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Poland's urban mining opportunities

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Abstract: The concept of urban mining, whose main postulate is to complement (or even to replace) natural raw material resources with deposits of anthropogenic origin, has been present in the scientific debate since the late 80s of the XX century. Despite a noticeable increase of interest in the implementation of the waste management hierarchy among the whole society - from the authorities of the European Union, through representatives of national authorities, large corporations and small businesses, and ending up at consumers, there is no circumstantial evidence indicating current use of the idea in a wide range in Poland. This is evidenced by, inter alia, still a very high percentage of municipal waste coming to local landfills every year (52.6% of the collected municipal waste in 2014) and a very low level of selective collection (19.8% of the collected municipal waste in 2014) [12]. The aim of the article is to review the evidence of an environmental-economic-legal nature justifying the implementation of the concept of urban mining in Poland and to analyse the possibilities and potential benefits from the use of the strategy for the Polish economy and society.

Introduction

The main task of urban mining (publications also use similarly sounding and largely synonymous terms: city mining, landfill mining, green mining, eco mining and urban mining) is the transformation of the majority of waste into natural resources. The concept fits in the long-promoted principle of sustainable development and a responsible approach to waste management with particular emphasis on problematic aspects of the depletion of natural resources. As early as 1972, when the Club of Rome issued a well-known report "Limits to Growth", the world community was strongly warned against further continuation in the consumer lifestyle and gophering approach to the Earth's resources [19]. Despite great interest in the publication and its translation into many languages, 44 years on from its release you can risk saying that it has not convinced mankind to abandon linear economic systems. To make matters worse, it also appears that the predictions of the authors of the report from nearly a half a century ago, to a large extent are confirmed in the present, which prophesies large deficiencies of natural resources in the near future [3].

Urban mining can and should be one of the elements that will allow decoupling of economic growth combined with the increase in world population from pressure growth exerted by man on the environment. The concept suggests a reversal of looking at waste: from the problematic sphere to the area of benefits; from substances which the holder wants to get rid of to useful materials, the acquisition of which processors are interested in. The idea comprehensively approaches all kinds of unused, unwanted products (in general understanding identified as waste) generated in the past, emerging now and those yet to be generated. This is reflected in the pillars concept, among which the following should be distinguished [8]:

- **Thoughtful and responsible product design**, allowing for efficient recycling at the end of the product's life. Individual substances used in a given product should be easy to separate and process. In an era of increasingly complex packaging and products made from permanently joined together different groups of materials, a change in approach in this area and the abandonment of marketing attitudes, causing

subsequent problems for recycling plants (e.g. the use of shrink films on PET bottles) are extremely important.

- **Management of information resources** consisting in the storage and transmission of important product information throughout the reverse chain, which will allow in the future for efficient and professional processing of substances. Elements of management of information resources should also comprise data acquisition on the possible deposits for urban mining, e.g. morphology of waste deposited in the landfill, the existing and unused network of utilities and the like.
- **A quest for deposits** that will enable competitive activities in relation to traditional methods of obtaining raw materials. These activities can significantly facilitate the collection of data on potential deposits.
- **Appropriate equipment and technology** allowing for environmentally and economically cost-effective segregation and recycling, both in relation to waste generated in the past, as well as in the present.

The real introduction of the above principles into socio-economic practice (on a revolutionary scale) would significantly contribute to changes in the way of waste management (moving away from landfills towards universal recycling) and would activate new deposits of raw materials (e.g. in the form of landfills). Hurray optimism may be prevented, however, by the fact that although these paradigms have been known for some time, in our country they still have not translated into real change in the attitudes of producers and consumers. Therefore, it is worth considering what the objective chances of implementing the concept of urban mining in Poland are like, what potential benefits they may be associated with and what they are dependent on.

Raw material Armageddon on the world markets

The year 2015 proved to be another (the fifth in row) which brought decrease in raw materials prices worldwide. Such a long-lasting bear market caused the prices of many raw materials to reach ten-year lows. The world commodity market index CRB (Commodity Research Bureau) illustrating the situation, which includes prices of 19 basic raw materials (such as metals, fuels), at the beginning of this year fell to the lowest level in 14 years reaching a value not listed since July 2002. [22], [23]. The goods whose prices fell most last year include, inter alia: oil, palladium and platinum. Although in March and April there was a slight index rebound, this does not change the fact that on an annual basis it continues to lose almost 20%. Decreases are caused primarily by the slowdown in the world economy, especially noticeable in China, which over the past years has been a major consumer of copper, cement, coal, aluminium and steel. The situation described in the commodity market does not encourage the seeking alternative sources, which include anthropogenic deposits used by urban mining. However, there is a belief among experts that prices of such materials are overvalued inadequately against their real value (including the ongoing geopolitical game-play), and prices will soon rebound.

