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SUSTAINABLE SOLID WASTE UTILISATION OPTIONS FOR THE HISTORICAL CITY OF ISTANBUL

Sustainable disposal and utilization of solid waste is of utmost importance for Istanbul, the historically and geographically magnificent city of Turkey with its over 10 million inhabitants. The article shortly introduces the reader to the history and geography of Istanbul and underlines some important figures. The current efforts and projects undertaken by both the municipalities and private companies in order to utilize solid waste in a sustained way are described.

1. ABOUT ISTANBUL

The distinguishing features of the city of Istanbul are its geographic location, unique natural beauty, and the great historical and cultural heritage. There are many legends related to the foundation date of Istanbul, according to the best known one, the first foundations of today's Istanbul were laid down in the 7th century BC. Excavations have revealed findings dating back to the 3rd millennium BC at the tip of the Golden Horn and on the Asian side. It was rebuilt and made the capital city (Constantinople) by Emperor Constantine in the 4th century AD. Since then, for sixteen centuries, the city has retained its position as the capital city of Eastern Rome, the Byzantine Empire, and Ottoman Empire. In addition to becoming one of the centers of Christianity under the reign of Emperor Constantine, Istanbul became the most important center in the Islamic world following the conquest of the city by the Ottoman Turks in 1453.

As early as at the ancient times the city enjoyed an advantageous position in terms of the control of both the east-west road from Europe to Asia Minor and the sea connection in the north-south direction. Established at the crossroads of human history, Istanbul has for centuries attracted the interests of many emperors, armies, adventur-

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ers, merchants, philosophers, and great religious personalities. There are narratives that assert that possession of Istanbul means possession of the world. Istanbul rises in all her beauty and splendor on the shores of the Bosphorus, the Golden Horn, the Black Sea, and the Marmara Sea – the smallest sea on earth, keeping the memories of her past alive. The Old Town is spread on the seven hills of a triangular promontory encircled by 22 km of city walls. What used to be small individual villages are now united to form a whole magnificent city of vast dimensions.

Istanbul – the largest city in Turkey – is also among the major cities of the world. By official statistical data the population of Istanbul is 10 million (according to the 2000 census), which means that Istanbul is larger than 177 countries in the world in terms of population. Even as early as in the 16th century the city had a population over one million. However, it has reached its current size in the recent past. Parallel to Turkey's rapid industrialization beginning in the 1950s, an immigration process began towards this most industrialized city in the country. This is a trend which still continues at the present time. Istanbul's share of Turkey's total industrial output is 38%. The ratio of taxes collected in this city by the central government is 40% of the country's total tax revenues.

A big portion of the thermal energy for households and establishments supplied by lower quality coal or heavy fuel oil has been replaced by the imported natural gas since 1988 [3]. The current Istanbul city pipeline network is above 10⁴ km long and has reached about 3×10⁶ customers. As a result of all these activities the sulphur dioxide rate, which was 250 microgram/cubic meter in 1994–1995 winter in Istanbul, was reduced to 115 microgram/cubic meter in 1995–1996 winter. Since 1996, the sulphur dioxide rate in Istanbul has never reached the 150 microgram/cubic meter border level specified by WHO (World Health Organisation).

Almost a quarter of all the motorized vehicles in Turkey are operating within Istanbul; and passenger cars constitute more than 80% of them. Fuels are unleaded and emission controls are established regularly [1]–[7].

2. SOLID WASTE OF ISTANBUL

Istanbul's daily average solid waste production is enormous – around 10 000 tons [4]–[7]. Therefore sustainable collection, storage and disposal and/or utilization of solid waste materials are of utmost importance for Istanbul. According to ISTAC data [4], when solid wastes such as “old items” and “scraps” that can be used in the industry collected by the seekers from dump areas and the construction debris and rubble discarded illegally to empty areas are added to this amount, it can be seen that Istanbul's per capita garbage production is around one kilogram. Solid waste of Istanbul can be classified under four groups, which are domestic, medical and hazardous solid wastes, and construction debris and rubble. Average values concerning the content of

Table 1

The content of the solid waste produced in Istanbul

Type of solid waste	Average daily amount [t]	Average percentage [%]
Organic material	4500	45.0
Paper and cardboard	1450	14.5
Ash	1500	15.0
Plastics	950	9.5
Textile	560	5.6
Ceramics-bricks-inerts	440	4.4
Glass	380	3.8
Metal	220	2.2
Total	10000	100.0

Table 2

Annual solid waste production (tonnes) predicted for 2020

Istanbul	Annual solid waste production (tonnes) predicted for Istanbul in 2020
European side	3.01
Asian side	1.74
Total	4.75

the solid waste produced in Istanbul are given in table 1, while table 2 presents the prediction for the year 2020 [4]–[7]. The scope of the recently launched Solid Waste Project of the Istanbul Metropolitan Municipality covers services for solid waste transportation, production of compost, recycling, disposal via regulated storing, controlled incineration of medical waste and electric energy generation from landfills [1]–[7].

3. LANDFILL FIELDS

The presence of landfill fields with underground draining prevents environmental pollution due to garbage spread around and garbage juice penetration into water along with the risk of explosion and fire because of compressed methane [4], [6], [7].

