China's Green Economy: Corporate Acquisitions and Political Strategy

Karl-Heinz Müller and Peter Werz

1. Environmental conditions in China

1.1. Growth and development of urban centres

In the years since Deng Xiaoping's policy of reform and opening was introduced in 1978, the People's Republic of China has undergone an unparalleled transformation. In just a few decades, China has developed from a centrally planned economy with relatively low GDP into a global economic superpower. Even though the growth rates of recent years – 7 % in 2015 and 8 % in 2016 – have tapered off slightly, the long-term trend curve showing the absolute change in gross domestic product continues to point upward to this day.

Along with this economic development, the country is undergoing an unprecedented process of urbanization that amounts to a staggering mass migration. In 1996, 373 million Chinese, or around 30 % of the population, lived in cities. By 2016, the urban population had soared to around 793 million [4]. According to the most recent statistics, 57 % of the population, or more than one in two Chinese citizens, lives in cities. The influx of around 420 million people into China's urban centres over the past two decades means that Chinese cities have gained an average of about 21 million residents annually during this period.

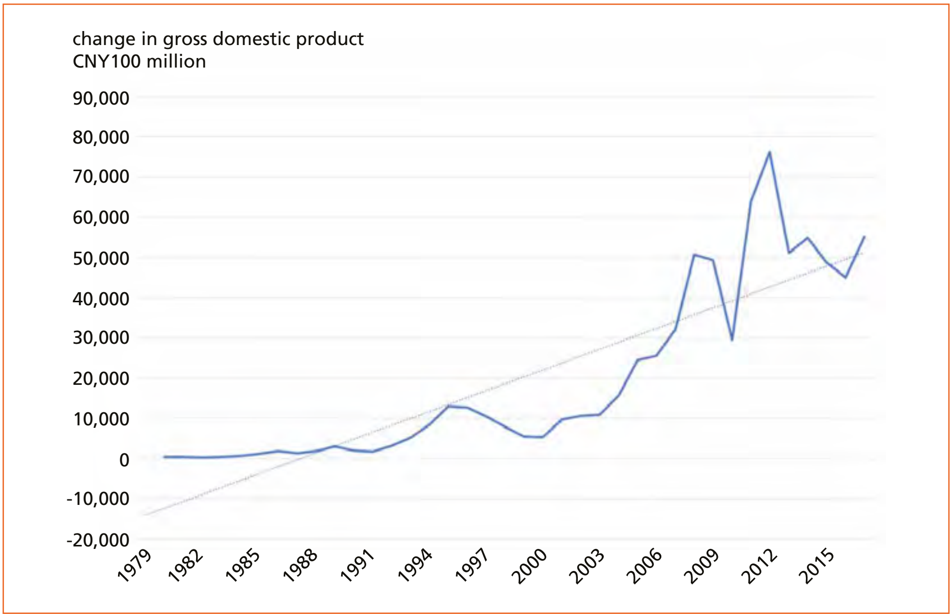

Figure 1: Change in gross domestic product in China in comparison to previous year

Source: National Bureau of Statistics of China. (2017). Population and its Composition. Retrieved 06. 06., 2018, from China Statistical Yearbook 2017: http://www.stats.gov.cn/tjsj/ndsj/2017/indexeh.htm

1.2. Lack of waste management infrastructure

Any country in the world would feel the impact of such an inflow of people on its urban infrastructure – especially in waste management. In China, the situation was even more difficult because the waste management sector was insufficiently developed even before roughly half a billion people moved to the cities, as Figure 2 shows. This migration thus further intensified the existing pressure in urban centres.

Figure 2 clearly shows the discrepancy between the volumes of waste collected and transported, on the one hand, and the volume of waste that was managed more or less professionally, on the other. In the years 2004 to 2006, for example, the volumes collected by Chinese waste transporters were roughly twice as high as the total waste management capacity. If managed at all, household waste was generally sent to landfill, which is where around 68 million tonnes ended up in 2004. Only 4.5 million tonnes were thermally treated. The majority of waste collected – more than 74 million tonnes in 2004 – was likely dumped in unsecured tips without undergoing any treatment at all or *disappeared* mysteriously.

