The Waste-to-Energy Power Station – The Perfect Location to Build a Fermentation Plant

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1 Introduction

Since the concept of a separate collection of waste by categories was first thought of in 1983, the protagonists of conventional waste disposal have faced off against their opponents who wanted to recycle materials exclusively.

In the mean time, there are many reasons to abandon these contrary positions and think about synergies between the concepts of thermal and material recycling processes. The latest impulse for this is surely the most recent legal development in the European Union in accordance with national objectives of having a waste management system that is more directed at the protection of the climate and resources.

2 Summary

Until now little attention has been paid to organic waste treatment facilities as sources of critical greenhouse gas emissions, methane and laughing gas. The European Waste Framework Directive, as well as the current working paper on the Recycling Act gives reason to expect that these problems will be exacerbated by increasing capacities, since the intention is to increase separate collections of organic waste.

Against this backdrop, the Working Group of Thermal Waste Treatment Plant Operators in Bavaria (ATAB) commissioned the consortium of ia GmbH, Munich and Qonversion, Bamberg with the study at hand in autumn 2009: "Optimisation of Eco-efficiency in Fermentation Plants through the Integration of Thermal Waste Recycling". The project was financed by the Bavarian State Ministry for Environment and Health.

The goal of the project was to check the eco-efficiency of integrating organic waste fermentation plants (BGA) into the operation and infrastructure of existing waste-to-energy power stations.

The focus of the examinations was the minimisation of the climate-damaging greenhouse gas emissions of methane and laughing gas from organic waste fermentation plants, efficiency enhancement of organic waste fermentation, as well as the operational optimization of organic waste fermentation plants with regard to optimizing power-heat coupling by common use of the infrastructure and technological facilities of waste-to-energy power stations.

Three different sites in Bavaria with different sized waste-to-energy power stations were taken on a model basis and re-designed with specific fermentation plants tailored to the respective local peculiarities. Following the detailed examination of these three facilities the improvement of eco-efficiency can clearly be demonstrated:

- The greenhouse gas emissions of a fermentation plant integrated into a waste-to-energy power station can be significantly reduced.
- In comparison to single standing facility ("green field") greenhouse gas emissions can be reduced by between 53% and 69% with the integrated concept.

- In the integrated operation, the interplay between costs and revenues demonstrates a saving of over 25% on average in comparison to a green field reference facility.

In the case of all three examples that were considered, it was discovered that the integrated operation of a fermentation plant in a waste-to-energy power station generally brings advantages. In the event that a new fermentation plant is to be constructed and it is possible to use an existing waste-to-energy power station, then this potential realization is strongly recommended – also for reasons of acceptance by the general public.

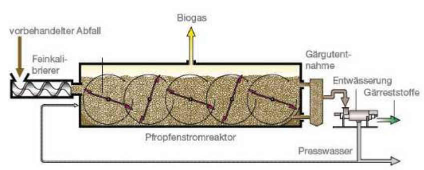
3. Problem Definition

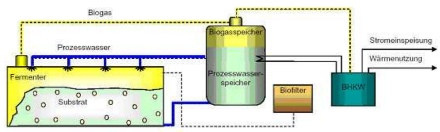
The problem definition required on the one hand a technical evaluation of the participating waste incineration plants, in order to give the study a sound practice-relevant basis, and on the other hand, the examination and evaluation of the competing fermentation technologies currently available on the European investment market within the framework of a detailed comparison. The evaluation of the participating waste-to-energy power stations took place in close consultation and discussion with the operators of the plants, in order to grasp the peculiarities of the respective sites and to develop sound approaches to the possible synergies for the specific locations, together with on-site experts.

