

# “Integrated Green Spots” for Household Hazardous and Municipal Waste Disposal

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**Abstract** *This paper proposes a concept for household hazardous waste (HHW) collection in municipalities, which promotes separation at source and a cooperation between municipalities and hazardous waste management companies. In order to align with the country’s goals, the ‘Integrated Green Spots’ concept uses the new legal context in Greece as a backbone and is based on the idea that every citizen who delivers their household waste in appropriate packaging will have to pay, as per the legislation. In turn, the municipality is responsible for the storage of this waste and its final disposal, with the help of a licensed company. Critical sectors in the chain of distribution of HHW are also examined, such as the recognition of the problem, the treatment of HHW, its collection, separation, transport, and final disposal. We propose a guide of the designated household hazardous waste drop-off area (Integrated Green Spot) and the means to sort HHW upon drop-off. Moreover, we go into the benefits of implementing such a system, as well as the intricacies that surround its creation. Finally, we conclude that it the proposed outlook would facilitate the reinforcement of the new Greek legislation by municipalities and we suggest its implementation as opposed to alternatives.*

**Key Words** *Household hazardous waste, separation at source, municipal waste, disposal, hazardous waste management*

## Introduction

The term ‘toxic waste’ is generally referenced to imply an effluent of heavy industrial activities whose production processes produce hazardous waste and cause gaseous pollutants as emissions. Apparently, the risk of pollution is not limited to the industrial area. In fact, toxic waste can be a product of materials of quotidian usage in households, known as Household Hazardous Waste, (HHW). The management of HHW has been a prominent issue in the European waste management community due to the lack of specific legislation [1]. Currently in the EU, only a selective number of countries have created an optimal concept for the collection of HHW[1]. In Greece, new legislation has created a context where such a concept can be implemented. This paper presents and explores an efficient and innovative HHW collection and management concept, focusing on separation at source and efficient disposal, as well as the facilitation of proper waste disposal by residents.

## Household Hazardous Waste in Greece

As aforementioned, local authorities in Greece (i.e. municipalities) lack a designated drop-off points for HHW. Therefore, the hazardous waste that is accumulated in households, pollutes the sewage system, our cities, and often the Aegean Sea [2], with microplastics and other pollutants ending up in the water. Research suggests that HHW comprises approximately 1%–4% of municipal solid waste [3]. Furthermore, it has been estimated that over a period of 2 years, an average Greek household accumulates hazardous waste and contaminated packages of 40-liters [4]. Due to the volume of HHW that is accumulated, it becomes clear that this issue should be combated through the establishment of designated drop-off points for proper HHW handling, to which citizens have immediate access. Greece has already taken steps to minimize pollutants, by placing battery recycling bins around key areas of cities. However, there is still a gap in public policy for other types of HHW.

On 23.07.2021, Greek Law 4819 was passed, delegating municipalities responsible for the handling and short-term storage of HHW. Article 46 of law 4819 states that municipalities must provide a designated area for residents to deliver their HHW. Article 46 also notes that should the municipality have a designated recycling area, HHW collection should be integrated within that area [5]. In cooperation with licensed certified companies, municipalities will be able to forward HHW for management and proper disposal. In order to implement this law, this paper explores the methodology behind the creation of the “Integrated Green Spots” innovative concept in each municipality, for the collection, sorting and disposal of HHW and recyclable waste in a safe and easy manner.

## Integrated Green Spots

The ‘Integrated Green Spots’ concept uses the new law as a backbone and is based on the idea that every citizen will be able to deliver HHW in appropriate packaging, and engage in the financial transaction predicted by the law. In turn, the municipality will store this waste and ensure its separation and final disposal. In order to achieve an optimal disposal of HHW, the creation of a permanent designated disposal space is highly suggested and beneficial, so as to prevent potential hazards. Since municipalities are also responsible for providing a disposal spot for recyclable waste [5], is suggested that the IGS also accommodate for recyclable municipal waste, thus facilitating the process of collection for both the municipalities and their residents. This is our definition of the “Integrated Green Spots” (IGS).

