculation

- Assumptions:
  - Assumptions are principally based on BMA's future plans, e.g. most waste will be continuously treated at landfill sites in coming years while some are converted to compost or incinerated at waste incineration plant.
  - Waste and wastewater is expected to increase in line with growing population.
- Some BAU emissions are estimated using the available data.



III. Mitigation target in Waste and Wastewater Sector

I. Mitigation Scenario; Waste

Category	Action
Waste generation	**1.Promote participation on waste reduction and separation at source**
	1.1 Enhance public awareness and partnership on waste management
	1.2 Develop waste management model
	1.3 Expand CBM
	1.4 Promote partnership with the private sector in the management of solid waste at source
	2. Reduce the amount of plastic waste incineration
	2.1 Encourage cloth bags and bio-packing use instead of plastic bags
	2.2 Promote plastic waste separation for recycling
	2.3 Promote manufactures and trader to reduce packaging and foam
Waste collection and transportation	**3. Improve fuel efficiency of waste collection and transportation system**
	3.1 Implement environmentally friendly trucks
	3.2 Improve waste collection and transportation routes
	3.3 Develop Eco-driver awards program
Intermediate treatment	**4. Promote utilization of organic waste**
	4.1 Promote composting and utilization of Kitchen waste, Nightsoil, sludge and yard waste.
	4.2 Construct composting plant with 600 tons/day at On-Nuch Transfer station
	4.3 Increase production of biogas in BMA's school, market, hotel, restaurant and community
	5. Construct waste-to-energy incineration facility
	5.1 Construct waste-to-energy incinerator with 300 tons/day at Nong Khaem Transfer Station
	6. Construct Waste segregation Plant
	6.1 Construct waste segregation Plant with 300 tons/day at On nuch Transfer station
Final disposal	**7. Install environment-friendly landfill system**
	7.1 Encourage methane collection and power generation from landfill
	7.2 Reduce GHG from landfill

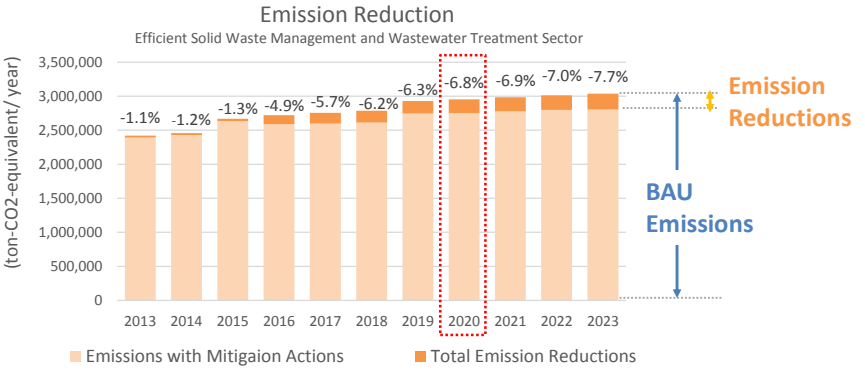
I. Mitigation Scenario; Wastewater

Category	Action
Wastewater generation	**1.Promote reduction of water usage at house**
	2. Promote collection of wastewater tariff
Wastewater collection	**3. Expand and improve sewage system**
	3.1 Expand collection system in order to receive and collect inlet wastewater to WWTP and rearrangement of the existing treatment area
	3.2 Expand of WWTP-connected area
	3.3 Improvement of scattering discharge point by rehabilitation of collection system
	4. Implement separate collection system
	4.1 Implement separate Sewerage system pilot project 4.2 separate Sewerage system pilot project
Wastewater treatment	**5. Improve operation & Equipment of existing WWTP**
	5.1 Increase efficiency of wastewater treatment process
	5.2 Prevention of N_2O generation by setting anaerobic and aerobic operation adequately in the aeration tank
	5.3 Increase efficiency of wastewater treatment process such as air control of reaction tank
	5.4 Reduction of energy/electricity consumption by campaign to public reduce environmental load such as edible oil or discharged wastewater
	6. Construct new WWTPs
	6.1 Construct New Central WWTPs
	6.2 Energy efficient improvement at new WWTPs
	6.3 Construct a new sludge treatment system to reduce excess sludge generation at new WWTPs
Sludge treatment	**7. Promote utilization of sludge**
	7.1 Promote sludge conversion to fertilizer
	7.2 Encourage energy creation by digestion gas
	7.3 Reduction of fuel by using sewage sludge as solid fuel
Water reuse	**8. Increase quantity of treated wastewater use**

