Republic of Turkey

Data Collection Survey on Solid Waste Management in Turkey

Final Report

December 2015

Japan International Cooperation Agency (JICA)

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Target area of the survey

Map of Turkey and Metropolitan Municipalities which are targets of this survey

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List of Abbreviations

Abbreviation	Explanation
CAPEX	Capital expenditures
CPI	Consumer Price Index
DoEU	Directorate of Environment and Urbanization
DM	District Municipality
EC	European Community
ECT	Environmental Cleansing Tax
EEC	European Economic Community
EIA	Environmental Impact Assessment
EMRA	Energy Market Regulatory Authority
EU	European Union
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
FIT	Feed-in Tariff
GDP	Gross Domestic Product
IEE	Initial Environmental Evaluation
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
MBT	Mechanical biological treatment
MCP	Market clearance price
MDM	Metropolitan District Municipality
MM	Metropolitan Municipality
MMA	Metropolitan Municipal Assembly
MoE	Ministry of Economy
MoEU	Ministry of Environment and Urbanization
MoENR	Ministry of Energy and Natural Resources
MoF	Ministry of Finance
MoI	Ministry of Interior
MoSIT	Ministry of Science, Industry and Technology
OPEX	Operational Expenditure
PM	Provincial Municipality
PPP	Purchasing Power Parity
RDF	Refuse-derived fuel
SWM	Solid Waste Management
SWMT	Solid Waste Management Tariff
TRY	Turkish lira
USD	United States Dollar
VAT	Value-Added Tax
WCG	Waste characterization guidelines

Abbreviation	Explanation
WtE	Waste-to-Energy

Note: The rate applied in this report is 1 TRY = 45 JPY、1 USD = 123 JPY.

1 Background and objective of the survey

1.1 Background

The amount of wastes in the urban areas of the Republic of Turkey (hereinafter "Turkey") continue to increase due to rapid economic and population growth. As the waste amount is beginning to exceed the capacities of existing transfer stations and final disposal sites, there are concerns that environmental pollution and degradation in livelihoods would occur. For this reason, introduction of waste incineration in Turkey is now being discussed, and major municipalities such as Ankara and Istanbul which have high financial and technical capacity have started to consider introduction of waste incineration power plants. Although such projects have not yet been realized, it is likely that such projects will be implemented in the future in partnership with the private sector in such major cities. Meanwhile, for middle-sized municipalities that do not have sufficient financial or technical capacity, support from the central government is essential to implement such projects. Municipalities such as Kocaeli with high level of industrialization and japan-based investment are in urgent need to find a solution for their wastes, as environmental pollution and lack of land for the new disposal site is becoming a serious problem. Therefore, solving these issues is crucial for these municipalities to attract more foreign investment and thus to promote regional economic growth.

"Livable Places, Sustainable Environment" is one of the priority areas in the 10th Development Plan 2014-2018 of the Government of Turkey, and the Government aims to increase the coverage rate of waste collection, treatment, and disposal services. Furthermore, as Turkey is aiming to become a member of the European Union, it is urgent that a waste treatment system in line with EU standards consisting of principles of waste prevention, waste minimization, appropriate treatment, and safe disposal. Turkey has stipulated regulations on waste treatment based on the Environmental Law No: 2872 stipulated in 1983 and laws in line with the European Union Waste Framework Directive stipulated after 2007. From the organizational side, the Ministry of the Environment and Urbanization has been restructured to be the ministry in charge of waste management policies in July 2011. In addition, municipalities have become the responsible organization to conduct waste management from collection to disposal based on the "Metropolitan Municipality Law" and "Municipality Law".

1.2 Objective

The objective of this survey is to explore the potential cooperation between JICA and Government of Turkey in the waste sector through data collection and consultation with relevant ministries/agencies and municipalities and to draft JICA assistance policies or scenarios in the waste management sector in Turkey through collection of information on the current status, needs, and policies concerning waste management in middle to large municipalities.
However, it should be noted that the results of this survey do not guarantee JICA's assistance.

Waste-to-Energy (hereinafter "WtE") technology has a long history in Japan. In this survey, a special focus will be given on examining the possibility to introduce WtE technology in municipalities in Turkey to minimize and properly treat the wastes.

1.3 Outline of the survey

The outline of the survey is as follows.

1 Current situation and challenges in the waste management sector

1.1 Current status and issues in Turkey

1.2 Current status of target municipalities

2 Applicability of Japanese technologies

3 Environmental and social considerations

4 Possible Japanese assistance

5 Possible project ideas

Annex 1: Program of the visit to Japan

Annex 2: Seminar on Japanese Technologies on Solid Waste Management

1.4 Survey period

The survey was conducted from January 16, 2015 to December 11, 2015.

1.5 Target municipalities

This survey targeted the following middle to large-scale municipalities in Turkey.

- Bursa Metropolitan Municipality
- Kocaeli Metropolitan Municipality
- Izmir Metropolitan Municipality
- Antalya Metropolitan Municipality
- Sakarya Metropolitan Municipality

1.6 Target organizations

This survey was conducted in collaboration with the following ministries and agencies concerned in the waste management sector.

- Ministry of the Environment and Urbanization (hereinafter “MoEU”)
- Ministry of Energy and Natural Resources (hereinafter “MoENR”)
- Iller Bank
- Target metropolitan municipalities (hereinafter "MM") outlined in Section 3
- Other relevant ministries or agencies

1.7 Work plan

The survey began in mid-January 2015 and finishes in 11.5 months. The work plan is as shown below.

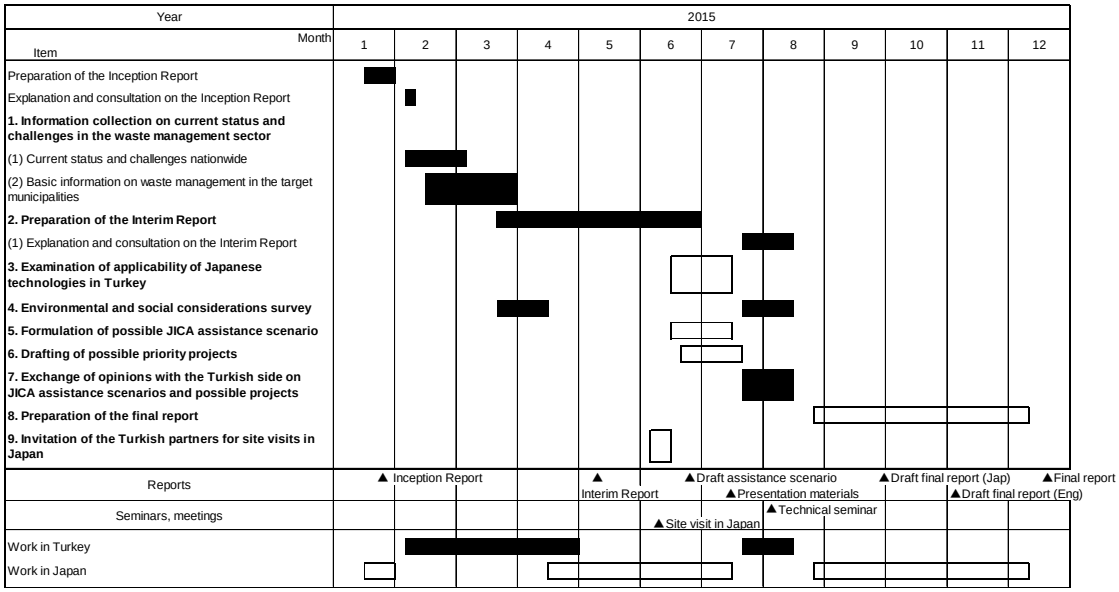


Figure 1-1: Work plan

2 Basic information of Turkey

2.1 General information

Turkey is located between Asia and Europe, having a border with Georgia, Armenia, Azerbaijan, and Iran in the east, Iraq and Syria in the south, and Greece and Bulgaria in the west as well as surrounded by Mediterranean Sea in the south, Aegean Sea in the east, and Black Sea in the north. It stretches 1,500 km from east to west, 550 km from south to north, and the area is 783,562.38 km^2.

Table 2-1: General information about Turkey

Country Name	Republic of Turkey
Capital City	Ankara
Government	Parliamentary democracy
Population	77.7 million (2014)
Working population	29.2 million (2014)
Average age	30.7 (2014)
Common language	Turkish

Source: http://www.invest.gov.tr/ja-JP/turkey/factsandfigures/Pages/TRSnapshot.aspx

2.2 Natural environment

Turkey has four seasons similar to Japan, and the country enjoys different climates such as mild maritime climate near Black Sea and Sea of Marmara in the north, continental climate in inland region, and Mediterranean climate in the west along Aegean Sea and the south. Monthly average temperature and precipitation in major cities in Turkey are shown below.

Table 2-2: Climate indicators in major cities in Turkey

City	**Ankara**		**Istanbul**		**Izmir**		**Antalya**	
Geography	Inland		On the coast of Sea of Marmara		On the coast of Aegean Sea		On the coast of Aegean Sea	
Month	Average Temp (℃)	Precipitation (mm)	Average Temp (℃)	Precipitation (mm)	Average Temp (℃)	Precipitation (mm)	Average Temp (℃)	Precipitation (mm)
Jan	0.8	36	6.4	80.6	9.1	101.8	9.6	203.7
Feb	2.1	34.7	6.2	71.8	9.4	104.3	10.1	134.7
Mar	6.1	38.5	8.1	62.4	11.7	80.5	12.5	100.1
Apr	11.5	48.9	12.4	38	16.3	45	16	63.9
May	16.1	48	17.1	29	21.1	224.	20.5	35.5
Jun	20.4	38.8	21.8	20.9	26	8.4	25.6	7.2
Jul	23.7	17.7	24.2	22.9	28.4	1.5	28.5	3.3
Aug	23.5	14	24.2	27.6	28	2.4	28.3	1.5
Sep	18.8	17.3	20.5	36.1	23.9	23.1	24.7	10.8
Oct	13	33.8	15.9	88.1	19	46.2	20	80.6
Nov	6.9	40	11.4	94.6	13.9	111.8	14.4	166.6
Dec	2.6	40.1	8.2	98	10.5	128.1	11	235.7
Avg.	12.1	407.8	14.7	680	18.1	675.5	18.4	1043.6

Source: Meteorological Bureau Website (Japan)

Anatolia Peninsula is a seismically active region which makes Turkey one of the most earthquake-prone countries in the world. In particular, the great Izmit Earthquake in 1999 caused severe damage which caused about 20,000 deaths and injuries. Japan has provided support for the recovery of this damage along with many other countries.

Similarly, Japan is a country prone to earthquakes and thus strict infrastructure standards against earthquake have been established. For instance, there is no waste treatment facility including waste incineration facilities in Japan that has suffered serious damage due to earthquakes because they

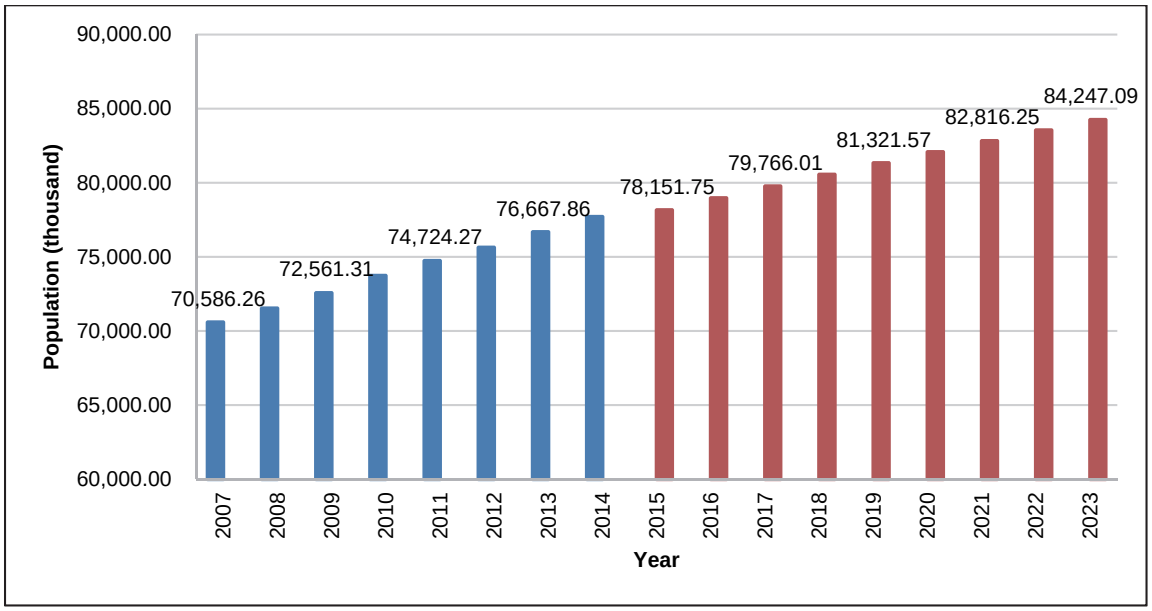
follow the strict quake-resistance design standards established for thermal power plants, by the Japan Electronic Association.

2.3 Socio economic environment

2.3.1 Social overview

a. Population

Total population in Turkey was 77.7 million in 2014 and it is expected to increase to 84.2 million by 2023.



Source: http://www.turkstat.gov.tr/Start.do

Figure 2-1: Population growth and projection in Turkey

b. Population density

Turkey consists of 81 provinces, and population density was 101 habitants/km^2 in 2014. Among the target five MMs, the municipality with the lowest density was Antalya MM with 107 habitants/km^2 which ranked 22nd nationally in 2014.

Table 2-3: Population Densities in Turkey

Unit: habitants/km^2

	Year	2007	2008	2009	2010	2011	2012	2013	2014
	National average	92	93	94	96	97	98	100	101
1	İstanbul	2,420	2,444	2,486	2,551	2,622	2,666	2,725	2,767
2	Kocaeli	398	413	421	432	443	453	464	477
3	İzmir	311	316	322	329	330	333	338	342
4	Gaziantep	229	236	243	249	257	264	270	277
5	Bursa	234	241	245	250	254	258	263	267
6	Yalova	215	233	239	241	244	250	260	267
7	Hatay	238	242	249	254	253	255	258	261
8	Ankara	182	186	190	195	199	203	206	210
9	Sakarya	173	176	178	180	184	186	190	193
10	Zonguldak	186	187	188	188	185	184	182	181

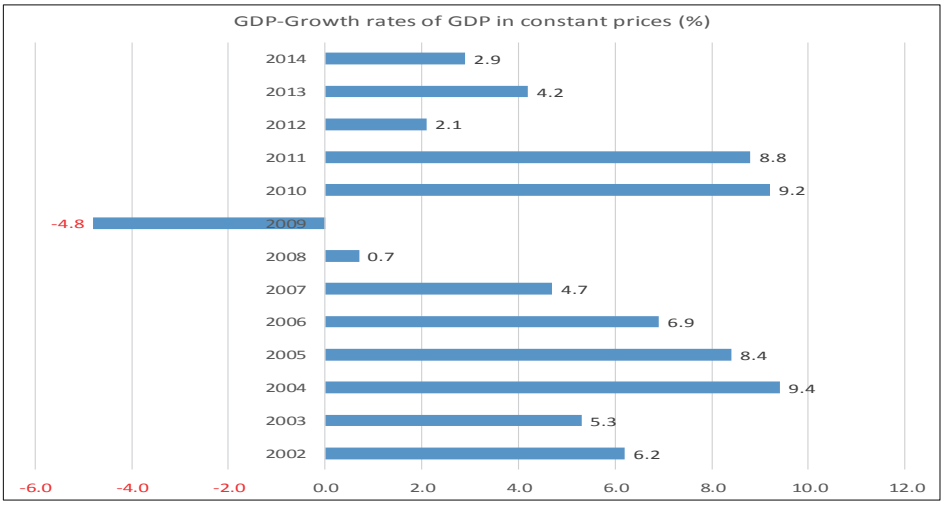
	Year	2007	2008	2009	2010	2011	2012	2013	2014
11	Trabzon	159	161	164	164	162	162	163	164
12	Osmaniye	145	149	151	153	155	158	160	162
13	Adana	144	146	148	150	152	153	154	156
14	Tekirdağ	115	122	124	126	131	135	139	144
15	Samsun	135	136	138	138	138	138	139	140
16	Düzce	126	128	131	132	133	135	137	139
17	Aydın	121	123	125	126	127	128	130	133
18	Ordu	120	121	122	121	120	125	123	122
19	Batman	102	105	107	110	113	115	118	120
20	Mersin	103	104	106	106	108	109	110	112
21	Diyarbakır	97	99	100	101	104	106	107	109
22	Antalya	86	90	93	95	99	101	104	107

Source: http://www.turkstat.gov.tr/Start.do

c. GDP

c.1.GDP growth

Although the GDP growth rate of Turkey dropped to -4.8% in 2009 due to global economic crisis in 2008, it recovered in 2010 and has shown steady growth since then.

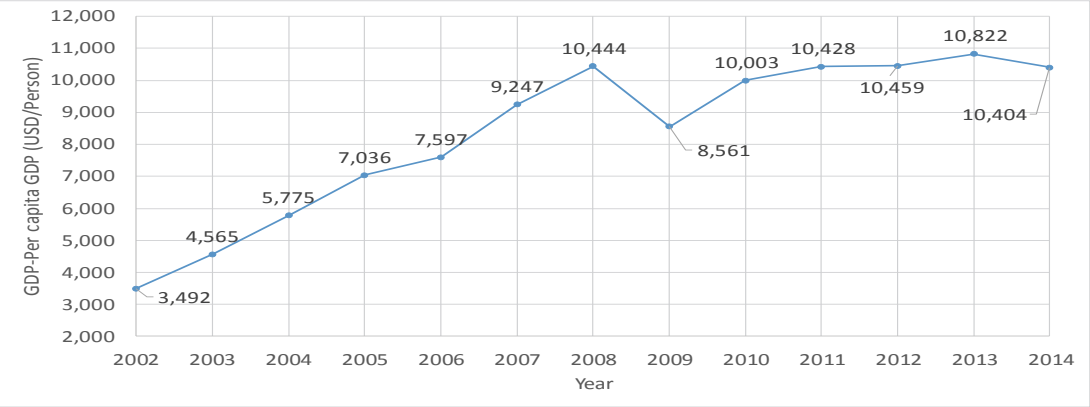


Source: http://www.turkstat.gov.tr/Start.do

Figure 2-2: Historical change of GDP growth rate in Turkey

c.2.GDP per capita

In a similar way to GDP growth, after GDP per capita in Turkey dropped in 2009, it has recovered to 10,000 USD in 2010 and has kept this level since then.

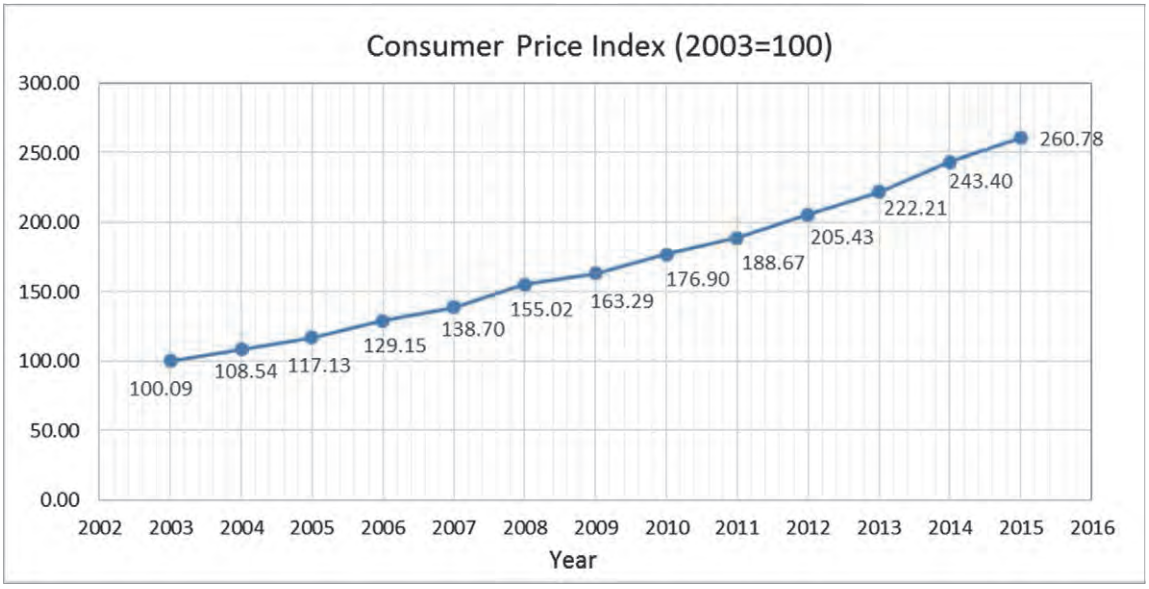


Source: http://www.turkstat.gov.tr/Start.do

Figure 2-3: Historical change of GDP per capita in Turkey

d. Consumer price index (CPI)

The consumer price index (CPI) in 2014 has more than doubled compared to that in 2003 (CPI of 2003 is represented as 100 in the figure below).



Source: http://www.turkstat.gov.tr/Start.do

Figure 2-4: Historical Change in CPI of Turkey

2.3.2 Economic overview[1]

Turkish economy has shown steady growth in the last 10 years thanks to its macro-economic strategies including sound fiscal policies and large-scale structural reform since 2002. Currently, Turkey is integrated into the global economy and has become an attractive destination for foreign direct investment in the region.

As a result of structural reform accelerated by the Turkish EU accession process, the role of private sector was strengthened, the efficiency and resilience in the financial sector was improved, and the social security system was reinforced. This structural reform strengthened the macro economy which helped Turkey to achieve average 5% GDP growth in the past 10 years from 2002 to 2012.

In addition to this steady economic growth, the state of national finance also improved. Turkey's debt-to-GDP ratio fell from 67.7% to 37.3% between 2003 and 2013, achieving EU Maastricht

[1] http://www.invest.gov.tr/ja-JP/turkey/factsandfigures/Pages/Economy.aspx

Criteria of 60% from 2004. Further, its national budget deficiency dropped from 10% to less than 3%, also achieving EU Maastricht Criteria of under 3%.

GDP has grown from 305 billion USD in 2003 to 820 billion USD in 2013. In the same period, the GDP per capita increased from 4,565 USD to 10,782 USD.

These growths lead to increase in foreign trade as well. Export has increased from 47 billion USD in 2003 to 152 billion USD in the end of 2013. Similarly the revenue from tourism has grown from 14 billion USD in 2003 to 32.3 billion USD in 2013.

Turkey, which has achieved the rapid economic growth within a short period, is now one of the most outstanding emerging economies worldwide. In terms of GDP based on purchasing power parity (PPP) in 2013, it ranked 16th in the world and 6th in EU region. Furthermore, the country has now set a goal to be in the top 10 largest economies by 2023, which is the 100th year of national foundation, through realizing 2 trillion USD of GDP, 500 billion USD of exports, and 1 trillion USD of foreign trade.

2.3.3 Japanese investment in Turkey

As of April 2015, there were 129 cases of investment by the Japanese private companies in Turkey since 2007, and this number continues to grow. The type of business includes types such as trade and finance with a central focus on manufacturing. Leading Japanese companies have their factories and offices in the target five municipalities as shown below.

Table 2-4: Japanese manufacturing companies in the target 5 MMs

MM	Company	Manufactured product
Bursa	Yazaki	Wire Harness
	Toyota Tsusho	Processing of metal and metallic steel sheets
	MITSUI & CO., LTD.	Steel plates
Kocaeli	Honda Motor Co., Ltd.	Automobile
	Isuzu Motors Limited	Automobile
	Bridgestone Corporation	Tire
	DENSO Corporation	Automobile parts
	IHI Infrastructure Systems	Bridge construction (opened office for construction work)
Izmir	JTI	Cigarettes
	KANSAI PAINT CO.,LTD.	Paint
	NH Foods Ltd.	Food products
	Yusen Logistics Co., Ltd.	Logistics
	DIC	Chemical products (ink)
	Hitachi Transport System	Logistics
Antalya	―	
Sakarya	Toyota Motor Corporation	Automobile
	Yazaki	Wire Harness
	Toyota Boshoku Corporation	Automobile parts
	Takeda Pharmaceutical Company Limited.	Pharmaceutical
	Nissin Food Products Co., Ltd.	Food products
	DAIKIN INDUSTRIES, Ltd.	Air conditioners

Source: Webpage of each company

Likewise, other international companies, such as Renault, have their manufacturing plants in these five MMs and export their products to Europe, and as a result, Japanese companies may have many business opportunities.

2.4 Public administration

2.4.1 Local administration

Turkey consists of 81 provinces since 1999. Turkish local governance system has two pillars of administrative structures; one is the administration by the central government and the other is the administration by the local autonomy.

2.4.2 Administration by the central government[2]

A province is administered by an appointed governor (vali) from the Ministry of Interior who preside the Provincial Governorate (Valiliği). The provincial assembly (consisting of council members that are elected every five years) is the highest authority in the province, and a governor executes his/her duties according to the decisions made by the provincial assembly. Based on the revision of Law No. 6360 on Establishment of Metropolitan Municipalities[3], local elections were conducted in March 2014. Since then, the provincial assemblies were abolished and replaced with metropolitan municipality assemblies.

Districts in a province are divided into two types, namely provincial capital districts (*İlçe Kaymakamlığı*) and other districts (*kaymakamlığı*). Each district has an appointed administrative officer (*kaymakam*) from the Ministry of Interior as a governor of a district, and this structure is applied to both 30 provinces that have metropolitan municipalities and other 51 provinces that do not. According to the website of the Ministry of Interior, the total number of districts (*İlçe*) is 919 for the 81 provinces nationwide. Each province and district has provincial governor and district governor respectively. [4]

The following departments are subordinate offices of ministries and are located inside provincial governorates. Such offices also exist inside the District Governorate (*İlçe Kaymakamlığı*) according to the needs.

- Directorate of Security
- Directorate of Environment and Urbanization
- Directorate of Public Health
- Directorate of Family and Social Policy
- Directorate of Food and Agriculture
- Directorate of Education
- Directorate of Forestry and Water Works

Basic roles and responsibilities of the subordinate offices of the ministries are to execute duties of the central government including control and supervision. Therefore, authorization and monitoring for solid waste treatment facility is implemented by Directorate of Environment and Urbanization, which is MoEU's subordinate office in each provincial governorate.

2.4.3 Administration by the local autonomy

With regard to local administration by the local autonomy, the situation is different between provinces that have a MM (i.e. with population of 750,000 or more) and those without a MM (i.e. with population of less than 750,000).

2.4.4 Provinces with population less than 750,000 that do not have MM

Other than the boundaries of "provincial municipalities in provinces without MM (*İl Belediyesi* or

[2] Based on information from Turkish Ministry of Interior (http://www.migm.gov.tr/en/PDF/GeneralInformation.pdf,), Reports of Institute of Developing Economies Japan External Trade Organization, and interviews

[3] Law No. 6360 on Establishment of Metropolitan Municipalities in 14 Provinces and 27 Districts, and Amendment of Certain Laws and Decree Laws (published in the Official Gazette No, 28489 dated 6/12//2012)

[4] Local Authorities in Turkey

hereinafter "PM")" and "district municipalities in provinces without MM (*İlçe Belediyesi* or hereinafter "MDM")", there is an area called "special provincial administration (SPA)" of which the provincial government is directly in charge. Basically, SPAs are found in rural areas, and elected executive officers (Muhtars) are in charge of their administration. The head of SPA is the provincial governor and he/she has the authority over its development. In the provincial capital and the district municipalities (DM), mayor and councilors are elected and take charge of their administration. Figure 2-5 shows the administrative districts of a province with population less than 750,000.

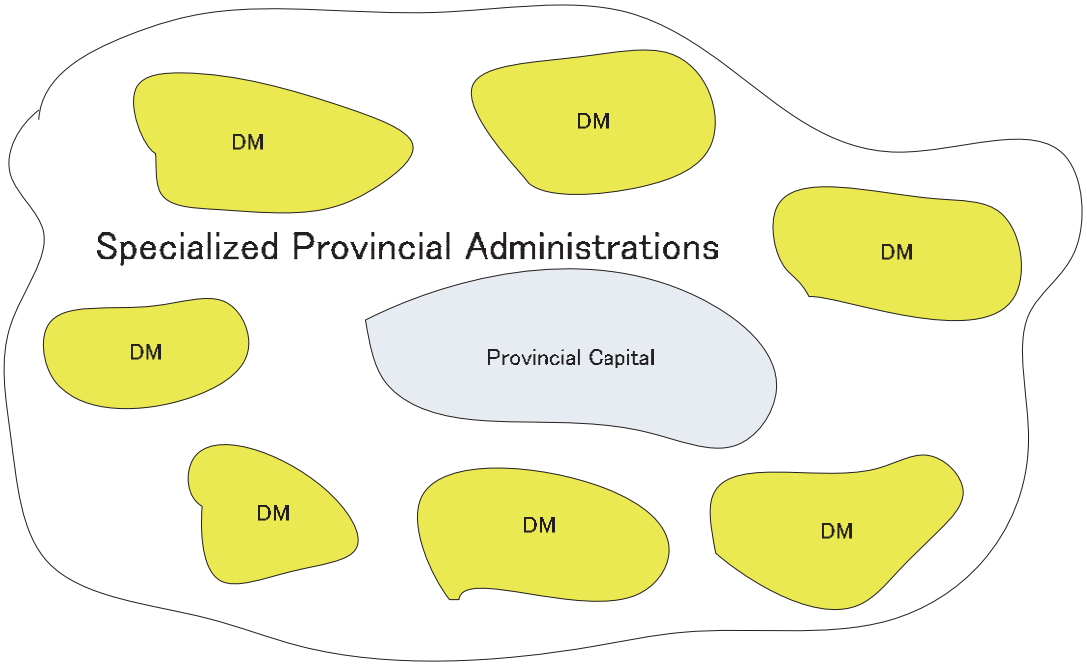


Figure 2-5: Administrative districts of a province with population less than 750,000

2.4.5 Provinces with population of750,000 or more that have MM

A metropolitan municipality (*büyükşehir belediyesi* or MM) is established in a province that has population of 750,000 or more. The boundaries of MMs are the same as those of the province. Due to the legal revision in November 2012, boundaries of 30 provinces became the same as those of the MMs. In other words, provincial municipalities (*İl Belediyesi* or PM) in provinces without MM became MMs, and the provincial territory became their administrative district. Further, within MM boundaries, there is no SPA and MMs are consisted of metropolitan district municipalities (*Büyükşehir İlçe Belediyesi*, hereinafter "MDM"). With regard to 30 provinces that have become MMs, Investment Monitoring & Coordination Directorate (*Yatirun Izleme ve Koordinasyon Baskanligi* or YIKOB) having Provincial Governor as its chairman was established for each province. YIKOB plays a similar role with the State Planning Organization (SPO, currently the Ministry of Development) which is an agency established in the Office of Prime Minister responsible for national development planning, and it manages all the investment activities in a province. Therefore, the territories of MMs overlap with those of MDMs and there are no SPAs in provinces with population of 750,000 or more. MDMs are governed by MM led by an elected mayor, and provision of inter-district public services such as operation of public transportation including buses and subways is under the responsibility of MM. MDMs are established within a MMs and each MDM has an elected mayor and a council. [5]

2.4.6 Restructuring of municipalities (2013)

According to the Ministry of Interior, the number of municipalities has decreased from 2,947 in

[5] In March 2014, councilors for MM Assembly were for the first time elected instead of the provincial councils.

2009 to 1,394 in March 2014 due to revision of the Law No. 6360 on Establishment of Metropolitan Municipalities in November 2012. Based on the government's policy to decrease the number of municipalities, the number of town municipalities continue to decrease.

Table 2-5: Type and number of municipalities (March 29, 2014)

Type of municipality	Number
Metropolitan municipality (*Büyükşehir Belediyesi* or MM)	30
Provincial municipalities in provinces without MM (*İl Belediyesi* or PM)	51
Metropolitan district municipality (*Büyükşehir İlçe Belediyesi* or MDM)	519
District Municipality in province without MM (*İlçe Belediyesi* or DM)	400
Town Municipality in province without MM (*Belde Belediyesi* or TM)	394
Total	1,394

Source: Cumhuriyet newspaper 29 March 2014 and Ministry of Interior Website

In comparison, central government related administrative organizations are categorized as below.

Table 2-6: Type and number of central government related administrative organizations

Type	Number
Province (***İl***)	81
District (***İlçe***)	919
Neighbor (***Mahalle***)	31,829
Village (***Köy***)	18,327
Community (***Bağlı***)	26,001

Source: Ministry of Interior Website

2.5 Roles and responsibilities of relevant ministries and agencies

2.5.1 Relevant ministries and agencies and their roles

Agency Name	Roles and Responsibilities
Ministry of Environment and Urbanization (MoEU)	The main duty of MoEU is to develop laws and regulations in general terms and to ensure their implementation aiming to protect the environment and to prevent and reduce pollution. Responsibilities of MoEU in terms of waste management are ;: • Development of by-laws and national regulations; • Drafting of policies and strategies; • Organization of nation-wide actions on waste management; • Research and coordination with regard to preparation of waste management plans; • Precautionary measures; • Establishment of technical standards; • Licensing, monitoring, regulation, and keeping track of given licenses;, • Data collection and exportation of wastes; • Release of permits regulating import of hazardous wastes and transportation of such wastes inside the Turkish territory; and • Ensuring the continuation of trainings.
Ministry of Development (MoD) Before June 2011, it was State Planning Organization (SPO)	It is responsible for preparing Development Plans, medium-term and annual programs and annual investment plans. In this regard, MoD is developing macro-economic policies for waste management and taking relevant measures to ensure coherence of legal and institutional arrangements with these policies. Moreover, the projects of central administrative institutions and the projects of municipalities that need foreign loan are appraised by the Ministry of Development and the projects that are evaluated feasible are included into public investment portfolio.

Agency Name	Roles and Responsibilities
Under secretariat of Treasury（UoT）	It has the role of following up and finalizing credit negotiations where external financing is provided for the waste related projects.
Ministry of Health（MoH）	It has the role of monitoring and ensuring coherence of policies with respect to its mandate on public health.
Ministry of Interior（MoI）	It is responsible for developing, monitoring and controlling policies regarding local authorities.
Ministry of Finance（MoF）	It is responsible for taxation methods, tax collection, and follow-up. It is responsible for preparing the legal arrangements for financing the waste management activities.
Ministry of Industry and Trade（MoIT）	It is responsible for supporting and controlling establishment of small and large-scale industries, preparing standards for industrial products or publishing prepared standards, and controlling the quality of industrial assets.
Directorate-General of Bank of Provinces（DoBP）	It is providing technical support to municipalities for the waste management projects operated by municipalities. It provides financing for solid waste management projects on municipality's request and becomes credit guarantor.
Ministry of Transport（MoT）	It is responsible for establishment and development of transport and communication systems and services based on the needs of the country. Authorization documents for waste transportation are issued by MoT.
Ministry of Energy and Natural Resources（MoENR）	It is responsible for energy and natural resource related affairs.
Prime Ministry Investment Support and Promotion Agency of Turkey (ISPAT)	It is responsible for provision of information necessary for investment such as those regarding local infrastructure, local costs, and necessary permits.
Turkish Standards Institution	Among other responsibilities, it is responsible for preparing standards for waste management services.

a. Local government agencies

Agencies Name	Roles and Responsibilities
Province (*İl)*	Led by the provincial governor appointed by Ministry of Interior, the following central government's subordinate offices inside the province handle matters they are responsible for respectively. • Directorate of Environment and Urbanization (DoEU) • Directorate of Public Health (DoPH) • Directorate of Forestry and Water Works (DoFWW)
District (*İlçe*)	Led by the district governor appointed by Ministry of Interior, central government's subordinate offices inside the District handle matters they are respectively responsible for. However, the number of offices is quite limited.
MM	Led by elected mayors and councils, MMs have responsibilities for the following items for its administrative territory. • Development of municipal waste management plans • Implementation of municipal waste collection, treatment and disposal projects • Construction and operation of municipal waste management facilities (i.e. transfer stations, treatment facilities, and disposal site) • Treatment of medical wastes • Treatment of industrial wastes • Treatment of hazardous wastes
MDM	Led by elected mayors and councils, MDMs have the responsibilities for the following items for its administrative territory. • Development of municipal waste collection plans • Provision of municipal waste collection services • Procurement of equipment for municipal waste collection

The figure in the next page shows organizational structure within a MM with regard to solid waste management. Actual works are managed by heads and executed by staffs in each department. The

mayor is at the top of the organization, the secretary general is under the supervision of the mayor, and the deputy secretary general is under the supervision of the secretary general. The Environmental Protection and Control Department is responsible for handling environmental related issues, and one of the sections in this department is responsible for waste management issues.

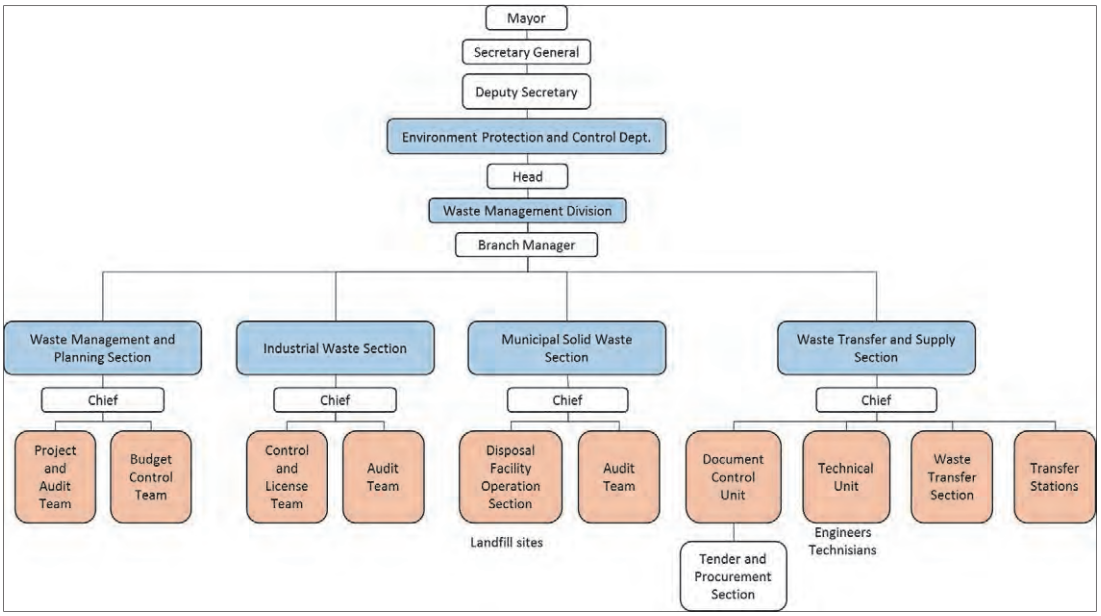


Figure 2-6: Standard organizational structure of MM

b. Finance

Agency	Roles and Responsibilities
MoEU and Central Government Agencies	MoEU has three types of financial support scheme for local governments as follows: 1. **Budget from MoEU**: MoEU's budget support for solid waste management by municipalities is called budget from MoEU. The financial department manages this budget similarly with that for waste water management. However, this budget is focused on supporting financially vulnerable municipalities only and not allocated to the MMs which generally have higher financial capacity. Small-sized municipality can allocate this budget from MoEU for construction of waste management facilities and purchase of waste collection vehicles. 2. **EU Support Fund**: This is for Investment for Pre-Accession of EU (IPA) and managed by the EU Investment Department of MoEU. However, recipients of this fund have already been determined up to the year 2020, and the five target MMs are not included. 3. **Loan from Central Government or International Lending Agencies through Iller Bank**: The Iller Bank provides loans to municipalities for infrastructure development projects which are financed by central and local governments. Based on financial applications from municipal governments, the Iller banks reviews the financial and technological capabilities of the municipalities and then provide financing at a low interest rate. The usual repayment period is five years. The Iller Bank also provides loans to municipalities financed by international donors such as the World Bank and EBRD. In this case, financial support is provided to municipalities in accordance with terms and conditions established by each donor or for each loan.
Environmental Cleansing Tax (ECT)	In Sakarya MM, • The Municipal Revenue Law revised in 2003 defines ECT payers. Solid wastes generated by offices and restaurants in the central area are collected by DM as with general household wastes, and the generators of these wastes are obliged to pay ECT. Industries in suburbs outside the DM's collection area bring their own solid wastes directly to disposal sites and pay the fee of 81 TRY/t. • Environmental Revenue Law states that the tax rate is determined by the Provincial Governor every year. MDMs directly collect ECT from commercial

Agency	Roles and Responsibilities
	establishments and Sakarya Water and Sewerage Administration (SASKİ) collect ECT from households together with water supply fee. • ECT for general households in 2015 is as follows. Within MM: 0.26TL/m^3, Other areas: 0.20TL/m^3 Schools and public buildings of Sakarya MM are exempted from paying ECT. • 20% of collected ECT is allocated to the MM and 80% is allocated to the MDMs automatically based on the registered address written in the resident's water bill. The allocation rate is the same for ECT collected by the MDMs. • There are seven different rates for ECT collected by the MDMs which differ according to the scale of business and the district in which the business is registered. The businesses are obliged to pay once a year, and the ECT rate is between 55 TRY/year and 2,500 TRY/year.
Solid waste management tariff:	In Kocaeli MM, • MoEU issued an ordinance on solid waste management tariff in 2010 which came into force on December 31, 2011. This ordinance stipulates that MMs are to determine the rate of this tariff and to obtain the approval by the municipal council about this rate. When deciding the tariff rate, the MMs are required to obtain agreements from all the solid waste generators (i.e. households, industry and commercial establishments). • As the total number of solid waste generators in Kocaeli Province is 600,000 with 550,000 households, obtaining the consensus from all the generators is not an easy task. Therefore, Kocaeli MM is forced to postpone the commencement of tariff collection up to December 31, 2015. The ordinance stipulates that the collection can be postponed up to December 31, 2015 in case the agreements from all the generators could not be obtained. There are several municipalities which succeeded in obtaining agreements such as Kuşadası in Aydın Province, but these are all municipalities with small population. Meanwhile, there is no MM so far that has succeeded in obtaining agreements from all generators. Kocaeli MM is making efforts to introduce the solid waste management tariff such as by examining the possibility of revising the ECT rate so that all the costs of solid waste management would be covered by ECT. As the Kocaeli Water and Sewerage Administration has already established a database on client information, the situation of ECT payment of ECT can be easily identify. • The solid waste management tariff was introduced, because the ECT system could not be an enforceable system as many of the residents did not pay ECT to cover the solid waste management costs. Under this situation, MMs demanded increase in ECT rate to the central government. However, the central government decided to introduce solid waste management tariff instead of increasing the ECT rate. • According to the Guideline of Solid Waste Management Tariff and its regulations revised in February in 2013, public service fees that Sakarya MM should collect with regard to waste management are as follows. <u>The fee collection methods are determined by Metropolitan Municipal Assembly</u>. (1) Sewerage fee (no less than 0.30 TRY/m^3) (2) Municipal solid waste management fee for separation and recycling (3) Municipal solid waste treatment fee • With regard to the fee collection system of (2) and (3) above, MM will obtain approval from the Metropolitan Municipal Assembly after submitting a comprehensive analysis of current solid waste management cost. Only Izmir MM has finished this process and noticed all the residents that the MM will start collection of (2) and (3). These revenues will be accounted as ECT (specific contents and timing to start collection should be confirmed with Izmir MM). • Sakarya MM has obtained approvals from several MDMs for the fee collection system, but it is still in the process of discussion with the rest of the MDMs.

2.5.2 Flow of planning and constructing WtE facilities

A pre-feasibility study should be conducted to construct and operate WtE facilities, followed by an investment agreement between the project owner and the MM. This is followed by approval by the Local Environmental Board[6], land allocation, environmental impact assessment, and finalization of the feasibility study based on the results of environmental impact assessment. Then, the facilities are constructed, MoEU gives temporary environmental permit for 3-month pilot operation under the supervision of DoEU, and an environmental permit for five years is issued by MoEU if the results of pilot operation are satisfactory. The flow of this system is shown in the figure below.

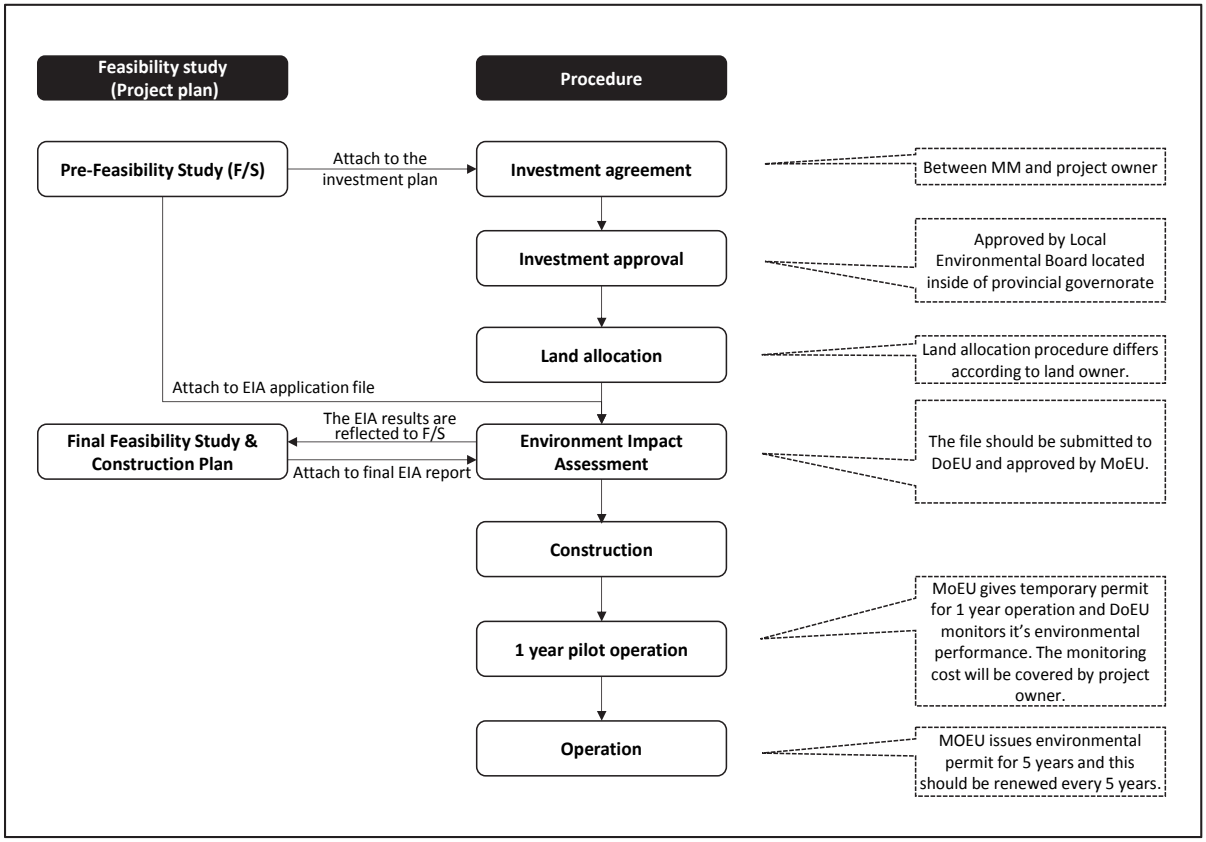


Figure 2-7: Flow of planning and constructing the WtE facilities

[6] The Local Environmental Board is consisted of representatives from MM in the Province, and any decisions made by this Board is considered as decision approved by these MMs.

3 Current status and issues in solid waste management

3.1 Plans and strategies at national level

3.1.1 Tenth Development Plan (2014-2018)

The rate of wastes disposed in sanitary landfill sites in Turkey was 34% in 2006 and it increased to 60% in 2012. Although the Tenth Development Plan set national goals to increase recycling rate to 56% and sanitary landfill rate to 85% by 2018, this Plan also pointed out that recycling is still not widespread in Turkey due to low awareness and lack of policies to promote recycling such as standards for recycled products or incentives for recycling activities.

Table 3-1: Targets in urban infrastructure in Tenth Development Plan

Table 33: Developments and Targets in Urban Infrastructure

	2006	2012	2013	2018
Ratio of Municipal Population That Have Access to Drinkable Water to Total Municipal Population (%)	98	99[1]	99	100
Ratio of Municipal Population Served with Sanitation Network to Total Municipal Population (%)	87	88[1]	91	95
Ratio of Municipal Population Served with Wastewater Treatment Plant to Total Municipal Population (%)	51	62[1]	68	80
Rate of Recycling of Packaging Waste (%)	33	50	53	56
Ratio of Municipal Population Benefiting from Sanitary Landfill (%)	34	60	65	85
Length of Intra-city Rail Systems (km)	292	455	477	787

Source: Data of 2006 and 2012 are from TURKSTAT and Ministry of Environment and Urbanization. Data of 2013 and 2018 are estimates of the Tenth Development Plan.
(1) 2010 TURKSTAT Data

Source: Tenth Development Plan (2014-2018) was approved at the 127th plenary session of The Grand National Assembly of Turkey, on 1 July 2013, in accordance with the Law No.3067, dated 30 October 1984, P129

EU Integrated Environmental Approximation Strategy (2007-2023)

Ministry of Environment and Forestry of Turkey (hereinafter "MoEF") developed EU Integrated Environmental Approximation Strategy and laid out goals, objectives, strategies and the timetable to make the Turkish solid waste management laws and regulations be in line with EU directives and regulations on waste management.

a. Time table

Table 3-2 shows the schedule set by the EU Integrated Environmental Approximation Strategy[1]. The following sections explain the goals, objectives, and strategies in this Strategy.

Table 3-2: Timetable for Approximation

Name of the EU Legislation	Number	Foreseen Transposition Date	Foreseen Implementation/Enforcement Date	Remark
Directive on Hazardous Waste	91/689/EEC	2005	2005	Target4
Directive on Packaging and Packaging Wastes	94/62/EC	2004	30.07. 2004 Issued. 01.01.2005 In force.	Target1
Directive on Disposal of Waste Oils	75/439/EEC	2004	2004	Target4
Directive on Batteries and Accumulators Containing Certain Dangerous Substances	91/157/EEC	2004	2004	Target4
Directive on Waste (Waste Framework Directive)	75/442	2006	2006	Target1
European Waste Catalogue	2000/532	2006	2006	Target4
Directive on the Landfill of Waste	99/31/EC	2006	2006	Target1
Waste Shipment Regulation	259/93/EEC	2008	Upon Membership	-
Directive on the Incineration of Waste	2000/76/EC	2006	2006	Target1
Directive on the Disposal of Polychlorinated Biphenyls and Polychlorinated Terphenyls (PCB/PCT)	96/59/EC	2007	2008	Target4
Directive on the End-of-Life Vehicles	2000/53/EC	2007	2008	Target2
Directive on the Management of Waste from the Extractive Industries (Mining Waste Directive)	2006/21/EC	2008	2008	Target4
Directive on the Waste from the Titanium Dioxide Industry	78/176/EEC	2010	2010	Target4
Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)	2002/95/EC	2007	2008	Target4
Directive on Waste Electrical and Electronic Equipment (WEEE)	2002/96/EC	2007	2008	Target4

Source: EU INTEGRATED ENVIRONMENTAL APPROXIMATION STRATEGY, (2007 - 2023), Ministry of Environment and Forestry 2006

b. Goals, Objectives, and Strategies

Goals, targets, and strategies set in the EU Integrated Environmental Approximation Strategy of Turkey are as follows.

Goal 1: Solid waste production is going to be decreased.

Objective:

1. Solid waste production is going to be recorded
2. Volume and weight of the solid wastes are going to be minimized

Strategy:

[1] EU Integrated Environmental Approximation Strategy is available from: https://www.joi.or.jp/modules/investment/custom/documents/TUR_EU_INTEGRATED_ENVIRONMENTAL_APPROXIMATION_STRATEGY.pdf

1. Building the necessary capacity for monitoring, inspection and assessment of solid waste disposal facilities
2. Establishing the necessary mechanisms to reach public awareness.

Goal 2: By using the appropriate methods, necessary measures are going to be taken to ensure the recycling and the landfill disposal of solid waste.

Objective:

1. Necessary measures are going to be taken for decreasing the biodegradable solid waste quantity going to landfills.
2. Solid waste production is going to be recorded.
3. Solid waste recycling and disposal facilities are going to be installed.
4. Solid wastes are going to be inspected from production until disposal.

Strategy:

1. Forming the "National Strategy" regarding the reduction of biodegradable waste.
2. Building the necessary capacity for monitoring, inspection and assessment of solid waste disposal facilities.
3. Forming the financing scheme for waste management, taking the principle of "Polluter Pays" into account
4. Establishing a licensing system for solid waste recycling and disposal facilities.
5. Establishing the necessary mechanisms to reach public awareness.

Goal 3: Measures concerning packaging and packaging waste management are going to be taken, considering the conditions of competition within the community and the requirements of internal market.

Objective:

1. Hazardous substance utilization in packaging materials, batteries, end-of-life vehicles and electrical and electronic equipment is going to be minimized.
2. Packages are going to be produced in a way that will make reuse and recycling possible and will minimize the negative impacts on environmental quality.

Strategy:

1. Forming the financing scheme for waste management taking the principle of "Polluter Pays" into account
2. Preparing the Solid Waste Management Plan.

Goal 4: Hazardous wastes are going to be managed.

Objective:

1. Solid waste production is going to be recorded.
2. Solid waste recycling and disposal facilities are going to be installed.
3. Solid waste recycling and disposal facilities are going to be licensed.
4. Solid wastes are going to be inspected from production until disposal.

Strategy:

1. Building the necessary capacity for monitoring, inspection and assessment of solid waste disposal facilities.
2. Forming the financing scheme for waste management taking the principle "Polluter Pays" into consideration
3. Establishing a licensing system for solid waste recycling and disposal facilities.
4. Preparing the Solid Waste Management Plan.

Goal 5: Medical and exceptional wastes are going to be managed

Objective:

1. Harmonization studies regarding medical and special wastes are going to be initiated.
2. Solid waste production is going to be recorded.
3. Solid waste recycling and disposal facilities are going to be installed.
4. Solid waste recycling and disposal facilities are going to be licensed.
5. Solid wastes are going to be inspected from production until disposal.

6. Volume and weight of solid wastes are going to be minimized

Strategy:

1. Building the necessary capacity for monitoring, inspection and assessment of solid waste disposal facilities.
2. Forming the financing scheme for waste management taking the principle “Polluter Pays” into consideration
3. Establishing a licensing system for solid waste recycling and disposal facilities.
4. Preparing the Solid Waste Management Plan.

To achieve the above objectives and strategies, the EU Integrated Environmental Approximation Strategy stated that significant amount of investment is needed for policy improvement, recycling of packages and containers, environmentally sound hazardous waste management, and construction of facilities such as final disposal sites and waste incinerators. Table 3-3 shows the amount of necessary investment estimated to implement this plan.

Table 3-3: Necessary investment amount for solid waste management sector (2007-2023)

Unit: Million EUR

Year	Landfill	Packaging	Incineration	Hazardous Waste	Total
2007	200	-	-	-	200
2008	245	41	-	-	286
2009	345	41	-	-	386
2010	345	40	89	4	478
2011	345	41	89	4	478
2012	400	41	89	4	534
2013	425	41	90	5	561
2014	475	41	90	5	611
2015	500	41	90	5	636
2016	500	41	90	5	636
2017	500	41	90	6	637
2018	500	41	90	6	637
2019	550	41	90	6	687
2020	550	41	90	6	687
2021	550	41	90	6	687
2022	550	41	90	6	687
2023	594	41	90	6	731
合計	7,574	655	1,257	74	9,560

Source: EU INTEGRATED ENVIRONMENTAL APPROXIMATION STRATEGY, (2007 - 2023), Ministry of Environment and Forestry 2006

3.1.2 Strategic Plan 2013-2017 of MoEU

Strategic Plan 2013-2017 of MoEU has strategic objectives and detailed targets for each area. The targets with regard to waste management are stated in "Objective 2 – Preventing environmental pollution, improvement of environmental standards, fight against climate change and improving its natural assets".

Table 3-4: Target 2.2 and strategies in Strategic Plan 2013-2017 of MoEU

Target	Strategies
To improve basic facilities for solid waste management by the end of 2017, − At least 85% of the municipal population will be provided with waste disposal services; − At least 50% of recoverable waste will be separated at its source; and − At least 75% of waste is recycled.	The number of landfill facilities of solid waste will be increased
	Waste receiving centers will be established
	Dual-collection system will be introduced

Source: Waste Management and Waste Water Management in Turkey Switzerland Global Enterprise

The number of sanitary landfill sites which used to be 15 has been increased to 38 in 2008, to 41 in 2009, and reached 69 in 2012. Currently, and they serve for total of 903 district municipalities (i.e. MDMs and DMs) for 44.5 million people. The goal of this Plan is to increase this number from 80 at the end of 2013 to 130 by the end of 2017.

The Plan also aims to build waste collection centers for municipalities for target population of 400,000 as bases for waste collection, separation, and recycle as well as centers for education and awareness-raising where people learn about waste reduction at source and separate collection. By the end of 2013, centers were established in 37 municipalities which serve for a population of more than 400,000. It is planned that new waste collection centers will be established in 550 district municipalities (MDMs and DMs) and that 10,000 waste deposit spots will be installed by the end of 2017. In small-scale municipalities, by applying economy of scale, operation of waste bringing centers by unions or collective organizations is encouraged. In 2013, six district municipalities (MDMs and DMs) initiated the dual collection system, and 63 district municipalities (MDMs and DMs) will establish the dual collection system by the end of 2017.

Table 3-5: Performance indicators in Strategic Plan 2013-2017 of MoEU

	Current	2013	2014	2015	2016	2017
Number of solid waste landfill sites (cumulative)	69	79	89	99	114	130
Number of established solid waste landfill sites per year	-	10	10	10	15	16
Ratio of population receiving landfill services (%)	60	65	70	75	80	85
Number of municipalities established waste bringing centers (cumulative)	0	37	88	142	236	550
Number of municipalities traversed to dual-collection system (cumulative)	0	6	16	37	50	63
Number of municipalities traversed to dual-collection system per year	0	6	10	21	13	13

Source: Waste Management And Waste Water Management In Turkey Switzetland Global Enterprise

3.1.3 National Recycling Strategy and Action Plan 2013-2016[2]

One of the important goals of the “EU Sustainable Development Strategy” is “to increase the efficient use of natural resources and avoid waste production by applying the life-cycle concept and encouraging the re-use and recycling of waste”. Major EU countries aim to increase their recycling rates to 70 to 80%.

More than half of the waste generated in Turkey is recyclable. The Ministry of Science, Industry and

[2] WASTE MANAGEMENT AND WASTE WATER MANAGEMENT IN TURKEY SWITZETLAND GLOBAL ENTERPRISE

Technology (hereinafter "MoSIT") has prepared the “National Recycling Strategy and Action Plan 2013-2016” which is also incorporated in the “Strategic Plan 2013-2017” of MoSIT. Its target wastes include municipal waste, waste batteries, packaging waste, waste electrical and electronic equipment, end-of-life vehicles, waste oils, expired tires, metal scrap, animal waste, industrial waste and excavation, construction and demolition waste. There are the following 6 strategic objectives associated with this recycling strategy document:

- Objective 1: Establishing recycling / recovery and collection-separation awareness in all segments of society.
- Objective 2: Making the relevant legislation compliant with the purpose of recycling / recovery and collection-separation.
- Objective 3: Storage, collection and transport of all the recyclable waste separately at source.
- Objective 4: Preparing and implementing funding and support models with regard to recycling / recovery and collection-separation.
- Objective 5: Establishing infrastructure that will allow public-private co-operation and co-ordination.
- Objective 6: Establishing an effective control system by registering the production of waste.

Relevant governmental action will be undertaken in order to achieve these targets by 2016. As the main contents of Objective 1 are awareness-raising and education, responsible institutions for this objective include the Ministry of Education, MoEU and MoSIT.

Table 3-6: Responsible institution for Objective 2

Action	Responsible Institution	Period
Determination of facility standards regarding recycling / recovery and collection-separation facilities	Turkish Standards Institution (TSE)	2013 - 2014
Determination of standards regarding recyclable secondary products	Turkish Standards Institution (TSE)	2013 - 2014
Analysis and revision of legislation concerning waste trading (import-export) considering country conditions	Ministry of Economy (MoE)	2013 - 2014
Changing legislation for adding supplementary budget to the waste management costs of public institutions and organizations	Ministry of Finance (MoF)	2013
Preparing a Prime Ministry Circular regarding the promotion of the use of products obtained by recycling / recovery and collection-separation	Ministry of Science, Industry and Technology (MoSIT)	2013
Establishing restrictions on the use of materials that cannot be recycled / recovered, collected-separated	Ministry of Environment and Urbanization (MoEU)	2013-2016
Establishing waste management incentive legislation prioritizing recycling / recovery, collection-separation	MoE, MoF	2013-2016
Establishing regulation regarding the recyclable waste defined in the municipality and Metropolitan municipality law	Ministry of Interior (MoI)	2013
Establishing legislation such that municipalities are able to make long-term service purchasing contracts with regard to the collection, transfer and recovery of packaging waste	MoEU	2013-2016
Establishing regulations such that excavation, construction and demolition waste and the separated collection of packaging waste in the municipality and Metropolitan municipality law will be one of the core responsibilities of municipalities	MoEU	2013-2016

Table 3-7: Responsible institution of Objective 3

Action	Responsible Institution	Period
Establishing systems allowing the at source collection and transportation of recyclable waste, being under the authority and responsibility of municipalities, done by licensed companies which will have agreements with municipalities	MoI	2014 - 2016
Making the collection of waste at source (dual system: recyclable + organic) mandatory	MoEU	2013
Developing existing laboratory infrastructure regarding the product quality obtained by recycling / recovery, collection-separation	MoEU	2013 - 2016
Determining strategic sectors with regard to recycling / recovery, collection-separation	MoEU	2013 - 2016

Table 3-8: Responsible institution of Objective 4

Action	Responsible Institution	Period
Supporting R&D activities, technology transfer and dissemination of applications with regard to recycling strategies	MoSIT	2013 - 2016
Supporting projects and providing project finance to small- and medium-sized enterprises in order to facilitate the financing of projects associated with recycling / recovery, collection- separation	The Small and Medium-sized Enterprise Development and Support Organization (KOSGEB) of MoSIT	2013 - 2016
Establishing a financing support mechanism based on the cost of the investment project with regard to recycling / recovery, collection-separation	MoE	2013 - 2016
Supporting recycling / recovery, collection-separation facilities with special incentives	Treasury	2013 - 2016
Promoting of products obtained by recycling	The Public Procurement Authority (KIK) of the Prime Ministry	2013 - 2016
Providing encouraging support (social security and energy / fuel) for people and organizations performing recycling / recovery, collection-separation	MoE	2013 - 2016
Re-regulating the special consumption tax rate of recycling / recovery, collection-separation in order to support the return on investment	MoF	2014
Providing project-based grants or financing for entrepreneurs targeting to build recycling /recovery, collection-separation facilities	MoEU	2013 - 2016

Table 3-9: Responsible institution of Objective 5

Action	Responsible Institution	Period
Establishing a reliable information infrastructure in the created public-private sector common database with regard to waste.	MoEU	2013 – 2016
Establishing a waste coordination board.	MoEU	2013 – 2014
Establishing waste coordination boards on province basis.	MoI	2014 – 2014
Establishing a waste market (waste exchange) coordination center.	TOBB[3]	2013

Responsible institutions of Objective 6 are MoEU and Ministry of Interior (MoI) in cooperation with other relevant governmental agencies because the works include administrative works such as establishment of committee between 2013 and 2016.