There is no doubt that dealing with waste in this way eventually proves enormously hazardous to the environment and thus also to human health. A study published a few months ago found that marine plastic litter, a topic extensively covered by the media worldwide, largely results from plastic waste debris being carried by rivers to the sea.

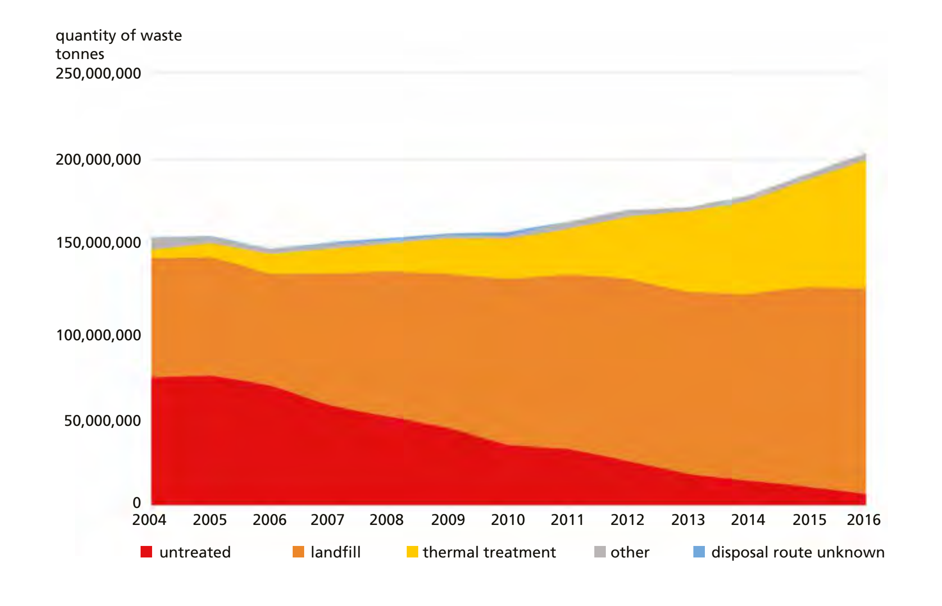

Figure 2: Waste collection and management in China 2004 to 2016

Source: National Bureau of Statistics of China. (2005-2017). Statistical Yearbook 2005 - 2017. Retrieved 06.06.2018, from http://www.stats.gov.cn/english/statisticaldata/annualdata/

Some 88 to 94 % of this plastic waste can be traced back to the ten rivers with the most plastic debris [8]. The plastic concentration in these rivers is up to 50 times higher than in the oceans – with all the associated consequences for water quality, human health and marine life. Halving the plastic debris in these ten rivers could reduce the volume of plastic entering the oceans by 45 % , the scientists conclude in their study [8]. Five of these highly contaminated rivers are located in China, or flow at least partially through Chinese territory, such as the Mekong [9].

Besides plastic, sewage sludge is another contaminant found in China's waters: More than 22 million tonnes of sewage sludge are produced each year in China. In 2013, 80 % of these volumes ended up in landfills without any treatment [3]. The poisonous substances contained in the sewage sludge leach out of the landfill bodies when it rains and then end up in Chinese rivers and water bodies. In the North China Plain, a study by the Ministry of Land and Resources found that 70 % of groundwater reserves were *unfit for human touch* as a result of high pollutant contamination [1]. There are other estimates that 80 % of Chinese drinking water reserves are contaminated [5]. At the same time, China has relatively limited drinking water reserves compared to the rest of the world.

Although the Chinese government has been working on improving waste management since the 11th Five-Year Plan (2006-2010) [5] and statistics since then show a steady and considerable improvement in this area, the Chinese government was well advised to tackle environmental pollution with another large-scale investment program in 2014.

