

## Battery Collection in Turkey, Case Study of Küçükçekmece Municipality

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**Abstract:** Batteries are classified as hazardous waste according to European Union and Turkish laws and regulations. Battery waste contains electrolyte solutions as basic or acidic forms that could get involved with underground water or soil. Metallic ingredients on the other hand, are valuable source for metal recovery. This paper evaluates status quo in battery collection schemes in Turkey and Küçükçekmece Municipality as a case study. Population over 80 million people with use of over 10.000 kilograms of battery every year makes Turkey an interesting example in developing countries in case of battery collection. Küçükçekmece Municipality waste battery collection scheme is explained and collected amounts are given in this paper. Küçükçekmece has a population of 750,000 people approximately with being one of the most crowded cities in Turkey. High population density and being a recently urbanized region makes Küçükçekmece an interesting example of Turkish battery collection scheme.

**Keywords:** Waste Battery, Waste Battery Collection, Waste Management

### Introduction

European Union has the legislation especially for batteries, battery waste and battery collection. Legislation 2006/66/EC is a document of 28 pages defines battery, accumulator, battery pack, portable battery, button cell etc. (EU Directive, 2006). The Directive defines collection scheme and gives collection targets for the member states which is at least 45% after September of 2016. According to EU Stat database this target was fulfilled in 2017 by Austria, Belgium, Denmark, Finland, Germany, Lithuania, Luxembourg, Netherlands, Sweden, Switzerland (Eurostat, 2018).

In Turkey battery use per capita is 110 grams yearly which is quarter of the European mean (Eurostat 2018, Directive, 2019) Legislation on battery use and collection is regulated by Directive on Control of Waste Battery and Accumulators (Directive, 2019). This regulation is on the same basis as 2006/66/EC with deviations in details. Turkish regulation divides batteries in two groups; non - Ni-Cd and Hg-O batteries, Ni-Cd and Hg-O batteries. These two groups have different collection targets. Although collection targets are set there is not any legal burden in case of collection targets are not fulfilled. Waste battery collection in Turkey is done by Turkish Battery Importers Association (TAP) by law. TAP has 562 registered members by the time 2019 January (TAP, 2019) TAP states that agreement of waste battery transportation with two national cargo company, organized industrial zones, public establishments and military organizations. Municipalities have two sided agreements with TAP. TAP provides collection materials to municipalities.

This study aims to increase awareness of battery collection, battery use and waste battery for Turkey and other developing countries. Küçükçekmece Municipality is a good example of micro battery collection scheme of Turkey. Küçükçekmece Municipality is collecting waste batteries in 81 collection points in contact with TAP. Educational operations in schools for both waste batteries and recycling is in contact with schools are conducted.

### Materials and Method

This study is conducted with data from Eurostat for European Union battery use and collection numbers, TAP for Turkey battery use and collection numbers and Küçükçekmece Municipality Annual Report for Küçükçekmece battery collection numbers. Simple methodology is used for evaluating numbers. All data is collected and compared with each other. Life cycle assessment of Turkish battery

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market could not be performed due to lack of data. Collection data and status quo is collected via personal interviews and reports.

### **World Battery Market**

Worldwide battery market has gigantic economic value. In 2016, solely alkaline battery market value was 7.25 billion U.S. Dollars and further expansion is forecasted for the next years (Statista, 2018). Lithium based battery market had value of 9.80 billion U.S. Dollars in 2015 (Roland Berger, 2011). Electric vehicles are expected to have revenue of 271.67 billion U.S. Dollars in 2019 (Roland Berger, 2011) Battery industry worldwide has great economic value and raw material demand. Increase in electric vehicles, electrified transportation and global climate change pushes countries and companies to produce more efficient batteries and increases battery market interest.

#### *Battery Collection Around The World*

World battery collection for sustainable environment and sustainable economy is a crucial area of interest. Depletion in battery raw materials makes it mandatory to recycle waste batteries. Battery collection is becoming a point of interest within the past years. The European Union has legislation on battery collection which is called 2006/66/EC. According to this legislation every member of union have to achieve at least %45 level of battery collection (EU Directive, 2006) This collection rate was fulfilled by 10 member state yet for collection target remains to be reached for other 18 member state.

In Japan battery collection has been done by municipalities and Japan Portable Battery Recycling Center oversees collection and recycling of batteries. Japan battery collection scheme consists of separate battery collection which different type of batteries collected separately. This system is found to be inefficient against all type battery collection rule in European Batteries Directive (Terazeno et.al., 2015)

Waste battery management in Mexico is only consists of limitations to maximum levels of Hg, Pb and Cd of batteries. Batteries in Mexico are landfilled. Legislation situations in other Latin American countries are similar and mainly prohibit maximum levels of heavy metals therefore permits landfill of waste batteries in acceptable level of heavy metal ingredients (Guevara-Garcia, and Montiel-Corona, 2012). Zand and Abduli (2008) stated that in Iran spent batteries are landfilled with municipal solid waste without any treatment.

