Problems with Biodegradable Wastes – Potential in Myanmar and Other Asian Countries for Combination of Drying and Waste Incineration

Maw Maw Tun and Dagmar Juchelková

1. An overview of waste management in Asian countries

Waste become a global issue [19] and If not properly dealt with [19], the waste generated from various human activities, both industrial and domestic, can result in health hazards and have a negative impact on the environment [2]. Nowadays, solid waste management in developing countries has a significant impact on environment and public health due to the improper waste services and treatment system. The consequences of doing little or even nothing to address waste management can be very costly to society and to the economy overall [19]. Currently, along with economic development, population growth, and rapid urbanization and industrialization, the most immediate environmental issues related to municipal solid waste (MSW) have accelerated the need for sustainable waste management in the developing countries.

1.1. Waste generation and collection efficiency

Per capita waste generation depends greatly on economic development of the country. While the countries with higher gross domestic product (GDP) have higher per capita waste generation, for example, Japan, Hong Kong, Singapore have above 1.5 kg per capita per day. Compared to other Asian countries, Myanmar still has lower per capita waste generation, with about 0.44 kg per capita per day because of low economic development (Figure 1). It is in the same situation with Nepal, India and Bangladesh.

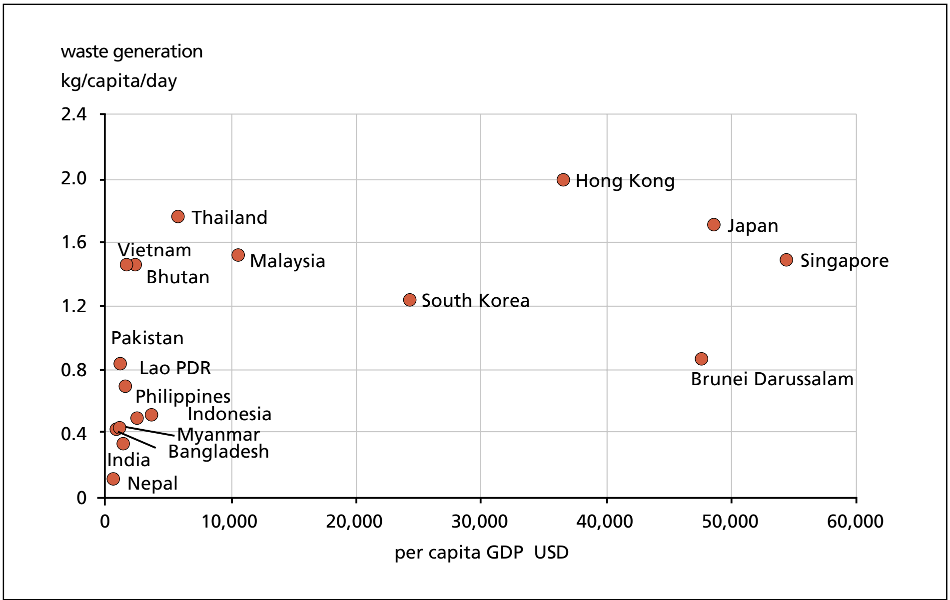

Figure 1: Comparison of per capita waste generation and GDP growth in selected Asian countries (2012)

Source: IMF Estimate, 2012; World Bank, 2012

There are various waste collection methods in the Asia developing countries. The methods may vary among the countries. Regarding the research studies [6, 10, 13], waste collection methods in Myanmar include door to door waste collection, bell ringing block collection to the household, collection of waste from the kerb site bins, collection at street dump yards, collection at temporary storage system and sweeping the wastes on the road.

According to the World Bank 2012 report, while low-income countries spend the majority of their MSW budgets on waste collection, high-income countries spend majorly on disposal. Currently, collection costs in low-income countries represent 80 to 90 % of MSW budget [5]. Waste fees are regulated by some local governments, but the fee collection system is inefficient [5]. Due to the inefficient fee collection system and insufficient budget on MSW management, low-income countries like Myanmar, Nepal, Lao PDR and Bangladesh had overall collection efficiency below 50 % (Figure 2). On the other hand, high income countries like Singapore, Japan and Hong Kong had the highest collection coverage, with 100 %.

