MBT in Germany and Europe – Development, Status and Outlook

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Abstract

The waste management in Europe has to arrange itself more and more with the guidelines of sustainable resources management and climate change targets. Therefore the material specific waste treatment by the MBT-technology, as a switch point of mass flow separation with energy-efficient treatment and utilisation of the partial streams, offers an ideal starting position. Against this background this conference paper will comment the previous development, the status and the outlook of the Mechanical-Biological-Treatment in Germany and Europe (France, Great Britain, Italy, Austria and Spain).

Keywords

Mechanical-Biological-Treatment (MBT), technical optimisation, energy efficiency, economy, climate chance/protection, energetic recovery, high caloric residual waste materials, Germany, Europe

1 Introduction

Waste management in Europe has to arrange itself more and more with the guidelines of sustainable resources management and climate change targets.. According to present studies waste management can contribute here by a material and energetic recovery of wastes by means of optimising treatment plants in an energy-efficient way. The definite implementation of the EU Waste Framework Directive in the Member States will lead to a change of the waste arising regarding quantity and quality and its whereabouts that is presently difficult to be assessed. The MBT must and will challenge the competition around the quantities and qualities of the material streams. The technical requirements and developing potentials for this purpose are given. The material-specific waste treatment with plants operating with MBT technology as switch point mass flow separation with energy-efficient treatment and utilisation of the partial streams offers not only in Europe a good starting position. The technical design of the MBT technology can be adjusted flexibly to the individual requirements and frame conditions.

Before this background the paper explains the latest development, the status and outlooks of the mechanical-biological waste treatment in Germany (NELLES ET AL., 2011) and Europe (France, Great Britain, Italy, Austria and Spain).

2 MBT in Germany

2.1 Development and status of MBT

For the moment 46 MBT plants with a capacity of approx. 6 million Mg p. a. are operating in Germany and in these plants approx. 25 % of the arising municipal solid wastes are treated in a mechanic-biological way (ASA, 2010). The realised process concepts o are varying strongly and can't be compared easily.

Basically two extreme variations can be differentiated before the background of the legal frame condition primarily of the requirements of the Waste Storage Ordinance AbfAblIV and the 30th Emissions Protection Act BImMSchV. Final rotting process types (aerobic/anaerobic) are aiming for a biological stabilisation of the organic components of the waste to be landfilled. The ideal case with the dry stabilisation variations is to furnish all the arising solid residual material for an energetic respectively material recovery (see figure 2). At present round 20 to 30 plants with a capacity of 2 to 3 millions Mg/a are in operation in Germany additionally preparing the medium-calorific refuse derived fuels (RDF) by means of mechanical and physical processes (MA-plants). (ASA, 2010). They are exclusively energetically recovered in coal-fired power plants, in the cement industry or more often in industrial mono-incineration plants (RDF power plants).

Figure 1: Plants with MBT technology in German [ASA, 2010]

Most of the plants with MBT technology presently operated have been planned in the years 2001 to 2005. Generally a comparably short time was available for the realisation. As of the middle of 2005 the MBT plants must prove themselves on the market and fulfil the high requirements of the AbfAblV and 30. BImSchV safely and continuously during operation. Before this background the plants with MBT technology have been and are continuously optimised over the last 6 years, the teething troubles are solved and the process concepts adapted to the changing frame conditions in the waste market. Meanwhile the plants with MBT technology achieved a high processing standard and developed themselves to an important cornerstone in waste management.

The essential approach for optimising and retrofitting of plants with MBT technology in practise are explained in chapter 2.2. In many cases they have been realised respectively are momentarily realised. Hereby the present developments in the areas of plant input, mechanical pre-treatment, biological treatment, exhaust air purification, residual waste and the topics climate protection, energetic efficiency and cost-effectiveness are addressed (NELLES ET AL., 2010).