* WWTP: wastewater treatment plant

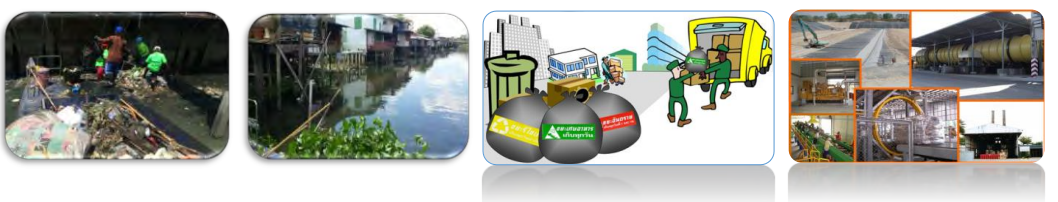
2. Methodologies for Calculation in 2020

- A bottom-up approach was applied
  (mitigation reduction target is aggregated by the amount of expected emission reduction of each mitigation action)
- Quantifiable mitigation actions were identified based on MRV-ability and data availability
- Appropriate activity data and emission factor were identified and selected
  - BMA's actual data
  - Estimated value based on reasonable and conservative assumptions
  - Default data provided by IPCC Guidelines, etc.



Bangkok Climate Change of Master Plan Efficient Solid Waste Management and Wastewater Treatment Sector

การจัดการขยะและการบำบัดน้ำเสียอย่างมีประสิทธิภาพ



แผนแม่บทว่าด้วยการลดปัญหาภาวะโลกร้อนของกรุงเทพมหานคร ระหว่างปี พ.ศ. 2556 – พ.ศ. 2566

- องค์กรความร่วมมือระหว่างประเทศ ประเทศญี่ปุ่น ได้ร่วมมือกันดำเนินงานจัดทำแผนแม่นบท เมื่อเดือนพฤษภาคม พ.ศ. 2556
- ระยะเวลาการดำเนินงาน มีนาคม 2556 – กันยายน 2558
- ประกอบด้วยแผนงาน 5 ด้าน

❑ด้านการพัฒนาระบบส่งมวลชนแบบยั่งยืน

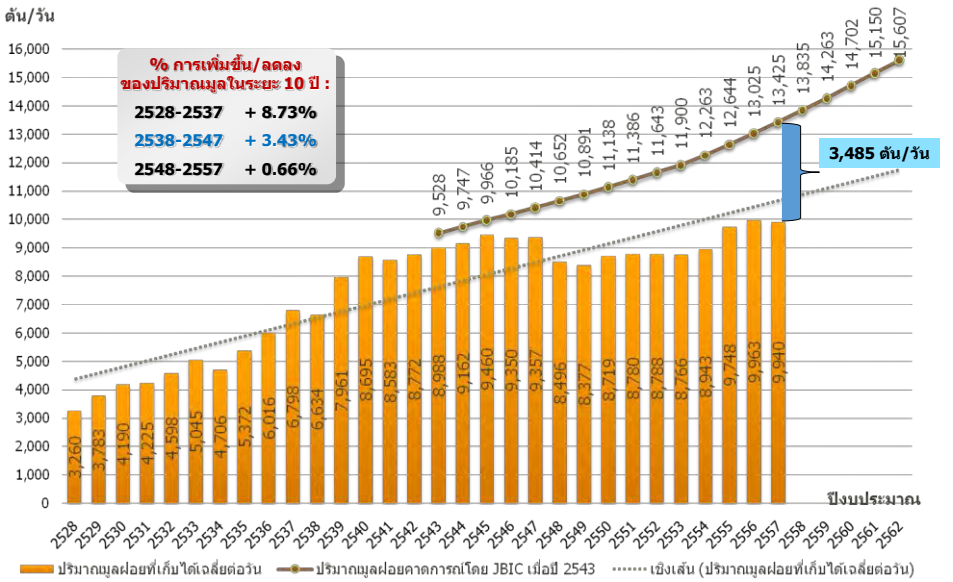
❑ด้านการใช้พลังงานอย่างมีประสิทธิภาพและการส่งเสริมการใช้พลังงานทางเลือก