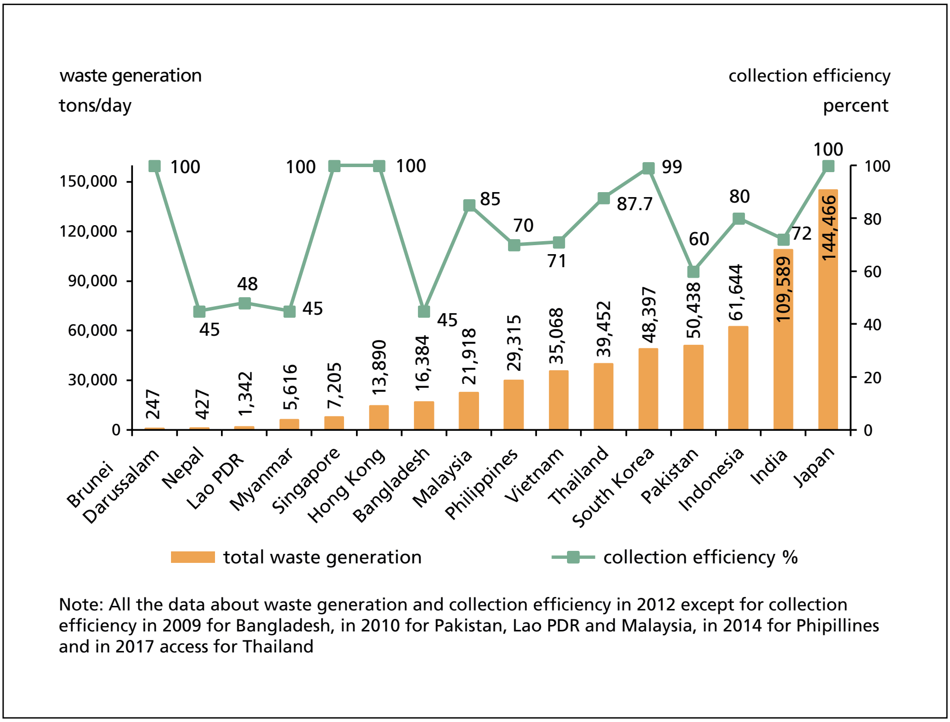

Figure 2: Comparison of waste generation and collection efficiency in selected Asian countries

Source: World Bank, 2012; Beck, 2017; Ejaz et al, 2010; Glawe et al., 2005; Jungrungrueng, 2017; Kaushal et al, 2012; Jungrungrueng, 2017; Sisoulath, 2010; Nguyen, 2006; Waste Concern; 2009

1.2. Waste composition

Figure 3 shows the comparison of waste composition among the countries of various income levels in the world. The consumption patterns, living standards and economic development categorically characterize waste composition and per capita waste generation. High-income countries had higher composition of paper with 24 % of MSW while low-income countries had a major percentage of organic fraction, being 53 % of MSW in 2015.

A comparison of waste composition and per capita GDP in Asian countries is shown in Figure 4. The composition of organic wastes in the low- and middle-income countries such as Nepal, Bangladesh, Cambodia, Myanmar, Pakistan, Thailand and Malaysia ranged from 41% to 80 %. The composition of organic wastes might vary country to country, depending on the economic development, geographical location, energy resources, climate, consumption patterns and living standards of a country. Since Myanmar was an agriculture-based country, the organic waste contributed 54 %, followed by plastic waste (16 %), paper (8 %), meatal (8 %), glass (7 %) and other (7 %). Myanmar's MSW largely originated from households (60 %), markets (15%), commercial producers (10 %), hotels (2 %), gardens (5 %) and others (8 %) [6].

