Fourty Years of Waste Management in Germany
– A Success Story with a few Errors –

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Following the Second World War, along with rising prosperity, the amount and quality of waste also changed. Waste disposal was characterised by substantial deficits as regards the treatment capacity and the quality of the treatment plants. The few plants that were in existence did not adhere to the necessary standards as regards their technology, hygiene and environmental protection. The waste treatment plants – as far as they were even in existence – caused substantial environmental damage as well as displeasure and opposition amongst citizens. Waste incineration plants were equipped with inadequate waste gas treatment facilities; in composting plants composts of low quality were produced – incidentally along with a substantial smell nuisance; landfill sites had hardly any base or surface liner, landfill gas and leachates were only captured and treated in exceptional cases. Towards the end of the sixties of the twentieth century, the legislative powers were moved – partly due to the obvious shortcomings in waste treatment – to put into action a number of environmental laws, e.g. the Waste Disposal Act (Abfallbeseitigungsgesetz), the Pollution Act (Immissionsschutzgesetz) and the Federal Water Act (Wasserhaushaltsgesetz). These legal standards were complemented and concretised by various regulations. Following this, more laws were passed that have to be adhered to in the planning and implementation of waste disposal, e.g. the Environmental Impact Assessment Act (Gesetz über die Umweltverträglichkeitsprüfung), the Federal Soil Protection Act (Bundesbodenschutzgesetz) and the Federal Nature Conservation Act (Bundesnaturschutzgesetz). Today Germany has adequate treatment capacity for the recovery and disposal of waste (Table 1).

The emission limits comply with the targets of the European Union and the applicable regulations at the very least. Often, as in the case of waste incineration plants for example, the values fall below the set limits by at least ten per cent.

Table 1: Waste treatment plants in Germany

Amount	Type of waste treatment plant
~ 1,000	Sorting facilities
277	Bio waste composting plants
672	Green waste composting plants
800 to 900	Fermentation plants with permit for bio waste
62	Mechanical-biological waste treatment plants
67	Waste incineration plants with strict emission control limits
1	Pyrolysis facility
35	Solid recovered fuels power plants running (1 more being built, as at August 2012)
346	Landfills before 1st June 2005 (before coming into force of the Landfill Ordinance)
196	Landfills in Class II since 2006 (only authorised for pre-treated waste then)
166	Landfills in Class II running at the end of 2010 (preliminary indication)

Below a few faulty developments will be presented, which can be rectified by changes in the legal and administrative conditions.

The *Waste Disposal Act* (Gesetz über die Beseitigung von Abfallstoffen, AbfG) of 7th June 1972, was the first legal regulation of waste disposal in Germany. It was amended several times in the following years and eventually developed into the Waste Management Act (Abfallwirtschaftsgesetz, AbfG) on 27th August 1986. With the amendment of 27th September 1994, its name changed to *Closed Substance Cycle Waste Management Act* (Kreislaufwirtschafts- und Abfallgesetz, KrW-/AbfG), in an attempt to document the responsibility of producers and distributors of products.

On 1st June 2012, the *Closed Substance Cycle Act* (KrWG) came into force in Germany, which translates the EU Waste Framework Directive of 19th November 2008 into national law. With the deletion of the waste term from the name of the German Act, it is sought to convey the impression, that the earlier ambition of environmentally friendly and hygienic handling of waste steps back in favour of complete prevention and recovery of waste – catchword: *zero waste society*. This ambition bypasses reality just like the assumption, that the newly formulated approach for the primary role of waste disposal is purposeful. General interests have to be at the forefront of waste management, in other words long term environmental and health protection. In the 72 paragraphs of the Act, only 11 mention the words *closed substance cycle*. Most of the rules deal with the treatment of waste. The name of the Act therefore only reflects its content to a small extent; in the substantially largest part of the Act, aspects of waste legislation are dealt with. The name of the Act is therefore misleading; as a further defect it is an expression of political will and does not adequately describe the content. A correct description would be *Waste Management Act*, just as it was prescribed by the EU Waste Framework Directive. The addition of *closed substance cycle* could clarify the intended political direction. It is still a waste management act. Why however, is the main purpose hidden behind the inadequate description of the content by using the term *closed substance cycle*?