❑ด้านการจัดการขยะและการบำบัดน้ำเสียอย่างมีประสิทธิภาพ

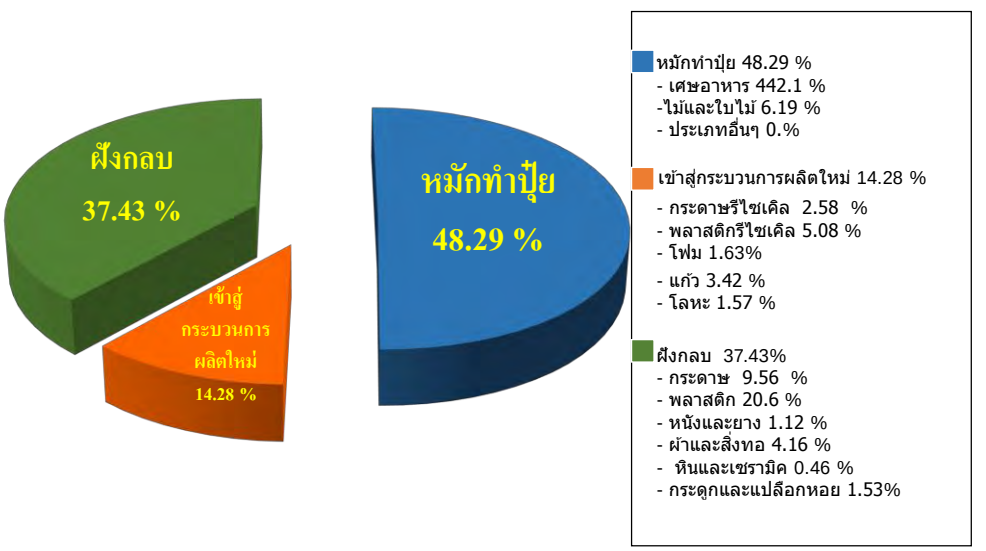
❑ด้านการพัฒนาเมืองสีเขียว

❑มาตรการ การปรับตัวเพื่อรองรับการเปลี่ยนแปลงสภาพภูมิอากาศ

สถานการณ์ขยะกรุงเทพมหานคร
ปี 2528-2557(ปริมาณเฉลี่ยต่อวัน)



องค์ประกอบขยะปี 2557



กำหนดเวลาทิ้ง-เวลาเก็บขน และเก็บแยกประเภท

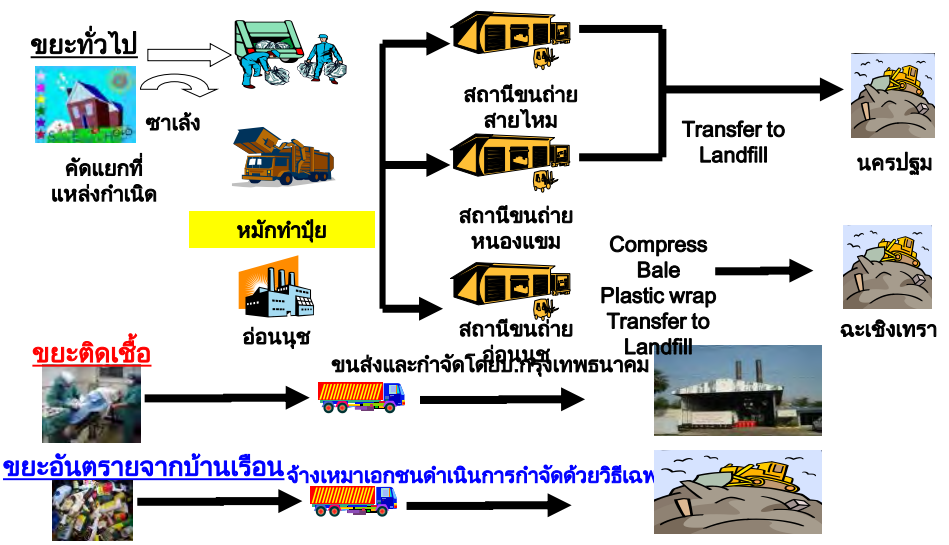
วิธีการเก็บขน

- ✓ ถนนสายหลัก สายรอง ทิ้งขยะไว้หน้าบ้าน ในช่วงเวลา 20.00 – 03.00 น.ของทุกวัน ดำเนินการจัดเก็บขยะเสร็จภายใน เวลา 06.00 น.
- ✓ ตรอก ซอยและชุมชน เก็บทุกวัน หรือวันเว้นวัน หรือความเหมาะสมกับสภาพพื้นที่