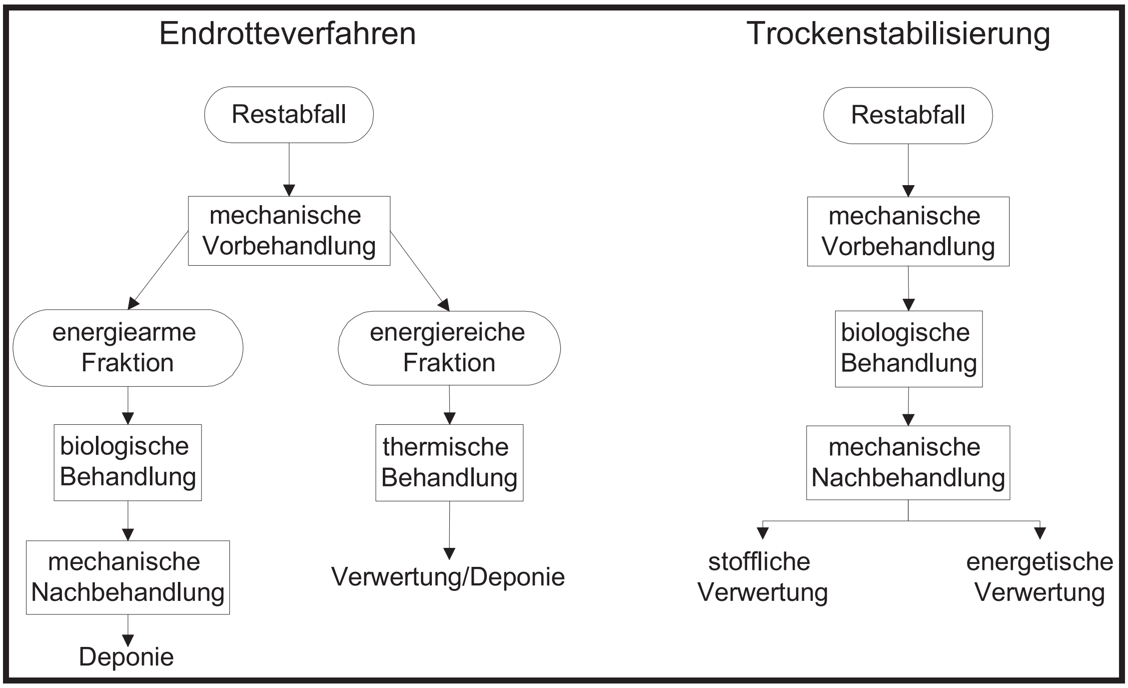

Figure 2: Simplified Illustration of basic MBT concepts in simple terms

Legend:	
Endrotteverfahren = Final rotting processes	***Trockenstabiliserung= Dry stabilisation***
Restabfall = residual waste	*Restabfall = residual waste*
Mechanische Vorbehandlung = mechanical pre-treatment	*Mechanische Vorbehandlung = mechanical pre-treatment*
Energiearme Fraktion = low calorific fraction	*Biologische Behandlung= biological treatment*
Biologische Behandlung = biological treatment	*Mechanische Nachbehandlung = mechanical post-treatment*
Mechanische Nachbehandlung = mechanical post-treatment	*Stoffliche Verwertung = material recovery*
Deponie = landfill	*Energetische Verwertung = energetic recovery*
Energiereiche Fraktion = high calorific fraction	
Thermische Behandlung = thermal treatment	
Verwertung/Deponie = recovery/landfill	

Municipal solid wastes are pre-treated in plants with MBT technology with a material specific waste treatment. This means that for selection and agreement on treatment steps of these wastes their - mostly very different - material properties are decisive. This approach is reflected in three process concepts:

– **M**echanical **b**iological waste **t**reatment (MBT process, aerobic/anaerobic)

– **M**echanical **b**iological **s**tabilisation (MBS process)

– **M**echanical **p**hysical **s**tabilisation (MPS process)

The mostly used process for a material specific waste treatment is the mechanical biological waste treatment. Here the material streams are segregated for further biological treatment or for recycling or for energy recovery. The biological treatment is realised in rotting processes (channels or windrows) or in digestion steps (dry and wet digestion). The final product is a material which can be landfilled (material to be landfilled) With mechanical biological stabilisation biological drying fo the total solid wastes, the total waste input is used generate high calorific value wastes while minimisation of the material stream to be landfilled. With mechanical physical stabilisation the high calorific wastes waste components from municipal solid wastes are only separated by means of mechanical and physical processes and pre-treated in the frame of a multistage treatment process to a refuse derived fuel. This pre-treatment process e.g. comprises a separation of the low calorific value components and the Fe and non-Fe metals together with a multistage crushing. If necessary, harmful fractions are segregated and the fraction rich in calorific values dried.

