Plastics Recycling and Energy Recovery Activities in Poland
– Current Status and Development Prospects –

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1. Waste management in Poland – changes in waste law

The waste disposal system in Poland is one of the least advanced in Europe.

Despite great efforts over the last 20 years municipal waste landfilling has only reduced from 95 percent in 1991 to 73 percent in 2010. This still means that millions of tonnes of post-consumer waste continue to be landfilled.

Poland generates yearly between 10 and 11.5 Mt (million tonnes) of post-consumer waste although exact data are not consistent. The Polish Statistical Office GUS published that in 2014 post-consumer waste generation was at the level of 10.3 Mt which corresponds to about 270 kg per capita per year [3] – one of the lowest figures in Europe. In terms of waste treatment methods, 21 percent of this waste was recycled in mechanical recycling, 11 percent was recovered by composting, 15 percent was used in energy recovery processes. The remaining 53 percent (5.4 Mt) was landfilled which is a great reduction as compared to 2010 (landfilling at the level of 73 percent), however it needs to be mentioned that many experts challenge these figures claiming that waste generation and landfilling in reality are significantly (1 to 2 Mt) higher.

Until 2011 there was in Poland a very liberal approach to municipal waste management and as a result thousands of entrepreneurs successfully found their role in establishing an opportunity to gain a foothold in this market segment. Unfortunately, the effects on a macro scale have not been very positive with no big improvements in waste management driven by fierce competition to secure business at the lowest price with only a few incentives to recycle or recover materials from waste. This, in parallel with the lack of sufficient control from the administration, has led to serious infringements of existing regulations and *grey economy* within this sector have accounted for a big share of the waste sector.

In order to catch up with EU requirements imposing – by means of the Waste Framework Directive – various targets that need to be achieved – such as reduction of landfilling, high levels of recycling of municipal waste – the Polish government decided to drastically change waste law in order to introduce measures that could allow Poland to improve waste management and fulfil its obligations regarding municipal waste.

The introduction in 2011 of the Act on Maintaining Cleanliness and Order in Municipalities (AMCOM) enhanced the roles and responsibilities of local governments in municipal waste management. Local governments (municipalities) are obliged to organize a collection of municipal waste from homeowners, including the duty to sign a contract with the waste collection company that will collect and/or treat the waste. Thus the municipalities have become owners of the waste generated in their area and are obligated to build systems for local waste collection. Municipalities, alone or in cooperation with private entities through public-private partnership or through tendered contracts, are expected to be capable of building and/or maintaining installations to process unsorted municipal waste.

Regional governments (voivodships) need to establish regional plans of waste management and coordinate investment plans to make sure that the necessary infrastructure for waste treatment exists in the regions.

By transposition of European directives into Polish law, the municipalities are required to achieve certain targets for waste recovery and recycling – 50 percent for selected fractions of MW and 70 percent of construction & demolition waste – and to gradually reduce volumes of biodegradable waste sent to landfills compared to 1995 levels (50 percent reduction by July 16th, 2013 and 75 percent reduction by July 16th, 2020). Municipalities will be faced with fines for failing to reach the required level of recovery and recycling and/or to reduce the volume of municipal waste.

It was assumed that to cover the costs of municipal waste collection and its further treatment citizens would pay a fee – the waste tax – that cannot exceed 27 PLN[1] per person per month. In fact the average amounts paid by citizens are much lower (below 10 PLN/month).

[1] Precisely speaking: the waste fee may not be higher than 2 percent of *monthly disposable income*. This value is communicated every year by GUS. In 2015 monthly disposable income was 1386 PLN.

The new AMCOM, called by some commentators *waste revolution*, indeed has changed the municipal waste management system however the results are not as bright as one might have expected. Many local authorities have chosen rather to look for the cheapest waste subcontractor (thinking of the pockets of their citizens but also of the next local elections with hopes to be re-elected) than to create efficient systems of waste collection, recovery and disposal. Such efficient systems are necessary in the municipalities to fulfil requirements imposed on them (landfilling reduction targets and steadily increasing recycling and recovery targets).