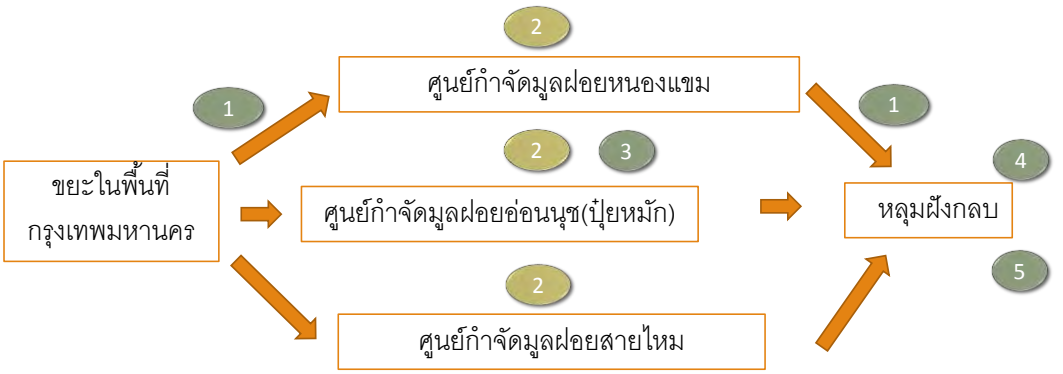
การจัดเก็บมูลฝอยตามประเภท

- เศษอาหาร ขยะทั่วไป	เก็บทุกวัน
- รีไซเคิล	เก็บทุกวันอาทิตย์หรือสัปดาห์ละครั้ง
- ขยะอันตราย และกิ่งไม้	เก็บทุกวันที่ 1 และ 15