3.2 Laws and regulations concerning solid waste management

3.2.1 Solid waste management

Turkish legal framework consists of laws established by parliament and enacted by government (primary legislation) and rules, regulations, and notices established by ministries (secondary legislation).

Secondary legislations related to solid waste management are under the jurisdiction of MoEU and are consistent with EU directives based on EU Integrated Environmental Approximation Strategy for Turkey 2007-2023. Further, WtE is under the jurisdiction of Energy Market Regulatory Authority (hereinafter EMRA). Brief overview of each legislation is explained as follows.

a. Law on Environment no. 2872

This law stipulates basic principles related to various environmental activities. For example, Article 8 prohibits discharge and storing of all sorts of waste and residue directly or indirectly into the receiving environment or engaging in similar activities. Further, Article 29 stipulates that incentive measures for environmental pollution prevention are to be provided and that these incentive measures are to be revised yearly by MoEU. Currently, electricity fee discount by 50% for wastewater treatment is being implemented under this Article.

b. Law on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy no. 5346

This law stipulates the feed-in tariff (hereinafter FIT) system that determines unit price of renewable energy according to the type of energy source. Procedures and rules regarding the connection between the national grid system and the waste-to-energy plants are stated in this law.

c. Municipal Law no. 5393

Article 14 and 15 state that municipalities are responsible for waste collection, transportation, separation, recycling, disposal, and storage.

d. Law on Metropolitan Municipality no. 5216

Article 7 of this law states that metropolitan municipalities are in charge of development and implementation of their Solid Waste Management Plans which do not include waste collection and transportation to transfer stations.

e. Public Procurement Law no. 4734

As this law applies to all public procurement, it also applies to solid waste management projects.

[3] The Union of Chambers and Commodity Exchanges of Turkey (TOBB) is the umbrella organization of the Chambers of Commerce, Chambers of Industry, Chambers of Commerce and Industry, Chambers of Maritime Trade and Commodity Exchanges.

3.2.2 Environment impact assessment

The laws and regulations related to Environmental Impact Assessment (hereinafter "EIA") in Turkey are as follows.

- Law No. 5491 amending the Environmental Law No. 2872 *(Kanun Çevre Kanununda Değişiklik Yapilmasina Dair Kanun*）[4] enacted August 11, 1983 and revised May 13, 2006.
- EIA Regulation (*Çevresel Etki Değerlendirmesi Yönetmeliği*)[5] enacted August 11, 1983, revised November 25, 2014
- Regulation amending the Regulation on permits and licenses foreseen by the Environment Act (*Çevre Kanununca alinmasi gereken izin ve lisanslar hakkinda yönetmelikte değişiklik yapilmasina dair Yönetmelik*)[6] enacted February 24, 2010, revised September 10, 2014

Article 7 of the Environmental Law stipulates that organizations that may cause environmental impact must prepare an EIA report. The projects that require EIA are stipulated in the EIA Regulation. Projects that must conduct EIA are listed in Annex 1 of EIA Regulation, and projects subject to screening on whether EIA would be required or not are listed in Annex 2 of EIA Regulation. The Table below shows the projects related to WtE projects that are target of EIA procedures. In the case where a project is an integrated project consisting of several sub-projects that require EIA (e.g. construction of both incineration plant and final disposal site), there is a possibility that MoEU would ask applicants to submit one EIA report that covers the whole integrated project.

Table 3-10: Waste-to-Energy Related Projects that Require EIA

Type	Businesses
Subject to EIA (listed in Annex 1)	2. Thermal power plants: a) Thermal power plants and other combustion systems with total thermal power capacity of 300 MW and greater, 10. Wastes which are hazardous and which are subject to special processing: a) Facilities for recycling, incineration (incineration by oxidation, pyrolysis, gasification, plasma etc. thermal processes), regular storage, and recycle of wastes which are hazardous and which are subject to special processing b) Medical waste incinerator with projected capacity of 1 ton/day c) Facilities designed for recycling of waste oil with annual processing capacity of 2,000 tons and over 11. Facilities which have area of 10 ha or greater and/or target daily capacity of 100 tons and over for recovery, incineration (by thermal processes such as oxidation, pyrolysis, gasification, plasma etc), storage, and final disposal of wastes excluding construction, demolition and excavation wastes
Subject to screening to determine whether EIA would be required or not (listed in Annex 2)	5. Facilities which have daily target capacity of under 100 tons for recovery, incineration (by thermal processes such as oxidation, pyrolysis, gasification, plasma etc), storage, and final disposal of wastes excluding construction, demolition and excavation wastes

Source: EIA Regulations

[4] Original text in Turkish: http://faolex.fao.org/docs/texts/tur65097.doc
[5] Original text in Turkish: http://www.mevzuat.gov.tr/Metin.Aspx?MevzuatKod=7.5.20235&MevzuatIliski=0&sourceXmlSearch=%C3%A7evresel
[6] Original text in Turkish: http://www.mevzuat.gov.tr/Metin.Aspx?MevzuatKod=7.5.20033&MevzuatIliski=0&sourceXmlSearch=izin

a. Related agencies and organizations and their roles in EIA

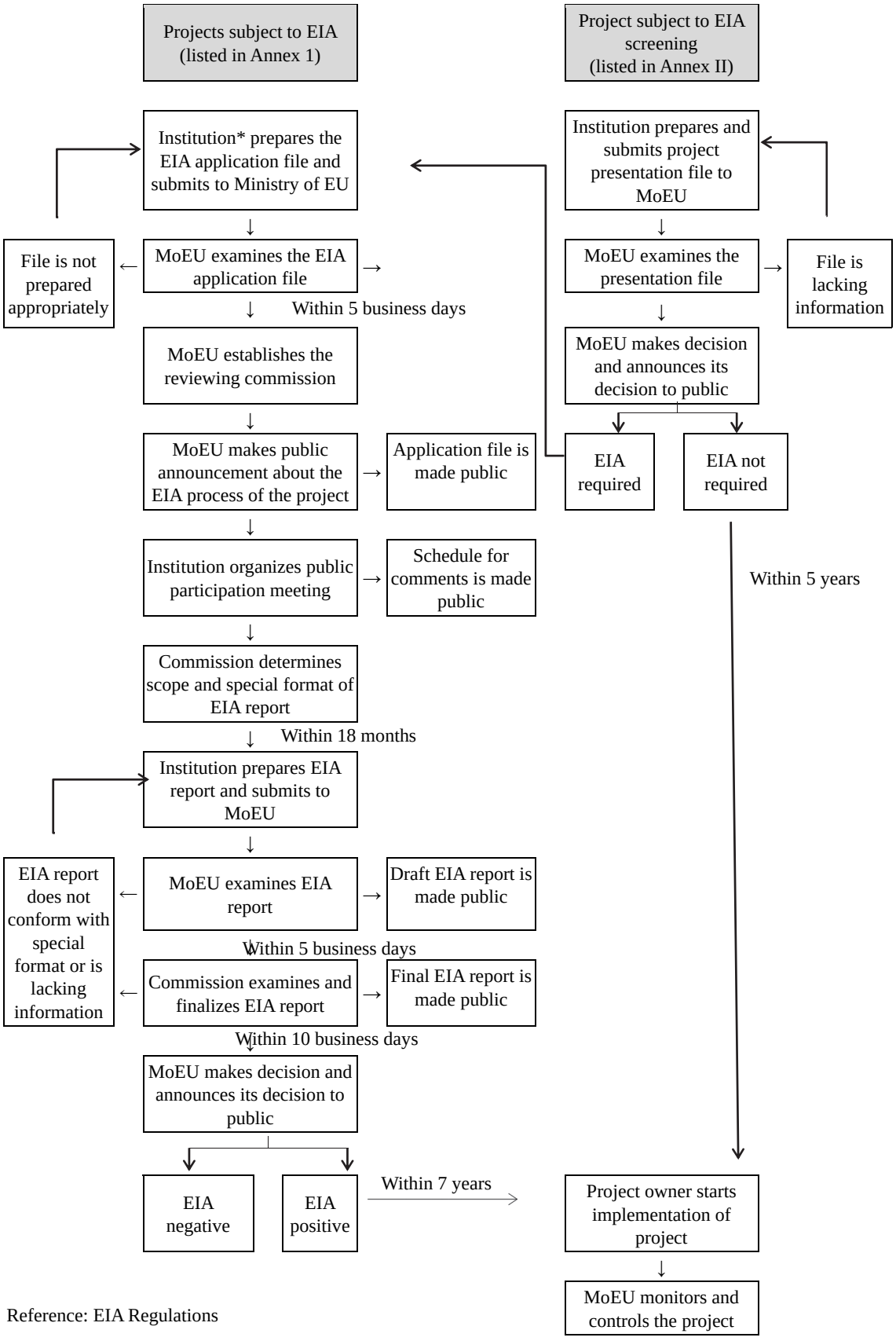
The roles and responsibilities of organizations in the EIA process in Turkey are as follows.

Table 3-11: Roles and responsibilities of different organizations in the EIA process

Organizations	Roles and Responsibilities
MoEU	・ Establish an EIA review committee, hold public consultation on the review, and approve EIA report for projects subject to EIA in the Annex 1. ・ Conduct screening on whether or not EIA is required for projects in the Annex 2. ・ Monitor projects with EIA approval.
Provincial Governate of MoEU	・ Serve as a chairman in the public consultation (or appoint someone to deputize)
Review Committee established by MoEU	・ Determine the scope and reporting format and review EIA reports ・ Committee consists of representatives from MoEU related public corporations.
Agencies approved by MoEU (e.g. consultant)	・ Prepare EIA application, report, and project outline. ・ Prepare monitoring report for a project approved.
Applicants for EIA	・ Submit related documents of EIA above by commissioning an agency (consultants) to prepare them. ・ For approved projects, notify project program change if any.
Citizens	・ Submit opinions for disclosed information on EIA.

b. EIA process

The EIA process stipulated in the EIA Regulation is shown in Figure 3-1.



*Institution: Institutions authorized by MoEU to prepare and submit EIA application file, EIA report, project presentation file, and to perform reporting of monitoring and control of construction period of projects which have EIA affirmative decisions

Figure 3-1: EIA Process

The projects that are listed in Annex 1 of EIA Regulation which include WtE facilities must submit EIA application to MoEU, and then MoEU establishes a review committee within five days from the date of submission. Then, the review committee makes a public announcement about the EIA of the project and organizes a public participation meeting. Based on the comments given in this meeting, the committee determines the scope of the EIA, and the applicant prepares the draft EIA report within 18 months. The draft EIA report is made public after examination by MoEU. If it is considered that the report does not respect the determined format or is lacking information, the report must be re-submitted. Within 10 days after the finalization of the EIA report, the decision on whether the project is EIA positive or negative is announced. The project owner must implement the project within 7 years after this decision, ant the project would be monitored by MoEU.

c. Related laws and regulations in the EIA process

In the EIA process, it is necessary to comply with the current environment-related laws and regulations as shown in Table 3-12.

Environmental laws and regulations are based on Environmental Law, and all environmental issues including waste management issues must comply with this law. Furthermore, regarding implementation of EIA, the necessary procedure is stated in the EIA Regulation. With regard to installment of waste treatment centers, appropriate laws and regulations would be applied depending on the project site and the impact on environment during its operation.

Table 3-12: Environment-related laws and regulations in Turkey

Type	Name of law/regulation
Laws	- Environmental law - Labor law - Water products law - Law regarding underground waters - Public health law - National parks law - Law on protection of cultural and natural assets - Archeological sites law - Coast law - Forest law - Pasture law - Building law - Law regarding improvement of olive cultivation and vaccination of wild ones - Municipal law - Metropolitan municipality law - Public works law - Tourism incentive law - National forestation and erosion control law - Soil protection and land use law
Regulations	- Environmental Impact Assessment Regulation - Air Quality Protection Regulation - Control of Industrial Sourced Air Pollution Regulation - Assessment and Management of Environmental Noise Regulation - Water Pollution Control Regulation - Water Products Regulation - Regulation Regarding General principles of Waste Management - Control of Solid Wastes Regulation - Control of Hazardous Wastes Regulation - Control of Medical Wastes Regulation - Control of Waste Oils Regulation - Control of Herbal Waste Oils Regulation - Control of Packaging Wastes Regulation - Control of Waste Battery and Accumulator Regulation - Hazardous Chemicals Regulation - Control of Harmful Chemical Substances and Products Regulation - Regulation Regarding Wastes Arising from Use of Radioactive Substances - Regulation Regarding Control of Polychlorinated Biphenyl and Polychlorinated Terphenyls - Control of Excavation Soil, Construction and Debris Wastes Regulation

Type	Name of law/regulation
	- Control of Soil Pollution Regulation - Soil protection and Land Use Law Implementation Regulation - Regulation Regarding Protection and Use of Agricultural Lands - Protection of Wetlands Regulation - Regulations Regarding implementation of International Trade of Endangered Animal and Plant Species - Regulation Regarding Procedures and Principles of Protection of the Habitat of Game Animals and Wild Animals and Fighting Against Ones Harmful for Them - Regulation Regarding Protection of Wildlife and Sites of Improvement of Wildlife - Highway Traffic Regulation - Regulation Regarding Opening Workplace and Work Permits - Work Health and Safety Regulation - Regulation Regarding Environmental Health Inspection and Inspectors - Receipt of Waste from Ships and Control of Wastes Regulation

d. Permits and licenses related to environment

Projects that will have environmental impacts should obtain "environmental permits" or "environmental licenses" according to Regulations on Permit and Licenses". Environmental permits are required for any type of emission of air pollutants, noise, wastewater discharge to sea and river, and generation of hazardous waste. Environmental license must be obtained for operation of waste collection, treatment, recycling, and disposal.

Projects subject to obtaining environmental permits or licenses are stated in Annex 1 and 2.Approvals for Annex-1-project are issued by MoEU while approvals for Annex-2-projects are issued by Provincial Governate of MoEU. Table 3-13 shows the list of projects related to WtE that require environmental permits or licenses.

Table 3-13: List of Projects Related to Waste-to-Energy that Require environmental permits or licenses

Type	Authority which gives permit/ license	Businesses
Businesses with high environmental impact (listed in Annex 1)	MoEU	1.1 Thermal power plants. 1.1.1 Thermal power plants and other combustion systems for solid and liquid fuel with capacity of over 100 MW 8. Waste Management 8.1 Facilities for interim storage, recycling and disposal of wastes 8.2 Facilities for storage or processing of end-of-life vehicles or scraps, waste electrical and electronic equipment with tank cleaning facilities, processing plants including scrap shredding plant 8.3 Ship recycling facilities 8.4 Advanced thermal processing facility (pyrolysis , gasification) 8.5 Refuse-derived fuel (RDF) preparation facility 8.6 Medical waste stabilization facility
Environmental contaminating businesses (listed in Annex 2)	Provincial Directorate of MoEU	1.1 Thermal power plants. 1.1.1 Thermal power plants and other combustion systems for solid and liquid fuel with capacity of 100 MW and under

Source: Regulations on Permit and Licenses

Project operator who is required to obtain environmental permits and licenses should obtain temporary environmental operation certificate before starting operation. As temporary environmental operation certificate is effective for one year, operators should complete the application process of environmental permits and licenses at least 3 months before the expiry date of the temporary one.

Once it is obtained, environmental permits and licenses are effective for five years and should be renewed at least 180 days before the expiry date.

3.2.3 Gaps between JICA Environmental and Social Consideration Guideline (as of April 2010) and Turkish laws and regulations

In order to conduct EIA in an appropriate manner, the gaps among the Turkish regulations (Law No. 5491 amending the Environmental law No. 2872, EIA Regulation, Regulation amending the Regulation on permits and licenses foreseen by the Environment Act), JICA Guidelines for Environmental and Social Considerations (April 2010), and the World Bank Safeguard Policy were examined. The result of comparison is shown in the table below.

	Item	JICA Guidelines	World Bank Safeguard Policy	Turkish laws and regulations*	Gaps (If gaps exist, measures to fill the gaps)
Principles of EIA Report	Compliance	When assessment procedures already exist in host countries, and projects are subject to such procedures, project proponents etc. must officially finish those procedures and obtain the approval of the government of the host country.	(Same with the left column)	Procedures regarding EIA is stipulated by the Turkish law	No gap
	Language	EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them	(Same with the left column)	There is no rule regarding language of the EIA report	There is a gap; EIA report will be written in Turkish
	Disclosure	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted	For a Category A project, the borrower makes the draft EIA report available at a public place accessible to project-affected groups and local NGOs.	EIA report is disclosed to the public before its finalization.	No gap

	Item	JICA Guidelines	World Bank Safeguard Policy	Turkish laws and regulations*	Gaps (If gaps exist, measures to fill the gaps)
	Consultation	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared	Consultation with stakeholders and public information disclosure should be conducted.	Public participation meeting is held prior to determination of EIA scope. Draft EIA report is disclosed to a public to reflect public opinions to final EIA report.	There is a gap; Records of discussion should be made in the public participation meeting.
	Time of consultation	Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared	For all Category A and B projects, the borrower initiates consultations with project-affected groups and local NGOs about the project's environmental aspects and takes their views into account as early as possible.	Public participation meeting is held prior to determination of EIA scoping. Draft EIA report is disclosed to a public and those who have opinions can submit their opinions to the EIA commission. Commission should reflect these opinions of stakeholders when finalizing the EIA report.	There is a gap; Consultation should be held also when preparing the draft EIA report
Contents of EIA Report	Executive summary	This concisely discusses significant findings and recommended actions.	Concisely discusses significant findings and recommended actions.	There is no section similar to executive summary.	There is a gap; Significant findings and recommended actions should be concisely discussed in the summary.
	Policy, legal, and administrative framework	Discusses the policy, legal, and administrative framework within which the EIA is carried out.	Discusses the policy, legal, and administrative framework within which the EIA is carried out. Explains the environmental requirements of any co-financers. Identifies relevant international environmental agreements to which the country is a party.	Place of project with the scope of EIA Directive (sector and sub-sector) should be given but does not specify as detail as JICA Guideline and World Bank Safeguard Policy.	There is a gap; Instead of provision of sector and sub-sector of the project defined in the EIA Directive, it should discuss policy framework including EU EIA Directive and other relevant environmental policies and requirements.

	Item	JICA Guidelines	World Bank Safeguard Policy	Turkish laws and regulations*	Gaps (If gaps exist, measures to fill the gaps)
	Project description	This describes the proposed project and its geographic, ecological, social and temporal context, including any off-site investments that may be required (e.g. dedicated pipelines, access roads, power plants, water supply, housing, or raw material and product storage facilities). It also indicates the need for any resettlement or social development plan. It normally includes a map showing the project site and the area affected by the project.	Concisely describes the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities). Indicates the need for any resettlement plan or indigenous people's development plan. Normally includes a map showing the project site and the project's area of influence.	Section I: Description of the Project and Specs a) Definition, properties, life, service purposes, significance and necessity of the investment being subject of project b) Location and technology alternatives of the project, coordinates of the location selected for the project	There is a gap; In addition to the Section I, EIA report should concisely describes its geographic, ecological, social and temporal context. Also, the need for any resettlement plan lr indigenous people's development plan should be indicated here. Further, a map showing the project site and project's area of influence should be provided.
	Baseline data	This assesses the dimensions of the study area and describes relevant physical, biological, and socio-economic conditions, including all changes anticipated to occur before the project commences. Additionally, it takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project site, design, operation, or mitigation measures, and it is necessary to indicate the accuracy, reliability, and sources of the data.	Assesses the dimensions of the study area and describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.	Sector II: Current environmental Status in the Project Site and Its Impact Area: Population, fauna, flora, geological and hydrogeological properties, natural disaster status, soil, water, air, atmospheric conditions, climatic factors, property status, architectural and archeological heritage, landscape properties, land usage status, sensitivity degree and similar properties of the project area and of the surrounding possible to be affected due to the recommended project	There is a gap; Section II does not cover socio-economic conditions therefore chapter studying socio-economic status in the impact area should be added to section II. Also takes in to account current and proposed development activities. Data should be relevant to decisions about project location, design, operation or mitigatory measures. The section should indicate the accuracy, reliability, and sources of the data.

	Item	JICA Guidelines	World Bank Safeguard Policy	Turkish laws and regulations*	Gaps (If gaps exist, measures to fill the gaps)
	Environmental impacts	This predicts and assesses the project's likely positive and negative impacts in quantitative terms, to the extent possible. It identifies mitigation measures and any negative environmental impacts that cannot be mitigated, and explores opportunities for environmental enhancement. It identifies and estimates the extent and quality of available data, essential data gaps and uncertainties associated with predictions, and it specifies topics that do not require further attention.	Predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. Identifies mitigation measures and any residual negative impacts that cannot be mitigated. Explores opportunities for environmental enhancement. Identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.	Section III: Environmental Impacts and measures to be Taken in the Project's Construction and Operation Phases a) Identify of possible problems which may affect the environment, amount of contaminants, its interaction with recipient environment, determination of cumulative effects b) Calculate greenhouse gas emissions and its effects on climate change c) Measures to be taken in order to decrease the negative effects of the project on the environment d) Monitoring plan for construction period	There is a gap; In addition to Section III, EIA report should explore opportunities for environmental enhancement. Also it should identify and estimate the extent and quality of available data, essential data gaps and uncertainties associate predictions, and topics that do not require further attention.

	Item	JICA Guidelines	World Bank Safeguard Policy	Turkish laws and regulations*	Gaps (If gaps exist, measures to fill the gaps)
	Analysis of alternatives	This systematically compares feasible alternatives to the proposed project site, technology, design, and operation including the "without project" situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, it quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. It also states the basis for selecting the particular proposed project design, and offers justification for recommended emission levels and approaches to pollution prevention and abatement.	Systematically compares feasible alternatives to the proposed project site, technology, design, and operation--including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.	No regulation	There is a gap; Analysis of alternatives should be conducted according to JICA Guidelines and WB Safeguard Policy.
	Environmental Management Plan (EMP)	This describes mitigation, monitoring, and institutional measures to be taken during construction and operation in order to eliminate adverse impacts, offset them, or reduce them to acceptable levels.	Covers mitigation measures, monitoring, and institutional strengthening	Section III: Environmental Impacts and measures to be Taken in the Project's Construction and Operation Phases c) Measures to be taken in order to decrease the negative effects of the project on the environment d) Monitoring plan for construction period	There is a gap; In addition to Section III, monitoring plan for operation period and institutional strengthening should be described.

	Item	JICA Guidelines	World Bank Safeguard Policy	Turkish laws and regulations*	Gaps (If gaps exist, measures to fill the gaps)
	Consultation	This includes a record of consultation meetings (date, venue, participants, procedures, opinions of major local stakeholders and responses to them, and other items), including consultations for obtaining the informed views of the affected people, local NGOs, and regulatory agencies.	Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations (NGOs). The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs.	Section IV: Public Participation a) Determination of relevant public possible to be affected by the project and methods proposed in order reflect the opinions of public on the Environmental Impact Assessment study b) Other parties anticipated for obtaining opinions	There is a gap; Records of discussion should be made for different consultation meetings based on JICA and World Bank policies

*Turkish laws and regulations referred to here are Law No. 5491 amending the Environmental law No. 2872, EIA Regulation, and Regulation amending the Regulation on permits and licenses foreseen by the Environment Act.

3.2.4 Environmental standards to be respected

In order to avoid negative environmental and social impact, it must be confirmed whether the project will comply with the Turkish laws and regulations when the details of the project are determined. Standards to be respected differ depending on the type of the project. The main environmental standards to respect when constructing and operating waste incineration facilities are listed below. When the project owner enters into the EIA process, it must measure the current environmental quality (or conduct qualitative survey for certain items if quantitative measurement is inappropriate), predict, and evaluate the impact.

a. Air pollution

Generally, air pollution is considered to be the most significant environmental impact to be caused by waste incineration facilities. With regard to air pollution, the facilities must respect the air emission limit values as stipulated in Regulation on Incineration of Wastes (*Atıkların yakılmasına ilişkin yönetmelik*) (Table 3-14).

Table 3-14: Air emission limit values from wastes incinerators

AIR EMISSION LIMIT VALUES

(a) **Daily average values**

Total dust	10 mg/m^3
Gaseous and vaporous organic substances, expressed as total organic carbon	10 mg/m^3
Hydrogen chloride (HCl)	10 mg/m^3
Hydrogen fluoride (HF)	1 mg/m^3
Sulphur dioxide (SO_2)	50 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide for existing incineration plants with a nominal capacity exceeding 6 tonnes per hour or new incineration plants	200 mg/m^3 (*)
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as nitrogen dioxide for existing incineration plants with a nominal capacity of 6 tonnes per hour or less	400 mg/m^3 (*)

(b) **Half-hourly average values**

	(100 %) A	(97 %) B
Total dust	30 mg/m^3	10 mg/m^3
Gaseous and vaporous organic substances, expressed as total organic carbon	20 mg/m^3	10 mg/m^3
Hydrogen chloride (HCl)	60 mg/m^3	10 mg/m^3
Hydrogen fluoride (HF)	4 mg/m^3	2 mg/m^3
Sulphur dioxide (SO_2)	200 mg/m^3	50 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as nitrogen dixoide for existing incineration plants with a nominal capacity exceeding 6 tonnes per hour or new incineration plants	400 mg/m^3 (*)	200 mg/m^3 (*)

(c) **All average values over the sample period of a minimum of 30 minutes and a maximum of 8 hours**

Cadmium and its compounds, expressed as cadmium (Cd)		
Thallium and its compounds, expressed as thallium (Tl)	total 0,05 mg/m³	total 0,1 mg/m³ (*)
Mercury and its compounds, expressed as mercury (Hg)	0,05 mg/m³	0,1 mg/m³ (*)
Antimony and its compounds, expressed as antimony (Sb)		
Arsenic and its compounds, expressed as arsenic (As)		
Lead and its compounds, expressed as lead (Pb)		
Chromium and its compounds, expressed as chromium (Cr)		
Cobalt and its compounds, expressed as cobalt (Co)	total 0,5 mg/m³	total 1 mg/m³ (*)
Copper and its compounds, expressed as copper (Cu)		
Manganese and its compounds, expressed as manganese (Mn)		
Nickel and its compounds, expressed as nickel (Ni)		
Vanadium and its compounds, expressed as vanadium (V)		

(*) Until 1 January 2007 average values for existing plants for which the permit to operate has been granted before 31 December 1996, and which incinerate hazardous waste only.

These average values cover also gaseous and the vapour forms of the relevant heavy metal emissions as well as their compounds.

(d) **Average values shall be measured over a sample period of a minimum of 6 hours and a maximum of 8 hours. The emission limit value refers to the total concentration of dioxins and furans calculated using the concept of toxic equivalence in accordance with Annex I.**

Dioxins and furans	0,1 ng/m³

(e) **The following emission limit values of carbon monoxide (CO) concentrations shall not be exceeded in the combustion gases (excluding the start-up and shut-down phase):**

— 50 milligrams/m³ of combustion gas determined as daily average value;
— 150 milligrams/m³ of combustion gas of at least 95 % of all measurements determined as 10-minute average values or 100 mg/m³ of combustion gas of all measurements determined as half-hourly average values taken in any 24-hour period.

Exemptions may be authorised by the competent authority for incineration plants using fluidised bed technology, provided that the permit foresees an emission limit value for carbon monoxide (CO) of not more than 100 mg/m³ as an hourly average value.

Source: Regulation on Incineration of Wastes

b. Water pollution

One of the main types of waste water from the waste incineration facilities is that from cleaning of exhausted gases. When discharging this to public waters, the emission limit values stipulated in the Regulation on Incineration of Wastes must be respected (Table 3-15).

Table 3-15: Emission limit values for discharges of waste water from the cleaning of exhaust gases from waste incinerators

Emission limit values for discharges of waste water from the cleaning of exhaust gases

Polluting substances	Emission limit values expressed in mass concentrations for unfiltered samples	
1. Total suspended solids as defined by Directive 91/271/EEC	95 % / 30 mg/l	100 % / 45 mg/l
2. Mercury and its compounds, expressed as mercury (Hg)	0,03 mg/l	
3. Cadmium and its compounds, expressed as cadmium (Cd)	0,05 mg/l	
4. Thallium and its compounds, expressed as thallium (Tl)	0,05 mg/l	
5. Arsenic and its compounds, expressed as arsenic (As)	0,15 mg/l	
6. Lead and its compounds, expressed as lead (Pb)	0,2 mg/l	
7. Chromium and its compounds, expressed as chromium (Cr)	0,5 mg/l	
8. Copper and its compounds, expressed as copper (Cu)	0,5 mg/l	
9. Nickel and its compounds, expressed as nickel (Ni)	0,5 mg/l	
10. Zinc and its compounds, expressed as zinc (Zn)	1,5 mg/l	
11. Dioxins and furans, defined as the sum of the individual dioxins and furans evaluated in accordance with Annex I	0,3 mg/l	

Source: Regulation on Incineration of Wastes

With regard to other wastewaters discharged to public waters, the discharge limits stipulated by Regulation for Water Pollution Control (*Su Kirliliği Kontrolü Yönetmeliği*) must be respected (Table 3-16). If the waste waters are to be discharged to the sewage, the discharge limits stipulated by municipalities are to be respected. An example of discharge limit by the Izmir Water and Sewerage Administration (IZSU) is shown in Table 3-17.

Table 3-16: Discharge limits for waste treatment and disposal facilities

Parameter	Unit	Composite Sample 2 Hours	Composite Sample 24 Hours
Biochemical Oxygen Demand (Bod5)	(mg/l)	100	50
Chemical Oxygen Demand (Cod)	(mg/l)	160	100
Suspending Solid Materials (SSM)	(mg/l)	200	100
Oil and Grease	(mg/l)	20	10
Total Phosphor (Po4-P)	(mg/l)	2	1
Total Chromium	(mg/l)	2	1
Chromium (Cr+6)	(mg/l)	0.5	0.5
Lead (Pb)	(mg/l)	2	1
Total Cyanide (Cn)	(mg/l)	1	0.5
Cadmium (Cd)	(mg/l)	0.1	
Iron (Fe)	(mg/l)	10	
Fluoride (F)	(mg/l)	15	
Copper (Cu)	(mg/l)	3	
Zinc (Zn)	(mg/l)	5	
Fish Bio-Experiment (Zsf)		10	
pH		6-9	6-9

Source: Regulation for Water Pollution Control

Table 3-17: Discharging limits to the sewage system by Izmir Water and Sewerage Administration (IZSU)

Parameter	IZSU Discharge Standards	Parameter	IZSU Discharge Standards
Temperature (◦C)	40	Pb (mg/L)	3
PH	6.5 – 10	Cd (mg/L)	2
SS (mg/L)	500	Total Cr (mg/L)	5
Oil and Grease (mg/L)	250	Hg (mg/L)	0.2
COD (mg/L)	4000	Cu (mg/L)	2
SO_4^{-2} (mg/L)	1000	Ni (mg/L)	5
Sulphur (mg/L)	2	Zn (mg/L)	10
Phenol (mg/L)	10	B (mg/L)	3
Free Chlorine (mg/L)	10	Sn (mg/L)	5
Arsenic (mg/L)	3	Oil (Tar – petroleum) (mg/L)	50
Total Cyanide (mg/L)	10	Surfactants	It is forbidden

Source: Assessment of Izmir Sewage Project and its environmental impacts

http://ressources.ciheam.org/om/pdf/a53/03001730.pdf#page=4&zoom=auto,-82,830

c. Noise and vibration

Under the Regulation on Incineration of Wastes, all necessary precautions should be taken in order to avoid negative environmental impact by noise. Although standards for noise and vibration could not be confirmed in the survey, the following items must be reported[7] when the project owners apply for the environmental permit necessary for operation.

- Information about the source of the noise (location, characterization of noise, frequency, sound power or pressure)
- Description of the construction of the premises including Sound Reduction Index
- Identification and description of receivers of noise (e.g. hospital, school) and their height and distance from the waste incineration facilities
- Noise level in different circumstances in day-time and night-time (in dB)

[7] Based on "Integrated Environmental Permits: Supporting guideline for the Applicants".

d. Odor

Similar to noise, all necessary precautions must be made in order to prevent negative environmental impact by odor based on Regulation on Incineration of Wastes (no standard could be confirmed for odor during the survey). Considerations should be made so that the odor from the waste stocking area (e.g. waste pit) does not reach the surrounding residential areas or other facilities.

e. Impact on ecological system

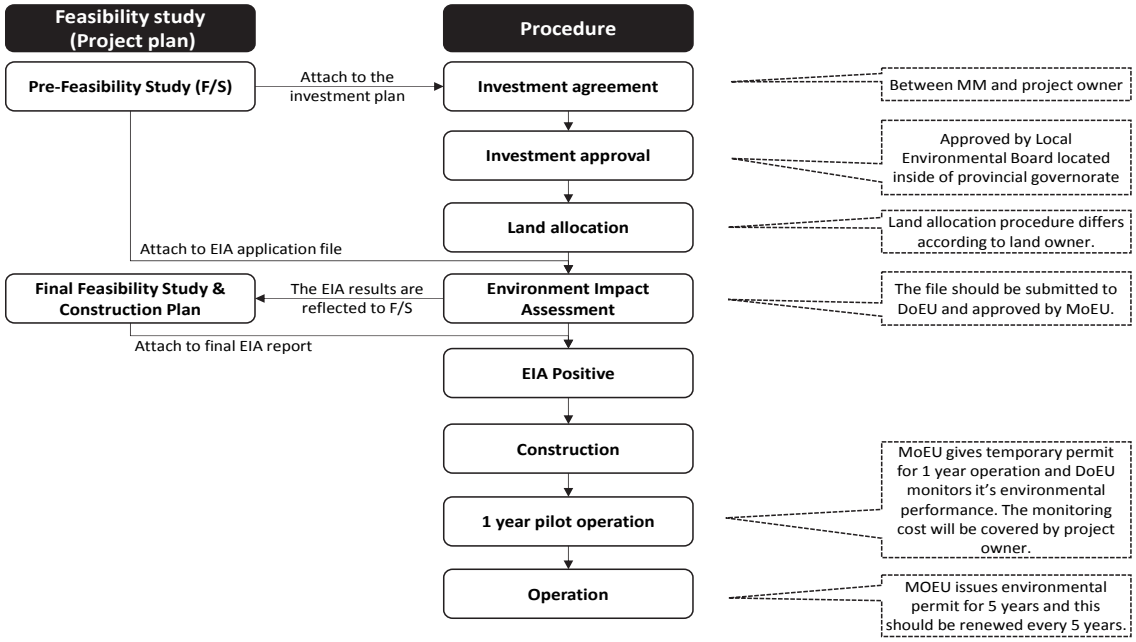
Based on Turkish laws and regulations including Law on National Parks and Regulation on Wildlife Conservation and Wildlife Development Areas and international treaties concluded by the Turkish government, considerations must be made so that there are no negative impact to rare flora and fauna, ecological system, protected areas, and national parks by the project.

f. Socio-economic impact

Based on Turkish laws and regulations including Law on Protection of Cultural and Natural Assets and international treaties concluded by the Turkish government, precautions should be made so that there is no negative impact to cultural heritage, landscape, livelihood, local economy (including employment) by the project.

3.2.5 Procedures for construction and operation of WtE facilities

The steps to be followed before constructing and operating the WtE facilities are shown in the figure below. After the pre-feasibility study, an investment agreement shall be signed between the project owner and the MM. Then, there is the approval of the investment plan by the Local Environment Board under the Provincial Governate followed by land allocation and the EIA process. The investment plan which is revised based on the results of EIA and the feasibility study is finalized and attached to the EIA report. After it is confirmed that the project is EIA positive, construction works will be commenced. After construction, MoEU will authorize one-year pilot environmental license, and environmental monitoring will start. If the monitoring results can meet the standard emission level, environmental permit is issued which is effective for five years (it must be renewed in every five years).

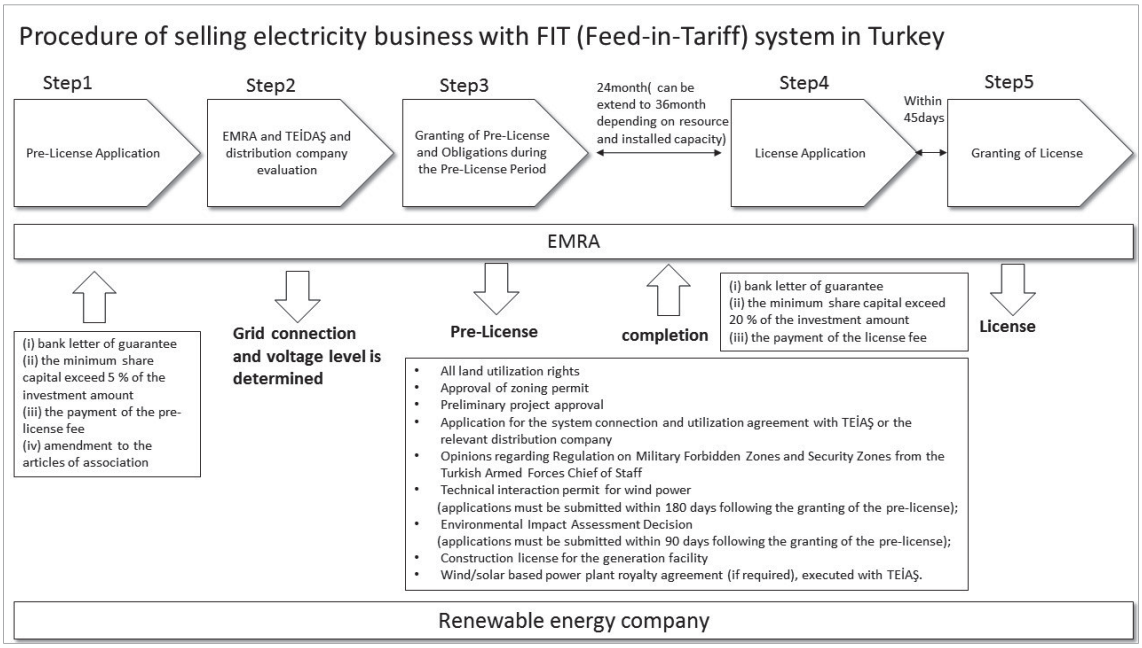


Source: Interview with MoEU

Figure 3-2: Flow for construction and operation of WtE facilities

3.2.6 Electricity

The project owner who is to sell electricity is required to obtain a license for power generation. Procedure to obtain the license will be in accordance with Electricity Market Law No.6446 and "EMRA's decision regarding the list of documents and information required for pre-license and license application (No. 4709-7)". The process flow is as shown in Figure 3-3.



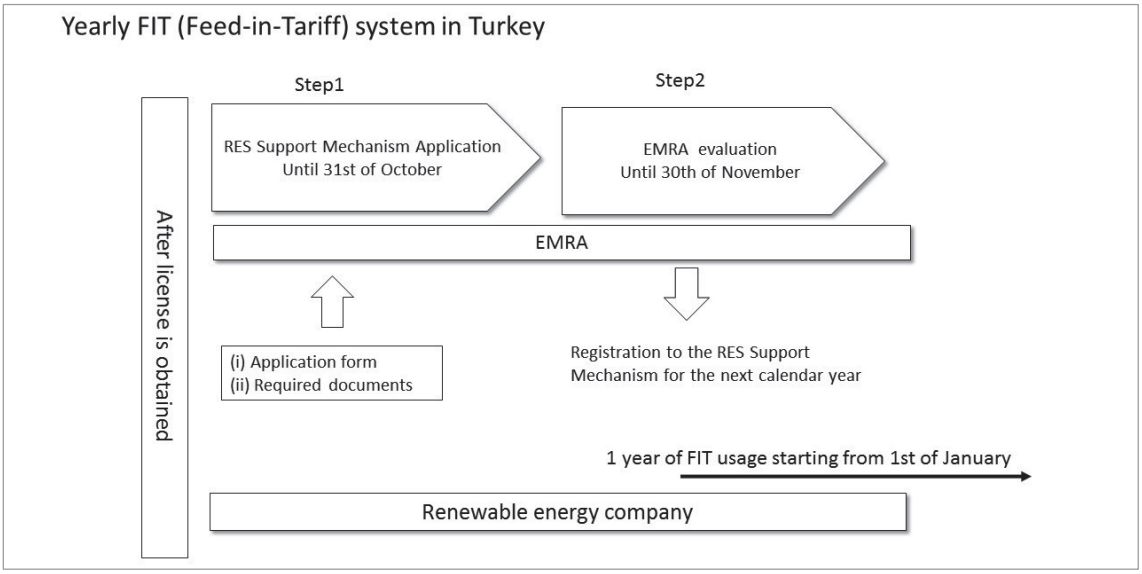
Created based on interview with GEDİK & ERAKSOY, Energy Market Law No.6446, and EMRA/MoENR

Figure 3-3: Licensing procedure

The licensing procedure is divided into two stages, namely the pre-license stage and license stage. Stage for the pre-license is the stage of checking the eligibility of the applicant. Once a pre-license is obtained, the project owner is required to conduct necessary administrative procedures such as acquisition of the right to develop the site for power generation within 24 months (this can be extended to 36 months depending on type of power plant and project scale). After the completion of administrative procedures, the project owner can apply for the license, and the license is issued within 45 days. With the license, the operator can proceed to contracting for grid connection, applying for renewable energy certification (if power would be sold under the FIT program), and construction of the power plant.

It should be noted that the discussions for grid connection is to be held during the application process for the power generation license. The project owner is required to submit information about grid connection to EMRA at the time of the application for pre-license. Since this is an informal submission, the project owner provides to the extent possible basic information such as information on connection point, power output, map of the area around the plant, and skeleton diagram of the power receiving point. Turkish Electricity Transmission Co. (Türkiye Elektrik Iletim A.Ş., hereinafter "TEIAŞ") and power distribution company conduct technical assessment based on the pre-license application and information on grid connection to determine connection point and electrical voltage. Within 24 months (or up to 36 months) after preliminary licensing, contract on grid connection is signed between the project owner and TEIAŞ.

On the other hand, procedure for the FIT certificate should be conducted in accordance with the Law on Utilization of Renewable Energy Sources for The Purpose of Generating Electrical Energy No.5346 (hereinafter "Renewable Energy Law") and the Regulation on Certification and Promotion of Renewable Energy Sources. Application for FIT is conducted after obtaining the power generation license. The specific steps of the procedure are shown in Figure 3-4. The unit price under the FIT program is updated every year on October 31st. After the approval, the FIT unit price is applied from January 1st to December 31st of the following year.



Created from: Law on Utilization of Renewable Energy Sources For The Purpose Of Generating Electrical Energy No.5346 and interview to MoENR/EMRA

Figure 3-4: FIT approval procedure

3.3 Current Status of Solid Waste Management

3.3.1 Amount of collected wastes

The table below shows total amount of collected municipal waste in Turkey, amount of collected municipal waste per capita, and rate of population served by municipal waste collection services in Turkey.

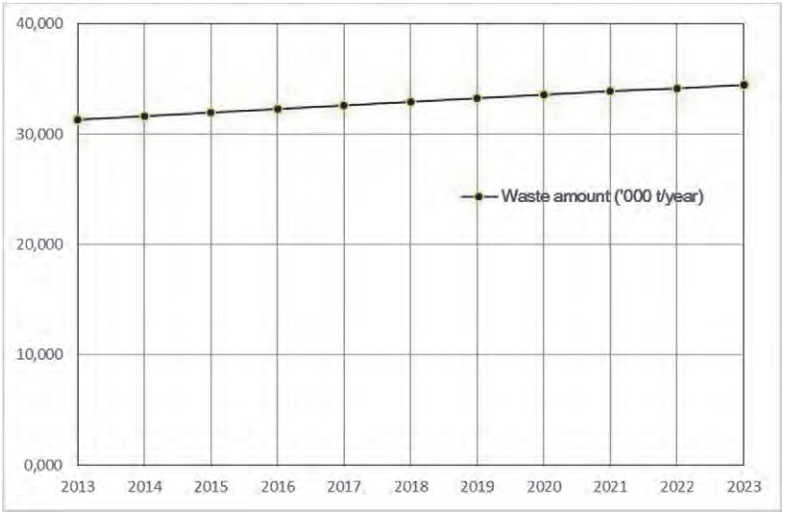
Table 3-18: Amount of Collected Municipal Waste

Item \ Year	2002	2004	2006	2008	2010	2012
Total Population (persons)	67,803,927	67,803,927	70,586,256	70,586,256	73,722,988	75,627,384
Amount of municipal waste collected (thousand ton/year)	25,373	25,014	25,280	24,361	25,277	25,845
Amount of municipal waste per capita (kg/capita-day)	1.34	1.31	1.21	1.15	1.14	1.12
Rate of population served by municipal waste services in total population (%)	76	77	81	82	83	83
Rate of population served by waste disposal and recovery facilities in total population (%)	30	26	34	39	47	54

Source: Turkish Statistical Institute website (http://www.turkstat.gov.tr/Start.do)

The amount of collected municipal waste in 2002 and 2004 was 1.3kg per capita/day and this amount has been decreasing since 2006. This is partly because of implementation of By-law on Packaging and Packaging Waste Control in January 2005 based on the EU Legislation Directive on Packaging and Packaging Wastes 94/62/EC. The law has encouraged more recycling of package waste and been successful in decreasing the amount of waste collected per capita per day.

The future projection of waste amount is shown in Figure 3-5. In Turkey, population is projected to increase by 1% annually. As economy is also expected to grow, amount of municipal solid waste is also expected to grow. As stated in the following sections, increase in waste amount is expected in all of the target municipalities. This implies that there may be limitations to deal with the wastes in the future by the current methods applied in Turkey.



Note: Population projection is based on data from Turkish Statistic Bureau. The most recent waste amount per person per day was applied.

Figure 3-5: Projection of future wastes amount

3.3.2 Treatment and disposal

Between the years 2002 and 2004, more than 60% of solid waste was disposed to open dumping sites, and less than 30% was disposed to sanitary landfill sites in Turkey. However, the rate of disposal in sanitary landfill increased to 60% by 2012 due to the implementation of By-law on Landfill of Waste in 2006 based on the EU Legislation Directive on the Landfill of Waste (99/31/EC). The table below shows the transition in solid waste treatment and disposal methods. In 2012, the major waste treatment and disposal method applied in Turkey was direct landfill while the rate of composting was low.

Table 3-19: Historical change in solid waste treatment and disposal methods

unit : thousand t/year

Waste disposal methods	Year											
	2002		2004		2006		2008		2010		2012	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Amount of municipal waste collected	25,373	100.0	25,014	100.0	25,280	100.0	24,361	100.0	25,277	100.0	25,845	100.0
Municipality's dumping site	16,310	64.3	16,416	65.6	14,941	59.1	12,678	52.0	11,001	43.5	9,771	37.8
Waste delivered to sanitary landfill site	**7,047**	**27.8**	**7,002**	**28.0**	**9,428**	**37.3**	**10,947**	**44.9**	**13,747**	**54.4**	**15,484**	**59.9**
Waste delivered to composting plant	383	1.5	351	1.4	255	1.0	276	1.1	194	0.8	155	0.6
Burning in an open area	221	0.9	102	0.4	247	1.0	239	1.0	134	0.5	105	0.4
Lake and river disposal	197	0.8	155	0.6	70	0.3	48	0.2	44	0.2	33	0.1
Burial	500	2.0	426	1.7	144	0.6	100	0.4	34	0.1	94	0.4
Other	716	2.8	563	2.3	195	0.8	73	0.3	122	0.5	202	0.8

Source: http://www.turkstat.gov.tr/Start.do

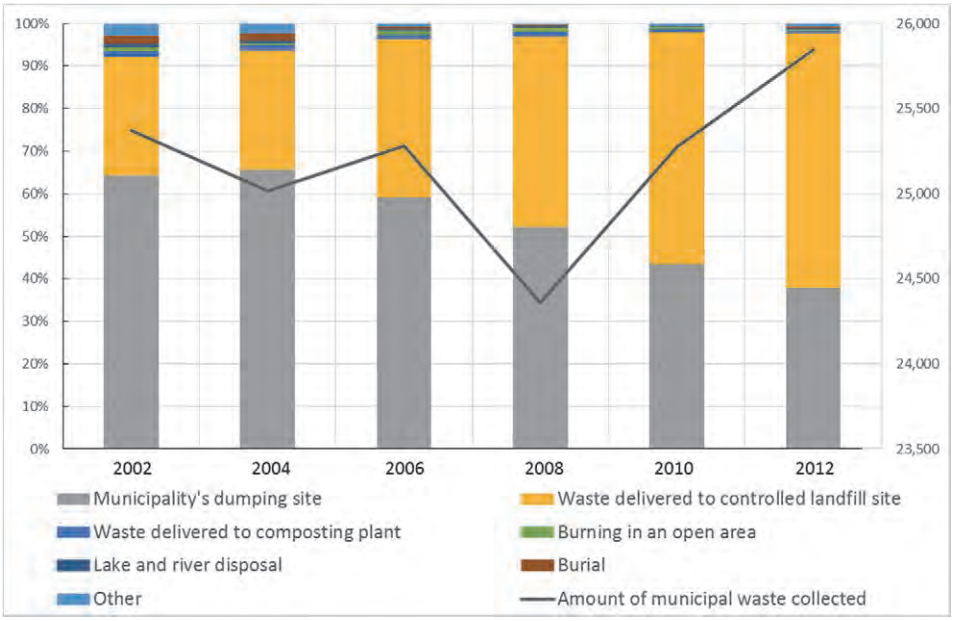


Figure 3-6: Historical change in solid waste treatment and disposal methods (Graph)

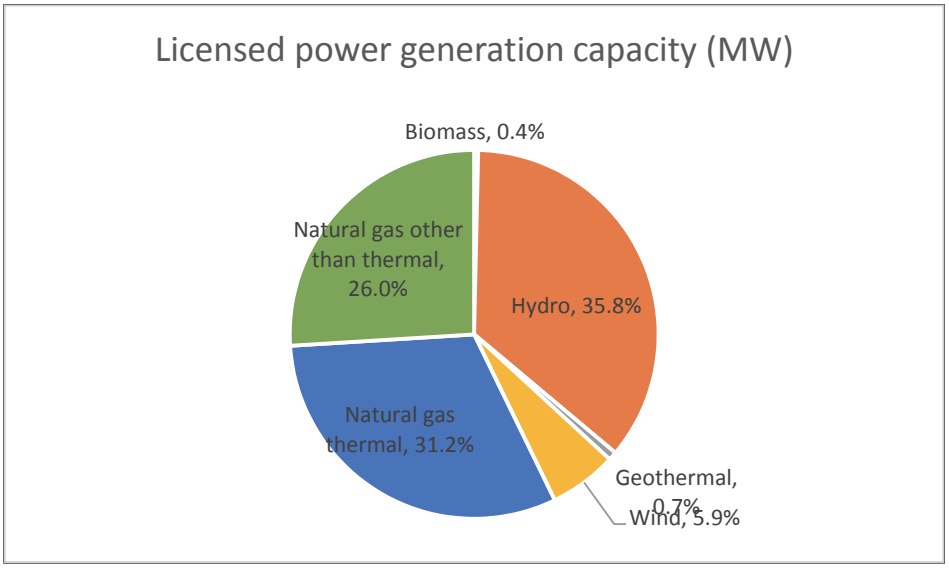
3.3.3 Treatment of industrial wastes

According to "Bylaw on the General Principles of Waste Management (2008)", waste is categorized into 20 different types. One of them is defined as municipal waste, and the remaining 19 types are defined as industrial waste. If a certain amount of certain chemical substances is contained in the industrial wastes, they are defined as hazardous wastes. Management of non-hazardous waste is conducted by the municipalities. Hazardous waste should be landfilled in Class I disposal site or incinerated at the three hazardous waste incineration facilities in Turkey. One out of the three facilities is owned by a private company to treat hazardous waste generated in their property while the other two facilities that accept and treat hazardous waste generated countrywide are located in Izmir MM and Kocaeli MM. The facility in Kocaeli MM has treatment capacity of 90 t/day and is operated by İzaydaş, an operational company fully financed by Kocaeli MM.

3.3.4 WtE

a. Current Status of FIT System in Turkey

As of April 2015, the electric generation capacity of licensed power generation facilities in Turkey is 57,308 MW. 56.2% of the power is generated by combustion of fossil fuel and 43.8% by renewable energy sources (including power generated by WtE).



Source: EMRA

Figure 3-7: Electric generation capacity according to facility types (licensed)

Article 3 (1) 8 of Renewable Energy Law defines renewable energy as non-fossil energy resources such as hydraulic, wind, solar, geothermal, and biomass energy. Biomass is defined in (1) 9.

> Renewable Energy Law No. 5346
>
> Article 3- (1) 8. Renewable Energy Resources (RES): (Amended: 29/12/2010-6094/Art. 1) Non-fossil energy resources such as hydraulic, wind, solar, geothermal, biomass, biogas (including landfill gas), wave, current and tidal energy

As municipal solid waste is currently not considered as biomass, the FIT program currently does not apply for energy made from municipal solid wastes.

Renewable energy can be sold at the price shown below based on the FIT system. The price is relatively lower compared to the price under the FIT system in Japan.

Table 3-20: Comparison of FIT program in Turkey and Japan

Renewable resource	Turkey	Japan	
Solar	13.3cUSD/kWh 10years	<10kW	26cUSD/kWh 20years
		10kW≦	30cUSD/kWh 10years
		10kW≦ + fuel cell	24cUSD/kWh 10years
Wind	7.3cUSD/kWh 10yeas	20kW≦	18cUSD/kWh 20years
		<20kW	45cUSD/kWh 20years
		Off shore type	29cUSD/kWh 20years
Geothermal	10.5cUSD/kWh 10years	1,500kW≦	21cUSD/kWh 15years
		<1,500kW	33cUSD/kWh 15years
Hydro	7.3cUSD/kWh 10years	1,000kW≦ <30,000	20cUSD/kWh 20years
		200≦ <1,000	24cUSD/kWh 20years
		200kW<	28cUSD/kWh 20years
		1,000kW≦ <30,000, use of existing headrace	11cUSD/kWh 20years
		200≦ <1,000, use of existing headrace	17cUSD/kWh 20years
		200kW<, use of existing headrace	20cUSD/kWh 20years
Biomass	13.3cUSD/kWh 10years Including landfill gas captured type	Methane gas from sewage sludge, livestock dung, food residue	32cUSD/kWh 20years
		Wood chip from forest thinning or final cutting	26cUSD/kWh 20years
		Wood chip other than forest thinning (timber, scraps, palm kernel shell) or agricultural residue(rice husk, rice straw)	11cUSD/kWh 20years
		Construction waste wood	11cUSD/kWh 20years
		Municipal solid waste (paper, food waste, cooking oil, sludge, etc.) or other biomass	**14cUSD/kWh 20years**

Created from Agency for Natural Resources and Energy, Japan and Turkish Renewable Energy Law No. 5346 (1cUSD=1.23JPY)

Further, additional prices shown in the Table3-21 can be added to the above prices in Table 3-20 in case the mechanical parts of the power plant are manufactured in Turkey,

Table 3-21: Additional unit prices according to parts

Type of Facility	Domestic Production	Domestic Contribution (US Dollar cent/kWh)
A-Hydroelectric production facility	1- Turbine	1,3
	2- Generator and power electronics	1,0
B- Wind power based production facility	1- Wing	0,8
	2- Generator and power electronics	1,0
	3- Turbine tower	0,6
	4- All of the mechanical equipment in rotor and nacelle groups (excluding payments made for the wing group and the generator and power electronics.)	1,3
C- Photovoltaic solar power based production facility	1- PV panel integration and solar structural mechanics production	0,8
	2- PV modules	1,3
	3- Cells forming the PV module	3,5
	4- Invertor	0,6
	5- Material focusing the solar rays onto the PV module	0,5
D- Intensified solar power based production facility	1- Radiation collection tube	2,4
	2- Reflective surface plate	0,6
	3- Sun chasing system	0,6
	4- Mechanical accessories of the heat energy storage system	1,3
	5- Mechanical accessories of steam production system that collects the sun rays on the tower	2,4
	6- Sterling engine	1,3
	7- Panel integration and solar panel structural mechanics	0,6
E- Biomass power based production facility	1- Fluid bed steam tank	0,8
	2- Liquid or gas fuel steam tank	0,4
	3- Gasification and gas cleaning group	0,6
	4- Steam or gas turbine	2,0
	5- Internal combustion engine or Sterling engine	0,9
	6- Generator and power electronics	0,5
	7- Cogeneration system	0,4
F- Geothermal power based production facility	1- Steam or gas turbine	1,3
	2- Generator and power electronics	0,7
	3- Steam injector or vacuum compressor	0,7

Source: Law on Utilization of Renewable Energy Sources For The Purpose Of Generating Electrical Energy No.5346

Article 3 of Renewable Energy Law as shown below defines criteria for the mechanical parts of Turkish production.

> The regulations for local production of the equipment used in facilities generation electric energy from renewable energy resources
>
> Definitions
> Article 3 - (1) (Amended: 2nd Article of the Regulations published in the Official Gazette with 26/07/2012 date and 28365 number)
>
> Local Components: "At least 55% of the mechanisms manufactured through domestic added value based on the domestic mechanism rate of the supplementary parts described in the Attachment-1 The List of Mechanisms and Supplementary Parts Manufactured Domestically" which is an attachment of these Regulations

As municipal wastes include plastics and other substances that are not biomass, they do not meet the definition of biomass as defined below. Therefore, energy derived from incineration of municipal solid wastes is not considered as renewable energy and thus currently not covered by FIT program.

> Renewable Energy Law No. 5346
>
> Article 3- (1) 9. Biomass (Amended: 29/12/2010-6094/Art.1): Resources obtained from agricultural and forestry products including vegetable oil wastes, agricultural harvesting wastes as well as from organic wastes, and from the byproducts formed after their processing.

b. Current status of biomass power generation facilities in Turkey

Major types of WtE facilities are those that generate power through incineration, gasification, landfill gas, and anaerobic digestion. Istanbul, the city with the largest population in Turkey, has publicly announced to launch an engineering, procurement and construction (EPC) project to construct WtE facilities which had been planned for years. However, no agreement was reached between the city and the bidder due to its budget constraint.

Major biomass power generation facilities that utilize waste-originated biomass that are covered by the FIT program are facilities that utilize landfill gas and anaerobic digestion technologies. Table 3-2222 shows the biomass power generation facilities licensed and currently in operation in Turkey. Landfill gas utilization and anaerobic digestion are the most typical power generation method, as there are 19 cases of landfill gas utilization, 23 cases of anaerobic digestion, 6 cases of sewage sludge digestion, and 4 others.