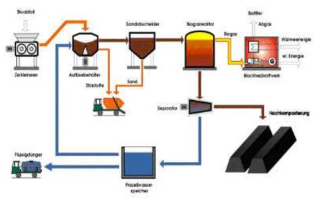
On the basis of the insight gained and in consideration of the basic framework of the individual waste-to-energy power stations recorded by questionnaires, the choice of the optimal fermentation technology for each respective waste incineration plant participating in the pilot project was made. With regard to optimizing the eco-efficiency by using existing buildings, the following combinations were chosen for the study:

GfA Geiselbullach:	discontinuous dry fermentation
ZAS Burgkirchen:	wet fermentation
AVA Augsburg:	continuous dry fermentation







Illustrations 1-6 clockwise: AVA Augsburg, GfA Geiselbullach, ZAS Burgkirchen, BTA International GbmH, Loock Biogas Systems GmbH, Strabag Environmental Systems GmbH

While planning the integration of fermentation plants, the following points were above all decisive:

- Treatment of BGA exhaust air streams in the furnace of the waste-to-energy power stations
- Spatial conditions for coping with the impending or potentially available organic waste
- Possibilities to utilize fluid fermentation residue, resp. surplus water
- Energy use and availability

4. Accounting of the Plants

The most important data of the waste-to-energy power stations concerned, which were ascertained during on-site visits, are presented in short form in Table 1.

	GfA Geiselbullach	ZAS Burgkirchen	AVA Augsburg
Waste input (Mg/a)	100,745	228,000	~200,000
Number of furnace lines	2 (+1)	2	3
Energy output to third parties -Electricity [MWh/a] -Heat [MWh/a] -Process steam [MWh/a]	 48,143 13,511 -	 75,000 - 73,000	 78,085 38,008 -
Type of flue gas cleaning (FGC)	Dry FGC with bicarbonate and fibrous filter, SCR with natural gas furnaces	Electrostatic filter, three-stage scrubber, SCR with steam heating, fibrous filter with active coke	Electrostatic filter, two-stage scrubber, SCR with steam heating, fibrous filter with active carbon
Liquid which can be used additionally in the waste-to-energy power station [m^3/a]	~4,500	~15,000	7,000 – 15,000

Table 1: Short Overview Waste-to-Energy Power Station

Together with the plant operators the existing organic waste potential in the catchment areas of the respective plants was estimated. Table 2 shows the essential parameters which provided the basis for the allocation of procedures.

Site		Geiselbullach	Burgkirchen	Augsburg
Chosen procedure		Closed dry fermentation	One-stage wet fermentation	Dry fermentation plug-flow process
Organic waste flow-rate	Mg/a	15,000	25,000	45,000
Space available on plant grounds	-	yes	yes	yes
Fluid fermentation residue / Surplus water from BGA	m^3/a	800	9,500	13,800
Solid fermentation residue from BGA	Mg/a	12,300	10,300	18,300
Producible volume of (raw) biogas	m3N/a	1,337,000	2,550,000	4,208,000
Biogas utilisation	-	CHP, long-distance heating	Treatment for feed into natural gas grid	CHP, long-distance heating

Table 2: Overview of the essential parameters of the chosen fermentation technologies

While ascertaining the plant data of the waste-to-energy power stations participating in the project, the most important parameters in the power stations were the deployable volume of fluid, the use, respectively the availability of heat energy, as well as the volume of exhaust air that can be integrated.

In order to illustrate the synergetic effects of the operation of a BGA in a waste-to-energy power station site, the facility layout of every fermentation plant to be integrated was developed for the green field and its emissions and profitability analysis carried out under comparable basic conditions. As a basis for the calculation of emissions in this study, the emission factors from [Cuhls, 2009 and Cuhls, 2010] were used.

5. Integration of the Fermentation Plants into the Waste-to-Energy Power Station Sites

5.1 Implementation of the BGA at Each Respective Site

In order to demonstrate the synergy effects of an integrated operation in detail, the implementation of the plan to integrate the respective fermentation process at the waste-to-energy power station sites in Geiselbullach, Burgkirchen and Augsburg was effected. In addition to the integrated process layout, the pipeline routes for the connection of exhaust, heat, wet fermentation residue and biogas to the respective waste-to-energy power station was planned.

From the plant layout it can also be seen what volume of exhaust air is to be treated in the waste-to-energy power station, respectively the biofilter.

5.1.1 GfA Geiselbullach

After rerouting the traction current lines, the closed system with a capacity of 15,000 Mg per year can be integrated in the area of the bale storage on the waste-to-energy power station site in Geiselbullach. The plant layout displays the following major parts of the process: Delivery and treatment of encapsulated organic and green waste storage, mashing area, the fermenter tunnel and the rotting tunnel for the purification of the fermentation residue. The packaging of the fresh compost after its purification takes place off-site by third parties.