Because of the indispensable need for treatment and subsequent landfill of waste that is not suitable for recycling, the term *closed substance cycle* in the description of waste management will mislead the unsuspecting citizen.

1. Waste volume and municipal competence

Municipal waste, for which those in charge of public waste management, in other words the municipalities, are mainly responsible, only amounts to a small share of the total waste volume, i.e. 350 millions tonnes per year in Germany. The majority of the waste volume is being disposed of (and mostly recovered) by the industry itself, i.e. privately. Municipal waste amounts to around forty million tonnes per year; that is around twelve per cent of the total waste volume. The municipalities – public waste management authorities – have the primary responsibility for a good reason. They handle this task themselves or delegate it after public tender, whilst keeping full responsibility in the process, to private companies or companies in a public-private-partnership. With this allocation of tasks, a high standard of waste management was and is being reached in Germany.

The management of municipal waste is an essential part of the public interest. Thanks to the competence of the public waste management authorities the management of municipal waste in Germany – also when compared internationally – is at a high technical and organisational standard, which takes account of hygienic, ecological and social aspects whilst also remaining affordable for the citizens. Table 1 shows an overview of the waste treatment plants in Germany and gives an impression of the standard of waste management.

Packaging waste was removed from the responsibility of the public waste management authorities by way of the Packaging Ordinance of 1991 (Verpackungsverordnung), at a time of a perceived *waste crisis*. As a consequence, responsibility was moved to the dual system (Duales System Deutschland), which instructs mainly private but also public companies with the operative tasks.

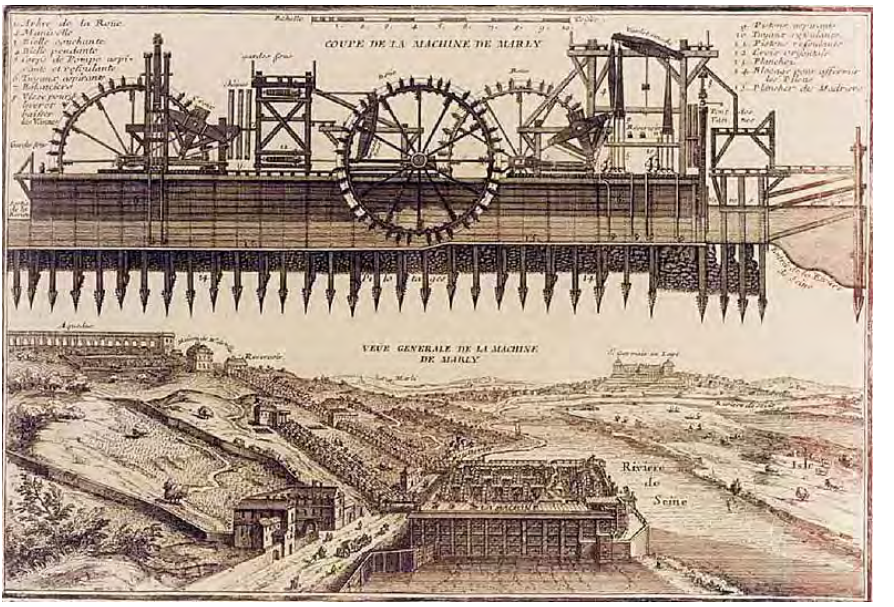
2. The need for pollution sink as part of the recovery of waste

The full recycling of waste would lead to a catastrophic enrichment of pollutants in our environment and is therefore neither desirable nor realistic.

Every raw material is more or less intensively mixed with other materials during its extraction, its further processing, during the production of products from different materials, its consumption and its collection and treatment as waste. Nearly all products that become waste are not present in their essentially homogenous form. Rather the products being produced from different original materials are contaminated with additions during their life cycle and, once they have become waste, by other types of waste during their collection and transport. Contaminants as well as health and environmentally hazardous materials have to be separated ahead of a possible recirculation into the substance cycle. Therefore pollutant sinks are being integrated into the treatment processes.