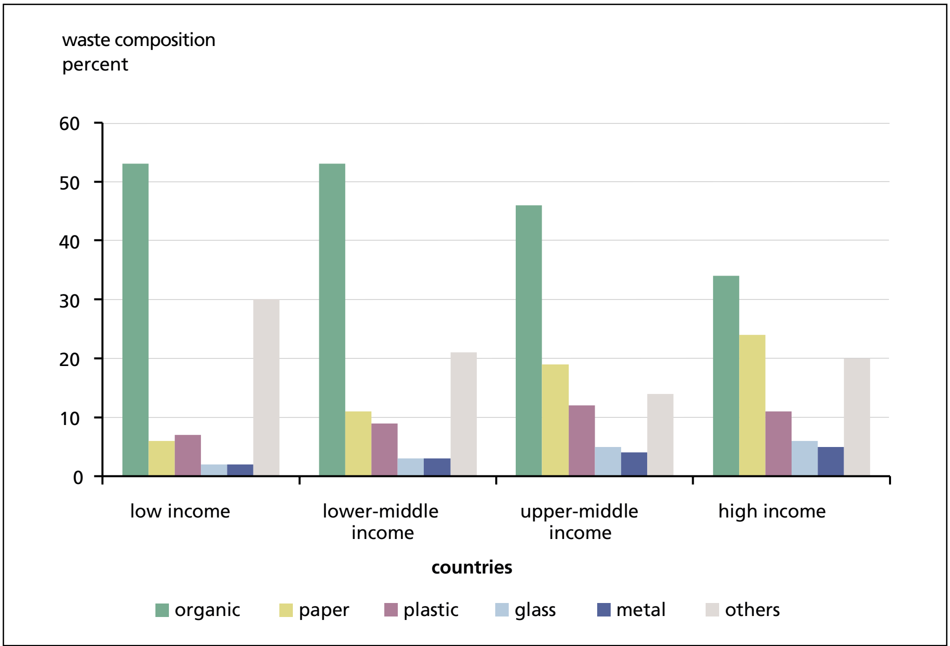

Figure 3: Comparison of waste composition around the world

Source: UNEP, 2015

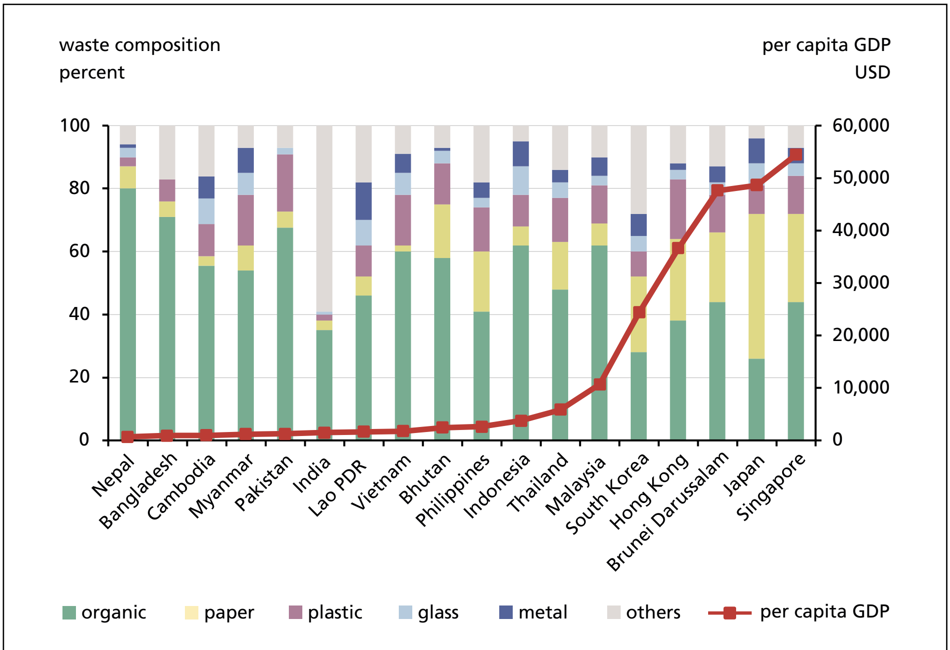

Figure 4: Comparison of waste composition and per capita GDP in Asian countries (2012)

Source: IMF Estimate, 2012; World Bank, 2012

1.3. Waste disposal methods

According to the World Bank 2012 [5], low-income countries have no organized program about source reduction, but reuse while in middle income countries, source reduction has not been well-developed yet. Informal sectors play a key role for recycling in these countries. Open dumping is also the major waste disposal methods [18]. Some small-scale composting projects at the community/neighborhood level have been successfully implemented despite being often unsuccessful for large composting plants due to contamination and operation costs [5]. As the examples of developing Asian countries, Philippine [7], Thailand [8], Indonesia [23] and Bangladesh [11] have successfully implemented composting facilities from their organic wastes to reduce waste disposal at landfills and open dumpsites.