The IGS, therefore, are gated designated disposal areas, which feature the correct disposal barrels and bins for HHW and recyclable waste. In order to ensure public safety in the IGS certain measures need to be taken for efficient handling and hazard minimization. The IGS should be sufficiently protected from weather conditions, to ensure the safekeeping of HHW. This can be achieved via proper insulation of the designated drop-off spot. Furthermore, the spots need to be properly secured to avoid tampering and to reduce the risk of accidents. Therefore, access should be granted solely to individuals who are qualified for handling and/or are employees of the municipality and the waste management company in charge. Moreover, the HHW bins and disposal containers should be separated from other waste that are disposed of in the area, as they could potentially pose a hazard to the community. This can be done by placing a container (Figure 1), where HHW can be stored. The container should be large enough to host a forklift, which will be able to extract the barrels where HHW is stored and subsequently transport them into the transport vehicle of the hazardous waste transport company. A container of such nature can provide the security needed in the temporary storage of HHW, as it can also be locked by employees at the end of shifts. Finally, the company in charge needs to install proper labelling, provide personal protection gear, and the robust safety measures to those who enter the IGS area. Any hazardous waste management company that works with municipalities for the purpose of HHW, will also be called to provide basic training to the municipal employees who will be in charge of IGS monitoring. This is of immense importance to the safe operation of the area, since HHW requires intricate handling and can pose a threat to the health of individuals if not handled correctly. The same is true for asbestos, as we explain later on in the text.

Maintaining the aim of legal and efficient HHW disposal, the municipality, in cooperation with licensed companies, will transport and manage the HHW waste. Therefore, it is imperative that IGS include a cargo area with a loading platform for the loading of HHW barrels or bins onto transport vehicles. In regards to HHW transport, it is important to note that the municipality should reach an agreement with a licensed transport and management company in order to guarantee that the transport method is conducted according to Greek waste management and transport laws. The municipality will also need to reach an agreement in regard to the timing of each bulk transport, thus minimizing potential overflow of IGS.

The disposal of HHW to the IGS will be done by residents, who will be guided through the process once they arrive at the designated disposal area. The IGS will feature hazardous waste disposal bins and barrels, which will correspond to types of HHW present in households. The IGS will also feature a smart touch screen and a scale where civilians can choose out of the predicted categories of HHW, depending on the type of waste they wish to dispose of. As civilians are to bare the disposal cost, they will have to weigh the waste on the scale present. The weight will be then used to calculate the cost of disposal. Citizens will then have the choice to pay for the disposal via card or cash, using an automated payments system, which will be able to provide receipts and change. Post-payment, the smart screen will be able to guide them to the corresponding unit the waste should be disposed in. There should be employees present to control the correct execution of procedures. The employee at hand will guide citizens towards the correct disposal. They will also supervise the procedures carried out at the IGS, to ensure proper payment and correct storage of HHW.

## Types of HHW

For the creation of this concept, it is imperative that we provide a classification of HHW and ensure that all such waste can be properly stored and, subsequently, transported. Due to the intricacies of handling, the IGS will predominantly manage solid HHW, which are the most common in households, such as polluted packaging. However, should there be need for the temporary storage of small amounts of HHW in liquid, the IGS should be ready to accommodate that need with the presence of barrels which can host hazardous liquids before disposal. Appropriate classification of HHW will mitigate the risk of cross-contamination, and potential erroneous storage. The HHW that enters the IGS will be classified based on EWC codes, in order to place the appropriate disposal bins and platten bags (i.e. asbestos packing) in the IGS, as well as to ensure compliance with Greek and European waste management laws. More specifically, we separate HHW into sixteen (16) categories, each of which will have a separate designated packings to be disposed in (see **Table 1**). Our categories do not include HHW which is infectious, radioactive, and explosive.

**Table 1.** HHW Categories and Respective EWC Codes [6]

|   |  |
|---|--|
| Asbestos (chrysotile)   | <b>EWC 170605* (asbestos cement)</b>   |
| Asbestos (amosite, tremolite, actinolite, anthophyllite, crocidolite)   | <b>EWC 170605* (asbestos cement)</b>   |
| Paints (flammable, corrosive)   | <b>EWC 080111*</b>   |
| Pesticides, herbicides, insecticides and their packaging  | <b>EWC 160305* for pesticides, herbicides, insecticides and EWC 150110* for contaminated packaging ONLY if empty</b>   |
| Paint thinners, paint solvents, varnishes and polishes, oil paints and their packaging  | <b>EWC 16 03 05* for pesticides, herbicides, insecticides and EWC 150110* for contaminated packaging ONLY if empty</b> |
| Nail polishes   | <b>EWC 160305*</b>   |
| Packaging of chemicals for swimming pools, bathroom and floor cleaners  | <b>EWC 150110* for EMPTY contaminated packaging</b>  |
| Aerosol sprays, technical Spray   | <b>EWC 160305*</b>   |
| Ink cartridges  | <b>EWC 080317*</b>   |
| Pesticides  | <b>EWC 20 01 17*</b>   |
| Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries 20 01 34 | <b>EWC 20 01 33*</b>   |

|   |                      |
|---|----------------------|
| batteries and accumulators other than those mentioned in 20 01 33               |                      |
| Wood containing hazardous substances  | <b>EWC 20 01 37*</b> |
| Paint, inks, adhesives and resins containing hazardous substances               | <b>EWC 20 01 27*</b> |
| Paint, inks, adhesives and resins other than those mentioned in 20 01 27        | <b>EWC 20 01 28*</b> |
| Gases in pressure containers (including halons) containing hazardous substances | <b>EWC 16 05 04*</b> |
| Gases in pressure containers other than those mentioned in 16 05 04             | <b>EWC 16 05 05*</b> |