2.2 Optimisation of MBT technology, energy efficiency, climate protection and economy

Partly up to 70 waste codes as **plant input** are allowed for MBT plants so that a broad spectrum of wastes can be treated. This caused problems in the run of the first operation years in some plants with MBT technology, as sometimes fractions have been treat with MBT which could not yet be treated according to intended operation targets. In between most of the plants with MBT technology developed acceptance lists so that the obligation to dispose of a region no longer affects the operation safety of plants with MBT technology. On the other hand extensive experiences have been collected in practical operation so that further waste codes can be integrated in the operational run without endangering the treatment success. This is even necessary for many plants with MBT technology because the delivered waste amounts, especially from industrial and commercial sources, decreased strongly. Before this background it is attempted to acquire additional wastes (road sweeping with a high portion of organics, sewage screenings from waste water treatment etc.) at the disposal market.

A great advantage of the MBT technology can be seen in the high flexibility concerning changing requirements on the waste market. The basic components of this are the **mechanical pre-treatment steps,** acting as switch point for the market based individually adjusted treatment and steering of the material streams. In this area very different systems have been realised in practise as well and about 6 years of experience were collected. Hereby the preparation steps prior to and after biological treatment are continuously optimised to improve the biological degradation respectively drying of the native-organic fraction in order to enable the energetic recovery of the high calorific fraction as far as possible in industrial incineration plants with a high total efficiency factor. In this way the plants with MBT technology in Germany are able to provide constant good qualities for the most different applications (coal power plants, cement plants or refuse e derived fuel RDF power plants). This is also important as the high-grade energetic utilization of the RDF is of decisive importance for the ecological overall assessment of the individual MBT concept. Despite of this a need for further optimisation of the mechanic pre-treatment steps can be seen in nearly all of the plants with MBT technology in Germany in order to improve the quality of the pre-treatment products and to increase the economy of the pre-treatment (reduction the energy consumption, wearing etc.).

During the first years of operation many plants with MBT technology optimised especially the **biological treatment**, i.e. shortening of the treatment time to produce a material suitable to be landfilled. In this aspect the plants with MBT technology could achieve considerable progress and usually the criteria for landfilling are met in less than 10 weeks. This creates additional capacity of treatment and it is ecologically advantageous leading to an improved cost-efficiency of the MBT. As a reduced biological treatment time leads in many cases to lower exhaust air quantities advantages can be seen in the range of exhaust air purification as well. In future anaerobic systems will achieve higher importance as energy can be "generated" from certain fractions intended to be land-filled. By the integration of digestion steps the energy efficiency of the overall MBT concept can be influenced positively and thus the positive ecological effects can be enforced. That the retrofitting of an anaerobe step is sensible even in existing MBT plants proves e.g. the MBT Rostock that was supplemented by a partial stream digestion plant with three thermophile operated fermenters (NELLES ET AL., 2009a).

The 30. BImSchV requests for MBT plants in Germany a thermal exhaust **air purification**. The air quantities where drastically reduced on behalf of the demands in the 30. BImSchV with its limitation TOC and N_2O loads based on treated waste amounts. This has been achieved by multiple use, cooling re-circulated air etc. of exhaust air partial streams. Up to now in a number of MBT plants the regenerative thermal oxidation (RTO) part didn't fulfil the expectations on availability and technical maturity of the very special exhaust air treatment from MBT (corrosion, blocking of the heat exchanger packing with components of silicon dioxide etc.). Despite of the continuous efforts for a technical optimisation of the RTO it must be noted here that a use of a thermal exhaust air purification of MBT exhaust air must be critically assessed under eco-balance point of views! The exhaust air purification in the MBT plant Rostock has been realised in an ecological and elegant manner. Here the exhaust air is not treated anymore via the RTO but forwarded as combustion air of the RDF power plant to the neighbouring site in the deep-sea port of Rostock (NELLES ET AL., 2009a).