For organic pollutants, the best-case sinks are waste incineration plants, where organic substances are destroyed. Non-organic pollutants will be concentrated by the waste gas treatment of the waste incineration plants and have to be stored away from the biosphere in over- or underground landfill sites for hazardous wastes. Waste that is not suitable for recycling and cannot be incinerated will be landfilled, depending on its pollutant content following pre-treatment.

Landfill sites have two functions that are essential for a functioning waste management system: Non-hazardous non-utilisable waste is stored in landfill sites of different classes that are equipped according to the hazard potential of the waste. Hazardous waste is stored in specific landfill sites, if by way of treatment the hazard potential of the waste could not be reduced down to a level, where they could also be stored in a landfill site for non-hazardous waste.



The Machine of Marly

When talking about companies whose efforts far outweigh their usefulness, we often hear the description the Maschine of Marly. This was one of the most expensive and at the same time most inefficient prestige projects of absolutist ruler Louis XIV. His impressive water features in the park of Versailles were run with inappropriate efforts that put pressure on the French state budget; however he only partially reached his goal. It is not surprising that authors often associate the dual system (Duales System Deutschland) with this machine when looking at the treatment of packaging waste.

Several lavish water features were planned for the park of Versailles. On the grounds and their surroundings there were no natural sources that would have been able to supply the necessary water with the required pressure. Therefore the Machine of Marly was supposed to take over this task. It consisted of two hydraulically driven pumping stations that were to pump water from the Seine towards the fountains.

The Seine, which runs north of Versailles, was nearly eight kilometres away from the castle and lay significantly lower than the park. For the transport from the Seine valley to the height of the castle's park, for the establishment of a sufficient gradient of the aqueducts towards the park and for the creation of the pressure needed to run the fountains, the water would have had to be pumped about 160 metres high. In order to avoid this, a mechanical pumping station was constructed and built, which was to overcome the, at the time, nearly insurmountable demands. This installation, the first Machine of Marly was put up between 1681 and 1684.

As the location, the south bank of a loop of the river Seine below the castle Marly-le-Roi was chosen. Fourteen water wheels with a diameter of twelve metres each drove around 250 pumps, which transported the water uphill through pipes. Two additional pumping stations – one at halfway on the hill, the other at the top immediately in front of the aqueduct – created the required pressure. The pumps were driven by the water wheels. The unique construction cost four million Livres.

On 16th June 1684, the Machine of Marly was officially opened by Louis XIV. The deficits were apparent straight away: the water wheels could only insufficiently supply the water features with water. Therefore only those fountains which lay within view of the king were supplied with water.

The mechanics of the machine caused so much noise with their drive shafts, that Madame Dubarry, the inhabitant of the castle of Marly, could not sleep at night when the reservoirs were being filled up for the following day. Furthermore the machine was delicate and constantly had to be repaired; sixty workers were occupied with its maintenance at all times. The machine mainly consisted of wood, which got mouldy due to the moisture and had to be renewed regularly. This caused the maintenance costs to rise even further.

The Machine of Marly was first seen as a miracle of technology and admired by many visitors – for example Peter the Great in 1717 and Thomas Jefferson in 1784. It was even described in Denis Diderot's Encyclopédie. In the 18th century the admiration sank due to the continuously rising maintenance costs. In 1758 parts of the installation were put out of service, so that it was working with reduced performance. Nevertheless it remained operational until 1817. After futile attempts for improvement, it was finally taken out of service and demolished on 25th August 1817.

Despite the enormous efforts, the performance of the gigantic Machine of Marly was modest. Under optimum conditions a maximum of 2.000 to 2.500 cubic metres of water could be pumped to the water features within 24 hours.

Following extensive dismantling of the old Machine of Marly a steam driven pumping station was built in the same location, which supplied the park and the surrounding communities with water – again only two thousand cubic meters per day – from 1827. Large amounts of coal were needed for the running of the steam engine, so it remained too expensive.