It is important to note that asbestos is separated from other HHW. Asbestos in households in Greece is mainly found in tin roofs and cement, known as bonded-in asbestos cement. Due to the intricate extraction asbestos removal needs, residents will be able to mainly remove tin-roofs that contains asbestos and dispose of them in IGS. The new law states that municipalities should be able to host properly packaged asbestos, should there be demand for temporary storage [5]. The IGS will provide the appropriate temporary storage for asbestos, which is of immense importance for the safety of both residents and municipal and hazardous waste management employees. A separate container with platten bags (Figure 2) will be placed in order to host asbestos disposed of by civilians.

## IGS Benefits and Alternative Concepts

The main benefit of IGS implementation is the facilitation of HHW handling and sorting. This concept allows municipalities to be in charge of the handling, as per Greek legislation, but also ensures that the expertise of the hazardous waste management companies is used for the environmental and socioeconomic benefit of local communities. Furthermore, it features a means of payments, which will minimize mischarges, but also aids citizen compliance with the law. It needs to be noted, however, that the municipality should also consider the possibility that individuals may still dispose of their HHW in municipal bins, and take measures to prevent that.

The imposition of this system, can also mitigate the problem of asbestos contamination in Greece. Currently, asbestos is lawfully handled by companies who are licensed for its removal. Although the law promotes a safe way of handling the hazardous material, by prohibiting the use of asbestos and promoting its removal [7], citizens can often opt to remove asbestos in their homes themselves, thus avoiding costs associated with professional removal. This, in turn, leads to improper disposal, since asbestos-contaminated materials end up in municipality landfill and subsequently handled as non-hazardous waste. Since Greece has once found itself to be the within the 7 largest producers of asbestos worldwide [8], this issue takes a grant scale. The disposal of asbestos in the IGS, will serve as a great alternative to citizens who wish to remove and dispose of asbestos tin-roofs in their homes. The aforementioned guidelines on the IGS will aid citizens in properly packaging asbestos and minimizing the risks of infection. Since the municipality will bare the financial burden of transportation and disposal, citizens are more likely to opt for disposing asbestos in the IGS.

One feasible alternative to the creation of IGS could be the placement of HHW bins across municipalities, which will be used at the discretion of the residents, while also requiring payment for disposal. This, however, does not ensure separation at source. Residents who are not aware of the type of waste they own, will opt for disposing of it at their best guess. This, however, will constitute a major issue to the municipality, since the HHW will need to be re-organized and separated, costing labor hours which can be avoided via the creation of the IGS.

Municipalities could also follow a ‘pop-up drop-off station’ system, with scheduled stations within set timeframes. Although this alternative is feasible and could provide an appropriate solution for both payments and disposal, there is always a risk of citizens not being able to attend and opting for disposal of their HHW in regular waste bins. Assuming that HHW is accumulated in households at a fast pace, the ideal system will feature a permanent disposal site for HHW within municipalities.

Finally, due to the involvement of sector experts and the protection of the area, the IGS concept promotes separation at source, and it provides a solid means to eliminate cross-contamination. Finally, the permanent presence of a drop-off spot for both HHW and recyclable materials creates optimal circumstances for residents to dispose of HHW and recyclables at their discretion and convenience.

## Conclusion

According to existing research on HHW, it is evident that there is currently no designated point for HHW storage and the benefits of its creation are notable. The study concludes that the imposition of this concept to municipality will aid cross-contamination elimination, while facilitating the process of HHW handling and granting direct access of proper disposal to residents. Through the consideration of benefits and alternative systems, we conclude that the IGS system provides an ideal solution in the Greek legal context and this paper can be used as a guide by municipalities for the creation of IGS. Finally, we conclude that among the alternatives, the IGS ensure separation at source, minimizing risks of contamination and securing lawful disposal. Lastly, the study concludes on the most appropriate classification method of the waste, which based on European and Greek hazardous waste legislation.



*Figure 1: Model container for household hazardous waste*



*Figure 2: Asbestos Big Bag Model, from My Pallets Online*

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