Next to the hall, the biofilter and the lean gas flare, and/or emergency flare are situated. The thermal power station for biogas utilisation is next to the central long-distance heating unit, approximately 80 meters away. The connection of the exhaust air to the furnace of the waste-to-energy power station takes place by channelling the exhaust air into the primary air extraction of the bunker. The usable heat is fed into the long-distance heating grid via the central long-distance heating unit. The wet fermentation residue is channelled into a neighbouring sewage treatment plant over a pressure line.

In the closed system, the exhaust air from the fermentation requires special attention. The fermentation exhaust air from the delivery and removal processes cannot be entirely fed into the biogas system of the process (this differs between the different system manufacturers). Exhaust air polluted with methane with a methane volume of 20 to 1% is normally burnt off in the lean gas flare. In an integrated system, the fermenter exhaust of between 5 and 1% can be fed into the furnace of the waste-to-energy power station. In this way, an additional 14,000 m^3/a of biogas can be utilised at the thermal power station in Geiselbullach.

5.1.2 ZAS Burgkirchen

At the Burgkirchen site, the integration of a one-stage wet fermentation process with a capacity of 25,000 Mg/a is foreseen. The delivery of organic waste by the collection vehicles, the preparation of organic waste, the drainage of the fermentation residue and the technical facilities can be integrated into the existing slurry storage area. In the outside areas, the fermentation stage, fermentation residue, biofilter, gas preparation, purification and emergency flare can be situated.

The purified dry fermentation residue can be utilised as fresh compost directly in agriculture, used in the manufacture of substrate or refined to finished compost. A further treatment at the plant is not planned. It is to be noted that with an extension of the fermentation stage with a further fermenter, the capacity of the organic waste fermentation plant (with a two-shift operation) can be increased up to 50,000 Mg per year.

The connection of the exhaust air to the furnace of the waste-to-energy power station takes place with a direct feed of the BGA exhaust into the secondary air extraction above the wet purification. The wet fermentation residue is injected into the furnace. The connection of heat from the biogas preparation takes place over the low-pressure steam line of the waste-to-energy power station (2.5 Bar, 130°C). The prepared biogas can be fed into the natural gas grid.

5.1.3 AVA Augsburg

The delivery of the organic waste by collection vehicles and its preparation in existing systems is continued unchanged. The exhaust air in these areas is channelled as before as input air to the composting plate. The integration of the plug-flow process with a capacity of 45,000

Mg/a takes place in the area of composting plate 2 at the Augsburg plant. Conveyor belts transport the prepared material into holding storage. The plug-flow fermenter is separated from the drainage and the intermediate storage of encapsulated fermentation residue and green material. Only the emergency flare is situated in the outside area next to the biofilter.

After the drainage, the dry fermentation residue is mixed with the shredded green material and in the area of the composting plate 1 with existing process technology is further processed via intensive and final composting into finished compost. Further integration optimisation measures such as alternative final composting concepts and expansion planning were not considered in the study.

The pipeline to connect the wet fermentation residue is already available from the equivalent usage for excess water from composting and can continue to be used for this purpose. The exhaust air and heat pipes are each laid above ground alongside existing buildings to the waste bunker respectively the heating centre of the waste-to-energy power station. The connection of the exhaust air to the furnace of the waste-to-energy power station takes place analogue to the procedure in GfA Geiselbullach, where the extracted exhaust air is injected into the primary air extraction of the bunker.

5.2 Thermal Preparation of the BGA Emissions

The eco-efficiency for the integration of a fermentation plant into the infrastructure of a waste-to-energy power station is mainly linked to the question whether, and if so, to what extent the BGA emissions in the furnace of the power station can be made inert. The climate-relevant hazardous gas components are primarily eliminated there along with the odours that can hardly be reduced with standard biofilters. In this connection the main climate gases are methane (CH4, GWP 25) and laughing gas (N2O, GWP 298). These occur in different locations within the system, for example the storage, preparation and especially by the transition from the anaerobic phase to the aerobic after-treatment.