The European Union – first of all closing of the loop

The global sell-off in the commodity markets has not affected the policy of the European Union. This is clearly evidenced by

the fact that at the time in which the said CRB index reached its minimum of over ten years, the European Commission announced an ambitious plan for a circular economy [17]. A need to introduce a coherent and comprehensive policy on closing the loop of the supply chain on the Old Continent has been postulated for a relatively long time. One of the first documents touching this issue was a report of the European Commission “The possibility to replace manpower with energy” of 1976, whose authors - Walter Stahel and Genevieve Reday - outlined the vision of a circular economy and its impact on, inter alia, saving resources and preventing waste [25], [26]. In subsequent years, the idea was developed and implemented gradually, which is reflected in, for example, the emergence of provisions relating to the hierarchy of waste disposal methods or extended producer responsibility [4]. But only July 2014 brought a coherent action plan in the field of closed circuit [16]. It is true that after less than six months the European Commission withdrew from this proposal [18], but it was motivated by the ambitious aim of creating a more comprehensive design, emphasising not only desirable ways of waste management, but also preventing it from occurring and a thoughtful product design enabling its subsequent processing (which forms part of the most important postulates of urban mining). The final design of the package for circular economy was presented in December 2015. Currently, the document is consulted by representatives of the authorities, waste management sector and industry and, despite comments to some of its detailed provisions, it has been approved by them [5]. Comparing the magnitude of resources (time, human, legislative and consultative) already loaded into the preparation of this package and most of all, the size of investment in the future technological and organisational changes, which will be enforced by new proposals, it appears advisable to question the reasonableness of the efforts made in the face of prices of raw materials systematically falling in recent years. The answer is simple – the European economy needs transformation to a closed circuit (including the use of the concept of urban mining), in order to remain competitive and at least partially to protect itself against price volatility and shortages of stocks, and on the occasion to create new local jobs [10]. With technological progress Europe has become heavily dependent on imports of metals such as cobalt, platinum, rare earth metals and titanium, essential in electronics. The European Commission says openly that in the case of raw materials used in the new technology sector, import dependence is considered crucial because of their economic value and high supply risks [15]. The European Union is on a global scale the provider of approximately 3% mineral resources, while consuming 20% of the world market. It is estimated that Member States of the Community are (already) forced to import between 60% and even 100% of many metals and energy resources and by 2030 this deficit will have deepened further. [2]

Raw materials in Poland

One gets the impression that the widespread presence of the topic of waste management and raw materials in discussions on the European arena does not translate directly to the domestic backyard. The confirmation of this thesis is in the recently announced “Morawiecki’s Plan” [20], which ac-

According to representatives of the government is to constitute a signpost and a cornerstone of the dynamic development of Poland in the coming years. It is pointless to look in it for any references to waste management and related opportunities for the replacement of goods with natural anthropogenic resources. This fact is all the more surprising that Poland has been for years among the countries with the worst operating system in this area and EU requirements for waste management from year to year are becoming more restrictive. It is true that Poland is still a country relatively rich in deposits and major in the world in the production of certain mineral resources (e.g. copper and silver, zinc, lead, rhenium or carbon), but estimates show that with extracting continuing to be at the 2013 level most resources will be depleted in the next 50 years [1]. Besides home products of the raw materials industry on the international market are becoming less and less competitive. Already by the 1990s, Poland had ceased to be a country specialising in the export of raw materials and in the subsequent years the situation has got worse. [2] In the face of these facts, the concept of urban mining seeking and promoting the use of anthropogenic resources can become, also in Poland, a competitive alternative to the exploration of minerals increasingly less available in traditional form.

Urban mining - How rich deposits are Polish landfills?

