

## Waste-to-Energy Plant Krakow – On the Status of Thermal Waste Treatment in Poland –

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In the mid-nineties one of the first waste management conferences in Poland took place in Miedzyzdroje. Municipal representatives and technology providers came together to discuss the introduction of an orderly and environmentally sound waste management structure. At that time there was a spirit of optimism in that there was consensus that waste incinerators should be a substantial part of waste management with a significant market potential. In other words waste was available for projects which would be completed in the not too distant future.

Actually it will have taken two decades from the development of these initial ideas to the start-up of the first projects. In our neighbour country Poland a market with major potential has been created by forward-looking waste management measures and investments. The last two years have seen numerous contracts for new plants being awarded which have been designed to ensure the efficient and environmentally-friendly disposal of waste. However, it was not until Poland joined the European Union on first May 2004 that this development was significantly accelerated and the path to eco-friendly waste management was mapped out.

Using the example of a waste-to-energy plant in Krakow this paper sets out the long-term development from the initial project idea through to the awarding of contracts and their subsequent implementation together with the prospects of future opportunities and associated risks.

### 1. Basics of waste management in Poland

With regard to the total amount of urban waste produced Poland with approximately twelve million tonnes per year is ranked sixth in the EU after Germany, France, England, Italy and Spain. Interestingly, however, in Europe, Poland with 317 kg per capita is in the (positive) last place in relation to the amount of waste produced specifically per inhabitant. This figure varies from 234 kg per capita in rural areas and 386 kg per capita in major cities.

In reality only about ten million tonnes per year were collected in Poland with the difference to the above mentioned number being due to the fact that at the time of data collection (2009) one citizen in five was not connected to an organised collection system [3].

The prognosis for waste generation from the national waste management plan for 2010 in Poland expects an increase of approximately nineteen percent by 2018 in the quantities of household waste compared to 2006. This means that population-specific waste would rise with the expected number of inhabitants remaining almost unchanged. The total waste generation or specific waste per inhabitant in Poland has remained relatively constant since 2005 until today.

In Poland there is currently only one publicly operated waste incineration plant which is in Warsaw. According to the operator this system has the following parameters:

- total treated waste: 120,000 tonnes per year including sorting and composting as pre-treatment stations,
- incineration capacity: 57,000 tonnes per year with the actual throughput being about 75 percent due to technical problems and high gate fees,
- compost production approximately 11,500 tonnes per year.

According to the plant operator the gate fee ranges currently from 78 to 91 EUR/t (for municipal waste).

The acceptance of the construction of incinerators is though quite high among the population. In a survey in major Polish cities an average of 73 percent of respondents expressed their support for the construction of modern incinerators with the condition that modern technologies are used and both electricity and heat are produced. Only 22 percent of respondents opposed the construction of a plant in their district. The acceptance in the city of Krakow was particularly high with an approval rating of 82 percent [3].

The waste management situation in Poland has been shaped by several factors since the country joined the EU in 2004. With the necessary integration of municipal waste disposal systems, co-financing possibilities for waste management systems via EU funding, along with accession obligations imposed by the EU, Polish municipalities were forced to reform their waste management infrastructures according to European standards in terms of quantitative and qualitative targets [6]. The variety of waste collection companies and technical equipment in need of modernisation has had a negative impact on the proper organisation of disposal processes. The local authorities had only limited control of waste disposal. There was also a lack of alternative recovery and disposal installations as a replacement for the landfills and illegal dumping sites to be shut down.

In October 2005 the rules of the EU were ultimately adopted into Polish waste legislation with transition periods for their implementation.

The amounts of waste landfilled must be reduced on the basis of the requirements of the Landfill Directive taking the transitional periods into account. The landfilling of biodegradable waste is to be reduced by 65 percent by 2020 compared to the levels in the base year of 1995.

Set against the background of the situation in Poland with a very high proportion of landfill, a lack of alternative treatment capacity and growing volumes of waste these reduction targets were, and still are, very ambitious. In the event of non-compliance the Polish State faces penalties from the EU which currently may include daily rates of approximately 5,000 to 300,000 EUR in accordance with the directives of the European Commission, in addition to a lump sum of about 4.2 million EUR [3].