Table 3-22: Licensed biomass power generation facilities in Turkey

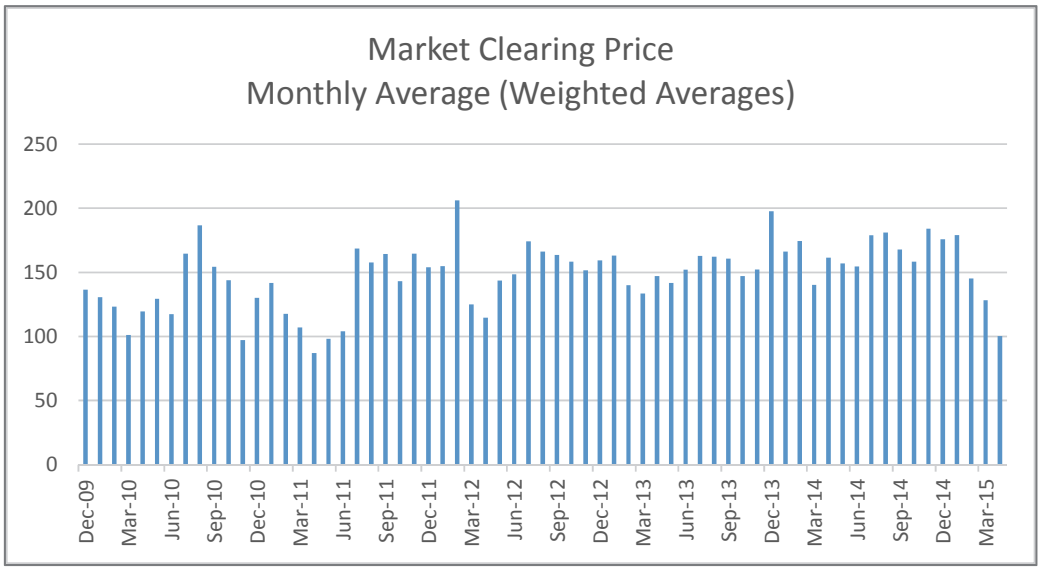
No.	Facility Name	Prefecture	Power generation capacity in operation (MW)	Power generation method
1	Biosun Bilecik Kojenerasyon Enerji Santrali	BİLECİK	0	landfill gas
2	Ovacık Biyogaz Enerji Santrali	KIRKLARELİ	0	anaerobic digestion
3	Amasya Çöp Gaz Elektrik Üretim Tesisi	AMASYA	1.2	anaerobic digestion
4	Karacabey 2 Biyogaz Tesisi	BURSA	2.134	sewage sludge digestion gas
5	Modern Biyokütle Enerji Santrali (MOBES)	TEKİRDAĞ	6	landfill gas
6	ITC Aksaray Üretim Tesisi	AKSARAY	1.415	landfill gas
7	Doğu Atıksu	ADANA	0.8	landfill gas
8	Cargill Bioenerji Tesisi	BURSA	0.12	sewage sludge digestion gas
9	Tatlar Köyü-Sincan-Ankara	ANKARA	3.2	landfill gas
10	Batı Atıksu	ADANA	0.803	landfill gas
11	ES ES Biyogaz	ESKİŞEHİR	2.042	landfill gas
12	Hasdal Çöp Gazından Enerji Üretim Tesisi	İSTANBUL	4.024	landfill gas
13	Polatlı BES	ANKARA	0.834	landfill gas
14	Aksaray OSB Biyogaz Tesisi	AKSARAY	2.134	landfill gas
15	ITC-KA Biyokütle Gazlaştırma Tesisi	ANKARA	5.425	anaerobic digestion
16	Albe-I Biyogaz Santrali	ANKARA	1.813	landfill gas
17	Gönen Biyogaz Tesisi	BALIKESİR	3.621	landfill gas
18	Kadirli BES	OSMANİYE	0	landfill gas
19	Arel Enerji Manavgat Biyokütle Tesisi	ANTALYA	2.4	anaerobic digestion
20	Hayat Biyokütle Üretim Santrali	KOCAELİ	0.995	anaerobic digestion
21	Zgc Bes Enerji Anonim Şirketi	BOLU	0	sewage sludge

No.	Facility Name	Prefecture	Power generation capacity in operation (MW)	Power generation method
	Bolu Üretim Santrali			digestion gas
22	EDİNCİK BES	BALIKESİR	2.134	landfill gas
23	Afyon Biyogaz Santrali	AFYONKARAHİSAR	0	landfill gas
24	Kırıkkale Çöp Gazı Tesisi	KIRIKKALE	1.003	landfill gas
25	Karma 1 BES	SAKARYA	1.487	sewage sludge digestion gas
26	Senkron Efeler Biyogaz Santrali	AYDIN	2.4	landfill gas
27	Karaman Biyogaz Tesisi	KARAMAN	0	landfill gas
28	Kula Piroliz Yöntemiyle Atıklardan En. Ürt. Tes.	MANİSA	0	landfill gas
29	Sezer Bio Enerji Biyogaz Tesisi Biyokütle Projesi	ANTALYA	0.5	landfill gas
30	Ekim Grup Biyogaz Tesisi	KONYA	1.2	landfill gas
31	Arel Enerji Biyokütle Tesisi	AFYONKARAHİSAR	2.4	landfill gas
32	İzaydaş Biyogaz Enerji Üretim Tesisi Biyokütle Pro	KOCAELİ	0.33	anaerobic digestion
33	ITC Bursa Hamitler Tesisi	BURSA	9.8	landfill gas
34	Beypazarı Biyogaz Tesisi	ANKARA	0.793	landfill gas
35	Sigma Suluova Biyogaz Tesisi	AMASYA	1	landfill gas
36	Kocaeli Çöp Biyogaz Santrali Biyokütle Projesi	KOCAELİ	5.093	anaerobic digestion
37	Her Enerji Kayseri Katı Atık Depo Sahası Biyogaz otoprodüktör Santrali	KAYSERİ	5.782	anaerobic digestion
38	Samsun Avdan Biyogaz Tesisi	SAMSUN	6	sewage sludge digestion gas
39	Pamukova Biyogaz Santralı	SAKARYA	1.4	landfill gas
40	Karaduvar Atıksu Arıtma Tesisi Biyogaz Santralı	MERSİN	0	landfill gas
41	Aslım Enerji Üretim Tesisi	KONYA	5.66	landfill gas
42	Kumkısık Lfg Santrali	DENİZLİ	0.635	sewage sludge digestion gas
43	Bolu Çöp Biyogaz Projesi	BOLU	1.131	landfill gas
44	Konya Atıksu Arıtma Tesisi Elektrik Santrali	KONYA	2.436	landfill gas
45	ITC Adana Enerji Üretim Tesisi	ADANA	15.565	landfill gas
46	Gaziantep Büyükşehir Belediyesi Katı atık Depolama Alanı	GAZİANTEP	5.655	landfill gas
47	Sincan Çadırtepe Biyokütle Enerji Sanrali	ANKARA	22.656	landfill gas
48	Karatepe Katı Atık Bertaraf Tesisi	TEKİRDAĞ	0	landfill gas
49	Odayeri Çöp Gazı Santralı	İSTANBUL	28.147	anaerobic digestion
50	Kömürcüoda Çöp Gazı Santralı	İSTANBUL	14.15	landfill gas
51	GASKİ Enerji Yatırım Hizmetleri İnşaat San. ve Tic.A.Ş. Üretim Santralı	GAZİANTEP	1.56	landfill gas
52	Mamak Katı Atık Alanı Enerji Üretim Tesisi	ANKARA	25.434	landfill gas
53	Kemerburgaz Çöp	İSTANBUL	0.588	anaerobic digestion
total			**203.899**	

Source: EMRA (April 22, 2015)

c. Electricity Market

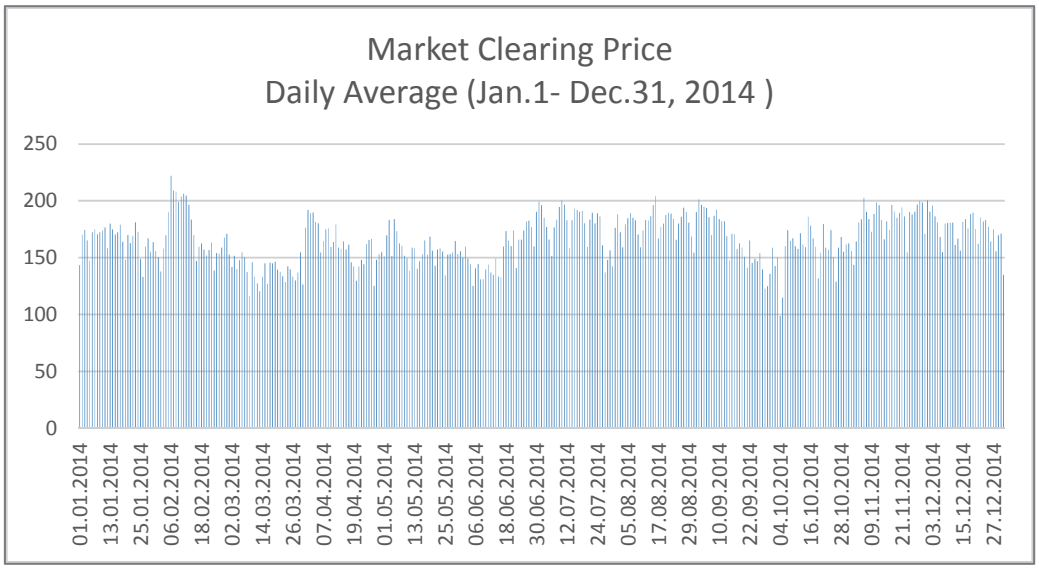
Currently, the FIT program cannot be applied to power generation by waste incineration. Other methods to sell electricity are to sell the power in electric power market or by negotiation transaction. Electricity unit price in the electric power market fluctuate from time to time. The figure below shows monthly weighted average Market Clearance Price (MCP) that underwent wide fluctuation.



Source: PMUM[8]

Figure 3-8: Weighted Average MCP from December 2009 to March 2015

The daily weighted average MCP changed from 4.9 to 11.1 JPY/kWh (from 98.669 to 222.007 TL/MWh, when 1 TL=50 JPY) from January 1 to December 31 in 2014.

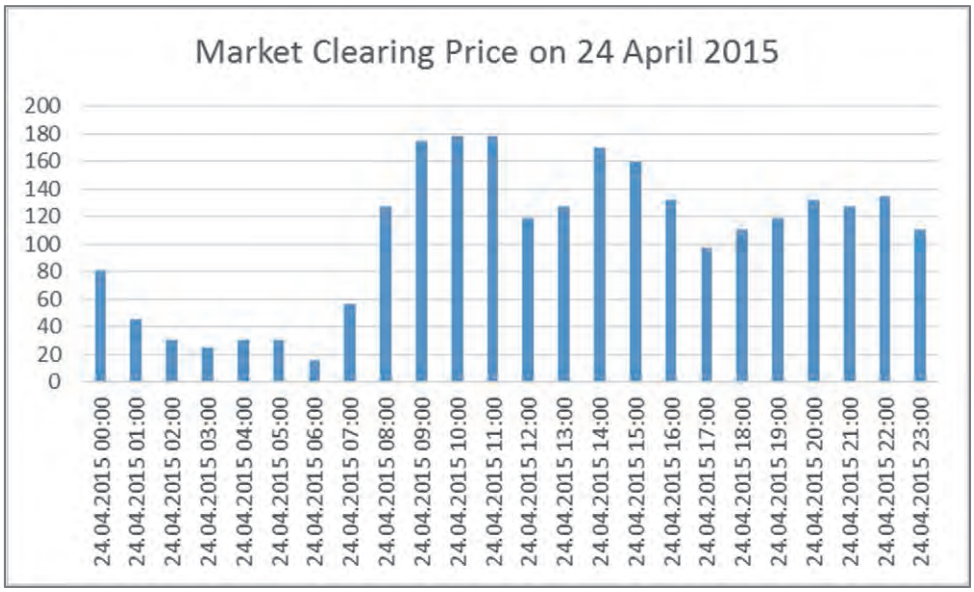


Source: PMUM

Figure 3-9: Daily Weighted Average MCP in 2014

Further, within a day, MCP is relatively high before and around noon and evening, while lower from midnight to early morning.

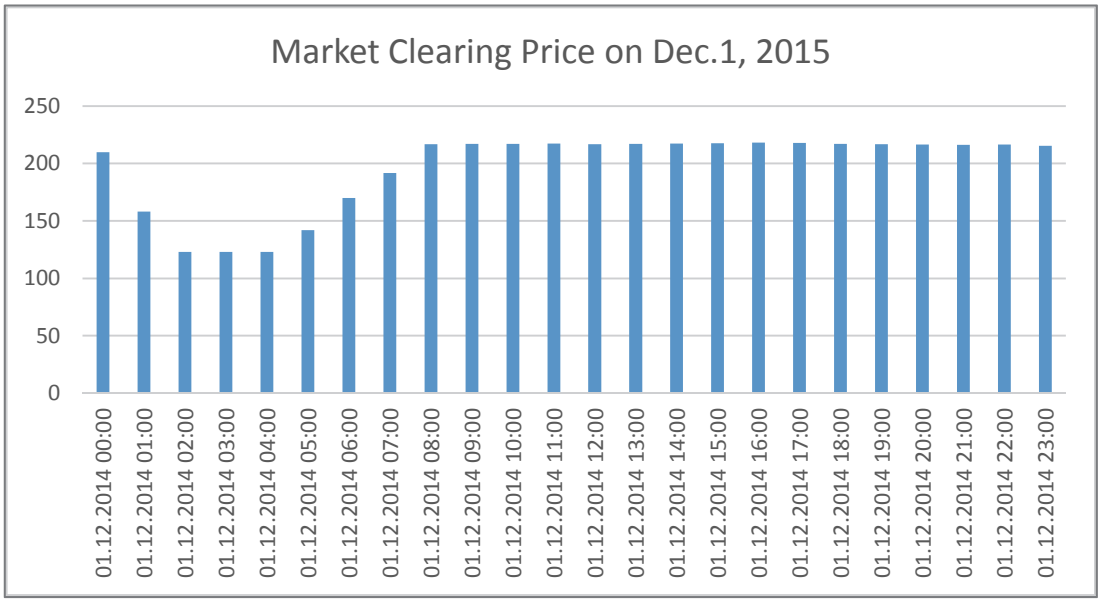
[8] PMUM: Piyasa Mali Uzlaştırma Merkezi (Market Financial Settlement Center) is the energy exchange in Turkey



Source: PMUM

Figure 3-10: Hourly MCP in April 2015

MCP also fluctuates seasonally, and it is higher in winter and lower between the seasons. This is because natural gas is traded at a relatively high price for heating in winter, and electricity demand is high in summer.



Source: PMUM

Figure 3-11: Hourly MCP in winter (December 1, 2014)

On the other hand, negotiation transaction is a method to sell electricity by contracting with individual customers. The sales unit price is determined based on the negotiation. Therefore, the risk of the price fluctuation in the market can be avoided although the price would not be as high as under FIT program.

The table below summarizes key points of different electricity sales methods.

Table 3-23: Comparison of different methods of selling electricity

	FIT	Negotiation transaction	Electricity Power Market
Unit price	・ Fixed ・ Unit price is high	・ Fixed ・ The price cannot be as high as FIT ・ Reduce risk of frequent price change	・ Price changes hourly ・ Price varies largely
Amount of electricity selling	・ All the generated power can be sold	・ The amount agreed in the contract ・ There might be deficiency and excess	・ The amount agreed ・ There might be deficiency and excess
Appraisal	Very good	Relatively good	Not good

Although the power sales unit price would be the highest under the FIT program, FIT cannot be applied to waste incineration power plants. MoENR, which is responsible for FIT program, has stated that it will consider applying FIT to waste incineration power plants if there are requests by the private sector. However, this will require legal reforms, and as preconditions for such legal reforms, MoEU will be required to review their policies on waste incineration power plants so that it would be more prioritized.

3.4 Solid waste management issues at the national Level in Turkey

The challenges in solid waste management at the national level in Turkey to be overcome are stated in EU Integrated Environmental Approximation Strategy as the goals to achieve.

Goal 1: Solid waste production is going to be decreased.

Goal 2: By using the appropriate methods, necessary measures are going to be taken to ensure the recycling and the landfill disposal of solid waste.

Goal 3: Measures concerning packaging and packaging waste management are going to be taken, considering the conditions of competition within the community and the requirements of internal market.

Goal 4: Hazardous wastes are going to be managed.

Goal 5: Medical and exceptional wastes are going to be managed

Solid waste generation amount in Turkey has not increased in spite of rapid economic growth, and therefore it can be said that waste generation itself is not a serious issue at the national level. However, in cities and towns which face rapid urbanization such as target municipalities in this survey, appropriate countermeasures should be taken to prevent solid waste generation increase that is expected to occur in the near future.

Hazardous, medical, and other special wastes are transferred across the country. Although environmentally sound management of such wastes has been conducted so far, measures that are more effective are expected to be taken in the future.

This Strategy was developed in 2006 and has been gradually enforced and implemented and as a result increased the number of sanitary landfills and recycling rate of package wastes. However, there is still large space for improvement for both indicators. As Tenth National Development Plan mentioned, improvement of recycling rate and sanitary landfill disposal rate are still a pressing issues in Turkey.

3.4.1 Challenges with regard to sanitary landfill

a. Challenge 1: Reduction of biodegradable wastes in landfills

The EU Landfill Directive (99/31/EC) stipulates that the rate of biodegradable municipal waste going to landfills should be gradually decreased from the rate in 1995. In response to this directive, EU Integrated Environmental Strategy of Turkey sets Objective 1 of Goal 2 as "Necessary measures are going to be taken for decreasing the biodegradable solid waste quantity going to landfills".

Table 3-24: Reduction rate of biodegradable municipal waste going to landfills stipulated in EU Landfill Directive (99/31/EC)

Schedule	Reduction rate of biodegradable municipal waste going to landfills
Within 5 years after enforcement of directive	25%
Within 8 years after enforcement of directive	50%
Within 15 years after enforcement of directive	65%

EU Landfill Directive states that possible measures to realize this goal include recycling, composting, biogas production, and material/energy recovery.

In order to achieve these goals, Turkey is currently introducing new facilities such as mechanical biological treatment (MBT) and biogas facilities. However, in order for MBT or biogas facilities to properly function, it is essential that the wastes are sorted beforehand so that biodegradable wastes are separated from other wastes.

Method of sorting includes sorting at the source and sorting at the facility. However, it is essential that sorting is conducted both at source and at the facility to obtain highly pure biodegradable wastes.

As the municipal wastes are not separately collected in Turkey at present, separate collection method should be introduced in order to efficiently extract the biodegradable wastes. Necessary measures for starting separate collection include increasing the number of collection vehicles, increasing the number of collection personnel, and raising awareness of citizens and other waste generators to sort the wastes. The facilities that will accept the collected wastes must also install facilities and personnel for sorting, which implies that establishment of separate collection system may require a long time and much effort.

In order to introduce MBT or biogas facilities in line with goals set in EU Landfill Directive (99/31/EC), the above mentioned issues need to be solved.

b. Challenge 2: Finding land for landfill sites

The most suitable and affordable method of treatment and disposal of municipal solid waste is sanitary landfill, but this requires a large area of land. Turkey is overall a land-rich country and thus sanitary landfill is considered as the appropriate treatment and disposal method in general. However, in urban areas where the population density is significantly high, finding land for sanitary landfill sites seems to be a challenge. It is expected that securing land for landfill sites will become more and more difficult especially in metropolitan municipalities because of the continuous population increase caused by natural and economic reasons. Although simple disposal of wastes does not require a high cost, as cities continue to become more and more populated, introduction of new waste management technologies should be considered.

3.4.2 Solutions to the challenges

a. Solutions to Challenge 1

With regard to Challenge 1 which is to introduce intermediate treatment to reduce biodegradable wastes that go into landfill sites, the rate of biodegradable wastes can drastically reduce (reduction rate of over 90%) if they are incinerated. However, in order to introduce incineration, it is necessary that the wastes to be incinerated will have enough calorific value so that they can be incinerated without auxiliary fuel.

By use of the Japanese technology, wastes to be incinerated would require as low as 1,000 kcal/kg (4,200 kJ/kg) of calorific value in order for them to be incinerated without auxiliary fuel. If the calorific value is lower, other fuel such as kerosene or gas must be added for the wastes to incinerate.

Based on the three-content analysis of the wastes in the target municipalities conducted in this Survey, it is estimated that the lower heating value (LHV) of these wastes is above 1,000 kcal/kg (4,200 kJ/kg). Therefore, it can be said that these wastes can be incinerated without auxiliary fuel. However, as these are estimated values, the accurate values should be measured before planning actual installment of waste incineration facilities.

Table 3-25: Estimated lower heating value (LHV) of target municipalities

	45B	6W	waste calorific value 45B-6W (kcal/kg)	waste calorific value (kJ/kg)
Bursa	1,629.5	326.5	1,303.0	5,451.7
Kocaeli	1,471.2	321.3	1,149.9	4,811.3
Izmir	1,416.7	315.9	1,100.9	4,606.0
Antalya	1,518.3	338.0	1,180.3	4,938.3
Sakarya	1,490.1	258.5	1,231.6	5,153.2
Average	-	-	1,193.1	4,992.1

Further, the construction and operation cost of incineration facilities is significantly higher compared to sanitary landfill sites; its construction and operation cost after deduction of revenue from power sales is generally from 70 USD to 90 USD per ton depending on the capacity of the facility.

In this report, the construction and operation costs of waste incineration and power generation facilities with daily treatment capacity of 500, 1,000, and 1,500 tons were calculated based on numerous assumptions such as the followings (details will be explained in Chapter 8):

- Price of power sales is 0.165 TL/kWh[9]
- Tipping fee is 175 TL/ton (approximately 70 USD/t)

As a result, FIRR was estimated as 10.22% when the treatment capacity is 1,000 t/day.

Further, if the power sales price becomes 0.133 USD/kWh (i.e. equivalent of sales price by biomass energy under FIT), the tipping fee becomes 143 TL/ton (approximately 57.2 USD/ton) and FIRR becomes 10.23%.

b. Solutions to Challenge 2

Incineration is highly effective in reducing wastes that go to landfill sites. Generally, the volume of wastes is to be reduced to approximately one tenth to twentieth (5 to 10%) from its original volume before incineration (100%), depending on the rate of incombustible content in the wastes. Therefore, introduction of incineration would drastically contribute to overcoming Challenge 2.

c. Conclusion

Based on the above analysis, waste incineration is considered as one of the most effective measures for overcoming the challenges with regard to sanitary landfill sites in Turkey. At the same time, incineration will require a significantly high cost. In order to lower this cost, it is essential that FIT program is applied for power generated from waste incineration.

In order to apply the FIT program to energy derived from waste incineration, change in legislation

[9] Average power sales price from January to February 2015

would be required. Therefore, actions by MoEU which is the responsible ministry for waste management such as drafting or implementing the national strategy on waste incineration is considered to be essential.

3.5 Assistance by other donors in the waste management sector

It has been confirmed that other major donors are not providing support with regard to WtE facilities. The content of assistance by different donors in the field of waste management is summarized as follows.

3.5.1 French Development Agency (AFD)

French Development Agency (Agence Française de Développment, hereinafter " AFD") has no technical or financial assistance project currently in solid waste sector in Turkey. In the period of 2012-2013, the members of the Union of Municipalities in Turkey were invited to visit solid waste management facilities in France by a French private company while no further activities have been made in relation to this invitation so far.

AFD's present focus of technical and financial assistance is placed on transport and energy sector. AFD provides financial assistance to Iller Bank under "Local Solid Waste and Sanitation Program" which is a grant aid for formulation of municipal plans and implementation of feasibility studies but not for investment in relevant infrastructure. A French private company has conducted a feasibility study on biogas capture and energy utilization from solid waste in Bursa while no further progress is seen on its follow-up. During this feasibility study, AFD confirmed with the Bursa MM that it has a strong interest in receiving technical and financial assistance to improve its solid waste management.

3.5.2 German Development Bank (KfW)

German Development Bank (hereinafter "KfW") has provided financial assistance for construction of final disposal sites in several municipalities while no assistance have been provided so far in building WtE facilities with incineration technology.

KfW currently pledges 880 million EUR to Turkey including grant and loan for the investment in municipal infrastructure development. KfW's focus sector consists of water supply, urban wastewater treatment, and solid waste management while no concrete project is identified in solid waste management sector.

KfW also provides on-lending to Turkish banks that cover solid waste management investment. However, the loan requests in this sector is limited to biogas collection and energy utilization and landfill gas capture projects and no loan request has been made for development of WtE facilities with incineration.

3.5.3 Development Bank of Turkey (TSB)

Development Bank of Turkey (hereinafter "TSB") is currently providing loans to two landfill gas capture and energy utilization projects with the on-lending facility of the World Bank. There is no funding project in relation to WtE with incineration. TSB also manages the Japan's on-lending facility for renewable energy and energy-saving investment.

Although it is assumed that WtE projects would be eligible for TSB's financial assistance, actually obtaining the financial assistance may be difficult considering the scale of investment such as 100 million EUR. TSB can only provide its loans to the public or private corporate entities, and TSB is not entitled to provide loans directly to municipal governments.

TSB only provides corporate finance and no project finance. Therefore, the borrowers are required to provide collaterals or guarantees by Turkish Banks. Loan conditions include the maximum repayment period of 14 years with grace period of two or three years, and the interest rate ranges from 3.4 to 4.4% per year for the borrowers with the bank guarantees.

3.5.4 World Bank

The World Bank has been providing on-lending through TSB and Iller Bank for the public infrastructure investment by municipalities. As far as the solid waste sector is concerned, the World Bank only finances construction of final disposal landfills and landfill gas capture/utilization projects and does not finance construction of waste incineration power plants. The two final disposal landfill projects with this on-lending are implemented by the private company ITC.

The World Bank together with AFD is currently preparing a new on-lending program called "Sustainable Cities Project (SCP)". During the project period of 2015-2019, it will provide 500 million EUR in total.
The major components of this on-lending program are as follows:

Component A: Sustainable City Planning and Management Systems
A total of 25 million EUR of grant aid is to be utilized for formulation of sustainable city planning including land use plan, strategic environment assessment (SEA), urban transport/transit plan, mid- and long-term public investment plan and also development of planning tools such as GIS by the municipalities.

Component B: Municipal Investment
A total of 50 million EUR of on-lending is to be utilized for public infrastructure investment by the municipalities. The eligible sectors of this facility include water supply, wastewater, solid waste management, urban transport, and renewable energy/energy saving.

Component C: Project Management and Institutional Capacity Building
A total of two million EUR is to be provided to Iller Bank for project monitoring, supervision and appraisal of the on-lending projects. It can also be utilized for hiring experts and capacity building of Iller Bank staffs on handling of this on-lending program.
This on-lending under "Sustainable Cities Project" is only available for the metropolitan municipalities of Turkey. Finally, eight municipalities are planned to be selected in accordance with the criteria below.

- Credit-Worthiness
  Eligible metropolitan municipalities should have no arrears owed to Treasury or the Social Security Administration and should be eligible to borrow up to the amount allowed by Turkish Law.
- Planning
  Eligible metropolitan municipalities should commit to strengthening urban planning in their cities utilizing the grant aid by signing a memorandum of understanding (MOU).

- Readiness
  Eligible metropolitan municipalities should identify investment priorities using the Sustainable Cities Program investment sector prioritization tables and should prepare feasibility studies for those investments and specific sustainability improvement targets.

The integrated solid waste management system including transfer, sorting, recycling, and disposal (e.g. landfill development) are considered as the one of the examples of eligible investment projects under Sustainable Cities Project in solid waste sector. Although the WtE is not clearly included, the inclusion of WtE will be decided based on the negotiation in the future.

3.5.5 European Bank for Reconstruction and Development (EBRD)

95% of assistance by the European Bank for Reconstruction and Development (hereinafter "EBRD") in Turkey is targeted at the private sector, and thus assistance in the waste management sector is limited as private partnership is still limited in the sector. As it is difficult for EBRD to directly support the municipalities, it does not provide financial support to projects such as construction of disposal facilities.

Meanwhile, EBRD provides support to the recycling industry with the objective to realize

recycling-based economy in Turkey. It has implemented pilot activities on recycling glass and awareness-raising, and it will launch a grant program for activities that reduce wastes or improve resource efficiency (Near-Zero Waste programme).

3.5.6 European Union (EU)

European Union (hereinafter "EU") provides financial and technical assistance to Turkey with regard to construction of sanitary disposal sites for municipal wastes under the Instrument for Pre-Accession Assistance (hereinafter "IPA"). The IPA projects that are currently being implemented or being planned in the waste management sector are as shown in Table 3-26.

Although the budget for projects under planning are not yet decided, it is expected that it would be from 9 to 35 million EUR per project. In many of the disposal sites that are constructed with the support of IPA, facilities for composting, material recovery, leachate treatment, and medical waste treatment are included.

Other than the above, EU is implementing bilateral technical assistance called "Twinning" where it supports Turkey in aligning its legislation with the EU legislation, and Germany is providing support to Turkey in aligning its legislation with the EU legislation with regard to waste management.

EU has provided financial support for consulting services and facility construction. These projects are implemented in a tied manner with EU countries. The box below shows EU Service Contract Notice.

> Participation is open to all natural persons who are nationals of and legal persons [participating either individually or in a grouping (consortium) of tenderers] which are effectively established in a Member State of the European Union or in a eligible country or territory as defined under the Regulation (EU) N°236/2014 establishing common rules and procedures for the implementation of the Union's instruments for external action (CIR) for the applicable Instrument under which the contract is financed (see also heading 22 below) . Participation is also open to international organizations.

Source: EU Service Contract Notice (ec.europa.eu/europeaid/prag/annexes.do?...B2a...en)

Table 3-26 shows solid waste management consulting services or facility construction projects provided/implemented under the EU financial support.

Table 3-26: IPA projects under implementation or planning in Turkey in waste management sector

Project Category	Project Name	Project Budget (EUR)	Waste Management Method*	Implementation Deadline**
On-going projects	Diyarbakır Solid Waste Management Project	34,046,238	Conventional landfilling	31 December 2017
	Balıkesir Solid Waste Management	18,210,226	Conventional landfilling	31 December 2017
	Konya Solid Waste Management	21,267,325	Conventional landfilling	31 December 2017
	Çorum Solid Waste Management	23,529,975	Conventional landfilling	31 December 2017
Potential projects	Elbistan SWMP (Kahramanmaraş)	unknown	Conventional landfilling	November 2015
	Hakkari SWMP	unknown	Conventional landfilling	November 2015
	Viranşehir and Ceylanpınar SWMP (Şanlıurfa)	unknown	Conventional landfilling	November 2015
	Akdeniz SWMP (Mersin)	unknown	Conventional landfilling	December 2015

Project Category	Project Name	Project Budget (EUR)	Waste Management Method*	Implementation Deadline**
	ÇOKAB SWMP (Artvin&Erzurum)	unknown	Conventional landfilling	January 2016
	Silvan SWMP (Diyarbakır)	unknown	Conventional landfilling	February 2016
	Ordu SWMP	unknown	Conventional landfilling + bio-drying (energy recovery)	April 2016
	Kastamonu SWMP	unknown	Only rehabilitation of sites and leachate treatment plant (Municipality have the landfill)	November 2015
	Körfez SWMP (Balıkesir)	unknown	Conventional landfilling	January 2016
	TEKKAB-3 SWMP (Çorlu/Tekirdağ)	unknown	Only rehabilitation of sites (Municipality will construct landfill)	January 2016
	Yedigöze SWMP (Adana)	unknown	Conventional landfilling	August 2016
	Tunceli SWMP	unknown	Conventional landfilling	January 2016
	Van SWMP	unknown	Conventional landfilling	February 2016
	Batman SWMP	unknown	Conventional landfilling	unknown

Source: EU Ankara office

4 Current status of target metropolitan municipalities

4.1 Bursa MM

4.1.1 General information

Bursa Metropolitan Municipality (hereinafter "Bursa MM") is located in the North-West region of Turkey, or in the Marmara region to the South-East of Istanbul. Bursa MM is consisted of 17 MDM and has the administrative jurisdiction for the entire Bursa province. The population of Bursa province was approximately 2.79 million in 2014. The northern regions face the Marmara Sea, and Iznik and Orhangazi MDM are surrounded by the Iznik Lake. Karacabey, Mustafa Kemalpaşa, and Nilüfer MDM are surrounded by the Ulubat Lake. Unlike other metropolitan municipalities such as Kocaeli or Sakarya, there is no network of the express trains in Bursa MM and thus the main method of transportation from Bursa to cities such as Ankara or Istanbul is either by bus or car. Currently, as there is no highway connection to Istanbul, one must travel from Bursa to Istanbul through Kocaeli by either crossing the Marmara Sea in ferries or by taking a detour path by car. However, as a highway across the Marmara Bay will be constructed and completed before the end of 2015, the access from Bursa to Kocaeli is expected to drastically improve. The transportation time between Gemze MDM of Kocaeli MM and Yalova Province to the south of Marmara Bay will be reduced from 80 minutes to only 6 minutes, and the transportation time between Istanbul and Bursa will be reduced from two and a half or three hours to only one hour. The population of the MDMs in Bursa MM is shown in Table 4-1.

Table 4-1: Population of 17 MDMs in Bursa MM

Metropolitan District Municipality (MDM)		Population (2014)
1.	Büyükorhan	11,396
2.	Gemlik	103,390
3.	Gürsu	74,827
4.	Harmancık	6,873
5.	İnegöl	242,232
6.	İznik	42,727
7.	Karacabey	80,594
8.	Keles	13,123
9.	Kestel	52,938
10.	Mudanya	80,385
11.	Mustafakemalpaşa	99,651
12.	Nilüfer	375,474
13.	Orhaneli	21,563
14.	Orhangazi	76,143
15.	Osmangazi	813,262
16.	Yenişehir	52,215
17.	Yıldırım	640,746
	Total	2,787,539

Source：Turkish Statistical Institute HP (http://www.turkstat.gov.tr)

4.1.2 Projection of municipal solid waste amount

The "Waste Management Action Plan 2008-2012" estimates that the amount of waste generated per person per day in Bursa MM is 1.06 kg/person/day[1]. Based on this figure, the future municipal solid waste amount in Bursa MM is estimated as follows.

[1] This value is not the same with the current collected amount. However, this value was used for the projection in this Survey, as this is the value takes into account the future changes and is applied in the Waste Management Action Plan 2008-2012 which is a national action plan.

Table 4-2: Projection of municipal solid waste amount in Bursa MM

Year	Population	Daily waste amount (ton/day)	Yearly waste amount (ton/year)
2014	2,764,826	2,931	1,069,711
2015	2,802,142	2,970	1,084,149
2016	2,838,680	3,009	1,098,285
2017	2,874,481	3,047	1,112,137
2018	2,909,499	3,084	1,125,685
2019	2,943,725	3,120	1,138,927
2020	2,977,228	3,156	1,151,890
2021	3,009,998	3,191	1,164,568
2022	3,042,079	3,225	1,176,980
2023	3,073,486	3,258	1,189,132

Source: Population: TurkStat, Population Projections, 2013-2075, Waste generation amount per person per day: Waste Management Action Plan 2008-2012

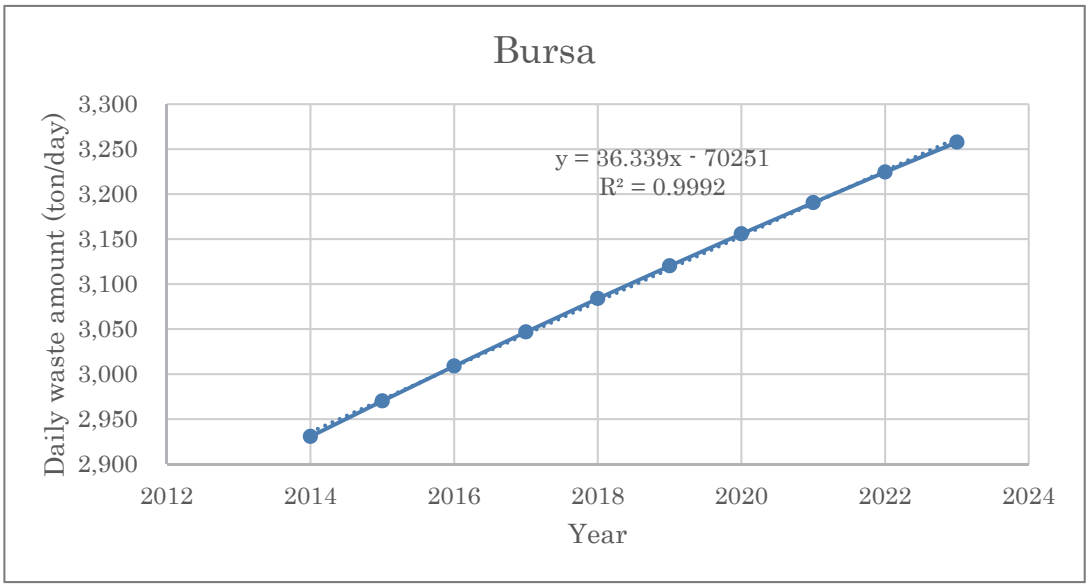


Figure 4-1: Projection of total municipal solid waste amount in Bursa MM

From 2014 to 2023, the population is estimated to increase by 310,000 and the yearly waste amount by 120,000 ton/year or daily waste amount by 330 ton/day.

4.1.3 Current municipal solid waste management

Bursa MM is currently preparing the Integrated Solid Waste Management Plan for the coming 40 years. Its contents will be shared with the public after the approval by the municipal council.

a. Collection

Collection of municipal solid wastes is under the responsibility of the MDMs, and MDMs contract with private companies for the collection service. One district municipality can contract with either one collection company or multiple collection companies. Therefore, some collection companies contract with multiple district municipalities

b. Waste amount collected in each MDM

The population and the amount of collected wastes from each MDM in Bursa MM are shown in Table 4-3. Regarding the MDMs that have become a part of Bursa MM in March 2014, there is not sufficient data at the moment, and it is written as “Not Available” in their cells in the table below.

Table 4-3: Population and waste collection amount of MDMs in Bursa MM

MDM	Population	Amount of collected municipal solid wastes (ton/year)	Amount of separately collected wastes (ton/year)	Executing organization	Unit cost of collection (TRY/ ton)
Osmangazi	813,262	273,326	7,034	Only collected in Arcan-Gintem-Ortem-Reis district	96.1
Yildirim	640,746	193,031	3,689	Only collected in Lider1-Lider2-Gintem district	140.1
Nilüfer	375,474	130,158	10,366	Only collected in Karacan district	41.9
Gürsu	74,827	26,185	517	Collected by MDM	95.8
Kestel	52,938	14,834	1,331	Collected by private company (Kılıçoğulları)	150.9
Mudanya	80,385	40,743	0	Only collected in Y.dünya Anka district	188.8
Gemlik	103,390	38,233	5,108	Private company (Maramara)	135
Karacabey	80,594	10,355	1,239	Private company (Üstündağ)	230.1
Kemalpaşa	99,651	12,635	776	Private company (Mat)	94.3
Orhangazi	76,143	20,245	0	Private company (Marmara)	209.0
İnegöl	242,232	17,361	13,549	Only collected in Ortem district	125.0
Yenişehir	52,215	3,023	0	Private company (Reis-Kervan-Kılıçoğlu)	94.8
İznik	42,727	Not available	0		73.3
Keles	13,123	Not available	0		92.0
Orhaneli	21,563	Not available	0		46.7
Büyükorhan	11,396	Not available	22		35.2
Harmancik	6,873	Not available	0		250.3
Total	2,787,539	780,129	43,631		

c. Transfer of wastes

Bursa MM has no transfer station. The wastes collected from each MDM are transported directly to the disposal sites.

d. Waste flow (from collection, transport, to disposal)

The wastes collected by the MDMs are transported to either the sanitary disposal sites or the open dump sites. Details on the waste flow in Bursa MM are shown in Figure 4-2.

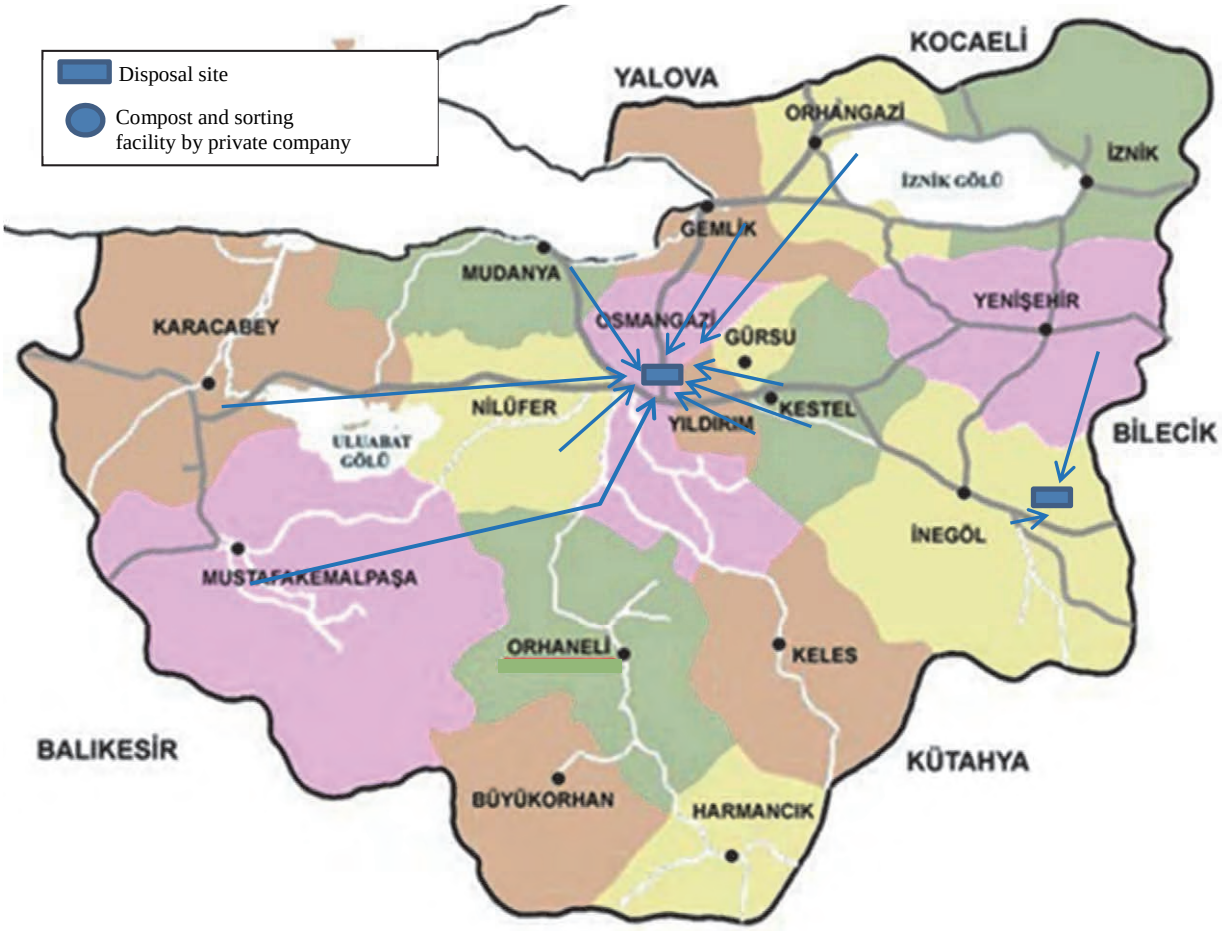


Figure 4-2: Waste flow from MDMs in Bursa MM

e. Disposal

There are currently two sanitary disposal sites in Bursa MM, namely Yenikent (often called Hamitler) and İnegöl disposal sites. District municipalities in the mountainous areas, namely İznik, Keles, Orhaneli, Büyükorhan, and Harmancik MDMs are currently disposing their wastes in open dumping sites operated by district municipalities. Information on the waste where the district municipalities dispose their wastes can be found in the following table.

Table 4-4: Disposal of wastes by each MDM in Bursa MM

Name of district municipality	Disposal amount (ton/day)	Name of disposal site	Type	Operating organization
Osmangazi	273,326	Yenikent (Hamitler) Sanitary disposal site	Sanitary disposal site (Class II)	YİS Construction Company
Yildirim	193,031			
Nilüfer	130,158			
Gürsu	26,185			
Kestel	14,834			
Mudanya	40,743			
Gemlik	38,233			
Karacabey	10,355			
Kemalpaşa	12,635			
Orhangazi	20,245			
İnegöl	17,361	İnegöl Sanitary disposal site		
Yenişehir	3,023			
İznik	N/D	Open dump site		MDM
Keles	N/D	Open dump site		MDM
Orhaneli	N/D	Open dump site		MDM
Büyükorhan	N/D	Open dump site		MDM
Harmancik	N/D	Open dump site		MDM

The outline of the two disposal sites in Bursa MM are outlined below.

Table 4-5: Outline of disposal sites in Bursa MM

Item	Yenikent (Hamitler)	İnegöl
1)Method of operation	Sanitary landfill	Sanitary landfill
2)Disposal amount (ton/day)	300	350
3)Expected remaining life span (years)	11	23*
4)Executing organization of final disposal site	YİS Construction Company	
5)Operation charge paid by BMM to YİS Construction Company (TRY /ton)		
6)Unit cost of operation (TRY/ton)	3.3 TRY /ton	3.3 TRY /ton
7)Total Capacity (m^3)	830,000 m^3	246,000 m^3
8)Class [2]	Class II	Class II

* The site was planned to be used until 2036 under the assumption that it will accept only wastes from İnegöl DM. However, the site is currently accepting wastes also from Yenişehir DM and it is planned that it will also receive wastes from İznik DM. Thus, this remaining life span must be re-calculated.

4.1.4 Waste composition

The metropolitan municipalities in Turkey conduct waste composition survey every year in winter and summer in accordance with "Guidelines on Waste Composition Survey Methods" established by the MoEU (hereinafter "MoEU WCS Guidelines"). The MoEU WCS Guidelines classify wastes into 17 categories which are quite different from the categories applied in Japan which are namely paper, textile, kitchen wastes, green wastes, plastics, other combustibles, metal, glass, rock, ceramics and other incombustibles. These categories were established in order to promote recycling and separate collection which is already being applied in Japanese cities. The analysis in this Chapter regarding

[2] Article 5 of Regulation on Landfill of Wastes defines the classes for sanitary disposal sites. Article 5 is given below:

ARTICLE 5 - (1) Sanitary disposal sites are classified as following:

a) Class I sanitary disposal site: The facility having required infrastructure for storing hazardous wastes.

b) Class II sanitary disposal site: The facility having required infrastructure for storing municipal wastes and non-hazardous wastes.

c) Class III sanitary disposal site: The facility having required infrastructure for storing inert wastes.

waste composition analysis conducted by the metropolitan municipalities in Turkey refers to those conducted in line with the MoEU WCS Guidelines. The survey is conducted twice in summer and winter.

Table 4-6: Waste composition categories in Turkey and Japan

Waste composition categories in Turkey	Waste composition categories in Japan
Domestic wastes	Kitchen wastes
Paper	Paper
Carton	
Bulky Carton	
Plastic	Plastic
Glass	Glass
Metal	Metal
Bulky metal	
Wastes from parks and gardens	Trees, grass
Other combustibles	Textile and other combustibles
Other bulky combustibles	
Other incombustibles	Ceramics and other incombustibles
Other bulky incombustibles	
Electric and electronic equipment wastes	
Hazardous waste	

a. Waste composition survey conducted by Bursa MM

Bursa MM has been conducting the waste composition survey since 1998 in line with the MoEU WCS Guidelines.

b. Target area

At the early stage of the survey, wastes only from the residential areas were analyzed. Since 2009, Bursa MM has been sampling wastes from four generation sources, namely low, middle, and high-income areas and commercial areas.

c. Methodology

The target wastes, survey period, and method of analysis are in accordance with the MoEU WCS Guidelines.

d. Results of pervious surveys

The results from the previous surveys are shown in Table 4-7 and Figure 4-3.

Table 4-7: Results of waste composition survey of Bursa MM

Year	2009								2010								2011								2012								2013								2014							
Season (Month)	Winter (February)				Summer (July)				Winter (February)				Summer (July)				Winter (January)				Summer (July)				Winter (March)				Summer (September)				Winter (March)				Summer (August)				Winter (March)				Summer (August)			
Component	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial	Low	Middle	High	Commercial
Domestic wastes	45.21	49.72	47.09	23.30	56.75	52.10	19.09	10.88	52.30	58.12	52.05	9.06	63.50	62.98	9.22	9.49	62.99	63.80	18.05		47.15	52.10	48.43	35.05	45.57	50.75	26.25		48.68	52.55	45.28		23.41	49.65	34.49	11.97	46.93	52.66	26.45		50.92	41.96	32.63	14.49	66.39	54.69	40.22	
Paper	6.78	4.04		13.12		9.42	10.62	5.18	7.96	8.37	10.29	11.58	1.11	7.38	1.90	31.09	1.71	2.52	20.67	51.33	1.33	3.68	3.21	10.42	1.86	2.54	1.39	33.62	2.47	2.56	2.97	3.95	10.36	2.63	6.96	14.19	5.78	2.57	3.16	52.17	7.81	9.05	1.00	10.38	3.74	2.78	15.95	2.82
Carton	0.62	0.80	1.70	8.21	3.86		1.14	38.78	0.94				0.51		0.20	0.50	2.12	1.80	18.48	18.05	3.92	4.11	7.04	9.62	2.38	3.37	7.14	13.90	12.22	4.10	0.54	5.86	5.66	3.49	4.40	6.98	0.60	4.11	8.45	8.68	6.48	1.66	3.97	6.28	0.65	4.45	0.41	25.06
Bulky Carton	6.15	10.11	16.20				6.10				8.26	13.16	1.48		3.11	11.52	0.50	2.42	7.97						0.00												1.88								4.47		2.57	0.84
Plastic	15.49	17.46	19.20	9.83	17.67	17.64	5.89	15.97	4.64	12.44	14.43	3.63	14.07	12.35	8.96	21.46	11.00	9.96	23.84	16.22	16.86	16.20	23.08	25.14	15.98	19.61	23.22	13.02	11.32	16.24	29.80	11.07	22.91	20.29	24.40	20.32	10.88	16.27	13.42	37.61	21.45	13.19	9.28	30.64	10.02	16.16	25.17	30.64
Glass	1.11	1.59	2.44	2.79	2.36	3.90	3.76	2.82	1.24		3.41	0.26	1.24	2.51	0.45	4.44	1.75	1.50	0.96	5.10	3.12	3.77	5.94	7.06	1.06	0.98	2.63	6.22	2.20	4.06	1.80	1.64	0.45	0.75	5.77	0.83	0.51	3.86	0.91	0.98	0.61	4.92	3.19	3.69	2.60	4.39	6.03	0.77
Metal	1.21	1.91	2.95	3.41	0.14	1.31	0.59	1.59	0.29	0.54	0.55		0.50	1.43	0.32	0.36	0.54	1.07	2.09	1.75	1.28	1.88	0.98	0.85	4.09	3.21	0.59	8.50	0.94	0.34	0.00	0.72		3.32	0.72			0.34	0.43				0.62		0.04	0.37	0.64	
Bulky Metal																																			0.57								0.82						
Electric and Electronic equipment waste												5.61	0.05		0.30	0.15		0.50														1.42																
Hazardous waste																0.18					1.49	0.77		4.11											27.75													25.37
Wastes from parks and gardens			4.96		2.23	4.46	36.55	16.47	7.96		0.65		1.87	2.87	62.72	0.71	0.05	0.05			7.41	3.77	0.27	3.20	3.00	0.06	24.17		3.25	9.65	8.99	64.81		0.14			4.83	9.67	11.08		1.80	9.54	39.48			7.24	0.98	
Other incombustibles	1.00				9.52		8.45					51.07	4.14			7.47											4.09									0.24											
Other combustibles	14.32	7.98	1.51	36.29	7.48	11.17		8.32	21.22	17.83	8.82	5.64	11.51	10.47	12.75	12.61	8.65	7.81	4.53	7.55	16.51	13.73	4.91	4.31	17.47	16.40	2.39	1.03	18.92	10.50	9.14	10.53	27.99	16.61	14.56	10.29	22.68	10.53	36.09	0.56	2.78	12.68			12.08	9.93	6.24	14.50
Other combustible bulky wastes			1.52				2.83																					23.71													1.63		7.13	31.44			1.78	
Other incombustible bulky wastes							4.99																								0.21																	
Others													0.01		0.07		0.05	0.14	0.13		0.94		6.13	0.24	5.08	0.27					1.26			0.28	0.20	5.29	5.66					0.98							
Ash	8.11	6.39	2.42	3.06					3.45	2.70	1.54	0.00					10.63	8.44	3.29						3.50	2.77	8.13						9.22	2.87	7.93	2.37					6.51	5.20	2.71	3.07				
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

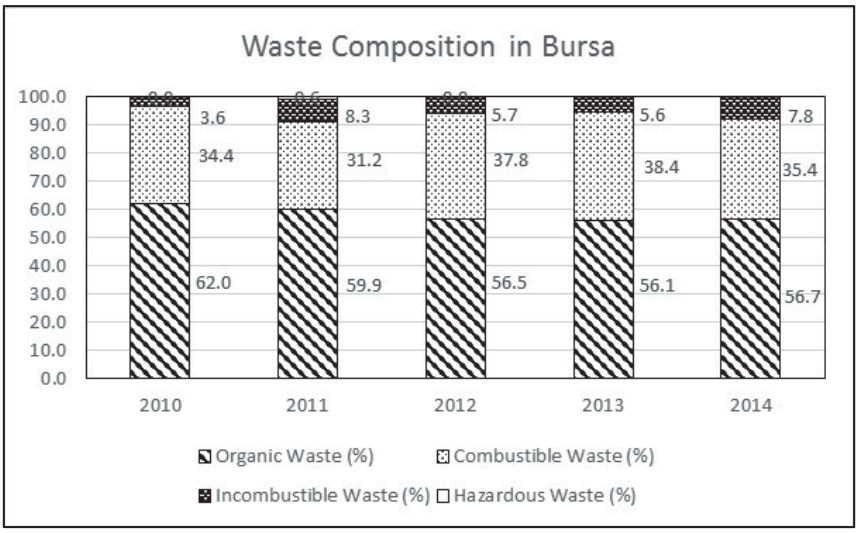


Figure 4-3: Composition of organic, combustible, incombustible, and hazardous wastes

e. Observations regarding waste composition of Bursa MM

Regarding the physical composition, share of plastic wastes have been increasing and that of organic wastes have been decreasing over the years (excluding in low-income class). Further, the difference in waste composition in summer and winter is shown in Figure 4-4. The waste composition survey in Turkey separates wastes into 17 categories, presumably taking into consideration of sorting or waste generation prevention measures in the future. However, as these purposes are not relevant to our Survey, the waste composition in summer and winter was reanalyzed by waste categories used in Japan.

With regard to paper and organic wastes, the difference in share was not so significant between the two seasons. With regard to green wastes, the share is larger in summer. With regard to incombustible wastes, the share in winter is more than double of that in summer due to existence of ash.

When evaluating these wastes as fuel for WtE facilities, as wastes should be completely combusted, the organic wastes should be reduced in summer, and the incombustible wastes should be reduced in winter.

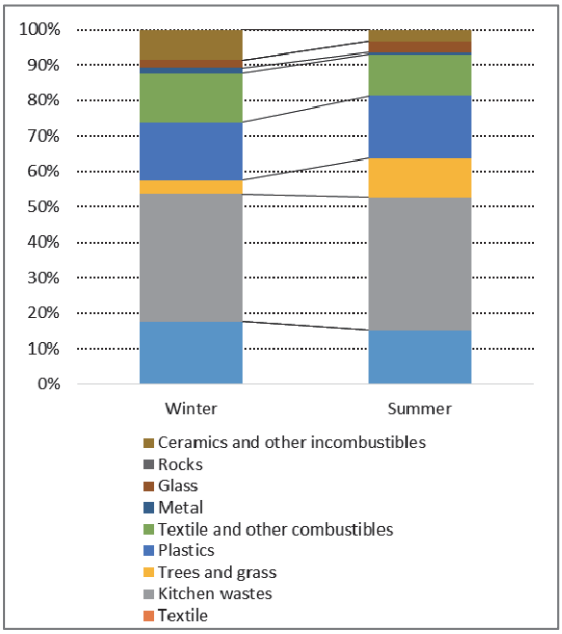


Figure 4-4: Comparison of waste composition of Bursa MM in winter and summer

Further, the characteristics of wastes in Japan and those in Bursa MM were compared. The simple average of waste composition in Bursa MM and the waste composition in Itabashi incineration facility in Tokyo in 2013 were compared. The wastes incinerated in Japan is high in paper wastes and low in organic wastes. Further, as wastes are sorted so that they would be well-suited for incineration, the share of incombustible wastes is very low in Japan.

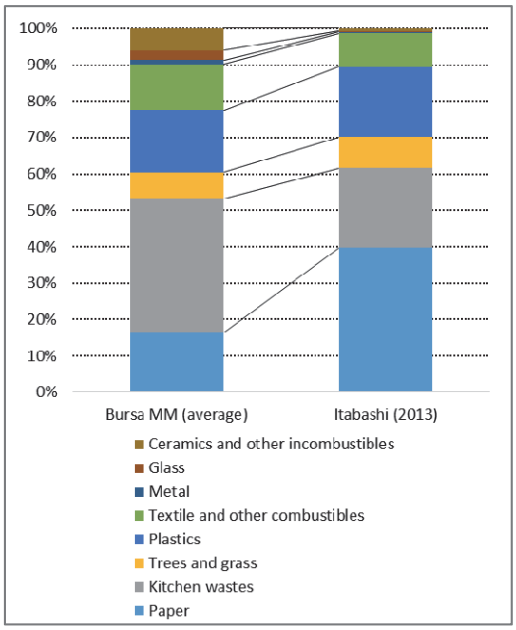


Figure 4-5: Comparison of waste composition of Bursa MM and Japanese cities

4.1.5 Financial status

Information regarding revenue and expenditure with regard to municipal solid waste management in Bursa MM can be found in "Financial Report for Collection of Taxes with regard to Waste Management". This report is based on actual data from January to September 2014. Although there is no data for the whole year, the current situation was analyzed based on this report as the role and the responsibilities of metropolitan and district municipalities have changed in 2014 and the data prior to 2013 are not useful in understanding the current situation.

a. Responsibility and share of costs regarding municipal waste management between MM and MDM

MM is responsible for collection and transport (to the transfer station if there is transfer station, to the disposal site if there is no transfer station), and MDM is responsible for the other activities. The budget is allocated based on this share of responsibilities, and the expenditures for municipal solid waste management is managed separately by MM and MDM. As there is no transfer station in Bursa MM, MDM is responsible for collection and transport, and MM is responsible for treatment and disposal.

The table below shows the costs related to municipal solid waste management and the amount of wastes collected, transported, and treated/disposed from January to September 2014.

Table 4-8: Amount of municipal solid waste in Bursa MM and waste management costs (January to September 2014)

Collection and transport costs (responsibility under MDM)			**Treatment and disposal costs** (responsibility under MM)		
ton	TRY	TRY/ton	ton	TRY	TRY/ton
582,897	64,333,429	110.36	650,634	2,213,369	3.40

Note: Treatment and disposal costs include only the annual operation and maintenance costs and do not include construction costs

Based on the above, the unit cost of collection and transport of municipal solid wastes in Bursa MM is 110 TRY (approximately 4,950 JPY) per ton and the unit cost of treatment and disposal is 3.4 TRY (approximately 150 JPY) per ton.

b. Financial source for municipal solid waste management expenditures

The financial source for the municipal solid waste management costs is the tax collected from households called Environmental Cleansing Tax (hereinafter "ECT") which is collected together with the water tariff and power sales from biogas from disposal sites. The expenditure and revenue in Bursa MM with regard to municipal solid waste management is shown in the table below.

Table 4-9: Expenditure and revenue with regard to municipal solid waste management in Bursa MM (January to September 2014)

Unit: TRY

	Expenditure	Revenue from ECT	Revenue from power sales	Fiscal balance
Collection and transport	72,239,427	13,568,388	0	-58,671,039
Treatment and disposal	4,108,381	3,605,306	7,033,986	6,530,910
Total cost	76,347,808	17,173,694	7,033,986	52,140,128

With regard to costs for collection and transport, the deficit is covered by the general budget of MDMs. Meanwhile, with regard to costs for disposal, as the revenue from power sales is exceeding the expenditure, there is no additional budget allocated from the MM.

The total cost for collection, transport, treatment, and disposal is estimated to be 80 TRY (approximately 3,600 JPY) per ton.

4.1.6 Operational cost of municipal solid waste management

a. Financial source

The main financial source for municipal solid waste management by MDM and MM is the ECT. The revenue from ECT for MDM and MM in Bursa from January to September 2014 was 13,568,388.39 TRY and 3,605,305.89 TRY respectively. Thus, the annual revenue is estimated to be 18,091,000 TRY and 4,807,000 TRY respectively.

b. Collection cost

The total cost of waste collection by the 17 MDMs in Bursa MM was 72,239,427 TRY from January to September 2014. Simply calculated, the annual cost is estimated to be 96,319,000 TRY.

c. Operational cost of transfer stations

There is no operation cost for transfer stations as there is no transport station in Bursa MM.

d. Operational cost of disposal site

The total cost for disposal was 4,108,381 TRY from January to September 2014. Simply calculated, the annual cost is estimated to be 5,478,000 TRY.

4.1.7 Industrial wastes

Bursa MM provides no collection service for industrial wastes. The non-hazardous wastes are transferred by the generating facilities to the Yenikent (Hamitler) disposal site.

a. Amount generated and treated

The total amount of non-hazardous industrial wastes was 44,453 tons in 2014. These were the wastewater treatment sludge and residues disposed in Yenikent disposal site.

b. Cost of treatment and disposal

The generators of non-hazardous wastes must pay 65 TRY/ton, and generators of wastewater sludge must pay 100 TRY/ton as tipping fee.

c. Collection and transport

The generator of industrial waste is responsible for transport of non-hazardous wastes of which the characterization has been identified. They can be disposed in Class II disposal site in accordance with the regulations regarding sanitary disposal sites.

d. Treatment and disposal

In Yenikent disposal site, the industrial wastes are disposed in the same lots as with the municipal solid wastes.

4.1.8 Medical wastes

Inside the Yenikent disposal site, there is a medical waste sterilization facility operated by a private company named ERA.

a. Amount generated and treated

Approximately 10 ton/day of medical wastes is transported to the Yenikent disposal site. These are collected from 1,621 discharge points including those in Bursa MM and also in Yalova and Balıkesir provinces.

b. Cost of treatment and disposal

The medical waste disposal fee is determined every year by the Local Environment Board[3]. These fees are collected by the operating company (ERA Çevre Teknololileri A.Ş.), and 10% of these fees go to the operating company.

c. Collection and transport

Collection of the medical wastes is conducted by two licensed companies. One of them is ERA which also collects medical wastes in Yalova Province, Bursa's neighboring province.

d. Treatment and disposal

The medical wastes are sterilized with high heat (142°C). After sterilization, they are landfilled in the Yenikent disposal site together with the municipal solid wastes.

4.1.9 Needs regarding solid waste management

Bursa MM will require some time to integrate information on waste management from all the MDMs, especially for the five MDMs that have recently become a part of Bursa MM. Information such as waste amount, cost, and revenue should be identified and managed for the whole MM.

Further, since five MDMs still dispose their wastes in open dumping sites in their own district, planning should be made for installing sanitary disposal sites like the Hamitler disposal site.

Bursa MM has been conducting a feasibility study for installing new waste disposal facilities. Although the study is under the screening process and prior to disclosure, it is assumed that the study is related to installing treatment facilities that can substitute Hamitler disposal site in the future. Such facilities should have enough capacity to accept future wastes and also have the flexibility so that new facilities or technologies can be installed or applied as necessary.

With regard to WtE facilities, introduction of facilities that can either substitute or supplement the existing facilities should be discussed. Generally, the lifetime of waste treatment facilities in Turkey is about 30 years. Considering the fact that the waste amount may rapidly increase in the coming years, it may be efficient to construct new facilities in multiple periods. WtE technologies could be introduced in Bursa MM either as supplementing technology for the existing facilities or for new facilities to be constructed in the next planning phase.

[3] Brochure "Sanitary Landfill Site and Facilities" by Bursa Metropolitan Municipality

4.2 Kocaeli MM

4.2.1 General information

Kocaeli Metropolitan Municipality (hereinafter "Kocaeli MM") is located in the Marmara Region to the east of Istanbul in the northern west part of Turkey. Kocaeli MM consists of twelve MDMs. The total population of Kocaeli Province reached approximately 1.72 million in 2014. In Kocaeli MM, there are a number of ports on the Marmara Sea and several main highways going toward Europe, Asia, and southern inland. Therefore, Kocaeli Province is an important point for sea and land traffics. The Marmara Region including Kocaeli MM is called the industrial capital of Turkey and more than 7,000 firms and more than 1,000 factories are located in the region. Approximately 70% of domestic industrial products in Turkey are estimated to be produced in Marmara Region. With the administrative restructuring in 2014, there are now 12 MDMs in Kocaeli MM. The population of each MDM is shown in the following table.

Table 4-10: Population of 12 MDMs in Kocaeli MM (in 2014)

MDM	Population
1. Başiskele	79,625
2. Çayırova	109,698
3. Darıca	173,139
4. Derince	133,739
5. Dilovası	45,714
6. Gebze	338,412
7. Gölcük	149,238
8. İzmit	338,710
9. Kandıra	49,203
10. Karamürsel	54,225
11. Kartepe	104,882
12. Körfez	146,210
Total	1,722,975

Source: Turkish Statistical Institute website (http://www.turkstat.gov.tr)

4.2.2 Projection of municipal solid waste amount

The future municipal solid waste amount in Kocaeli MM was estimated as shown below based on the waste generation amount of 1.06 kg/person/day which was calculated based on "Waste Management Action Plan 2008-2012"[4].

Table 4-11: Projection of municipal solid waste amount in Kocaeli MM

Year	Waste Management Action Plan			Prediction based on the actual population in 2014		
	Population	Waste generation amount		Population	Waste generation amount	
		(ton/day)	(ton/year)		(ton/day)	(ton/year)
2014	1,696,633	1,802	657,776	1,722,975	1,826	666,619
2015	1,726,325	1,837	670,330	1,753,127	1,858	678,285
2016	1,756,535	1,871	682,803	1,783,807	1,891	692,046
2017	1,787,275	1,905	695,197	1,815,024	1,924	702,233
2018	1,818,552	1,938	707,490	1,846,787	1,958	714,522
2019	1,850,377	1,972	719,684	1,879,106	1,992	727,026
2020	1,882,758	2,005	731,773	1,911,990	2,027	741,776
2021	1,915,706	2,038	743,767	1,945,450	2,062	752,695
2022	1,949,231	2,070	755,660	1,979,495	2,098	765,867
2023	1,983,343	2,103	767,451	2,014,136	2,135	779,269

Source: Population: TurkStat, Population Projections, 2013-2075 and Kocaeli MM, Waste generation amount per person per day: Waste Management Action Plan 2008-2012

[4] This value is not the same with the current collected amount. However, this value was used for the projection in this Survey, as this is the value takes into account the future changes and is applied in the Waste Management Action Plan 2008-2012 which is a national action plan.