Considerations concerning Polish opportunities arising from the use of the idea of urban mining can start from, ironically in this case, optimistic data on the ways of waste management in Poland. For years municipal waste produced in Poland flowed as a broad stream to landfills. Even until 2007 inclusive, 90% of the collected municipal waste was managed in this way [11]. In subsequent years, this ratio steadily declined until the 52.6% figure for 2014 quoted in the introduction. It cannot be denied that the sectoral environment undermines the full credibility of the quoted data (published by GUS). This is due to imperfections in data collection, due to, inter alia, continuous changes in the system and revealed, for example, in the reported in recent years decline in production of municipal waste in kg / 1 inhabitant (despite differing experiences of more developed countries, as well as analyses of national experts, indicating a high probability of increase in the volume of waste [13]). However, both academic community and specialist literature, as well as representatives of companies from the waste management sector do not question the fact that in Poland still the most popular form of waste disposal is landfill. Home landfills are therefore a large resource in terms of the amount of deposited waste, which due to the move away from this form of waste disposal in the more developed countries is their "competitive advantage" against landfills from Western Europe. But just as for the traditional mining, also for urban mining the quality of the deposit is important. In this case it is difficult to draw definite conclusions, due to differences in morphological composition of waste deposited in different places (e.g. arising from the characteristics of the service area or years of activity) [9]. In specialist literature [6] you can meet with the opinion that the extraction of waste from landfills, where mixed municipal waste was deposited, would be inappropriate substantially due to the high percentage of biodegradable materials. However, systematic, uniform tests in the field of morphologi-

cal composition of municipal waste landfills are not carried out in Poland, and those that have been done are characterised by a great diversity of results [14]. In addition, the results of a survey conducted among managers of municipal waste landfills indicate that even a quarter of them see a potential source of raw materials in their landfills, arguing their opinion that for many years unsegregated waste has been dumped on their landfills and the results of morphological composition confirm a large share of metal and plastics in the deposited waste [8]. It should therefore be noted that supposedly some Polish municipal landfills can be sufficiently affluent deposits for the concept of urban mining, and their use in the future, in addition to morphological composition, will be affected by the legislation and the availability of specialised technology.

A separate source of raw materials for urban mining in Poland may be in the future industrial waste landfills. Although the manufacturing industry for years has seen potential in waste and allocates only about 12 % for landfills compared to the amount produced, the enormity of waste resulting from technological processes in the industry (about 90% of all waste produced in Poland [21]) causes that also in this case, the existence of rich deposits in the form of certain industrial waste dumps may be presumed. For obvious reasons, it is more difficult here for specific figures, however, the case of the only and easily accessible deposit from the group of rare earth metals in Poland shows the possibilities available in this group of landfills. The quoted exception is the landfill of industrial waste at the Chemical Plant in Wizów which has resources of phosphogypsum estimated at 8.28 thousand tonnes [2]. In the future it may turn out that minerals mined earlier "on the occasion" of extracting raw materials from the basic deposit, treated for various reasons as waste, are a good alternative to traditional deposits of a given raw material.

Urban mining in Poland – not only landfills

An interesting case, somewhat similar to the situation with municipal waste landfills, is the area of vehicle recycling. It turns out that also in this aspect Poland's backwardness compared to the west of the continent may in the future turn into some kind of advantage and benefit. The number of passenger cars registered in Poland over the years has been increasing from year to year, however specific increase in the growth rate has been observed since 2004. It is associated with a massive import of used cars, which occurred after the accession of Poland to the European Union. Since a significant part of cars already at the moment of their arrival in Poland were heavily exploited, after several years of use, these vehicles are an attractive deposit for urban mining. With time an annual increase in the number of vehicles withdrawn from service has been observed in Poland. Only in the years 2007 - 2013 the number of cars deregistered in the country increased by over 100% and reached 383,567 (refers only to passenger cars) [24]. It is expected that in the coming years both the number of cars registered, and the ones withdrawn from use will increase [2]. End of life vehicles are likely to be transformed from a problem that contaminates Polish streets into a genuine raw material advantage.

