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Letter to Editor

Potential directions for the use of various types of waste in Mongolia

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INTRODUCTION

The development of human beings puts pressure on the living environment and raises the question of whether our future development should follow the previous path or not. The United Nations has identified several challenges encountered by humanity, including water contamination, climate change, health issues and access to food, etc. These challenges are caused by an increase in the number of different types of waste resulting from human activity.

Wastes can be divided into municipal solid waste, industrial waste, agricultural waste, and hazardous waste. To overcome the challenges, it is necessary to find a way of using these wastes. In this paper, I attempted to outline a potential strategy for the utilization of industrial and household wastes, which constitute the largest waste in Mongolia, based on global utilization trend.

Municipal Solid waste

The world generates 2.01 billion tons of municipal solid waste annually, and at least 33% of that, extremely conservatively, is not managed in an environmentally safe manner. Worldwide, the waste generated per person per day averages 0.74 kilograms, but ranges widely from 0.11 to 4.54 kilograms. Fig.1 shows the composition of municipal solid waste in the world.

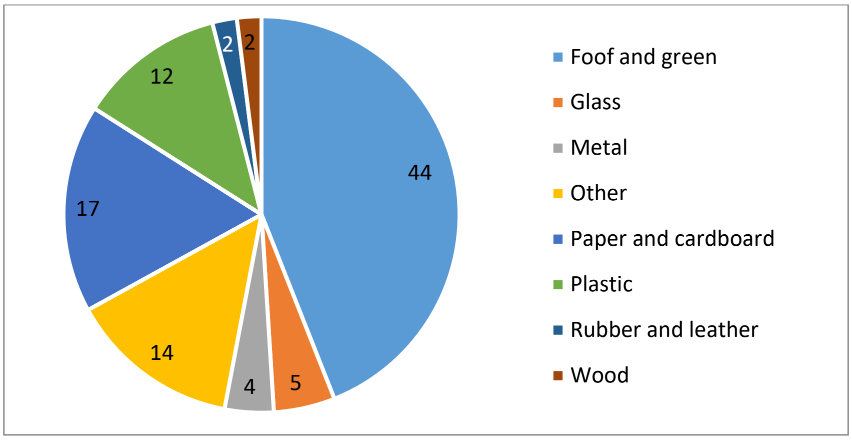

Figure 1. Global composition of municipal solid waste. Adapted from reference [1]

The main trend of waste management consists of prevention, minimization, recycling and reuse, biological treatment, incineration, and landfill disposal, as shown in Fig.2. Trends in solid waste utilization are generally related to the 3R strategy or Reduce-Reuse-Recycle.

Basically, the 3R concept (Reduce-Reuse-Recycle) is a sequence of steps on proper management of waste. The top priority is to reduce waste generation, then reuse and then recycle, to give waste material a second chance before it is disposed of in the landfill.

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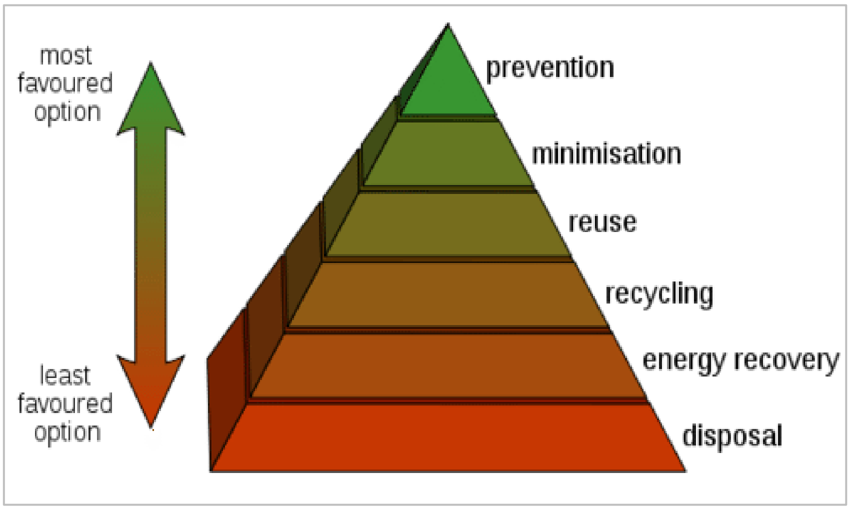

Figure.2. Hierarchy of waste management. Adapted from reference [2]

Common recycled materials include paper, plastics, glass, aluminium, etc. In addition, many construction materials can be reused, including concrete, asphalt materials, steel used for reinforcement as well as materials used in masonry. Green plant waste is often recovered and immediately reused for mulch or fertilizer applications. Many industries also recover various by-products and/or refine and "regenerate" solvents for reuse, which include copper and nickel recovery from metal finishing processes; the recovery of oil, fat and plasticizers by solvent extraction from filter media, such as activated carbon and clays; and acid recovery by spray roasting, ion exchange or crystallization waste can be directly incinerated to produce energy. Incineration consists of burning waste at very high temperatures to produce electrical energy. The by-product of incineration is ash, which requires proper characterization prior to disposal, or in some cases, beneficial reuse. It is widely used in developed countries because of the limitations of landfill space. It is estimated that about 130 million tons of waste are combusted annually in more than 600 plants in 35 countries [2].