As a result, in many municipalities there were problems with appropriate management of municipal waste. Income from low waste fees was not sufficient to cover the full cost of waste management, in some cases not even the cost of collection and landfilling alone (not to speak of recycling). As was revealed by the Supreme Audit Office (Najwyższa Izba Kontroli, NIK) in 2015, the number of unauthorized dumpsites has increased after the introduction of the AMCOM act. Another weakness of the Act implementation as indicated by NIK is the poor enforcement of the law in practice. It includes both lack of effective monitoring by state and local administration and control of waste operators chosen in tenders by the municipalities but also insufficient monitoring of the whole waste value chain. The Waste Act adopted in 2012 has introduced a new control instru-ment of waste flows – Waste Database that should have been implemented by 2016.Unfortunately this deadline was recently postponed till January 2018. Therefore the administration must continue to rely on the old method of paper reporting which is both indelibly flawed and at the same time impervious to adequate monitoring.

On the positive side, the waste reform and communication around it has increased citizens' awareness on wastes issues on waste as a valuable resource that can be used in its second life and on the necessity of implementing good management practices of handling municipal waste starting from waste selection at home. Separate collection at source has increased indeed from 860 kt in 2010 to 2050 kt in 2014 [3]. Another advantage of the new waste law is that automatically all the population should be within the waste management scheme (before 2011 it was estimated that only 78 percent of households had agreements with a waste collecting company). It has to be mentioned that only under the new law (municipalities are owners of the waste) is it possible to secure a long-term supply of waste needed for the operation of bigger waste treatment units as incinerators.

The Polish government is monitoring the situation and has opened stakeholders' discussion in order to work on modifications of the waste aiming at full implementation of the provisions of the law into practice. Today this discussion is being extended with new topics raised by the Circular Economy package proposed in December 2015 by the European Commission. Mid-term targets for the management of municipal waste in Poland, consistent with the EU guidelines and the national regulations, have been gathered in the National Waste Management Plan 2014 (Krajowy Plan Gospodarki Odpadami KPGO 2014) covering the years 2011 to 2014 with an outlook to the years 2015 to 2022. KPGO is recently being updated to include long-term strategy and guidelines from the Circular Economy package.

2. Plastics industry in Poland

The Polish plastics industry and consumption of plastics is among the fastest growing in Europe. As the local production of polymers in Poland is not sufficient to cover the ever increasing demand from plastics converters Poland has become one of the biggest importers of plastics in Europe. Altogether plastics companies employ 140 thousand employees in total who work in rather small companies (average size 19 employees) – this corresponds to about 10 percent of the employment in the entire industry in Europe.

Plastics processing companies constitute the largest subgroup of the Polish plastics industry. The most important are manufacturers of rigid and flexible packaging, manufacturers of pipes and profiles (for application in the construction industry) as well as manufacturers of cables. Long-term analyses based on the example of the manufacture of products from plastics and rubber reveal that over the past 15 years (2000 to 2014) the production has tripled, despite a slowdown during the 2008 to 2009 crisis.

Consumption of plastics in Poland

The demand for plastics raw materials has increased in the last 6 years (2010 to 2015) from 2,400 to 3,200 kt meaning that the average yearly growth rate (CAGR) was around 6 percent, far higher than the average EU-28 rate and much higher than the GDP growth rate of Poland.

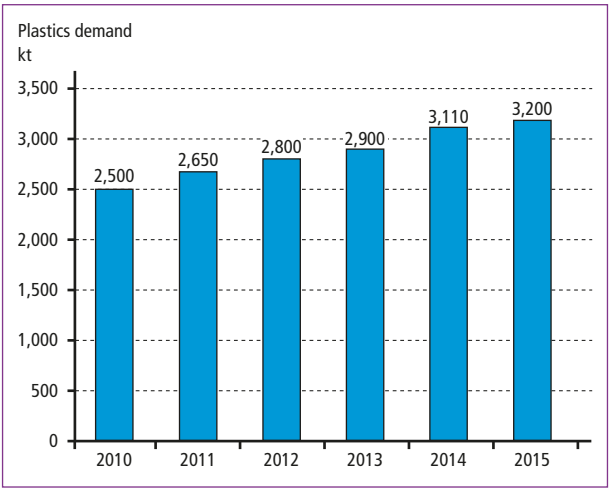

Figure 1:

Consumption of plastics in Poland

after Consultic/PlasticsEurope Market Research Group (PEMRG), 2015

The Polish plastics industry has been quickly developing in the last few years. One of the reasons for this situation is the development of related sectors, especially the automotive industry, the production of electrical & electronic (E&E) equipment – two sectors that have been draught horses of development of plastic processing – with average growth rates of 16 percent and 8 percent between 2009 and 2015 respectively. Plastics use for packaging production and for B&C sectors increased less dramatically by 6 and 4 percent in this period respectively. Total demand of Polish converters for

plastics in 2015 exceeded 3.2 Mt (million tonnes). This represents about 6.5 percent of the consumption of plastics in Europe and ranks Poland sixth in Europe, right after Germany, Italy, France, Spain and Great Britain.

The greatest amounts of plastics are used in the packaging production industry (about 32 percent) and in the construction industry (26 percent), whereas 9 percent of plastics were processed for the purposes of the automotive industry and 6 percent for the Electric & Electronic (E&E) industry (Figure 2). The consumption structure based on the type of polymer indicates the largest shares of polyethylene (LDPE, LLDPE, HDPE) – about 30 percent, polypropylene (18 percent) and polyvinyl chloride (14 percent), as well as polystyrene – PS and EPS collectively (15 percent).

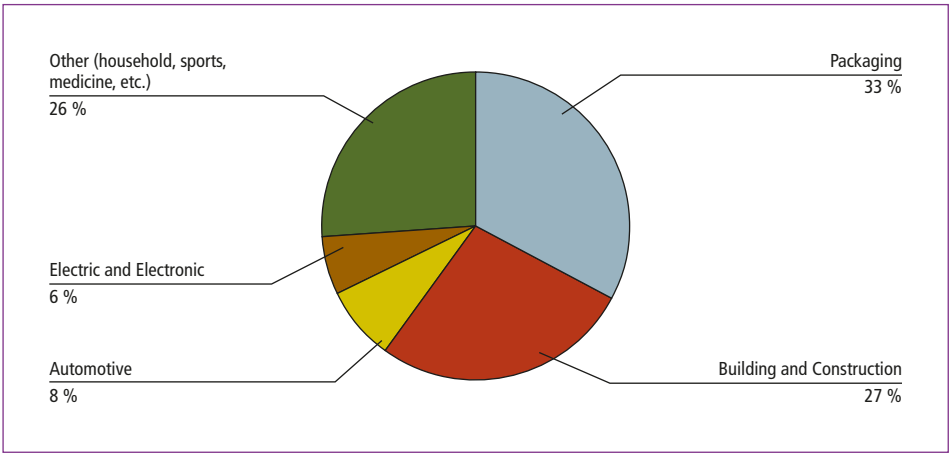

Figure 2: Consumption of plastics in Poland per sectors

3. Management of plastic waste

In 2014, Poland generated about 1.54 Mt (million tonnes) of plastic waste: 25 percent of this amount was mechanically recycled, 19 percent was used to recover energy and the remaining 56 percent was transferred to landfill sites.

If we look at medium term evolution of plastics waste recycling and recovery, definitely there is a visible increase, e.g. comparing 2014 results to 2009 (Figure 3).

One can see that recovery has increased from about 28 percent in 2009 to more than 43 percent in 2014 with most significant growth in packaging waste. However, in a shorter perspective, e.g. comparing 2014 data with the previous available, i.e. for 2012, it is clear that little has changed – recycling rates did not change in a significant way and landfilling of plastics waste remained at a very high level.

The introduction in 2012 to 2013 of the Polish new waste management policy has not given positive effects yet. Paradoxically, some plastics recyclers suffered shortages of

good material for recycling. It seems that the main reason for that was the chaos that has cut a lot of existing value chain links along with inefficient selective municipal waste collection schemes.