European environmental legislation and the associated planning of national strategies have prompted local authorities to implement their waste policies in line with the overall targets and to change the disposal structure. 2008 saw the introduction of the so-called Marschall fee, a fee for waste disposal (landfill tax) to control waste flows and as an incentive for waste producers to encourage their eco-friendly behaviour.

This fee provides for an increase of landfill fees from about 15 PLN in 2006 to 200 PLN in the year 2015.

The introduction of this landfill tax had, however, remarkable consequences because approved disposal routes were ultimately circumvented. Citizens terminated the existing disposal contracts and partly dumped their waste through tipping in forests or by burning it themselves. In the future however it is expected that waste will be directed to the new waste incineration plants rather than to illegal sites [6].

Consequently, from 2004, considerations on the construction of incinerators in the course of implementing upcoming EU directives became more concrete and a list of 'indicative' waste incineration projects in Poland was published. This was accepted and confirmed by the European Commission and the Polish Government at the end of 2007/beginning of 2008. It listed twelve projects with a total capacity of approximately 2.4 million tonnes per year and a total investment of approximately six billion PLN.

The basis for this was the implementation programme approved by the European Commission in December 2007 for Poland entitled *Operational Programme on Infrastructure and Environment*, valid for the period 2007 to 2013 [4]. This programme was allocated a total budget of EUR 37.56 billion with the community funding amounting to €22.18 billion from the Cohesion Fund and 5.74 billion EUR from the European Fund for Regional Development (EFRE).

It was the largest operational programme in Poland and also the largest across the EU promoting the development of a technical infrastructure and at the same time protect and improve the natural environment and public health. One of the focal points was precise waste disposal with the increased economic benefit from avoiding and reducing quantities of waste to be disposed of in local areas through the introduction of recycling methods and disposal technologies.

The EU Cohesion Fund was to supporting our neighbouring country in achieving the objectives of the various EU directives in relation to waste recycling. Plant construction projects that were going to benefit from this Fund should have been completed before December 31, 2015, i.e. the corresponding plants must be fully operational and handed over by that time.

Initially however, feasibility studies including environmental impact assessments and proposed sites which form part of the applications for financial support to the European Commission had to be submitted for the respective projects by June 30, 2010. For various reasons not all potential project owners did not or could not comply with this deadline.

The feasibility studies formed the basis for the relevant environmental impact assessments. The procedures and process steps laid down therein were in turn the basis for the tender documents which are to be accepted unreservedly by the bidders. Any deviations from this, even if these appear useful in terms of improving plant operation, are not permitted under public procurement law. In the period between the call for bids and the awarding of the tender there is an opportunity to clarify technical and commercial conditions but experience has shown that the scope for modifications on the part of the customer is very low.

In 2011 after the funding from the Cohesion Fund was secured the first calls for tender went out for the well-known waste incineration projects in Bydgoszcz, Bialystok, Krakow, Szczecin, Konin and Poznan.

After a few amazing developments during the individual awards for observers inexperienced with Polish public procurement law all five construction contracts as well as the PPP model Poznan were finally awarded in 2012 and signed. The building permits have since been awarded for most of the projects (status November 2013). If there are no delays all systems should be operational by the end of 2015 and handed over to the end customer.

However, the most important step on Poland's path to a modern integrated waste structure did not happen until not too long ago. In 2011 the *Act on the maintenance of cleanliness and order in municipalities* was passed by the Polish Parliament and ultimately introduced the obligation to transfer the ownership of municipal waste to the public bodies. At the same time those local authorities were obliged to put waste disposal services out to tender [8].

The introduction of this obligation to transfer the ownership of municipal waste from private households represented a serious change in Polish waste legislation for up until then no such constraint existed in Poland. Property owners were previously obliged to enter into waste disposal service contracts and provide corresponding proof to the community. The local authority simply had to ensure that all residents were connected to appropriate waste management systems. In this legal framework owners usually entered into disposals contracts with selected service providers who then decided in which place the different types of waste should be disposed of [8].

Usually the waste was dumped on one of the numerous landfills that did not necessarily meet European standards. In 2004 the number of landfills in Poland was well over 1,000 around 300 of which were to be closed by the end of 2011. Even in the year 2008 there were nearly 8.7 million tonnes of waste dumped on landfill sites [9].

At the end of the year 2011 there were ultimately still 578 official landfills in Poland of which 428 were operated without gas extraction. The others had gas combustion with and without energy recovery [1]. However, there is still an ongoing struggle against illegal waste dumping. Although several thousand illegal landfills were closed in the course of 2011 officially over 2,500 illegal waste storage facilities have currently been statistically logged.