Beijing announced that between 2015 and 2020 it planned to spend around 40 billion USD on waste management upgrades [2], including the construction of 300 new energy from waste (EfW) plants. The target is for 65 % of household waste to be thermally treated with energy recovery in the future [10]. Especially in the economically developed regions and large cities, thermal recovery is tapped as the primary technology for treating household waste. By contrast, China wants to reduce the landfilling of untreated waste [5].

1.3. Growing demand for energy

China's economic ascent and growing urbanisation are not only causing problems in the waste management sector. Energy consumption has been rising continuously for years and has more than tripled since the mid-1990s [4].

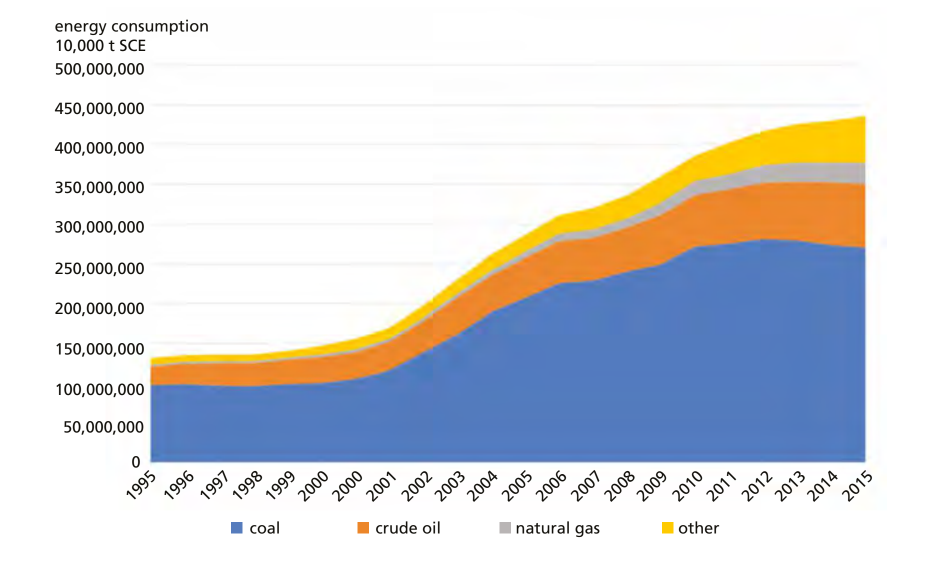

Figure 3: Energy consumption and fuels in China 1995 to 2016

Source: National Bureau of Statistics of China. (2017). Population and its Composition. Retrieved 06. 06., 2018, from China Statistical Yearbook 2017: http://www.stats.gov.cn/tjsj/ndsj/2017/indexeh.htm

Despite all the positive reports about the growing use of renewable energy in China, coal remains the country's dominant energy source. In 2016, coal accounted for approximately 62 % of the energy consumed. This share has been steadily falling since 2011, when coal-fired electricity still accounted for around 70 % of the energy consumed in China. However, the overall increase in energy consumption means that coal-based energy generation also continues to rise. While China burned around 3.9 billion tonnes of standard coal equivalent (SCE) to generate energy in 2011, by 2016 this figure had risen to around 4.4 billion tonnes of SCE. To meet its own energy demand, China must increasingly rely on coal imports. From 577 million tonnes of SCE purchased from abroad in 2010, imports reached 775 million tonnes by 2015 [4].

The burning of coal to generate energy is one of the main contributors to air pollution in China. A study by scientists at the research institute Berkeley Earth found that around 90 % of sulphur dioxide (SO_2) emissions in China resulted from coal-fired electricity generation [7]. SO_2 pollution in many regions is 10 to 17 times higher than the level recommended by the World Health Organisation (WHO) [5]. Furthermore, China's population is increasingly exposed to emissions of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen oxides (NO_x) and carbon monoxide (CO). The weighted average of particulate matter with a particle size of $PM_{2.5}$ is 52 µg/m³, five times higher than the WHO threshold [5]. In many parts of China, the air quality is so alarming that around 92 % of the population is exposed to unhealthy air more than 120 days of the year. On a sustained basis, 38 % of the population is breathing air with average pollutant concentrations that are considered unhealthy. The researchers at Berkeley Earth estimate that around 17 % of all deaths in China are attributable to air pollution [7].