PlasticsEurope estimates that in 2014 over 25 percent of all generated plastic waste was recycled – the figure very close to 2012. The main sources of waste for recycling were packaging waste which accounts for the largest group of plastic waste while in other application sectors recycling rates were significantly lower.

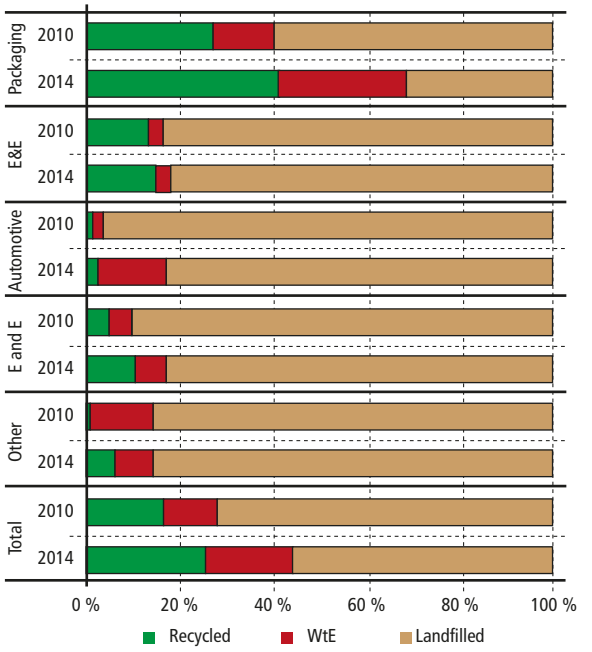

Figure 3:

Evolution of plastics waste management in Poland in recent years

3.1. Recycling and recovery of specific plastics waste streams

3.1.1. Packaging

Poland introduced its Packaging and Packaging Waste Act (PPWA) in line with the EU directive in 2001 coinciding with the act on Obligations for Entities regarding management of specific waste streams (Polish version of Extended Producers' Responsibility (EPR). PPWA was recently (2013) updated with the introduction of specifications for recovery organisations, which among others included requirement of yearly audits by external experts.

Under the PPWA law recovery organizations are authorized to take over the duty of the recycling of packaging wastes from producers and fillers. On this basis a recovery organization should ensure the implementation of fillers' obligations in cooperation

with recyclers. Recovery organizations pay the recyclers a *recycling fee* for the quantities of packaging waste they claim to have recovered and recycled. A system of documents (PRN-like) has been created in order to control the materials flow.

Despite prohibitive legal obligations related to the establishment of recovery organizations – a requirement to register a joint-stock company, high share capital – since 2001 a few dozens of recovery organisations have appeared on the market. They were partly motivated by a business incentive and driven by an expected quick Recovery-on-Investment ratio only. This has led to fierce competition on the market which – combined with lack of administrative control from the state – resulted in significant lowering of fees paid by the fillers and in consequence – recycling fees paid to recyclers. Today's level of those fees may be as low as a few euro per ton of plastics packaging waste. It is obvious that such a low fee barely contributes to improving recycling levels. Fortunately, the industry itself realizes that this situation needs to be changed and voluntarily it has started working on remodelling the whole EPR system.

The 2013 update of PPWA has introduced a new scheme and new requirements for recycling and recovery of composite packaging waste and packaging waste of household dangerous goods – some household chemicals, repellents, crop protection agents etc. This new requirement imposes a new obligation on the fillers to achieve set targets of recycling of this specific packaging waste. Given the greater difficulty of recycling of composite materials those targets are lower than targets set for single component packaging waste – e.g. paper, glass, plastics. The fillers may fulfil recycling targets on their own or via consortia in partnerships with business chambers or associations.

The roadmaps to arrive at 2020 targets are different for standard packaging and for composite and dangerous goods packaging but final recovery and recycling targets of packaging waste are set at equal values for the year 2020: 61 percent and 23.5 percent for recovery and recycling respectively. Of course, if Circular Economy package is adopted most probably those targets will be geared towards higher values.