การกำจัดมูลฝอยของกรุงเทพมหานครในปัจจุบัน

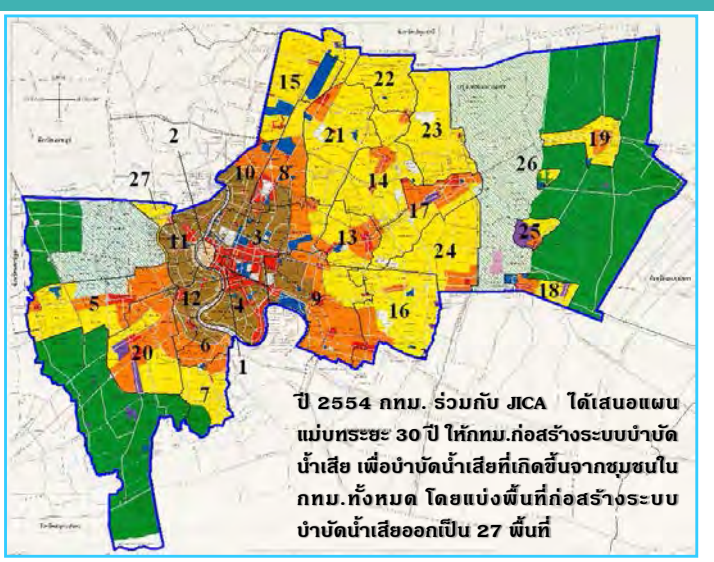


แหล่งที่มาก๊าซเรือนกระจกจากการจัดการขยะ

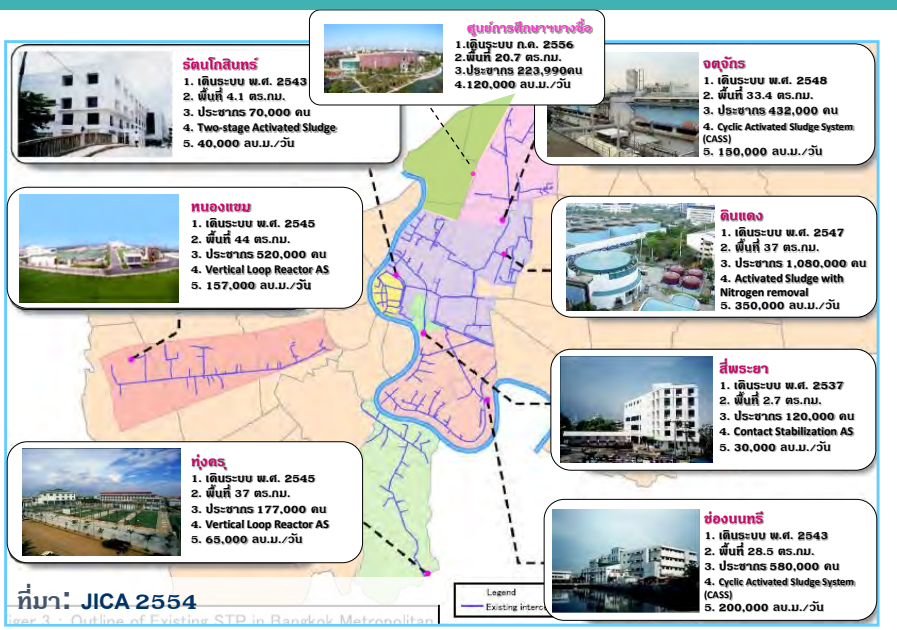


1 จากการขนส่งขยะ
2 การใช้ไฟฟ้าและน้ำมันในการจัดการขยะที่ศูนย์กำจัดมูลฝอย
3 ก๊าซเรือนกระจกจากกระบวนการเกิดปุ๋ยหมัก (CH_4, N_2O)
4 ก๊าซมีเทนจากหลุมฝังกลบ
5 การใช้ไฟฟ้าและน้ำมันที่หลุมฝังกลบ

แผนแม่บทการจัดการน้ำเสีย ปี 2554 (27 พื้นที่)



โครงการบำบัดน้ำเสียรวมปัจจุบันของกทม.



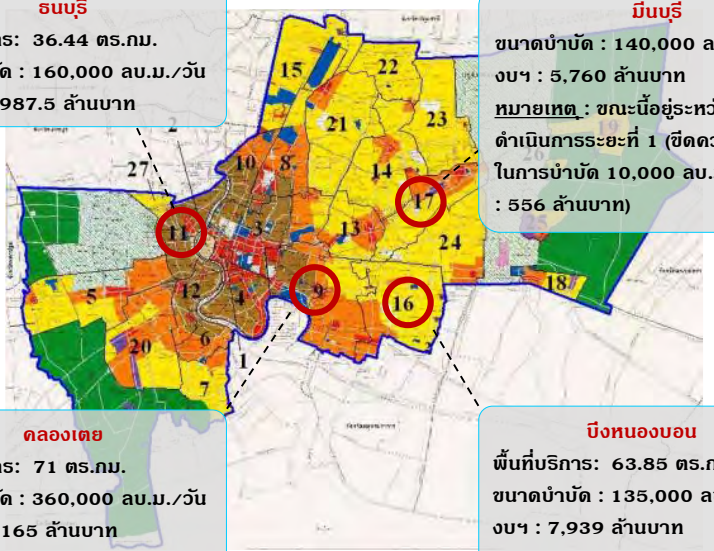
ขีดความสามารถในการบำบัดน้ำเสียของโครงการบำบัดน้ำเสียรวมปัจจุบันของกทม.

โรงควบคุมคุณภาพน้ำ	รองรับขนาดประชากร (คน)	พื้นที่บริการ (ตร.กม.)	ขนาดบำบัด (ลบ.ม./วัน)	เริ่มเดินระบบ (ปี พ.ศ.)	ค่าใช้จ่ายในการก่อสร้าง (ล้านบาท)
1. โรงควบคุมคุณภาพน้ำสี่พระยา	120,000	2.7	30,000	2537	464
2. โรงควบคุมคุณภาพน้ำรัตนโกสินทร์	70,000	4.1	40,000	2543	883
3. โรงควบคุมคุณภาพน้ำช่องนนทรี	580,000	28.5	200,000	2543	4,552
4. โรงควบคุมคุณภาพน้ำหนองแขม	520,000	44	157,000	2545	2,348
5. โรงควบคุมคุณภาพน้ำทุ่งครุ	177,000	42	65,000	2545	1,760
6. โรงควบคุมคุณภาพน้ำดินแดง	1,080,000	37	350,000	2547	6,382
7. โรงควบคุมคุณภาพน้ำจตุจักร	432,000	33.4	150,000	2548	3,482
8. ศูนย์การศึกษาและอนุรักษ์สิ่งแวดล้อมบางซื่อ	223,990	20.7	120,000	2556	4,732
รวม	3,202,990	212.4	1,112,000		24,603
ร้อยละของผลการดำเนินการ		12%ของพื้นที่กทม.	44%ของน้ำเสียในกทม.*	*คิดจากปริมาณน้ำประปาปี 2556	