In the frame of material recovery of **residual wastes** the metal separation has been strongly intensified lately, increasing raw material prices show here a positive effect. Especially non-ferrous metals are becoming increasingly interesting. Problems existed with the energetic recovery of the high calorific fraction some three years ago. This was due to the lack of sufficient industrial incineration plants willing to accept the processed refuse derived fuel. In between some additional RDF power plants have been realised. Capacities of about 5.8 million Mg/ are running or are under construction and further 1.4 million Mg/a are approved respectively in the approval stage.

After realisation of these plants a total capacity of over 7 millions Mg/a are available in future (ASA, 2010). On the other hand the quality assurance of the RDF has been considerably improved during the last years so in between constant fuel qualities adjusted to the individual RDF power plant can be delivered. Thus the situation in practical operation has been reversed. The additional payments by the MBT operator for energetic utilisation of the RDF dropped strongly and in between revenues for high calorific fuels are achieved at least to some extent. he landfilling of a biological stabilised or mechanically separated inert "fraction to be landfilled" is a component but not the prior-ranking target of the MBT concepts in Germany. The quantitative and especially the treated waste with a higher energy content is forwarded towards material and energetic recovery. For the moment utilisation concepts are tested for the fine and inert fraction from the MBT. As long as the fine fraction is landfilled a development and monitoring of adjusted landfill concepts are necessary. Fears of a insufficient stability of MBT landfills could be refuted in between by the practice.

The **energy efficiency** of combined processes with plants for MBT technology and energetic utilisation of the high calorific fraction is determined already today by the energy efficiency of downstream processes of the energetic recovery. On the contrary the energy demand for the pre-treatment of wastes in the MBT is subordinate. In cases where high calorific fraction of the waste components is separated and their effective utilisation in coal-power or cement plants takes place higher net efficiency factor can be achieved than with the combustion of the total wastes in a waste incineration plant (MVA). Yet the energy efficiency of the overall process and thus the contribution to climate protection can be further improved. To be named among others are here the integration of digestion steps, the optimisation of the energy consumption, the increase of the yield and quality of the high calorific waste fraction, the optimisation of the separation of Fe and non-Fe metals and further partial fractions with the target of material recovery.

The optimisation of the **economy** of plants with MBT technology is a central topic in the disposal market before the background of the present frame conditions with the considerable over capacities in the range of thermal waste treatment. These over capacities caused a considerable decrease in prices during the last two years. This tense situation can only be defused slowly. The plants with MBT technology must hold their ground in this conflict and this isn't easy work. The specific treatment costs including residual waste disposal in most plants with MBT technology are approximately 80 to 120 €/Mg even at full capacity. The possibility of influencing the overall treatment costs are differing between all plants and depend on the individual specific frame conditions. The advantage of a plant with MBT technology e.g. compared with an incineration plant can actually be seen in the fact that the MBT can actively influence the material streams in quantity and quality leading to an improved cost-effectiveness in the individual case. Furthermore there are many other starting points for the improvement of the economy beyond the MBT borderlines what implies the use of synergy effects by integrated solutions as well. In the city of Lübeck the leachate with a low contamination coming from an adjacent municipal landfill can be integrated in the process water loop of the MBT that means that it is not necessary for the landfill to operate an own plant for the treatment of leachate. (NELLES ET AL., 2009b).

3 MBT in Europe

3.1 Development, status and perspective of the MBT

Within a few years the MBT technology in Germany achieved a high status of development and this experience must be established in foreign countries in an adapted form during the coming years. Two groups of countries can be distinguished in a simplified approach.

On the one hand these are the countries which already have a well functioning waste management sector in place. These EU countries having already realised similar MBT standards in waste treatment (e.g. Austria), but also the "new" and some of the "old" countries in the EU with waste management still in a starting phase. Here material stream specific optimised waste management concepts with an integrated MBT solution can provide an essential contribution for a sustainable development. The processing of refuse derived fuels and their ecologically viable energetic recovery is more and more the main emphasis.