PlasticsEurope/Consultic data indicate that in 2014 about 1,010 kt of plastics were used for the manufacturing of packaging – 31.5 percent of all plastics consumption in Poland. Packaging waste generated in 2010 was estimated at 840 kt (55 percent of the whole plastics waste stream) out of which 330 kt was recycled and 230 kt was used for energy recovery [1], i.e. about 41 percent and 27 percent respectively.

This data differs from data published by GUS (recycling 2014 – 29 percent) and from recovery organisations [9] (Table 1). We think however that the recovery organization reported only what was required by their customers – in 2014 the obligation for the fillers was to recycle minimum 23.5 percent[2] of plastic packaging introduced on the market.

[2] It has to be noted that fillers obligation of recovery and recycling is limited only to targets set yearly by the government. For example, if a filler cannot prove that he reached 23.5 percent of recycling in 2014 he has to pay a fine which is proportional to the a difference between the recycling target and level claimed by the filler

	unit	2009	2014
Plastic packaging waste put into market	kt	681	859
Recycled in current year	kt	128	217
Achieved recycling level in current year	%	19	25

Table 1:

Recycling of plastics packaging waste in Poland

Although much more plastics waste has been collected separately in recent years (and most of it is packaging waste) – it has not been not directly translated into much higher recycling rates. There are several reasons for this:

- The AMCOM act introduced in 2012 increased pressure on the municipalities and on citizens to collect waste separately. Although the citizens are still allowed to dispose of mixed waste only – without any sorting at source – they are in this case confronted with a much higher waste fee to pay. Another unresolved problem involves multi-family residential buildings with common waste bins where – due to lack of control – quality of sorted waste is much lower than in detached houses.
- There is no universal system of separate collection in Poland. In fact, each municipality may adopt their own collection scheme based on availability of the local infrastructure. This causes confusion among inhabitants which results in a large number of separate collection misplacements mistakes and contamination is sometimes higher than 30 to 40 percent.The most popular separate collection schemes in Poland in 2014 [11] were:
  - 4-bin schemes (paper, glass, plastics+composite+metal, residual waste) or (paper, glass, plastics, residual waste)
  - 3-bin scheme (glass, paper+plastics+composite, residual waste)
- Some municipalities have introduced *dry-wet* schemes whereas in *dry bins* all recyclable materials are collected and in *wet-bins* kitchen waste but also everything that does not fit into *dry bins* are collected. It is to be noted that almost everywhere glass is collected separately and in many municipalities seasonal separate collection of *green waste* is organized mainly for garden owners.
- A still low quality of sorting equipment that is used in a sorting plant is not capable of yielding bigger quantities of materials for recycling. Although, in this aspect a lot has changed in Poland, mainly in the field of automated optical sorting that apparently has reached a capacity of 2 Mt in Poland. The majority of sorting operations is still handled in older MBT plants, very often with very basic separation equipment (drum sieves, magnetic separators) where sorting efficiency is very low (below 10 percent).
- Sorting plants work with feedstock both from separately collected waste and from residual (or mixed) waste. Materials recovered from separately collected streams have usually rather good quality for recycling. Nevertheless, it is not always possible to reach sufficient cleanliness of material fractions recovered from residual (mixed) waste. This has an impact on the marketability of those lower quality materials and ultimately on their recycling.

3.1.2. Building and construction plastics waste

Unlike in packaging in the B&C sector plastics are used almost entirely in long term applications. The biggest areas of use are insulation, pipes and ducts, profiles (windows, doors) and in floor/walls covering. In 2015 the consumption of plastics in the B&C sector was estimated at 820 kt.

Poland like all EU member states is obliged to achieve a high rate of recycling of B&C waste (70 percent in 2020 according to Waste Frame Directive). Polish waste strategy plan KPGO 2014 foresees implementation of necessary steps and a road map to reach this target.

In existing Polish official statistics no data is available on plastics B&C waste. The Consultic study demonstrated that in 2014 in Poland 93 kt of plastics waste were generated in the B&C sector. This corresponds to about 6 percent of the total post-consumer plastics waste stream, 18 percent of this waste was recovered, mainly via mechanical recycling (15 percent). These figures do not differ much from the last study done in 2012.