โครงการบำบัดน้ำเสียระยะสั้นที่อยู่ระหว่างดำเนินการ (ถึง ปี พ.ศ. 2565)

ธนบุรี
พื้นที่บริการ: 36.44 ตร.กม.
ขนาดบำบัด : 160,000 ลบ.ม./วัน
งบฯ : 10,987.5 ล้านบาท

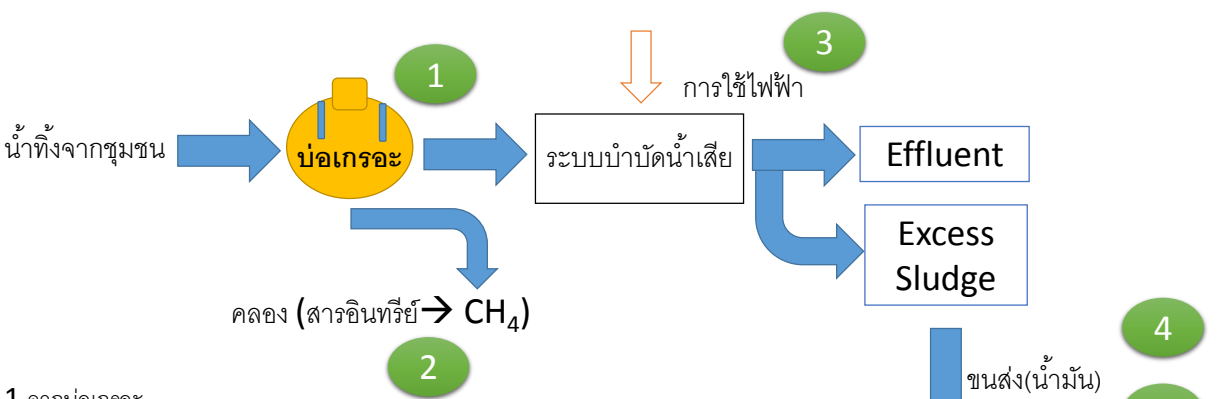
มีนบุรี
ขนาดบำบัด : 140,000 ลบ.ม./วัน
งบฯ : 5,760 ล้านบาท
หมายเหตุ : ขณะนี้อยู่ระหว่างดำเนินการระยะที่ 1 (ขีดความสามารถในการบำบัด 10,000 ลบ.ม. และงบฯ : 556 ล้านบาท)



คลองเตย
พื้นที่บริการ: 71 ตร.กม.
ขนาดบำบัด : 360,000 ลบ.ม./วัน
งบฯ : 12,165 ล้านบาท

บึงหนองบอน
พื้นที่บริการ: 63.85 ตร.กม.
ขนาดบำบัด : 135,000 ลบ.ม./วัน
งบฯ : 7,939 ล้านบาท

แหล่งที่มาก๊าซเรือนกระจกจากการจัดการน้ำเสีย

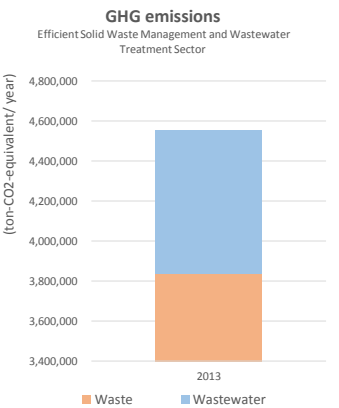


1 จากบ่อเกรอะ
2 จากน้ำเสียที่ไม่ได้ผ่านการบำบัด
3 จากการใช้ไฟฟ้าในการบำบัดน้ำเสีย
4 จากการขนส่งตะกอนสลัดจ์ไปบำบัด
5 จาก Sludge digestion unit

Current status of GHG emission

Results of Calculation by data collection

Sub-sector	GHG emissions (tCO_{2-e}/year) (2013)
Waste	3,837,438
Wastewater	714,388
Total	4,551,826



Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector

W1. Waste generation | W2. Waste collection and transportation | W3. Intermediate treatment | W4. Final disposal

W1.1 Promote participation on waste reduction and separation at source

Title	W1.1 Promote participation on waste reduction and separation at source
Details	a) Enhance public awareness and partnership on waste management through public relation and campaigns b) Develop waste management model in district office, BMA's school, BMA hall1&2, BMA's health center service and BMA offices c) Promote partnership with the private sector in the management of solid waste at source
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, district offices, community, schools, university, private sector
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction	304 ton-CO_{2e} /year (2013) – 9,330 ton-CO_{2e} /year (2023) (for mitigation action b)

Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector

W1.2 Reduce the amount of plastic waste

Title	W1.2 Reduce the amount of plastic waste
Details	a) Encourage cloth bags and bio-packing use instead of plastic bags b) Promote plastic waste separation for recycling c) Promote manufactures and trader to reduce packaging and foam
BMA's Responsibility	BMA (Indirectly implemented)
Stakeholders	Dept. of Environment, district offices, community, private sector, scavenger
Implementation schedule	Mid to long term (2016-2023)
Estimated GHG emission reduction (average)	2,391 ton-CO_{2e} /year (a)

Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector

W2.1 Improve fuel efficiency of waste collection and transportation system

Title	W2.1 Improve fuel efficiency of waste collection and transportation system
Details	a) Implement environmentally friendly trucks b) Improve waste collection and transportation routes c) Develop Eco-driver awards program
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, district offices, truck rental companies
Implementation schedule	Long term (2019-2023)
Estimated GHG emission reduction (average)	114 ton-CO_{2e} /year (b)

Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector

W 3.1 Promote utilization of organic waste

Title	W3.1 Promote utilization of organic waste
Details	a) Promote composting and utilization of organic waste, nightsoil, sludge and yard waste b) Construct composting plant with 600 tons/day at On-Nuch Transfer station c) Increase production of biogas in BMA's school, market, hotel, restaurant and community
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, private sector
Implementation schedule	Mid to long term(2016-2023)
Estimated GHG emission reduction (average)	5,567 ton-CO_{2e} /year (2015) – 38,517 ton-CO_{2e} /year (2023) (a) 12,154 ton-CO_{2e} /year (2016) – 81,111 ton-CO_{2e} /year (2023) (b) 12 ton-CO_{2e} /year (2013) – 37 ton-CO_{2e} /year (2023) (c)

Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector

W3.2 Construct waste-to-energy incineration facility

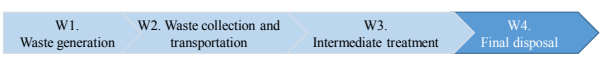
Title	W3.2 Construct waste-to-energy incineration facility
Details	Construct waste-to-energy incinerator with 300 tons/day at Nong Khaem Transfer Station
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, private sector
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	31,364 ton-CO_{2e} /year (2015) – 65,691 ton-CO_{2e} /year (2023)

Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector

W3.3 Construct Waste segregation Plant

Title	W3.3 Construct Waste segregation Plant
Details	Construct waste separation plant for recyclable wastes with 300 tons/day at On nut transfer station
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, private sector
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	-

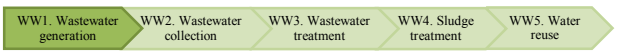
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



W4.1 Install environment- friendly landfill system

Title	W4.1 Install environment- friendly landfill system
Details	a) Encourage methane collection and power generation from landfill b) Reduce GHG from landfill
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	Dept. of Environment, Private sector
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction	-

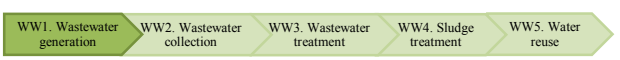
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 1.1 Promote reduction of water usage at house

Title	WW1.1 Promote reduction of water usage at house
Details	a) Promote use of water saving device b) Raise awareness of water saving
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Dept. of Environment, Sanitation Dept. of District Offices, Community, private sector (water saving devices manufacture, advertising), NGO, (private WWTP operators)
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	-

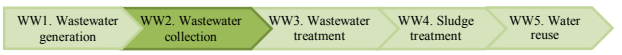
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 1.2 Promote collection of wastewater tariff