The number of the mechanical-biological waste treatment plants in Europe did increase during the years 2005 to 2011 about 60 % on more than 330 plants, whereas an increase of treatment capacities about 70 % on 33 million Mg occurred. (ECOPROG, 2011). Countries like Germany, Austria and Italy where the mechanical-biological waste treatment has a longer tradition, a relatively larger part of the population is connected to MBT systems (see figure 3) than in other EU countries. These countries show correspondingly higher treatment capacities whereas Italy has the highest treatment capacity all over the world.

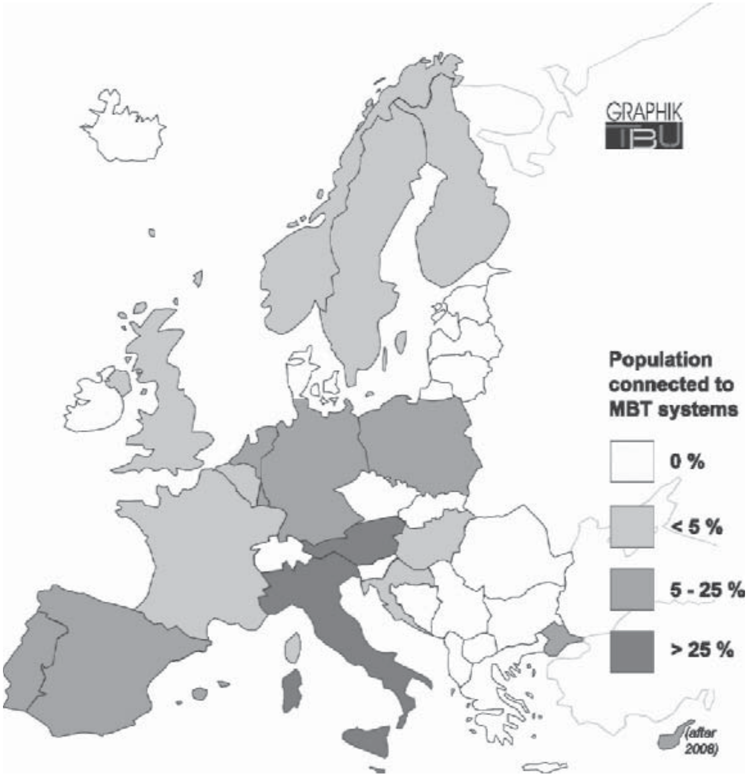

Figure 3: Estimated percentage of the users of MBT systems in Europe (STEINER, 2007)

According to the *„Market Study MBT"* one can assume that within the next five years the number of mechanical-biological waste treatment plants will rise onto more than 450 plants and the treatment capacities onto 46 million Mg. (ECOPROG, 2011).

The requirements of the EU Landfill Directive article 5 to reduce the amount of organics by 65 % caused to an introduction of different parameters and limit values in some EU countries for the assessment of the stability of the treated organics (see table 1). Yet not all of the EU countries adopted own standards in their national legislation to implement the requirements of the Landfill Directive. Those countries often come back to the limit values and parameters of the "Working document on the Biological Treatment of Bio-waste, 2nd draft", whereby in Germany and Austria the limit values to be kept are essentially more demanding.

Table 1: Parameter for the assessment of the stabilisation of organics in different countries (MÜLLER ET AL, 2011)

Country	Parameter	Limit value
EU	Respiration activity "AT4"	< 10 mg O_2/g DM
	Dynamic respiratory Index "DRI"	< 1.000 mg O_2/(kg oDM x h)
Germany	Respiration activity "AT4"	< 5 mg O_2/g DM
	Digestion test "GB21"	< 20 Nl/kg DM
Austria	Respiration activity "AT4"	< 7 mg O_2/g DM
	Gas formation test "GB21" or "GS21"	< 20 Nl/kg DM
Italy	Dynamic respiratory Index "DRI"	< 1.000 mg O_2/(kg oDM x h)
UK and Wales	Change of the gas formation potential of the treated waste In relation to the fresh waste determined over gas formation potential in 100 days "BM100"	No limit values regarding the gas formation potential of the waste to be landfilled but comparison with assigned maximal quantities of organic to be landfilled
Scotland	Organic degradation in the treatment process	Analogous to UK and Wales
	Determination parameter Volatile solids	
	Other evaluation options can be proposed	
Sweden/Norway	TOC-solid material organic-content	< 10 % DM < 20 % DM

3.2 France

France is one of the few EU countries that doesn't push separate collection of biowastes thus not following the European approaches. France still uses compost and digestate from mixed waste in agriculture and viniculture. By means of the extensive mechanical preparation composts shall be produced with a low content of harmful matter and the a corresponding high quality. On account of this assumption separate collection in France is looked upon as being not necessary.