Several companies producing plastics products for B&C in Poland, mainly PVC pipes and profiles, participate in the VinylPlus recovery program and contribute to high quality recycling. Information from VinylPlus suggests that quantities of PVC waste recycled within this program in Poland – mainly profiles and cables – in 2015 is higher than the Consultic figures for all B&C plastics waste recycling. We think that most probably, VinylPlus data include PVC waste imported to Poland for recycling.

3.1.3. Other plastics waste sources

Other plastics waste sources: automotive, E&E, agriculture, furniture, sports, medicine etc. contribute to a much smaller extent (each stream smaller than 10 percent of total post-consumer waste) to the generation of plastics waste. Except agriculture plastics waste, all mentioned streams represent multi-material waste where plastics constitute only a minor part of the waste. Another feature of these streams is the presence of a variety of different plastics (different polymer types), sometimes mixed with other plastics or other materials, e.g. plastics compounds or alloys, plastics composites with glass or carbon fibres etc. Such characteristics make it very difficult to recover plastics for recycling as it is practically impossible to separate different polymer types in standard procedures of preparation to recycling. Therefore, those streams are characterized by low recycling rates (not more than 10 percent) but also low energy recovery ratios.

Agriculture plastics waste recovery is an example of a subsector that is developing well in Poland. Despite lack of any official collecting schemes some entrepreneurs have organized their own local systems of collection of used agriculture films (from greenhouses, mulching) from farmers. Agriculture plastics films are usually rather thin and often heavily soiled with organic matter and sand, therefore they require cautious handling in recycling but they have the advantage of being a single material film (usually LDPE) and may be rather easily recycled again into films. The biggest producers of waste bags in Poland use a lot of LDPE recycled from agricultural film. We estimate that over 100 kt of plastics waste in the agriculture sector is generated yearly out of which about 30 percent is being recycled.

3.2. Plastics waste for energy recovery

The plastics industry has been advocating full valorisation of plastics waste for years and calling for the banning of landfilling of this waste.

Recycling is high in waste treatment hierarchy but not always is it the most sustainable way of waste recovery. For example, multilayer films used in food packaging protect food in an excellent way keeping it safe and extending its shelf life. Till now no reliable industrial process of sustainable recycling of such films has been developed. Another example of a *difficult-to-recycle* case is plastics material compounded with other materials like glass fibers, metals etc. The share of plastics waste that may be sustainably recycled depends on the nature of plastics products, their application area but also on the existing local waste management system and available infrastructure.

The Austrian consulting company denkstatt GmbH has tried to estimate limit levels of sustainable (eco-efficient) recycling analysing different plastics items. Denkstatt arrived at a conclusion [2] that with present technology and existing waste management systems actual maximum levels of eco-efficient recycling vary between 29 percent and 45 percent.

Fortunately, such difficult-to-recycle streams of plastics waste are characterized by their high calorific value and may be a perfect component for any fuel from waste. Here we speak of direct incineration of mixed waste (Municipal Solid Waste Incinerators, MSWI) but also of preparations of fuels made of waste (RDF, SRF) that are mainly used in co-incineration processes – e.g. along with coal.

Official Polish statistical data [3] show that 1560 kt of municipal waste was used for energy recovery in 2014 showing a rapid increase from 766 kt in the previous year (2013). We understand these data do contain RDF incineration but both figures look imprecise: to our knowledge the 2014 figure is too high and the 2013 one too low. Nevertheless, we see the improvement in statistical reporting as before 2013 RDF use for energy recovery was not reported at all.

3.2.1. Municipal solid waste incineration

Since there is a separate paper presented on MSWI projects in Poland in this book [6] we will only slightly mention MSWI in this article. Six big incineration projects in Poland that have just started operation or are close to commissioning have their overall capacity of about 1 Mt of mixed waste. It is therefore expected that already in 2016 and more pronounced in 2017 the share of plastics waste that will be used for energy recovery should increase significantly.

New projects that are already quite advanced indicate a further 5 to 6 cities that intend to build MSWI plants; roughly that would mean another 1 Mt – including plans of extension of the Warsaw incinerator to 300 kt – of mixed waste and RDF and sludge.