General opinion and start point of collection schemes in countries and studies make EU Directive 2006/66/EC basis of battery collection operations. Realistic collection targets and collection scheme that considers environmental impacts of waste batteries make the directive basis of battery collection idea.

#### *Battery Collection in Turkey*

Turkish battery market has a steady condition since 2007 with exception 2010. Annual battery import reports are given in Table 1. There is no battery manufacturing operation in process for now with exception of automotive batteries. Thus imported battery numbers indicates Turkish annual battery use.

**Table 1.** Turkish Battery Import Numbers. (TAP-1, 2018)

<b>Year</b>	<b>Primary Batteries, mt</b>	<b>Secondary Batteries, mt</b>
2005	6745	49
2006	5816	926
2007	10862	235
2008	10222	241
2009	9096	366
2010	6756	133
2011	8870	279
2012	10262	284
2013	8896	276
2014	9215	314
2015	9569	302
2016	10612	292
2017	10083	260

Table 1 shows battery imports in Turkey, these numbers exclude automotive accumulators and built-in batteries on imported electronics. Primary batteries have dominance over secondary batteries in Turkish battery market. Primary batteries can only be used for once therefore they are consumed in higher numbers. There is not any official explanation of decreasing battery imports in 2010. Battery imports of Turkey for specified battery types are given in Table 2. Table 2 shows battery import number of 2016 and 2017 according to imported battery type (TAP-1, 2018). Zn-C and alkaline batteries are the highest imported battery type. This can be explained by their large area of application with different electronic devices. Other battery types are generally considered for specialized applications.

**Table 2.** Battery imports of Turkey according to types in 2016 and 2017 (TAP-1, 2018)

Battery Type	2016, mt	2017, mt
ZnC & Alkaline	7730	6521
Lithium Batteries	184	165
Silver – Oxide	12.1	11.6
Zinc – Air	33.7	41.1
Lithium Button Cell	63.6	62.7

Imported batteries are also source of raw materials after use. The possible created source of batteries are calculated and given in Table 3. Table 3 shows imported battery chemistries per year, metallic values possible to recover and replacement of yearly use for Turkey. Manganese is the highest rate of metal in batteries for Turkey metal use. Manganese need of Turkey can be fulfilled by waste batteries by 5.64% and can create an economic value of 195.000 US \$. Total economic value of metals in batteries are over 1 million US \$ for Turkish economy.

**Table 3.** Battery imports of Turkey, metallic material value and replacement of yearly need.

Battery Type	Zn, mt	Mn, mt	Fe, mt	Li, mt	Ag, mt	Hg, mt
Zn-C, Alkaline (Yeşiltepe and Şeşen, 2016)	1777	2040	2300	-	-	-
Lithium Batteries (Yun et.al., 2018)	-	10.8	16.2	2.35	-	-
Silver – Oxide (Jadhar et. al., 2018; Aktaş, 2010)	0.61	-	6.68	-	2.78	0.24
Lithium Button Cell	-	10.4	26.3	1.15	-	-
2016 Use in Turkey (MTA, 2016)	423.057	36.557	10.420.000	4569	620	0
Replacement of Batteries, %	0.4	5.64	0.02	0.07	0.4	N/A
Possible Economic Value, US \$(MTA, 2016)	754.000	195.000	143.000	4100	1600	-

TAP (Turkish Battery Manufacturers Association) is the only legal institution on battery collection in Turkey. Savaş Arna, manager of TAP battery collection operation, stated that “Turkish battery market consists of imported batteries. Turkey produces only automotive accumulators and collection and recycling of lead acid accumulators are under control of their manufacturers by law. Our operation is to collect waste batteries from public areas like mosque, museum, school, hospital etc. Also we arrange campaigns in schools to educate young citizens to recycle and dispose batteries at battery collection points”. TAP has 561 members around Turkey. Collection is done in public areas by application of municipalities. Collected batteries are send to TAP collection points or in possible occasions TAP collects them by their own collection vehicles. Logistics are done and covered by TAP (Arna, 2018). Waste battery collection numbers and collection rate of Turkey is given in Table 4. Collection amounts are available up to 2016. Collection rate which is given in Table 4 is collected amount in respect to previous years sold amount. Collected waste batteries are not classified consequently collected battery chemistries are not available in statistics. Collected waste batteries are placed in underground collection depots which is isolated and fortified with concrete (Arna, 2018). Underground waste battery collection point can be seen in Figure 1.



