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A new dawn for buried garbage? An investigation of the marketability of previously disposed shredder waste

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ABSTRACT

This paper examines the market potential of disposed shredder waste, a resource that is increasingly emphasized as a future mine. A framework with gate requirements of various outlets was developed and contrasted with a pilot project focusing on excavated waste from a shredder landfill, sorted in an advanced recycling facility. Only the smallest fraction by percentage had an outlet, the metals (8%), which were sold according to a lower quality class. The other fractions (92%) were not accepted for incineration, as construction materials or even for re-deposition. Previous studies have shown similar lack of marketability. This means that even if one fraction can be recovered, the outlet of the other material is often unpredictable, resulting in a waste disposal problem, which easily prevents a landfill mining project altogether. This calls for marketability and usability of deposited waste to become a central issue for landfill mining research. The paper concludes by discussing how concerned actors can enhance the marketability, for example by pre-treating the disposed waste to acclimatize it to existing sorting methods. However, for concerned actors to become interested in approaching unconventional resources such as deposited waste, greater regulatory flexibility is needed in which, for example, re-deposition could be allowed as long as the environmental benefits of the projects outweigh the disadvantages.

1. Introduction

Today, the increasing demand for resources is mainly met by traditional extractive industries searching for previously inaccessible reserves, accompanied by severe social and ecological consequences. Recycling can partly substitute for primary production, but the waste streams are too small to cover a significant share of the increasing demand for resources, especially for critical metals, such as rare earth elements. However, due to our inherent wastefulness, huge amounts of material and energy resources have accumulated in different waste deposits. Some researchers claim that such deposits are bursting with resources, e.g., globally the deposited amount of copper is comparable to the current in-use stock (Kapur, 2006), and in some regions, the amount of landfilled combustibles could potentially cover the demand for district heating for decades (Frändegård et al., 2013). Given this potential, the extraction of inactive resources has been proposed as an alternative strategy to quantitatively increase recycling and thereby replace a more significant share of primary production (Ayres, 1999; Johansson et al., 2013). Such a resource strategy could lead to avoided climate emissions from primary production (Frändegård et al., 2013), an opportunity to treat hazardous substances in the landfill and thus a better local environment (Johansson et al., 2012), and strengthened local economies by job creation (Jones et al., 2013). Extracting landfills, i.e., landfill mining could also have geopolitical advantages if it leads to a reduction in imports of metals and minerals. Such innovative resource extraction operations are thus closely related to several national (Swedish EPA, 2012; Swedish Government, 2013) and international (European Commission, 2008) policy objectives such as increased recycling, resource conservation, reduced climate impact and remediation of contaminated land.

Landfill mining is an emerging research field, which is limited to the mapping of small-scale pilot studies (Krook et al., 2012) when it comes to landfill material composition (e.g., Hull et al., 2005; Cossu et al., 1996; Hogland et al., 2004; Quaghebeur et al., 2013), applicability of different technologies (e.g. Dickinson, 1995; Reeves and Murray, 1997; Zhao et al., 2007; Bosmans et al., 2013), environmental and health risks (Cossu et al., 1995; EPA, 1997), and economic feasibility (e.g. Fisher and Findlay, 1995; Dickinson, 1995; Hull et al., 2005). Given this lack of real-life projects, conducted assessments about the resource potential of landfills (Hogland et al., 2004; Tanha and Zarate, 2012) and related economic and environmental impacts of realizing such full-scale mining operations rely on hypothetical conditions and cases

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(Frändegård et al., 2013; van Passel et al., 2013; Winterstetter et al., 2015). Although useful for pinpointing the potential, such an approach is insufficient because it builds upon assumptions about landfill mining fundamentals in terms of technical feasibility and market acceptance of the extracted resources.

Indeed, some reports state that deposited waste has been recovered in previous landfill mining operations. For example, extracted soil-type material has been used as fertilizer (e.g. Savage et al., 1993), separated combustibles as fuel in waste incinerators (e.g. Johansson et al., 2012), and different types of metals have been material recycled (e.g. Hino et al., 1998; Zanetti and Godio, 2006). However, several of these cases were performed during a time when environmental standards were lacking or at least significantly lower than what is normally the case today. Others involved pilot studies, in which only small quantities of waste were sent to material and energy companies on a trial basis without any need for material characterization or fulfilment of current market and regulatory demands.