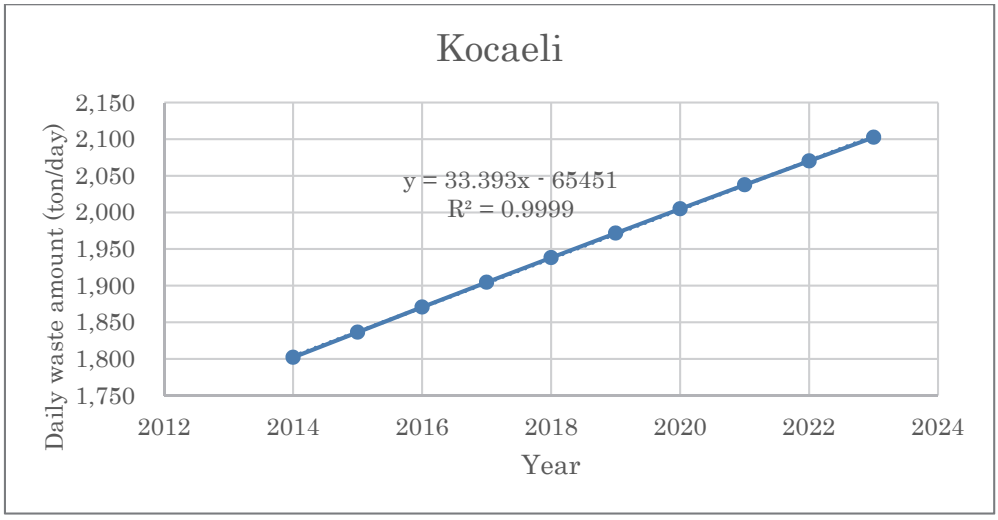


Figure 4-6: Projection of municipal solid waste amount in Kocaeli MM

It is estimated that from 2014 to 2023 the population will increase by 320,000 and the yearly waste amount by 110,000 ton/year or daily waste amount by 300 ton/day.

4.2.3 Current municipal solid waste management

a. Collection

Each MDM has the duty of collection and transportation of municipal solid waste to transfer stations or disposal sites. In Çayırova MDM, MDM collects and transports the municipal solid waste by themselves, but in other MDMs, the work is contracted out to private companies.

b. Waste amount collected in each MDM

Kandıra MDM with population of 49,203 in 2014 collected approximately 32 ton/day in 2014 which was the smallest amount in Kocaeli MM. İzmit MDM with population of 338,710 in 2014 collected approximately 348 ton/day in 2014 which was the largest amount in Kocaeli MM. Total collection amount of municipal solid waste from 12 MDMs in Kocaeli MM was approximately 1,591 ton/day in 2014.

Kocaeli MM also gathers information on amount of collected packaging wastes from each MDM. The amount of collected municipal solid wastes and packaging wastes and the executing bodies of collection works is shown in the following table.

Table 4-12: Collection amount of municipal solid waste, separately collected waste and execution body in each MDM in Kocaeli MM (in 2014)

MDM	Collected waste amount (ton/day)	Packaging waste amount (ton/day)	Executing body
1. Başiskele	78	1.1	Private
2. Çayırova	98	3.7	Çayırova MDM
3. Darıca	143	4.7	Private
4. Derince	110	0.6	Private
5. Dilovası	38	0.9	Private
6. Gebze	305	14.5	Private
7. Gölcük	128	3.9	Private
8. İzmit	348	24.4	Private
9. Kandıra	32	0.4	Private
10. Karamürsel	45	2.3	Private
11. Kartepe	96	4.7	Private
12. Körfez	122	2.6	Private
13. Other areas	48	-	Kocaeli MM
Total	1,591	63.7	

Source: Interview with Kocaeli MM

c. Transport

There are two ways of transporting wastes, namely direct transport to the disposal site and transport through transfer stations.

c.1. Direct transport to disposal site

The municipal solid waste collected by Gölcük, İzmit, Kartepe, and Başiskele MDMs and half of the wastes from Körfez MDM are directly transported to Solaklar final disposal site, while wastes collected by Dilovası, Gebze, Çayırova, and Darıca MDMs and half of the wastes from Körfez MDM are directly hauled to Dilovası sanitary disposal site.

c.2. Transport through transfer stations

There are three transfer stations, namely Körfez, Kandıra, and Çamçukur transfer stations. Körfez and Kandıra transfer stations are operated by İZAYDAŞ[5] contracted by Kocaeli MM, while Çamçukur transfer station is directly operated by Karamürsel MDM. The amount of waste loaded at each transfer station is shown in the following table.

Table 4-13: Amount of wastes loaded at each transfer station (in 2014)

Transfer station	Körfez Transfer Station (Operated by İZAYDAŞ)	Kandıra Transfer Station (Operated by İZAYDAŞ)	Çamçukur Transfer station (operated by Karamürsel MDM)
Amount of waste loading (ton/day)	232	32	45
Origin of wastes (MDM)	Körfez(1/2)/ Derince	Kandıra	Karamürsel

d. Waste flow (from collection, transport, to disposal)

There are two final disposal sites, namely Solakla and Dilovasi disposal sites and two transfer stations, namely Kandıra and Körfez transfer stations operated by the iZAYDAŞ which is a public corporation and contracted by Kocaeli MM. The municipal solid wastes collected by MDMs are loaded in the large-capacity containers at the two transfer stations or directly hauled to the two final disposal sites. The collected wastes in western part of Körfez District are transferred to Dilovası final disposal site in Dilovası District while in eastern part of Körfez District they are transferred to

[5] iZAYDAŞ is a public corporation established by 100% capital fund of Kocaeli Metropolitan Municipality (KMM) and the Mayor of KMM becomes the chairperson of board of directors

Solaklar final disposal site in Izmit District. The final disposal sites and the transfer stations in Kocaeli MM are shown in the following table.

Table 4-14: The final disposal sites and the transfer stations in Kocaeli MM (in 2014)

Sanitary disposal site	Transfer station or direct transportation	
Solaklar Sanitary Landfill (Operated by İZAYDAŞ)	Gölcük/ İzmit/ Kartepe/ Başiskele	
	Körfez Transfer Station (Operated by İZAYDAŞ)	Körfez (1/2) / Derince
	Kandıra Transfer Station (Operated by İZAYDAŞ)	Kandıra
	Çamçukur Transfer station (Operated by Karamürsel MDM)	Karamürsel
Dilovasi Sanitary Landfill (Operated by İZAYDAŞ)	Dilovası / Gebze/ Çayırova/ Darıca/Körfez (1/2)	

Source: Interview with Kocaeli MM

Districts in Kocaeli MM have been implementing separate collection for recyclables which are categorized as packaging wastes[6] since 2009, based on the policy by the central government announced in 2004 through its Packaging Waste Control Regulation. Residents are requested to discharge recyclables separately from the other types of waste into designated containers (Note: blue containers are for packaging wastes, gray containers for other general wastes
Photo 4-1). Eight private companies located in Kocaeli MM collect the recyclables from these containers and transport them to their respective sorting facilities. Collected recyclables are further segregated into different types of recyclables at the facilities and sold to final recycling facilities. However, the quality of separate discharging by residents is not sufficient since other wastes are often mixed in the containers designated for the recyclables.

Note: blue containers are for packaging wastes, gray containers for other general wastes

Photo 4-1: Waste containers installed in Kocaeli MM

According to Kocaeli MM, after these private companies contracted by Kocaeli MM sort the wastes at their sorting facilities, the recyclable materials are sold to recycling companies and the residues are brought to the disposal sites. The frequency of collection of packaging wastes is different in each MDM.

On the other hand, recyclables discharged from factories located in the industrial zone of Kocaeli MM are outside the responsibility of municipalities, and they are collected and recycled by various private companies. Therefore, both Kocaeli MM and the MDMs have no information regarding recycling in the industrial zone. The type of wastes included in the packaging wastes and the method of collection are outlined in the following table.

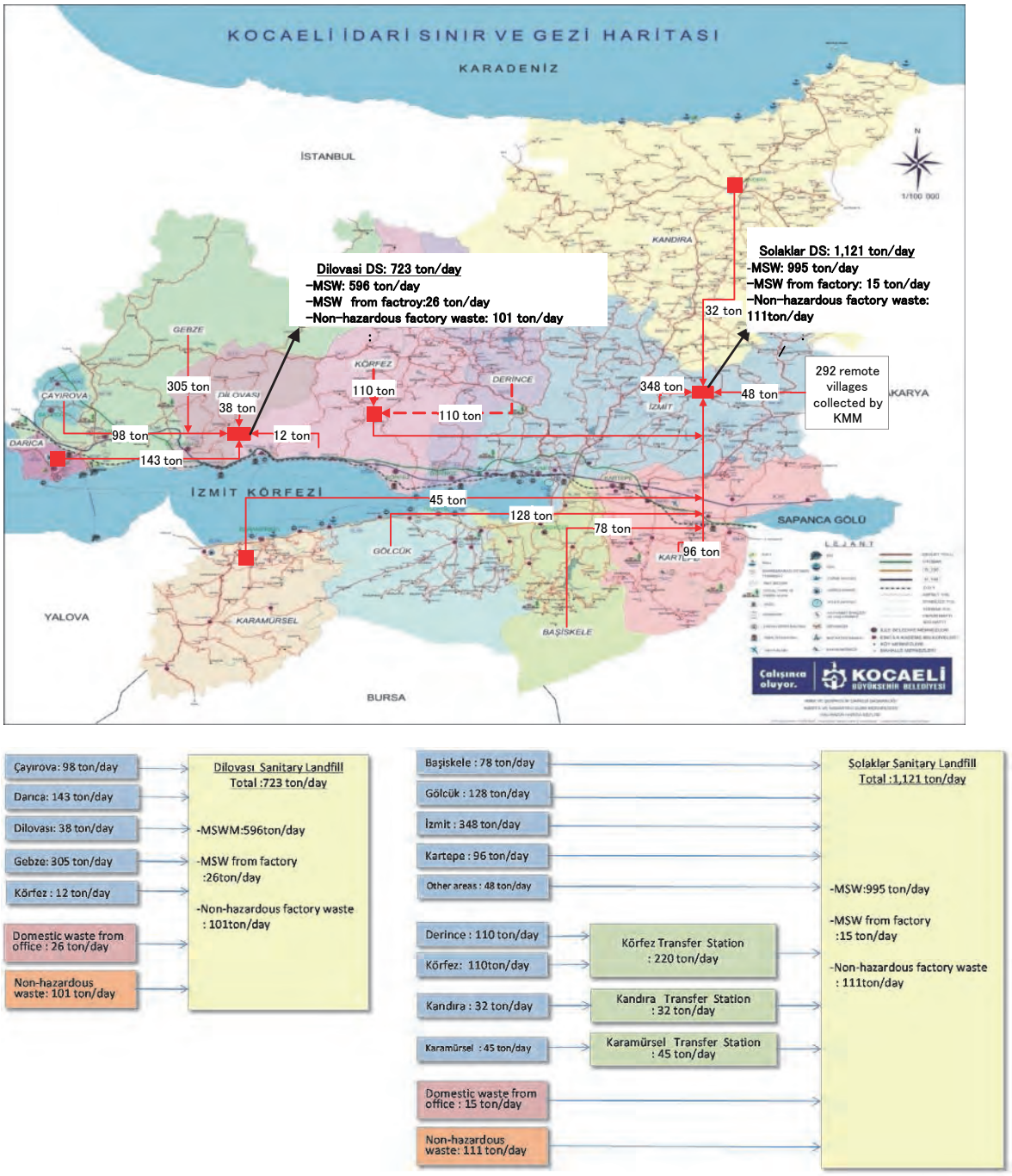
[6] Packaging Waste: Shall mean all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from the producer to the user or the final consumer, excluding production residues; and sales, secondary and transportation packaging wastes including recyclable packaging wastes that are generated after using of the product for which lifetime expired and can be reused and discharged to or left the environment.

Table 4-15: Type of wastes separately collected and method of collection

Type of wastes separately collected	Method of collection
Copying Paper	Separate waste containers for recyclable wastes and other wastes are installed and citizens are asked to dispose wastes in the respective containers.
Newspaper	
Magazine	
Other printed materials	
Paper	
Cardboard	
Plastics (PET, hard plastic, packaging plastic)	
Glass	
Metal	

Source: Interview with Kocaeli MM

The flow of municipal solid wastes in Kocaeli MM is shown in the following figure.



Note: Amount of hazardous industrial wastes and medical wastes are not included in the final disposal amount.
Source: Interview with Kocaeli MM

Figure 4-7: Flow of municipal solid wastes in Kocaeli MM (2014)

e. Disposal

The municipal solid waste collected by each MDM is disposed at Solaklar disposal site which received 1,121 ton/day in 2014 and Dilovası sanitary disposal site which received 723 ton/day in 2014. Although Kocaeli MM has the responsibility to manage and operate both of the disposal sites, Kocaeli has contracted out the work to iZYDAŞ. The expected remaining life of both of the final disposal sites is four years. The land acquisition for the new disposal site which will substitute the Dilovasi disposal site has been completed and site approval procedure from relative Ministry has been implemented. The details of both final disposal sites are shown in the following table.

Table 4-16: Outline of disposal sites in Kocaeli MM

Site name			Solaklar sanitary disposal site				Dilovası sanitary disposal site			
1) Method of operation			Sanitary Landfill				Sanitary Landfill			
	Year	Total	MSW	Domestic waste from office	Non-hazardous waste	Sub total	MSW	Domestic waste from office	Non-hazardous waste	Sub total
2) Disposal amount (ton/day)※	2014	1,844	995	15	111	1,121	596	26	101	723
	2013	1,820	1,475	13	188	1,676	78	35	31	144
	2012	1,648	1,338	15	82	1,435	124	43	46	213
	2011	1,739	1,194	15	119	1,328	298	61	52	411
	2010	1,479	792	20	112	861	522	47	49	618
3) Expected remain of life span (years) in 2014			4				4			
4) Executing organization of final disposal site in 2014			Izmit Waste and Residual Treatment Incineration and Utilization Inc. (İZAYDAŞ)				Izmit Waste and Residual Treatment Incineration and Utilization Inc. (İZAYDAŞ)			
5) Operation charge paid by KMM to İZAYDAŞ (TRY /ton) in 2014			15.42				15.42			
6) Unit cost of operation (TRY/ton) in 2014			N.A.				N.A.			
7) Disposal area (m^2)			300,000				66,000			
8) Class [7]			Class I and Class II				Class II			

Source: Interview with Kocaeli MM

Solaklar
Sanitary Landfill site

Dilovası
Sanitary Landfill site

Figure 4-8: Aerial photo of Solaklar and Dilovası disposal sites

f. Projection of future disposal amount

The amount of waste generated in Kocaeli MM in 2014 was 1,826 ton/day and the amount collected was 1,591 ton/day, which implies that the collection rate was 87.1%. Future waste amount to be

[7] Article 5 of Regulation on Landfill of Wastes defines the classes for sanitary disposal sites. Article 5 is given below:
ARTICLE 5 - (1) Sanitary disposal site are classified as following:
a) Class I sanitary disposal site: The facility having required infrastructure for storing hazardous wastes.
b) Class II sanitary disposal site: The facility having required infrastructure for storing municipal wastes and non-hazardous wastes.
c) Class III sanitary disposal site: The facility having required infrastructure for storing inert wastes.

disposed was projected under the assumption that the collection rate of 87.1% in 2014 would not change. Further, assumption was made that municipal waste from offices which was 41 ton/day in 2014 and non-hazardous industrial waste which was 212 ton/day in 2014 will increase by 1.75% (i.e. same growth rate as the population growth rate).

Table 4-17: Projection of final disposal amount

Items	unit	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Generation of MSW	ton/day	1,826	1,858	1,891	1,924	1,958	1,992	2,027	2,062	2,098	2,135
Collection of MSW (Collection rate: 87.1%)	ton/day	1,591	1,618	1,647	1,676	1,705	1,735	1,766	1,796	1,827	1,860
Domestic waste from office (increasing rate: 1.75%)	ton/day	41	42	43	44	45	46	47	48	49	50
Non-hazardous waste (increasing rate: 1.75%)	ton/day	212	216	220	224	228	232	236	240	244	248
Total amount	ton/day	1,844	1,876	1,910	1,944	1,978	2,013	2,049	2,084	2,120	2,158
	ton/year	673,060	684,740	697,150	709,560	721,970	734,745	747,885	760,660	773,800	787,670
Final disposal amount	m^3/year	616,972	627,678	639,054	650,430	661,806	673,516	685,561	697,272	709,317	722,031
Accumulated Required Landfill Volume (m3)	m^3	616,972	1,244,650	1,883,704	2,534,134	3,195,940	3,869,456	4,555,017	5,252,289	5,961,606	6,683,637

Unit Weight of MSW at the Landfill: 1.2 (ton/m^3), Cover Soil Rate to Landfilled Waste: 10%

If wastes are to be landfilled up to 10m of height in both Solaklar and Dilovası disposal sites, the remaining capacity for disposal is 3,660,000m^3 as shown below, and they would be full by 2019.

Solaklar disposal site: 300,000m^2x10m = 3,000,000m^3
Dilovası disposal site: 66,000m^2x10m = 660,000m^3
Total = 3,660,000m^3

4.2.4 Waste composition

a. Waste composition survey conducted by Kocaeli MM

Kocaeli MM has been conducting waste composition survey (physical composition analysis) in winter and summer every year since 2008 in accordance with the guideline set by the MoEU in 2007. Based on interviews with Kocaeli MM, the outline of the waste composition survey in Kocaeli MM can be summarized as follows.

a.1. Target area

The survey targets municipal solid wastes from all 12 MDMs in Kocaeli MM. According to the MoEU Guideline, the survey should target wastes generated in areas categorized as low, middle, and high-income levels in addition to commercial areas. Therefore, Kocaeli MM requests MDMs to select the areas that can meet the respective categories and only target wastes from such areas in its waste composition survey.

As the selection of such areas is under the discretion of the MDMs, there is no unified standard for low, middle, and high-income areas or commercial areas. Kocaeli MM is also not aware of how these areas are determined.

a.2. Methodology

a.2.1 Target wastes

Districts in Kocaeli MM have been implementing separate collection for recyclables categorized as packaging wastes since 2009, based on the policy by the central government announced in 2007 through its Packaging Waste Control Regulation. Although the survey targets wastes selected from each district, it does not include the recyclables that are separately collected since 2009.

As the MoEU Guideline indicates that the municipalities should survey waste generated on Sunday (as a weekend) and Monday (as a weekday), Kocaeli MM collects waste from the selected areas on Mondays and Tuesdays. After collection, the wastes are sorted into different waste composition by each area type. The wastes collected from low, middle, and high income area and commercial area are analyzed separately even if they come from the same district.

a.2.2 Survey period

Due to the following factors, Kocaeli MM conducts the waste composition survey for 3 weeks.

- Physical composition analysis is implemented four times for the waste collected from the 12 MDMs.
- Samples are taken from wastes generated on Sundays and Mondays
- Within one week, 4 out of 12 MDMs are selected, the wastes are collected on Monday and Tuesday, and the wastes are analyzed on Wednesday and Thursday.

a.3. Method of analysis

a.3.1 Sampling

The target waste is unloaded in a place at the disposal sites separately by district and target area. According to the MoEU Guideline, samples should be taken after mixing target waste in order to homogenize the composition of the sampled wastes. However, Kocaeli MM does not mix the wastes due to the required labor and time (usually, 4 workers from İZAYDAŞ are allocated for the survey). Workers select garbage bags from the different parts of the unloaded piles of target waste and put the bags into prearranged box with a volume of 0.5 m^3 until the box becomes full.

Having filled the box, the selected waste becomes the sample to be analyzed and the remainder of the wastes in the pile is discarded.

a.3.2 Sorting

The sample prepared during the previous stage is sorted into 16 waste components based on the MoEU Guideline if the survey is conducted in the summer. The components are: (1) kitchen waste, (2) paper, (3) carton, (4) bulky carton (card boxes), (5) plastic, (6) glass, (7) metal, (8) bulky metal, (9) e-waste, (10) hazardous waste, (11) park and garden waste, (12) other combustibles, (13) other incombustibles, (14) other bulky combustibles, (15) other bulky incombustibles, and (16) other waste.

If the survey is conducted in the winter, “ash” will be added to the above and the number of total components becomes 17.

The physical composition of the sample waste is identified by putting the sorted components into different buckets and measuring the weights one by one.

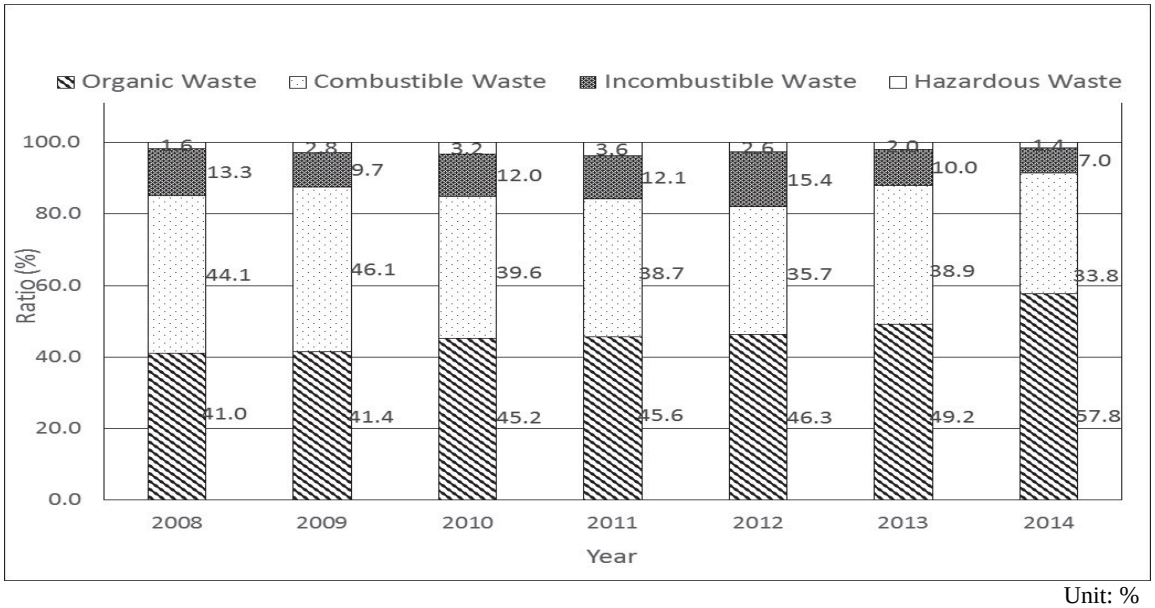
b. Results of previous surveys

As mentioned above, Kocaeli MM conducts the physical composition analysis of 4 samples from each district (each from low, middle, and high income area and commercial area). Therefore, the total number of samples for one waste composition survey is 48 (12 MDMs times 4 samples). For the whole year, the total number of samples becomes 96 since the survey is conducted twice, namely in summer and winter.

The results of the previous surveys conducted by Kocaeli MM in the past 7 years are summarized into four categories, namely organic (A), combustible (B), incombustible (C) and hazardous (D) wastes. The results are presented in following table and figure.

Table 4-18: Results of waste composition survey in Kocaeli MM

	Waste components	2008	2009	2010	2011	2012	2013	2014	Annual Average	MIN Value	MAX Value
	Number of districts*	44	12	12	12	12	12	12			
	Number of samples		96	96	96	96	96	96			
A	**Organic Waste**										
1	Kitchen waste	38.8	37.9	41.9	42.4	43.2	48.3	56.4	44.1	37.9	56.4
2	Park And Garden Waste	2.2	3.5	3.3	3.2	3.2	0.9	1.3	2.5	0.9	3.5
	Total Organic Waste	41.0	41.4	45.2	45.6	46.3	49.2	57.8	46.7	41.0	57.8
B	**Combustible Waste**										
3	Paper	5.0	5.5	4.3	4.1	5.1	8.2	6.1	5.5	4.1	8.2
4	Carton	2.6	1.6	0.9	1.5	1.9	1.2	2.3	1.7	0.9	2.6
5	Bulky Carton	4.4	3.9	3.4	5.1	5.3	2.4	0.0	3.5	0.0	5.3
6	Plastics	14.9	12.2	9.3	8.6	7.2	8.3	10.2	10.1	7.2	14.9
7	Other Combustible	17.0	22.6	21.6	19.3	15.7	17.9	15.2	18.5	15.2	22.6
8	Other Bulky Combustible	0.1	0.1	0.0	0.0	0.5	0.9	0.0	0.2	0.0	0.9
	Total Combustible Waste	44.1	46.1	39.6	38.7	35.7	38.9	33.8	39.6	33.8	46.1
C	**Incombustible Waste**										
9	Glass	3.4	2.8	2.7	2.8	3.3	4.4	4.1	3.3	2.7	4.4
10	Metal	1.4	2.3	1.9	1.7	2.0	1.2	1.0	1.7	1.0	2.3
11	Bulky Metal	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2
12	Other Incombustible	1.9	1.5	2.9	1.3	1.5	0.3	0.0	1.3	0.0	2.9
13	Other Bulky Incombustible	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.1
14	Ash (Dust, Sand, Stone Inclu	5.6	3.0	4.4	6.3	8.6	3.7	1.9	4.8	1.9	8.6
	Total Incombustible Waste	13.3	9.7	12.0	12.1	15.4	10.0	7.0	11.3	7.0	15.4
D	**Hazardous Waste**										
15	WEEE	0.4	0.6	1.0	0.9	0.6	0.4	0.4	0.6	0.4	1.0
16	Hazardous Waste	1.2	2.2	2.2	2.7	2.0	1.6	1.0	1.8	1.0	2.7
	Total Hazardous Waste	1.6	2.8	3.2	3.6	2.6	2.0	1.4	2.5	1.4	3.6
	Total Waste	**100.0**	**100.0**	**100.0**	**100.0**	100.0	100.0	100.0	100.0		



Unit: %

Figure 4-9: Shares of organic, combustible, incombustible and hazardous wastes in Kocaeli MM

According to the figure, the share of organic waste increased gradually from the 41% of 2009 to 49% in 2013. The increase was drastic in 2014 as it reached 58%. The major reason for the change in the shares of organic waste can be considered as the decrease in combustible and incombustible wastes, which was caused by the implementation of separate collection of packaging wastes by Kocaeli MM since 2009 in accordance with the policy by the central government.

c. Observation regarding waste composition of Kocaeli MM

Over the years, the share of organic and plastic wastes has been increasing. The difference in composition in winter and summer based on Japanese category of wastes types is shown in Figure 4-10. Although there is no significant difference in paper, organic, green, and plastic wastes, the share of other combustible wastes is higher in summer and that of incombustible wastes is higher in winter.

Within the incombustible wastes, ash makes up more than 8% in winter. This is assumed to be the ash from home heating, but as the number of such heating devices has been decreasing year by year, the share is estimated to decrease in the future.

When evaluating these wastes as fuel for WtE facilities, the share of organic wastes should be reduced in summer so that the wastes can be completely combusted.

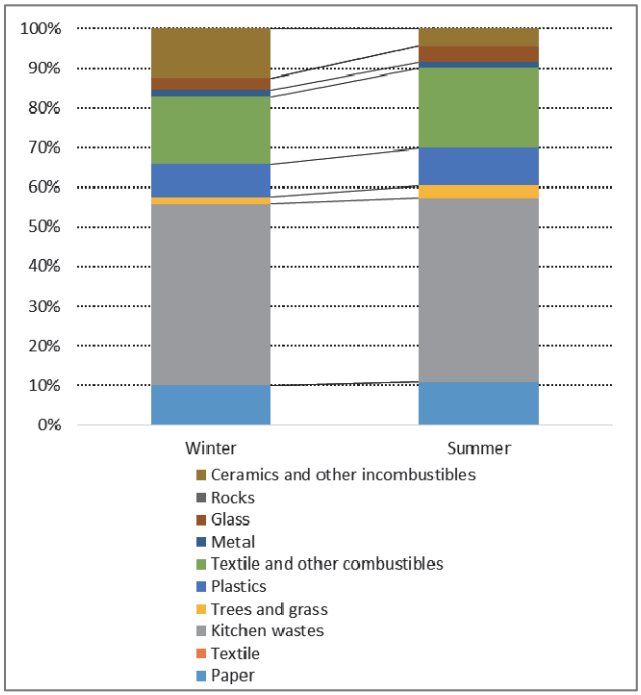


Figure 4-10: Comparison of waste composition of Kocaeli MM in winter and summer

Further, the difference between the wastes composition in Japanese cities and in Kocaeli MM was analyzed. The average waste composition in Kocaeli MM and the composition of wastes at Itabashi incineration plant in Tokyo in 2013 was compared (Figure 4-11). The wastes incinerated in Japan is high in paper wastes and low in organic wastes as mentioned in the previous section related to Bursa MM. Although the share of incombustible wastes in Kocaeli MM is lower than in other Turkish cities, the share is not negligible compared to that in Japan.

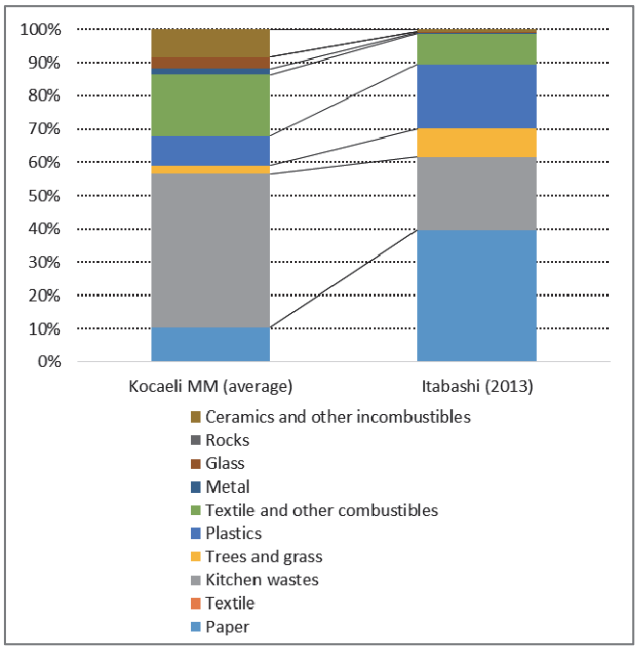


Figure 4-11: Comparison of waste composition of Kocaeli MM and Japanese cities

d. Additional waste composition survey conducted by the JICA Survey Team (detailed results are in 5.1)

The waste composition survey in Kocaeli MM was simply a survey on physical composition, and the three contents, namely water, combustible matter, and ash content, were not identified. Therefore, the JICA Survey Team analyzed the three contents of each physical composition which was analyzed in the waste composition survey by Kocaeli MM.

The schedule of the waste composition survey conducted by Kocaeli MM in winter 2015 is shown below.

– 1st week (18 and 19 February): Gebze and Derince MDM
– 2nd week (25 and 216 February): Dilovası, Darica, Gölcük, and Başiskle MDM
– 3rd week (4 and 5 March): Körfez, Kartepe, Kandıra, and Karamürsel MDM
– 4th week (11 March): Izmit and Çayırova MDM

Further, the JICA Survey Team took one sample each week taking into consideration weather fluctuations from the areas below so that all 17 waste types can be collected.

– 2nd week: Gölcük MDM (high-income area)
– 3rd week: Körfez MDM (high-income area)
– 4th week: Izmit MDM (middle-income area)

4.2.5 Financial status

As with the other metropolitan municipalities, MDMs are responsible for collection and transport up to the transfer stations and the Kocaeli MM is responsible for transport from the transfer stations and disposal. The operation and maintenance of transfer stations and disposal sites has been contracted out to İZAYDAŞ and the company collects 14.5 TRY (approximately 650 JPY, excluding VAT) per ton for treatment and disposal.

Meanwhile, the cost of collection and transport by each MDM is shown in table below. The average cost of collection and transport is 167 TRY (approximately 7,500 JPY) per ton of waste collected/transported.

Table 4-19: Collection and transport cost of MDMs in Kocaeli MM (2013)

MDM	Total Cost (TRY)	ECT (TRY)	Net Cost (TRY)	Waste Amount (ton/year)	Unit cost (TRY/ton)
Basiskele	3,381,089	686,471	2,694,618	24,407	139
Cayirova	3,815,412	1,102,518	2,712,894	30,904	123
Darica	10,955,211	1,373,368	9,581,843	46,564	235
Derince	5,099,260	1,078,648	4,020,612	39,425	129
Dilovasi	3,733,492	247,828	3,485,664	13,104	285
Gebze	15,653,555	2,248,533	13,405,022	101,031	155
Golcuk	9,688,821	1,192,306	8,496,515	44,346	218
Izmit	18,245,009	2,811,567	15,433,442	124,490	147
Kandira	795,148	274,925	520,223	9,628	83
Karamursel	2,469,756	624,131	1,845,625	15,899	155
Kartepe	8,341,669	917,052	7,424,617	37,031	225
Korfez	6,021,953	1,184,030	4,837,923	40,977	147
TOTAL	88,200,375	13,741,377	74,458,998	527,806	167

4.2.6 Operational cost of municipal solid waste management

a. Financial source

Major financial source of municipal solid waste management is ECT. ECT is charged in proportion to the water supply consumption at each household, and unit charge rates are 0.26 TRY/m^3 in MMs, while 0.20TL/m^3 in PMs. The unit charge rate of ECT is annually determined by the central government throughout the nation, therefore, it cannot be easily changed by MM, PM or MDM. Water bill of each household is collected by Kocaeli Water Supply Public Cooperation under the jurisdiction of Kocaeli MM while water bills of commercial buildings, shops, and restaurants are collected by Water Supply Department under the jurisdiction of MDMs. The collected water bill is distributed to MDM and DM, and the distribution ratio is 20% and 80%.

ECT covers approximately 25% of the operation cost of municipal solid waste management in Kocaeli MM, and the remaining 75% is financed by the general revenue of Kocaeli MM.

b. Cost of collection

Collection of municipal solid waste is conducted by each MDM and MM does not have data on the collection cost.

c. Operational cost of transfer stations

There are three transfer stations, namely Körfez, Kandıra, and Çamçukur transfer stations. Körfez and Kandıra transfer stations are operated by IZAYDAŞ contracted by Kocaeli MM, while Çamçukur transfer station is directly operated by Karamürsel MDM. Kocaeli MM does not pay fees to İZAYDAŞ as operation fee of Körfez and Kandıra transfer stations. This is because the tipping fee at the disposal site (15.42 TRY/ton) includes not only operation cost of the disposal site but also the operation cost of the transfer stations.
The operation cost of Çamçukur transfer station operated by Karamürsel MDM is not available at present, as interview could not be conducted with Karamürsel MDM.

d. Operational cost of disposal sites

As the total operation cost of Solaklar disposal site, Dilovası disposal site, Körfez transfer stations, and Kandıra transfer station, the charge of 15.42 TRY/ton is paid to İZAYDAŞ by Kocaeli MM. The operation cost of each final disposal site is unidentified, as interview could not be conducted with İZAYDAŞ.

4.2.7 Industrial wastes

a. Amount generated and treated

a.1. Hazardous industrial wasets

Solaklar disposal site is the only disposal site in Turkey which accepts and treats hazardous industrial waste. Thus, the hazardous industrial waste collected from the entire nation is transferred to this disposal site. The hazardous industrial waste treatment facility is operated by İZAYDAŞ contracted by Kocaeli MM. According to MoEU, approximately 2,000,000 ton of hazardous industrial waste is generated annually in Turkey, and 253 ton/day is treated at the facility in Solaklar disposal site.

b. Cost of treatment and disposal

b.1. Operational costs regarding industrial wastes

Treatment facilities are operated by İZAYDAŞ. İZAYDAŞ collects 45 TRY/ton for municipal solid wastes from offices and 220 TRY/ton for non-hazardous industrial wastes generated from production in factories. The tipping fee for the hazardous industrial waste treatment is classified by the waste type.

c. Collection and transport

Collection and transport of hazardous industrial wastes is the responsibility of the generators and not the MDMs.

d. Treatment and disposal

Bottom ash and fly ash from incineration of hazardous industrial wastes are mixed and then landfilled. The remaining life of disposal sites designated for hazardous industrial wastes in Solaklar and Dilozasi disposal sites is approximately 25 years.

4.2.8 Medical wastes

a. Amount generated and treated

There are medical waste treatment facilities operated by SAS Sludge Dewatering Foreign Trade Ltd contracted by İZAYDAŞ inside the Solaklar disposal site. The generation and treatment amount of medical waste in Kocaeli Province is approximately 5.07 ton/day, while its treatment capacity is 8 ton/day.

b. Cost of treatment and disposal

The operation cost of medical waste treatment is financed by the tipping fees from the following facilities and wastes.

- Large and middle-scale healthcare centers (hospitals, dialysis centers): 2,067 TRY/ton + VAT
- Small-scale health centers (clinic, healthcare units at work place): 3,630 TRY/ton + VAT
- Pathogenic wastes: 1,431 TRY/ton + VAT

c. Collection and transport

The medical wastes are collected and transported by SAS Sludge Dewatering Foreign Trade Ltd. There is no information about the costs at this moment.

d. Treatment and disposal

The collected and transferred medical waste is sterilized by autoclave and incinerated by the designated medical waste incinerator in the same premises of Solaklar disposal site. The ash and incineration residue are disposed at the disposal site together with municipal solid wastes in Solaklar final disposal site.

4.2.9 Needs regarding solid waste management

There are two sanitary disposal sites operated in Kocaeli MM and the remaining life of each site is

four years. With regard to Dolvasi disposal site, the area for the substituting facility has been decided. However, as there is no facility that will substitute Solaklar disposal site, it is expected that the site will be forced to accept more wastes than its capacity. Thus, construction of new waste treatment and disposal facilities is considered to be an urgent issue for Kocaeli MM.

Further, as an incineration facility for hazardous wastes already exists in Kocaeli MM, Kocaeli MM already holds the experience of waste incineration and understands its efficiency as a waste treatment technology. Therefore, the expectations towards introduction of waste incineration power plant for municipal solid wastes is also high.

Although the size of Kocaeli Province is not small (about 1.5 times the size of Tokyo Metropolitan Government), finding land as large as that of Solaklar disposal site is not an easy task. This is also the reason why installment of intermediate treatment facility would be needed.

Moreover, as Kocaeli MM has conducted a feasibility study in collaboration with Kobelco Eco-Solutions Co., Ltd. in 2012 with regard to WtE utilizing subsidies from the Japanese Ministry of the Environment, Kocaeli MM has basic technical knowledge on WtE. Therefore, it is assumed that they already have enough understanding on technical aspects of waste incineration power plants.

Financially, Kocaeli MM finances 75% of the waste management costs by the general budget. Although Kocaeli understands that construction and operation of waste incineration power plants will be more costly compared to the current methods, the issue of how to cover this cost needs to be seriously considered.

4.3 Izmir MM

4.3.1 General information

Izmir Metropolitan Municipality (hereinafter "Izmir MM") is the third largest city in Turkey in the central-west part of the country. It is composed of 30 MDMs and its administrative territory covers the entire Izmir Province. Its population was approximately 4.113 million in 2014 and it is rich in touristic destinations such as Bergama, Foça, Çeşme, and Selçuk including world heritage sites. Izmir is known as an international industrial city, and its trading port is the second largest in Turkey after Istanbul. The MDMs in Izmir MM and the population of each MDM are shown below.

Table 4-20: Population of 30 MDMs in Izmir MM

	MDM	Population (2014)
1.	Aliağa	83,366
2.	Balçova	77,311
3.	Bayındır	40,310
4.	Bayraklı	310,765
5.	Bergama	101,813
6.	Beydağ	12,457
7.	Bornova	431,149
8.	Buca	461,761
9.	Çeşme	39,243
10.	Çiğli	176,864
11.	Dikili	41,999
12.	Foça	30,002
13.	Gaziemir	130,870
14.	Güzelbahçe	28,470
15.	Karabağlar	473,741
16.	Karaburun	9,456
17	Karşıyaka	325,717
18.	Kemalpaşa	99,626
19.	Kınık	28,072
20.	Kiraz	43,971
21.	Konak	380,295
22.	Menderes	81,297
23.	Menemen	148,662
24.	Narlıdere	64,599
25.	Ödemiş	129,407
26.	Seferihisar	35,960
27.	Selçuk	35,281
28.	Tire	81,315
29.	Torbalı	150,127
30.	Urla	59,166
	Total	4,113,072

Source: Turkish Statistical Institute HP (http://www.turkstat.gov.tr)

4.3.2 Projection of municipal solid waste amount

The "Waste Management Action Plan 2008-2012" estimates that the amount of waste generated per person per day is 1.06 kg/person/day[8]. Based on this figure, the future municipal solid waste amount in Izmir MM was estimated as follows.

Table 4-21: Projection of municipal solid waste amount in Izmir MM

Year	Population	Daily waste amount (ton/day)	Yearly waste amount (ton/year)
2014	4,089,055	4,334	1,582,055
2015	4,129,112	4,377	1,597,553
2016	4,167,958	4,418	1,612,583
2017	4,205,647	4,458	1,627,165
2018	4,242,048	4,497	1,641,248
2019	4,277,194	4,534	1,654,846
2020	4,311,079	4,570	1,667,956
2021	4,343,706	4,604	1,680,580
2022	4,375,101	4,638	1,692,727
2023	4,405,279	4,670	1,704,402

Source: Population: TurkStat, Population Projections, 2013-2075, Waste generation amount per person per day: Waste Management Action Plan 2008-2012

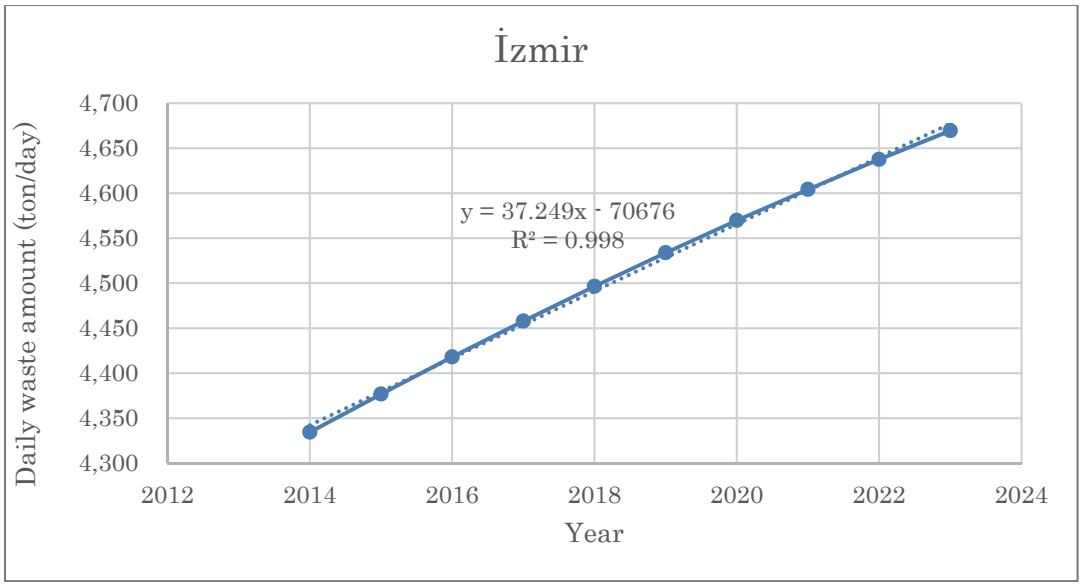


Figure 4-12: Projection of municipal solid waste amount in Izmir MM

From 2014 to 2023, the population is expected to increase by 320,000 and the yearly waste amount by 120,000 ton/year or daily waste amount by 340 ton/day.

4.3.3 Current municipal solid waste management

The solid waste management plan of Izmir MM has been submitted to the MoEU, but it is not yet approved. The contents must also be reviewed and revised, as the plan that is submitted was prepared before the change in administrative borders in March 2014. The district municipality has the obligation to submit this plan, as the MoEU will draft the national strategies on waste management based on these plans by the municipalities.

[8] This value is not the same with the current collected amount. However, this value was used for the projection in this Survey, as this is the value takes into account the future changes and is applied in the Waste Management Action Plan 2008-2012 which is a national action plan.

Meanwhile, as the volume of wastes in the Halmandali disposal site is reaching its capacity, Izmir MM is conducting a pre-feasibility study to consider construction of new facilities.

a. Collection

Collection of municipal solid wastes including packaging wastes is conducted under the responsibility of the MDMs. Each MDM delegates the collection works to private companies.

b. Population of MDM and collected waste amount

Waste collection service including separate collection for package wastes is under the responsibility of the MDM. Izmir MM is not aware of the amount of collected wastes by each MDM.

c. Transport of wastes

As of April 2015, there are eight transfer stations in operation in Izmir MM. The view of the transfer station is shown in Photo 4-2. All stations load the wastes by gravity and horizontal pressure. Unlike the transfer stations in Kocaeli MM, each container contain hydraulic pressure units for compacting the wastes. There were previously ten transfer stations, but two stations were closed in the year 2014. Four more are planning to be constructed in the MDMs of Dikili, Karaburun, Çeşme, and Kemalpaşa.


Photo 4-2: Waste transfer station (Türrkelit)

d. Intermediate treatment

There is no sorting or treatment facility operated by the Izmir MM at this moment. However, there are private companies that conduct such activities, and the list of private sorting facilities with operation permission is disclosed through the website of MoEU. Previously, there was a composting facility in Menemen DM, but it is no longer used. At the moment, a new medical sterilization facility is planned to be constructed in this site along with composting and refuse-derived fuel (RDF) production facilities.

e. Waste flow (from collection, transport, to disposal)

The municipal solid wastes collected by MDM in Izmir MM are first transferred to the eight waste transfer stations where they are loaded in larger trucks and then transferred to the disposal sites. The MDMs that are far from the central part of Izmir MM transfer their wastes to their own disposal sites. The waste flow in Izmir MM is shown in the figure below.

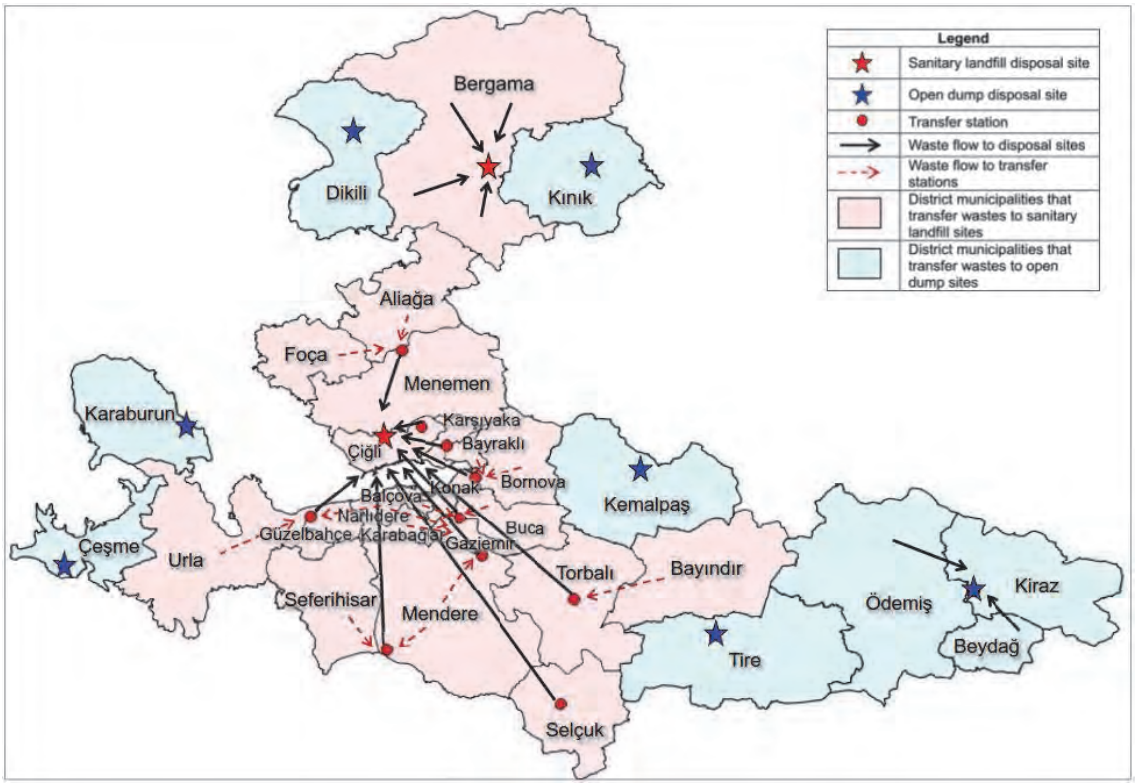


Figure 4-13: Waste flow from MDM in Izmir MM

f. Disposal

f.1. Current situation

As of April 2015, there are two sanitary disposal sites in Izmir MM, namely Harmandali and Bergama final disposal sites. Seven MDMs, namely Dikili, Kınık, Karaburun, Çeşme, Kemalpaşa, Tire, and Kiraz MDMs, have open dump sites in their own district municipalities. Ödemiş and Beydağ MDM transfer their wastes to the open dump site in the neighboring Kiraz MDM (see Figure 4-13).

Harmandali final disposal site is the largest and the oldest disposal site in Izmir MM and has been operating since 1992. The outline of each disposal site is shown in Table 4-22.

Table 4-22: Outline of sanitary disposal sites in Izmir MM

Site name	Harmandali disposal site	Bergama disposal site
1) Method of operation	Sanitary Landfill	Sanitary Landfill
2) Disposal amount (ton/day)	See Table 4-23	
3) Expected remaining life span (years)	Although the waste amount has reached the landfill capacity, wastes are continued to be brought in as there is no choice.	31
4) Executing organization of final disposal site	Beyha (private company)	Beyha (private company)
5) Operation charge paid by IMM to operator (TRY /ton)	Not disclosed	Not disclosed
6) Unit cost of operation (TRY/ton)	Not disclosed	Not disclosed
7) Total Capacity (m^3)	10,600,000 m^3	Not identified as the area has become part of Izmir MM in 2014
8) Class [9]	Class II	Class II

[9] Article 5 of Regulation on Landfill of Wastes defines the classes for sanitary disposal site. Article 5 is given below:

Photo 4-3: Harmandali disposal site

Photo 4-4: Bergama disposal site

The amount of waste disposed in Harmandali disposal site between the years 2010 and 2014 is shown in table below.

Table 4-23: Amount of municipal solid wastes disposed in Harmandali disposal site

Unit: ton/month

Year / Month	2010	2011	2012	2013	2014
Jan	89,736	93,652	105,338	111,685.05	103,385.40
Feb	86,266	79,553	105,325	111,586.55	95,287.10
Mar	109,054	93,180	106,125	113,237.90	103,613.40
Apr	87,963	90,080	99,765	105,919.80	107,347.85
May	88,151	93,504	107,169	98,325.25	121,355.87
Jun	89,553	97,796	104,103	100,363.50	114,112.85
Jul	100,006	100,177	119,787	107,457.80	110,229.70
Aug	95,930	100,064	108,157	103,983.25	108,771.60
Sep	93,255	95,750	105,037	101,248.05	108,551.25
Oct	95,208	102,846	110,384	107,349.30	113,532.66
Nov	87,637	96,280	101,060	103,117.45	108,797.68
Dec	93,256	105,188	112,304	107,353.10	121,355.87
TOTAL	1,037,951	1,148,070	1,284,553	1,271,627	1,316,321.23

f.2. Future plans

Izmir MM is planning to divide the municipality into 4 regions and to install disposal facilities for each region (Figure 4-14). Currently, a plan is being prepared to install a new integrated solid waste management facility in the Yamannar DM which is not too far from the Harmandali disposal site. The public meeting for the EIA was conducted at the end of March 2015.

ARTICLE 5 - (1) sanitary disposal sites are classified as following:
a) Class I sanitary disposal site: The facility having required infrastructure for storing hazardous wastes.
b) Class II sanitary disposal site: The facility having required infrastructure for storing municipal wastes and non-hazardous wastes.
c) Class III sanitary disposal site: The facility having required infrastructure for storing inert wastes.

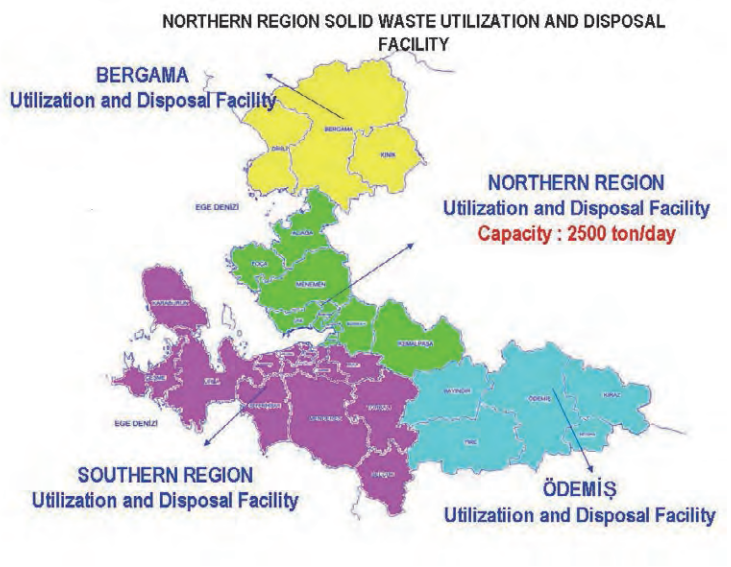


Figure 4-14: Planning on construction of disposal facilities by region in Izmir MM

The planned treatment flow of the new facilities is as shown below.

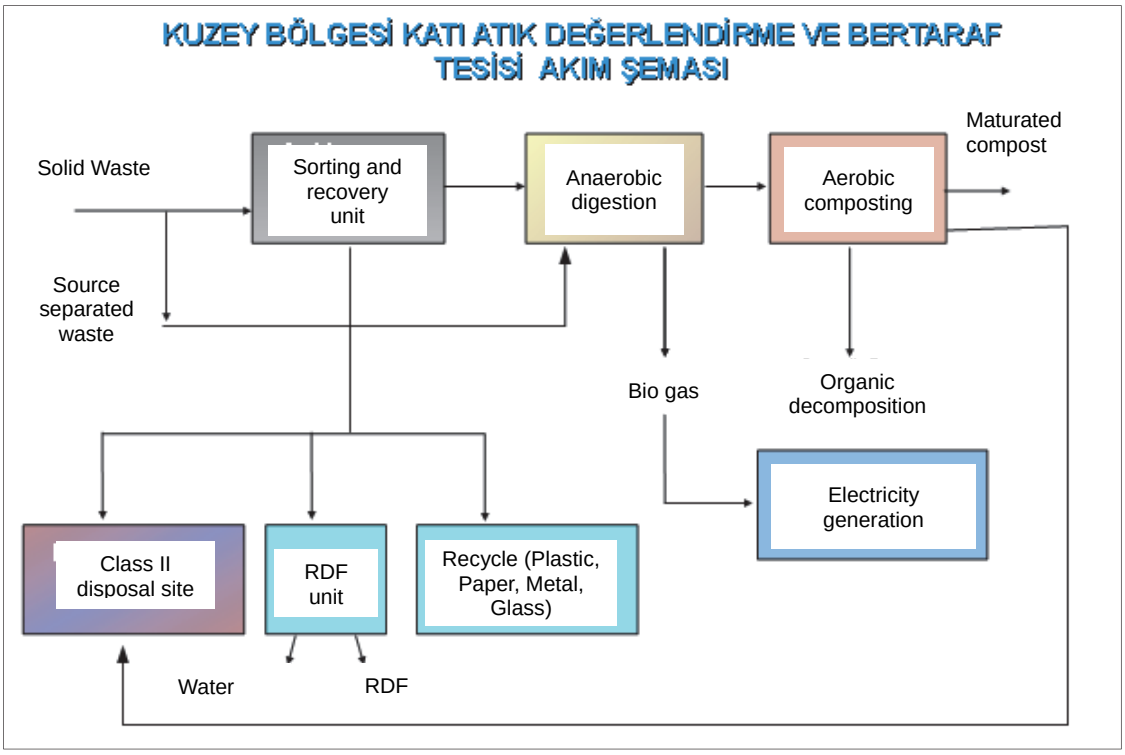


Figure 4-15: Intermediate and final disposal flow of wastes in the new integrated solid waste management facilities

4.3.4 Waste composition

a. Waste composition survey conducted by Izmir MM

Izmir MM has been conducting waste composition survey in line with MoEU WCS Guidelines since the year 2002.

b. Target area

Samples were taken from low, middle, and high-income areas and commercial areas.

c. Methodology

The target wastes, survey period, and method of analysis are in accordance with the MoEU WCS Guidelines. However, it is possible that interpretation of these guidelines differ from staff to staff or year to year. In the summer, the survey is generally conducted around June, July, or August, and in the winter, it is generally conducted around February or March. However, survey was not conducted in 2014 due to administrative change and lack of budget.

d. Results of pervious surveys

The results from the previous surveys in Izmir MM are shown in Table 4-24 and Figure 4-16.

Table 4-24: Results of waste composition survey in Izmir MM

Year	2009			2010			2011			2012			2013		
Solid waste component	Winter	Summer	Average (%)	Winter	Summer	Average (%)	Winter	Summer	Average (%)	Winter	Summer	Average (%)	Winter	Summer	Average (%)
Kitchen waste	21.29	58.12	39.71	49.10		49.10	51.88	57.45	54.66		46.71	46.71	54.91	57.95	56.43
Paper	5.79	6.92	6.36	6.58		6.58	5.10	6.52	5.81		5.70	5.70	4.59	3.38	3.99
cardboard	2.93	2.57	2.75	2.45		2.45	2.22	1.83	2.02		3.29	3.29	2.19	2.34	2.27
bulky cardboard	0.92	3.19	2.05	0.42		0.42	1.61	1.98	1.80		3.97	3.97	1.40	2.95	2.18
Plastic	3.72	10.74	7.23	8.36		8.36	10.35	8.63	9.49		14.91	14.91	12.64	11.20	11.92
Glass	4.91	5.28	5.09	4.43		4.43	4.34	6.41	5.37		6.55	6.55	4.90	5.03	4.97
Metal	0.32	0.34	0.33	0.51		0.51	0.66	0.59	0.63		1.24	1.24	0.62	1.32	0.97
Bulk metal	0	0.19	0.09	0.00		0.00	0.04	0.00	0.02		0.00	0.00	0	0	0.00
Waste electrical and electronic equipment	0.17	0.10	0.14	0.13		0.13	0.31	0.51	0.41		0.07	0.07	0.08	0.78	0.43
Hazardous waste	0.51	0.61	0.56	0.13		0.13	0.81	1.21	1.01		1.50	1.50	1.03	2.55	1.79
Park and garden waste	7.87	1.52	4.70	0.85		0.85	1.45	1.14	1.29		1.94	1.94	0.13	1.78	0.96
Other incombustibles	21.99	0.43	11.21	0.73		0.73	1.66	2.58	2.12		0.90	0.90	0.42	0	0.21
Other combustibles	17.98	6.55	12.26	7.77		7.77	13.25	10.99	12.12		12.15	12.15	9.39	9.79	9.59
Other combustible bulky wastes	0	1.94	0.97	0.65		0.65	0.68	0.15	0.41		0.72	0.72	0.48	0	0.24
Other incombustible bulky wastes	0	0	0.00	0.00		0.00	0.01	0.00	0.00		0.35	0.35	0.30	0.92	0.62
Others	0	1.49	0.75	12.87		12.87	0.07	0.00	0.03		0.00	0.00	0	0	0.00
Ash (1 cm sieve dust, sand, stone included)	11.61	0	5.80	5.02		5.02	5.57	0.00	2.79		0.00	0.00	6.92	0	3.46
TOTAL	**100**	**100**	**100**	**100**	**0**	**100**	**100**	**100**	**100**	**0**	**100**	**100**	**100**	**100**	**100**

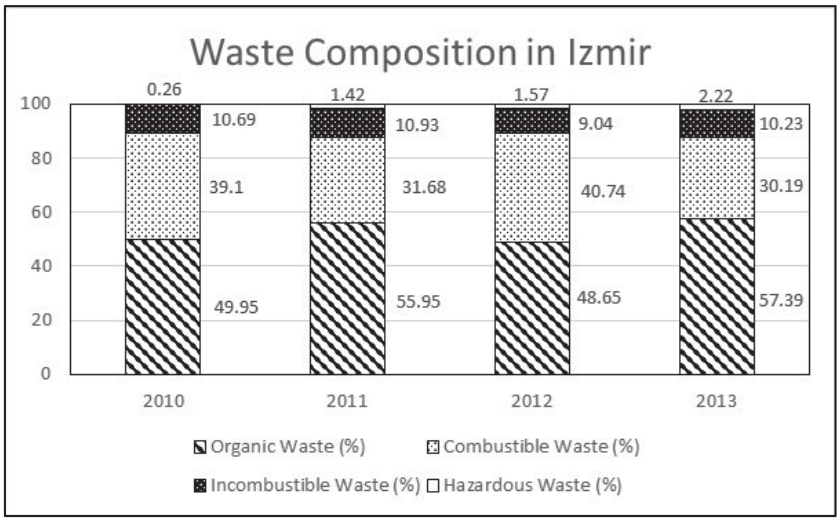


Figure 4-16: Share of organic, combustible, incombustible, and hazardous wastes in Izmir MM

e. Observation regarding waste composition of Izmir MM

With regard to physical composition, the share of plastic wastes is increasing and that of organic wastes is decreasing. The comparison between the wastes in winter and summer is shown in Figure 4-17. These wastes were compared based on the Japanese categories of wastes. Although there is no significant difference with regard to paper, there are more organic wastes in summer and more incombustible wastes in the winter.

Further, in winter, more than 7% of the incombustible wastes consisted of ash. This is because heating with charcoal is still common in homes in the suburban areas in Turkey. Thus, the impact of ash in winter should be considered for the coming years.

When considering the wastes in Izmir MM as fuel for WtE facilities, it is ideal that the incombustible wastes which make up about 20% of the wastes be removed from wastes both in winter and summer. In summer, the share of organic wastes should also be reduced.