The new law was supposed to lead to a change in the culture of waste disposal. To pay for the disposal obligation the public waste disposal bodies were given the right to impose waste charges. In addition the communities were required to introduce separate collection for paper, metal, plastics and glass as well as biodegradable municipal waste and appropriate target values were introduced.

In addition the new law committed Polish municipalities to put waste disposal services out to tender. This obligation applies to the construction and operation of plants in which the municipal waste is to be disposed. Alternatively, local authorities can enter into public private partnerships [8].

It was only with the adoption of this law that the legal conditions were ultimately created to award contracts for the construction of incinerators in Poland within the framework of public tenders.

The corresponding obligation for the transfer of waste came into force on January 1, 2012 and a transition period of 18 months until June 30, 2013 was granted for its implementation.

It remains to be seen what impact the new waste Act will have on the estimates of waste arising in Poland. Once the communities themselves have to determine the waste generated it could be the case that totals will rise significantly compared to those actually estimated to date as considerable amounts have been disposed of illegally.

Waste incineration plants are currently under construction in the following cities or municipalities. The Polish construction company Mostostal Warszawa was awarded the contract for the construction of the waste incineration plant in Szczecin. By 2015, this waste incineration plant should be treating 150,000 t waste a year. The waste incineration plant in Bydgoszcz is being completed by an Italian consortium under the management of the company Astaldi. This plant too is to be completed by the end of 2015 and will then annually convert 180,000 t of waste into energy. The waste incineration plant in Bialystok will be built by a consortium led by the Polish construction company Budimex, the waste incineration plant in Konin will be built by a consortium including the Polish construction company Erbud. On average a total of approximately sixty percent of the required investment is funded by the EU.

The Korean company Posco is handling the construction of the waste incineration plant in Krakow. The value of the project is 650 million PLN (net) and this plant too, with an annual capacity of 220,000 t, is to be completed and put into operation by the end of 2015.

The project in Poznan will be completed by 2016 with the community being part of a public private partnership (PPP).

With regard to the projects that were awarded in 2012 as pure plant construction contracts, what is striking is that all projects with the exception of Bydgoszcz were awarded with contract values in some cases considerably above the budgets of the contracting authorities previously mentioned. There are overruns of up to forty percent. Also the specific investments per tonne treated annually are consistently well above the level known from Western European awards. In an analysis of the indicative list of projects the observer was already able to see that the indicated price levels were not very consistent.

The reasons for this are on the one hand an increased scope of supply above and beyond that normally required for a full plant and secondly, possibly to cover the risks arising from what are in some cases quite one-sided contractual terms. Including the Poznan project processing capacities of about one million tonnes per year were awarded and the total related investment is about 680 million EUR. An examination of the average values shows that the award value for the Bydgoszcz project may be regarded as comparably low.

In all the cases mentioned the award methodology used was related to the overall project and it can be assumed that this form will be the main form in the future. Multi contract awards of single lots are not favoured. The reason for this lies in the desire by the developers for an absolute risk reduction model which requires such a form of contract. Shifting any risk onto the contractor and the obligation to fully accept the technical and commercial conditions – regardless of whether these are partly contradictory or have potential for improvement – must ultimately result in a significantly higher procurement price.

The option of making the invitation to tender available only to a selected circle of applicants, i.e. the actual bid and award phase is preceded by a pre-qualification in which the awarding authority based on set conditions creates a pre-selection of bidders was only found in two of the EPC projects (Krakow, Bialystok) and Poznan. In three projects, on the other hand, the prequalification and the submission of the bid were done in parallel. This approach is rather unusual for bidders in this business. The bidding companies have to take an assessment of their ability to win the contract taking into account the costs associated with the preparation of a bid and also the possibility of disqualification due to ultimately non-relevant formal errors which eventually cannot be ruled out. The high costs of the preparation of the quotation could be therefore completely in vain.

The application of an open procurement procedure, with or without prior prequalification, which is useful for the procurement of low value goods is not unproblematic when it comes to the contracting of a highly complex plant that requires intense exchange between the parties. The partnership dialogue between the issuing body and the contractor is crucial and ensures as well the selection of the most technically and cost-effective bidder or bid.