A number of questions have to be answered in order to enable a safe treatment and the highest volume possible of these climate-relevant emissions in the furnace of a waste incineration plant. These points will be discussed in the following chapters and suggestions derived for the technical implementation for the three applicable plants, explained and justified.

5.2.1 Substitutable Combustion Air Flow Rate

According to current technology, the extraction of combustible air for the waste-to-energy power station from the bunker creates negative pressure that prevents odour emissions from this area. In general, this is fed into the primary air for the waste incineration. The secondary air is mostly extracted from the boiler house. In some plants, extraction is made from selectively critical areas via the secondary air blower(s), for example in the area of wet purification as the formation of phosphine is feared here [Spiegel, 2002]. Therefore it is not possible to replace the entire combustion air for the waste-to-energy power station with contaminated exhaust air from the waste fermentation plant.

A further problem is that the furnaces cannot be run at full capacity for several weeks in a year (average 8-12 weeks p.a.) due to inspections. One or more combustion lines are shut down and taken out of service to conduct these inspections. In some plants this can result in a complete shutdown, i.e. all combustion lines are taken out of service. This is, however, the exception and only occurs for a short period, no longer than one working week.

As a rule, these general conditions and restrictions mean that the available combustible air capacity isn't sufficient to thermally treat the entire exhaust air of a waste fermentation plant. It is therefore necessary to capture specifically contaminated exhaust air and feed only this for thermal treatment. Exhaust air that is contaminated with odorous substances can be treated by a biofilter that is set up to handle the entire exhaust air during shutdown periods. The climate-relevant components are not removed during this period. So, due to the short inspection periods, the release of climate-relevant components is negligible in relation to the annual volume. The BGA state-of-the-art technology (reference process "green field") uses biofilters for the entire exhaust air treatment.

It proved difficult to determine the maximum volume of BGA exhaust air that can substitute combustion air, since no empirical values exist from the operators' side. In order to proceed, the operators' matching statements were used, according to which even if only one combustion line is in operation, the required air volume is sufficient to guarantee the extraction of the critical areas. Therefore, the primary air volume from one line was set as sufficient extraction volume for the bunker area. After consultation with their operators, concrete values were set for the extraction of the wet purification area.

This study, which was based on the three plants investigated, is generally applicable to further plants. The following values can be used to estimate the volume of air required to treat BGA exhaust air:

$$\dot{V}_{BGA} = (n-1)\cdot\dot{V}_{Primary} + n\cdot\dot{V}_{Secondary} - \dot{V}_{Purification}$$, with

$\dot{V}_{BGA}$	=	maximum treatable exhaust air volume from BGA	$\dot{V}_{Secondary}$	=	Secondary air volume per line
$\dot{V}_{Primär}$	=	Primary air volume per Line	$\dot{V}_{Purification}$	=	Extraction purification
n	=	Number of combustion lines in operation			

Extraction volumes from BGA that exceed these capacities have to be treated by biofilter. The extraction at emission-relevant locations of the biogas plant should therefore be as concentrated as possible for the climate-relevant components to undergo thermal treatment on a large scale.

5.2.2 Behaviour of Gas Components in the Furnace

The exhaust air from organic waste fermentation plants contains different environmental and climate-relevant toxic gases, especially methane, hydrocarbons (VOC), ammonia and nitrous oxide. In case of methane (CH4, GWP 25) – the dominating toxic component of BGA exhaust air – is the reduction of global warming potential (GWP) obvious, since it will safely oxidise during incineration to carbon dioxide (CO2, GWP 1) and water. Apart from the significant reduction of global warming potential, the furnace can possibly be fuelled with a low volume of an additional energy source with a high concentration of methane. This is especially pertinent when the lean gas from the discontinuous closed fermentation process, which occurs at the beginning of the anaerobic phase or occurs as flushing gas before the exchange of the fermenter content, is treated in the furnace. Higher hydrocarbons (NMVOC) are completely and safely converted to carbon dioxide and water in the furnace.