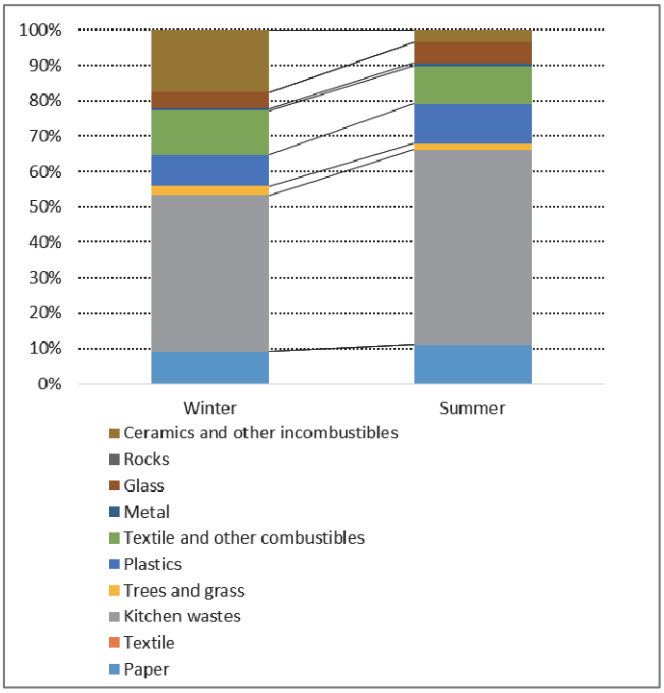


Figure 4-17: Comparison of waste composition of Izmir MM in winter and summer

Further, the wastes of Izmir MM were compared with the typical wastes in the urban areas of Japan. The average composition of wastes in Izmir MM and that of wastes at Itabashi incineration facility are compared in Figure 4-18. The characteristics of wastes that are incinerated in Japan are as explained in Section 4.1.4 regarding Bursa MM. Similar with the wastes in other MMs, the wastes in Izmir MM is high in organic and incombustible wastes.

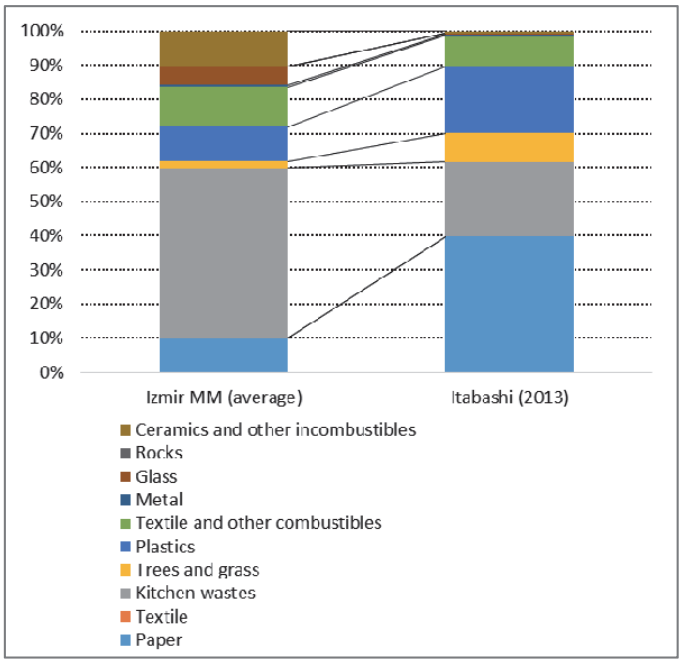


Figure 4-18: Comparison of waste composition of Izmir MM and Japanese cities

4.3.5 Financial status

As is the case with other MMs, the MDMs are responsible for collection and transport, and the MM is responsible for treatment and disposal. There are several transfer stations and two disposal sites operating in Izmir MM. The financial status was reviewed regarding transportation from transfer stations to disposal which is under the responsibility of the MM.

The expenditures for municipal solid waste management by Izmir MM is shown in the table below. The costs for collection and transport to transfer stations are not included here, as those works are under the responsibility of the MDMs and the MM is not aware of such information.

Table 4-25: Municipal solid waste management expenditure in Izmir MM (2014)

Responsible agency	Transfer station			Treatment and disposal		
	ton	TRY	TRY/ton	ton	TRY	TRY/ton
Izmir MM	763,044	27,387,531	35.89	1,352,821	5,443,895	4.02

Note: Costs for treatment and disposal are operation costs and do not include investment costs

Based on the above, it is estimated that the annual expenditure for solid waste management by Izmir MM is 24.26 TRY (approximately 1,100 JPY) per ton. These expenditures are financed by environmental taxes which were equivalent to 9,860,000 TRY or 35% of the total solid waste management expenditures in 2014. The remaining expenditures are financed by the general budget of MM.

4.3.6 Operational cost of municipal solid waste management

a. Financial source

The costs for transport and disposal of municipal solid wastes in Izmir MM are financed by waste management tariff and ECT. These fees are collected from generators together with the water bill. The ECT rates for different generators are shown below. The ECT rates are revised and collected annually, and the revenue from ECT in Izmir MM was 9,861,311.68 TRY in 2014.

Table 4-26: ECT rate of Izmir MM

Unit: TRY/m^3-water

MDM	Cost (TRY/ Month)	Household	Non-Household	Public Buildings	Hospital and School	Touristic Facility	Bakery and Bath	Industry
		Household, Veteran, Disabled, Well, Sewerage Household	Non-household, Well Sewerage Non-household	Municipality, Public Building, NATO, Embassy,	Hospitals, School (Public and Private)	Touristic Facilities	Bakery, Bath, Sport Club	Industrial Facilities
	Unit transport cost	0.71	2.61	2.61	13.03	13.03	6.51	13.03
	Unit disposal cost	0.21	0.79	0.79	3.97	3.97	1.99	3.97
	Total unit cos	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Aliağa **	Rate (fee)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balçova	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Bayındır	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Bayraklı	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Bornova	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Buca	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Çiğli *	Rate (fee)	0.21	0.79	0.79	3.97	3.97	1.99	3.97
Foça	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Gaziemir	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Güzelbahçe	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Karabağlar	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Karşıyaka	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Kemalpaşa **	Rate (fee)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Konak	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Menderes	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Menemen *	Rate (fee)	0.21	0.79	0.79	3.97	3.97	1.99	3.97
Narlıdere	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Seferihisar	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Selçuk	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Torbalı	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00
Urla	Rate (fee)	0.92	3.40	3.40	17.00	17.00	8.50	17.00

* No transport
** No transfer and no disposal
Note: the above include value-added tax (VAT)

b. Collection cost

No information has been obtained for collection cost.

c. Operational cost of transfer stations

The total operation cost of transfer stations was 27,387,531.51 TRY in 2014.

d. Operational cost of disposal sites

The total of the operation cost for final disposal was 5,443,895.12 TRY in 2014.

4.3.7 Industrial wastes

a. Amount generated and treated

There are several petroleum refining companies that produce industrial wastes, and these facilities treat their own wastes in their sites under their responsibility. The amount of non-hazardous industrial waste disposed at the disposal site for the last 5 years is given below.

Table 4-27: Amount of industrial waste in Izmir MM

Unit: ton

Type of waste	2010	2011	2012	2013	2014
Non-Hazardous Industrial Waste	72.766	36.417	70.134	69.788	61.641
Expired Supermarket Food	4.142	4.842	5.915	4.265	4.915
Biological Treatment Sludge	5.580	40.675	42.810	42.741	30.757
Chemical Treatment Sludge	41.505				

b. Cost of treatment and disposal

Izmir MM has no data regarding this issue.

c. Colelction and transport

Izmir MM has no data regarding this issue.

d. Treatment and disposal

Izmir MM has no data regarding this issue.

4.3.8 Medical wastes

a. Amount generated and treated

17.5 ton of medical waste is generated in Izmir MM per day. Currently, there is no sterilization facility for medical wastes in Izmir MM and thus such wastes are transferred to the sterilization facility in the neighboring Manisa MM.

Izmir is the only metropolitan municipality that does not have a medical waste treatment facility among the MMs in Turkey. It is planned that a new medical waste sterilization facility will be constructed in Menemen DM where there is a non-operating composting facility at the moment. The planned area is 6,000 m^2 and it has been decided that EIA is unnecessary.

b. Cost of treatment and disposal

As the wastes are transferred directly from the medical facilities to the sterilization facility in Manisa MM and the medical facilities pay directly the treatment fee to the operation company as per the tariff set by Local Environment Board at Provincial Governate, Izmir MM has no data on cost of treatment and disposal of medical wastes. The collection and disposal fee paid by healthcare facilities is 1.5 TRY/ton.

c. Collection and transport

Collection and transport is conducted by private operator.

d. Treatment and disposal

Medical wastes are sterilized at autoclave by using calcium oxide and heat.

4.3.9 Needs regarding solid waste management

As Izmir MM is the third largest city in Turkey after Istanbul and Ankara, it has a large surface area which is about 12,000 km^2 or about six times larger than the size of the Tokyo Metropolitan Government. Currently Izmir MM is planning to introduce a waste management

system that would integrate the waste management in the 9 MDMs which newly joined the Izmir MM. However, due to its vast area, an integrated system for the whole MM has not yet been established.

There is an on-going plan to construct integrated waste management facilities in Yamanlar District. The first public consultation meeting has been organized and the detailed design is currently being prepared. However, the strategy for managing the wastes in the southern region which generate 1,500 to 2,000 ton of wastes daily has not been established. Although Izmir MM would be able to manage its wastes for a few years if the new facilities in Yamanlar start to operate, planning for the new facilities to be constructed in the southern region is an urgent task. Currently, several candidate sites for the new facilities are under consideration. Izmir faces urgent need to develop a waste management strategy for the entire MM.

With regard to WtE technologies, it is considered that application of such technologies in the southern region would be effective. Generally, the lifetime of waste treatment facilities in Turkey is about 30 years. Considering the fact that the waste amount may rapidly increase in the coming years, it may be efficient to construct new facilities in multiple periods. Introduction of WtE technologies could be considered as the technology to supplement existing facilities in the future.

4.4 Antalya MM

4.4.1 General information

Antalya province is located in Mediterranean Region in the south-western part of Turkey. The province consists of nineteen districts and the total population is 2,222,200 as of the end of 2014. The southern part of the province faces the Mediterranean Sea in which the temperate climate attracts many tourists in summer.

Following the amendments in the Law on Metropolitan Municipality in December 2012, the autonomous area of Antalya MM expanded to the whole area of Antalya Province and the Antalya Metropolitan District Municipality (MDM) in March 2014. The central district of the MM was divided into 5 MDMs (Aksu, Döşemealti, Kepez, Konyaalti, and Muratpaşa MDM). As a result, the number of districts in Antalya province increased to 19 MDMs. The population of each MDM is shown in the following table.

Table 4-28: Population of the 19 MDMs in Antalya MM (2014)

Metropolitan District Municipality (MDM)	Population
1. Akseki	12,254
2. Aksu	68,106
3. Alanya	285,407
4. Döşemealti	53,554
5. Demre	26,059
6. Elmali	38,598
7. Finike	46,853
8. Gazipaşa	48,561
9. Gündoğmuş	7,949
10. İbradi	2,800
11. Kaş	55,574
12. Kemer	41,621
13. Kepez	470,759
14. Konyaalti	145,648
15. Korkuteli	52,913
16. Kumluca	66,783
17. Manavgat	215,526
18. Muratpaşa	465,927
19. Serik	117,670
Total	2,222,562

Source:Turkish Statistical Institute HP (http://www.turkstat.gov.tr)

4.4.2 Projection on municipal solid waste amount

The "Waste Management Action Plan 2008-2012" estimates that the amount of waste generated per person per day is 1.06 kg/person/day[10]. Based on this figure, the future municipal solid waste amount in Antalya MM was estimated as follows.

[10] This value is not the same with the current collected amount. However, this value was used for the projection in this Survey, as this is the value takes into account the future changes and is applied in the Waste Management Action Plan 2008-2012 which is a national action plan.

Table 4-29: Projection of municipal solid waste amount in Antalya MM

Year	Population	Daily waste amount (ton/day)	Yearly waste amount (ton/year)
2014	2,191,410	2,323	847,857
2015	2,240,640	2,375	866,904
2016	2,289,667	2,427	885,872
2017	2,338,474	2,479	904,756
2018	2,387,054	2,530	923,551
2019	2,435,395	2,582	942,254
2020	2,483,488	2,632	960,862
2021	2,531,304	2,683	979,362
2022	2,578,910	2,734	997,780
2023	2,626,299	2,784	1,016,115

Source: Population: TurkStat, Population Projections, 2013-2075, Waste generation amount per person per day: Waste Management Action Plan 2008-2012

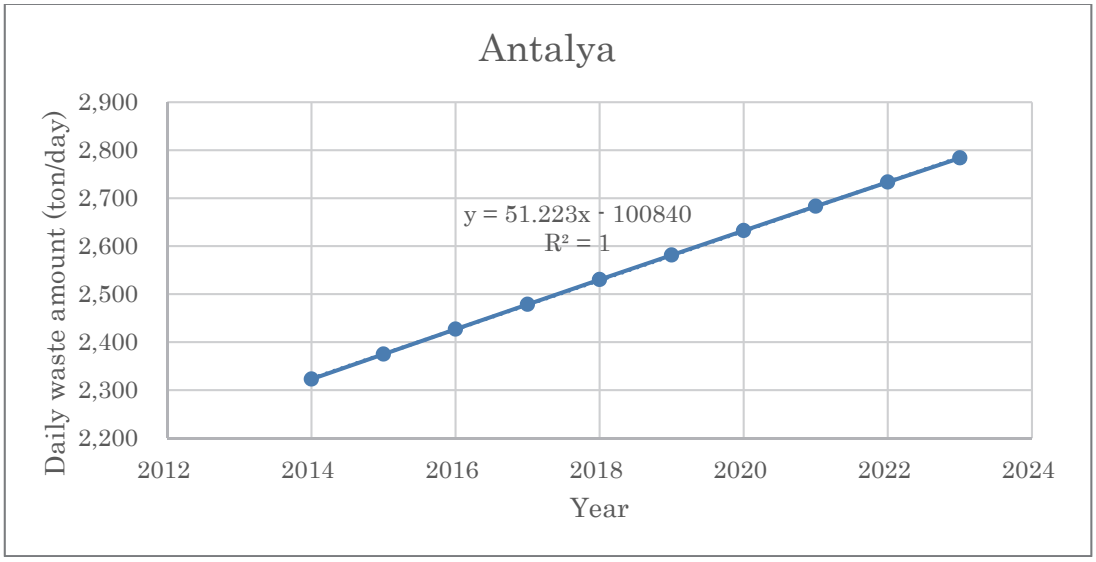


Figure 4-19: Projection of municipal solid waste amount in Antalya MM

From 2014 to 2023, the population is expected to increase by 430,000 and the yearly waste amount by 170,000 ton/year or daily waste amount by 460 ton/day.

4.4.3 Current municipal solid waste management

a. Collection

In Antalya MM, 13 MDMs directly provide wastes collection service while the remaining 6 MDMs outsource the service to private companies.

b. Population of MDM and amount of collected wastes

Among the districts, İbradi MDM with a population of 2,800 is the smallest in terms of the daily collection amount of 2.0 ton/day while Muratpaşa MDM with a population of 465,927 is the biggest with the collection amount of 469.32 ton/day. The total collection amount of solid waste in Izmir MM is 1,988.75 ton/day as of February 2015.

As data of collection amount was not available for the open dump sites in the 4 eastern MDMs (Akseki, İbradi, Gazipaşa, and Gündoğmuş MDMs) and the 4 western MDMs (Demre, Elmali, Kaş, and Korkuteli MDMs), the figures were estimated by multiplying the amount of waste generation per person (calculated from the data of 11 districts transporting waste to the sanitary disposal sites) by the populations of the respective districts.

Table 4-30: The collection amount of municipal solid waste, packaging wastes and execution body in each MDM in Antalya MM

	MDM	Collected amount (ton/day) February 2015	Packaging waste amount (ton/day)	Executing body
1	Akseki	5.0	U.S	Municipality
2	Aksu	50.1	U.S	Municipality
3	Alanya	200.0	U.S	Municipality
4	Döşemealti	49.2	U.S	Municipality
5	Demre	28.0	U.S	Private Company
6	Elmali	33.2	U.S	Municipality
7	Finike	40.3	U.S	Private Company
8	Gazipaşa	40.0	U.S	Municipality
9	Gündoğmuş	6.0	U.S	Municipality
10	İbradi	2.0	U.S	Municipality
11	Kaş	30.0	U.S	Municipality
12	Kemer	42.0	U.S	Private Company
13	Kepez	432.5	U.S	Private Company
14	Konyaalti	140.8	U.S	Municipality
15	Korkuteli	80.0	U.S	Private Company
16	Kumluca	56.3	U.S	Municipality
17	Manavgat	194.0	U.S	Private Company
18	Muratpaşa	469.3	U.S	Municipality
19	Serik	90.0	U.S	Municipality
	Total	1,988.8		

Note: The amount was estimated by multiplying "average collection amount per person" by "population"
U.S. implies "under survey".

Source: Interview with Antalya MM

c. Transport

c.1. Direct transport to the disposal site

8 out of 19 MDMs, namely 4 eastern MDMs (Akseki, İbradi, Gazipaşa, and Gündoğmuş MDMs) and 4 western MDMs (Demre, Elmali, Kaş, and Korkuteli MDMs) dispose their waste in open dumping sites, and the rest of the MDMs transport their wastes to sanitary disposal sites. However, it is likely that wastes from all MDMs would be transported to the sanitary disposal site in the future as shown in Figure 4-21.

c.2. Trasport through transfer stations

There are two transfer stations in Antalya MM, namely Kemer transfer station operated by Antalya MM and Manavgat transfer station operated by the DM, although Kemer Transfer Station is currently under rehabilitation. As the self-governing territory of Antalya MM expanded to the Antalya province in March 2014, Manavgat DM attempted to transfer the responsibility of managing its transfer station to Antalya MM. However, as Antalya MM rejected the request in accordance with the Law which indicates that a transfer station is needed only if its distance from the disposal site is of more than 30 km. Therefore, Manavgat transfer station is still managed by Manavgat DM.

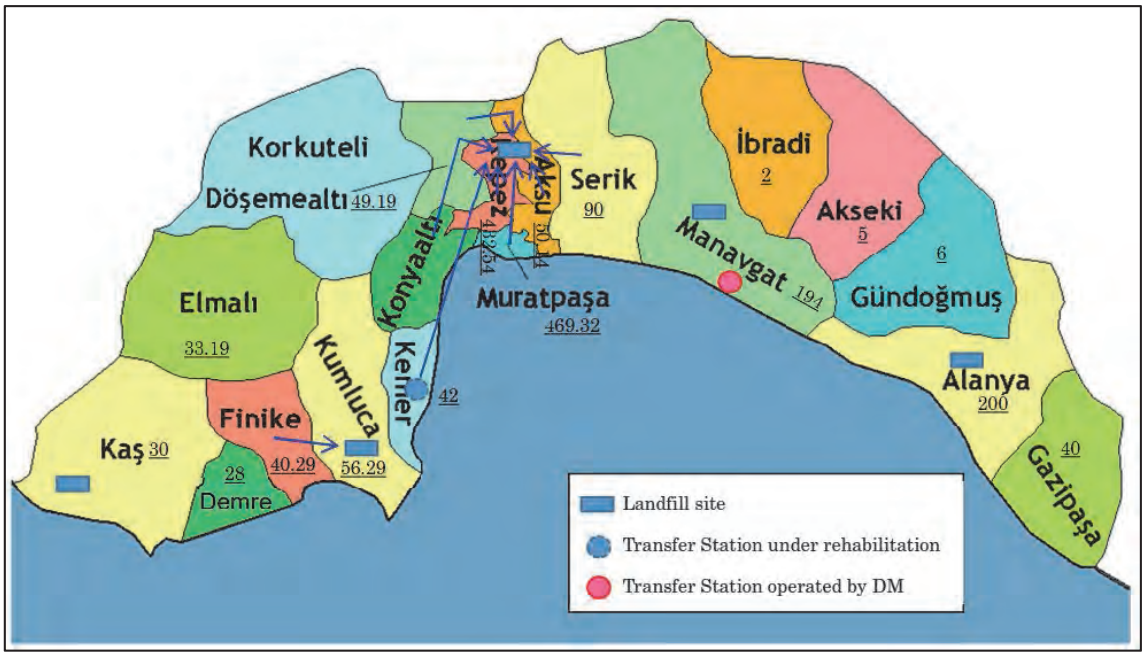
d. Waste flow (from collection, transport, to disposal)

There are five final disposal sites in Antalya province, namely Alanya, Kaş, Kepez, Kumluca and Manavgat disposal sites. Three of these sites, namely Alanya, Kaş and Manavgat disposal sites, accept only the solid waste generated in each MDM. The disposal site in Kepez MDM accepts wastes from seven MDMs, namely Aksu, Döşemealti, Kemer, Kepez, Konyaalti, Muratpaşa, and Serik MDMs. The disposal site in Kumulca MDM accepts wastes from Kumulca and Finike MDM. As the self-governing territory of Antalya MM expanded to Antalya province in March 2014, Antalya MM is in the middle of revising the process of collection and transport of solid waste, and planning to construct two new disposal sites.

Currently, there are 33 open dump sites total in the four MDMs in the eastern region, namely Akseki, Gazipaşa, Gündoğmuş and İbradi, and four MDMs in the western region, namely Elmalı, Kale, Kaş and Korkuteli. The closing of these open dump sites are currently being considered. Antalya MM is also planning to close the existing disposal sites and to construct new integrated final disposal sites. It is currently preparing to call out tender for the construction project of integrated final disposal site. The current management plan and the future plan regarding the disposal sites are outlined in the table below. The current and future waste flows in Antalya MM are illustrated in Figure 4-20 and Figure 4-21.

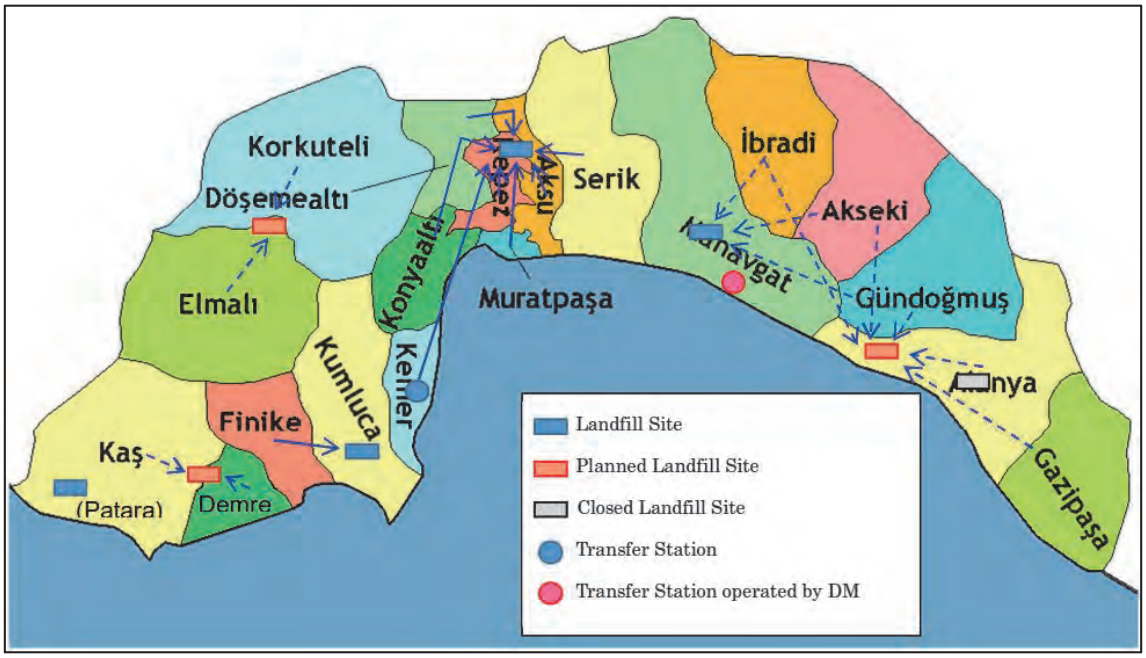
Table 4-31: The management plan and future plan of final disposal site for solid waste collected by each MDM in Antalya MM

Waste Disposal Site	Current direct transportation	Future direct transportation
Kizilli Solid Waste Sanitary Landfill Site (Operated by ITC (Invest Trading & Consulting AG))	7 Districts (Aksu, Döşemealti, Kemer, Kepez, Konyaalti, Muratpaşa, Serik)	Same as the current situation
Manavgat Central Landfill Site (Operated by Arel Çevre Yatırımları Enerji ve Elektrik Üretim Ltd.)	Manavgat	Manavgat+ 3Districts (İbradi, Akseki, Gündoğmuş) (If possible)
Alanya Landfıll Sıte (Operated by Atık Çevre)	Alanya	Alanya Integrated SW Disposal Site Alanya+ Gazipaşa+3District (İbradi, Akseki, Gündoğmuş)
Kumluça Landill Site (Operated by Remondis Çevre Tek. ve San. A.Ş.)	Kumulça, Finike	Same as the current situation
Pataya (Kaş) small Landfill Site (Operated by Remondis Çevre Tek. ve San. A.Ş.)	Pataya (Kaş)	Same as the current situation
New Landfill Site at the boundary between Korkuteli and Elmarı		Korkuteli and Elmarı
New Landfill Site at the boundary between Demre and Kaş		Demre and Kaş
Open Dumping Site	4 Districts (Akseki, Elmarı, İbradı, Gündoğmuş, Korkuteli, Gazipaşa, Demre, Kaş)	Planning to close all of them



Note: Patara is not DM and is a "quarter" which is part of Kaş district.

Figure 4-20: Current flow of municipal solid wastes in Antalya MM



Note: Patara is not DM and is a "quarter" which is part of Kaş district.

Figure 4-21: Future plan of municipal solid waste flow in Antalya MM

e. Disposal

11 out of 19 MDMs dispose wastes in the 5 sanitary disposal sites. The private companies which are outsourced by the Antalya MM operate these sites as outlined in table below.

Table 4-32: Outline of disposal sites in Antalya MM (1)

Site name	Kızıllı Solid Waste Sanitary Landfill	Manavgat Solid Waste Sanitary Landfill
1) Method of operation	Sanitary Landfill	Sanitary Landfill
2) Disposal amount (ton/day)	1,351 (2010), 1,460 (2011), 1,556 (2012), 1,612 (2013), 1,750 (2014)	370
3) Expected remain of life span (years)	Unknown	15
4) Executing organization of final disposal site	ITC (Invest Trading & Consulting AG)	Arel Çevre Yatırımları Enerji ve Elektrik Üretim Ltd.
5) Operation charge paid by Antalya MM to ITC (TRY /ton)	Unknown	Unknown
6) Unit cost of operation (TRY/ton)	Unknown	Unknown
7) Total Capacity （m^2)	Unknown	Unknown
8) Class	Class II	Class II

Table 4-33: Outline of disposal sites in Antalya MM (2)

Site name	Antalya Solid Waste Sanitary Landfill	Kumluca Solid Waste Sanitary Landfill
1) Method of operation	Sanitary Landfill	Sanitary Landfill
2) Disposal amount (ton/day)	400	60.71
3) Expected remain of life span (years)	1	Unknown
4) Executing organization of final disposal site	ITC (Invest Trading & Consulting AG)	Remondis Çevre Tek. ve San. A.Ş.
5) Operation charge paid by Antalya MM to ITC (TRY /ton)	Unknown	Unknown
6) Unit cost of operation (TRY/ton)	Unknown	Unknown
7) Total Capacity （m^2)	Unknown	Unknown
8) Class	Class II	Class II

Table 4-34: Outline of disposal sites in Antalya MM (3)

Site name	Patara Solid Waste Sanitary Landfill
1) Method of operation	Sanitary Landfill
2) Disposal amount (ton/day)	23.28
3) Expected remain of life span (years)	Unknown
4) Executing organization of final disposal site	Remondis Çevre Tek. ve San. A.Ş.
5) Operation charge paid by Antalya MM to ITC (TRY /ton)	Unknown
6) Unit cost of operation (TRY/ton)	Unknown
7) Total Capacity （m^2)	Unknown
8) Class	Class II

4.4.4 Waste composition

a. Waste composition survey conducted by Antalya MM

Antalya MM conducted waste composition survey both in winter and summer from 2009 to 2011. However, Antalya MM suspended the survey after 2011 due to lack of human resources. The outline of waste composition survey in Antalya MM is described as follows.

b. Target area

Target area of waste composition survey should contain both residential and commercial area according to the waste composition survey guideline prepared by MoEU in 2007. Moreover, samples from the residential area should be taken from low, middle, and high-income areas. The target area of waste composition survey in Antalya MM is shown in the following table.

Table 4-35: Target area of waste composition survey in Antalya MM

No	Category	Name of area
1	Low-income area	Habipler Mah area
2	Middle-income area	Zafer Mah area
3	High-income area	Dedeman area
4	Commercial area	Plaza 2000 Binası area

c. Methodology

The details of the previous surveys were unavailable during the survey. However, it is assumed that the basic methodology was in line with the MoEU WCS Guidelines.

d. Results of previous surveys

In the results of the previous surveys conducted by Antalya MM, wastes were categorized into four types - organic (A), combustible (B), incombustible (C) and hazardous (D) wastes. The results are shown in the table and figure below.

Table 4-36: Physical composition of municipal solid waste in Antalya MM

	Waste componebrs	2008	2009	2010	2011	Annual average	Min Value	Max Value
A	**Organic Waste**							
1	Kitchen waste	58.5%	52.8%	57.1%	60.7%	57.3%	52.8%	60.7%
2	Park And Garden Waste	0.6%	11.6%	2.1%	0.0%	3.6%	0.0%	11.6%
	Total Organic Waste	59.0%	64.4%	59.2%	60.7%	60.8%	59.0%	64.4%
B	**Combustible Waste**							
3	Paper	9.9%	6.8%	8.0%	10.1%	8.7%	6.8%	10.1%
4	Carton	1.7%	0.9%	2.2%	0.4%	1.3%	0.4%	2.2%
5	Bulky Carton	0.0%	0.6%	0.7%	0.0%	0.3%	0.0%	0.7%
6	Plastics	11.3%	14.8%	15.4%	12.5%	13.5%	11.3%	15.4%
7	Other Combustible	8.1%	3.8%	9.2%	11.1%	8.0%	3.8%	11.1%
8	Other Bulky Combustibles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	Other Waste	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Total Combustible Waste	31.1%	26.7%	35.6%	34.1%	31.9%	26.7%	35.6%
C	**Incombustible Waste**							
10	Glass	4.0%	4.3%	4.0%	3.9%	4.0%	3.9%	4.3%
11	Metal	0.8%	0.9%	0.8%	0.3%	0.7%	0.3%	0.9%
12	Bulky Metal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	Other Incombustible	4.4%	0.0%	0.0%	0.1%	1.1%	0.0%	4.4%
14	Other Bulky Incombustible	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15	Ash (dust, sand, including stone) *	0.0%	3.6%	0.0%	0.0%	0.9%	0.0%	3.6%
	Total Incombustible Waste	9.2%	8.8%	4.8%	4.3%	6.8%	4.3%	9.2%
D	**Hazardous Waste**							
16	E-Waste	0.3%	0.1%	0.4%	0.1%	0.2%	0.1%	0.4%
17	Hazardous Waste	0.4%	0.0%	0.0%	0.8%	0.3%	0.0%	0.8%
	Total Hazardous Waste	0.7%	0.1%	0.4%	0.9%	0.5%	0.1%	0.9%
	Total Waste	100.0%	100.0%	100.0%	100.0%	100.0%		

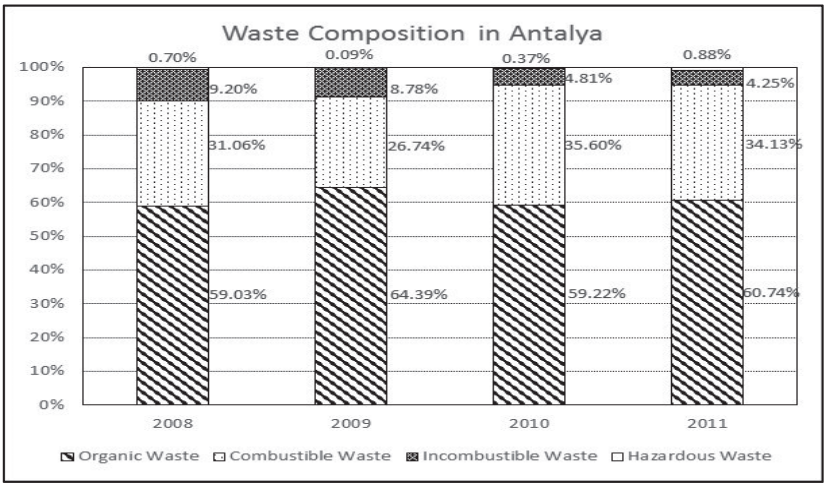


Figure 4-22: Shares of organic, combustible, incombustible and hazardous wastes

e. Observations regarding waste composition of Antalya MM

The share of organic wastes has been increasing and that of plastic wastes and other incombustible wastes has been decreasing. The difference between wastes in winter and summer was compared in Figure 4-23 by using waste categories applied in Japan. Although there is no significant difference in paper and organic wastes, the share of other incombustible wastes is higher in summer and the share of incombustible wastes is much higher in winter.

Further, ash makes up more than 10% of the incombustible wastes in winter which is a phenomenon that is not observed in summer. As homes in the suburban areas still use charcoal for home heating in winter, its impact should be considered for the coming years.

If these wastes are to be considered as fuel for WtE facilities, incombustible wastes which make up more than 10% of the wastes in both summer and winter should be reduced. In summer, the share of organic wastes should also be reduced.

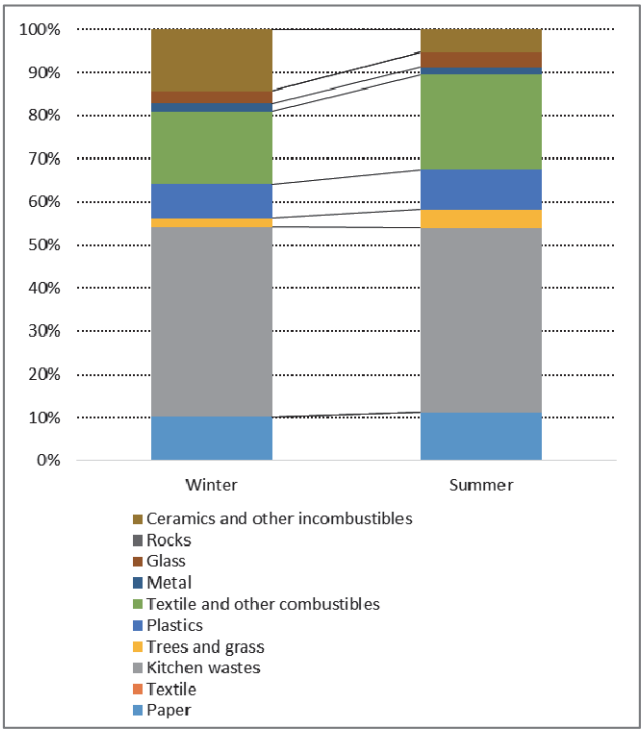


Figure 4-23: Comparison of waste composition of Antalya MM in winter and summer

Further, the characteristics of wastes in Japan and those in Antalya MM were compared. The simple average of waste composition in Antalya MM and the waste composition in Itabashi incineration facility in Tokyo in 2013 were compared. As mentioned in the previous sections, regarding the wastes incinerated in Japan, the share of paper wastes is high and the share of organic wastes is low. As the share of organic wastes and incombustible wastes is high in Antalya MM, these wastes are not highly suitable as fuel for WtE facilities.

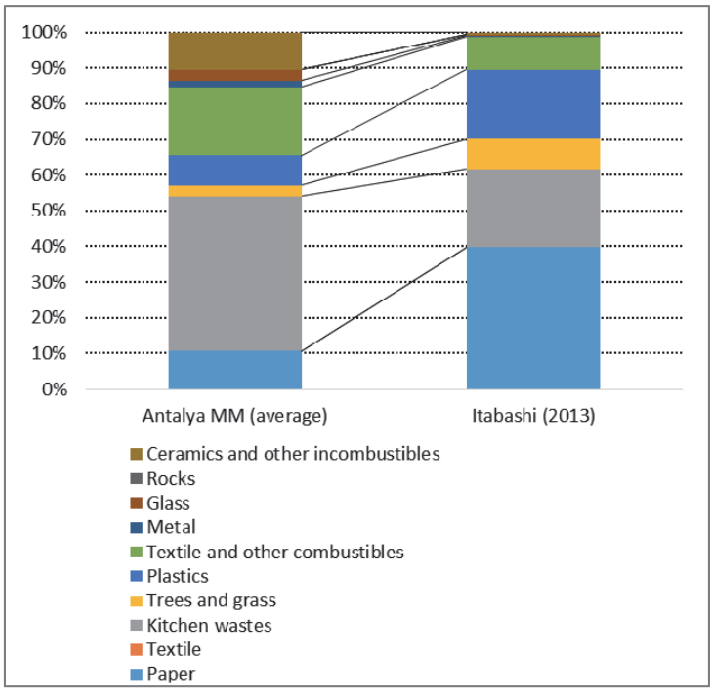


Figure 4-24: Comparison of waste composition of Antalya MM and Japanese cities

f. Schedule of waste composition survey in 2015

Waste composition survey was not conducted by Antalya MM in winter 2015.

4.4.5 Financial status

No information has been obtained during the survey.

4.4.6 Operational cost of municipal solid waste management

a. Financial source

The major financial source for municipal solid waste management in Antalya MM is ECT. ECT is charged to generation sources in proportion to their water consumption. The unit charge rate is 0.26 TRY/m^3 in MM, whereas it is 0.20TL/m^3 in PM. The unit charge rate of ECT is annually determined by the central government which is applied throughout the nation, and thus MMs and MDMs are not authorized to change the rates. ECT from households is collected by Antalya Water Supply and Sewerage Authority (ASAT) under the jurisdiction of Antalya MM together with water utilization fees. Meanwhile, ECT from commercial organizations, shops, and restaurants is collected by Water Supply Departments under the jurisdiction of each MDM. The water supply organizations distributes 20% of the collected ECT to the MM and 80% to the respective MDMs. The amount of ECT collected in Antalya MM in 2014 was 4,591,000 TRY.

b. Collection cost

As MDMs are responsible for collection of the municipal solid wastes, MM does not have data on collection cost.

c. Operational cost of transfer station

There is a transfer station in Kemer MDM. However, detailed information is not available at this point.

d. Operational cost of disposal site

Antalya MM contracts with the private company Çınar Çevre Laboratuvarı A.Ş. for the operation of the disposal site. The unit cost for waste management is 4,768 TRY/ day, and budget for the year 2015 is 1,475,000 TRY/year.

4.4.7 Industrial wastes

As Antalya MM does not treat hazardous industrial wastes, this section only deals with non-hazardous industrial wastes.

a. Amount generated and treated

Amount of collected and treated non-hazardous industrial waste in Antalya MM is 0.504 ton/day. The amount of generation has not been identified.

b. Cost of treatment and disposal

Antalya MM contracts with the private company Çınar Çevre Laboratuvarı A.Ş. for the operation of the disposal site. Although the cost for treatment is not clear, 34.57 TRY/ton is collected from generators as tipping fee.

c. Collection and transport

Collection and transport of non-hazardous industrial waste is beyond the jurisdiction of DMs, since generators of non-hazardous industrial waste are responsible for transporting this type of waste to the disposal site on their own.

d. Treatment and disposal

The non-hazardous industrial waste is treated in the same way with municipal solid waste in Antalya MM.

4.4.8 Medical wastes

a. Amount generated and treated

The medical wastes generated in Antalya MM are treated in the Kızıllı disposal site. 7.56 ton/day of medical wastes is generated and treated in Antalya MM.

b. Cost of treatment and disposal

A facility for sterilization of medical wastes is located in the premise of the disposal site in Antalya which is operated by the company ERA Çevre Teknolojileri A.Ş. based on the 10-year contract with Antalya MM. The operation cost of the facility is 2,200 TRY/ton. For transport and treatment of medical waste, the company collects 2.1 TRY/ton plus VAT of 18% from medical organizations and 20 TRY/ton + VAT of 18% from small-scale hospital or clinics which generate less than 10 kg/month of medical wastes.

c. Collection and transport

No information has been obtained regarding collection and transport of medical wastes.

d. Treatment and disposal

The medical wastes collected and transported to the Antalya disposal site is sterilized and disposed in the landfill area together with the municipal solid wastes.

4.4.9 Needs regarding solid waste management

Since March 2014, Antalya MM is responsible for waste management of the newly joined 14 MDMs which implies that the amount of wastes to be managed was doubled. As of March 2015, Antalya MM is still in the process of collecting data required for managing the wastes within its newly expanded territory. The organizational structure for waste management is also being restructured. Thus, it is estimated that it will take some time for its waste management system to be fully functional.

One of the characteristics of Antalya MM is the high volume of wastes in the summer time due to the increase in number of tourists as Antalya is ranked in top 10 touristic destinations internationally which host more than 10 million tourists annually. Thus, when considering the installment of intermediate treatment facilities, the question of how to deal with the wastes in the summer should be taken into account.

As there is still time left before Kızıllı disposal site reaches its capacity, it is considered most realistic that Antalya in the coming years will prioritize closure of the 30 existing open dump sites, integration of existing disposal sites, and construction of new sanitary disposal sites.

4.5 Sakarya MM

4.5.1 General information

Sakarya MM is located in Marmara Region, the north-western part of Turkey. It consists of sixteen districts and the total population was approximately 933,000 as of the end of 2014. The northern part of the province faces the Black sea, while the central districts of Arifiye, Serdivan and Sapanca face Lake Sapanca.

As an advantage to Sakarya MM, the highway that connects Istanbul and Ankara crosses through its territory. Further, there are many Japanese-affiliated companies such as Toyota and Honda operating in Sakarya province.

In 2000, a Metropolitan Municipality (MM) was established as Adapazari MM. Then, the autonomous area of the MM was expanded twice in 2004 and 2008 and renamed into Sakarya MM in relation with the latter expansion. Following the amendments in the Law on Metropolitan Municipality in December 2012, the autonomous area of Sakarya MM expanded to the whole area of Sakarya Province and the Sakarya Metropolitan District Municipality (MDM). Further, the central district of the MM was divided into 4 MDMs (Adapazari, Arifiye, Erenler and Serdivan MDMs). As a result, the number of districts in Sakarya province increased to 16 MDMs. The population of each MDM is shown in the following table.

Table 4-37: Population of 16 MDM in Sakarya MM

MDM)	Population
1. Adapazarı	263,408
2. Akyazı	84,865
3. Arifiye	39,024
4. Erenler	79,934
5. Ferizli	24,944
6. Geyve	48,051
7. Hendek	76,664
8. Karapürçek	12,373
9. Karasu	57,008
10. Kaynarca	23,297
11. Kocaali	21,800
12. Pamukova	28,309
13. Sapanca	39,437
14. Serdivan	112,611
15. Söğütlü	13,988
16. Taraklı	6,993
Total	932,706

Source: Turkish Statistical Institute HP (http://www.turkstat.gov.tr)

4.5.2 Projection on municipal solid waste amount

The "Waste Management Action Plan 2008-2012" estimates that the amount of waste generated per person per day is 1.06 kg/person/day[11]. Based on this figure, the future municipal solid waste amount in Sakarya MM was estimated as follows.

Table 4-38: Projection of municipal solid waste amount in Sakarya MM

Year	Population	Daily waste amount (ton/day)	Yearly waste amount (ton/year)
2014	925,662	981	358,139
2015	937,215	993	362,608
2016	948,675	1,006	367,042
2017	960,035	1,018	371,438
2018	971,302	1,030	375,797
2019	982,451	1,041	380,110
2020	993,501	1,053	384,386
2021	1,004,444	1,065	388,619
2022	1,015,253	1,076	392,801
2023	1,025,905	1,087	396,923

Source: Population: TurkStat, Population Projections, 2013-2075, Waste generation amount per person per day: Waste Management Action Plan 2008-2012

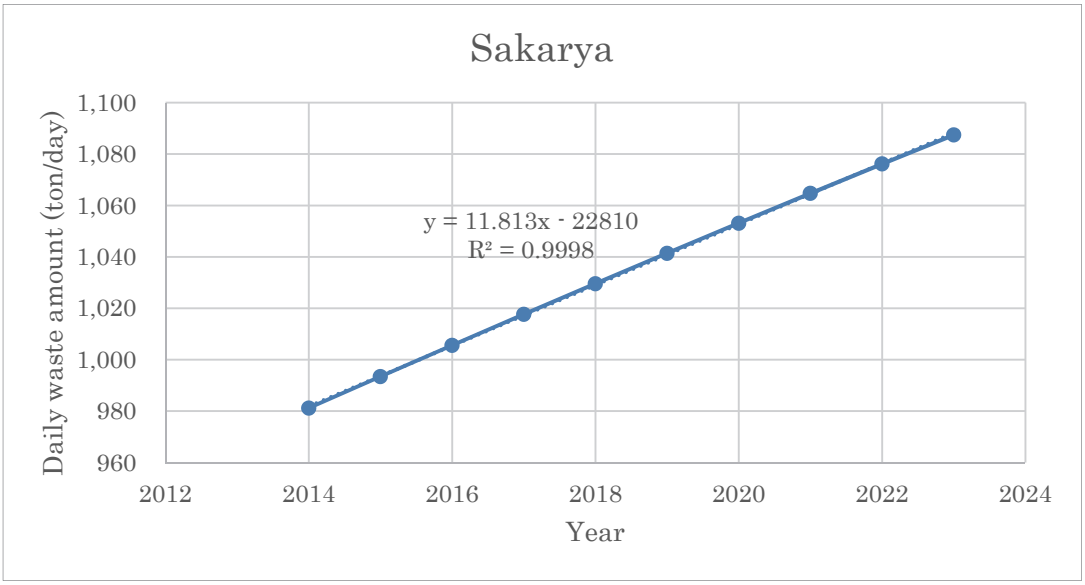


Figure 4-25: Projection of municipal solid waste amount in Sakarya MM

From 2014 to 2023, the population is expected to increase by 100,000 and the yearly waste amount by 39,000 ton/year or daily waste amount by 110 ton/day.

4.5.3 Current municipal solid waste management

a. Collection

Waste collection service is conducted by the 8 MDMs themselves in Sakarya MM while the rest of the MDMs contract the service to private companies. Among the districts, Tarakli

[11] This value is not the same with the current collected amount. However, this value was used for the projection in this Survey, as this is the value takes into account the future changes and is applied in the Waste Management Action Plan 2008-2012 which is a national action plan.

MDM with population of 6,993 collects the smallest daily amount of (3.5 ton/day) while Adapazari MDM with population of 263,408 collects the largest (218.9 ton/day). The total collection amount in Sakarya MM is 751.9 ton/day. As collection amount of wastes from 4 MDMs in the East and 3 MDMs in the South which are disposed at open dumpsites is not available, the relevant figures were estimated by multiplying the amount of waste per person calculated from the data of 12 MDMs transporting waste to the disposal site by the populations of the respective districts.

As for recycling of packaging wastes, 7 private companies are conducting separate collection of packaging waste[12] in Sakarya MM. As MDMs are responsible for organizing separate collection and reporting the progress to the MoEU directly, Sakarya MM is not aware of the detailed information about the current conditions of waste recycling.

The collection amount of municipal solid waste, the amount of collected packaging wastes and executing bodies of the wastes are shown in the table below.

Table 4-39: Collected amount of municipal and separately collected recyclables in each MDM in 2014

(MDM	amount (ton/day)	Separately collected amount (ton/day)	Executing body
1. Adapazarı	218.9	6.26	Private company
2. Akyazı	67.5*	0.59	Private company
3. Arifiye	42.1	1.62	Private company
4. Erenler	75.5	2.2	Private company
5. Ferizli	7.6	-	MDM
6. Geyve	35.7*	0.84	MDM
7. Hendek	69.0*	3.1	Private company
8. Karapürçek	3.5	0.15	MDM
9. Karasu	42.4*	2	MDM
10. Kaynarca	9.1	0.3	MDM
11. Kocaali	14.5*	0.6	MDM
12. Pamukova	18.0*	2	Private company
13. Sapanca	41.4	0.27	Private company
14. Serdivan	95.0	4.32	Private company
15. Söğütlü	8.2	0.2	MDM
16. Taraklı	3.5*	-	MDM
Total	751.9	24.45	

* Estimated based on average waste amount per person multiplied by population

Source: Interview with Sakarya MM

b. Transport

There are two types of transport, namely direct transport to disposal site and transport through transfer stations.

b.1. Direct transport to disposal site

In Sakarya MM, there is only one sanitary disposal site and it receives waste from all the 12 MDMs except for Karasu, Kocaali, Hendek and Akyazi MDMs, which transport their waste to local open dumpsites located in their districts. Although the 3 MDMs in the south (Pamukova, Geyve, and Tarakli MDMs) were also using open dumpsites, they have started transporting their wastes to the sanitary disposal site.

[12] Packaging Waste: Shall mean all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from the producer to the user or the final consumer, excluding production residues; and sales, secondary and transportation packaging wastes including recyclable packaging wastes that are generated after using of the product for which lifetime expired and can be reused and discharged to or left the environment.

b.2. Transport through transfer stations

Although there is no transfer station in Sakarya MM, there are plans to construct 3 transfer stations, namely 2 transfer stations for the 4 MDMs in the east and 1 transfer station in Pamukova MDM.

c. Waste flow (from collection, transport to disposal)

In Sakarya MM, there is only one sanitary disposal site and it receives waste from all the MDMs except for Karasu, Kocaali, Hendek and Akyazi MDMs which transport their waste to local open dumpsites located in their districts. Although the 3 MDMs in the south (Pamukova, Geyve, and Tarakli MDMs) were also using open dumpsites, they have started to transport their wastes to the sanitary disposal site since March 2014 as they have been integrated as a part of Sakarya MM.

However, several issues such as how to finance the transportation cost are under discussion between Sakarya MM and the 3 MDMs in the south that have changed their disposal destination. Therefore, Sakarya MM considers these districts as under transition period from open dumping to landfilling.
The operation and maintenance of the disposal site has been outsourced to a private company Çınar Çevre Laboratuvarı A.Ş under one-year contract since 2012 and the contract is renewed annually.
At the same time, a private company, Hexagon, operates a biogas plant combined with sorting and compost facilities. The company treats municipal solid wastes collected from the 3 southern MDMs and organic wastes from large-scale supermarkets such as Migros located both inside and outside of the Sakarya MM.

Table 4-40: Disposal sites and the sources of accepted wastes in Sakarya MM (in 2014)

Waste Disposal Site	Targeted Direct
Sakarya Solid Waste Sanitary Landfill Site (Operated by Çınar Çevre)	12 Districts (Adapazarı, Arifiye, Erenler, Ferizli, Geyve, Karapürçek, Kaynarca, Pamukova, Sapanca, Serdivan, Söğütlü, Taraklı)
Biogas Unit including Sorting and Compost facility (Operated by HEXAGON)	3 Districts (Geyve, Pamukova, Taraklı)
Open Dumping Site	4 Districts (Akyazı, Karasu, Kocaali, Hendek)

The flow of municipal solid wastes in Sakarya MM is shown in the following figure.

Notes:

- *Unit of figures are "ton/day"*
- *As the 3 MDMs in the south are in transition from open-dumping to sanitary landfill (as of March 2015), the arrows are shown in dashed lines*
- *The 4 MDMs in the west are continuing to transport their wastes to open-dumping sites.*

Figure 4-26: Flow of municipal solid wastes from MDMs in Sakarya MM (in 2014)

d. Disposal

The daily amount of waste to be received at the Sakarya Solid Waste Sanitary Landfill is 450 ton/day. Although the disposal site is under the competences of Sakarya MM, its operation and maintenance is outsourced to a private company Çınar Çevre Laboratuvarı A.Ş based on contract established between Sakarya MM and the company. The expected remaining lifetime of the site is 12 years from the year 2015. The detailed information about the site is presented in the table below.

Table 4-41: Outline of disposal sites in Sakarya MM

Site name		Sakarya Solid Waste Sanitary Landfill
1) Method of operation		Sanitary Landfill
2) Disposal amount (ton/day)	2014	470
	2013	438
	2012	451
	2011	470
	2010	441
3) Expected remain of life span (years) in 2014		12
4) Executing organization of final disposal site		Çınar Çevre Laboratuvarı A.Ş.
5) Operation charge paid by Sakarya MM to Çınar Çevre (TRY /ton) in 2014		MDM: No Charge Private Sector: 81.0
6) Unit cost of operation (TRY/ton) in 2014		9.54
7) Total Capacity （m^2)		2,895,770
8) Class[13]		Class II

Source: Interview with Sakarya MM

4.5.4 Waste composition

a. Waste composition survey conducted by Sakarya MM

Sakarya MM has been conducting waste composition survey (physical composition analysis) in winter and summer every year since 2011 in collaboration with Sakarya University based on the MoEU WCS Guidelines stipulated in 2007. There are also years when the low-heat value of the solid wastes were analyzed. The summary of the wastes composition surveys conducted by Sakarya MM is outlined below.

a.1. Target area

Among the 16 MDMs in Sakarya MM, 4 MDMs are selected as target districts for waste composition survey, namely Adapazari, Akyazi, Erenler, and Serdivan MDMs. The major reasons for selecting these districts are because of the fact that they have the highest population and the amount of wastes collected from these MDMs make up 60% of the total wastes in Sakarya MM.

Table 4-42: Target MDMs and representative areas for wastes composition survey

Name of sampled MDMs	Representative areas
Adapazari	Commercial
Akyazi	Low-income residential
Erenler	Middle-income residential
Serdivan	High-income residential

[13] Article 5 of Regulation on Landfill of Wastes defines the classes for sanitary disposal sites. Article 5 is given below:

ARTICLE 5 - (1) Sanitary disposal sites are classified as following:

a) Class I sanitary disposal site: The facility having required infrastructure for storing hazardous wastes.

b) Class II sanitary disposal site: The facility having required infrastructure for storing municipal wastes and non-hazardous wastes.

c) Class III sanitary disposal site: The facility having required infrastructure for storing inert wastes.

Based on the MoEU WCS Guidelines, areas in each target MDM are identified as low, middle, and high-income areas and commercial areas, and the wastes from these areas are sampled and analyzed.

a.2. Methodology

a.2.1 Target wastes

As mentioned above, the target wastes are collected from the areas identified in the selected 4 MDMs. According to our survey conducted in February 2015, separate collections of recyclable materials are only being conducted in Pamukova, Sapanca, Geyve, and Arifiye MDMs. Therefore, it can be considered that the physical composition of the sampled wastes is similar to those of the wastes prior to separate collection.

a.2.2 Survey period

The survey is conducted on Mondays and Tuesdays. The first day is allocated for analysis of the waste collected from 4 sampling areas of 1 MDM. The target wastes from one MDM is collected on the day allocated for that MDM and analyzed separately by each sampling area of the MDM on the same day. The implementation period of the survey is 2 weeks, and the actual number of days for analysis is 4 days (2 Mondays and 2 Tuesdays).

a.3. Method of analysis

a.3.1 Sampling

The target waste is unloaded in a place at the disposal site by each sampling area on the day allocated for that district. According to the MoEU WCS Guidelines, samples should be taken after mixing the collected wastes in order to homogenize the composition of the target waste in the sample. However, workers do not mix the waste and only select bags of wast from the different parts of an unloaded pile and put the bags into prearranged box with a volume of 0.5 m^3 until the box becomes full. This process is repeated again for the same pile of waste, and the total volume of sample for the survey becomes 1 m^3.

a.3.2 Sorting

The prepared samples are sorted into 16 waste components except for ash in summer and 17 components in winter, as ash is added in winter. The sorted wastes are put into buckets and weighed one by one.

b. Results of previous surveys

As Sakarya MM conducts the physical composition analysis of 4 samples from each of 4 target areas, the total number of samples is 16 for one season. As the survey is conducted twice a year in summer and winter, the total number of samples in a year becomes 32.

The results of the previous surveys conducted by Sakarya MM from 2012 to 2014 are summarized into four categories, namely organic (A), combustible (B), incombustible (C) and hazardous (D) wastes. The results are presented in table and figure below.

Table 4-43: Results of wastes composition analysis

	Waste components	2012	2013	2014	Annual Average	MIN Value	MAX Value
	Number of districts*	4	4	4	4		
	Number of samples	32	32	32	32		
A	**Organic Waste**						
1	Kitchen waste	40.9	41.2	40.6	40.9	40.6	41.2
2	Park And Garden Waste	1.4	0.5	0.5	0.8	0.5	1.4
	Total Organic Waste	42.4	41.6	41.2	41.7	41.2	42.4
B	**Combustible Waste**						
3	Paper	5.9	5.5	5.9	5.8	5.5	5.9
4	Carton	2.7	4.3	4.2	3.7	2.7	4.3
5	Bulky Carton	2.1	1.6	1.7	1.8	1.6	2.1
6	Plastics	15.2	16.3	15.9	15.8	15.2	16.3
7	Other Combustible	9.2	7.8	7.3	8.1	7.3	9.2
8	Other Bulky Combustible	0.4	0.7	0.6	0.6	0.4	0.7
9	Other Waste	0.2	0.9	1.0	0.7	0.2	1.0
	Total Combustible Waste	35.5	37.0	36.5	36.3	35.5	37.0
C	**Incombustible Waste**						
10	Glass	3.9	4.2	4.4	4.2	3.9	4.4
11	Metal	1.8	2.3	2.4	2.2	1.8	2.4
12	Bulky Metal	0.0	0.0	0.0	0.0	0.0	0.0
13	Other Incombustible	1.8	0.7	0.9	1.1	0.7	1.8
14	Other Bulky Incombustible	0.2	0.5	0.6	0.4	0.2	0.6
15	Ash (Dust, Sand, Stone Included)	12.2	11.2	11.5	11.7	11.2	12.2
	Total Incombustible Waste	19.9	18.9	19.8	19.5	18.9	19.9
D	**Hazardous Waste**						
16	WEEE	0.7	0.2	0.3	0.4	0.2	0.7
16	Hazardous Waste	1.6	2.3	2.3	2.1	1.6	2.3
	Total Hazardous Waste	2.3	2.5	2.5	2.4	2.3	2.5
	Total Waste	100.0	100.0	100.0	100.0		

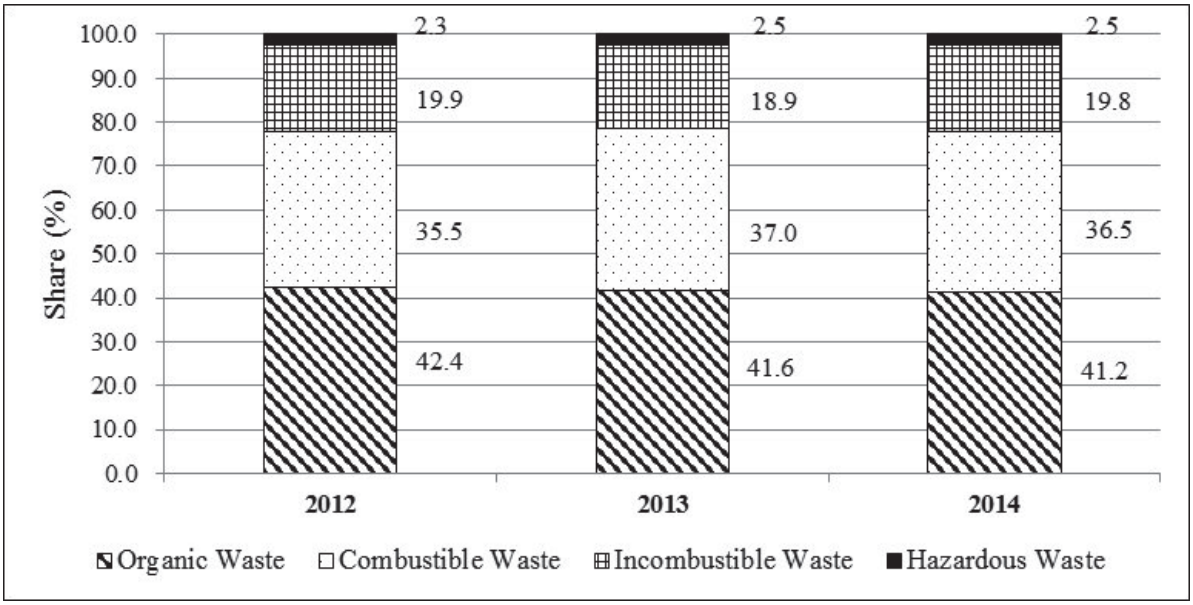


Figure 4-27: Share of organic, combustible, incombustible, and hazardous wastes in Sakarya MM

c. Observations regarding wastes composition

Over the years, the share of plastics is increasing while the share of organic wastes stays at the same level. The comparison between the waste composition in winter and summer is shown in Figure 4-28. There is no significant change in share of paper wastes, the share of organic wastes is higher in summer, and the share of incombustible wastes is significantly higher in winter.

Further, among the incombustible wastes, the ash makes up more than 23% of the wastes in winter, which is a phenomenon that cannot be seen in summer. As the share of ash is higher in Sakarya MM than in other cities, this matter should be taken into consideration.

Considering these wastes as fuel for WtE facilities, the incombustible wastes that make up about 20% in both summer and winter should be reduced. Further, the organic wastes in summer should also be reduced.

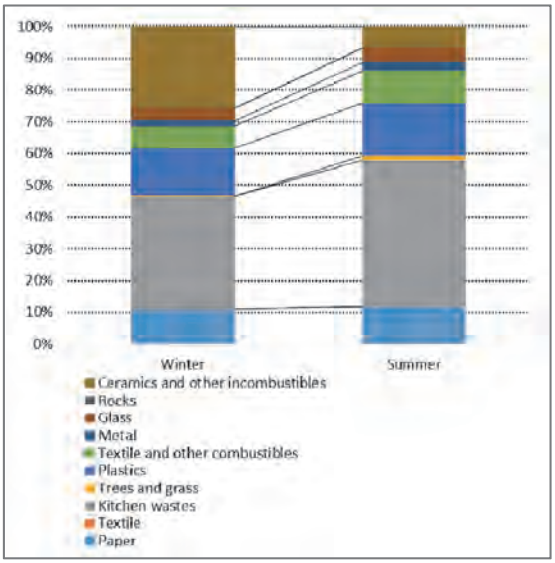


Figure 4-28: Comparison of waste composition of Sakarya MM in winter and summer

The difference in composition of wastes in Sakarya MM and Tokyo (sample taken from Itabashi incineration plant in 2013) is shown in Figure 4-29. The wastes in Sakarya are significantly high in organic and incombustible wastes and thus currently not ideal for WtE plants.

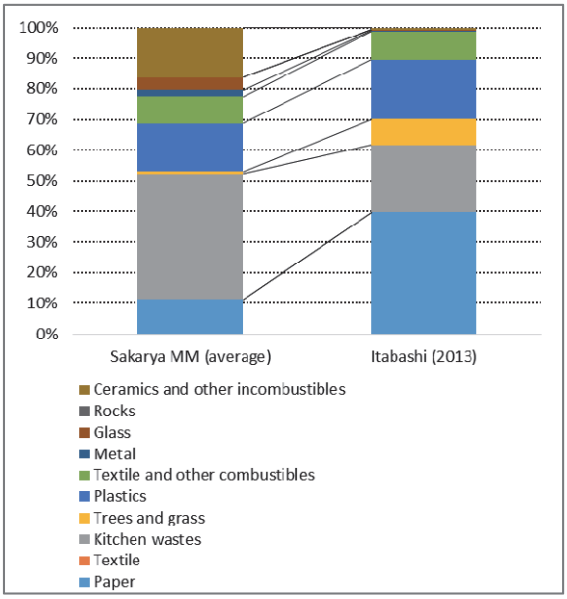


Figure 4-29: Comparison of waste composition of Sakarya MM and Japanese cities

d. Additional waste composition survey conducted by the JICA Survey Team (results are summarized in 5.1)

As the waste composition survey by Sakarya MM was only a physical composition survey, the three contents of the wastes, namely water, combustible matter, and incombustible matter, were not identified. Therefore, the JICA Survey Team analyzed the three contents with the samples used for the physical composition survey by Sakarya MM. The schedule of the waste composition survey conducted by Sakarya MM is shown below.