Title	WW 1.2 Promote collection of wastewater tariff
Details	Prepare and implement the tariff collection
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Dept of Finance, Dept of Strategies and Evaluation Env, Sanitation Dept of District Office Community (service area) MWA (Metropolitan water Authority), NGO, private Sector
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	-

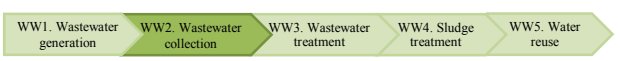
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 2.1 Expand sewage area

Title	WW 2.1 Expand sewage area
Details	Rearrange existing sewage collection and improvement of BMA combined type sewage collection system
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Env, Sanitation Dept of District Offices, private sector (wastewater facilities construction manufacture), community
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	28,373 ton-CO_{2e} /year

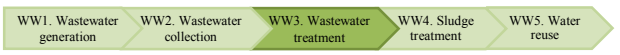
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 2.2 Implement separate collection system

Title	WW 2.2 Implement separate collection system
Details	a) Implement separate sewerage system pilot project at new urban residential/commercial area b) Implement separate Sewerage system pilot project at existing treatment area
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Dept. of Environment, Sanitation Dept. of District Offices, community, private sector (establishments, manufactures, company, etc.)
Implementation schedule	Mid to long term (2016-2023)
Estimated GHG emission reduction (average)	-

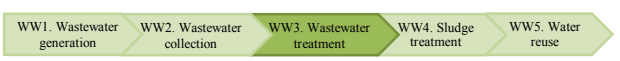
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 3.1 Improve operation and equipment of existing WWTPs

Title	WW 3.1 Improve operation and equipment of existing WWTPs
Details	a) Increase efficiency of wastewater treatment process b) Campaign regarding wastewater pollution resolution
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, academic and research institutions, private sector (WWTP operators)
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	151 ton-CO_{2e} /year (a)

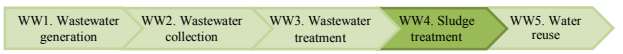
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 3.2 Construct new energy efficient WWTPs

Title	WW 3.2 Construct new energy efficient WWTPs
Details	a) Construct New Central wastewater treatment plants (WWTPs) 1. Minburi (10,000 m3/d) 2. Thonburi (160,000 m3/d) 3. Klongtoey (360,000 m3/d) 4. Nongbon (135,000 m3/d) b) Energy efficient improvement at new WWTPs c) Construct a new treatment system which can reduce sludge aeration from new WWTPs
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Ministry of Interior, Ministry of Finance, National Economic and Social Development Board
Implementation schedule	Long term (2019-2023)
Estimated GHG emission reduction (average)	434 ton-CO_{2e} /year (2018) – 28,849 ton-CO_{2e} /year (2023) (a) 15 ton-CO_{2e} /year (2013) – 994 ton-CO_{2e} /year (2023) (b) 4 ton-CO_{2e} /year (2013) – 11 ton-CO_{2e} /year (2023) (c)

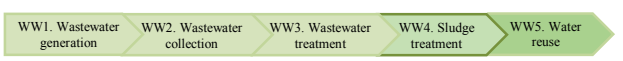
Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 4.1 Promote utilization of sludge

Title	WW 4.1 Promote utilization of sludge
Details	a) Promote sludge conversion to fertilizer b) Encourage energy creation by digestion gas c) Reduction of fuel by using sewage sludge as solid fuel
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, Public Parks Office, farmers, academic and research institutions, private contractors
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	797 ton-CO_{2e} /year (2013) – 2,387 ton-CO_{2e} /year (2023) (a) 66 ton-CO_{2e} /year (2013) – 199 ton-CO_{2e} /year (2023) (b) 66 ton-CO_{2e} /year (2013) – 199 ton-CO_{2e} /year (2023) (c)

Mitigation actions for the Efficient Solid Waste Management and Wastewater Treatment Sector



WW 5.1 Promote water reuse

Title	WW 5.1 Promote water reuse
Details	a) Increase quantity of treated wastewater use for agricultural and community application b) Reduction of heat exchange by using treated wastewater for cooling
BMA's Responsibility	BMA (Directly implemented)
Stakeholders	DDS, farmers, community, private sectors, academic and research institutions
Implementation schedule	Short to long term (2013-2023)
Estimated GHG emission reduction (average)	426 ton-CO_{2e} /year (a)

Comments by stakeholders