Figure 5 describes MSW disposal methods of the selected Asian countries. Open dumping is majorly practiced in Myanmar, with a waste disposal rate of 80 % at open dumpsites, owing to lower economic development of the country. That situation was similar to other low-income Asian countries such as Lao PDR, Bangladesh, Cambodia and Vietnam. However, it is observed that most high-income countries like Japan, Taiwan and Singapore significantly have adopted waste to energy as their major waste treatment option.

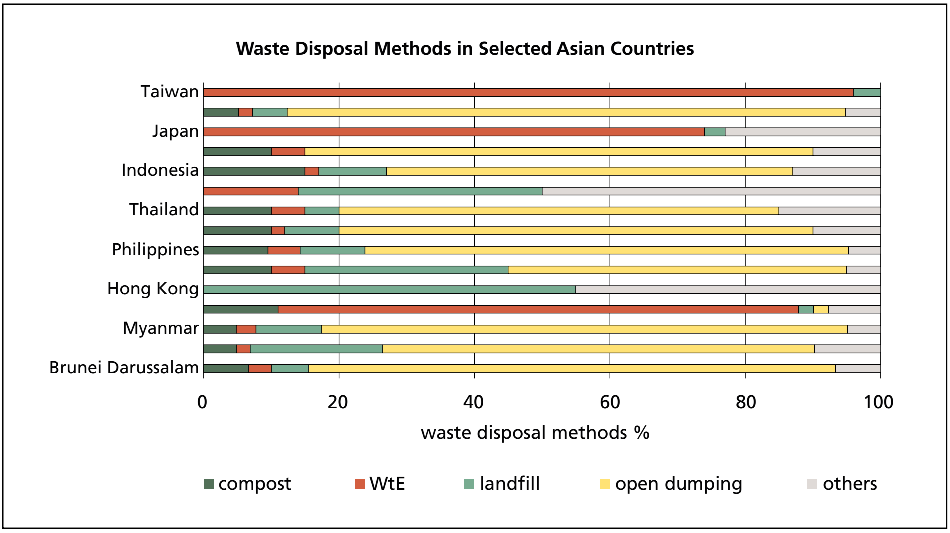

Figure 5: Waste disposal methods in selected Asian countries

Source: Chin et al., 2011; Ngoc and Schnitzer, 2009; Work Bank, 2012

2. Impact of MSW in Asian developing countries

The impact of MSW in Asian developing countries has increasingly affect the public health, environment and resource and energy recovery due to the insufficient waste collection service and improper waste disposal methods. Waste disposal at illegal dumpsites is a cause of spreading diseases by germs, rats, mosquitos and other insets around the environment and polluting the water in the rivers and ground water. These negative impacts affect the health of the residents and waste workers. The children are the most vulnerable with the unhygienic environment [1]. In addition, the uncontrolled burning of waste creates particulate and persistent organic pollutant emissions to the atmosphere [19]. Therefore, uncontrolled burning and illegal waste disposal at the nearby streams, rivers, illegal dumpsites and uncontrolled landfills could negatively affect the environment, leading to land pollution, air pollution and water pollution.

3. Current problems with biodegradable wastes in Asian developing countries

MSW in developing countries is mainly composed of organic waste which is about over 50 %. Due to the high organic composition in their MSW, thermal waste treatment for energy recovery is not suitable without additional fuel supply in these countries. This high moisture content of MSW could lower the recovery of recoverable material and increase the operating cost of combustion [21]. Owing to the high moisture content inside their MSW and high investment costs of waste-to-energy technologies, the developing countries use open dumping and landfilling for their major waste disposal methods. However, waste disposal at open dumpsites and landfills could negatively affect the environment due to the greenhouse gas emission generated from anaerobic digestion of biodegradable organic wastes to the atmosphere and landfill leachate impact on the ground water. Further, booming economy, growing population and rapid urbanization and industrialization in the developing countries have accelerated MSW generation rates, which may potentially encounter the scarce land area for waste disposal at open dumpsites and landfills.