1st week:	(a) 2 Mar 2015: Serdivan MDM	(b) 3 Mar 2015: Adapazari MDM
2nd week:	(a) 9 Mar 2015: Erenler MDM	(b) 10 Mar 2015: Akyazi MDM

4.5.5 Financial status

In Sakarya MM as with in other MM, the collection and transport is under the responsibility of the MDMs and the treatment and disposal is under the responsibility of MMs. As there is no transfer station in Sakarya MM, the expenditures by MM are restricted to operation and maintenance of the disposal site. The expenditures in relation to wastes management by Sakarya MM is shown in the table below.

Table 4-44: Expenditures for municipal solid waste management in Sakarya MM (in 2014)

Executing body	Amount treated and disposed (ton/year)	Expenditure for treatment and disposal (TRY/year)	Unit cost for treatment and disposal (TRY/ton)
Sakarya MM	210,714	1,475,000	7.00

Note 1: These expenditures include only annual operation and maintenance cost and do not include investment costs
Note 2: The source of the data above is interview with Sakarya MM (documented data are not disclosed)

The breakdown of this disposal cost consists of fuel (52%) and personnel cost (48%). Like in other MM, Sakarya MM collects environmental tax (tax rate is not disclosed) to finance waste management activities. However, as this revenue is not enough, the activities are also financed by the general budget.

4.5.6 Operational cost of municipal solid waste management

a. Financial source

The major financial resource for municipal solid waste management in Sakarya MM is ECT. ECT is charged to generation sources in proportion to their water consumption. The rates are 0.26 TRY/m^3 in MMs and 0.20 TRY/m^3 in PMs. The unit charge rate of ECT is annually determined by the central government which is applied throughout the nation. Therefore, MMs and MDMs are not authorized to change the rates by themselves. ECT from households is collected by SASKi (Sakarya Water Supply Public Cooperation) under jurisdiction Sakarya MM together with water utilization fees, while those from commercial organizations, shops, and restaurants are collected by Water Supply Departments under the jurisdiction of each MDM. The water supply organizations distributes 20% of the collected ECT to the MM and 80% to respective MDMs. The amount of ECT collected in 2014 in Sakarya MM was 6,856,200 TRY.

b. Collection cost

As MDMs are responsible for collection of the municipal solid wastes, MM does not have data on collection cost.

c. Operational cost of transfer station

There is no transfer station in Sakarya MM.

d. Operational cost of final disposal site

The operation and maintenance of Sakarya disposal site is implemented by the private company Çınar Çevre Laboratuvarı A.Ş. based on contract with Sakarya MM. The unit operation cost of the disposal site is 4,768 TRY/day and the amount of the annual budget for the year 2015 is 1,475,000 TRY/year.

4.5.7 Industrial wastes

As there are no treatment facilities for hazardous industrial wastes in Sakarya MM, this part of the report focuses on the disposal of non-hazardous industrial waste.

a. Amount generated and treated

The amount of collected and treated non-hazardous industrial wastes in Sakarya MM is 0.504 ton/day (the generation amount is unknown).

b. Cost of treatment and disposal

As mentioned above, Çınar Çevre Laboratuvarı A.Ş. Company has been contracted for treatment of non-hazardous industrial waste. Although the treatment cost for this type of waste is unknown, 81.0 TRY/ton as of 2015 is collected from dischargers as a tipping fee.

c. Collection and transport

In Sakarya MM, generators of non-hazardous industrial waste are obliged to transport this type of waste to the disposal site by themselves. Therefore, the collection and transportation of non-hazardous industrial waste is beyond the jurisdiction of relevant MDMs.

d. Treatment and disposal

The non-hazardous industrial waste is treated in a same way with municipal solid waste in Sakarya MM.

4.5.8 Medical wastes

a. Amount generated and treated

The generation and treatment amount of medical waste in Sakarya MM is 3.05 ton/day.

b. Cost of treatment and disposal

A sterilization facility for medical waste is located in the premise of the Sakarya Solid Waste Sanitary Landfill Site which is operated by ERA Çevre Teknolojileri A.Ş. Company based on 10-year contract with Sakarya MM. The operation cost of the facility is 2,200 TRY/ton. The company collects 2.2 TRY/ton + VAT of 18% from medical organizations as a treatment fee of medical waste and transfers 5% of the collected fees to Sakarya MM throughout the initial 5 years of the contract and 10% throughout the remaining 5 years in accordance with the contract.

c. Collection and transport

The collection and transportation cost is unavailable at the moment.

d. Treatment and disposal

The medical waste transported to Sakarya Solid Waste Sanitary Landfill site is disposed in the same way as municipal solid waste after sterilization at the medical waste treatment facility.

4.5.9 Needs on solid waste management

After change in administrative district or integration of new MDMs, Sakarya MM has been coordinating with the MDMs with regard to sharing responsibilities in waste management. Currently, it is at the transition stage where destination of disposal sites are being changed and integrated. Further, the private sector is active in intermediate treatment of wastes in Sakarya MM and reports directly to MoEU, and as a result the MM faces the difficulty to grasp all the

data and look at waste management within its administrative boundary as a whole.

Moreover, there may be significant gaps between the amount of wastes generated and the amount of wastes disposed. Therefore, it is essential for Sakarya MM to first gather information regarding discharge, collection, transport, treatment, and disposal at the level of each MDM. Then, future planning should be developed in line with the waste treatment flow.

Fortunately, there is still some capacity left at the disposal site in Sakarya MM. Therefore, there still remains some time before Sakarya MM would need to consider introduction of new waste treatment/disposal facilities.

With regard to WtE, as Sakarya is not rich in land area similarly with Kocaeli MM, introduction of WtE facilities could be considered for the future, in mid to long-term.

5 Waste Composition Survey

5.1 Outline

The main objective of the waste composition survey was to identify physical composition and three components of municipal solid waste and recycling residues generated in Kocaeli MM and Sakarya MM at the stage of final disposal.

MoEU considers establishment of proper waste treatment facilities by local governments as the key for better waste management in the country and has formulated the MoEU Guidelines on waste composition survey in 2007 (MoEU WCS Guidelines) in order for local governments to collect basic data for formulation of their future plans. Following the publication of this Guideline, local governments including Kocaeli MM and Sakarya MM started to implement waste characterization surveys in their municipalities in 2008.

When Kocaeli MM and Sakarya MM conducted waste characterization surveys in February and March 2015, the JICA Survey Team participated in this survey together with the local consulting company Aquadem. The methodology applied by the municipalities was observed and the samples were taken from the selected areas by the survey team for three components analysis.

In order to identify the difference in results, the Survey Team conducted supplementary waste composition survey by use of the sample obtained by the quartering method in Kocaeli, Sakarya, and Bursa MM in April 2015, and the results were compared with those conducted by the Municipality1.

This section compiles the results of the above-mentioned activities conducted by the Survey Team from February to April 2015.

5.2 Target areas

According to the MoEU WCS Guidelines, samples of waste for the survey should be taken from both residential areas and commercial areas. Since the former varies in types depending on the income levels of residents, samples should be taken from three different types of areas – high, middle and low income level areas – in order to ensure the reliability of the results.

Therefore, local governments select at least four different types of areas in their municipalities as target areas for waste characterization surveys. Waste characterization surveys are conducted twice a year in summer and winter.

Based on the above indication in the MoEU WCS Guidelines, Kocaeli MM selects the four types of areas in each of its 12 districts and analyses a total of 48 samples in a seasonal survey. As for Sakarya MM, it selects 4 districts (Adapazari, Serdivan, Erenler and Akyazi MDM) out of its 16 districts and identifies the four types of areas in each of the selected districts. Therefore, the number of samples for a seasonal survey to be conducted by Sakarya MM becomes 16.

The JICA Survey Team took samples from the sorted waste of the selected areas during the waste composition surveys by the municipalities in February 2015 for the three composition analysis. These areas were decided as target areas for the supplementary surveys conducted by the Survey Team in April 2015.

[1] The survey conducted in Bursa was a demonstration survey based on the request by Bursa MM. Municipal solid waste in addition to residue from a recycling company was analyzed.

The list of the selected areas for sampling is presented in the table below.

Table 5-1: Selected areas for sampling

No	MM	District	Preferable Areas
1	Kocaeli MM	Golcuk	High income level residential area
2	Kocaeli MM	Korfez	High income level residential area
3	Kocaeli MM	Izmit	Middle income level residential area
4	Sakarya MM	Serdivan	Commercial area
5	Sakarya MM	Adapazari	Commercial area
6	Sakarya MM	Erenler	Middle income level residential area

Note: (1) The demonstration survey for officials of Bursa MM targeted the waste collected in Osmangazi district of Bursa MM. (2) Information of the recycling facilities that provided the residues are not included.

The location maps of the selected areas are shown in the following figures.

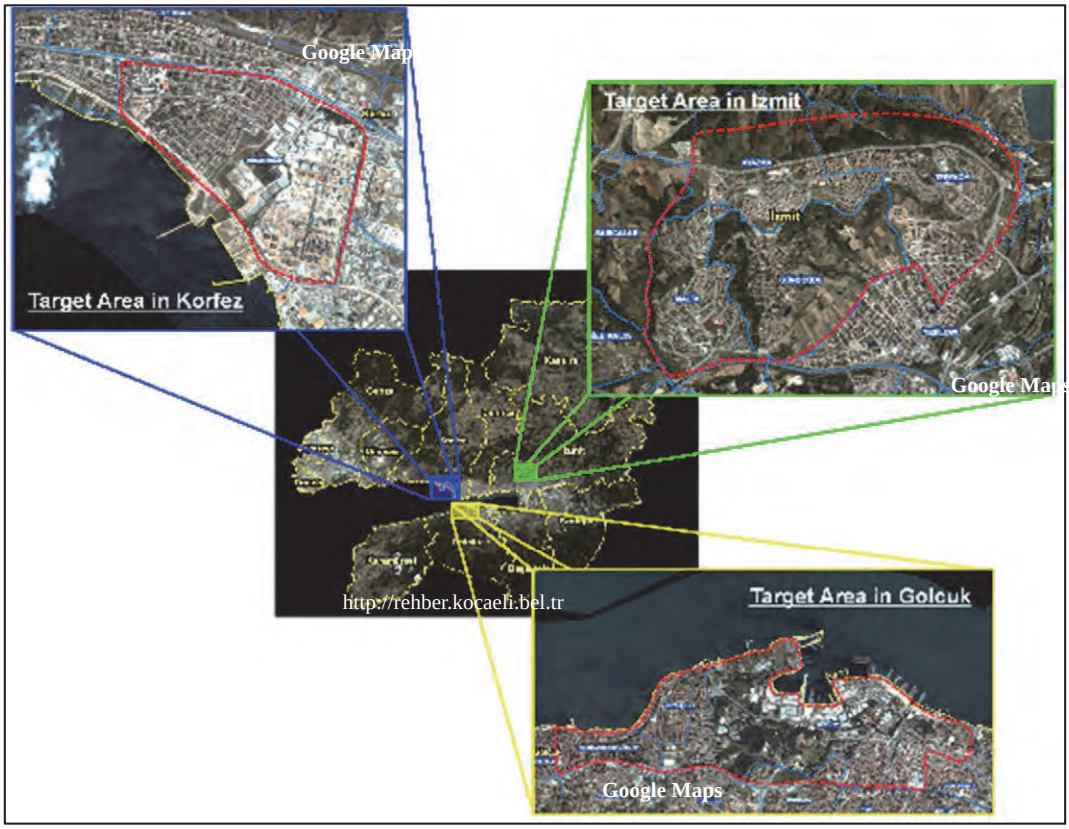


Figure 5-1: Selected areas in Kocaeli MM

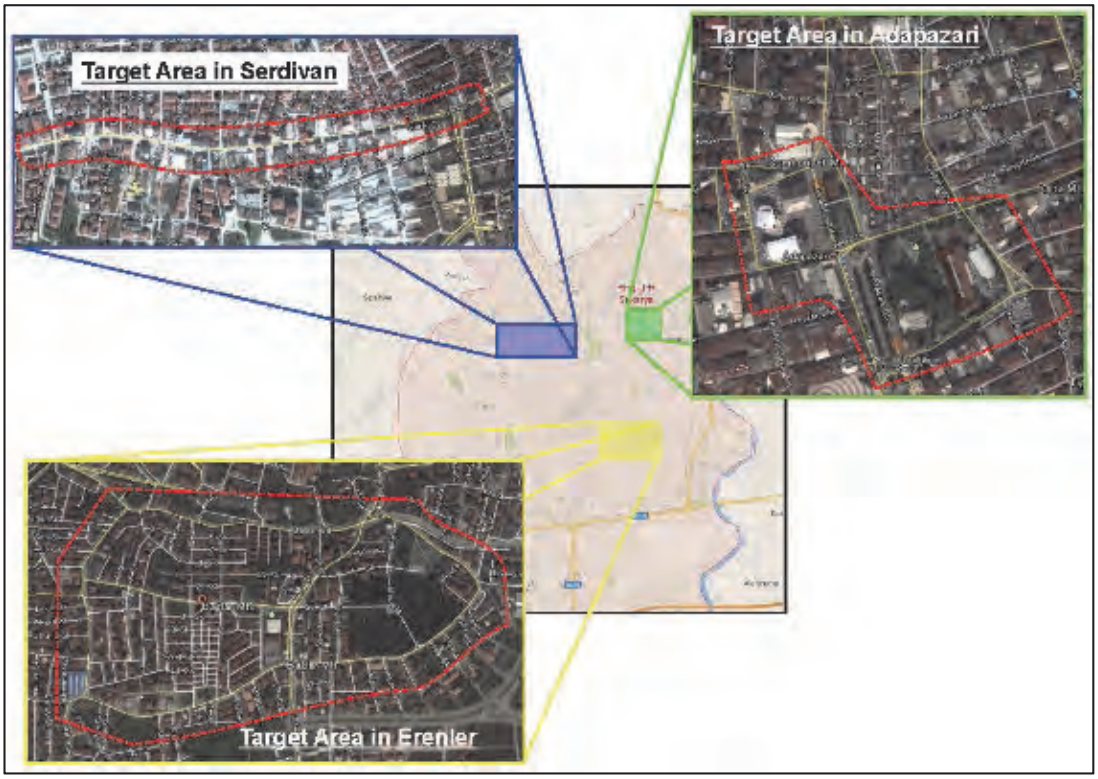


Figure 5-2: Selected areas in Sakarya MM

Recycling residue samples were collected from three recycling companies in Kocaeli MM (namely Tanrikulu, Cevre, and Kocaeli Atik) and one recycling company in Bursa MM.

5.3 Implementation period

The implementation periods for each waste characterization survey conducted by local governments and the Survey Team are as follows.

The waste composition survey conducted by local governments required 4 weeks starting from February 18, 2015 since the sample waste should be collected only on Mondays and Tuesdays in accordance with the MoEU WCS Guidelines. The dates of actual sampling dates are compiled in the table below.

Table 5-2: Waste composition survey schedule by Kocaeli and Sakarya MM

MM	Date		Targeted districts	Number of samples
Kocaeli MM	1st week	18 Feb	Çayırova	4
	2nd week	25-26 Feb	Dilovası, Kandıra, Gölcük, Başiskle	16
	3rd week	5 Mar	Körfez, Kartepe	8
	4th week	11-12 Mar	Darica, Karamürsel, Izmit, Gebze , Derince	20
Sakarya MM	1st week	2 Mar	Serdivan	4
		3 Mar	Adapazari	4
	2nd week	9 Mar	Erenler	4
		10 Mar	Akyazi	4

As for the supplementary survey conducted by the Survey Team, it took one month starting from April 5, 2015 to conduct all activities including necessary arrangements. The actual sampling dates in each area were as follows:

Table 5-3: Dates of sampling in the supplementary survey

MM	Date	Targeted districts	Number of samples
Kocaeli MM	15 Apr	Izmit	1
	16 Apr	Körfez, Gocuk	2
	17 Apr	Recycling residue	1
Sakarya MM	22 Apr	Adapazari	1
	23 Apr	Serdivan, Erenler	2
Bursa MM	28 Apr	Osmangazi, Recycling residue	2

5.4 Applied methodologies

The methodologies of the waste characterization surveys conducted by the local governments in February and by the JICA Survey Team in April were compared in Table 5-4.

While the municipalities applied the methodology indicated in the MoEU WCS Guidelines, the Survey Team applied the quartering sampling method which is widely applied in Japan. The results were compared to see if there were any differences between the two methods.

The details of the survey methodologies are compiled in the following table.

Table 5-4: Comparison of the methodologies

No	Items	Waste composition survey by Kocaeli MM and Sakarya MM	Waste composition survey by the JICA Survey Team
1.	Base of the methodology	"Guidelines on Waste Composition Survey Methods (MoEU WCS Guidelines)	Method of Quartering
2.	Target waste	Both of the local governments use the waste collected from the 4 types of areas (high, middle, low income level residential areas and a commercial area) predefined in each selected district as target waste of their surveys. . Around 1 ton of waste (2 to 3 m3) is unloaded from a collection truck for the survey to take waste composition survey sample from.	Waste collected from only selected areas in selected districts was targeted during the survey (the information about the areas is presented in “5.2 Target area”). In addition to these areas, residue discharged by recycling companies in Kocaeli MM and Bursa were also covered. Although recycling companies collect recyclables either from containers placed in residential areas for packaging waste or from factories and businesses, the survey targeted only the residue left after segregation of packaging waste collected from the containers in residential areas. All waste of a collection truck is unloaded, mixed with a wheel loader and 3 to 4 m3 of waste was picked for waste composition survey sample to take from.
2.	Collection of samples	As the WCS Guideline indicates that the target waste should be generated in weekends and weekdays, the local governments collect the target waste on Mondays and Tuesdays only in order to meet the requirement. Therefore, several weeks are necessary for the survey to cover all target areas: 4 weeks for Kocaeli MM and 2 weeks for Sakarya MM. The difference between the target wastes of Kocaeli MM and Sakarya MM is as follows: 1. Kocaeli MM collects waste from each target area of each district twice (both on Mon and Tue), mixes the two waste collected from same area and implements analysis on a different day (on Wed or Thu) separately for each areas. Therefore, sample from each area consists of waste generated both on a weekday and a weekend. 2. As Sakarya MM allocates one day (either Mon or Tue) for a district (for 4 types of areas in that district) for both collection of target waste and implementation of sampling, the sample to be taken from each area consists of waste generated only one day.	During this survey, the difference in waste composition between weekdays and weekends was not considered and assumed as similar. Therefore, the waste generated on weekdays were collected for the survey on the previous days of the scheduled for each target areas to implement sampling processes. In each of the areas, the waste generated only 1 day was covered in the survey.
3	Sampling method	As mentioned above, sampling processes are conducted for each of the predefined 4 areas in selected districts in accordance with indications of WCS Guideline. However, the local governments do not open all bags of target waste; and therefore, do not mix the waste before taking samples. Bags of waste are taken directly from each side of the piled target waste. Following the MoEU WCS Guidelines, the picked bags of waste are put into a bottomless box of 0.5 m3. Picking bags continues until the box becomes full. The amount of a sample to be taken from a target area by Kocaeli MM is 0.5 m3 while that of Sakarya MM is 1.0 m3 since Sakarya MM takes samples twice with the box. After taking samples, the remained file of waste is discharged.	In order to maintain the portions of waste components in sample waste, the Survey Team paid much attention to mixing before taking samples. As mentioned above, target wastes were taken after mixing all the waste transported in the trucks with a wheel loader. Since the amount of the target waste is too much for sorting (around 3 to 4 m3), bulky-sized waste or items that are not proper for the further sampling processes (example: bulky waste, electronic equipment, some types of glass etc, clothes and plastic bags) were picked and put aside separately by types of materials. The remaining waste was reduced to a proper amount (1 m3 or around 200 kg) through Method of Quartering. Therefore, the sample consisted of picked part and mixed part. The detailed information about sampling processes or the applied method of quartering was the following: 1. All bags of waste regardless of their sizes were opened and plastic bags/sacks were put aside separately by their types. 2. As mentioned above, all other bulky-sized waste such as cardboard boxes, hard plastics and even clothes were also picked and put aside separately by their types. Some of papers were torn into smaller pieces and returned to the pile of the waste. The waste picked and put aside during Step1 and

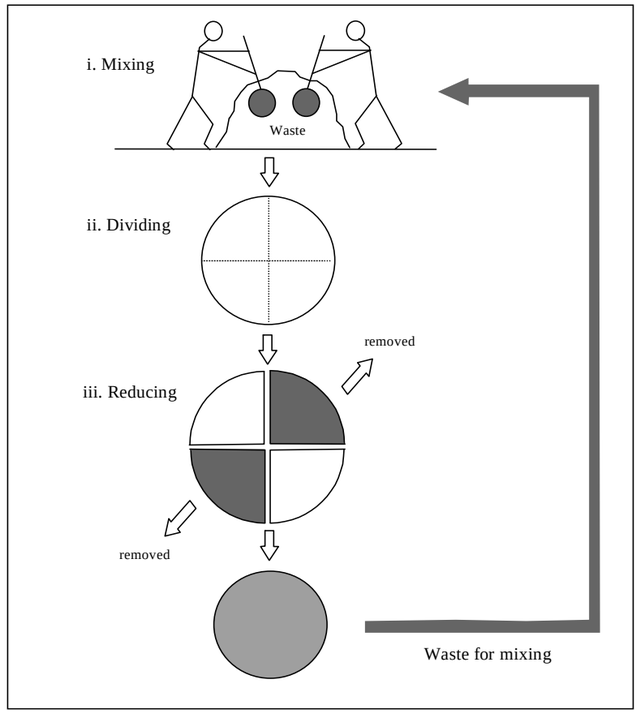

Figure 5-3: Taking samples from target waste (Kocaeli MM)


Figure 5-4: Taking samples from target waste (Sakarya MM)

Step 2 was considered as picked waste from which the picked part of the sample was calculated.

3. All the remaining waste was mixed until the composition in all parts of the pile became similar. This waste was considered as mixed waste from which the mixed part of the sample was taken.

4. After mixing, the waste was reduced based on Method of Quartering. In order to do so, the mixed waste was divided into four equal parts and two of them were selected diagonally and removed. By selecting diagonally, it was assumed that any possible impacts of unevenness in the mixture was eliminated. The method is illustrated in the following figure.



5. The steps No3 and No4 were repeated until the amount of waste became around 200 kg or 1 m3. The waste remained at this stage was considered as the mixed part of the sample.

6. Picked part of the sample was calculated from the amount of all picked waste in proportion to the share of the mixed part in the total mixed waste at the stage of data analysis.

Figure 5-5: Taking target and sample waste

4	Sorting	Each bag of waste taken for the sample is opened and sorted directly into the waste types indicated in the MoEU WCS Guidelines. The items are 16 for a summer waste composition survey (1. kitchen waste, 2. paper, 3. carton, 4. bulky carton, 5. plastic, 6. glass, 7. metal, 8. bulky metal, 9. e-waste, 10. hazardous waste, 11. park and garden waste, 12. other combustibles, 13. other incombustibles, 14. other bulky combustibles, 15. other bulky incombustibles, 16. other waste) and 17 for a winter waste composition survey since “Ash” is generated mainly during the winter. Sorted waste is put into buckets by each type of waste.	In order to compare the results with those of the surveys conducted by the local municipalities, the samples were sorted into 17 items indicated in the MoEU WCS Guidelines of Turkey.   Figure 5-6: Sorting

		  Figure 5-7: Waste sorting during Kocaeli MM survey	

		 Figure 5-8: Waste sorting during Sakarya MM survey	
5	Identification of physical composition	After sorting, each bucket is weighed by waste types (gross weights), recorded into data record sheets and net weights are calculated by subtracting the bucket weights from the recorded gross weights. Based on the results, physical composition is identified for each target area.  Figure 5-9: Weighing and data recording	When determining the physical compositions, amounts of waste components sorted from the mixed waste were measured in same method with that of Kocaeli MM and Sakarya MM. However, the amounts of the waste picked from the target waste before applying the method of quartering must have been included in the sample, and relevant amounts of picked waste were estimated in proportion to the share of the mixed sample in the total mixed waste. After adding the mixed part and picked part of each waste component, the physical composition was calculated.

5.5 Physical composition of the municipal solid waste

5.5.1 Kocaeli MM

a. Trend of physical composition of waste in Kocaeli MM

The table below presents the annual change of physical composition of waste in Kocaeli MM from 2008 to 2014 based on the past survey results, in which the physical components of waste are categorized into 4 types, namely organic waste, combustible waste, incombustible waste, and hazardous waste.

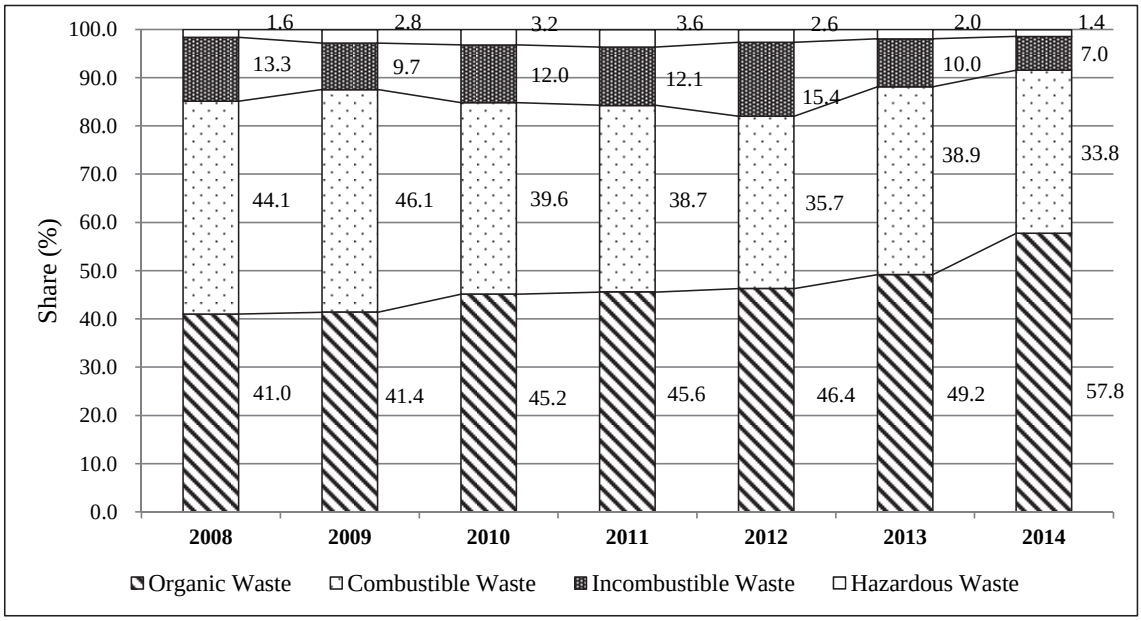


Figure 5-10：Trend of physical composition of waste in Kocaeli MM

The percentage of organic waste gradually increased until 2013 while it showed a significant increase in 2014 reaching 58%. The Smirnov-Grubbs outlier test was conducted to examine the ratio of organic waste mentioned above, and the table below shows its result.

Result of 2σ test		
	Final data	Original data
Number of data samples	6	7
Mean value (m)	44.8	46.7
Standard deviation	3.108	5.666
Dispersion	9.661	32.107
Maximal value	49.2	57.8
Minimal value	41.0	41.0
Level of significance	0.05	0.05
m -2σ	38.6	35.3
m +2σ	51.0	58.0
Number of date samples rejected	0	0
Final number of data samples rejected	1	

Significance level of Smirnov-Grubbs test		
Average value		44.8
Standard deviation		3.108
Maximal value		49.2
T		1.418
Significance level S-G test (t)		1.822
Judgement: rejection T > t		OK

The value in 2014 is rejected as the outlier, while the level of significance of the data up until 2013 remains at 0.05 (95%). Though the future trend of physical composition of waste is still uncertain without the survey result of 2015, the relative increase in percentage of organic waste is presumably attributed to prior collection of recyclables from the waste before its disposal at landfills. The yearly decrease in the amount of final disposal of waste, as shown in the table below, supports this projection.

Table 5-5: Trend of the amount of final landfill disposal of waste

Unit: g/person/day

Year / MM	2010	2011	2012	2013	2014
Bursa	685.7	711.8	745.5	752.5	807.4
Kocaeli	852.8	905.7	929.7	944.1	923.5
Izmir	866.1	955.0	1,057.8	999.1	1,022.9
Antalya	1,349.0	1,401.6	1,449.4	1,402.4	1,471.1
Sakarya	996.1	1,025.6	961.4	817.4	824.6

b. Results of survey in 2015

b.1. Results of survey by Kocaeli MM (2015 winter survey)

The physical compositions of municipal solid waste were estimated from the results of 2015 winter survey which was conducted by Kocaeli MM in February 2015. The summary results are compiled in the table below.

Table 5-6: Summary results of 2015 winter survey (Kocaeli MM)

No	Solid waste components	Kocaeli MM (12 districts)		
		Total weights (kg)	Physical composition (%)	
			Ash included	Ash excluded
A	**Organic:**			
1	Kitchen waste	3,007.0	47.9%	50.4%
2	Park and garden waste	72.0	1.1%	1.2%
	Organic waste	3,079.0	49.0%	51.6%
B	**Combustibles:**			
3	Paper	319.0	5.1%	5.3%
4	Carton	241.4	3.8%	4.0%
5	Bulky carton	136.3	2.2%	2.3%
6	Plastics	797.3	12.7%	13.4%
7	Other combustibles	865.2	13.8%	14.5%
8	Other bulky combustibles	0.0	0.0%	0.0%
	Combustible waste	2,359.3	37.6%	39.5%
C	**Incombustibles:**			
9	Glass	295.7	4.7%	5.0%
10	Metal	60.9	1.0%	1.0%
11	Bulky metal	5.6	0.1%	0.1%
12	Other incombustibles	39.3	0.6%	0.7%
13	Other bulky incombustibles	0.0	0.0%	0.0%
14	Ash	313.8	5.0%	-
	Incombustible waste	715.3	11.4%	6.7%
D	**Hazardous:**			
15	e-Waste	27.7	0.4%	0.5%
16	Hazardous waste	78.5	1.2%	1.3%
	Hazardous waste	106.2	1.7%	1.8%
E	**Other waste**	22.8	0.4%	0.4%
	Total (Ash included)	**6,282.6**	**100.0%**	**-**
	Total (Ash excluded)	**5,968.8**	**-**	**100.0%**

In Table 5-67, the results of the above survey were compared with the results of the 2014 winter survey. According to the comparison, the biggest change of share was observed in kitchen waste, which decreased by more than 5 %, while no significance could be observed in the changes of share in all the other types.

Table 5-7: Comparison of 2014 and 2015 winter surveys (ash included)

	Waste components	Kocaeli MM		
		2014 waste composition survey (%)	2015 waste composition survey* (%)	Change (pts)
A	**Organic:**			
1	Kitchen waste	53.7	47.9	(5.8)
2	Park and garden waste	0.9	1.1	0.3
	Organic waste	54.5	49.0	(5.5)
B	**Combustibles:**			
3	Paper	7.9	5.1	(2.8)
4	Carton	0.8	3.8	3.1
5	Bulky carton	0.0	2.2	2.2
6	Plastics	9.7	12.7	3.0
7	Other combustibles	17.5	13.8	(3.7)
8	Other bulky combustibles	0.0	0.0	0.0
	Combustible waste	35.8	37.6	1.7
C	**Incombustibles:**			
9	Glass	3.2	4.7	1.5
10	Metal	1.4	1.0	(0.4)
11	Bulky metal	0.0	0.1	0.1
12	Other incombustibles	0.0	0.6	0.6
13	Other bulky incombustibles	0.0	0.0	0.0
14	Ash	3.2	5.0	1.8
	Incombustible waste	7.8	11.4	3.6
D	**Hazardous:**			
15	e-Waste	0.6	0.4	(0.1)
16	Hazardous waste	1.3	1.2	(0.1)
	Hazardous waste	1.9	1.7	(0.2)
E	**Other waste**	0.0	0.4	0.4
	Total (Ash included)	**100.0**	**100.0**	

c. Results of Survey by JICA Survey Team (conducted in 2015 April)

c.1. Target waste and sample waste

The survey conducted by the Survey Team in Kocaeli MM targeted 2,379 kg of waste, which was collected from the selected areas. The actual sampling was conducted on 760.9 kg (32%) by using the method of quartering.

Table 5-8: Amount of sampled municipal solid wastes in Kocaeli MM (unit: kg)

Target Areas	Target Waste			Removed Waste			Sample Waste		
	Picked	Mixed	Total	Picked	Mixed	Subtotal	Picked	Mixed	Subtotal
Golcuk (RA: HIL)	96.4	455.4	551.8	47.4	223.9	271.3	49.0	231.5	280.5
Izmit (RA: MIL)	134.4	1,100.1	1,234.5	113.0	924.7	1,037.7	21.4	175.4	196.8
Korfez (RA: HIL)	87.1	505.6	592.7	45.4	263.7	309.1	41.7	241.9	283.6
Total	317.9	2,061.1	2,379.0	205.8	1,412.3	1,618.1	112.1	648.8	760.9

For the breakdowns of the sample waste, please refer to Table 5-8.

c.2. Physical composition

The physical composition of municipal solid waste was calculated for two cases - ash included and ash excluded - from the amounts of waste components in the sample waste (Table 5-9).

Table 5-9: Physical composition of municipal solid waste in Kocaeli MM

Type of Waste	Amount of sample waste (kg)				Physical composition (%)							
					Ash included				Ash excluded			
	Golcuk	Izmit	Korfez	Kocaeli MM total	Golcuk	Izmit	Korfez	Kocaeli MM total	Golcuk	Izmit	Korfez	Kocaeli MM total
Organic waste:												
Kitchen waste	139.9	94.7	136.3	370.9	49.9	48.1	48.1	48.7	51.2	48.6	48.3	49.4
Park and garden waste	1.5	2.2	0.0	3.7	0.5	1.1	0.0	0.5	0.6	1.2	0.0	0.5
Total Organic	141.4	96.9	136.3	374.6	50.4	49.3	48.1	49.2	51.7	49.7	48.3	49.9
Combustible waste:												
Bulky carton	0.0	1.9	0.0	1.9	0.0	1.0	0.0	0.3	0.0	1.0	0.0	0.3
Carton	7.5	9.6	6.8	23.9	2.7	4.9	2.4	3.1	2.7	4.9	2.4	3.2
Other combustibles	40.6	31.1	54.1	125.8	14.5	15.8	19.1	16.5	14.8	16.0	19.2	16.8
Paper	16.8	8.3	15.3	40.4	6.0	4.2	5.4	5.3	6.2	4.3	5.4	5.4
Plastics	49.5	35.9	56.8	142.2	17.7	18.3	20.0	18.7	18.1	18.4	20.1	19.0
Total Combustible	114.4	86.9	133.1	334.4	40.8	44.1	46.9	43.9	41.8	44.5	47.2	44.5
Incombustible waste:												
Ash (soil, stone included)	7.0	1.8	1.3	10.1	2.5	0.9	0.5	1.3				
Glass	12.3	4.9	9.9	27.1	4.4	2.5	3.5	3.6	4.5	2.5	3.5	3.6
Metal	1.9	3.7	1.4	7.0	0.7	1.9	0.5	0.9	0.7	1.9	0.5	0.9
Other incombustibles	2.7	2.0	0.0	4.7	0.9	1.0	0.0	0.6	1.0	1.0	0.0	0.6
Total Incombustible	23.9	12.4	12.7	49.0	8.5	6.3	4.5	6.4	6.2	5.4	4.0	5.2
Hazardous waste:												
e-Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous waste	0.8	0.6	1.5	2.9	0.3	0.3	0.5	0.4	0.3	0.3	0.5	0.4
Total Hazardous	0.8	0.6	1.5	2.9	0.3	0.3	0.5	0.4	0.3	0.3	0.5	0.4
Grand Total (Ash included)	280.5	196.8	283.6	760.9	**100.0**	**100.0**	**100.0**	**100.0**				
Grand Total (Ash excluded)	273.5	195.0	282.2	750.7					**100.0**	**100.0**	**100.0**	**100.0**

As the table shows, the highest share is occupied by organic waste (49% if ash included and 50% if ash excluded) that consists of solely “kitchen waste” (“park and garden waste” occupies less than 1%).

The share of combustible waste is equally high, which accounts for 44% to 45% regardless of ash/soil inclusion. Among the combustible types of waste, shares of plastics and other combustibles are relatively high, which account for 17% to 20%. The major types of waste in “other combustibles” are textiles and diapers.

According to the figures in the table, the share of total incombustible waste in Kocaeli MM was relatively low, which accounted for 5.2% (if ash excluded) and 6.4% (if ash included). The major type in “incombustibles waste” is glass if ash/soil is not considered.

c.3. Apparent specific gravity

During the sampling processes, volume and weight were measured from the part of the target waste collected from each target area in order to identify the apparent specific gravity (a box with capacity of 0.5m3 was used for volume measurement). Bulky sized waste which was taken out before mixing was not included when measuring the volume.

The apparent specific gravity calculated from the measured volume and weight is shown as follows.

Table 5-10: Apparent specific gravity (ASG) of municipal solid waste (Kocaeli MM)

No	Municipalities	Target Areas	Measured Volume (m3)	Measured Weight (kg)	Specific Gravity (kg/m^3)
1	Kocaeli MM	Izmit (RA: MIL)	1.00	175.4	175.0
2	Kocaeli MM	Korfez (RA: HIL)	1.00	241.9	242.0
3	Kocaeli MM	Golcuk (RA: HIL)	0.80	231.5	289.0
	Average ASG of General Waste				**235.0**

The table shows the specific gravity of municipal solid waste in Kocaeli MM is 235 kg/m3.

d. Comparison between results of surveys by Kocaeli MM and JICA Survey Team

The results of the surveys conducted by the municipality and the JICA Survey Team were compared. In order to simplify the comparison, overall average values were adopted for the past surveys conducted between 2008 and 2014 by Kocaeli MM, and ash was excluded from the results of all surveys for a better understanding.

The most recent surveys are those conducted in 2015 either by the Municipality or the Survey Team.

The shares of 5 major waste categories (organic, combustible, incombustible, hazardous and other waste) by each survey are shown in the figure below:

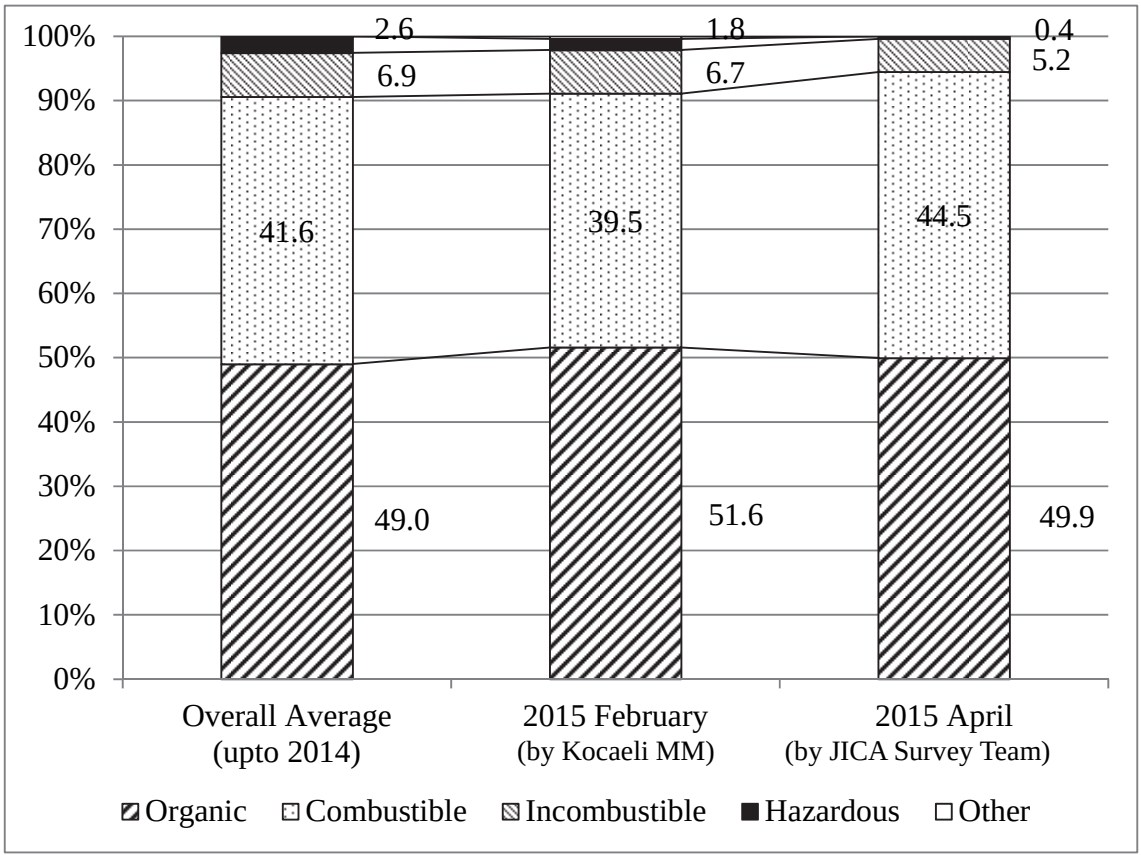


Figure 5-11: Comparison of surveys in Kocaeli MM (by 5 categories)

According to the figure, the shares of all categories in Kocaeli MM are also almost at the same level for both of the past (the series "Overall Average (up to 2014)") and the current surveys (the series "2015 February") conducted by Kocaeli MM: organic waste - around 50%, combustible waste - around 40%, incombustible waste - 7% and hazardous waste - around 2 to 2.5% (other waste was neglected since the shares are less than 1%). As for the survey conducted by the Survey Team in April (the series "2015 April"), the share of organic waste was almost same with those of Kocaeli MM surveys. However, the share of combustible waste increased by 5 % reaching 45%. Therefore, those of other categories decreased in relation with the increase in the share of combustibles (the

share of hazardous waste shrank considerably and dropped to a level near zero).

In Figure 5-12 waste compositions summarized from the major waste components were compared.

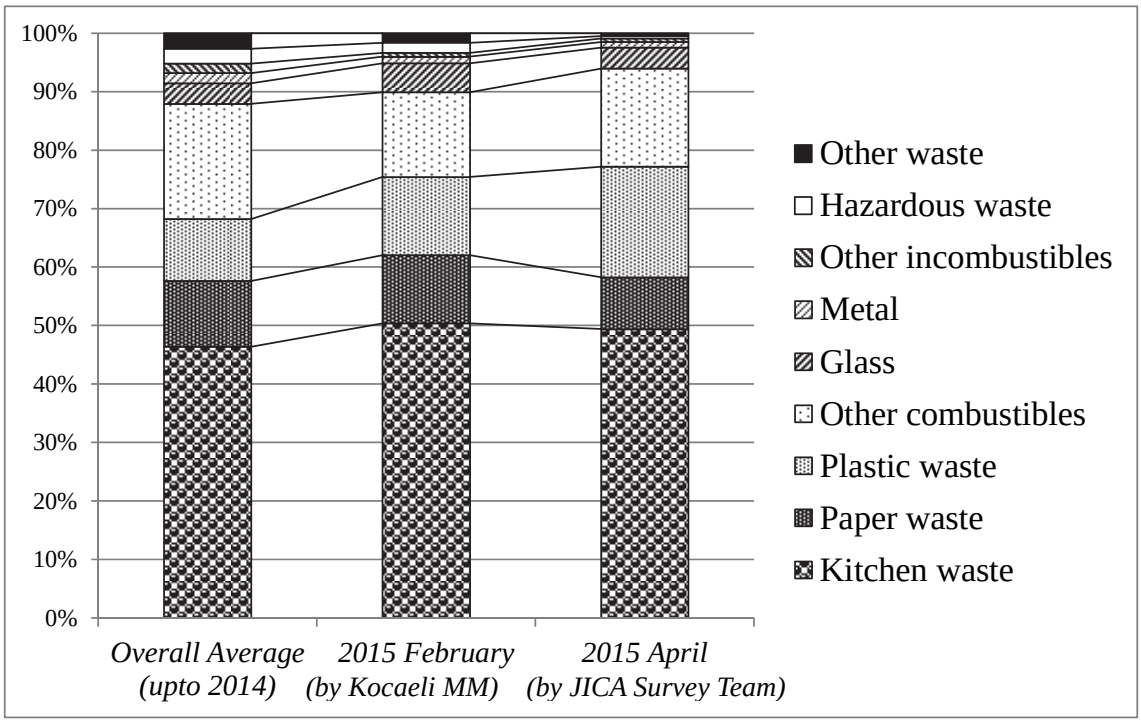


Figure 5-12: Waste composition survey results in Kocaeli MM (waste components)

According to Figure 5-12, the portions of kitchen waste (park and garden waste is included in "Other waste") are at the same level for the latest two surveys.

Among the types of combustible waste, the share of papers (cartons included) estimated during the survey by the Survey Team is less than that in the surveys by Kocaeli MM, while the share of plastics is almost two times higher in the survey by the Kocaeli MM. Other combustibles can be considered to be at the similar level with those of Kocaeli MM surveys since the share is smaller than the overall averages of previous surveys and slightly higher than that of the current survey by Kocaeli MM.

The share of all other types of waste in the Survey Team's survey are smaller than the ones in the Kocaeli MM surveys.

5.5.2 Sakarya MM

a. Results of previous surveys conducted by the Municipality

Like Kocaeli MM, Sakarya MM has been conducting waste composition survey since 2008. However, the results of surveys conducted between 2008 and 2011 were neglected in this report since the municipality considers the reliability of the results is low due to the applied methodology in those surveys.

Dynamics of physical composition data re-categorized into four sub-categories - Organic waste (A), Combustible waste (B), Incombustible waste (C) and Hazardous waste (D) - are presented in Figure 5-13.

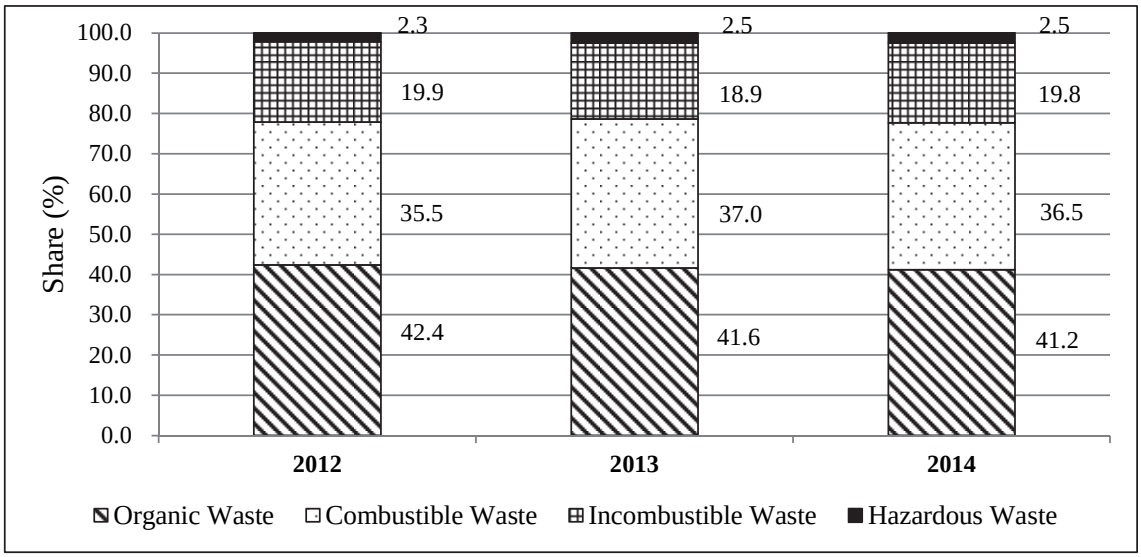


Figure 5-13: Dynamics of waste composition in Sakarya MM

According to the above figure, changes in share were not observed in organic, combustible and incombustible types for the past 3 years (Figure 5-13).

Table 5-11 shows overall averages, maximum and minimum values, and variances estimated for the shares of waste components from the data of the municipality in order to identify the degree of changes in the physical composition for the past 3 years.

Table 5-11: Overall averages of waste composition survey results by Sakarya MM

	Waste components	Sakarya MM (3 years' average)			
		Overall average (%)	MIN (%)	MAX (%)	Variance (pts)
A	**Organic Waste:**				
1	Kitchen waste	40.9	40.6	41.2	0.5
2	Park and garden waste	0.8	0.5	1.4	1.0
	Total organic waste	41.7	41.2	42.4	1.2
B	**Combustible Waste:**				
3	Paper	5.8	5.5	5.9	0.4
4	Carton	3.7	2.7	4.3	1.6
5	Bulky carton	1.8	1.6	2.1	0.5
6	Plastics	15.8	15.2	16.3	1.1
7	Other combustible	8.1	7.3	9.2	1.9
8	Other bulky combustibles	0.6	0.4	0.7	0.2
9	Other waste	0.7	0.2	1.0	0.8
	Total combustibles	36.3	35.5	37.0	1.5
C	**Incombustible Waste:**				
9	Glass	4.2	3.9	4.4	0.6
10	Metal	2.2	1.8	2.4	0.6
11	Bulky metal	0.0	0.0	0.0	0.0
12	Other incombustibles	1.1	0.7	1.8	1.2
13	Other bulky incombustibles	0.4	0.2	0.6	0.4
14	Ash (dust etc. included)	11.7	11.2	12.2	1.0
	Total incombustibles	19.5	18.9	19.9	1.0
D	**Hazardous Waste:**				
15	e-Waste	0.4	0.2	0.7	0.5
16	Hazardous waste	2.1	1.6	2.3	0.7
	Total hazardous waste	2.4	2.3	2.5	0.3
	Total Waste	100.0	-	-	-

According to the table above, the variances estimated for the waste components are small, and almost no or small differences were observed. Therefore, it can be considered that the results of the surveys conducted by the municipality have been comparatively stable.

b. Results of the surveys in 2015

b.1. Results of survey by Sakarya MM (2015 winter survey)

The physical compositions of municipal solid waste were estimated from the results of 2015 winter survey, which was conducted by Sakarya MM in March 2015. The summary results are compiled in the table below.

Table 5-12: Summary results of 2015 winter survey (Sakarya MM)

No	Solid waste components	Sakarya MM (4 districts)		
		Total weights (kg)	Physical composition (%)	
			Ash included	Ash excluded
A	**Organic:**			
1	Kitchen waste	1,319.1	45.5%	49.7%
2	Park and garden waste	40.0	1.4%	1.5%
	Organic waste	1,359.1	46.9%	51.2%
B	**Combustibles:**			
3	Paper	142.4	4.9%	5.4%
4	Carton	108.5	3.7%	4.1%
5	Bulky carton	1.3	0.0%	0.0%
6	Plastics	478.3	16.5%	18.0%
7	Other combustibles	340.1	11.7%	12.8%
8	Other bulky combustibles	37.9	1.3%	1.4%
	Combustible waste	1,108.5	38.3%	41.8%
C	**Incombustibles:**			
9	Glass	99.5	3.4%	3.8%
10	Metal	29.4	1.0%	1.1%
11	Bulky metal	0.0	0.0%	0.0%
12	Other incombustibles	25.6	0.9%	1.0%
13	Other bulky incombustibles	0.0	0.0%	0.0%
14	Ash	243.5	8.4%	-
	Incombustible waste	398.0	13.7%	5.8%
D	**Hazardous:**			
15	e-Waste	7.0	0.2%	0.3%
16	Hazardous waste	23.5	0.8%	0.9%
	Hazardous waste	30.5	1.1%	1.1%
E	**Other waste**	0.0	0.0%	0.0%
	Total (Ash included)	**2,896.1**	**100.0%**	**-**
	Total (Ash excluded)	**2,652.6**	**-**	**100.0%**

In

Table 5-13, the waste compositions in 2015 were compared with the results of the 2014 winter survey (ash included). As the table shows, the biggest changes of share were seen in kitchen waste (4.9 % increase) and other combustible waste (4.5 % increase), while, the shares of other types of waste decreased slightly or unchanged.

Table 5-13: Comparison of 2014 and 2015 winter surveys (ash included)

	Waste components	Sakarya MM		
		2014 waste composition survey (%)	2015 waste composition survey (%)	Change (pts)
A	**Organic:**			
1	Kitchen waste	40.6	45.5	4.9
2	Park and garden waste	0.5	1.4	0.9
	Organic waste	41.2	46.9	5.8
B	**Combustibles:**			
3	Paper	5.9	4.9	(1.0)
4	Carton	4.2	3.7	(0.4)
5	Bulky carton	1.7	0.0	(1.6)
6	Plastics	15.9	16.5	0.6
7	Other combustibles	7.3	11.7	4.5
8	Other bulky combustibles	0.6	1.3	0.7
	Combustible waste	35.5	38.3	2.7
C	**Incombustibles:**			
9	Glass	4.4	3.4	(1.0)
10	Metal	2.4	1.0	(1.4)
11	Bulky metal	0.0	0.0	(0.0)
12	Other incombustibles	0.9	0.9	0.0
13	Other bulky incombustibles	0.6	0.0	(0.6)
14	Ash	11.5	8.4	(3.1)
	Incombustible waste	19.8	13.7	(6.1)
D	**Hazardous:**			
15	e-Waste	0.3	0.2	(0.0)
16	Hazardous waste	2.3	0.8	(1.5)
	Hazardous waste	2.5	1.1	(1.5)
E	**Other waste**	1.0	0.0	(1.0)
	Total (Ash included)	**100.0**	**100.0**	

c. Results of survey by Survey Team (in 2015 April)

c.1. Target waste and sample waste

The survey conducted by the Survey Team in Sakarya MM targeted around 2,600 kg of waste that was taken from the waste collected in the selected areas. The actual sampling was conducted on about 378 kg (around 15%) of wastes by using the method of quartering (Table 5-14).

Table 5-14: Calculation of sample waste (General waste of Sakarya MM), unit: kg

Target Areas	Target Waste			Removed Waste			Sample Waste		
	Picked	Mixed	Total	Picked	Mixed	Subtotal	Picked	Mixed	Subtotal
Adapazari (CA)	213.8	886.1	1,099.9	195.0	808.0	1,003.0	18.8	78.1	96.9
Erenler (RA: Mil)	113.0	682.6	795.6	86.5	522.5	609.0	26.5	160.1	186.6
Serdivan (CA)	120.7	581.3	702.0	104.5	503.3	607.8	16.2	78.0	94.2
Total	447.5	2,150.0	2,597.5	386.0	1,833.8	2,219.8	61.5	316.2	377.7

c.2. Physical composition

The physical composition of the sample waste was calculated for two cases – if ash is included and if ash is excluded.

Table 5-15: Physical composition of municipal solid waste in Sakarya MM (unit: %)

Type of Waste	Amount of sample waste (kg)				Physical composition (%)							
					Ash included				Ash excluded			
	Adapazari	Erenler	Serdivan	Sakarya MM total	Adapazari	Erenler	Serdivan	Sakarya MM total	Adapazari	Erenler	Serdivan	Sakarya MM total
Organic waste:												
Kitchen waste	34.1	88.2	32.1	154.4	35.2	47.3	34.1	40.9	39.0	52.6	35.4	44.6
Park and garden waste	4.0	0.3	0.2	4.5	4.1	0.2	0.2	1.2	4.5	0.2	0.2	1.3
Total Organic	38.1	88.5	32.3	158.9	39.3	47.4	34.3	42.1	43.6	52.8	35.6	45.9
Combustible waste:				0								
Bulky carton	1.1	1.5	4.7	7.3	1.1	0.8	5.0	1.9	1.2	0.9	5.2	2.1
Carton	4.6	4.0	4.1	12.7	4.7	2.1	4.4	3.4	5.2	2.4	4.5	3.7
Other combustibles	9.2	26.8	10.7	46.7	9.5	14.4	11.4	12.4	10.5	16.0	11.8	13.5
Paper	9.5	8.0	11.1	28.6	9.8	4.3	11.8	7.6	10.9	4.8	12.2	8.3
Plastics	12.9	28.4	19.9	61.2	13.3	15.2	21.1	16.2	14.8	16.9	21.9	17.7
Total Combustible	37.3	68.8	50.5	156.6	38.5	36.9	53.6	41.5	42.7	41.0	55.6	45.3
Incombustible waste:				0								
Ash (soil, stone included)	9.6	18.9	3.3	31.8	**9.9**	**10.1**	**3.5**	**8.4**				
Glass	7.5	4.4	6.5	18.4	7.8	2.4	6.9	4.9	8.6	2.6	7.2	5.3
Metal	0.6	1.5	1.2	3.3	0.6	0.8	1.3	0.9	0.7	0.9	1.4	1.0
Other incombustibles	3.2	4.0	0.2	7.4	3.3	2.2	0.2	2.0	3.7	2.4	0.2	2.2
Total Incombustible	20.9	28.9	11.2	61	21.6	15.5	11.9	16.2	13.0	5.9	8.7	8.4
Hazardous waste:				0								
e-Waste	0.1	0.2	0.0	0.3	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1
Hazardous waste	0.6	0.3	0.1	1	0.6	0.1	0.1	0.3	0.7	0.2	0.1	0.3
Total Hazardous	0.7	0.5	0.1	1.3	0.7	0.2	0.1	0.3	0.7	0.3	0.1	0.4
Grand Total (Ash included)	96.9	186.6	94.2	377.7	**100.0**	**100.0**	**100.0**	**100.0**				
Grand Total (Ash excluded)	87.3	167.7	90.9	345.9					**100.0**	**100.0**	**100.0**	**100.0**

As the table shows, the shares of organic waste and combustible waste are almost equal, which account for 41 to 42% if ash is included or 45 to 46% if ash is excluded of the total wastes. As park and garden waste account for less than 1.5% of total wastes, the organic waste consists mainly of kitchen waste.

The combustible wastes consisted mainly of plastics (16 to 18%) and other combustibles (12 to 13%). The major types of waste in “other combustibles” were mainly textiles and diapers.

According to the figures shown in

Table 5-15, the share of total incombustible waste is high, which accounts for 16.2% (ash included). This was resulted by high share of ash/soil, which account for 8.4%. Therefore, the share of total incombustible waste drops to 8.4% if ash/soil is excluded.

c.3. Apparent specific gravity

During the sampling processes, volume and weight were measured for parts of the target waste, which was collected from each target area in order to identify the apparent specific gravity (a box of $0.5m^3$ was used for volume measurement). Bulky-sized waste which was taken out before mixing was not included when measuring the volume.

The apparent specific gravity calculated from the measured volume and mass is as follows.

Table 5-16: Apparent specific gravity (ASG) of municipal solid waste (Sakarya MM)

No	Municipalities	Target Areas	Measured Volume (m3)	Measured Weight (kg)	Specific Gravity (kg/m3)
1	Sakarya MM	Adapazari (CA)	0.50	78.1	156.0
2	Sakarya MM	Serdivan (CA)	0.50	78.0	156.0
3	Sakarya MM	Erenler (RA: MIL)	0.50	160.1	320.0
	Average ASG of General Waste				**210.0**

According to the table, the specific gravity of municipal solid waste in Sakarya MM is 210 kg/m^3.

d. Comparison of past and current surveys

The results of the past and current surveys conducted by the municipality and the JICA Survey Team were compared in the following section. In order to simplify the comparison, overall average values were adopted for the past surveys conducted between 2012 and 2014, and ash/soil was excluded from the results of all surveys for a better understanding. The latest surveys are those conducted in 2015 either by the municipality or the Survey Team.

The shares of 5 major waste categories (organic, combustible, incombustible, hazardous and other waste) by each survey are shown in the figure below.

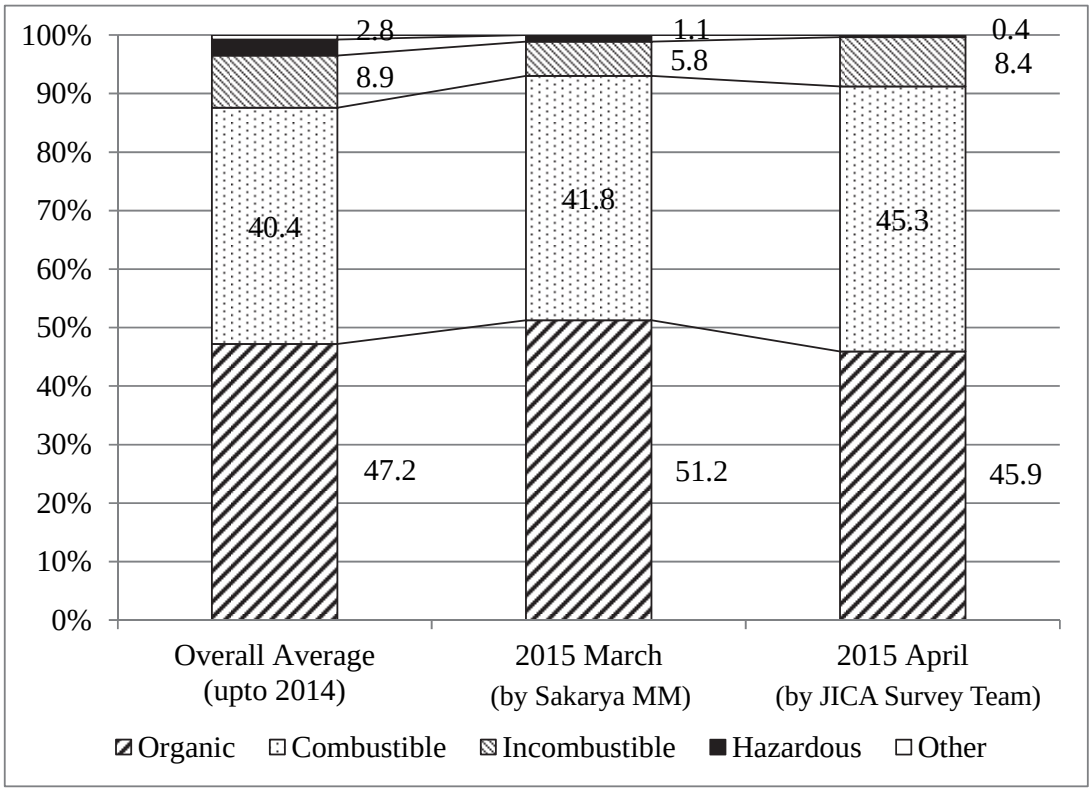


Figure 5-14: Comparison of surveys in Sakarya MM (by 5 categories)

The shares of organic and combustible wastes in the latest survey conducted by Sakarya MM were slightly higher than those in the past surveys. As the figure shows, the shares of organic waste and combustible wastes increased by 4% and 2% respectively. Therefore, those of incombustible and hazardous wastes decreased by 2 to 3% in relation with the increase in the organic and combustible wastes. However, the shares estimated by the Survey Team in April 2015 were quite different when compared to the surveys by Sakarya MM. As the results indicate, the share of kitchen waste was lower than those in the past and the latest surveys conducted by the municipality (the share was 46%, which was 5% lower than that of the latest survey by Sakarya MM). On the contrary, the share of combustibles was 45% which was 3 to 5% higher than those in the surveys by Sakarya MM. However, the share of incombustible waste is at the same level with that of the overall averages of

the past surveys by Sakarya MM (only 2.6 points higher than the result of Sakarya MM"s latest survey).