Another example of an urban source of raw materials is used electrical and electronic equipment (Eng. WEEE - Waste of Electrical and Electronic Equipment). According to the GIOŚ

data [7] in 2013 a total of over 500 thousand tons of electrical and electronic equipment was introduced on Polish territory, while the rate of collecting this type of equipment was at the level of 34.74%. Almost all of the collected waste of electrical and electronic equipment was processed (mostly recycled). In the recycling process mainly such fractions were isolated: ferrous and coloured metals, plastic, rubber, glass, batteries and accumulators. It should be noted, however, that per capita in 2014, 4.15 kilograms were collected and the result was worse than in the years 2012 and 2013, and much worse than in the leading European countries. Additionally in the coming years the amount of production of this type of waste is expected to increase, which is associated with the shortening life cycle of products, the emergence of new devices and their increasing availability. Urban mining also in this area has a very large field to the activation of deposits.

Urban mining in Poland may also operate in obtaining resources from buildings and infrastructure projects. Widely understood construction is characterised by waste generated at each stage of work: construction, extension, modernisation, demolition. As a side element of this type of activity mainly aggregate is produced, having the potential to replace natural resources, even in road construction. Additionally, construction works are often associated with the exchange of network of utilities, for the re-use of which and restoration to raw material circulation urban mining calls. It is difficult to assess unambiguously the abundance of these deposits, but Poland as a country which is still under construction, with a relatively large number of construction projects, should not underestimate the importance of this type of waste.

Summary

Definitely the concept of urban mining (complementary to the strategy for circular economy) has a chance to get a more real shape in the near future. Despite significant declines in raw material prices in recent years, developed countries show interest in both philosophies. In this regard, a particular activity of the European Union (publication of a package of changes in the legislation) can be seen. Acquiring raw materials from waste on the Old Continent is seen as a real alternative to traditional deposits and the possibility of obtaining a competitive advantage. The above is important in particular in relation to key raw materials with a very limited occurrence (e.g. rare earth metals, commonly used in electronics). The resources, which in the future may be used by urban mining in Poland are municipal waste landfills, where still a large mass of waste goes. The actual mining of landfills must, however, be preceded by an accurate study of the deposited waste morphology. In addition, it is necessary to develop efficient methods for the extraction of raw materials from the landfill and the creation of appropriate legal framework. In the context of landfills, a valuable anthropogenic raw material deposit may also be the accumulation of industrial waste. In addition to landfills a large resource group of an urban mining strategy includes, inter alia, decommissioned vehicles, waste of electrical and electronic equipment and construction waste. The activation of these deposits (organised waste collection) will largely depend on whether they are used effectively. The real existence of the urban mining strategy in Poland requires the support of the political and scientific environment.

Determinants of changes in addition to the expected raw material and economic aspects (increasing prices of raw materials, problems with their availability) will probably become the European Union's action (as regards the publication of the overall strategy and the implementation of specific modification of the directives). Poland, using the experience of more developed countries and the unexpected opportunities provided by outdated waste management systems currently in use (promoting landfilling), has great potential for the implementation of the concept of urban mining. A responsible approach would enjoin remodelling of waste management policy so as to promote real hierarchy of ways of dealing with waste and to investigate any type of anthropogenic deposits of raw materials which, as has been shown with high probability, the country has. It is necessary to continue research and engineering services in the subject undertaken in the article, focusing on the search for potential deposits, analysing their abundance and proposing specific technical solutions enabling the exploration of resources. Scientific community increasingly observes this problem by organising dedicated thematic studies, e.g. engineering studies in the field of Material Recycling organised by the Częstochowa University of Technology or Closed Loop Supply Chain postgraduate studies organised by the Military University of Technology. ■