In the exhaust air of biogas plants there are also nitrogen components such as ammonia and laughing gas. The introduction of urea into the furnace is conceivable with the extraction of solid particles or drops of liquid. It is known that laughing gas can cause serious problems during its incineration – for example in the thermal oxidation systems of mechanical, biological treatment (MBT) plants. The behaviour of urea and ammonia depends mainly on its concentration, the place of introduction and the prevailing temperature. Principally, ammonia can contribute to the reduction of nitrogen oxides (reduction to nitrogen in the SNCR process[1]) escaping the furnace or even oxidising to NOx.

In the case of the treatment of exhaust air from biogas plants in waste furnaces, the BGA exhaust is injected as primary or secondary air into the furnace and thereby heated to higher temperatures than in fluidized-bed incinerators or in the SNCR area of grate furnaces. It can therefore be assumed that the laughing gas components initially oxidise to NO and converted to nitrogen in the subsequent dentrification system (SNCR or SCR). The existent ammonia should also not pose a problem since even in favourable temperature ranges, only small amounts of N2O are formed. However, if higher concentrations of urea are fed from the BGA exhaust air into the furnace at the corresponding temperature, then a formation of laughing gas cannot be excluded.

Due to the complexity of the system and varying conditions, it is not possible to make a definitive prediction concerning the behaviour of nitrogen components during the treatment of BGA exhaust air in a furnace using theoretical principles. The predominance of the nitrogen component ammonia in the BGA exhaust and the normally very high temperatures at the introduction of primary and secondary air, result in the conclusion that it seems unlikely that laughing gas would escape or build up in any significant concentration. Final certainty concerning this question can only be achieved by a corresponding experiment whereby ammonia, urea and laughing gas are alternately introduced into primary and secondary air feeds of waste incineration.

5.2.3 System-Specific Observations

The achievable reduction of greenhouse gas emissions from the biogas systems by treatment of the exhaust air in the waste-to-energy power stations involved in the study was observed on a system-specific basis. The volume of exhaust air that can be thermally treated was quantified and the resulting achievable reduction in climate-damaging gases thereby calculated. The results are depicted in Chapter 6. Each calculation assumed that the volumes of methane and laughing gas treated in the waste-to-energy power station are completely oxidised in the furnace. The discussion concerning the potential formation of laughing gas from urea or ammonia in Chapter 5.2.2 was not considered, because such an effect, as previously explained, would be highly unlikely under the prevailing temperatures. Even if this effect would occur to a significant extent, ammonia and urea could be removed from the exhaust air of the biogas system by a gas scrubber before its introduction to the furnace.

5.3 Optimised Energy Usage in a Network

The results of the investigation to increase the energy efficiency utilizing a network of energy from the waste-to-energy power station and BGA are presented in the following.

[1] SNCR: Selective Non-Catalytic Reduction; Non-catalytic process to reduce oxides of nitrogen by injection of ammonia or urea into the furnace of an incineration plant.

The heat derived during the operation of a waste-to-energy power station can be used to heat the fermenter. Generally this principle can be used if, for example as in Burgkirchen, the intention is to feed gas, so no thermal power station is to be installed. Since there is a general excess of heat at the Burgkirchen location, the electricity generation in a thermal power station in a heat and power combination is not considered viable. In this way, only a part of the biogas produced (approx. 40%) would be utilized as energy, whilst the larger part would be left as non-exploitable heat. Therefore the feed of the biogas into the natural gas grid has been planned for the waste-to-energy power station in Burgkirchen.

The biogas preparation in natural gas quality is only economically viable for plants with larger capacities. In a direct comparison of the preparation processes it becomes clear that the amine purification is the process with the least methane leakage, the highest purity of the product gas and the lowest electricity requirement. Since the regeneration has a comparatively high heat requirement, it is unproblematic in this case, since the available heat from the waste-to-energy power station can be utilised. For this reason, the location of Burgkirchen was chosen within the framework of this project, as its regeneration stage can be operated with a temperature level of 120 °C. The supply of this process heat in Burgkirchen can take place over the low-pressure steam line. The supply of thermal energy can take place in the form of a cascade utilisation. The heating of the BGA and the purification can thereby be covered by the exhaust heat from the biogas preparation (approx. 74%) in order to keep the requirement for low pressure steam from the waste-to-energy power station as low as possible.