A typical range of net electrical energy that can be produced is about 500 to 600 kWh of electricity per ton of incinerated waste. The energy generation scheme from solid waste is shown in Fig.3.

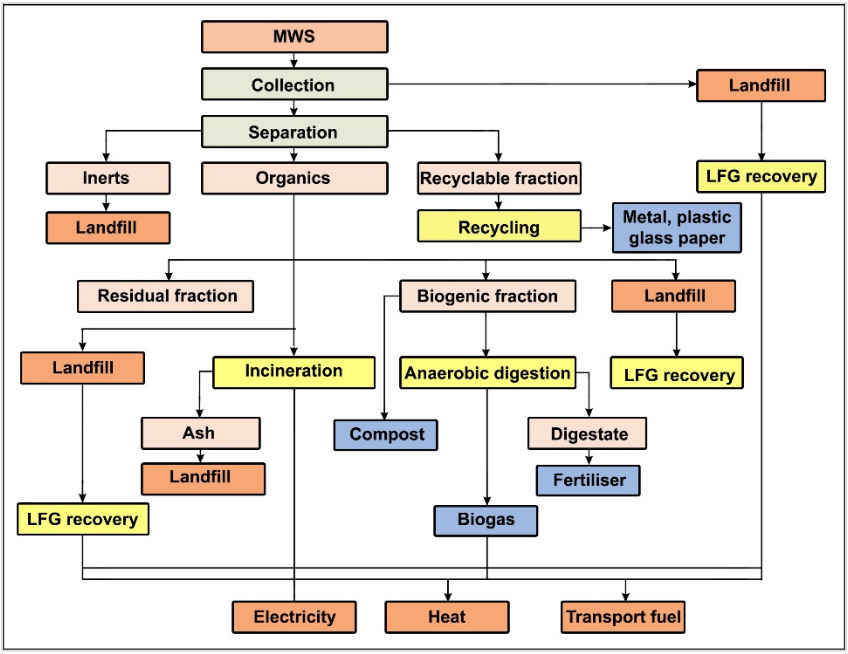

Figure.3. Energy generation from waste. Adapted from reference [3]

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When waste is deposited in landfills, the organic matter in the waste decomposes into Land Fill Gas (LFG). Complex chemical and biological decomposition processes occur that result in the production of landfill gas, a mixture of methane (45–60%), carbon dioxide (40–55%) and trace components [3]. LFG can be captured and used for energy generation or flared on-site to reduce greenhouse gas (GHG) emissions. The LFG collection is technically feasible a few years after landfill opening and can continue after landfill closure (typically 25 years). The recovery of methane from landfills is a low-cost and cost-effective technology that is currently applied in many developed countries and, in particular, in the EU and the US [3]. LFG is used as fuel in internal combustion engines, gas turbines and steam boilers for electricity or heat generation. LFG uses may include upgrading to methane gas quality. It can be suggested that in developed countries, the waste utilization strategy is related to reduced amount of waste, reuse, and recycling methods.

Solid waste utilization in Mongolia

The amount of solid waste generated in Mongolia has increased significantly from 0.3 to 3.3 million tons per year between 2008 and 2019 due to the change in urban lifestyles and consumption patterns. Although more than one half of the waste is recyclable, only 7% is reused or exported. In Mongolia, waste generation and utilization is regulated by various acts such as the Waste Law, adopted by the Mongolian Parliament on 12 May 2017; National Program for Improved Waste Management, adopted by the Government of Mongolia in 2015; Regulation of incentives to reduce and recycle waste, adopted by the Government of Mongolia in 2015; Green development strategic plan for Ulaanbaatar 2020; Sustainable development concept of Mongolia 2030 adopted on 5 February, 2016. According to these acts, various solid wastes in Mongolia are supposed to be used and treated in a similar manner as in the developed countries. Challenges to solid waste management in Mongolia are compounded by poor technologies, lack of infrastructure, equipment, and strategic planning for sustainable waste management. Unlike other countries, Ulaanbaatar city waste composition varies with season. Table 1 shows the annual composition of solid waste in Ulaanbaatar.