4. Contribution of MSW composition in Asian developing countries

As the typical composition of MSW, as stated by Tchobanoglous and Kreith [17], the combustibles contribute 50.89 %, while moisture and non-combustibles contributes 27.45 % and 21.57 % respectively. However, in the developing countries, the moisture content in composition of municipal solid wastes could be higher than 27.45 % because the major contribution of organic fraction in the MSW composition in developing countries is approximately over 50 %. By physical composition analysis, it is estimated that the composition of MSW in developing countries might range approximately 40-41 % moisture, 25-31 % non-combustibles and 28-35 % combustibles (Figure 6). The calorific values of the MSW of Asian countries are estimated at 6.4-9.8MJ per kg in India [12], 5.163-6.121 MJ per kg in Thailand [9], 5.52-9.37 MJ per kg in Lao PDR [15] and 5.82-10.11 MJ per kg in Malaysia [4], 5.37-13.509 MJ per kg in China [22] and 11.0–12.2 MJ/kg in South Korea [20] respectively.

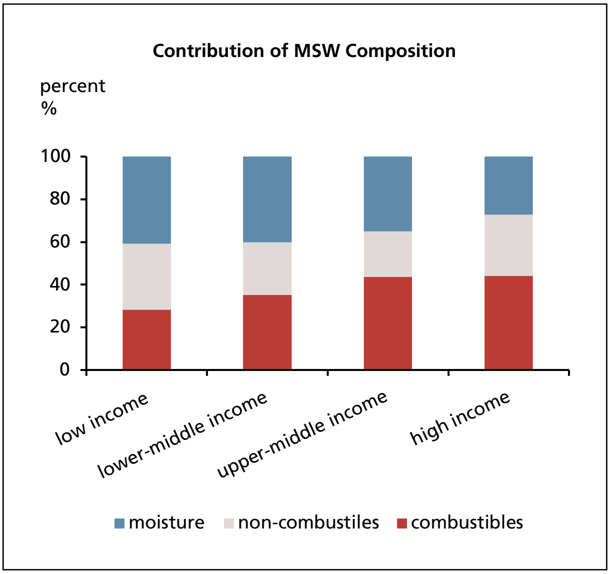

Figure 6:

Contribution of MSW composition (2015)

5. Possible solutions to the problems of biodegradable wastes

There are several possible methods for managing biodegradable wastes for fuel, waste to energy and resource for agricultural purposes in the Asian developing countries. Among them, the following are found as the most suitable:

- Composting
- Anaerobic Digestion
- Bio-drying and Bio-stabilization
- Landfills with landfill gas recovery system

Moreover, despite the high capital cost and operational and maintenance costs, waste incineration for waste-to-energy is also a possibility if the waste quality can be improved for higher heating value and lower moisture content. Drying of biodegradable wastes might be a possible potential method to improve the waste quality for waste incineration. The reason for exploring the possibilities and opportunities of waste incineration is because of that waste incineration plants have been advantageous not only for high reduction in mass and volumes of initial wastes but also energy recovery and reduction of land use for landfills. Despite being a greenhouse gas (GHG) emitter, MSW incineration can be considered as a net GHG reducer, if GHG reductions, achieved by accounting for waste-to-energy, exceed GHG emissions [16]. When incinerated, the waste is reduced by 80-85 % by weight and by 95-96 % by volume [14]. Hence, drying of biodegradable wastes and other unseparated combusted wastes before waste incineration could be a potential to improve the efficiency of waste to energy plants and reduce the use of landfills.

6. Potential for combination of drying and waste incineration

Waste incineration for waste to energy is not still common in developing countries, and generally not successful or experience financial and operational difficulties because of high capital costs, high moisture content and high percentage of inert [5]. On the other hand, waste incineration could offer a comparative reduction of weight and volume by 80-85 % and 95-96 % respectively [14]. When considering a waste-to-energy option, if the composition of MSW exceeds 50 % of organic wastes and 15 % of inert waste [3] or if its energy content is less than 2.326 MJ/kg [17], thermal waste treatment is not applicable. As a result, the overall efficiency of waste incineration plants depends on the waste quality with lower moisture content and higher heating values.