Napoléon III. arranged for the building of a new once again hydraulically driven pumping station in the same location in 1854. The second Machine of Marly was more productive than its predecessor from 1684. Six water wheels, each twelve metres in diameter and four metres wide, drove the pumps, which now drew between 18.000 and 20.000 cubic metres of water from the Seine per day. The second Machine of Marly provided its service less than good for around one hundred years. Slowly but surely the realisation rose, that this megalomaniac project would not reach responsible results with appropriate efforts. It was taken out of service due to permanent damage and high costs on 20th June 1963 and demolished in 1967.

3. Amendments through the Closed Substance Cycle Act and remaining deficits

Below three aspects of waste law will be discussed: the classification of the treatment plants for the light fractions into the **waste hierarchy**, the **waste term** and the unsuccessful implementation of the **Packaging Ordinance** on the basis of the Closed Substance Cycle Act.

Position of the treatment plants for the light fraction in the waste hierarchy

Instead of the former three-step **waste hierarchy** § 6 I of the Closed Substance Cycle Act stipulates the ranking order of waste management. It now introduces a five-step hierarchy as a guideline for waste management:

- Prevention,
- Preparing for reuse,
- Recycling,
- Other recovery, e.g. energy recovery and filling of excavations,
- Disposal.

This differentiated priority order in the recovery process is a new concept. *Preparing for reuse*, *Recycling* and *other recovery*, e.g. energy recovery and filling of excavations, have their own definitions. Energy recovery, i.e. waste incineration, therefore has a lower status than recycling. Through the backdoor however – calorific value of 11.000 kJ/kg – energy recovery can become equal to recycling.

Unlike *preparing for reuse, recycling* means intensive recovery methods, through which waste can be lead towards its original or a new purpose following treatment. *Recycling* solely constitutes material and raw material use, not a recovery method, through which waste is processed for use as fuel – energy recovery – or for use as backfill material – backfilling. The plants for the production of solid recovered fuels fall under the fourth hierarchy step. This leads to problems during the classification of sorting facilities, when aside from the fractions for recycling, solid recovered fuels are produced as well; the situation becomes even more problematic if there is *mainly* production of materials, that are destined for use as fuel. About two thirds of the input for solid recovered fuels are dealt with by treatment plants for the processing of light fraction packaging. The question whether those treatment plants are not to be classified as more legally compliant than plants for other recovery – energy recovery – is justified. A legal quota regulation could lead to more legal certainty.

In practice deviations from the priority order are possible under defined technical, ecological and economical aspects. *The measure that best ensures the protection of humans and the environment during the production and management of waste, in line with the precaution and sustainability principle, is to be given preference.*

The waste term

The waste term is clarified through the definitions of **by-products**, which develop during production, and for **end-of-waste criteria** for some recycling materials – e.g. scrap, waste paper, waste plastics and substitute fuels.

4. Ordinances under the Closed Substance Cycle Act

The Closed Substance Cycle Act is complemented by a number of ordinances that were enacted on the basis of the Act's predecessors. More regulations will follow shortly, e.g. an ordinance or an act on recyclables (Wertstoffverordnung, Wertstoffgesetz). A framework ordinance for mineral waste has been in the pipeline for a long time now.

5. Demand for reform of the Packaging Ordinance

In 1991, on the basis of the Waste Management Act, the **Packaging Ordinance** was enacted, which contained the legal basis for the dual system of packaging waste. This construct contains a number of organisational and economical deficits and is not acceptable in its current format. A few numbers for information purposes: the treatment of residual waste in incineration plants costs between 50 and 200 EUR per tonne; the disposal of light packaging materials from the **yellow system** – yellow bags and containers – costs around 400 EUR per tonne, which is made up of around 250 EUR per tonne for the collection and around 150 EUR per tonne for the sorting. The actual total cost for the dual system for the citizen is not even covered by this yet. To the disposal costs double the amount, namely around 800 EUR per tonne, has to be added to cover *unknown system costs/Overhead*. However these are only the system costs of the system operators, not the total amounts of all those involved. Further transaction costs accrue with the producers of packaging, in trade and in public administration. This economical and ecological nonsense is financed – not including the non-spreadable transaction costs – from three sources by the citizens of the Federal Republic of Germany, without them being able to notice it as such.