Table 1. Annual composition of solid waste in Ulaanbaatar in both winter and summer [4]

Waste type	Percent by weight	Waste type	Percent by weight
Food waste	15.7	Fabric and woven products	1.3
Glass	9.6	Metal	1.0
Bathroom waste	5.6	Tetra Pak cartons	0.8
Paper	5.3	E-waste	0.2
Bottles	3.6	Other	4.0
Plastic bags and packaging	3.0	Ash	48.2
Hard plastic (HDPE, LDPE, PVC etc.)	1.7		

The majority of waste from households in the Ger area during winter is ash, in contrast to apartment areas, where it is mainly food waste throughout the year. 26.5% of the total waste generated by the households in the vicinity of the Ger area is ash during summer, which increases significantly to 75.2% in winter [4]. 41% of the total summer waste generated by households in the apartment areas is food waste, which is relatively high compared to the 16% food waste generated by the households in the Ger area [4].

Another large amount of waste items that can be used in Mongolia and that have already been implemented with field experiments are plastic wastes. According to 2019 data, the amount of plastic waste in Mongolia has reached 198.7 thousand tons [5]. Approximately 80% of plastic waste include thermoplastics that soften after heating and can be remoulded [5].

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Thermoplastic pyrolysis of organic waste is a very promising utilization strategy in Mongolia. The products of pyrolysis of various organic materials such as coal, oil shale, wood waste, animal bone, cedar shell, polypropylene waste and milk case-in have been studied in Mongolia and have obtained very promising results [6].

Another large volume of waste released from the Ger district is mostly ashes in the winter season.

The number of households in Ulaanbaatar city is around 411.4 thousand, of which almost 55% live in the Ger area. 55% of all households in the Ulaanbaatar Ger area live in wooden or cement houses and 45% in the traditional Mongolian round felt dwellings called the Ger. Of these households, 93.5% use conventional stoves, 4.56% use low-pressure stoves, and only 2% of these households use electric heaters. Due to the lack of a centralized heating system, most residents of the Ger districts use stoves to heat and cook, which are fueled by burning coal briquettes. Unlike fly ash produced at the Thermal Power Station (TPS) by burning coal at about 1400° C, Ger district coal ashes are produced at temperatures of 600-700° C in the stoves. Therefore, the briquette ash shows higher activity than the fly ash from the TPS. The study results showed that the mineralogical and physicochemical characteristics of the briquette ashes depend on the stoves used. High-burning-rate stoves show a relatively low unburnt carbon content. According to weight loss, average particle size and density data, high-burning-rate and low-pressure stoves are more suitable for utilization as an adsorbent. The highest adsorption rate of methylene blue on the ashes of a low-pressure stove was 94.7%, while for Congo red it was 87.4%. The experimental results suggest that the low-pressure stove is more suitable for use by residents in the Ger district and the Ger district ash can be effectively used [7, 8]. However, it should be kept in mind that the use of briquette is not preferable in the Ger district as compared to a semi pyrolyzed coke, which has a high calorie and a low ash content. Although the issue of waste sorting has been consolidated in various legal acts adopted in Mongolia, little attention has been paid to the matter in the municipal solid waste utilization activity. Therefore, recyclable waste must be separated before transportation to dumping sites, and this would reduce the volume of transported garbage by 30-40%, thus lowering transportation costs and mitigating environmental pollution [9].

Municipal solid waste utilization strategy has received priority attention in the world, but in Mongolia this has not happened, because this type of waste is used for energy production either by incineration and electricity production or land fill gas (LFG) production. At the same time, direct electricity production by incineration has a good potential for utilization in the larger cities, whereas in smaller villages such as the Centre of Soum in the Mongolian countryside, LFG production clearly has a higher potential of utilization.

Another type of waste, such as hazardous waste, that must be given very high attention in Mongolia, are used car batteries. In the future, Mongolia should consider recycling batteries from hybrid cars such as the Japanese-made Prius cars, which is one of the most widely used vehicles in the country. According to 2020 data, from among the 600,000 cars registered in Ulaanbaatar more than 130,000 are hybrid “Prius” brand cars. However, until now there has been no attempt in Mongolia to utilize batteries from hybrid cars.

CONCLUSIONS

In order to fulfill Mongolia's long-term development policy, Mongolia must pay great attention to the utilization of various wastes. For this, the following measures should be taken:

- Educating citizens to use reusable cloth nets instead of single-use plastic nets;
- Promoting the production of energy through incineration of solid waste with advanced technology.
- Establishing small-scale facilities to produce LFG gas from organic waste in provincial areas and remote districts of larger cities;

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- Making primary waste sorting at the household level and placing special containers for its collection in large numbers at residential areas;

For utilization of hazardous waste, such as batteries from "Prius" hybrid cars it is important to promote direct foreign investment in the battery re-utilization factory and granting them most favorable legal tax holidays, as much as it is possible.

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