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Furthermore it should be noted that – certainly – not only the warranty values stipulated are to be complied with and proven but the technical specification must be implemented to the letter of the contract and ultimately all values, claims and descriptions named within the contract must be classified as guaranteed and implemented. As an example the compliance with the minimum value for which the R1 factor – according to research by the author – must be complied with a value of at least 0.65 (according to the guideline) in three projects while a value of at least 0.8 was specified in two projects and thus guaranteed by the bidders. It remains to be seen to what extent in particular the value of at least 0.8 can be demonstrated by the individual bidders under the given boundary conditions of the contract.

But the commercial conditions also caused concerns among potential bidders when it came to recurring requirements such as unlimited liability, acceptance of soil risks and all risks arising from the issuing of pending permits – in terms of content and time-scale. These examples represent risks which on the whole are almost not to calculate and are usually unacceptable across the board at least for the majority of technology suppliers even if comparable conditions in public procurement in other countries of the EU are similar. In other words it is not a country-specific problem – and obviously many bidders or groups of bidders took part in the procurement procedures. However, in the majority of cases local construction companies took over the project lead and this too is an approach known from other countries. In these cases technology suppliers are considered in a subcontractor function – a variant that has only been permitted under Polish public procurement law for the last few years. The opportunities and risks of this approach must be assessed by the participants individually but again in general will result in a higher price level.

It was only the specific references of the waste incineration technology suppliers and their specialists to be nominated that enabled the local construction companies to qualify as bidders. This approach implies that, provided the procedure and conditions do not change, these companies can independently participate in future procurement procedures the technology itself is therefore not important. Even in the contracts recently awarded there have been cases in which the technology was replaced after the contract was awarded, the value of the actual core technology of a plant must therefore unfortunately ultimately be classified as low.

## 2. The Krakow project

The city of Krakow in the Malopolskie Woiwodship is in the South of Poland and has about 750,000 inhabitants. In 2008 about 320.000 t of municipal waste were generated there, about 85 percent of which was landfilled [5]. Prior to the introduction of the new waste Act for 2011/2012, 25 companies had a permit for the collection and disposal of waste. The costs of waste disposal were charged to the waste producers via the individual companies and included costs for the collection, transport and disposal of waste. About two-thirds of the waste was collected and disposed of by the municipal company MPO. The fee for the disposal of a 120 litre bin was on average approximately 21 PLN. The existing landfill with a residual capacity at that time was about four to five years was complemented by a sorting plant plus two composting plants.

220,000 tonnes of the total of 320,000 tonnes of municipal waste generated in Krakow per year is to be burned in the incinerator. For this purpose a system with two incineration lines, each of 14.1 t/h capacity with a design calorific value of 8.8 MJ/kg, is to be built. The infrastructure of the system is also to contain the facilities for treating bottom ash (70,000 t per year) as well as the treatment of residues from flue gas treatment (15,000 t per year). In addition to generating electricity a connection to the district heating network is intended.

The Krakow waste-to-energy plant project was developed to close the existing gap in the community's wider waste management plan, on the one hand to thermally treat the remaining amounts of residual waste and on the other hand to ensure compliance with applicable regulations and directives. As part of a feasibility study locations and different solutions were considered to facilitate the future logistics of waste supply for the plant and also to make the connection to the different energy supply networks as efficient and as streamlined as possible. Four different sites were considered with the Nova Huta site ultimately being identified as the best location.

The capacity of the plant has been extrapolated taking into account the development of the population of the city of Krakow as well as the specific quantities of waste per inhabitant per year up to the year 2030. Although a decline in the population is expected rising specific waste amounts per capita are leading to an overall increase in waste generation during the period under review. Taking into account increasing separate collection and proposed recycling efforts the abovementioned capacity was finally set and should in principle suffice up to the year 2030.

In the course of an evaluation of alternative treatment methods it was found that the mechanical-biological treatment of waste would not lead to a solution to the waste problem. Pyrolysis and gasification processes were also excluded from further considerations. In an extensive investigation of thermal treatment grate-combustion once again proved the best possible alternative for the planned plant.

The budget proposed for the whole investment project has been set at approximately 150 million EUR. Taking into account operating costs, staff and financing costs and the income from the sale of energy produced, a gate fee of about 170 PLN has initially been calculated for the start of the plant operation which by the year 2030 could rise to about 340, or in other words double [5]. In the subsequent submissions from the bidders values of about 60 PLN/t for pure operating costs (consumables and internal power consumption) were identified. The percentage of these costs associated with the stabilisation of the FGC residues can amount to 30 to 45 percent thereof depending on the process technology used.