Table 2: Residual and biowaste treatment plants in France (MÜLLER ET AL., 2011)

		Number	Capacity (Mg/a)
MBT with compost production			
Composting plants	In operation	12	430.000
	under construction	11	300.000
	planned	7	300.000
Digestion plant with post-composting	In operation	3	270.000
	under construction	5	750.000
	planned	6	800.000
MBT without compost prodcution			
Composting plants	In operation	4	180.000
	under construction		
	planned		
Digestion plant with post- composting	In operation	1	70.000
	u. construction	0	
	planned	1	80.000
Sum MBT	In operation	20	950.000
	under construction	16	1.050.000
	planned	14	1.180.000
Biowaste recycling			
Biowaste compost plants	In operation	0	
	under construction	?	
	planned	?	
Biowaste digestion plants	In operation	3	150.000
	under construction	1	40.000
	planned	?	

3.3 Great Britain

The responsibility for waste disposal in the UK is delegated in the first instance to the municipal level which means an essential difference compared with other EU countries the national legislation of which is of highest importance. The local authorities decide among others which treatment methods for wastes from households should be applied. Additionally they are responsible to achieve binding targets of the EU Landfill Directive.

The waste market in the UK is one of the most dynamic in Europe. Few mechanical biological waste treatment plants are running in the UK. Especially during the last years the treatment method for residual wastes was pushed forward not only on account of the missing acceptance in the British population for waste incineration plants but also by the developments and requirements on a European level. For the moment more than 70 waste treatment plants (MBT, Incineration plants) are required whereby definite plans exist for 25 mechanical biological waste treatment plants (ECOPROG, 2010). Furthermore several high-class MBT systems are under construction. The biological treatment of most of the plants presently in operation is aerobic by composting. Additionally discussed in the UK is the autoclave method as a possible treatment method (MÜLLER ET AL., 2011).

3.4 Italy

The mechanical biological waste treatment in Italy has a long tradition. Italy is the country with most mechanical biological waste treatment plants and with the highest treatment capacity. A total of 133 plants with approved treatment capacities of 14 million Mg/a is in operation, whereby the exact capacity deviates from the approved one (MÜLLER ET AL., 2011). Reasons are on the one hand reconstruction measures and revisions and on the other hand many plants are modified for the treatment separately collected biowastes.

Italy is one of the few European countries exporting MBT technology. Examples can be found in Sydney and Abu Dhabi (STEINER, 2007).

Primarily very challenging MBT concepts were realised in Italy, many of them have been closed-down through the missing acceptance of the population. Predominantly the volume reduction in MBT concepts is in the focus at the moment. For this purpose conventional plant types with separation of the high calorific fraction and the aerobe treatment of organic part in the composting processes are applied. In addition many plants were equipped during the last years with dry fermentation steps.

The organic fraction generated after preparation and treatment is send to landfills subsequently. An individual permission must be obtained to apply MBT rotting material in agriculture as the legal authorities allow this land application only in special cases. In general the farmers rather prefer the abundantly produced biowaste compost, i.e. the MBT material is mainly for restoration measures only.

3.5 Austria

Austria implemented the requirements of the European Landfill Directive for waste in the year 2004 through a national Landfill Ordinance. In order to standardise the plants and technology and to simplify the approval process for all parties involved already in 2002 the Guideline for a mechanic biological waste treatment was adopted.