Nowadays, energy-oriented conversion technologies from wastes to fuel have gained attraction in the world cities to reduce dependency on fossil fuel and land use for waste disposal and to ensure economic and environmental benefits. Various Dryers such as bio-drying equipment, solar dryer, green house dryer, thermal dryers are currently being used for engineering applications such as refuse-derived fuel drying, sludge dewatering and volume reduction of bulk wastes and safer disposal of organic wastes at landfill sites. By optimizing MSW quality by different drying methods, the initial volume and weight of bulk wastes can be substantially reduced with a reasonable increase in heating values due to the significant removal of moisture inside the bulk wastes. Besides, dried waste materials may offer several benefits such as the easier recovery of recyclable materials, easier transportation, reduction of disposal costs, reduction of dependency on fossil fuels, reduction of waste odor, reduction of use of landfill sites, reduction of GHG emission and leachate from landfills and mitigation of global warming by reducing greenhouse gas emission. Hence, drying of MSW for waste to fuel or safer disposal at landfill could be a good potential to ensure economic and environmental benefits in the future.

In the world countries whose MSW consists of higher organic wastes, it could be more effective to use accessible drying methods for optimization of MSW quality for the purpose of waste fuel. Currently, drying of sludge or sewage sludge has been already applied in industrial scale but various research experiments of drying MSW are still in the lab and pilot scale, leading to an industrial/large scale. Therefore, in the future, it could be seen that drying of MSW for waste to fuel or safer disposal at landfill is a good potential to reduce dependency on fossil fuel and land use for waste disposal and to ensure economic and environmental benefits. It is suggested that the research and development of appropriate drying technologies from a laboratory and pilot scale to an industrial scale could be conducted with the accessible energy supply from renewable energy such as solar energy and from the other source that minimally affects the environment such as waste heat. In addition, more research on costs of drying for waste fuel of incineration plants could be conducted, regarding the locally available energy supply, the different seasonal waste composition and moisture contents of MSW in the developing countries.

7. Conclusion

Due to the high organic fraction in MSW of the Asian developing countries, thermal waste treatment is currently not applicable. However, energy-oriented conversion technologies from wastes to fuel have gained attraction in the world cities to reduce dependency on fossil fuel and land use for waste disposal and to ensure economic and environmental benefits. By optimizing MSW quality by different drying methods, the initial volume and weight of bulk wastes could be substantially reduced with a reasonable increase in heating values because of the significant removal of moisture inside the bulk wastes. The improvement of solid waste quality could potentially lead waste to fuel for waste incineration. Therefore, a sustainable waste disposal approach to MSW management in the developing may be taken through the development and improvement of appropriate drying technologies from a pilot and laboratory scale to an industrial scale, being based on accessible energy supply from renewable energy and from the other source that minimally affects the environment in the future.

8. References

[1] Africa, P. S.; Solid Waste Management in the World's Cities. Solid Waste Management in the World's Cities: Water and Sanitation in the World's Cities, p. 26. 2010.

[2] Asian Productivity Organisation, Solid waste management, issues and challenges in Asia. AP Organisation, Tokyo Google Scholar, 2007

[3] Collaborative Working Group, Solid Waste Management in Low- and Middle-income Countries, Waste to Energy Rapid Assessment Tool, 2016.

[4] Hassan, M. N.; et al. In: Solid waste management in Southeast Asian countries with special attention to Malaysia. Proceedings Sardinia, 8th International Waste Management and Landfill Symposium, Italy. 2001.

[5] Hoornweg, D. and Bhada-Tata, P. In: What a waste: a global review of solid waste management. Urban development series knowledge papers, 15, 2012. pp. 1-98

[6] Institute for Global Environmental Strategies (IGES) (2014). Commission Report: Supporting low-carbon Yangon city through Joint Crediting Mechanism (JCM) project formulation, March 2014.

[7] Institute for Global Environmental Strategies (IGES), Replications in Other Cities and Countries: Replication in the Philippines. 2009. https://kitakyushu.iges.or.jp/publication/Takakura/11%20 Philippines.pdf. (accessed 19 December 2017)

[8] Institute for Global Environmental Strategies (IGES), Replications in Other Cities and Countries: Replication in Thailand. 2009. https://kitakyushu.iges.or.jp/publication/Takakura/12%20 Thailand.pdf. (accessed 19 December 2017)

[9] Kaosol, T. In: Sustainable solutions for municipal solid waste management in Thailand. World Acad Sci Eng Technol, 2009, pp. 60, 665-670.