KHK S.A. (Krakowski Holding Komunalny AG) was appointed as responsible for the entire project management. The KHK SA is a wholly-owned subsidiary of the city of Krakow and ultimately represents a merger of different city owned companies with regard to heat and water supply.

As part of the two-stage tendering procedure a total of five bidders were qualified for the project, four of which participated in the competition by submitting a bid.

On October 31st, 2012, the contract for the construction of the plant was finally signed between the KHK SA and the company Posco E&C, thereby giving the go-ahead for the implementation of this project. Between the submission of the bids and the signature there were some surprising twists and turns that ultimately resulted in the bidder with the highest bidding price being offered the contract.

Between the time of the announcement of the procurement procedure and the signature of the contract there was a period of almost exactly one year which, as in the other procurement procedures, was used less for useful clarification of technical issues than for various legal clarifications before the procurement chamber.

Long before the start of the tendering procedure Posco had decided to go with a technology supplier from Ratingen. This experienced supplier was involved from the very beginning of the project in the processing and has assisted Posco in drawing up the prequalification documents and the actual bid.

To speed up the processing of permitting documents an engineering contract was already signed in November 2012 with the technology supplier. This agreement was supplemented by the granting of the actual supply contract for the entire grate and boiler lot in February 2013. The building permit was finally granted in November 2013 by the authorities and construction work started immediately. Under the contract the plant is to be operating and handed over at the latest by the end of 2015.

The collaboration between POSCO and the Ratingen technology supplier is running successfully and is geared towards close cooperation and an intensive exchange of information on all aspects of the waste incineration plant.

### 3. The technology of the waste-to-energy plant Krakow

The construction of the waste incineration plant is conventionally designed with the specified two-line layout. At the design point with a calorific value of 8.8 MJ/kg the throughput per line is 14.1 t/h resulting in an annual capacity of 220,000 t. According to the combustion diagram a maximum annual throughput capacity of 250,000 tonnes is available. Under the minimum requirements of the invitation to tender the steam was set at 40 bar and 415 °C, the boiler efficiency to be reached as a minimum is 85 percent and is expected to be exceeded.

In principle it would have been possible to create this throughput with only one incineration line. Larger throughputs are controlled safely and can contribute to a reduction in operating costs with the result that this approach could perhaps be taken into account in new plants in the future.

The incineration principle selected was a tried and tested two-stage air-cooled reciprocating grate system. The subsequent five-pass boiler generates approximately forty t/h steam which is converted in the following water-steam cycle into both electricity and district heating. A SNCR process is used to capture nitrous oxide to provide an emission value of approximately 100 mg/m<sup>3</sup>n. The downstream flue gas cleaning system with spray absorber and fabric filter is designed to ensure the attainment of the

contractually agreed emission limit values which, in some cases, are considerably below European guidelines. The plant equipment is supplemented by bottom ash treatment and a process to stabilise the residues from flue gas cleaning plant.



Figure 1: Award-winning architecture of the waste-to-energy plant Krakow

Another positive feature of the Krakow project is its interesting architecture. In a competition prior to the actual plant procurement procedure architectural firms were asked to draw up a proposal. The architectural firm Manufaktura Nr. 1 Boguslaw Wowrzeczka from Wroclaw submitted the design shown in Figure 1 which was selected by a Commission as the best.

In a further procurement process KHK put the engineering consulting services (owner's engineer) out to tender. The company Engergopomiar from Gliwice emerged as the successful bidder in this procurement procedure and monitors the development of the project today on behalf of KHK.

The original time schedule after the signing of the contract in October 2012 envisaged the beginning of civil work for mid-2013, immediately after the necessary permits were obtained. This was delayed so that the laying of the foundation stone and thus the start of construction could only take place in November/December 2013. However, it is anticipated that the handover of the plant will take place, as planned, by the end of 2015.

Based on the experience of the Ratingen technology supplier in the development of various turnkey power plants in Poland (CCPP Lublin 235 MWe and Rzeszow 96 MWe as well as the flue gas desulphurisation plant at Dolna Odra) the general contractor

Posco can expect full support. Also, the technology supplier provides the contractually guaranteed roles of the Contractor's Representative and Chief Designer. Additional support is also available from its Polish affiliate which has about 400 employees having a turnover of ninety million PLN in the service business. It goes without saying that Polish sources of supply are given adequate consideration in the awarding process.