In Figure 5-14, major waste compositions were compared among different surveys.

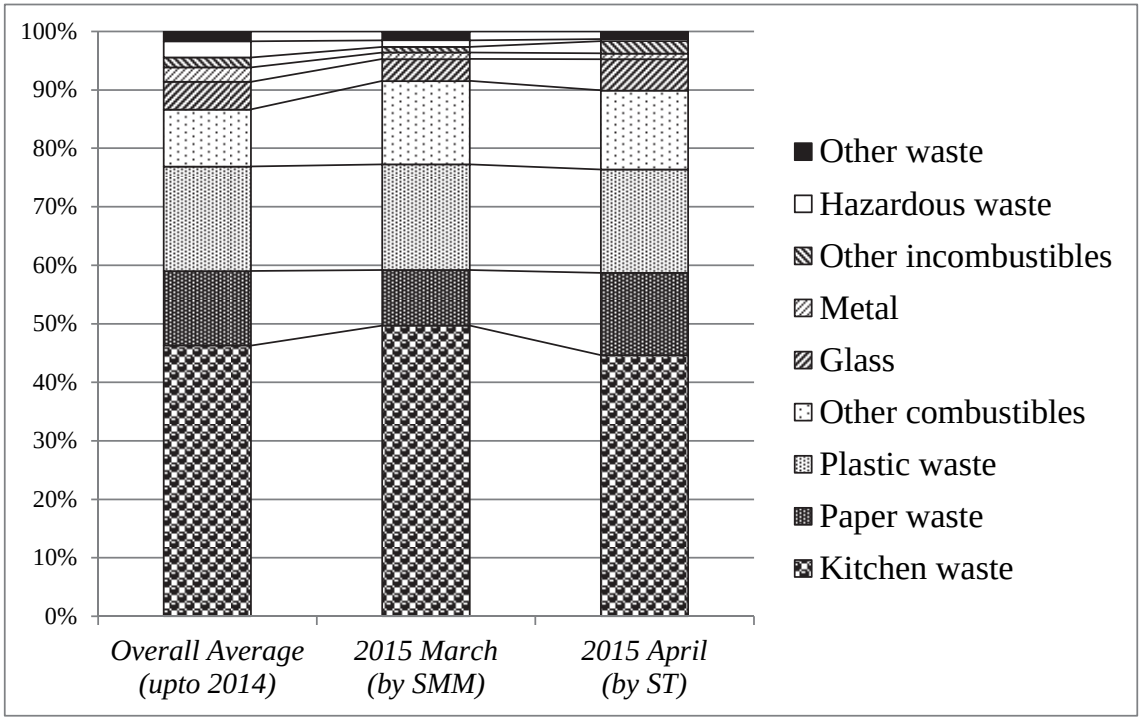


Figure 5-15: Waste composition survey results in Sakarya MM (waste components)

As Figure 5-15 shows, the share of kitchen waste estimated during the survey by the Survey Team is at the same level with that of overall averages of Sakarya MM past surveys. However, it was less than that in the latest survey conducted by the municipality.

The share of all combustible waste was higher in the survey by the Survey Team than that of the surveys by Sakarya MM, because of the increase in the portion of papers (cartons included). The portion of plastics is almost the same for all of the surveys.

The shares of all other types of waste estimated during the ST survey is relatively smaller than the overall averages of the past surveys conducted by Sakarya MM, but at a similar level when comparing to those of the Sakarya MM current survey.

5.5.3 Bursa MM

As the waste composition survey conducted in Bursa MM by the Survey Team was a demonstration for the municipality staffs, the survey targeted only municipal solid waste sample collected from Osmangazi MDM, and data of past surveys conducted by the municipality were not collected.

Therefore, the section includes the results which were obtained through the demonstration survey only.

a. Target waste and sample waste

The amounts of target and sample wastes are shown in the following table.

Table 5-17: Calculation of sample waste (General waste of Bursa MM), unit: kg

Target Areas	Target Waste			Removed Waste			Sample Waste		
	Picked	Mixed	Total	Picked	Mixed	Subtotal	Picked	Mixed	Subtotal
Osmangazi (RA: MIL)	157.8	545.9	703.7	119.5	413.3	532.8	38.3	132.6	170.9

b. Physical composition

The physical composition of municipal solid waste in Osmangazi MDM of Bursa MM is estimated as follows.

Table 5-18: Physical composition of municipal solid waste in Bursa MM (Target area: Osmangazi)

Type of Waste	Amount of sample waste (kg)	Physical composition (%)	
		Ash included	Ash excluded
Organic waste:			
Kitchen waste	67.2	39.3	40.1
Park and garden waste	0.2	0.1	0.1
Total Organic	67.4	39.4	40.2
Combustible waste:			
Bulky carton	1.6	0.9	0.9
Carton	8.5	5.0	5.1
Other combustibles	31.9	18.7	19.1
Paper	21.6	12.6	12.9
Plastics	26.5	15.5	15.8
Total Combustible	90.0	52.7	53.8
Incombustible waste:			
Ash (soil, stone included)	3.4	2.0	
Glass	8.3	4.9	5.0
Metal	0.9	0.5	0.5
Other incombustibles	0.6	0.4	0.4
Total Incombustible	13.2	7.7	5.8
Hazardous waste:			
e-Waste	0.0	0.0	0.0
Hazardous waste	0.3	0.2	0.2
Total Hazardous	0.3	0.2	0.2
Grand Total (Ash included)	170.9	**100.0**	
Grand Total (Ash excluded)	167.5		**100.0**

Organic waste makes up about 40% of the share regardless of ash/soil inclusion due to the low share of ash. Organic waste consisted of solely “kitchen waste” since the share of “park and garden waste” is near 0%. However, it should be considered that the result was obtained from one sample only.

Combustible waste occupies the highest share, which accounts for 53% to 54% of total wastes. Like other cities, plastics (16%) and other combustibles (19%) account for the higher shares. The major types of waste in “other combustibles” were textiles and diapers.

Like Kocaeli MM, the share of ash (including soil) is low, and thus, the share of incombustibles does not change significantly when ash is excluded (7.7% if ash included and 5.8% if ash excluded).

c. Apparent specific gravity

During the sampling processes, volume and weight were measured from the part of the target waste to identify the apparent specific gravity (a box of $0.5m^3$ was used for volume measurement). Bulky sized waste which was taken out before mixing was not included when measuring the volume.

The apparent specific gravity calculated from the measured volume and weight is as follows.

Table 5-19: Apparent specific gravity (ASG) of municipal solid waste (Bursa MM)

No	Municipalities	Target Areas	Measured Volume (m^3)	Measured Weight (kg)	Specific Gravity (kg/m3)
7	Bursa MM	Osmangazi (RA: MIL)	0.50	132.6	265.0

5.6 Physical composition of recycling residue

Residue discharged by 3 recycling companies in Kocaeli MM (3 trucks of waste) and 1 recycling company in Bursa MM (1 truck of waste) was sampled. The amount of wastes is shown as follows.

Table 5-20: Amount of the analyzed residue (unit: kg)

Target Areas	Target Waste			Removed Waste			Sample Waste		
	Picked	Mixed	Total	Picked	Mixed	Subtotal	Picked	Mixed	Subtotal
Kocaeli MM	107.5	470.7	578.2	103.5	461.3	564.8	4.0	9.4	13.4
Bursa MM	111.6	125.3	236.9	101.5	114.0	215.5	10.1	11.3	21.4
Subtotal	219.1	596.0	815.1	205.0	575.3	780.3	14.1	20.7	34.8

According to the results of survey, recycling residue consists of two major categories of waste: combustibles and incombustibles. More than 85% is occupied by combustibles (87% if ash included and 89% if ash excluded), which mainly consist of more than 45 % of “other combustibles, more than 25% of “papers (carton included)”, and around 15% of “plastics”.

The share of total incombustibles is 10 to 12%, which mainly consist of around 5% of “other incombustibles (mainly ceramics)” around 3% of and ash/soil or glass.

Table 5-21: Physical composition of recycling residue in Kocaeli and Bursa MM

Type of Waste	Amount of final sample (kg)			Physical Composition (%)					
				Ash included			Ash excluded		
	Kocaeli	Bursa	Total	Kocaeli	Bursa	Total	Kocaeli	Bursa	Total
Organic waste:									
Kitchen waste	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
Park and garden waste	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
Total Organic	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
Combustible waste:									
Bulky carton	0.2	0.2	**0.5**	1.8	1.1	1.4	1.8	1.1	1.4
Carton	0.7	0.6	**1.3**	4.9	2.8	3.6	5.2	2.9	3.7
Other combustibles	5.3	10.6	**15.9**	39.6	49.4	45.6	41.4	50.4	47.0
Paper	3.6	3.9	**7.5**	27.2	18.2	21.7	28.5	18.6	22.3
Plastics	1.3	3.7	**5.0**	10.0	17.2	14.4	10.5	17.5	14.9
Total Combustible	11.2	19.0	**30.1**	83.5	88.8	86.7	87.4	90.5	89.3
Incombustible waste:									
Ash (soil, stone included)	0.6	0.4	**1.0**	4.5	1.9	2.9	-	-	-
Glass	0.9	0.1	**1.0**	6.4	0.5	2.8	6.7	0.5	2.8
Metal	0.2	0.2	**0.4**	1.6	0.9	1.2	1.7	1.0	1.2
Other incombustibles	0.3	1.5	**1.8**	2.2	7.0	5.2	2.3	7.2	5.3
Total Incombustible	2.0	2.2	**4.2**	14.8	10.3	12.0	10.8	8.6	9.4
Hazardous waste:									
e-Waste	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
Hazardous waste	0.2	0.2	**0.4**	1.7	0.9	1.2	1.8	1.0	1.3
Total Hazardous	0.2	0.2	**0.4**	1.7	0.9	1.2	1.8	1.0	1.3
Total (Ash Included)	13.4	21.4	**34.8**	**100.0**	**100.0**	**100.0**	-	-	-
Total (Ash Excluded)	12.8	21.0	**33.8**	-	-	-	**100.0**	**100.0**	**100.0**

Figure 5-16 shows major composition indicators of recycling residue.

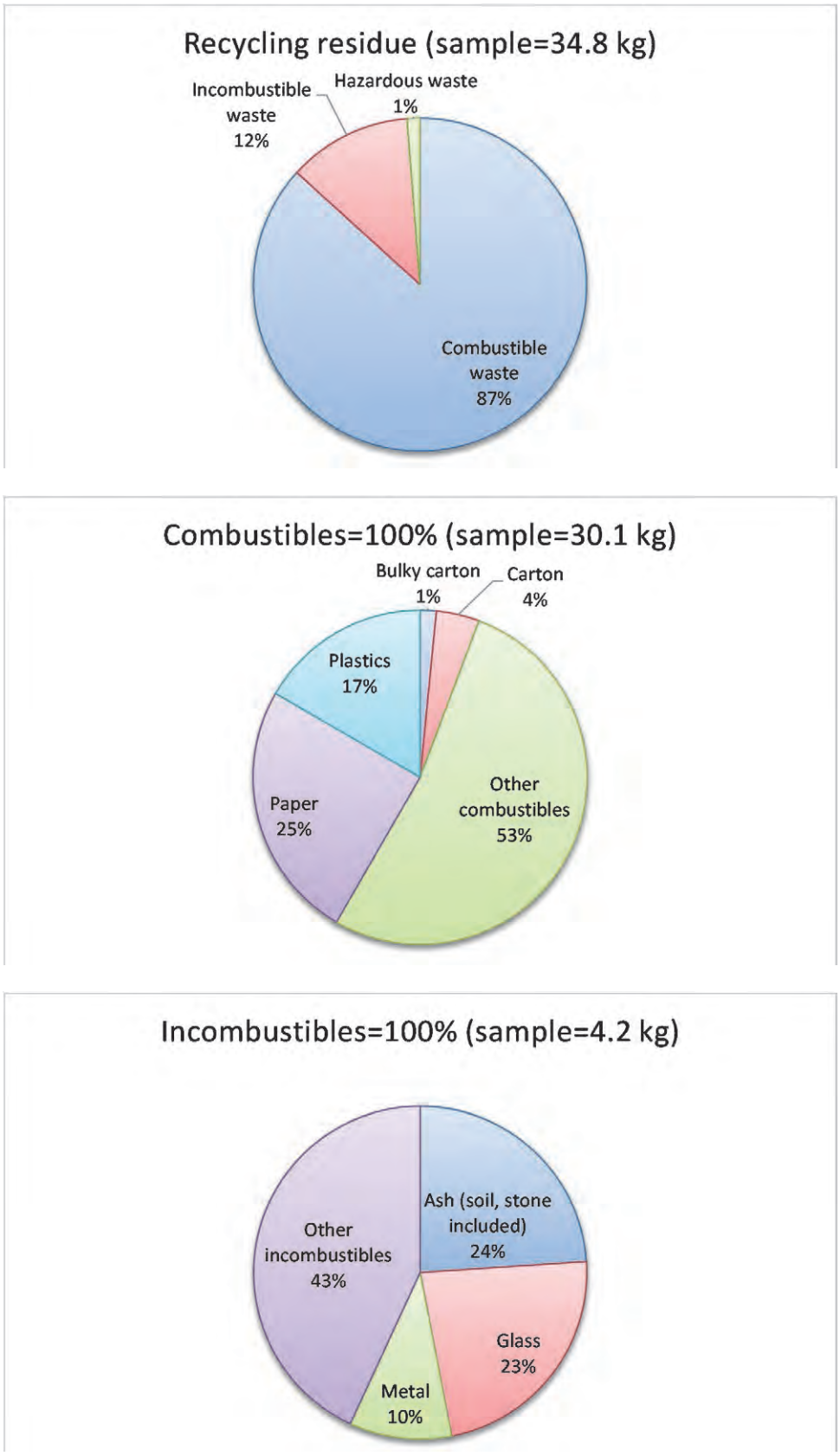


Figure 5-16: Composition of recycling residue, combustibles and incombustibles (with ash)

5.6.1 Three content analysis

a. Prepared samples

The Survey Team took samples for three composition analysis from the sorted waste during the 2015 winter survey conducted by Kocaeli MM and Sakarya MM in February and March 2015.

In each of the municipalities, 3 areas were selected for samples of three components analysis. The areas are shown in the table below.

Table 5-22: Areas selected for samples of three composition analysis

No	MM	District	Preferable Areas
1	Kocaeli MM	Gölcük	High income level residential area
2	Kocaeli MM	Körfez	High income level residential area
3	Kocaeli MM	Izmit	Middle income level residential area
4	Sakarya MM	Serdivan	Commercial area
5	Sakarya MM	Adapazari	Middle income level residential area
6	Sakarya MM	Erenler	Commercial area

The samples were collected from the sorted waste after physical composition analysis by the municipalities. The three composition samples were collected from 11 out of the 17 types of waste sorted during the physical composition. These are 1) Kitchen wastes, 2) Paper, 3) Carton, 4) Bulky carton, 5) Plastic, 6) Glass, 7) Metal, 8) Other incombustible, 9) Park and garden waste, 10) Other combustible and 11) Ash.

The detailed information about the samples collected for three composition analysis during the survey is summarized in the table below.

Table 5-23: Samples taken for three composition analysis (unit: kg)

No	Type of Waste	Kocaeli			Sakarya			Grand Total
		Golcuk*	Korfez	Izmit	Serdivan	Adapazari	Erenler	
		RA-HIL	RA-HIL	RA-MIL	CA	RA-MIL	CA	
		2015/2/26	2015/3/5	2015/3/12	2015/3/2	2015/3/3	2015/3/9	
1	Kitchen waste	0.315	0.413	0.297	0.398	0.465	0.336	2.224
2	Park and garden waste	0.230	0.209	0.267	0.254	0.212	0.281	1.453
3	Paper	0.315	0.302	0.282	0.273	0.250	0.300	1.722
4	Carton	0.299	0.273	0.314	0.311	0.275	0.245	1.717
5	Bulky carton	0.270	0.309	0.294	0.225	0.256	0.251	1.605
6	Plastic	0.257	0.260	0.290	0.289	0.291	0.320	1.707
7	Other combustibles	0.327	0.300	0.297	0.394	0.408	0.330	2.056
8	Glass	0.307	0.440	0.284	0.296	0.446	0.330	2.103
9	Metal	0.153	0.172	0.279	0.157	0.267	0.186	1.214
10	Other incombustible	0.312	0.171	0.248	0.474	0.226	0.203	1.634
11	Ash	0.300	0.300	0.251	0.354	0.385	0.335	1.925
	Totals	**3.085**	**3.149**	**3.103**	**3.425**	**3.481**	**3.117**	**19.360**

**-Samples for "Bulky carton", "Other incombustibles" and "Ash" were taken from Basiskele district*

(Note): (1) RA-HIL: Residential area: High income level; (2) RA-MIL: Residential area: Middle income level; (3) CA: Commercial area

b. Applied methodology

The three composition analysis was conducted by İZAYDAŞ at its laboratory in Izmit. According to İZAYDAŞ, the laboratory tests on the samples were conducted in accordance with Turkish Standard *"TS-9546 EN 12880: Characterization of Sludge – Determination of Dry Residue and Water Content"* and Turkish Standard TE EN 12089 published by Turkish Standards Institution in 2002.

During the three composition analysis, 100g from each sample were tested in the laboratory. In accordance with the standard, moisture was identified through drying process at in a specified condition by using designated crucibles and furnace. Loss of ignition (LOI) was determined through ignition from the samples dried during the initial process in order to identify combustible and incombustible substances of the samples. The weights of samples were measured before and after each of the processes and the three components were calculated from the measured values based on the following formulas.

For estimation of moisture and dry residual contents:

$$W_{dr} = \frac{(mc-ma)}{(mb-ma)} * f \quad \text{or} \quad W_{dr} = \frac{Dry\ weight}{Wet\ weight} * 100$$

$$W_w = \frac{(mb-mc)}{(mb-ma)} * f \quad \text{or} \quad W_w = \frac{Wet\ weight - Dry\ weight}{Wet\ weight} * 100$$

Herein:

W_{dr}: Dry residual content of sludge sample (% or g/kg in mass)

W_w: Water content of sludge sample (% or g/kg in mass)

ma: Mass of empty crucible (g)

mb: Mass of crucible or capsule containing sludge sample (g)

mc: Mass of crucible or capsule containing dry sludge (g)

f: Conversion factor, equals to 100 (if results are expressed in per cent) or 1000 (If results are expressed in g/kg).

For estimation of LOI:

$$W_v = \frac{(mb-mc)}{(mb-ma)} * 100 \quad \text{or} \quad W_v = \frac{Dry\ weight - Ash\ weight}{Dry\ weight} * 100$$

Herein:

W_v : Loss of ignition of sludge or sediment, in percent

ma : Mass of empty capsule or crucible (g)

mb: Mass of crucible including sample before ignition (g)

mc : Mass of crucible including sample following ignition test (g)

c. Estimated three components

During the three composition analysis, combustible solid contents were not determined for the samples taken from incombustible waste.

The items identified for each of the samples are compiled in the next table.

Table 5-24: Items identified through three composition analysis for each sample

No	Type of waste	Number of samples (delivered)	Identified items for each sample				Total Items to Identify
			Moisture	Combustible solid substance	Ash content	Number of Items	
1	Kitchen waste	6	○	○	○	3	18
2	Park and garden waste	6	○	○	○	3	18
3	Paper	6	○	○	○	3	18
4	Carton	6	○	○	○	3	18
5	Bulky carton	6	○	○	○	3	18
6	Plastic	6	○	○	○	3	18
7	Other combustibles	6	○	○	○	3	18
8	Glass	6	○	None	○	2	12
9	Metal	6	○	None	○	2	12
10	Other incombustible	6	○	None	○	2	12
11	Ash	6	○	None	○	2	12
	Total	66					174

The final results of three composition analysis are summarized in the following table. The values are the averages estimated from 6 samples for each type of waste components.

Table 5-25: Estimated Three Components (unit: %)

No	Waste Components	Moisture	Combustible solid content	Ash content	Total
1	Kitchen waste	81.4	17.1	1.5	100.0
2	Park and Garden Waste	62.6	32.5	4.9	100.0
3	Paper	44.0	50.7	5.3	100.0
4	Carton	25.1	62.5	12.4	100.0
5	Bulky Carton	25.3	66.0	8.7	100.0
6	Plastic	16.2	79.4	4.4	100.0
7	Other combustibles	25.4	70.3	4.3	100.0
8	Glass	8.7	0.0	91.3	100.0
9	Metal	5.1	0.0	94.9	100.0
10	Other incombustible	3.9	0.0	96.1	100.0
11	Ash	18.7	0.0	81.3	100.0

The details of moisture, combustible solid and ash contents for each sample are shown below.

Table 5-26: Moisture content (unit: %)

No	Waste Components	Kocaeli Metropolitan Municipality				Sakarya Metropolitan Municipality				Overall Average
		Golcuk*	Izmit	Korfez	Kocaeli MM average	Adapazari	Erenler	Serdivan	Sakarya MM average	
1	Kitchen waste	77.5	74.0	86.9	**79.5**	81.8	85.3	82.7	**83.3**	81.4
2	Park and garden waste	69.2	57.6	43.3	**56.7**	86.6	66.2	52.7	**68.5**	62.6
3	Paper	36.1	35.9	55.1	**42.4**	48.7	44.8	43.3	**45.6**	44.0
4	Carton	19.7	21.7	11.7	**17.7**	33.3	47.1	17.4	**32.6**	25.1
5	Bulky carton	19.6	28.8	19.9	**22.8**	25.9	43.2	14.3	**27.8**	25.3
6	Plastic	4.1	11.5	13.5	**9.7**	20.0	34.4	13.6	**22.7**	16.2
7	Other combustibles	30.9	25.8	23.9	**26.9**	27.8	32.3	11.6	**23.9**	25.4
8	Glass	3.6	3.6	3.6	**3.6**	3.6	0.5	37.3	**13.8**	8.7
9	Metal	3.7	11.4	3.6	**6.2**	4.0	4.3	3.6	**4.0**	5.1
10	Other incombustible	3.6	3.6	3.6	**3.6**	3.6	3.6	5.5	**4.2**	3.9
11	Ash	40.2	3.9	39.7	**27.9**	6.5	17.7	4.1	**9.4**	18.7

**Samples for "Bulky carton", "Other incombustibles" and "Ash" were taken from Basiskele district.*

Table 5-27: Combustible solid content (unit: %)

No	Waste Components	Kocaeli Metropolitan Municipality				Sakarya Metropolitan Municipality				Overall Average
		Golcuk*	Izmit	Korfez	Kocaeli MM average	Adapazari	Erenler	Serdivan	Sakarya MM average	
1	Kitchen waste	20.6	23.3	12.0	**18.6**	16.8	13.4	16.6	**15.6**	17.1
2	Park and garden waste	27.4	39.5	48.3	**38.4**	10.0	24.5	45.1	**26.5**	32.5
3	Paper	57.8	58.7	41.4	**52.6**	46.3	49.2	51.1	**48.9**	50.7
4	Carton	69.9	70.6	59.9	**66.8**	57.6	46.1	70.6	**58.1**	62.5
5	Bulky carton	71.1	63.8	71.2	**68.7**	63.6	50.1	76.3	**63.3**	66.0
6	Plastic	92.2	83.7	79.4	**85.1**	77.8	59.6	83.5	**73.6**	79.4
7	Other combustibles	64.8	72.7	71.6	**69.7**	70.8	61.2	81.0	**71.0**	70.3
8	Glass	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	0.0
9	Metal	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	0.0
10	Other incombustible	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	0.0
11	Ash	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**	0.0

**Samples for "Bulky carton", "Other incombustibles" and "Ash" were taken from Basiskele district.*

Table 5-28: Ash content (unit: %)

No	Waste Components	Kocaeli Metropolitan Municipality				Sakarya Metropolitan Municipality				Overall Average
		Golcuk*	Izmit	Korfez	Kocaeli MM average	Adapazari	Erenler	Serdivan	Sakarya MM average	
1	Kitchen waste	1.9	2.7	1.1	**1.9**	1.4	1.3	0.7	**1.1**	1.5
2	Park and garden waste	3.4	2.9	8.4	**4.9**	3.4	9.3	2.2	**5.0**	4.9
3	Paper	6.1	5.4	3.5	**5.0**	5.0	6.0	5.6	**5.5**	5.3
4	Carton	10.4	7.7	28.4	**15.5**	9.1	6.8	12.0	**9.3**	12.4
5	Bulky carton	9.3	7.4	8.9	**8.5**	10.5	6.7	9.4	**8.9**	8.7
6	Plastic	3.7	4.8	7.1	**5.2**	2.2	6.0	2.9	**3.7**	4.4
7	Other combustibles	4.3	1.5	4.5	**3.4**	1.4	6.5	7.4	**5.1**	4.3
8	Glass	96.4	96.4	96.4	**96.4**	96.4	99.5	62.7	**86.2**	91.3
9	Metal	96.3	88.6	96.4	**93.8**	96.0	95.7	96.4	**96.0**	94.9
10	Other incombustible	96.4	96.4	96.4	**96.4**	96.4	96.4	94.5	**95.8**	96.1
11	Ash	59.8	96.1	60.3	**72.1**	93.5	82.3	95.9	**90.6**	81.3

**Samples for "Bulky carton", "Other incombustibles" and "Ash" were taken from Basiskele district.*

5.7 Findings and observations

The findings and observations through the survey are the following:

- From the comparison of the surveys conducted by Kocaeli MM, Sakarya MM, and the JICA Survey Team, no significant difference was observed with the physical composition since the difference was less than 5%. Regarding some of the waste types, the survey results were almost the same.
- According to the waste composition survey conducted by the JICA Survey Team, the share of organic waste (mostly kitchen waste) in the municipal solid waste is 50% in Kocaeli MM and 46% in Sakarya MM (ash excluded). The combustible waste occupies 45% in both of the municipalities. Among the combustibles, the major types of waste are plastics and other combustibles (consisting of textiles, diapers, leather, wood, and others), which occupies 36% in Kocaeli MM and 31% in Sakarya MM.
- As for recycling residue, no organic waste was included. 87% was combustible waste (consisting of 46% of textiles, 27% of papers/cartons, and 14% of plastics), and 12% was incombustible waste (consisting of 5% of ceramics, 3% of glass, and 3% of ash).

- With regard to the three components, the degree of moisture contained in the municipal solid waste is very high since the water content is high in not only organic waste (62% in park/garden waste and 81% in kitchen waste) but also in all types of combustible waste (16 to 44% depending on the waste type). As a result, the overall water content of the municipal solid waste reaches relatively higher level since more than 90% of the municipal solid waste consists of these types of waste.

5.8 Lower heat value (LHV)

Based on the average three contents of each physical composition, the three contents of wastes was calculated (Table 5-29).

Table 5-29: Three contents of wastes in target MM

	Moisture contents	Combustible contents	Ash contents	Total	Year
Bursa	54.1	35.5	10.4	100.0	2014
Kocaeli	56.4	33.4	10.2	100.0	2014
Izmir	55.1	31.2	13.7	100.0	2013
Antalya	59.2	33.6	7.2	100.0	2011
Sakarya	45.2	32.7	22.2	100.0	2014

The values in the table above have been plotted in Figure 5-17. The three contents that can be incinerated without auxiliary fuel based on the World Bank Technical Guidance Report is shown in the colored area (water content below 50%, combustibles more than 25%, and ash less than 60%). This is a standard that was created by the World Bank based on various cases and not based on the Turkish conditions. The area in red-dotted line is the area where the three contents of the wastes can be incinerated without supplementary fuel by use of Japanese technologies.

As shown in Figure 5-17, according to the World Bank Technical Guidance Report, the wastes of all municipalities except for Sakarya are defined as wastes that cannot be incinerated without auxiliary fuel. Therefore, according to this Guidance, it can be said that incinerating the wastes of target municipalities would be highly costly as the wastes are high in water content and would require auxiliary fuel for incineration. However, if the three contents of the wastes that are actually incinerated in Japan are plotted in the diagram above, they would fall in the area in the red dotted line. Thus, this implies that even the wastes with high water-content can be incinerated with Japanese technologies.

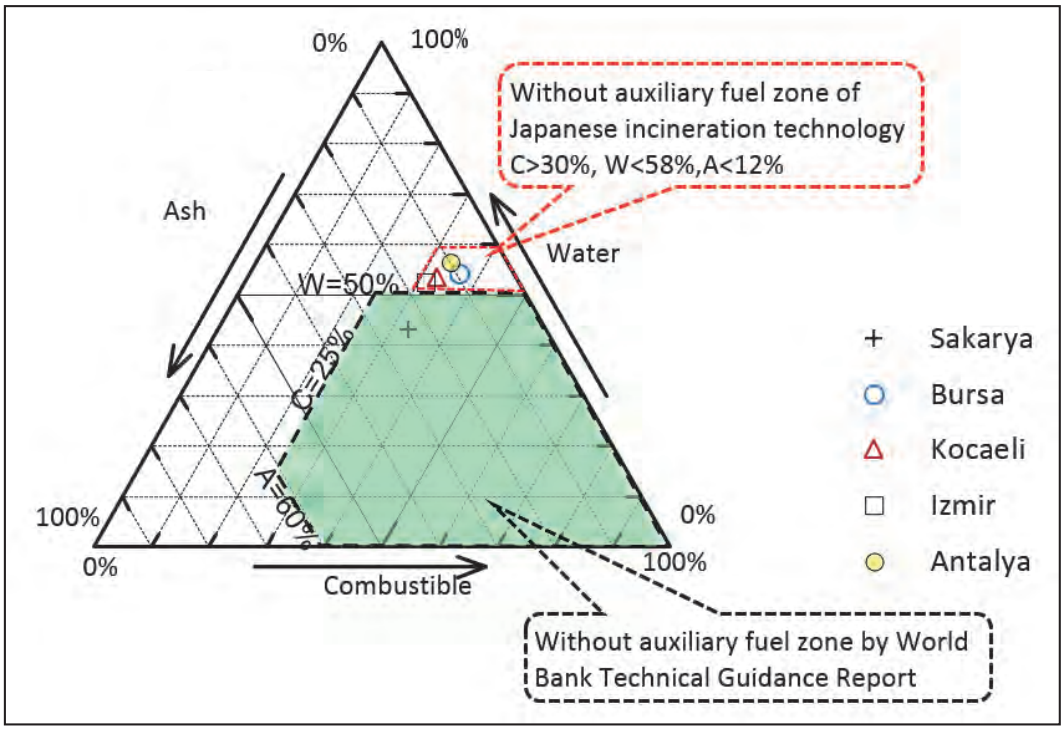


Figure 5-17: Three Contents Value in Different MMs Plotted in Triangular Coordinates

In this Survey, only the three contents were analyzed and the calorific values have not been directly measured. Therefore, the average calorific value of the combustible wastes may not be accurate. If further feasibility study is to be conducted, the accurate calorific values should be measured. Further, lower heating value was calculated by use of the following formula. The table below shows the result of the calculation.

Hu = 45B - 6w (Hu: Waste lower calorific value (kcal/kg), B: Combustible content (%), w: water content (%))

Table 5-30: Waste Calorific Value in Each MM

	45B	6W	waste calorific value 45B-6W (kcal/kg)	waste calorific value (kJ/kg)
Bursa	1,597.4	324.9	1,272.5	5,324.1
Kocaeli	1,502.9	338.3	1,164.6	4,872.5
Izmir	1,404.8	330.7	1,074.1	4,493.9
Antalya	1,512.0	355.5	1,156.5	4,838.8
Sakarya	1,469.9	270.9	1,199.0	5,016.6
Average	-	-	1,173.3	4,909.2

5.9 Trend in waste amount and composition

In general, the amount of paper, plastics, metals, and glass in wastes decrease as more recycling by separation at source progresses. As a result, the percentage of organic matter in waste will increase. Figure 5-18 and Figure 5-19 show the existing waste composition survey results and daily final disposal volume of waste per capita in different MMs. Distinctive trends in the MMs are summarized as follows.

- In Bursa MM, the volume of daily disposed wastes per capita increased, and the percentage of organic material decreased.
- In Kocaeli MM, the volume of daily disposed wastes per capita has decreased since 2013, and the percentage of organic matter in waste is increasing.
- In Izmir MM, the volume of daily disposed wastes per capita has decreased since 2012, and the percentage of organic matter in waste is increasing.

- In Antalya MM, the volume of daily disposed wastes per capita is increasing. Regarding the organic, survey team cannot make any evaluations, since data was not available.
- In Sakarya MM, the volume of daily disposed wastes per capita has started to decrease since 2012, and the percentage of organic matter in waste remains the same.

The above findings indicate that recycling by separation at source is progressing in Kocaeli MM and Izmir MM. It can be observed that as recycling activities become more widely spread, the percentage of organic matter in waste tend to increase, which leads to increase in water content.

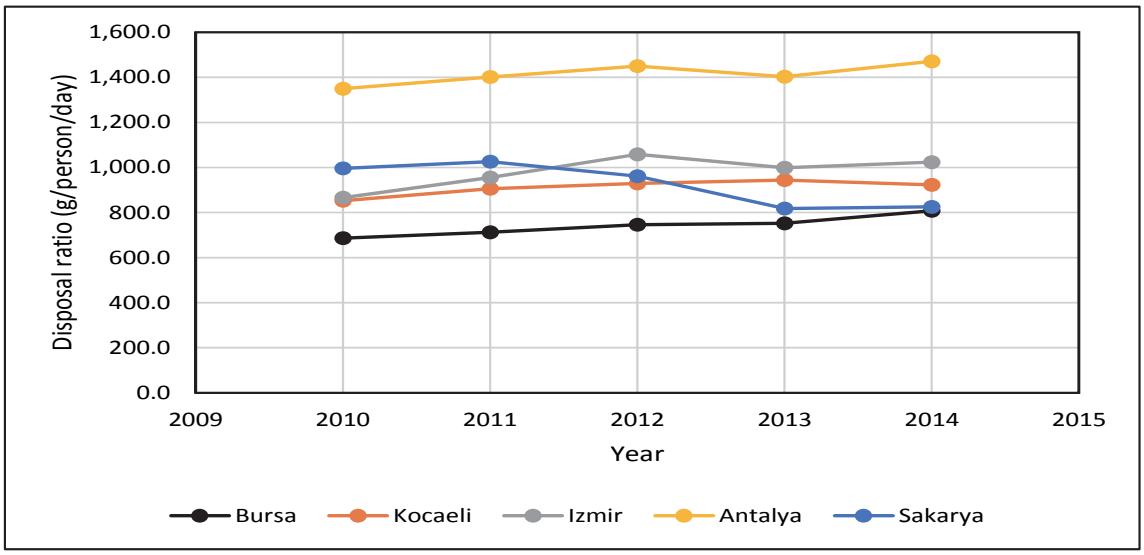


Figure 5-18: Disposal amount in sanitary landfill in each MM (g/person/day)

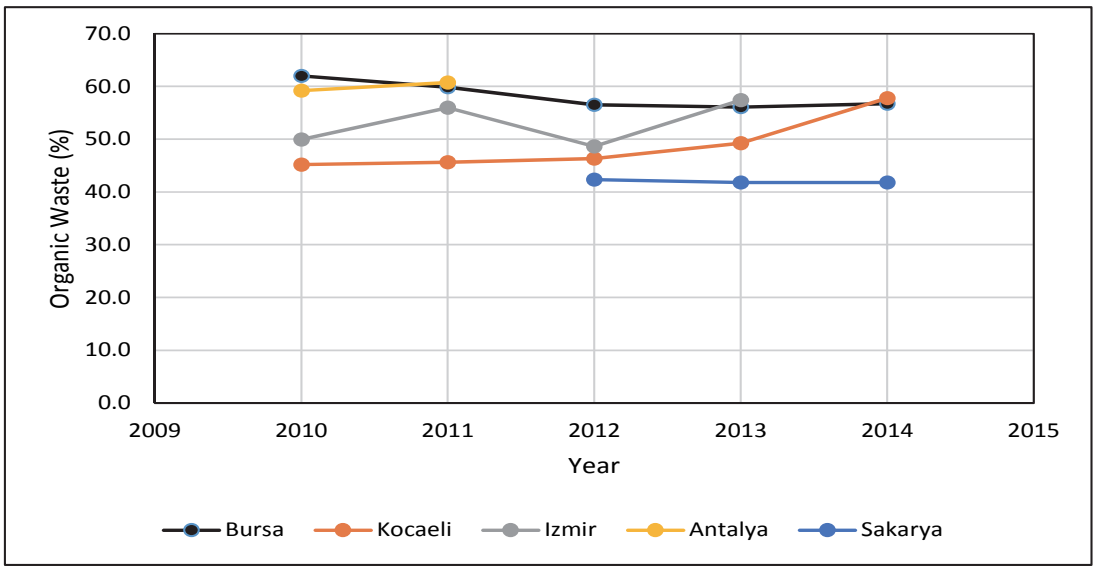


Figure 5-19: Change in share of organic wastes in each MM

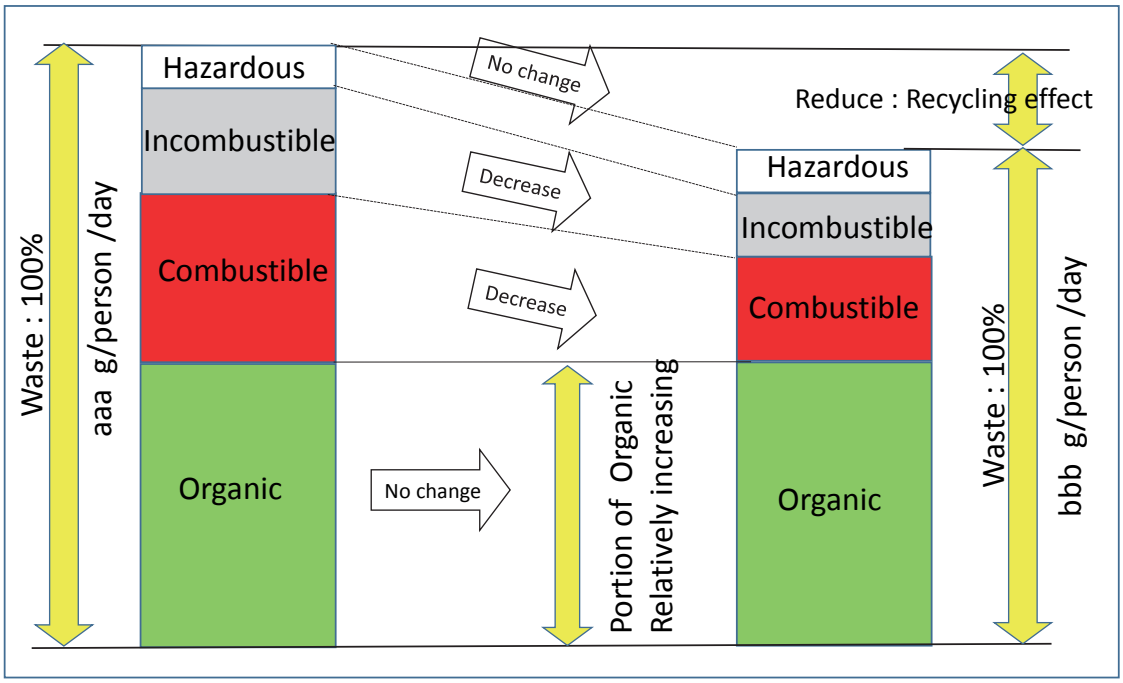


Figure 5-20: Change in waste quantity and composition by recycling (concept)

Table 5-31: Volume of wastes that go to sanitary landfill sites in target MM

Unit: ton/day

MM \ Year	2010	2011	2012	2013	2014
Bursa	1,787	1,888	2,004	2,063	2,251
Kocaeli	1,330	1,451	1,520	1,583	1,591
Izmir	2,844	3,145	3,519	3,484	3,606
Antalya	1,351	1,460	1,556	1,612	1,750
Sakarya	441	470	451	438	470

Table 5-32: Population served by sanitary landfill sites in target MMs

MM \ Year	2010	2011	2012	2013	2014
Bursa	2,605,495	2,652,126	2,688,171	2,740,970	2,787,539
Kocaeli	1,560,138	1,601,720	1,634,691	1,676,202	1,722,795
Izmir	3,283,525	3,293,524	3,327,004	3,486,929	3,525,713
Antalya	1,001,318	1,041,972	1,073,794	1,149,176	1,189,763
Sakarya	442,710	458,288	469,094	535,847	569,992

Table 5-33: Volume of daily disposed wastes per capita

Unit: g/person/day

MM \ Year	2010	2011	2012	2013	2014
Bursa	685.7	711.8	745.5	752.5	807.4
Kocaeli	852.8	905.7	929.7	944.1	923.5
Izmir	866.1	955.0	1,057.8	999.1	1,022.9
Antalya	1,349.0	1,401.6	1,449.4	1,402.4	1,471.1
Sakarya	996.1	1,025.6	961.4	817.4	824.6

Table 5-34: Waste composition and daily final disposal ratio in Bursa MM

Bursa	2010	2011	2012	2013	2014
Organic Waste (%)	62.0	59.9	56.5	56.1	56.7
Combustible Waste (%)	34.4	31.2	37.8	38.4	35.4
Incombustible Waste (%)	3.6	8.3	5.7	5.6	7.8
Hazardous Waste (%)	0.0	0.6	0.0	0.0	0.0
Total (%)	100.0	100.0	100.0	100.0	100.0
Disposal ratio (g/person/day)	685.7	711.8	745.5	752.5	807.4

Table 5-35: Waste composition and daily final disposal ratio in Kocaeli MM

Kocaeli	2010	2011	2012	2013	2014
Organic Waste (%)	45.2	45.6	46.3	49.2	57.8
Combustible Waste (%)	39.6	38.7	35.7	38.9	33.8
Incombustible Waste (%)	12.0	12.1	15.4	10.0	7.0
Hazardous Waste (%)	3.2	3.6	2.6	2.0	1.4
Total (%)	100.0	100.0	100.0	100.0	100.0
Disposal ratio (g/person/day)	852.8	905.7	929.7	944.1	923.5

Table 5-36: Waste composition and daily final disposal ratio in Izmir MM

Izmir	2010	2011	2012	2013	2014
Organic Waste (%)	49.95	55.95	48.65	57.39	N.D
Combustible Waste (%)	39.1	31.68	40.74	30.19	N.D
Incombustible Waste (%)	10.69	10.93	9.04	10.23	N.D
Hazardous Waste (%)	0.26	1.42	1.57	2.22	N.D
Total (%)	100	99.98	100	100.03	N.D
Disposal ratio (g/person/day)	866.1	955.0	1,057.8	999.1	1,022.9

N.D: No Data found

Table 5-37: Waste composition and daily final disposal ratio in Antalya MM

Antalya	2010	2011	2012	2013	2014
Organic Waste (%)	59.2	60.7	N.D	N.D	N.D
Combustible Waste (%)	35.6	34.1	N.D	N.D	N.D
Incombustible Waste (%)	4.8	4.3	N.D	N.D	N.D
Hazardous Waste (%)	0.4	0.9	N.D	N.D	N.D
Total (%)	100.0	100.0	N.D	N.D	N.D
Disposal ratio (g/person/day)	1,349.0	1,401.6	1,449.4	1,402.4	1,471.1

N.D: No Data found

Table 5-38: Waste composition and daily final disposal ratio in Sakarya MM

Sakarya	2010	2011	2012	2013	2014
Organic Waste (%)	N.D	N.D	42.3	41.8	41.8
Combustible Waste (%)	N.D	N.D	35.5	35.9	35.9
Incombustible Waste (%)	N.D	N.D	19.9	19.9	19.9
Hazardous Waste (%)	N.D	N.D	2.3	2.4	2.4
Total (%)	N.D	N.D	100.0	100.0	100.0
Disposal ratio (g/person/day)	996.1	1,025.6	961.4	817.4	824.6

N.D: No Data found

6 Current status of target municipalities and feasibilities of introducing WtE facilities

6.1 Current status of target municipalities

The table below summarizes the current status of each MM based on results of this Survey.

Table 6-1: Current status of target municipalities

Name of MMs	Bursa	Kocaeli	Izmir	Antalya	Sakarya
Population	2,787,359	1,722,975	4,113,072	2,222,562	932,706
Population density (person/km2)	267	477	342	107	193
Collected amount of solid waste (ton/day)	2,137	1,591	3,606*	1,989	752
Number of MDMs	17	12	30	19	16
Treatment and disposal method	Landfill (2 sites)	Landfill (2 sites)	Landfill	Landfill	Landfill
Disposed amount of municipal waste (ton/day)	2,137	1,591	3,606*	1,989	752
Surface area of disposal sites	Yenikent :830,000m3 İnegöl :246,000m3	Solakalar :30 ha Dilovasi :6.6 ha	Harmandali: 10,600,000m3 Bergama : unknown	Kizilli : unknown Manavgat: unknown Antalya: unknown Kumluca: unknown Patara: unknown	290ha
Remaining lifetime of disposal sites	11 years(Yenikent) 23years (İnegöl)	4 years (Solakalar) 4 years (Dilovasi) (To be expanded)	Harmandali: 0 years Bergama : 31years	Kizilli : unknown Manavgat:15 years Antalya: 1 year Kumluca: unknown Patara: unknown	12 years
Operation method of disposal sites	Commission to private sector	Commission to private sector	Commission to private sector	Commission to private sector	Commission to private sector
Operator of disposal sites	YİS Const. Co.	IZYDAS	Beyha	Kizilli : ITC Manavgat: Arel Çevre Antalya : ITC Kumluca: Remondis Çevre Patara: Remondis Çevre	Çınar Çevre Laboratuvari
Operation cost of disposal sites (TRY/ton)	3.4	14.5	4.02	34.57	7.00
Class of final disposal sites	Class II	Solakalar : Class I Dilovasi: Class II	Class II	Class II	Class II
Waste composition					
Moisture content (%)	54.1	56.4	55.1	59.2	45.2
Combustible content (%)	35.5	33.4	31.2	33.6	32.7
Ash content (%)	10.4	10.2	13.7	7.2	22.2
Estimated calorific value (kcal/kg)	1,273	1,165	1,074	1,157	1,199
Estimate calorific value (kJ/kg)	5,324	4,872	4,494	4,839	5,017
Future plan	There is an existing masterplan developed by the local university. Recently 7 municipalities have been integrated.	The area of expanded final disposal site is 150 ha. (71 ha of it will be landfilled)	Based on the feasibility study conducted by a local consultant, candidate site for a new waste treatment facility with sorting, anaerobic digestion, and residue landfill site with treatment capacity of 2,500 ton/day is in the north. A candidate site for a new transfer station in the south (not yet finalized).	There is no existing masterplan. 100 ha for expanding the existing disposal site is secured.	—

* Amount of disposed waste in Harmandali only.

As Turkey is a land-rich country, the most affordable and easy-to-operate method for treating and disposing municipal solid waste is to dispose them in sanitary disposal sites which require vast area of land.

In the EU Integrated Environmental Approximation Strategy of Turkey, it is estimated that the necessary investment for solid waste management between 2007 and 2023 is 9.56 billion EUR. However, 80% of this will be allocated for construction of disposal sites and only 13% will be allocated for construction of incineration facilities.

Thus, the basic national policy of Turkey with regard to treating and disposing wastes is to dispose them in sanitary landfill sites, and conducting intermediate treatment such as incineration should be considered only in cases where land for disposal sites cannot be secured.

From this point of view, the municipalities among the target metropolitan municipalities that may consider introduction of facilities for intermediate treatment such as incineration are the followings.

- Kocaeli MM: It has the high population density, the remaining lifetime of its final disposal site is short, and it is difficult to secure area for a new landfill site.
- Izmir MM: It has the second highest population density following Kocaeli MM, and there is no remaining capacity to accept wastes in Harmandali disposal site.

6.1.1 Waste management in target municipalities (degree of urgency for waste treatment/disposal facilities)

To consider the feasibility of introducing incineration facilities in the target MMs, the necessity and urgency as well as the readiness of the municipalities to install such facilities should be examined.

Applicability of Japanese technology in the five target MMs is as summarized in Table 6-2.

Based on this table, it is considered that the feasibility to introduce such facilities is especially high in Izmir MM and Kocaeli MM.

Table 6-2: Feasibility of introducing Japanese incineration technologies in the target municipalities

Name of MM	Status of waste management in general	Level of understanding of new technologies and incineration technology	Degree of urgency of introducing waste incineration	Feasibility of introducing Japanese incineration technologies
Bursa	Qualified staffs who control waste management facilities through both direct control and private contractors. Expansion of landfill site and landfill gas utilization project has been implemented as it was planned.	Bursa is implementing landfill gas utilization. Feasibility of introducing RDF production and gasification facilities is being considered. The staffs are learning characteristics of Japanese incineration technologies through this Survey.	The remaining lifetime of Hamitler disposal site is about 10 years. Integrated Solid Waste Management Plan (ISWMP) was drafted in June 2015 and currently under the process of approval (as of August 2015). New facilities should be constructed in accordance with ISWMP.	As future plans are still not clear, the feasibility is difficult to determine at this stage. The results of survey in Izmir MM and Kocaeli MM is likely to be applied also to Bursa MM.
Kocaeli	Sufficient staffs who implemented various solid waste management methods in collaboration with the operating company Izaydas.	Level of understanding is high, as it has been incinerating industrial wastes and applying anaerobic digestion.	As the remaining lifetime of Solaklar and Dilovasi disposal sites is about 4 to 5 years, construction of new disposal site is an urgent issue. However, candidate site has not been determined.	The feasibility should be conducted as soon as possible.
Izmir	Highly qualified staffs that control waste management facilities through both direct control and private contractors. Sufficient capacity to implement new projects.	Izmir MM is going to conduct a feasibility study regarding installation of RDF production and gasification plant. The staffs are learning characteristics of Japanese incineration technologies through this Survey.	The latest masterplan (or feasibility study) was prepared last year. It was decided that the new integrated waste treatment facility with capacity of 2,500 ton/day would be constructed in the Central area, and EIA is currently being conducted. In the South, immediate actions must be taken, as Halmandali disposal site is already 90% full with the wastes that come through transfer stations.	In the short-term, Izmir MM would be able to manage its wastes if the new facility in the North is to start its operation. However, for the long-term, introduction of incineration technologies should be considered soon.
Antalya	Waste management system of Antalya is not yet fully functional at this point due to recent integration of districts and change in mayor.	Landfill gas utilization has already been put into practice. The staffs are learning characteristics of Japanese incineration technologies through this Survey.	In order to meet the future demands, Antalya MM has already secured a new candidate disposal site. Thus, there is still time before considering introduction of new technologies.	The applicability of incineration technology should be studied in mid to long-term.
Sakarya	Solid waste management is implemented in a sound manner in general. There are some administrative work with regard to change in disposal sites which wastes are taken to.	The staffs are learning characteristics of Japanese incineration technologies through this Survey.	The current disposal site started its operation in 2009 and its remaining lifetime is 12 years. There is still time before considering introduction of new technologies.	The applicability of incineration technology should be studied over a medium term.

7 Possible assistance scenario

This chapter proposes possible JICA's assistance policies or scenarios in the waste management sector in Turkey based on the information in the previous chapters. It should be noted that this chapter does not mean JICA's official conclusion, guarantee of JICA's assistance to the sector as well as final agreement with the Government of Turkey.

7.1 Necessity and adequacy

Turkey is in its initial stage of introducing intermediate treatment facilities for municipal solid wastes, and several technologies are being proposed from both domestic and European companies including those that might not feasible for Turkey.
The necessity for Japanese assistance concerning municipal solid waste treatment can be summarized as follows.

- Metropolitan municipalities which are responsible for solid waste management are currently examining the possibility to introduce integrated waste treatment facilities and some have started operation. However, as noted in the previous chapters, based on the experience in Japan, the Survey Team considers that the possibility of this system to face difficulties/problems is high for various reasons when it is put into practice. Therefore, technical assistance from Japan could be a way to avoid the difficulties/problems that the municipalities may face in planning such facilities.
- While there is one waste incineration power plant for industrial wastes in Turkey, waste incineration power plant for municipal solid wastes has not yet been widely introduced. As mentioned in the previous chapters, taking into account the low calorific value of municipal solid wastes in Turkey, application of Japanese technologies could be the solution for efficient incineration of municipal solid wastes.

Therefore, it is considered that Japanese assistance to Turkey in this field could both be relevant and necessary.

As Japan has accumulated knowledge and experience through its trial and errors in constructing and operating different types of waste treatment facilities, these can be adopted to Turkey in order to construct and operate waste treatment facilities in an effective and efficient manner.

In the following sections, the major WtE technologies being considered to be introduced in Turkey are outlined along with precautions to take when introducing such technologies.

The most applied WtE technologies worldwide are power generation technologies by 1) landfill gas utilization, 2) anaerobic digestion, 3) incineration, and 4) gasification. During the field survey in Turkey, the Survey Team has explained the fundamental mechanisms and features of these four technologies to the five target municipalities and MoEU and MoENR.

a. Landfill gas utilization

Landfill gas utilization is a process where methane gas from anaerobic landfill areas (where landfill works have been completed) are gathered, treated, and utilized to generate power by gas-engine power generator. Methane gas from the anaerobic landfill areas can easily be collected by installing gas extraction wells, and this is a technology that is applied worldwide and promoted under international initiatives to reduce global warming gases including the clean development mechanism (CDM). Landfill gas utilization is already adopted in numerous cities in Turkey, and this is a technology that can be applied nationwide.

Meanwhile, the amount and quality of the landfill gas and the period of which it can be collected cannot be accurately predicted. As the amount of landfill gas fluctuates depending on the climate condition including weather and temperature, the amount of generated power also fluctuates. Therefore, in landfill gas utilization facilities in Turkey, the number of power generation units (consisting of gas-engine and power generators) are adjusted depending on the amount of collected landfill gas. If there is excessive landfill gas, it is combusted in the flare stack.

However, according to EU Integrated Environmental Approximation Strategy, Turkey shall comply

with the EU Landfill Directive (99/31/EC) and thus reduce the rate of biodegradable wastes that go into the landfill sites which generates the methane gas. Therefore, there is high possibility that amount of landfill gas that would be generated in Turkey would decrease in the future.

b. Anaerobic digestion

The technology of anaerobic digestion has been developed and put into practice in Europe and it has become popular in countries such as Germany and the Netherlands. This technology is designed under the assumption that separate discharge and collection system is appropriately in place and well-established as in the West European countries. However, this is still not the case in Turkey. Thus, if anaerobic digestion technology is applied in Turkey where mixed wastes are discharged and collected, extensive and complicated pre-treatment of wastes would be required. Therefore, challenges would be met if an anaerobic digestion plant is to be designed for a long-term operation in Turkey.

c. Incineration

A number of incineration power plants are operating in the West European countries with the objectives to reduce the volume of wastes to be landfilled and to recover collect energy (i.e. power and heat). These countries consider wastes as an energy source and thus waste incineration is commonly put into practice as an energy-recovery process.

In waste incineration power plants in Europe, a system to recover energy efficiently by utilizing wastes with high and stable calorific value such as paper and wood is designed under the assumption that separate discharge and collection system is in place as in the case of anaerobic digestion plants. Therefore, the wastes that can be incinerated without supplementary fuel (i.e. fossil fuel such as heavy oil or kerosene) with European technologies are those with minimum low calorific value of 1,400 kcal/kg (i.e. 5,950 kJ/kg)[1].

This Survey found that the calorific values of wastes in the target MMs are between 1,074 and 1,273 kcal/kg (i.e. between 4,494 and 5,324 kJ/kg) and average of 1,200 kcal/kg (i.e. 5,000 kJ/kg). Thus, if the wastes are incinerated with European technologies, fossil fuel should be added for proper incineration.

The following is considered to be the impact if the wastes are incinerated.

- The volume of wastes will significantly reduce in a very short time and thus the volume of wastes going in the landfill site will reduce significantly.
- As the volume of biodegradable wastes will significantly reduce, it will help Turkey in complying with EU Landfill Directive (99/31/EC).

It should be noted that the reason why this technology has not been spread in the country is due to the lower calorific value of the solid wastes compared to that in countries in Europe and the investment and operation costs for installing incineration plants which are much higher than those for other technologies such as landfill gas utilization.

d. Gasification

Commercial gasification plants have been introduced in Europe in the early 1990's and there are dozens of plants that were put into practice. However, there are no longer companies in the market that provides such technology for treatment of wastes today excluding a few Japanese companies.

As the gasification process consists of recovering heat after gasifying the wastes, the heat loss in gasification facilities is higher than that in incineration facilities. Therefore, a large quantity of fossil fuel is required to be added for the system to properly function if the calorific value of the wastes is lower than 1,800 kcal/kg or 7,500 kJ/kg.

In Japan, many waste melting furnace gasification plants have been constructed. This is an effective technology for treating wastes with high and stable calorific value such as industrial wastes, but it is not adaptable for treating wastes with relatively low and fluctuating calorific value as it requires a large quantity of fossil fuel to be added. While there are gasification systems designed to incinerate

[1] Steinmuller-babcock presentation Bangkok 2014/10/21, Steinmuller-babcock EfW Hefei : design calorific value 6.28/ton.95 Mj/kg,

wastes with supplementary fossil fuel, gasification has failed to become one of the major waste treatment technologies of today for the above reason.

e. Integrated solid waste management facility

Turkey started to install waste treatment facilities with the objective of complying with EU Landfill Directive (99/31/EC) such as mechanical biological treatment (MBT) facilities and biogas production facilities. Further, facilities called integrated solid waste management facilities composed of various treatment facilities interlinked are now being introduced. The figure below is an example of a flow chart of an integrated solid waste management facility.

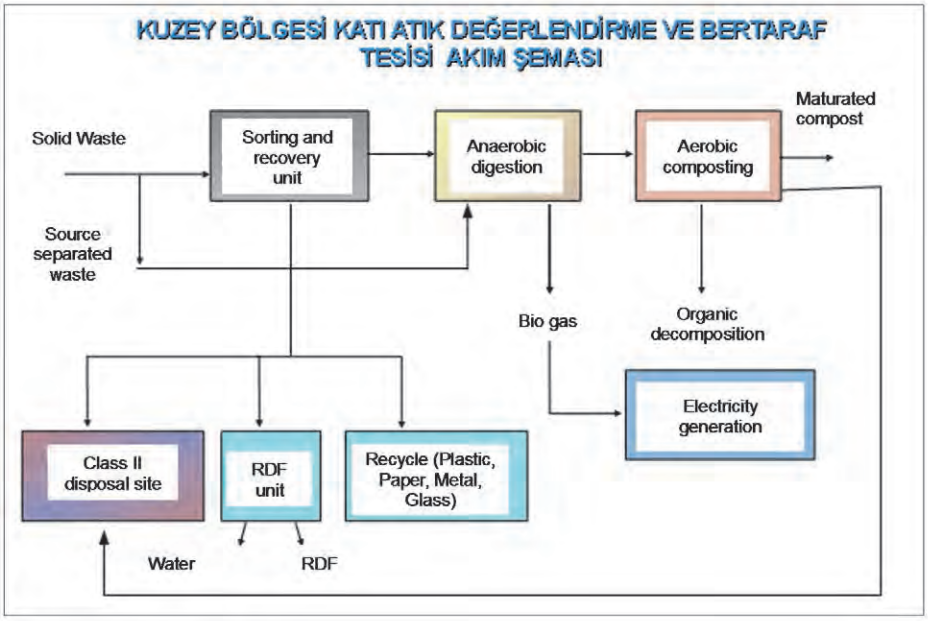


Figure 7-1: Example of flow chart of integrated solid waste management facility

Under the assumption that the wastes are sorted prior to being fed in this facility, this facility is designed to operate with the following steps.

- Separation of biodegradable and non-biodegradable wastes
- Power generation by biogas collected by anaerobic digestion of biodegradable wastes
- Composting of residue from anaerobic digestion (the compost is later recycled)
- Sorting of recyclable materials such as metal, paper, plastics, and glass among the non-biodegradable wastes for recycle
- Production of residue-derived fuel (RDF) from combustible wastes that cannot be recycled for heat and energy recovery
- Landfill of final residues

However, if the quality of the wastes fed in this facility would not meet the criteria of the treatment processes, the following problems may occur.

- Negative impacts to all of the treatment processes to be followed
- The compost produced in the facility may not be used for agriculture but used only for green spaces and for cover soil of landfill site.

This implies that there is a risk that the facility will not be able to properly operate unless the wastes are properly sorted by either proper separation at source (through well-established separate discharge and collection system) or a sophisticated pre-sorting facility that would remove all unwanted objects.

7.2 Applicability of Japanese technologies

7.2.1 WtE technologies in Japan

In Japan, the most widely applied WtE technology is incineration followed by gasification (mainly melting furnace gasification). Anaerobic digestion is applied only in limited cases, and landfill gas utilization does not exist in Japan.

Although Japanese incineration technologies are not fundamentally different from the European technologies, the Japanese technologies are considered to be more applicable to Turkey where moist and low-calorie wastes are incinerated for the reasons stated below.

- In Europe, waste incineration is considered as a method of energy recovery. Therefore, the European incineration technology is designed for only high-calorie wastes and cannot accept low-calorie wastes. Such technology is feasible in Europe due to its dry climate (i.e. wastes are dry) and the well-established sorting system (i.e. low-calorie wastes are separated and treated by other methods such as anaerobic digestion).
- On the other hand, Japanese waste incineration technology has developed for the purpose of treating solid wastes for public sanitation. As a result of this sanitary treatment, heat is produced and utilized for power generation. Currently, Japanese waste technology can incinerate both wastes of low calorific value (i.e. from 1,000 to 1,200 kcal/kg) and of high calorific value (i.e. over 2,000 kcal/kg) without using supplementary fossil fuel.
- Based on the long experience, waste incineration power plants utilizing Japanese technologies are able to maintain high performance over a long period with the appropriate maintenance.

7.2.2 Applicability

Turkey does not conduct sorted collection of municipal solid waste and its calorific value is between 1,000 and 1,200 kcal/kg (approximately between 4,000 and 5,000 kJ/kg). Thus, if these wastes are incinerated with European incineration technologies, supplementary fuel (fossil fuel) is required. These municipal solid wastes, on the other hand, can be incinerated without supplementary fossil fuel by the Japanese technologies. Therefore, it is considered that applicability of Japanese technologies for the incineration of Turkish municipal solid wastes is high.

7.2.3 Challenges with regard to application of Japanese technologies

The introduction of Japanese waste incineration power plants in Turkey is considered feasible from the technical perspective as explained above. It may be, however, less feasible from the economic perspective as the FIT is currently not applied to waste incineration power plants under the relevant law in Turkey. Thus, it should be noted that application of the FIT to waste incineration power plants is a precondition to introduce such plants in Turkey.

7.3 Possible Japanese assistance

7.3.1 Needs in the Target Municipalities

The needs from the target MMs with regard to Japanese assistance are summarized as follows.

a. Bursa MM

Bursa MM is currently conducting a feasibility study on installing a new waste treatment facility and is now in the process of authorization of this study. Although the details of this study cannot be made public before its authorization, it has been shared by Bursa MM that the type of this facility would be integrated solid waste management facility (ISWMF).