In those cases where a thermal power station is being constructed, (Geiselbullach und Augsburg), it is possible to link the exhaust heat of the combustion engine with the heating grid of the waste-to-energy power station. The high temperature heat from the exhaust flow of the thermal power station inside the waste-to-energy power station can be utilised, for example in pre-heating feed water or in increased steam generation, as a further possibility to utilise the exhaust heat. This steam could then be fed into the medium or low-pressure steam lines of the waste-to-energy power station. With this procedure the electricity generation of the waste-to-energy power station could be increased since less steam from the turbines has to be decoupled, for example to pre-heat the feed water or to supply long distance heat.

The extra energy available to the waste-to-energy power stations in Geiselbullach und Augsburg with this process amounts to approx. 20% of the amount of heat energy supplied to third parties on an annual average.

5.4 Products and Residual Material

High quality fertilizers can be produced from the organic material delivered to organic waste fermentation plants that can be utilized in agriculture, gardening centres and earthworks. In areas with intensive agricultural use, the finished compost and fermentation residue can be sold well during the fertilizing period. The purified fermentation residue at the Burgkirchen site can be utilised directly in agriculture during the fertilizing period.

The direct utilisation of energy recoverable from the fermentation residue, resp. the oversized wooden materials from the preparation area of the BGA doesn't represent an economic alternative for the waste-to-energy power station under full utilisation, as the delivery prices for waste suitable for energy recovery are clearly higher than the disposal costs of these wooden materials (recoverable energy in biomass cogeneration plants). This variation is only viable during periods of low utilisation.

Generally with the integration of the organic waste fermentation into the thermal waste treatment there is the possibility of the drainage from the fermentation being used in the flue gas cleaning of the waste-to-energy power station which is not only an environmentally friendly method of disposal, but also more economic. This disposal method has already been economically very successfully implemented by the three selected waste-to-energy power stations for external seepage water from rubbish tips and industrial wastewater. In view of the suspended solids in excess water, the injection of wet fermentation residue into the flue ducts of the waste-to-energy power stations has not proven practicable.

5.5 Infrastructure

According to the plant operators, the existing infrastructure for logistics (scales, cleaning equipment, access routes, plant areas etc.) of the waste-to-energy power station can be utilized without any problems for the delivery of the organic waste, whereby a minimization of surface sealing and investment for a new building can be achieved.

The organic waste fermentation plant can also be connected to the existing gas, water and electricity supplies of the waste-to-energy power station. In fermentation plants, an electricity blackout normally means that biogas is released directly into the atmosphere, whereas the joint utilization of the emergency power supply in a waste-to-energy power station means that emissions of climate-relevant biogas can be prevented during a power outage.

When observing synergy effects within the infrastructure, the operating and service personnel play an important role. At a common location, operational and administrative functions as well as vacation and sickness cover can all be optimised with existing personnel. Equally, electrical and metal working can be integrated into the entire operation.

6 Synergy Effects and Optimisation of Eco-Efficiency

6.1 Ecology

With the integration of the BGA at the three locations examined, greenhouse gas emissions in CO_2 equivalents can be avoided between 53% and 69%. It has to be noted that in the process areas “delivery and preparation”, “press fermentation residue, fermentation residue, supply solid fermentation residue” and “storage wet fermentation residue” the greenhouse gas emissions can also be almost completely eliminated with reductions ranging from 89% to 98%.

Since the different basic conditions of each specific location only permit a preparation of dry fermentation residue in varying degrees, the reduction in emissions in the process areas of “post-composting, purification and stabilisation of the fermentation residue” between 0% and 37%. In the following diagram, all the greenhouse gas emissions of the “green field” reference site are compared to the integrated plant concept and notated in CO_2 equivalents.