2. Energy from waste as a problem solver

China has made great strides in waste management over the past two decades: The volumes dumped in waste tips have been significantly reduced and numerous EfW plants have started operations. The impact of the steps taken by the Chinese government is clearly visible in the statistics. This deserves respect and recognition. Nevertheless, China has a long way to go before the infrastructure for a truly sustainable waste management system is established. Because despite all the successes, China's annual waste volumes – especially in the cities – are growing so rapidly that the construction of additional EfW plants is barely keeping up. This explains not only why new landfills are opening up each year, but also why the volume of landfilled household waste also continues to grow. In 2016, 203 million tonnes of household waste were collected, of which nearly 119 million tonnes were sent to landfill. One year prior to that, collections totalled 191 million tonnes and landfilled volumes stood at 115 million tonnes. In 2014, of the 179 million tonnes collected, 107 million tonnes were landfilled. So far, this steady upward trend in waste volumes shows no signs of stopping.

A few years ago, the Chinese government made what we consider the right decision to step up thermal recovery of household waste. After all, it is absurd that an energy-hungry country like China sends massive amounts of waste to landfill, thereby also polluting the environment, instead of using the waste as a fuel to generate energy via clean combustion. Of course, thermal waste recovery cannot meet all of China's energy demand. But it can be deployed in certain circumstances to solve both waste management and energy supply issues at the same time. In the coastal megacities in particular, EfW plants can safely treat the arisings of household and commercial waste while producing electricity and heat through combined heat and power (CHP) technology. The resulting electricity can be fed into the public grid and thus help to supply the metropolitan regions. The heat can either be supplied to industrial plants in the form of steam or used to provide district heating for residents. This is certainly a better alternative than waste piling up at ever-growing landfills on the outskirts of the megacities.

It is also clear, however, that thermal waste recovery is only a clean option if the plant has up-to-date technology and the operator is proficient in using this technology. Otherwise, in the worst-case scenario, pollutants and heavy metals are simply blown into the air and spread around the environment. Only thermal waste treatment plants fitted out with modern technology can act as true pollutant sinks. After all, the technology must be up-to-date to ensure that the temperatures in the combustion chamber are high enough to actually destroy the organic pollutants contained in the waste. Furthermore, modern flue gas cleaning is necessary in order to separate heavy metals, such as mercury, and capture them as flue gas dust to be sent for appropriate disposal. When carried out this way, thermal waste recovery is a clean operation that can also improve air quality, particularly in Chinese cities, especially when it is used as a substitute for coal-fired energy. However, this also requires accurate monitoring and publication of emissions data, which is sometimes questionable at existing Chinese plants.

However, it is not enough to simply build new EfW plants. It is equally important that these plants are operated efficiently to ensure high plant availability. Plant availability is essential to providing sufficient waste management capacity and securing energy supplies while maintaining the maximum standard of environmental protection. As of 2016, official statistics showed that around 74 million tonnes of the roughly 204 million tonnes of household waste collected were sent for thermal treatment. This equates to a share of approximately 36 %. According to the official figures from the Chinese statistics authority, however, the country's plants have a total incineration capacity of around 93 million tonnes.

There are various possible explanations for why there is such a gap between the technically feasible throughput and the actual volume incinerated. One such explanation is that there might not be sufficient waste available on the market for thermal treatment. This is certainly not the case in China. Another possibility is that plant availability does not correspond to the technological capacity. This would mean there is potential for significant efficiency improvements in plant operations. A further issue that could be contributing to the difference is the treatment of leachate. In Chinese plants, leachate is pumped out of the bunkers, which also could lead to the gap between the delivered and thermally recovered volumes. Nevertheless, assuming thermally recovered volumes of around 74 million tonnes of household waste in comparison to the installed incineration capacity of 93 million tonnes, this would mean the average plant availability across the country was 79 %[1]. Plant availability in thermal treatment facilities would thus be lower than the capacity utilisation rate across all waste management facilities, which stands at around 86 % [5].