3.2.2. Fuel from waste

RDF (Refuse-derived Fuel) or SRF (Solid Recovered Fuel) is a fuel produced by shredding, mixing and dehydrating municipal solid waste and other high calorific waste.

Generally, all kinds of combustible waste may be used: municipal mixed wastes, packaging wastes, post-producer waste, paper and textiles waste, wood waste, organic waste etc.

RDF in Poland is classified mainly under waste with code 191210 (*combustible waste – alternative fuel*), but also others along with code 191204 (*plastics and rubber from mechanical waste treatment*) and very often with code 191212 (*other non-hazardous wastes from mechanical treatment*). Code 191212 is sometimes used for a description of so called *pre-RDF* –calorific waste usually coming from MBT processes that is stored for future use in RDF formulations.

As a consequence of overcapacity of existing MBT plants and increasing restrictions of landfilling processed waste, it has become recently quite popular among waste operators to declare and gain permits for *production of alternative fuels*. We have now a situation where the declared production capacity of alternative fuels is 4 times higher than actual consumption. Of course, only a part of these capacities (probably less than 50 percent) is capable of producing high quality reproducible RDF that may be sold on the market (in Poland or abroad). The other part, usually *pre-RDF*, is mainly stored at waste operators' premises under the code 191212. The owners of pre-RDF hope that the alternative fuel market should grow progressively with the commissioning of new incinerators and RDF-fuelled power plants.

In Poland the largest consumer of RDF is by far the cement industry. Co-firing of RDF in the energy sector (power plants, CHP plants) is still almost non-existent despite many attempts made to introduce RDF also into this sector. The main obstacles are stricter emission standards required for waste incineration and inadaptability of existing older boilers to co-firing RDF with coal. This situation is slowly changing and new projects of co-incineration of RDF with traditional fuels are currently in the testing phase. Also two of the newly designed alternative fuels power plants (Zabrze and Olsztyn) that should start within 2 to 3 years will use RDF as fuel.

Polish cement plants are important consumers of fuels from waste substituting a part of fossil fuels – coal or gas. They started about 20 years ago with small experimental quantities imported from Germany and now are among European leading consumers achieving thermal substitution rates above 50 percent [10].

The cement industry in Poland, one of the most modern in Europe with 10 plants and a total production capacity of 22 Mt/year of cement, has made important investments to adapt their plants for reception, preparation and co-firing of alternative fuels. Those adaptations include storage, drying lines and feeding lines for alternative fuels. RDF constitutes over 80 percent of alternative fuels used by the Polish cement industry – the rest being used tyres, sewage sludge and other waste.

It is estimated that consumption of RDF (SRF) exceeded 1,100 kt in 2014 [10] and the practical limit is set to about 1,600 kt [5]. With an increasing substitution rate in the cement plants a higher calorific value of the RDF to be co-fired is usually required which in many cases may be impossible only on the basis of municipal waste [11]. In such a case additional blending with high calorific fractions (again plastics) might be necessary.

3.3. Plastics to fuel/plastics to chemicals

Plastics-to-Fuel processes were quite popular in Poland some 8 to 10 years ago when production of combustible fuel out of waste was exempt from excise tax. There were dozens of working installations, with a total capacity exceeding 50 kt of mixed plastics. The conversion to fuel was realized by pyrolysis – thermal cracking – of plastics to produce as an output a mixture of hydrocarbons that was used as a heating oil.

After annulment of excise exemption in 2008 most of the installations have been closed as the product – heating oil – was not competitive with large scale industrial refinery production. Some units survived however, especially where the oil might be used for internal consumption.

Some attempts were made in order to market Plastics-to-Chemicals technology – e.g. Clariter technology – with plastics waste as an input and chemicals (solvents, paraffin and waxes) as an output but they failed mainly because of problems with sources of good quality input material.

Currently, a few companies offer their own or imported pyrolysis technologies in Poland but to our knowledge conversion of plastics to oil on a larger scale does not exist in Poland. There is a visible interest from local authorities who seek an alternative to MSWI energy recovery processes since such units may be smaller and cheaper to construct. It seems however that with prerequisites for the smooth operation of such units – reproducible quality of the input plastic streams – it may be very difficult to introduce a wider use of pyrolytic technologies in Poland.