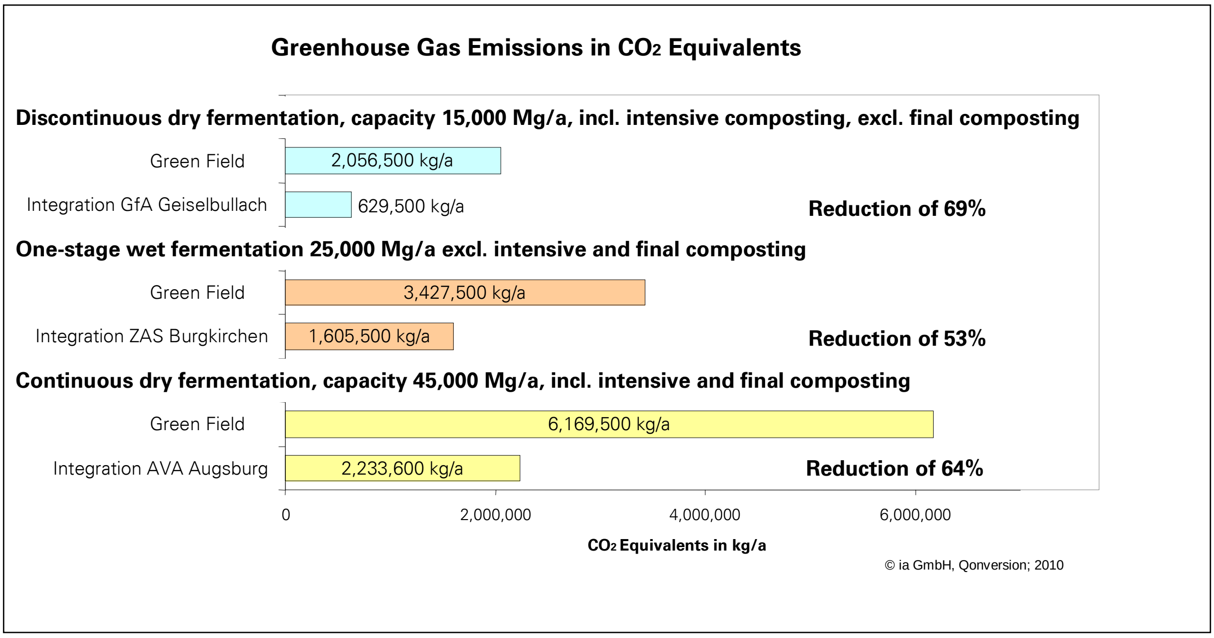


Diagram 1: Greenhouse Gas Emissions in CO2 Equivalents

6.2 Economy

On the basis of costs and revenues determined during the study, the sites at Geiselbullach and Burgkirchen can save between 19% and 43% in an integrated operation in comparison to the green field reference site. At the AVA Augsburg site, a direct comparison of the two systems is not possible the operating costs of the composting plant are confidential. The result of the study here is that with the integration of the BGA into the existing composting plant in Augsburg, additional costs of 11.50 EUR/Mg are incurred.

In the following diagram, the treatment costs for the “green field” reference plant as well as the integrated plant are depicted.