REFERENCES

1. *Bilans zasobów złóż kopalin w Polsce*, PIG-PIB, Warszawa 2015.
2. Bromowicz J., Bukowski M., Hausner J., Kasztelewicz Z., Kudłacz M., Kulczycka J., Piestrzyński A., Steinhoff J., Wilczyński M., *Polityka surowcowa Polski rzecz o tym, czego nie ma, a jest bardzo potrzebne*, Kraków 2015.
3. Day J. W., Hall Ch. A. S., *Revisiting the Limits to Growth After Peak Oil*, American Scientist, Volume 97, Maj – Czerwiec 2009.
4. DYREKTYWA PARLAMENTU EUROPEJSKIEGO I RADY 2008/98/WE z dnia 19 listopada 2008 r. w sprawie odpadów oraz uchylająca niektóre dyrektywy.
5. *FEAD position paper on a revised Commission proposal on Circular Economy*, Bruksela, marzec 2016.
6. Praca zbiorowa pod redakcją: Grabowski Z., *ZARZĄDZANIE GOSPODARKĄ ODPADAMI Nowe regulacje prawne*, Polskie Zrzeszenie Inżynierów i Techników Sanitarnych Oddział Wielkopolski, Poznań 2012.
7. GIOŚ, *RAPORT o funkcjonowaniu systemu gospodarki zużytym sprzętem elektrycznym i elektronicznym w 2014 roku*, Warszawa 2015.
8. Grodkiewicz P., Michniewska K., Siwiec P., *Efektywność surowcowa w Polsce. Wpływ sprawnej logistyki odzysku na tworzenie gospodarki o obiegu zamkniętym*, Difin, Warszawa 2015.
9. Grodkiewicz P., *Czynniki wpływające na możliwości efektywnego wdrożenia idei city mining w stosunku do polskich składowisk odpadów komunalnych*, „Logistyka Odzysku”, nr 4/2014 (13).
10. *Growth within: a circular economy vision for a competitive Europe*, Ellen MacArthur Foundation, McKinsey Centre for Business and Environment, Stiftungsfonds für Umweltökonomie und Nachhaltigkeit (SUN), 2015.
11. GUS, *INFRASTRUKTURA KOMUNALNA W 2007 R.*, Warszawa 2008.
12. GUS, *INFRASTRUKTURA KOMUNALNA W 2014 R.*, Warszawa 2015.
13. Jędrzak A., *Analiza dotycząca ilości wytworzonych oraz zagospodarowanych odpadów ulegających biodegradacji*, Zielona Góra 2010.
14. Jędrzak A., *Skład morfologiczny odpadów komunalnych w latach 2007-2012 w Polsce, według województw*, Uniwersytet Zielonogórski.
15. KOMUNIKAT KOMISJI DO PARLAMENTU EUROPEJSKIEGO I RADY, INICJATYWA NA RZECZ SUROWCÓW – ZASPOKAJANIE NASZYCH KLUCZOWYCH POTRZEB W CELU STYMULOWANIA WZROSTU I TWORZENIA MIEJSC PRACY W EUROPIE, Bruksela 4.11.2008.
16. KOMUNIKAT KOMISJI DO PARLAMENTU EUROPEJSKIEGO, RADY, EUROPEJSKIEGO KOMITETU EKONOMICZNO-SPOŁECZNEGO I KOMITETU REGIONÓW, *Ku gospodarce o obiegu zamkniętym: program „zero odpadów” dla Europy*, Bruksela 2.07.2014.
17. KOMUNIKAT KOMISJI DO PARLAMENTU EUROPEJSKIEGO, RADY, EUROPEJSKIEGO KOMITETU EKONOMICZNO-SPOŁECZNEGO I KOMITETU REGIONÓW, *Zamknięcie obiegu – plan działania UE dotyczący gospodarki o obiegu zamkniętym*, Bruksela 2.12.2015 r.
18. Matlak D., *W drodze ku gospodarce o obiegu zamkniętym*, „Logistyka Odzysku”, nr 4/2015 (17).
19. Meadows D. H., Meadows D. L., Randers J., Behrens III W. W., *The Limits to Growth: A report for the Club of Rome's project on the predicament of mankind*, Universe Books, Nowy Jork 1972.
20. UCHWAŁA NR 14/2016 RADY MINISTRÓW z dnia 16 lutego 2016 r. w sprawie przyjęcia „Planu na rzecz odpowiedzialnego rozwoju”.
21. www.archiwum.ekoportal.gov.pl/prawo_dokumenty_strategiczne/ochrona_srodowiska_w_polsce_zagadnienia/Odpady/Przemyslowe.html (dostęp 3.05.2016 r.).
22. www.bankier.pl/wiadomosc/Koniec-swiata-drogich-surowcow-7293184.html (dostęp 28.04.2016 r.).
23. www.bloomberg.com/quote/CRY:IND (dostęp 28.04.2016 r.).
24. www.cepik.gov.pl/statystyki (dostęp 1.05.2016 r.).
25. www.product-life.org/pl/c2c-od-kolyski-do-kolyski (dostęp 28.04.2016 r.).
26. Zarebska J., Joachimiak – Lechman K., *Gospodarka o obiegu zamkniętym – rola LCA, szanse, bariery, wyzwania*, „Logistyka Odzysku”, nr 1/2016 (18).