[10] Menikpura, N. Sustainable Consumption and Production (SCP) Group Institute for Global Environmental Strategies (IGES). Integrated Solid Waste Management: Towards Low-carbon Waste Management in Yangon – Myanmar. International workshop on sustainable waste management in Yangon, 2013.

[11] Menon, M. H.; In: Solid waste management in Dhaka Bangladesh, Innovation in community driven composting. Analysis of community based initiative for solid waste management, 2002.

[12] Nandan, Abhishek; Bikarama Prasad Yadav; Soumyadeep Baksi; and Debajyoti Bose. In: Recent Scenario of Solid Waste Management in India. World Scientific News 66 (2017): 56-74.

[13] Premakumara, D.G.J. and Hengesbaugh, M. Quick. In: Study on Waste Management in Myanmar: Current Situation and Key Challenges, 2016

[14] RenoSam and Rambøll. In: The most efficient waste management system in Europe: Waste-to-energy in Denmark, published by RenoSam Vesterbrogade 24, 2. sal tv. DK-1620 Copenhagen V. 2006. https://stateofgreen.com/files/download/275. (accessed 14 March 2017).

[15] Sisoulath, Solid Waste Management in Lao PDR, Second Meeting of the Regional 3R Forum in Asia Kuala Lumpur, Malaysia 4-6 October 2010.

[16] Tabata, Tomohiro. In: Waste-to-energy incineration plants as greenhouse gas reducers: A case study of seven Japanese metropolises. Waste Management & Research 31, no. 11, 2013, pp. 1110-1117.

[17] Tchobanoglous, G. and Kreith, F. In: Handbook of solid waste management. Second Edition. McGraw-Hill, 2002.

[18] United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 2017. Introduction Types of Wastes. www.unescap.org/sites/default/files/CH08.PDF. (accessed 27 March 2017)

[19] Wilson, David Curran; Ljiljana Rodic; Prasad Modak, Reka Soos; A. Carpintero; K. Velis; Mona Iyer; and Otto Simonett. Global waste management outlook. UNEP, 2015.

[20] Yi, Sora, Kee-Young Yoo, and Keisuke Hanaki. In: Characteristics of MSW and heat energy recovery between residential and commercial areas in Seoul. Waste management 31, no. 3, 2011, pp. 595-602.

[21] Yuan, Jing; Difang Zhang; Yun Li; David Chadwick; Guoxue Li; Yu Li; and Longlong Du. In: Effects of adding bulking agents on biostabilization and drying of municipal solid waste. Waste Management 62, 2017, pp. 52-60.

[22] Zhou, H.; Meng, A.; Long, Y.; Li, Q.; & Zhang, Y. In: An overview of characteristics of municipal solid waste fuel in China: physical, chemical composition and heating value. Renewable and Sustainable Energy Reviews, 2009, pp. 36, 107-122.

[23] Zurbrügg, Christian; Margareth Gfrerer; Henki Ashadi; Werner Brenner; and David Küper. In: Determinants of sustainability in solid waste management–The Gianyar Waste Recovery Project in Indonesia. Waste management 32, no. 11, 2012, pp. 2126-2133.

Contact Person

Maw Maw Tun, M.Sc.
Technical University of Ostrava (VŠB-TUO)
Department of Energy Engineering
17. Listopadu 15
708 33 Ostrava
CZECH REPUBLIC
Phone: 0042 - 077 328 74 87
Email: maw.maw.tun.st@vsb.cz

Bibliografische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.dnb.de abrufbar

Thiel, S.; Thomé-Kozmiensky, E.; Winter, F.; Juchelková, D. (Eds.):

Waste Management, Volume 8
– Waste-to-Energy –

ISBN 978-3-944310-42-8 Thomé-Kozmiensky Verlag GmbH

Publisher:	Thomé-Kozmiensky Verlag GmbH • Neuruppin 2018
Editorial office:	Dr.-Ing. Stephanie Thiel, Dr.-Ing. Olaf Holm, Elisabeth Thomé-Kozmiensky, M.Sc.
Layout:	Janin Burbott-Seidel, Ginette Teske, Roland Richter, Cordula Müller, Sarah Pietsch, Gabi Spiegel, Lena Bischkopf
Printing:	Universal Medien GmbH, Munich