Generally, the marketability of materials and energy resources from landfills has received limited attention, often only examined in passing in some studies. Therefore, the conclusions about market acceptance have often been incomplete or even inadequate. For instance, several previous studies provide a limited picture of the outlets since they only address the marketability of a few selected materials (e.g. Kaartinen et al., 2013; Prechthai et al., 2008; Hogland et al., 1995; Kornberg et al., 1993). This is problematic given that both the economic and environmental motives of any landfill mining initiative assume that most of the extracted materials can be recovered (e.g. Frändegård et al., 2013, 2015; van Passel et al., 2013; Winterstetter et al., 2015; Jain et al., 2013). In other cases, the waste was manually sorted prior to analysis – something which hardly reflects the characteristics of the material fractions that would be obtained in a full-scale mechanical operation (cf. Quaghebeur et al., 2013; Zhou et al., 2014). In principle, these incoherencies do not provide a sufficient basis for understanding if it is possible to find use for all of the exhumed material and thus obtain salable recyclables from waste deposits – essential knowledge for justifying any landfill mining operation as well as for evaluating the resource potential of such deposits in a circular economy.

The purpose of this study is to systematically examine the marketability of all material fractions generated from a landfill mining pilot project in Sweden. In doing so, a comprehensive framework for assessing possible outlets and related market and regulatory criteria is developed and contrasted to the physical and chemical properties of the separated materials. Apart from assessing if the market is ready to take back the material it once abandoned, such an analytical approach makes it possible to specify which critical criteria determine the usability of the different materials. Based on these fine-grained results, technical and regulatory measures for further improving the marketability of landfill mining materials are discussed. The market acceptance is limited in this study to gate requirements of downstream material and energy companies and accompanying regulations and laws.

2. Method

The method applied to investigate the marketability of previously deposited waste can be structured into six main sections, as seen in Fig. 1. First, (1) a landfill intended to be extracted was identified, which could serve as a starting point and frame the analytical approach. Then a framework for waste outlets was constructed by (2) identifying potential outlets and (3) mapping associated input requirements and regulatory demands for accepting the waste. The extracted material was (4) analyzed and (5) con-

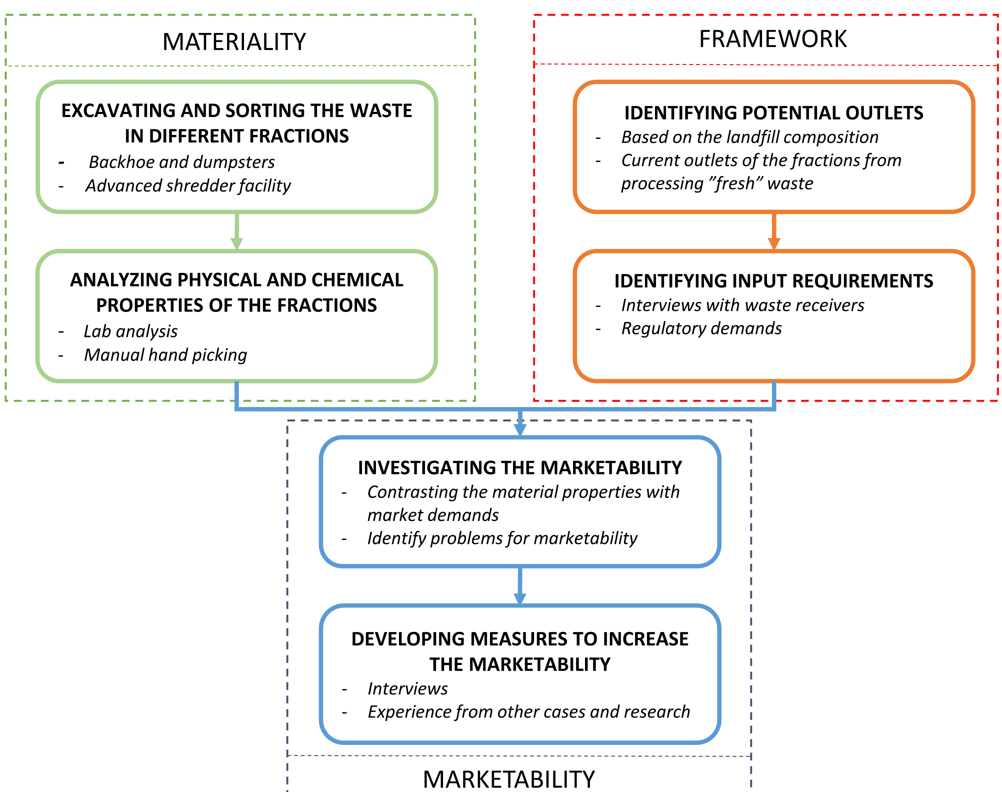

Fig. 1. A schematic overview of the methodological approach of this study. The points listed in each box indicates the procedures to collect information for the specified methodological step. However, the figure is a simplification. For example, the identification of potential outlets in the red box directly influenced the choice of analytical methods for the sorted fractions in the green box. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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