4. Summary and conclusions

Synthesis of plastics use and waste management in Poland is shown in Figure 4.

Despite a lot of work already done around municipal waste management in Poland, the country still has enormous challenges in order to align with existing and future (Circular Economy) European regulations concerning waste.

Plastics waste is one of the most important secondary raw materials and we are glad that the well-known slogan promoted by the plastics industry – *Plastics are too valuable to be wasted* – is understood and shared also by other stakeholders, including the waste sector and administration.

Moving forward would require efforts from all sides, starting from educating consumers of all ages, introducing a reliable EPR system that will contribute to the collection and recycling of waste, imposing more harmonized collection schemes in Poland and finally

implementing stricter control by local and central authorities. We believe that with such a background the plastics recycling industry will be able to reintroduce much bigger quantities of plastics into the loop and landfilling of plastics will be reduced to a minimum.

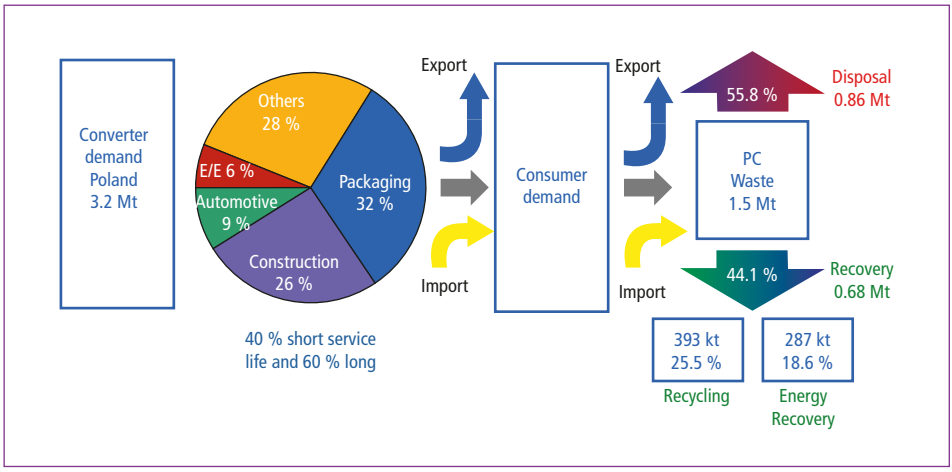

Figure 4: Plastics use and plastics waste management in Poland in 2014

Source: Consultic/PlasticsEurope Market Research Group (PEMRG), 2015

Innovations and wider separate collection may permit us to realize on a greater industrial scale such breakthrough technologies as chemical recycling with degradation plastics into other chemicals.

We believe that Waste-to-Energy technologies also in Poland will become an in-dispensable complementation of recycling allowing for definite withdrawal of plastics waste from landfills.

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Waste-to-energy plants

– Germany –

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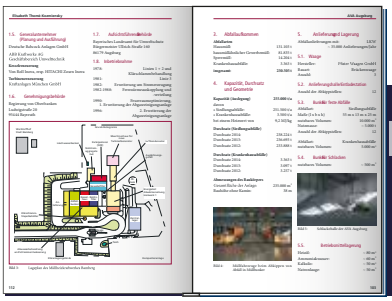
This book carries forward the survey of waste-to-energy plants in the Federal Rebublic of Germany which started in the 1990´s. This edition comprises:

- 52 plants that treat municipal solid waste.
- 1 plant that treats hazardous waste.

The investigation provides extensive information about the installed technology and the environmental impact of the waste-to-energy plants. The quality of the inquiry has been extended in terms of the technical data. Existing gaps regarding the data were partially filled, as a comparison with the survey of 1994 reveals. This is the result from the considerable assistance of numerous plant operators. The publication on hand shall be seen as an interims report. The work on the data acquisition will be continued. For this reason we ask plant operators and manufactures to critically review the release data.

The further investigations will be extended to the missing German waste-to-energy plants as well as to plants in other countries.



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