After the Survey Team explained the technical challenges with regard to this type of facility as mentioned in Section 7.1 e, Bursa MM has stated their interest in receiving technical assistance from Japan so that the facilities would properly operate and their objectives would be achieved.

b. Kocaeli MM

Kocaeli MM has been considering to introduce waste incineration power plant from prior to this Survey, and it has conducted a study in collaboration with Kobelco Eco-Solutions Co., Ltd. in 2012 with the financial assistance from the Ministry of Environment of Japan. Kocaeli shows interest in receiving Japanese assistance for conducting a feasibility study for introduction of waste incineration power plant. Further, as Kocaeli MM's concept for this feasibility study focused on detailed technical aspects and profitability of power sales, the Survey Team has explained the necessity of a more balanced terms of reference (TOR) covering various issues from site selection to technical aspects.

c. Izmir MM

Izmir MM is currently preparing to install a new integrated solid waste management facility (ISWMF) with treatment capacity of 2,500 ton/day in Yamanlar district near the current Harmandali disposal site. Similarly with Bursa MM, Izmir MM has stated their interest in receiving technical assistance from Japan in order to operate facilities in a proper manner to achieve its objectives. A public consultation meeting on environmental impact assessment (EIA) concerning this facility has been organized in the end of March 2015.

d. Antalya MM

Antalya MM is currently managing wastes from 19 MDMs. 14 MDMs were recently integrated into the municipality in March 2014, and as a result, the volume of waste to be managed by Antalya MM has almost doubled from March 2014. Antalya MM is still under the process of reinforcing its organizational capacity for proper management of all these wastes. Therefore, Antalya MM intended for technical assistance with regard to organizational capacity development for waste management.

e. Sakarya MM

While introduction of waste incineration in Sakarya MM may be beneficial for the Municipality in the future, this is considered to be less urgent as its sanitary landfills are being properly managed and these landfills also have abundant remaining capacity.

7.3.2 Prioritized needs of municipalities

Based on the needs of target MMs, the Survey Team has summarized the outline of prioritized needs from MMs as the table below.

Table 7-1: Needs for JICA assistance from target MMs and possible issues to be addressed

MM	Needs from Turkish side	Possible issues to be addressed
Bursa	Technical assistance with regard to installation of new integrated solid waste management facility	− Clarification of basic concept regarding integrated solid waste management facilities − Identification of advantages and disadvantages of each facility constituting the integrated solid waste management facility − Advice regarding selection the optimum type of integrated solid waste management facility − Advice regarding facility design and construction − Advice regarding facility operation and management
Kocaeli	Technical assistance with regard to installation of waste incineration power plant	− Feasibility study on introduction of waste incineration power plants (the terms of references for this study have already been prepared by the Survey Team and explained to Kocaeli MM)
Izmir	Technical assistance with regard to installation of new integrated solid waste management facility	− Clarification of basic concept regarding integrated solid waste management facilities − Identification of advantages and disadvantages of each facility constituting the integrated solid waste management facility − Advice regarding selection the optimum type of integrated solid waste management facility − Advice regarding facility design and construction − Advice regarding facility operation and management

MM	Needs from Turkish side	Possible issues to be addressed
Antalya	Capacity development regarding waste management	− Assistance for establishment of regional waste management system − Assistance with regard to implementing regional waste management
Sakarya	(No concrete request)	

The needs from the target MMs with regard to assistance from Japan are categorized into technical assistance and organizational reinforcement. If the Turkish side wishes to receive Japanese financial assistance based on the result of technical assistance, either ODA loan or private-sector investment loan would be the possible measures.

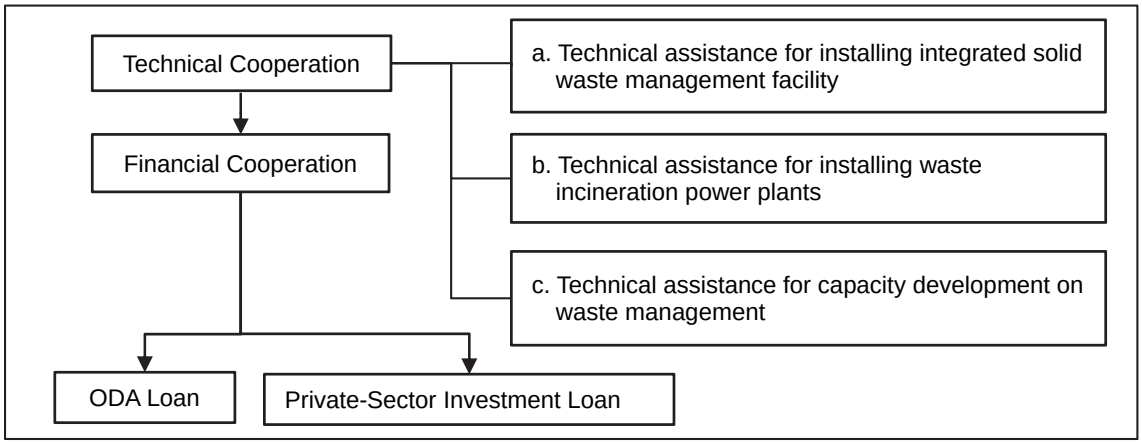


Figure 7-2: Possible JICA assistance schemes

7.3.3 Possible project ideas based on prioritized needs from municipalities

Based on the analysis in the previous section (7.3.2), the Survey Team has summarized the possible project ideas as below.

Table 7-2: Possible project ideas

MM	Survey result	Possible project ideas
Bursa	Bursa MM is currently in the final stage of its feasibility study on introducing integrated solid waste management facilities, and the details on its treatment system and technical specifications are currently being determined. Therefore, the Survey Team has considered that the scope of Japanese technical assistance is limited, since the possibility of Japanese technical assistance regarding facility planning and construction would be low under the current circumstances.	Capacity development with regard to operation of waste treatment facilities
Kocaeli	Surveys have been conducted regarding installation of waste incineration power plants in Kocaeli MM by utilizing the finance of Japanese Ministry of the Environment. Further, in Kocaeli MM, the remaining lifetime of the existing final disposal site is only 4 to 5 years, and the population density is the next highest in Turkey after Istanbul. Therefore, based on these backgrounds, the Survey Team has considered that the need to introduce waste incineration power plants is the highest for Kocaeli MM among any other MMs targeted under the survey. Kocaeli MM is also requesting for Japanese support to conduct a feasibility study for installation of waste incineration power plant. It is considered that there is high possibility to introduce WtE facilities by utilizing Japanese technologies in Kocaeli MM.	With regard to installation of new waste treatment facilities • Feasibility study on introducing waste incineration power plants • Examination of possibility for Japanese financial assistance • Capacity development on operation of facilities

MM	Survey result	Possible project ideas
Izmir	Izmir MM is currently in the final stage of its feasibility study on installation of integrated waste treatment facilities in the Northern district, and it is currently determining the details on its treatment system and technical specifications. Therefore, under the current circumstances, it is considered that there may not be enough time left for Japan to intervene and provide assistance to Izmir MM regarding these facilities. Meanwhile, as the treatment method in the Southern district which generate about 1,500 to 2,000 ton/day is still not determined, there is the possibility that waste incineration facilities by use of Japanese technologies to be introduced in this area.	With regard to installation of waste treatment facility in the Southern district: • Drafting of masterplan on waste treatment facilities • Feasibility study based on the masterplan above • Examination of possibility for Japanese financial assistance • Capacity development on operation of facilities
Antalya	Organizational and institutional capacity development in order to efficiently manage wastes from the 14 MDMs is considered to be needed.	Technical cooperation for capacity development of inter-municipal waste management

7.3.4 Priority projects

The Survey Team has summarized the ideas for projects with high priorities that could be supported by Japan as shown in the table below.

Table 7-3: Outlines of priority projects

MM	Priority project title	Activities (contents of assistance)
Bursa MM	Capacity development regarding operation of municipal solid waste treatment facilities	− Dispatch of expert(s) − Training in Japan
Kocaeli MM	Assistance regarding installation of new municipal solid waste treatment facilities (1)	− Feasibility study by utilizing Japanese loan assistance for the introduction of waste incineration power plants − Loan assistance for construction of waste incineration power generating facilities − Capacity development of administrators regarding construction and operation of waste incineration power generating facilities (technical cooperation project, dispatch of experts, training in Japan)
Izmir MM	Assistance regarding installation of new municipal solid waste treatment facilities (2)	− Formulation of masterplan on waste treatment facilities − Feasibility study on utilizing Japanese loan assistance for the introduction of waste incineration power plants − Loan assistance for construction of waste incineration power generating facilities − Capacity development of administrators regarding construction and operation of waste incineration power generating facilities (technical cooperation project, dispatch of experts, training in Japan)
Antalya MM	Assistance regarding establishment of regional municipal solid waste management structure	− Capacity development concerning regional solid waste management in the metropolitan areas (dispatch of expert(s), technical cooperation project, training in Japan)

The possible priority project in Bursa MM consist of activities such as collection of basic data (e.g. waste amount and composition) and examination of operation history towards capacity development for appropriate operation of integrated waste treatment facility. This know-how will then be disseminated to other areas in Turkey in order to enhance appropriate operation of facilities nationwide. The estimated period for the project is two years.

The possible priority projects for Kocaeli and Izmir MM are to conduct a feasibility study on installation of waste incineration and generation facilities by utilizing Japanese technologies with the goal to actually design and install such facilities in an appropriate manner by the use of Japanese loan assistance. Further, regarding Izmir MM, assistance should also be provided with regard to formulating a master plan on waste treatment facilities for the whole municipality. Project period is estimated to be of 6 to 7 years, including the period for loan assistance.

For Antalya MM, the possible priority project is to reinforce its capacity for proper management of

wastes in its district. The authorities from the Japanese major local government(s) are to provide organizational and technical support with regard to establishment of inter-municipal waste management based on its experience in Japan. The estimated project period is approximately 3 months.

8 Economic feasibility simulation

In order to examine the applicability of Japanese incineration technology in Turkey, not only technological feasibility but also financial feasibility should be examined. Here, the capital expenditure (hereinafter "CAPEX") and operational expenditure (hereinafter "OPEX") were estimated for waste incineration power plants with treatment capacity of three cases, such as 500 ton/day, 1,000 ton/day, and 1,500 ton/day.

CAPEX of incineration power plants will reduce as the treatment capacity of the facility increase. Here, the CAPEX was calculated for treatment capacities of 500, 1,000, and 1,500 ton/day based on the EPC unit cost used in the World Banks's cost model for waste incineration power plants[1].

Increase in treatment capacity will lead to increase in power generation capacity, which will lead to increase in amount of power to be sold. The amount of power to be sold for the three cases was calculated under the assumption that the calorific value of the wastes is 1,200 kcal/kg. Based on the assumptions above, the cash flow was analyzed for the three cases under the conditions shown in Table 8-1. The annual operation and maintenance cost was assumed to be 10% of CAPEX.

Table 8-1: Conditions for cash flow analysis

Case	Treatment capacity	EPC unit cost (TRY/ton)	CAPEX (TRY)	OPEX (TRY/year)	Power to be sold (kW)
1	500 ton/day	330,000	165,000,000	16,500,000	4,000KW
2	1,000 ton/ day	280,000	280,000,000	28,000,000	8,000KW
3	1,500 ton/ day	260,000	390,000,000	39,000,000	12,000KW

The result of the analysis is shown in the table below.

Table 8-2: Result of cash flow analysis for different cases

Case	Treatment capacity	Financial Internal Rate of Return (FIRR)	Loan repayment	Investment recovery
1	500 ton/day	6.33	In 11 years after beginning of operation	In 12 years after beginning of operation
2	1,000 ton/day	10.22	In 8 years after beginning of operation	In 11 years after beginning of operation
3	1,500 ton/day	12.52	In 7 years after beginning of operation	In 10 years after beginning of operation

[1] Municipal Solid Waste Incineration WORLD BANK TECHNICAL GUIDANCE REPORT

8.1 Basic framework of the project

The tables below shows the basic framework of the project for construction of intermediate treatment facility for municipal solid wastes.

8.1.1 Treatment method and operational framework

Items	Contents
Target solid waste	Municipal solid waste
Planned treatment capacity	The following treatment capacities are considered. − 500 ton/day − 1,000 ton/day − 1,500 ton/day
Assumed calorific value of solid waste	1,200 kcal/kg
Treatment system	All the solid wastes brought to the plant are incinerated using a stoker furnace and the produced heat would be utilized for power generation. The generated power will be partly self-consumed and the surplus will be sold through power grid.
Operation time	24 hours/day and 310 days/year.
Operational scheme	Operation by municipality
Project duration	20 years from the start of operation

8.1.2 Financial assumption

Items	Contents
Capital Fund	Municipalities provide 30% of capital cost through either in-kind (e.g. provision of land) or financial contribution.
Loan	70% of capital cost will be financed by domestic and/or international financial institutions. Conditions for the loan are as follows: – Yen loan: payback period is 20 years with 5 years of moratorium. Interest rate is 5% – Iller Bank: payback period is 5 years with 12% of interest rate (open market rate)

8.1.3 Assumptions in project cash flow analysis

<table>
<tr><th>Cash flow</th><th>Items</th><th>Assumption</th></tr>
<tr><td rowspan="2">Revenue</td><td>Revenue from waste management service fee</td><td>Waste management service fee: 175 TRY/ton
Amount of capacity: 500 ton/day, 1,000 ton/day, 1,500 ton/day
Operation time: 24 hour/day, 310 days/year</td></tr>
<tr><td>Revenue from power sales</td><td>Price of power sales: 0.165 TRY/kwh (Open market average electricity price from Jan to Feb 2015)
Amount of electricity to be sold is as follows:
<table>
<tr><td>Treatment capacity</td><td>Power to be sold (KW)</td></tr>
<tr><td>500 ton/day</td><td>4,000KW</td></tr>
<tr><td>1,000 ton/day</td><td>8,000KW</td></tr>
<tr><td>1,500 ton/day</td><td>12,000KW</td></tr>
</table></td></tr>
<tr><td>Expenditure</td><td>Capital cost</td><td>EPC cost is as follows:
<table>
<tr><td>Treatment capacity</td><td>EPC Cost (TRY/ton)</td></tr>
<tr><td>500 ton/day</td><td>330,000</td></tr>
<tr><td>1,000 ton/day</td><td>280,000</td></tr>
<tr><td>1,500 ton/day</td><td>260,000</td></tr>
</table>
(Based on World Bank's cost model)</td></tr>
</table>

Cash flow	Items	Assumption
Expenditure	Operation and maintenance cost	Operation and maintenance cost is assumed to be 10% of initial investment cost. Further, cost for preparation was calculated for the three years prior to beginning of operation.

8.2 Results of cash flow analysis

Based on the framework above, the cash flow was analyzed for each WtE facility capacity, namely 500 ton/day, 1,000 ton/day, and 1,500 ton/day. The tipping fee was set at 175 TRY/ton and electricity selling price was set as 0.165TL/kWh, and the result of analysis is shown in Table 8-2 in the previous page.

8.3 Results of Sensitivity analysis

Economic feasibility of a project can be analyzed through different indicators such as FIRR and net present value (NPV). However, the most important question for the municipalities regarding waste treatment is "What is the unit cost of treatment (i.e. tipping fee)?" Although this question is difficult to answer before determining the details of the project, how the change in different parameters would affect the tipping fee was analyzed for reference (sensitivity analysis).

8.3.1 Conditions

In order to analyze sensitivity of the unit treatment cost (i.e. tipping fee), the analysis was conducted under the condition where FIRR would be the same with the results shown in Table 8-2. The sensitivity of the tipping fee to four parameters, namely (1) low calorific value of waste, (2) power sales unit price, (3) EPC cost, and (4) operation and maintenance (O/M) cost, were analyzed.

With regard to operation and maintenance cost, the annual cost was assumed to be 10% of the EPC cost. In order to analyze the sensitivity to different parameters, the operation and maintenance cost was assumed to be constant. Further, although the amount of heat and power that can be recovered in the plant will depend on the calorific value of the wastes, the amount of energy that is consumed by the plant for waste incineration was assumed to be fixed.

8.3.2 Result of sensitivity analysis

The result of sensitivity analysis for these 4 parameters are shown in Figure 8-1. The tipping fee was calculated under the following assumptions: power sales unit price would fluctuate by ±20% taking into account the unit price under FIT, and other parameters would fluctuate by ±10%. It was found that the tipping fee has the highest sensitivity to EPC cost, as 10% of fluctuation would cause 7% change in tipping fee. In practice, sensitivity analysis should be conducted in further detail so that the sensitivity can be examined for the actual fluctuation that can be expected over time. Currently, this analysis is only a tool to understand the characteristics of the cash flow analysis in this Survey.

Figure 8-2 shows the result of sensitivity analysis when the fluctuation level is doubled. 20% change in EPC cost has resulted in more than 15% change in tipping fee.

					Result (TRY/ton)		
	Fluctuation	Low	Standard	High	High	Standard	Low
Low heat value of wastes (kcal/kg)	10%	1,080	1,200	1,320	179.5	175	170.3
Power sales unit price (TRY/kWh)	20%	0.132	0.165	0.198	181.4	175	168.7
EPC cost (1,000 TRY/ton)	10%	234,000	260,000	286,000	187.3	175	162.7
O/M cost (1,000 TRY/year)	10%	35,100	39,000	42,900	183.4	175	166.6

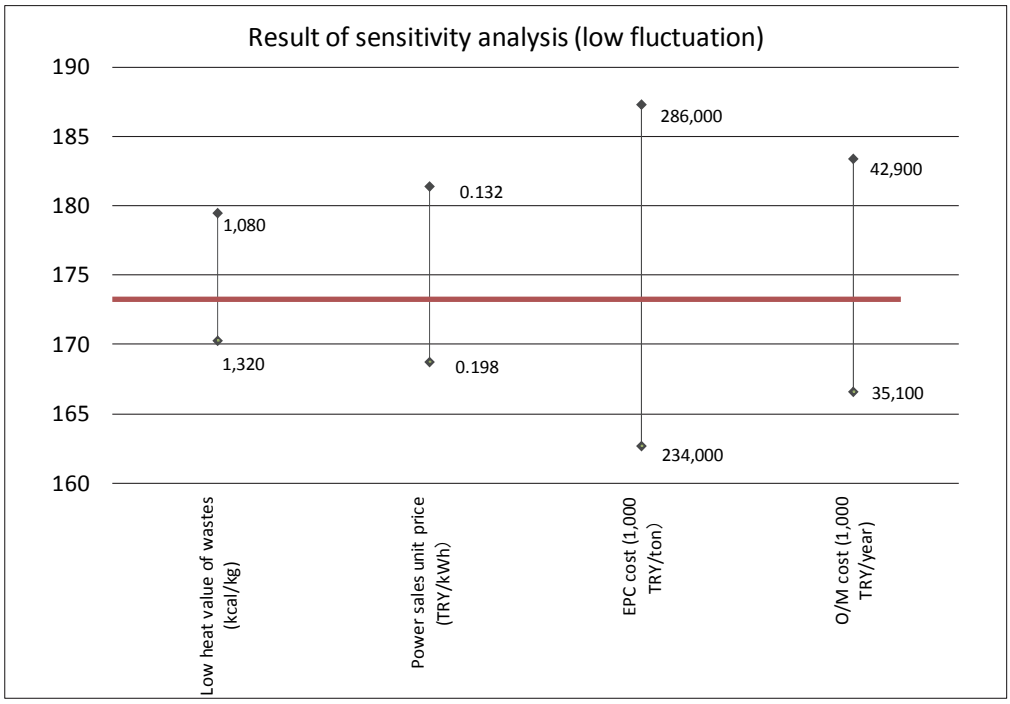


Figure 8-1: Result of sensitivity analysis (low fluctuation)

					Result (TRY/ton)		
	Fluctuation	Low	Standard	High	High	Standard	Low
Low heat value of wastes (kcal/kg)	20%	960	1,200	1,440	184	175	165.8
Power sales unit price (TRY/kWh)	40%	0.099	0.165	0.231	187.7	175	162.3
EPC cost (1,000 TRY/ton)	20%	208,000	260,000	312,000	199.6	175	150.4
O/M cost (1,000 TRY/year)	20%	31,200	39,000	46,800	191.8	175	158.2

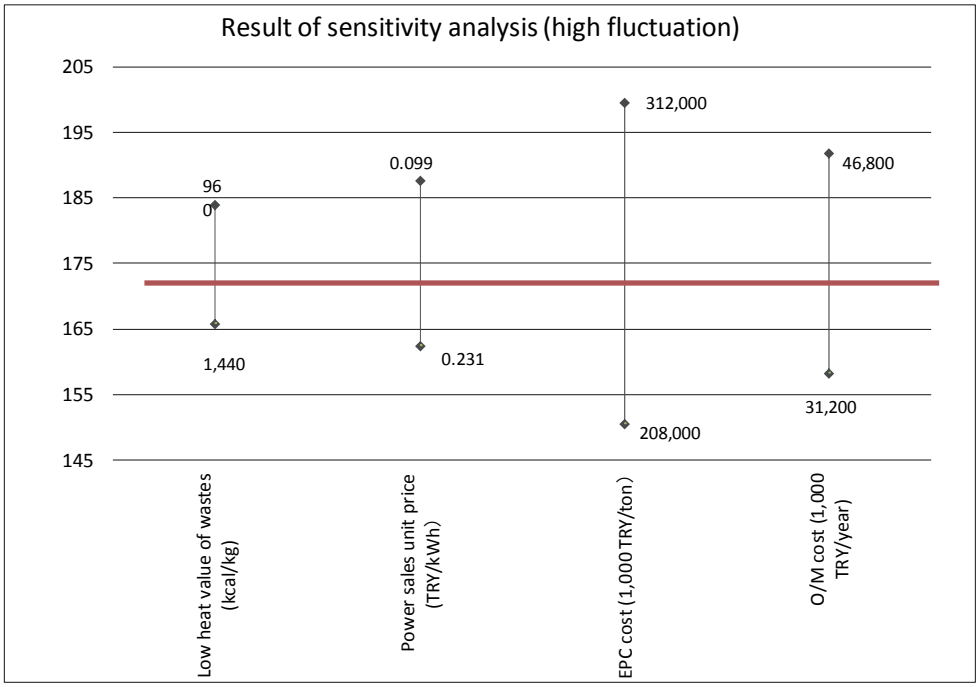


Figure 8-2: Result of sensitivity analysis (high fluctuation)

8.4 Detailed Results of cash flow analysis

The results of the cash flow analysis are shown below.

8.4.1 Case 1 (500 ton/day)

a. Tipping Fee and FIRR

Case 1: Waste-to-Energy 500t/day unit: 1,000 TRY

Year	Tipping fee	Power Selling	Initial Investment	O/M Expenses	Financial Cost	Financial cash flow	Accumulated Cash Balance
-2	0	0	34,500	0	34,500	-34,500	-34,500
-1	0	0	62,750	0	62,750	-62,750	-97,250
0	0	0	67,750	0	67,750	-67,750	-165,000
1	27,125	4,910	0	16,500	16,500	15,535	-149,465
2	27,125	4,910	0	16,500	16,500	15,535	-133,929
3	27,125	4,910	0	16,500	16,500	15,535	-118,394
4	27,125	4,910	0	16,500	16,500	15,535	-102,858
5	27,125	4,910	0	16,500	16,500	15,535	-87,323
6	27,125	4,910	0	16,500	16,500	15,535	-71,788
7	27,125	4,910	0	16,500	16,500	15,535	-56,252
8	27,125	4,910	0	16,500	16,500	15,535	-40,717
9	27,125	4,910	0	16,500	16,500	15,535	-25,181
10	27,125	4,910	0	16,500	16,500	15,535	-9,646
11	27,125	4,910	0	16,500	16,500	15,535	5,889
12	27,125	4,910	0	16,500	16,500	15,535	21,425
13	27,125	4,910	0	16,500	16,500	15,535	36,960
14	27,125	4,910	0	16,500	16,500	15,535	52,496
15	27,125	4,910	0	16,500	16,500	15,535	68,031
16	27,125	4,910	0	16,500	16,500	15,535	83,566
17	27,125	4,910	0	16,500	16,500	15,535	99,102
18	27,125	4,910	0	16,500	16,500	15,535	114,637
19	27,125	4,910	0	16,500	16,500	15,535	130,173
20	27,125	4,910	0	16,500	16,500	15,535	145,708
TOTAL	542,500	98,208	165,000	330,000	397,750	242,958	

6.33% (Including corporate income tax)

b. Revenue1: Tipping fee

Year	Unit price (TRY/ton)	Treatment capacity(ton/day)	Annual operational days (days/year)	Annual treated amount of SW (ton/year)	Annual revenue (thousand TRY/year)
0	175	0	0	0	0
1	175	500	310	155,000	27,125
2	175	500	310	155,000	27,125
3	175	500	310	155,000	27,125
4	175	500	310	155,000	27,125
5	175	500	310	155,000	27,125
6	175	500	310	155,000	27,125
7	175	500	310	155,000	27,125
8	175	500	310	155,000	27,125
9	175	500	310	155,000	27,125
10	175	500	310	155,000	27,125
11	175	500	310	155,000	27,125
12	175	500	310	155,000	27,125
13	175	500	310	155,000	27,125
14	175	500	310	155,000	27,125
15	175	500	310	155,000	27,125
16	175	500	310	155,000	27,125
17	175	500	310	155,000	27,125
18	175	500	310	155,000	27,125
19	175	500	310	155,000	27,125
20	175	500	310	155,000	27,125

c. Revenue 2: Income from selling electricity

Years	Unit price (TRY/kwh)	Annual amount of electricity sold (MWh/year)	Annual revenue (thousand TRY/year)
0	0.165	0	0
1	0.165	29,760	4,910
2	0.165	29,760	4,910
3	0.165	29,760	4,910
4	0.165	29,760	4,910
5	0.165	29,760	4,910
6	0.165	29,760	4,910
7	0.165	29,760	4,910
8	0.165	29,760	4,910
9	0.165	29,760	4,910
10	0.165	29,760	4,910
11	0.165	29,760	4,910
12	0.165	29,760	4,910
13	0.165	29,760	4,910
14	0.165	29,760	4,910
15	0.165	29,760	4,910
16	0.165	29,760	4,910
17	0.165	29,760	4,910
18	0.165	29,760	4,910
19	0.165	29,760	4,910
20	0.165	29,760	4,910

8.4.2 Case 2 (1,000t/day)

a. Tipping Fee and FIRR

Year	Tipping fee	Power Selling	Initial Investment	O/M Expenses	Financial Cost	Financial cash flow	Accumulated Cash Balance
-2	0	0	54,000	0	54,000	-54,000	-54,000
-1	0	0	108,000	0	108,000	-108,000	-162,000
0	0	0	118,000	0	118,000	-118,000	-280,000
1	54,250	9,821	0	28,000	28,000	36,071	-243,929
2	54,250	9,821	0	28,000	28,000	36,071	-207,858
3	54,250	9,821	0	28,000	28,000	36,071	-171,788
4	54,250	9,821	0	28,000	28,000	36,071	-135,717
5	54,250	9,821	0	28,000	28,000	36,071	-99,646
6	54,250	9,821	0	28,000	28,000	36,071	-63,575
7	54,250	9,821	0	28,000	28,000	36,071	-27,504
8	54,250	9,821	0	28,000	28,000	36,071	8,566
9	54,250	9,821	0	28,000	28,000	36,071	44,637
10	54,250	9,821	0	28,000	28,000	36,071	80,708
11	54,250	9,821	0	28,000	28,000	36,071	116,779
12	54,250	9,821	0	28,000	28,000	36,071	152,850
13	54,250	9,821	0	28,000	28,000	36,071	188,920
14	54,250	9,821	0	28,000	28,000	36,071	224,991
15	54,250	9,821	0	28,000	28,000	36,071	261,062
16	54,250	9,821	0	28,000	28,000	36,071	297,133
17	54,250	9,821	0	28,000	28,000	36,071	333,204
18	54,250	9,821	0	28,000	28,000	36,071	369,274
19	54,250	9,821	0	28,000	28,000	36,071	405,345
20	54,250	9,821	0	28,000	28,000	36,071	441,416
TOTAL	1,085,000	196,416	280,000	560,000	678,000	603,416	

10.22% (Including corporate income tax)

b. Revenue 1: Tipping Fee

Year	Unit price (TRY/ton)	Treatment capacity(ton/day)	Annual operation days (days/year)	Annual treated amount of waste (ton/year)	Annual revenue (thousand TRY/year)
0	175	0	0	0	0
1	175	1,000	310	310,000	54,250
2	175	1,000	310	310,000	54,250
3	175	1,000	310	310,000	54,250
4	175	1,000	310	310,000	54,250
5	175	1,000	310	310,000	54,250
6	175	1,000	310	310,000	54,250
7	175	1,000	310	310,000	54,250
8	175	1,000	310	310,000	54,250
9	175	1,000	310	310,000	54,250
10	175	1,000	310	310,000	54,250
11	175	1,000	310	310,000	54,250
12	175	1,000	310	310,000	54,250
13	175	1,000	310	310,000	54,250
14	175	1,000	310	310,000	54,250
15	175	1,000	310	310,000	54,250
16	175	1,000	310	310,000	54,250
17	175	1,000	310	310,000	54,250
18	175	1,000	310	310,000	54,250
19	175	1,000	310	310,000	54,250
20	175	1,000	310	310,000	54,250

c. Revenue 2: Income from selling electricity

Year	Unit price (TRY/kwh)	Annual amount of electricity sold (MWh/year)	Annual revenue (thousand TRY/year)
0	0.165	0	0
1	0.165	59,520	9,821
2	0.165	59,520	9,821
3	0.165	59,520	9,821
4	0.165	59,520	9,821
5	0.165	59,520	9,821
6	0.165	59,520	9,821
7	0.165	59,520	9,821
8	0.165	59,520	9,821
9	0.165	59,520	9,821
10	0.165	59,520	9,821
11	0.165	59,520	9,821
12	0.165	59,520	9,821
13	0.165	59,520	9,821
14	0.165	59,520	9,821
15	0.165	59,520	9,821
16	0.165	59,520	9,821
17	0.165	59,520	9,821
18	0.165	59,520	9,821
19	0.165	59,520	9,821
20	0.165	59,520	9,821

8.4.3 Case 3 (1,500 ton/day)

a. Tipping Fee and FIRR

Year	Tipping fee	Power Selling	Initial Investment	O/M Expenses	Financial Cost	Financial cash flow	Accumulated Cash Balance
-2	0	0	60,000	0	60,000	-60,000	-60,000
-1	0	0	151,500	0	151,500	-151,500	-211,500
0	0	0	166,500	0	166,500	-166,500	-378,000
1	81,375	14,731	0	39,000	39,000	57,106	-320,894
2	81,375	14,731	0	39,000	39,000	57,106	-263,788
3	81,375	14,731	0	39,000	39,000	57,106	-206,681
4	81,375	14,731	0	39,000	39,000	57,106	-149,575
5	81,375	14,731	0	39,000	39,000	57,106	-92,469
6	81,375	14,731	0	39,000	39,000	57,106	-35,363
7	81,375	14,731	0	39,000	39,000	57,106	21,743
8	81,375	14,731	0	39,000	39,000	57,106	78,850
9	81,375	14,731	0	39,000	39,000	57,106	135,956
10	81,375	14,731	0	39,000	39,000	57,106	193,062
11	81,375	14,731	0	39,000	39,000	57,106	250,168
12	81,375	14,731	0	39,000	39,000	57,106	307,274
13	81,375	14,731	0	39,000	39,000	57,106	364,381
14	81,375	14,731	0	39,000	39,000	57,106	421,487
15	81,375	14,731	0	39,000	39,000	57,106	478,593
16	81,375	14,731	0	39,000	39,000	57,106	535,699
17	81,375	14,731	0	39,000	39,000	57,106	592,805
18	81,375	14,731	0	39,000	39,000	57,106	649,912
19	81,375	14,731	0	39,000	39,000	57,106	707,018
20	81,375	14,731	0	39,000	39,000	57,106	764,124
TOTAL	1,627,500	294,624	378,000	780,000	946,500	975,624	

12.52% (Including corporate income tax)

b. Revenue 2: Tipping Fee

Year	Unit price (TRY/ton)	Treatment capacity(ton/day)	Annual operational days (days/year)	Annual treated amount of SW (ton/year)	Annual revenue (thousand TRY/year)
0	175	0	0	0	0
1	175	1,500	310	465,000	81,375
2	175	1,500	310	465,000	81,375
3	175	1,500	310	465,000	81,375
4	175	1,500	310	465,000	81,375
5	175	1,500	310	465,000	81,375
6	175	1,500	310	465,000	81,375
7	175	1,500	310	465,000	81,375
8	175	1,500	310	465,000	81,375
9	175	1,500	310	465,000	81,375
10	175	1,500	310	465,000	81,375
11	175	1,500	310	465,000	81,375
12	175	1,500	310	465,000	81,375
13	175	1,500	310	465,000	81,375
14	175	1,500	310	465,000	81,375
15	175	1,500	310	465,000	81,375
16	175	1,500	310	465,000	81,375
17	175	1,500	310	465,000	81,375
18	175	1,500	310	465,000	81,375
19	175	1,500	310	465,000	81,375
20	175	1,500	310	465,000	81,375

c. Revenue 2: Income from selling electricity

Year	Unit price (TRY/kwh)	Annual amount of electricity sold (MWh/year)	Annual revenue (thousand TRY/year)
0	0.165	0	0
1	0.165	89,280	14,731
2	0.165	89,280	14,731
3	0.165	89,280	14,731
4	0.165	89,280	14,731
5	0.165	89,280	14,731
6	0.165	89,280	14,731
7	0.165	89,280	14,731
8	0.165	89,280	14,731
9	0.165	89,280	14,731
10	0.165	89,280	14,731
11	0.165	89,280	14,731
12	0.165	89,280	14,731
13	0.165	89,280	14,731
14	0.165	89,280	14,731
15	0.165	89,280	14,731
16	0.165	89,280	14,731
17	0.165	89,280	14,731
18	0.165	89,280	14,731
19	0.165	89,280	14,731
20	0.165	89,280	14,731

8.4.4 Project Cash Flow

a. Case 1 (500 ton/day)

Case 1: Waste-to-Energy 500 ton/day

Project Cashflow Unit: 1,000 TRY

	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Cash in	**55,000**	**57,750**	**57,750**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**32,035**	**698,458**
Equity	55,000																							55,000
Long-term loan		57,750	57,750																					57,750
Subsidy																								0
Tipping fee		0	0	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	27,125	542,500
Electricity Sales		0	0	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	98,208
Cash out (excl. Repayment)	34,500	62,750	70,638	22,577	22,346	22,115	21,884	21,653	21,422	21,191	20,960	20,729	20,498	20,267	20,036	19,805	19,574	19,343	19,112	18,881	18,650	18,419	18,188	478,289
Initial Investment	29,500	57,750	57,750																					145,000
Project Preparation	5,000	5,000	10,000																					
O/M cost	0	0	0	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	330,000
Interest Payment	0	0	2,888	5,775	5,486	5,198	4,909	4,620	4,331	4,043	3,754	3,465	3,176	2,888	2,599	2,310	2,021	1,733	1,444	1,155	866	578	289	63,525
Depreciation	0	0	0	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	165,000
Profit Before Tax	0	0	0	1,510	1,799	2,088	2,377	2,665	2,954	3,243	3,532	3,820	4,109	4,398	4,687	4,975	5,264	5,553	5,842	6,130	6,419	6,708	6,997	85,071
Corporate Income Tax	0	0	0	302	360	418	475	533	591	649	706	764	822	880	937	995	1,053	1,111	1,168	1,226	1,284	1,342	1,399	17,014
Profit After Tax	0	0	0	1,208	1,439	1,670	1,901	2,132	2,363	2,594	2,825	3,056	3,287	3,518	3,749	3,980	4,211	4,442	4,673	4,904	5,135	5,366	5,597	68,056
Single Year CashFlow	20,500	-5,000	-12,888	3,683	3,914	4,145	4,376	4,607	4,838	5,069	5,300	5,531	5,762	5,993	6,224	6,455	6,686	6,917	7,148	7,379	7,610	7,841	8,072	104,669
Loan Repayment	0	0	0	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	5,775	115,500
Remaining Loan	0	57,750	115,500	109,725	103,950	98,175	92,400	86,625	80,850	75,075	69,300	63,525	57,750	51,975	46,200	40,425	34,650	28,875	23,100	17,325	11,550	5,775	0	
Balance Brought Forward	20,500	15,500	2,613	6,296	10,210	14,355	18,732	23,339	28,177	33,247	38,547	44,078	49,841	55,834	62,058	68,514	75,200	82,117	89,266	96,645	104,255	112,097	120,169	

<Balance Sheet>

Asset																							
Net Cash	20,500	15,500	2,613	6,296	10,210	14,355	18,732	23,339	28,177	33,247	38,547	44,078	49,841	55,834	62,058	68,514	75,200	82,117	89,266	96,645	104,255	112,097	120,169
Fixed Assets	34,500	97,250	165,000	156,750	148,500	140,250	132,000	123,750	115,500	107,250	99,000	90,750	82,500	74,250	66,000	57,750	49,500	41,250	33,000	24,750	16,500	8,250	0
Total Assets	55,000	112,750	167,613	163,046	158,710	154,605	150,732	147,089	143,677	140,497	137,547	134,828	132,341	130,084	128,058	126,264	124,700	123,367	122,266	121,395	120,755	120,347	120,169
Liability																							
Loan	0	57,750	115,500	109,725	103,950	98,175	92,400	86,625	80,850	75,075	69,300	63,525	57,750	51,975	46,200	40,425	34,650	28,875	23,100	17,325	11,550	5,775	0
Equity																							
Equity	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000
Retained Earnings	0	0	0	1,208	1,439	1,670	1,901	2,132	2,363	2,594	2,825	3,056	3,287	3,518	3,749	3,980	4,211	4,442	4,673	4,904	5,135	5,366	5,597
DSCR				1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.9	1.9	-	-	-	-	-

Assumptions:
(1) The project is public infrastructure development project that utilize Yen-loan.
(2) Capital is 94 million TRY (30% of initial investment).
(3) Loan from JICA is approximately 196 million TRY.
(4) Condition for JICA loan is 20 years of equal payments with interest. Interest rate: 5 %
(5) The infrastructure is fully depreciated in 20 years.
(6) Corporate tax is 20%.

b. Case 2 (1,000 ton/day)

Case 2: Waste-to-Energy 1,000 ton/day

Project Cashflow Unit: 1,000 TRY

	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Cash in	**94,000**	**98,000**	**98,000**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**64,071**	**1,379,416**
Equity	94,000																							94,000
Long-term loan		98,000	98,000																					98,000
Subsidy																								0
Tipping fee		0	0	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	54,250	1,085,000
Electricity Sales		0	0	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	9,821	196,416
Cash out (excl. Repayment)	54,000	108,000	122,900	40,254	39,862	39,470	39,078	38,686	38,294	37,902	37,510	37,118	36,726	36,334	35,942	35,550	35,158	34,766	34,374	33,982	33,590	33,198	32,806	853,503
Initial Investment	44,000	98,000	98,000																					240,000
Project Preparation	10,000	10,000	20,000																					
O/M cost	0	0	0	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	560,000
Interest Payment	0	0	4,900	9,800	9,310	8,820	8,330	7,840	7,350	6,860	6,370	5,880	5,390	4,900	4,410	3,920	3,430	2,940	2,450	1,960	1,470	980	490	107,800
Depreciation	0	0	0	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	280,000
Profit Before Tax	0	0	0	12,271	12,761	13,251	13,741	14,231	14,721	15,211	15,701	16,191	16,681	17,171	17,661	18,151	18,641	19,131	19,621	20,111	20,601	21,091	21,581	338,516
Corporate Income Tax	0	0	0	2,454	2,552	2,650	2,748	2,846	2,944	3,042	3,140	3,238	3,336	3,434	3,532	3,630	3,728	3,826	3,924	4,022	4,120	4,218	4,316	67,703
Profit After Tax	0	0	0	9,817	10,209	10,601	10,993	11,385	11,777	12,169	12,561	12,953	13,345	13,737	14,129	14,521	14,913	15,305	15,697	16,089	16,481	16,873	17,265	270,813
Single Year CashFlow	40,000	-10,000	-24,900	14,017	14,409	14,801	15,193	15,585	15,977	16,369	16,761	17,153	17,545	17,937	18,329	18,721	19,113	19,505	19,897	20,289	20,681	21,073	21,465	329,913
Loan Repayment	0	0	0	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	196,000
Remaining Loan	0	98,000	196,000	186,200	176,400	166,600	156,800	147,000	137,200	127,400	117,600	107,800	98,000	88,200	78,400	68,600	58,800	49,000	39,200	29,400	19,600	9,800	0	
Balance Brought Forward	40,000	30,000	5,100	19,117	33,525	48,326	63,519	79,103	95,080	111,448	128,209	145,362	162,906	180,843	199,172	217,892	237,005	256,510	276,406	296,695	317,376	338,448	359,913	

<Balance Sheet>

Asset																								
Net Cash	40,000	30,000	5,100	19,117	33,525	48,326	63,519	79,103	95,080	111,448	128,209	145,362	162,906	180,843	199,172	217,892	237,005	256,510	276,406	296,695	317,376	338,448	359,913	
Fixed Assets	54,000	162,000	280,000	266,000	252,000	238,000	224,000	210,000	196,000	182,000	168,000	154,000	140,000	126,000	112,000	98,000	84,000	70,000	56,000	42,000	28,000	14,000	0	
Total Assets	94,000	192,000	285,100	285,117	285,525	286,326	287,519	289,103	291,080	293,448	296,209	299,362	302,906	306,843	311,172	315,892	321,005	326,510	332,406	338,695	345,376	352,448	359,913	
Liability																								
Loan	0	98,000	196,000	186,200	176,400	166,600	156,800	147,000	137,200	127,400	117,600	107,800	98,000	88,200	78,400	68,600	58,800	49,000	39,200	29,400	19,600	9,800	0	
Equity																								
Equity	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	94,000	
Retained Earnings	0	0	0	9,817	10,209	10,601	10,993	11,385	11,777	12,169	12,561	12,953	13,345	13,737	14,129	14,521	14,913	15,305	15,697	16,089	16,481	16,873	17,265	
DSCR				1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	-	-	-	-	-	

Assumptions:
(1) The project is public infrastructure development project that utilize Yen-loan.
(2) Capital is 94 million TRY (30% of initial investment).
(3) Loan from JICA is approximately 196 million TRY.
(4) Condition for JICA loan is 20 years of equal payments with interest. Interest rate: 5 %
(5) The infrastructure is fully depreciated in 20 years.
(6) Corporate tax is 20%.

c. Case 3 (1,500 ton/day)

Case 3: Waste-to-Energy 1,500 ton/day

Project Cashflow Unit: 1,000 TRY

	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Cash in	**117,000**	**136,500**	**136,500**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**96,106**	**2,058,624**
Equity	117,000																							117,000
Long-term loan		136,500	136,500																					136,500
Subsidy																								0
Tipping fee		0	0	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	81,375	1,627,500
Electricity Sales		0	0	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	14,731	294,624
Cash out (excl. Repayment)	60,000	151,500	173,325	58,541	57,995	57,449	56,903	56,357	55,811	55,265	54,719	54,173	53,627	53,081	52,535	51,989	51,443	50,897	50,351	49,805	49,259	48,713	48,167	1,240,410
Initial Investment	45,000	136,500	136,500																					318,000
Project Preparation	15,000	15,000	30,000																					
O/M cost	0	0	0	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	39,000	780,000
Interest Payment	0	0	6,825	13,650	12,968	12,285	11,603	10,920	10,238	9,555	8,873	8,190	7,508	6,825	6,143	5,460	4,778	4,095	3,413	2,730	2,048	1,365	683	150,150
Depreciation	0	0	0	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	280,000
Profit Before Tax	0	0	0	29,456	30,139	30,821	31,504	32,186	32,869	33,551	34,234	34,916	35,599	36,281	36,964	37,646	38,329	39,011	39,694	40,376	41,059	41,741	42,424	718,799
Corporate Income Tax	0	0	0	5,891	6,028	6,164	6,301	6,437	6,574	6,710	6,847	6,983	7,120	7,256	7,393	7,529	7,666	7,802	7,939	8,075	8,212	8,348	8,485	143,760
Profit After Tax	0	0	0	23,565	24,111	24,657	25,203	25,749	26,295	26,841	27,387	27,933	28,479	29,025	29,571	30,117	30,663	31,209	31,755	32,301	32,847	33,393	33,939	575,039
Single Year CashFlow	57,000	-15,000	-36,825	23,915	24,461	25,007	25,553	26,099	26,645	27,191	27,737	28,283	28,829	29,375	29,921	30,467	31,013	31,559	32,105	32,651	33,197	33,743	34,289	545,214
Loan Repayment	0	0	0	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	13,650	273,000
Remaining Loan	0	136,500	273,000	259,350	245,700	232,050	218,400	204,750	191,100	177,450	163,800	150,150	136,500	122,850	109,200	95,550	81,900	68,250	54,600	40,950	27,300	13,650	0	
Balance Brought Forward	57,000	42,000	5,175	29,090	53,551	78,558	104,111	130,210	156,855	184,046	211,783	240,066	268,895	298,270	328,191	358,657	389,670	421,229	453,334	485,985	519,182	552,925	587,214	

<Balance Sheet>

Asset																								
Net Cash	57,000	42,000	5,175	29,090	53,551	78,558	104,111	130,210	156,855	184,046	211,783	240,066	268,895	298,270	328,191	358,657	389,670	421,229	453,334	485,985	519,182	552,925	587,214	
Fixed Assets	60,000	211,500	378,000	364,000	350,000	336,000	322,000	308,000	294,000	280,000	266,000	252,000	238,000	224,000	210,000	196,000	182,000	168,000	154,000	140,000	126,000	112,000	98,000	
Total Assets	117,000	253,500	383,175	393,090	403,551	414,558	426,111	438,210	450,855	464,046	477,783	492,066	506,895	522,270	538,191	554,657	571,670	589,229	607,334	625,985	645,182	664,925	685,214	
Liability																								
Loan	0	136,500	273,000	259,350	245,700	232,050	218,400	204,750	191,100	177,450	163,800	150,150	136,500	122,850	109,200	95,550	81,900	68,250	54,600	40,950	27,300	13,650	0	
Equity																								
Equity	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000	
Retained Earnings	0	0	0	23,565	24,111	24,657	25,203	25,749	26,295	26,841	27,387	27,933	28,479	29,025	29,571	30,117	30,663	31,209	31,755	32,301	32,847	33,393	33,939	
DSCR				1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.8	-	-	-	-	-	

Assumptions:
(1) The project is public infrastructure development project that utilize Yen-loan.
(2) Capital is 94 million TRY (30% of initial investment).
(3) Loan from JICA is approximately 196 million TRY.
(4) Condition for JICA loan is 20 years of equal payments with interest. Interest rate: 5 %
(5) The infrastructure is fully depreciated in 20 years.
(6) Corporate tax is 20%.

9 Conclusion and Recommendation

9.1 Conclusion

Strategic Plan for 2013-2017 of MoEU has identified detailed objectives and targets for different fields. With regard to waste management, the detailed specific objectives and strategies are stated under "Objective 2: Preventing environmental pollution, raising environmental standards, combating climate change and improving its natural assets "as follows.

Targets	Strategies
To improve basic facilities for solid waste management by the end of 2017, − At least 85% of the municipal population will be provided with waste disposal services; − At least 50% of recoverable waste will be separated at its source; and − At least 75% of waste is recycled.	The number of landfill facilities of solid waste will be increased
	Waste receiving centers will be established
	Dual-collection system will be introduced

In line with these strategies, new sanitary landfill facilities are being constructed nationwide. Further, Turkey must comply with the EU Landfill Directive (99/31/EC) and thus must reduce the rate of biodegradable wastes that go into the landfill sites which generate methane gas according to the EU Integrated Environmental Approximation Strategy. In order to comply with the EU Landfill Directive, introduction of mechanical biological treatment (MBT) facilities and biogas production facilities are being introduced in large cities.

However, such facilities are designed under the assumption that organic wastes would be sorted at source and separately collected as is done in the West European countries, while in Turkey, separate discharge and collection is not well established yet. Under this situation, it is considered that further efforts shall be made to make such facilities perform as designed in Turkey.

In the Western Europe, the main objectives of waste incineration power plants are to reduce the volume of wastes to be landfilled and to recover heat and energy, and many incineration power plants are under operation.

In these countries, only wastes with high and stable calorific value (e.g. paper, wood) are incinerated based on the system of separate discharge and collection. Therefore, the municipal solid wastes that can be incinerated without auxiliary fuel (i.e. fossil fuel such as heavy oil or kerosene) with European technologies are those with low calorific value of 1,400 kcal/kg or (5,950 kJ/kg)[1] or higher.

According to this Survey, the calorific values of wastes in the target MMs are estimated to be between 1,074 and 1,273 kcal/kg (between 4,494 and 5,324 kJ/kg) and average of 1,200kcal/kg (5,000 kJ/kg). Thus, if these wastes are to be incinerated with European incineration technologies, supplemental fossil fuel would be required for proper incineration. Meanwhile, by the use of Japanese technologies, these municipal solid wastes would be able to be incinerated without supplemental fossil fuel. Therefore, it can be said that Japanese incineration technologies are highly applicable to incinerate Turkish municipal solid wastes.

Incinerating the wastes will have the following impacts with regard to organic wastes going into the landfill sites.

- The volume of wastes going in to the landfill site will be significantly reduced in a short period.
- As the volume of biodegradable wastes will be significantly reduced, it will be in line with the EU Landfill Directive.

[1] Steinmuller-babcock presentation Bangkok 2014/10/21, Steinmuller-babcock EfW Hefei : design calorific value 6.28/t.95 Mj/kg,

However, waste incineration technologies have not yet been introduced for municipal solid wastes in Turkey, as the calorific value of the municipal solid wastes in Turkey is lower compared to those in Europe, and construction and operation costs are higher compared to those for landfill sites.

Thus, the most suitable and affordable method of treatment and disposal of municipal solid waste is sanitary landfill, but this requires a large area of land. Turkey is overall a land-rich country and thus sanitary landfill is considered as the appropriate treatment and disposal method in general.

According to EU Integrated Environmental Approximation Strategy, the necessary investment for the waste management sector between the years 2007 and 2023 is 9,560 million EUR, and 80% of this investment is for construction of final disposal sites and 13% for construction of incineration facilities.

The basic principle on treatment and disposal of municipal solid wastes in Turkey is sanitary landfill, with the exception that intermediate treatment would be introduced for cases which municipalities face difficulties to find land for final disposal sites.

Taking this point into consideration, the Survey Team considers that the necessities of the following two municipalities to introduce intermediate treatment facilities is higher than of other target MMs.

- Kocaeli MM: It has high population density, the remaining lifetime of its final disposal site is short, and it is difficult to secure area for a new landfill site.
- Izmir MM: It has the second highest population density following Kocaeli MM, and there is no remaining capacity to accept wastes in Harmandali disposal site.

9.2 Recommendation

9.2.1 Reduction of the Tipping Fee

As mentioned before, high construction and operation cost seems to be one of the reasons why waste incineration power plants for municipal solid waste has not been introduced in Turkey. Although the current operation cost of the municipal solid waste disposal sites in the target MMs are between 3.4 to 34.57 TRY/ton, the tipping fee for waste incineration facilities that was estimated in Chapter 8 was 175 TRY/ton. In order to introduce waste incineration technologies in Turkey, it is essential to reduce this gap in costs.

In order to close this gap, the followings ideas could be considered to be implemented.

- Application of FIT program for waste incineration power plants
- Reduction of EPC cost (i.e. construction cost)
- Acceptance of non-hazardous industrial wastes in addition to the municipal solid wastes for high tipping fee

a. Introduction of the FIT program for waste incineration

Currently, with regard to municipal solid waste, FIT program is applied only for power plants that utilize landfill gas or methane digestion gas, and WtE by use of municipal solid waste is out of the scope of FIT program.

MoENR which is the responsible agency for FIT program has stated that legal reform would be required in order to apply FIT for waste incineration power plants. For the legal reform, concrete actions by MoEU which is the responsible agency for waste management would be necessary, such as preparation and implementation of a national action plan on waste incineration. Under this situation, it is recommended that MoEU take actions for the application of FIT to power generated by waste incineration.

b. Reduction of EPC cost

The EPC cost that was shown in Chapter 8 to calculate the tipping fee was based on the waste incineration model of the World Bank[2]. Thus, in the future studies, it is recommended that the possibility of reducing this EPC cost would be further examined through on-site studies, technical

[2] Municipal Solid Waste Incineration WORLD BANK TECHNICAL GUIDANCE REPORT

identification of specifications of the facilities, and cost estimation by companies based on these specifications.

c. Acceptance of non-hazardous industrial wastes

The treatment fee of non-hazardous industrial wastes by İZAYDAŞ in Kocaeli MM is 220 TRY/ton and thus relatively high. Generally, the calorific value of industrial waste is higher and more stable compared to those of municipal solid waste. Therefore, accepting non-hazardous industrial wastes at the waste incineration plant may lead to reduction of the tipping fee for municipal solid wastes. In the further surveys, it is recommended that this option would be carefully considered.

9.2.2 Assistance from Japan

Since the major donors (i.e. AFD, KfW, TSB, WB, EBRD, and EU) had no cooperation with regard to waste incineration technologies in Turkey, Japanese assistance in this field would be recommended as one of the assistance options.

Annex

Annex 1

Outline of Site Visit in Japan

Annex- 2

Photos

11 June: Visit in Shibuya Incineration plant

12 June: Visit in Tokyo Waterfront Recycle Power

15 June: Lecture at Institute for Recycling & Environmental Control System of Fukuoka University

16 June: Wrap-up discussion at JICA

1 Outline of the site visit

1.1 Name of the site visit program

Site visit in Japan by Turkish partners within the framework of the Data Collection Survey on Solid Waste Management in Turkey

1.2 Dates of the site visit

From 9 June 2015 (arrival in Japan) to 16 June 2015 (departure from Japan)

1.3 Number of participants

16 participants from Turkish Ministries and Municipalities

1.4 Objective of the site visit

To invite partners from the Turkish central and local governments to share with them the technologies and the experience in Japan with regard to waste treatment and to exchange opinions with them regarding this issue.

2 Program of the site visit

The program of the site visit is shown in the table below. The site visit was composed of lectures and site visits and was concluded with a wrap-up discussion.

Table 1: Programme of the site visit

Date	Time	Type	Content	Place
9 June (Mar)			Arrival in Japan	
10 June (Wed)	10:30 ～ 11:30		Briefing by JICA	JICA Ichigaya Building
	13:00 ～ 15:00	Lecture	Greetings and lecture ・ Waste management in Tokyo ・ Waste incineration power generation ・ Operation and maintenance of waste incineration plants	Clean Authority of TOKYO 23 cities
11 June (Thu)	10:00 ～ 12:00	Site visit	Visit to Shibuya waste incineration plant	Shibuya waste incineration plant
	14:00 ～ 16:00	Site visit	Visit to Itabashi waste incineration plant	Itabashi waste incineration plant
12 June (Fri)	10:00 ～ 12:00	Site visit	Visit to medical and industrial waste treatment plant	Tokyo Waterfront Recycle Power
	13:30 ～ 15:30	Site visit	Visit to final disposal site	Chubo landfill site
13 June (Sat)			(a day off)	
14 June (Sun)			(Travel from Tokyo to Kitakyushu)	
15 June (Mon)	9:00 ～ 10:15	Site visit	Kitakyushu Institute of Environmental Sciences	Kitakyushu Institute of Environmental Sciences
	10:30 ～ 11:30	Site visit	Institute for Recycling & Environmental Control System of Fukuoka University	Institute for Recycling & Environmental Control System of Fukuoka University
	11:30 ～ 12:00	Site visit	Kitakyushu Eco-Town Center	Kitakyushu Eco-Town Center
	14:30 ～ 16:00	Site visit	Visit to Fushitani disposal site	Fushitani disposal site
			(Travel from Fukuoka to Tokyo)	
16 June (Tue)	13:00 ～ 15:00	Discussion	Wrap-up discussion (including discussion on possible future collaboration among municipalities) and evaluation of the site visit	JICA Ichigaya Building
			Departure from Japan	

3 Participating organizations

Two or three participants from each of the following organizations participated in the site visit.

- Ministry of Environment and Urbanization
- Ministry of Energy and Natural Resources
- Bursa Metropolitan Municipality
- Kocaeli Metropolitan Municipality
- Izmir Metropolitan Municipality
- Antalya Metropolitan Municipality
- Sakarya Metropolitan Municipality

Table 2: List of participants of the site visit in Japan

	Title
1	Head of Waste Management Department, Ministry of the Environment and Urban Planning
2	Department Head, Water and Soil Department, Ministry of the Environment and Urban Planning
3	Environment and Urbanization Expert, Ministry of the Environment and Urban Planning
4	Agricultural engineer, Ministry of Energy and Natural Resources
5	Agricultural engineer, Ministry of Energy and Natural Resources
6	Deputy Secretary General, Antalya MM
7	Environmental Engineer, Antalya MM
8	Department Head, Sakarya MM
9	Branch Manager, Sakarya MM
10	Branch Manager, Kocaeli MM
11	Branch Manager, Kocaeli MM
12	Department Head, Izmir MM
13	Branch Manager, Izmir MM
14	Department Head, Bursa MM
15	Branch Manager, Bursa MM
16	Environmental Engineer, Bursa MM

Annex 2

Seminar on Japanese Technologies on Solid Waste Management

Annex- 8

1 Objective, outline

The seminars on Japanese technologies on solid waste management were organized with the objective to share the knowledge and experience regarding waste treatment among the local government staffs of Japan and Turkey. The staffs from the Japanese local government visited Turkey for one week with the objective to hold seminars and discussions on possible collaboration with the Turkish side and to provide technical advice regarding waste treatment taking into account the local conditions.

2 Participants from Japanese local government

Three staffs from Clean Authority of TOKYO 23 cities

3 Schedule and program

3.1 Schedule

The schedule from 4 to 5 August 2015 was as follows.

Schedule

Date	Day	Content	Place
4 August	Tue	Seminar on Japanese Technologies on Solid Waste Management (1) Participants: Ministry of Environment and Urbanization, Ministry of Energy and Natural Resources, Izmir MM, and Antalya MM	Ankara
5 August	Wed	Seminar on Japanese Technologies on Solid Waste Management (2) Participants: Bursa MM, Kocaeli MM, Sakarya MM	Izmit

3.2 Seminar program

Program of the seminar (same in Ankara and Izmit)

Time		Content	Presenter
09 : 00 – 09 : 30	0:30	Registration	
09 : 30 – 10 : 15	0:45	Introduction to Tokyo model: collect, transport, and disposal of wastes in Tokyo	Clean Authority of TOKYO 23 cities
10 :15 – 10 : 30	0 : 15	Viewing of the DVD "Welcome to our incineration plant"	Clean Authority of TOKYO 23 cities
10 : 30 – 11 : 00	0:30	Q&A, Discussion	
11 : 00 – 11 : 15	0:15	Break	
11 : 15 – 12 : 00	0:45	Waste incineration power generation technologies and operation and maintenance of waste incineration power plants	Clean Authority of TOKYO 23 cities
12 : 00 – 12:10	0:10	Technical specifications of waste incineration power plants (case of Hikarigaoka incineration plant)	Clean Authority of TOKYO 23 cities
12 : 10 – 13:00	0:50	Q&A, Discussion	

4 Results of the seminar

4.1 Seminar in Ankara on 4 August 2015

4.1.1 Outline

- Venue: Hotel Houston
- Date and time: 9:00 to 12:30, 4 August 2015 (Turkish time)
- Participants:

  From Turkish side
  - Ministry of Environment and Urbanization
  - Ministry of Energy and Natural Resources
  - Izmir Metropolitan Municipality
  - Antalya Metropolitan Municipality

  From Japanese side
  - JICA (Europe Division, Middle East and Europe Department)
  - Clean Authority of TOKYO 23 cities
  - JICA Survey Team (EX Research Institute and Kokusai Kogyo)

4.1.2 Participants from the Turkish side

- Date and time: 9:00 to 12:30, 4 August 2015
- Venue: Houston Hotel, Ankara

No.	Organization	Post
1	Ministry of Environment and Urbanization	Expert
2	Ministry of Environment and Urbanization	Expert
3	Ministry of Environment and Urbanization	Assistant Expert
4	Ministry of Environment and Urbanization	Environmental Engineer
5	Ministry of Environment and Urbanization	Environmental Engineer
6	Ministry of Environment and Urbanization	Environmental Engineer
7	Ministry of Environment and Urbanization	Chemical Engineer
8	Ministry of Energy and Natural Resources	Agricultural engineer
9	Ministry of Energy and Natural Resources	Mechanical Engineer
10	Ministry of Energy and Natural Resources	Mechanical Engineer
11	Ministry of Energy and Natural Resources	Electrical Engineer
12	Izmir MM	General Secretary Assistant
13	Izmir MM	The Head of Waste Management Department
14	Izmir MM	Director of Waste Management Planning and Control Department
15	Izmir MM	Environmental Engineer PhD
16	Izmir MM	Environmental Engineer MSc
17	Antalya MM	Acting Director of Waste Management and Operation Branch Office
18	Antalya MM	Environmental Engineer
19	Antalya MM	Environmental Engineer
20	Antalya MM	Environmental Engineer
21	Antalya MM	Environmental Engineer

4.2 Seminar in Izmit on 5 August 2015

4.2.1 Outline

- Venue: Emex otel
- Date and time: 9:00 to 12:30, 5 August 2015 (Turkish time)
- Participants:

  From Turkish side
  - Kocaeli MM
  - Bursa MM
  - Buski (Bursa Water and Sewerage Administration)
  - Sakarya MM

  From Japanese side
  - JICA (Europe Division, Middle East and Europe Department)
  - Clean Authority of TOKYO 23 cities
  - JICA Survey Team (EX Research Institute and Kokusai Kogyo)

4.2.2 Participants from the Turkish side

- Date and time: 9:00 to 12:30, 5 August 2015
- Venue: Emex Otel, Izmit

No.	Organization	Post
1	Bursa MM	Deputy Secretary General
2	Bursa MM	Deputy Secretary General
3	Bursa MM	Head, Environmental Protection and Control Department
4	Bursa MM	Director, Solid Waste Management Department
5	Bursa MM	Environmental Engineer, Solid Waste Management Department
6	Bursa MM	Water and Sewage Works
7	Kocaeli MM	Environmental Engineer
8	Kocaeli MM	Chief
9	Kocaeli MM	Environmental Engineer-Chief
10	Kocaeli MM	Environmental Engineer
11	Kocaeli MM	Branch Manager
12	Kocaeli MM	Department Head
13	Kocaeli MM	Branch Manager
14	Kocaeli MM	Engineer
15	İZAYDAŞ	Project Chief
16	Sakarya MM	Branch Manager of Waste management
17	Sakarya MM	Engineer
18	Sakarya MM	Department Head
19	Sakarya MM	Branch Manager