In Austria 16 mechanic biological waste treatment plants are presently in operation and two are planned (see figure 4). The treatment of the accepted wastes is exclusively aerobic, whereby approx. 45 % of this waste stream is separated as high calorific fraction and in 29 % of the waste amount is landfilled afterwards. (BUNDESUMWELTSAMT GMBH ÖSTERREICH, 2011).

Figure 4: Location of the plants and projects in Austria 2011 (ECOPROG, 2011)

3.6 Spain

In Spain 30 mechanical biological waste treatment plants are presently in operation with a treatment capacity of more than 4.5 million Mg/a (see figure 5). Two further plants are under construction and five plants in the planning phase (see table 3). Furthermore an increase of treatment capacities up to more than 5.5 million Mg/a will be expected and a number of plants up to more than 35 until the year 2016 (see figure 5). Compared with other countries Spain has most of the waste digestion plants (MÜLLER ET AL., 2011).

Separate collection takes place mainly in the North of the country (e.g. Catalonia) with the resulting the production of high quality fertilizers whereas other regions don't follow. In these region agricultural application of the mixed waste composts is common whereby standards for the quality can be found in the *Real Decreto 824/2005*.

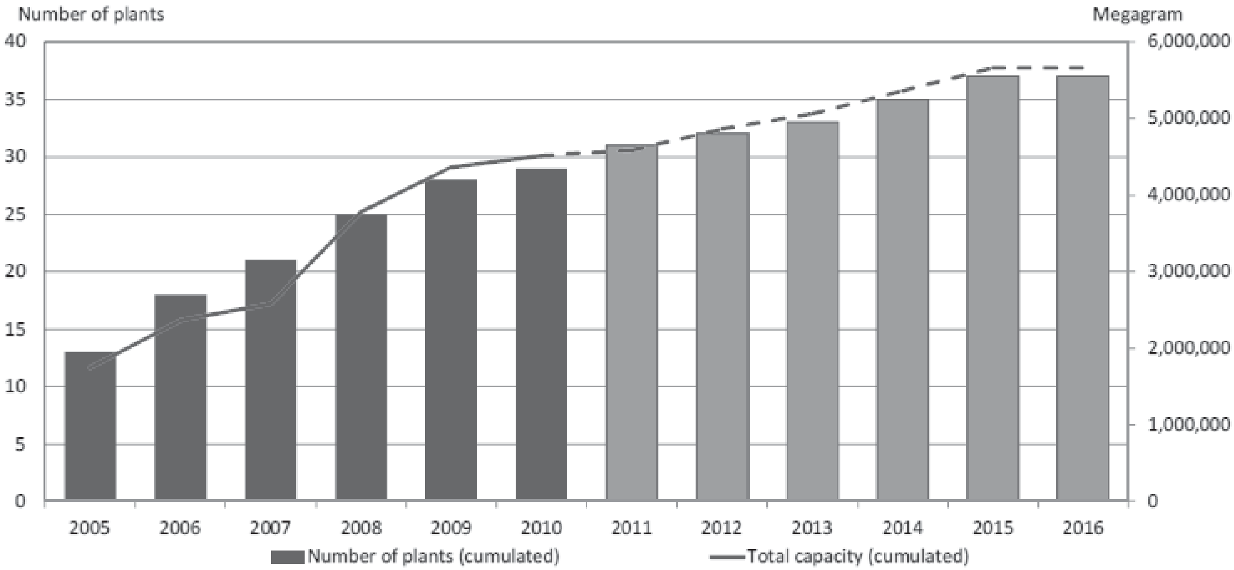

Figure 5: Prognosis MBT market in Spain (ECOPROG, 2011)

Table 3: Forecast MBT projects in Spain (ECOPROG, 2011)

Plant	Capacity (t/a)	Start	Status	Comment
Lloret de Mar	42,000	2011	under construction	planned by RosRoca/KELAG
Mataró	277,300	2012	under construction	n/a
Aretxbaleta	200,000	n/a	planned	planned by FCC
Bizkaia	180,000	n/a	planned	next to the WTE Zabalgarbi
Cervera del Maestre	70,000	n/a	planned	planned by Ecodeco
Pedret i Marzà	n/a	n/a	planned	planned by RosRoca/KELAG
Zubieta	168,000	n/a	planned	n/a

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