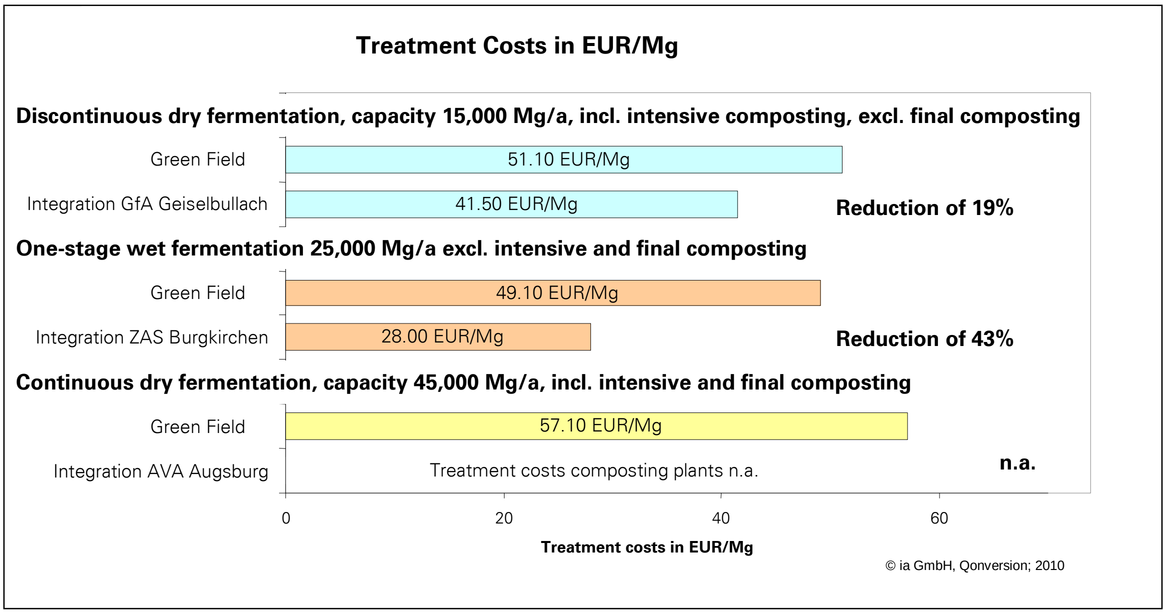


Diagram 2: Treatment Costs in EUR/Mg

6.3 Acceptance

The results from the previous chapter regarding the ecological and economic advantages of fermentation plants on site at waste-to-energy power stations should actually speak for themselves and prevent further questions from arising after acceptance of these measures.

However, the fears of the affected public cannot be suppressed with factual arguments, as they are often based on unrealistic premises and can only be dissolved by long-term confidence building measures. The public wants to be heard and their problems given an adequate hearing. This is true even if the project sponsor has convincing arguments and the project serves the interests of the public in general.

Against this background, the best argument for this concept is the construction of fermentation plants at the furnace of existing waste-to-energy power stations. Over and above the savings and low emissions, there are no new affected persons. As far as official approvals are concerned, the waste-to-energy power stations are higher ranking. In every examined case in this study, the fermentation can be setup within the boundaries of the existing plant and also partly within existing buildings. Land does not have to be purchased nor new access routes mapped out and pushed through.

The construction of a fermentation plant for organic waste at the location of an incineration plant can also positively affect the acceptance of the existing plant, as the attempted polarisation between incineration and recycling will be dissolved. In this sense, the fermentation plant can be an important step toward upgrading the entire location of the waste-to-energy power stations into a resource oriented supply centre with better acceptance by the general public.

6.4 Applicability to the Other Bavarian Waste-to-Energy Power Stations

As can be read in the study, the results from the examined sites were very different. However, it should be noted that the implementation of the integration of an organic waste fermentation plant into a waste-to-energy power station location is generally possible and significant advantages can be demonstrated in comparison to a green field system.

At every examined location it was possible to extract and integrate the most toxic part of the exhaust from the integrated organic waste fermentation process and feed this into the primary or secondary air of the respective waste-to-energy power station and oxidise it thermally. Equally at every location high greenhouse gas emissions normally arising from the storage of wet fermentation residue could be avoided by injection into the furnace (Augsburg, Burgkirchen), resp. channelling into the neighbouring sewage treatment plant (Geiselbullach).

Therefore, from an ecological point of view it can be assumed that the integration of an organic waste fermentation plant at a waste-to-energy power station location will result in avoidance of at least 50% of the CO2-equivalent emissions of a reference system. Equally it can be assumed that noticeable savings can be achieved in comparison to a green field system. As the example in Augsburg shows, an existing organic waste recycling plant can continue to be a more cost-efficient alternative in individual cases.

The details of the examination were very complex, which is evidenced for example with the connection of the BGA exhaust to the primary and secondary air systems, the reduced operating time of the lean gas flare and the extra biogas utilisation in the closed system or the heat connection at each location. The first indications for project feasibility can be seen with the aid of a checklist developed during the project.

With an implementation at 10 waste-to-energy power stations with a total throughput of 300,000 Mg organic waste per year, the total reduction of emitted CO2 equivalents in comparison with a green field implementation amounts to approximately 25,500 Mg per year. This corresponds to the annual electricity consumption of approx. 13,300 households [GEMIS 4.2]. With an average saving of EUR 17.50 per Mg of organic waste input, the resulting savings in treatment costs amount to EUR 5.25m.

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