The waste-to-energy project Krakow can be showcased today as a particularly good example of successful cooperation between a Polish local council, a Korean contractor and a German technology supplier.

#### 4. Future projects and outlook

As previously mentioned five of the six waste incineration contracts awarded in the year 2012 were tendered and awarded as construction contracts. The relevant contracting authorities intend to operate their plants later with their own, local companies. It remains to be seen whether this approach can and will be maintained in the future. In the interest of reducing the operating and disposal costs future customers could award the construction and operation of plants to private companies, in other words complete these projects as part of PPP projects as is already envisaged in the project Poznan. This project has shown that PPP projects are basically feasible for the construction and operation of waste incineration plants in Poland.

It is noteworthy the Poznan project was awarded on the basis of a dialogue procedure and the resulting price level was in line with expectations. It is hard to understand why this project was awarded along these lines while the pure construction contracts were tendered and awarded based on an inflexible, single-stage procedure not actually suitable for such projects. It would be preferable if in the future contracting authorities would also opt for the negotiation or dialogue procedure when they are awarding pure construction contracts for waste incineration plants. This could eventually lead to an optimised solution for customers even if this is associated with increased demands in terms of taking responsibility.

At this point, it should be noted that it is not the contract award procedure as such that is being criticised but rather how it applies to a complex construction project for which there is not just one solution. Conflicts arising from the inability to change the tender specifications in the course of the performance of a contract were thus avoided. The impression is created that here in some cases solutions simply have to be implemented because they have been incorporated in the tender in the course of the preliminary planning, maybe even justifiably, but have proved unfavourable in the course of the project execution. Innovation and optimisation possibilities are thus sidelined due to bureaucratic requirements and procedures and unnecessary extra costs must ultimately be borne by the citizens.

Overall, the market for waste incineration plants in Poland has developed quite dynamically. The market has contracted a little after the six contracts awarded in 2012. However, it is expected that many more waste incineration plants will be built in the future.

Optimistic estimates envisage the construction of up to thirty more plants by the year 2020 that will be distributed throughout the country. Two-thirds of the units could be erected in the south and southwest of the country alone. The greater Warsaw area with a population of around two million also offers huge potential for the construction of one or more large plants.

Given the associated high investment, the efforts of the Polish State in terms of waste separation and recycling, the necessary but limited resources to build the plants as well as the complex procurement procedures that are not likely to be simplified, the aforementioned volumes do not appear real. Analyses from the national waste management plan for 2010 [7] which already for 2010 and 2013 respectively forecast the construction of up to seven or up to ten waste incinerators in Poland proved much too ambitious. Even if waste incineration plants are politically desired in Poland – the national waste management plan 2014 defines the thermal recycling of waste as the preferred treatment method for unsorted municipal waste in economic regions with at least 300,000 inhabitants – each project involves a substantial timeframe with the result that a significant volume of procurement cannot be expected until the middle of the decade.

Starting from an annual amount of waste of 350 kg per person for approximately 38 million inhabitants and a rate of thirty percent for thermal waste recycling this equates to a further potential of eight to ten plants at a size of 250,000 tonnes each.

Under the assumption that these four million tonnes of waste are thermally treated, about 2.2 TWh of electricity and approximately 6.5 TWh of heat a year could be produced. In comparison with this around ten TWh were produced in 2010 in the Turow power plant in which approximately seven percent of all Polish electricity is generated using about ten million tonnes of lignite [3].

If the conditions of the German waste management market were transferred to Poland an incineration capacity amounting to 5.2 million metric tonnes of waste would even have to be installed [2].

With the necessary patience and staying power the success story of waste incineration in many Western European countries which have now fully moved away from land-filling untreated waste has shown that waste recycling and waste incineration can be developed together and complement each other.

Legislation and environmental awareness are the driving factors that will have a positive influence on the market volume for waste incineration plants in Poland. On the other hand bureaucracy and funding issues are the limiting factors. Poland is facing major challenges in relation to proper and environmentally sound waste management over the next few years and the company Doosan Lentjes is ready to contribute to the achievement of these goals with its sophisticated technology.

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