4. COMPOST AND RECYCLING FACILITY

Compost and recycling facility processes 700 tons of solid waste daily, discharges the garbage, and produces a new economic value, namely 200 tons of compost from

these wastes. Compost, a material of high organic value, improves the soil and has a high level of capability to keep water. Enriching it with nitrogen and phosphorus allow us to produce fertilizers [4], [6], [7].

5. LEACHATE PURIFICATION PLANT IN ISTANBUL

Within the scope of water pollution control regulation, municipalities are responsible for purifying the leachate accumulated at landfills. An average of 12 000 tons of domestic waste daily is stored at waste landfills overall Istanbul. Amount of leachate originating from these wastes is 2600 m³/day. The treatment systems put into service in 2004 are fully automatic and contain four treatment stages: pre-treatment, chemical treatment, anaerobic treatment and mud dehydration.

6. MEDICAL WASTES AND INCINERATION FACILITY

Municipalities are responsible for collecting the medical wastes and destroying them. Incineration process of medical waste in Istanbul is performed with full automation system in the “medical waste incineration facility” with a daily capacity of 24 tons. Waste is eliminated by being incinerated at 1000–1200 °C in the facility. At the end of controlled incineration, the waste is reduced by 95% by volume, and 75% by mass. While the medical waste is being eliminated in the incineration plant, electrical energy is generated at a capacity of around 0.5 MW. Table 3 summarizes some general characteristics of the medical waste incineration facility [4], [6], [7].

Table 3

General characteristics of the medical waste incineration facility

Furnace capacity	1.0 t/h (for 14 650 kJ/kg waste)
Calorific value of burnable waste	Min 8 400 kJ/kg; Max 19 000 kJ/kg
Thermal capacity of the plant	14 650 000 kJ/h
Steam production	5.22 t/h
Electricity production	428 kW

7. FACILITY FOR GENERATING ELECTRICITY FROM GARBAGE GAS

Gases released from 5.7 million m³ of solid waste are collected and sent to special gas motors where thermal energy is generated to be converted to electric energy in generators. The greenhouse effect created by the garbage gases released from the landfill to the atmosphere is 20-folds of that created by carbon dioxide. Kemerburgaz

dump previously used as wild storing area has been rehabilitated after 1995, and the project of generating electricity from garbage gas (35% methane) is launched. In the facility which has an established power of 4 MW, 8,000,000 kWh electric energy is generated annually. These gases released from the landfills will decrease over a period of 10 years [4], [6], [7].

8. PROJECT FOR WASTE SEPERATION AND RECYCLING

The most important step of a healthy recycling system is the collection of recycle-able materials at their origins. When mixed with normal garbage, the secondary materials produced from this mixture usually have a poor quality and pose problems during cleaning processes. A Management Plan of Package Wastes is prepared for Istanbul where the obligations and targets of market providers, municipalities and the public are determined in terms of where, how, when and under which type of collection the wastes will be collected, where they will be separated, where the recycled material will be evaluated, how the consumers/collectors will be trained, how the street collectors will be rehabilitated and reintroduced into the system. Certain pilot regions are selected within the scope of this project that will be put into practice within a short period of time [8]. As this project is put into life, materials such as aluminum, paper, plastic will be recovered, needs for imported scrap material will decrease, and energy will be saved. The amount and volume of reduced solid waste will be a great advantage, too [4], [6], [7].

9. TRANSFER STATIONS

A daily production of approx. 10 000 tons of domestic solid waste is carried to transfer stations by the support of district municipalities. The transfer stations help to reduce the high costs for the transportation of solid waste. Without these centers, the district municipalities would have to make a transporting effort of 51 100 km annually. Losses of work and personnel in collecting waste and garbage, maintenance and repair costs and many other costs would increase considerably. New ones would be added to the traffic problems of Istanbul. As the most important problem, a collateral damage would be inflicted upon the environment [4].

10. SOLID WASTE GASIFICATION PLANT

The two most commercially viable forms of large-scale conversion of solid waste to energy are controlled combustion and gasification. Combustion of wastes is a well-established practice, while gasification is still in its early stages as a large-scale com-

mercial industry. During combustion, dioxins/furans (PCDD/PCDFs) form in the flue gases as they leave the combustion chamber and cool to 650–300 °C. These dioxin/furan emissions are the primary issue for political and environmental opposition to the expansion of the solid waste to energy industry. Gasification has several advantages over traditional combustion. It takes place in a low-oxygen environment that limits the formation of dioxins and of large quantities of SO_x and NO_x. Furthermore, it requires just a fraction of the stoichiometric amount of oxygen necessary for combustion. As a result, the volume of process gas is low, requiring smaller and less expensive gas cleaning equipment. Finally, gasification generates a fuel gas that can be integrated with combined cycle turbines, reciprocating engines and, potentially, with fuel cells that convert fuel energy to electricity more than twice as efficiently as conventional steam boilers. During gasification, tars, heavy metals, halogens and alkaline compounds are released with the product gas and can cause environmental and operational problems. The key to achieving cost efficient, clean energy recovery from solid waste gasification will be overcoming problems associated with the formation and release of these contaminants [7]. A gasification plant at a capacity of 5 MW has been recently built and operated in Kemerburgaz-Istanbul to generate 127 million kWh of electricity per annum [7].

RERERENCES

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