**Figure 1.** Waste Battery Depots (TAP-2, 2018)

**Table 4.** Battery collection amounts of Turkey in metric tons (TAP-1, 2018)

<b>Year</b>	<b>Collected Amount, mt</b>	<b>Collection Rate, %</b>
2005	152	2.23
2006	226	3.35
2007	252	2.27
2008	325	3.10
2009	414	4.38
2010	451	6.54
2011	497	5.43
2012	526	4.99
2013	555	6.05
2014	628	6.60
2015	719	7.29
2016	730	6.70

Collection amounts in Turkey are not at satisfying level yet. Collected waste batteries are not even 10% of previous years sold amount. In 2004 in a short communication article Turkish battery collection is investigated and result was 1.2% of used batteries were collected by Istanbul Municipality (Aktaş et.al, 2004). Today collection rate of waste batteries is increased yet not to a satisfying level.

#### *Küçükçekmece Municipality Case Study*

Küçükçekmece Municipality is in Western or European side of Istanbul with the population over 700.000 residents. Urbanization in Küçükçekmece is accelerated in last decade. Increasing urbanization and industrialization increased waste amounts. Battery collection operation in Küçükçekmece Municipality is under administration of Environment and Waste Management Department. Municipality shares collected waste amounts via annual reports that can be accessed on the municipality website. Recyclable waste amounts of Küçükçekmece Municipality for 2016 and 2017 are given in Table 5.

**Table 5.** Collected Recyclable Waste in Küçükçekmece Municipality (Küçükçekmece Municipality Report, 2017)

<b>Year</b>	<b>2016 (mt)</b>	<b>2017 (mt)</b>
Packaging Waste	69860	43327
Waste Battery	10.6	6.9
Used Oil	92.8	99.6
Waste Electronics	0.7	1.8

Waste batteries are collected in 82 schools and public areas. Main collection target for municipality is schools and in 2017, 17.000 students are informed about waste management and recycling. Collection is being done by battery collection boxes and machines. Students are motivated through battery collection competitions between classes and schools. Ordinary citizen behavior is based on voluntary action. Municipality employee Ms. Merve stated that “Collection campaigns are based on voluntarily action and schools. Municipality is in charge of collection and storage of waste before shipped to TAP. TAP is informed when capacity is get full then licensed cargo trucks take waste battery for TAP’s action.” Battery collection machines and boxes are given in Figure 2. Battery collection machines give promotion tickets to students that can be turned into gifts. Küçükçekmece has the 1% of population in Turkey and collects 1% of collected waste batteries in Turkey. Collected batteries are given to TAP for further processing (TAP-1, 2018; TAP-2, 2018; Temel, 2018).



**Figure 2.** Battery Collection Machine and Box (Küçükçekmece Municipality Report, 2017)

## Conclusion

By means of battery materials over 6000 mt material is untreated and out of use for Turkey yearly. Total economic value is over 1 million US \$. This economic value is based on material price and can be improved by producing higher technology material. Küçükçekmece case is a minor example in Turkey waste battery management. Waste battery management is only collection and storage. Battery collection amounts are low for municipalities to be evaluated for recycle and legally municipalities are obligated to transfer collected waste batteries to TAP. This perspective shows municipalities are only in charge of collection and there is no motivation or challenge for them to increase collection rates indeed.

Battery collection situation in Turkey is evaluated in this paper with Küçükçekmece collection operation. Another study of battery collection in Turkey is done for Kahramanmaraş and results showed that total collected waste battery amount in 2016 is 1.957 kg (Karadeniz and Morcalı, 2018). Kahramanmaraş has higher population than Küçükçekmece yet collection amount in Küçükçekmece is higher. This result shows importance of Küçükçekmece within the waste battery collection scheme in Turkey. Turkish laws and regulations on battery use, disposal and recycling are evaluated. Battery collection is considered as an important issue for environmental care and mandatory laws are specified but battery collection scheme in Turkey yet to be improved. Statistical data is hard and complex to obtain. There is not licensed battery recycling facility on operation right now only physical separation of batteries conducted in a private sector company. Akın and Kuru (2011) suggested that electronic waste recycling should be evolved into industrial practice for both economic and environmental perspective. Low collection rates and battery usage in Turkey restrain economical recycling operation hence; battery collection rates should be increased in order to increase interest on this topic.

Low collection rates are result of authority gap in waste management laws. Laws are completely defined and in harmony with European Union laws though exercise of laws are not fulfilled. Low collection rates make recycling operation uneconomic and uneconomic recycling operation decreases collection motivation. Krekeler et al. (2011) stated that waste battery collection with low collection rate or low consumed battery amount increases per capita collection expenses. Situation in battery collection in Turkey is a complete dilemma right now. As a solution legal burdens, recycling or battery use tax should be considered. Otherwise uneconomic recycling without legal burdens is not a sustainable way through, this problem would not be solved in near future.

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