If plant availability in the thermal waste treatment segment could be increased by around 11 percentage points to 90 %, the existing installations could theoretically thermally recover more than 10 million additional tonnes of household waste.

[1] However, it is not clear whether other waste, i.e. waste not considered consumption or household waste, such as industrial waste, is thermally treated in the installed plants and if so, how large the volumes of other waste are. The statistics – similarly to those in Europe – do not provide any information on this. The statistics for industrial waste, which totalled around 3.1 billion tonnes in 2016, only differentiate between waste *comprehensively utilised*, disposed of and *stock* waste [4].

To sum up, three things are necessary: for sustainable energy from waste in China: First, the best available environmental technology in order to keep pollutant emissions as low as possible. Second, maximum energy yields in order to substitute as much coal as possible with thermal waste recovery. And third, the highest possible plant availability in order to get the maximum performance from the plants to provide waste management capacity and secure energy supplies.

3. Beihai project

To achieve exactly that, In one example of a sustainable EfW project, Beijing Enterprises Holdings Limited (BEHL), in cooperation with its German subsidiary EEW, is constructing a thermal waste recovery plant designed to European standards in the city of Beihai in southern China. The flue gas cleaning results as well as the environmental standards, energy efficiency and plant availability will be comparable to those found at any state-of-the-art EfW plant in Europe. The partners are also utilising global cutting-edge technology for the grate firing system.

The city of Beihai offers ideal conditions for this lighthouse project: With around 1.5 million residents in 2015, Beihai's population size is similar to large European cities. Furthermore, the plant can be built on a former landfill site near the city, so there are nearby potential buyers for the heat generated. The estimated investment for the project is around 625 million CNY, equivalent to about 80 million EUR.

Figure 4:

Lighthouse project in Beihai: A thermal waste recovery plant built to European standards

In this project, EEW's responsibilities will include certain issues related to the technical design of the plant. Specialists from Germany will, among other things, create a technical plan and define the performance requirements for the main equipment. The original plans for Beihai foresaw a three-line EfW plant with a capacity of around 1,400 tonnes per day. After the intervention of our experts, however, the project will now be implemented with two combustion lines. Each line has a throughput of 700 tonnes per day. After an approximately 24-month building phase, the plant will have a total annual throughput of around 450,000 tonnes.

Furthermore, it has been agreed that our technicians will work on the commissioning as well as preliminary operations in addition to training the future staff on the set-up and operation of the plant. The lack of qualified staff is currently one of the greatest challenges in the waste management sector in China [5].

One particular challenge for this project is the composition of the waste. Household waste in Beihai has an average water content of 50 %. This is slightly lower than the average for residual waste in China, which contains around 60 % water [6]. In Germany, by contrast, water makes up only approximately 30 % of mixed municipal waste. The high water content is a consequence of the relatively large share of biogenic waste contained in household waste. On average, kitchen scraps make up around 60 % of household waste in China [6]. This results in very low calorific values. In Beihai, the composition of the organic component also varies greatly depending on the season, which creates significant fluctuations in the calorific value of the household waste: According to our measurements, the calorific value in Beihai ranges between 4.19 MJ/kg and 8.37 MJ/kg. Because of these variations, fuel conditioning is necessary prior to thermal treatment [6]. For the future plant operations, our planning anticipates a calorific value averaging 6.9 MJ/kg. It is quite obvious that these are not perfect conditions for plant operations, since calorific values of below 9 MJ/kg are a technical challenge for any plant operator. Nevertheless, even low calorific values can be manageable with the right plant design.

In addition to the high water content and the high share of organics, waste from street cleaning also includes a lot of sediment. Commercial waste, on the other hand, contains a large amount of packaging material. Overall, though, waste in China generally has low calorific values. But we are convinced that we can overcome these challenges and guarantee the plant availability we typically achieve at EEW for this plant in Beihai as well. For us, this means that the performance period should not be less than 8,000 hours per year.

Our project in Beihai is a positive example of how the acquisition of a German company by a Chinese investor can support China's policy objectives of improving the environmental situation in the country. German know-how – not only in plant technology, but also in operations and plant management – can help make China's waste management more efficient. Not only can this contribute to a more sustainable way of doing business in China itself, in the medium to long term it can also protect globally connected ecosystems from further pollution caused by inappropriate waste disposal. Ultimately, this will also benefit us in Europe as well.

4. References

[1] Chinawater Risk. (2013, 02. 26.). North China Plain Groundwater: >70 % Unfit for Human Touch. Retrieved 06. 06., 2018, from Chinawater Risk: http://chinawaterrisk.org/notices/north-china-plain-groundwater-70-unfit-for-human-touch/

[2] GTAI. (2018, 01. 30.). Branche kompakt: China will bis 2020 über 38 Milliarden US-Dollar in die Abfallwirtschaft investieren. Retrieved 06. 08., 2018, from Germany Trade & Invest: http://bit.ly/2sSQhzW

[3] Harper, M. (2013, 09. 04.). The Money in Sludge. Retrieved 06. 06., 2018, from Chinawater Risk: http://chinawaterrisk.org/resources/analysis-reviews/the-money-in-sludg/

[4] National Bureau of Statistics of China. (2017). Population and its Composition. Retrieved 06. 06., 2018, from China Statistical Yearbook 2017: http://www.stats.gov.cn/tjsj/ndsj/2017/indexeh.htm

[5] Nelles, M., Morscheck, G., & Nassour, A. (2016). Abfallwirtschaft in der V.R. China - Stand und Perspektiven. Beitrag im Rahmen des RETech-Workshop, 30.11.2016 am BMUB in Berlin. Berlin.

[6] Nelles, M., Nassour, A., El Naas, A., & al., e. (2017). Verwertung von biogenen Fraktionen aus Siedlungsabfällen in der VR China. Rostock.

[7] Rohde, R. A., & Muller, R. A. (2015, 07. 09.). Air Pollution in China: Mapping of Concentrations and Sources. Retrieved 06. 10., 2018, from Berkeley Earth: http://bit.ly/2xXqFYx

[8] Schmidt, C., Krauth, T., & Wagner, S. (2017, 11. 10.). Export of Plastic Debris by Rivers into the Sea. Environ. Sci. Technol., 2017, 51 (21), S. 12246–12253, DOI: 10.1021/acs.est.7b02368, p. 12.251.

[9] Schmidt, C., Krauth, T., & Wagner, S. (2017a, 08. 17.). Export of plastic debris by rivers into the sea. Supporting Information. Retrieved 06. 07., 2018, from American Chemical Society: http://bit.ly/2sOXf9b

[10] trAIDe GmbH. (2015, 05. 27.). Zielmarktanalyse VR China 2015. Branche: Umwelttechnologien. Hrsg. v. Bundesministerium für Wirtschaft und Energie. Retrieved 06. 07., 2018, from ixpos. Das Außenwirtschaftsportal: http://bit.ly/2sH9lCd

Contact Persons

Dipl.-Phys. Karl-Heinz Müller
EEW Energy from Waste GmbH
Chief Operating Officer
Member of the Management Board
Schöninger Str. 2 – 3
38350 Helmstedt
GERMANY
Phone: 0049 - 0 53 51 18 22 77
Email: karl-heinz.mueller@eew-energyfromwaste.com

Peter Werz
EEW Energy from Waste GmbH
Head Marketing and Communications
Schöninger Str. 2 – 3
38350 Helmstedt
GERMANY
Phone: 0049 - 0 53 51 18 22 34
Email: peter.werz@eew-energyfromwaste.com

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