First and foremost source of finance for the dual system: each and every bit of packaging that enters the market and is bought by a consumer, carries a small licensing fee of a few cents. The proportion coming from this is estimated to be around 10 EUR per citizen per year. This sum is the main source of financing for the organisational and technical efforts, the logistics, the processing of the packaging materials and the marketing of the recovered products.

It is openly propagated that it would be a shame to incinerate the packaging materials and that they should be brought back into the substance cycle – i.e. recycled – via the dual system. In reality though, this waste is not being recycled quantitatively in the way that is being propagated. Rather about two thirds of the light packaging materials are confectioned into substitute fuels that according to the law, constitute waste and are mainly incinerated in industrial power plants. These power plants are technically speaking modified incineration plants. The main difference to the waste incineration plants, which are mainly geared towards the treatment of waste, is in their functional specification. In industrial power plants, which serve as a provider of electrical power and heating, waste is a substitute fuel for the regular fuels.

Only about a third of the total volume of light packaging materials is materially used, however mainly not in high-quality products; plastic waste for example is made into downpipes, ground-thresholds, plant pots etc. Only a small part is made into high-quality plastic granules, separated by type and produced with high technical effort. The quality of scrap parts from sorting facilities is much lower than the scrap parts from waste incineration plants, due to the foreign particles attached to the scrap – mainly plastics and paper.

The claim that it would be a shame to incinerate packaging materials from the yellow system and that they are to be recycled – materially used – is therefore wrong, because the majority of light packaging materials against the word of the official propaganda – *a shame to incinerate* – is actually being incinerated. The waste is merely **lead towards a recycling system** with great effort, but not even in its majority recycled. For the legally trained reader, this also emerges from the text of the law itself:

Closed substance cycle is defined for purposes of this Act *as the prevention and reclamation of waste.*

Prevention is any measure taken before a substance, material or product has become waste and which is intended to reduce the volume of waste, the harmful effects of the waste on humans and the environment, e.g. internal recycling of materials ... low-waste product design, reuse of products, extension of their operational life, and changed consumer behaviours.

Recycling is ... any reclamation process through which waste is transformed into products, materials or substances...; it includes the processing of organic materials, ...

The official data about the waste management routes (Table 2) raises the impression that the data on recycling means, that the shown amounts or proportions of, for example, municipal waste were recycled. This impression is wrong. The statistical data merely means, that the stated proportion is being **lead towards** a recycling plant; it does not conclusively tell us about the amounts actually recycled.

Table 2: Municipal waste in Germany – Volumes and waste management routes 2010

	Unit	Recycling	Composting	Incineration	Landfill	Total
Mass	t	21,251,000	8,234,000	18,020,000	186,000	47,691,000
Proportion	%	44.5	17.3	37.8	0.4	100

Source: Eurostat

With the wrong justification that what is being done here is not incineration but rather recycling, light packaging materials are withdrawn from the municipal systems of waste management, without any benefit for the citizens or the protection of the environment and our natural resources.

Secondly, there are additional costs for the citizens due to the underutilisation of the existing high-quality treatment plants for residual waste: the capacities of Germany's technically well equipped waste incineration plants are not being used to their full extent. Because the largest proportion of costs in waste incineration are fixed costs, an underutilisation leads to a rise in the specific waste treatment costs. The existing and not fully utilised waste incineration plants and the existing industrial power plants, can take in the light packaging materials at low cost and without the need for pre-treatment. Waste incineration plants comply with the high economical and ecological demands, thanks to increased energy efficiency and availability and excellent waste gas treatment systems in recent years. Waste incineration plants produce electrical power and remote heating or cooling. In addition, the ash/slag from waste incineration plants is used for the production of building materials as well as iron and non-iron metal scraps; these are of higher quality than scraps from the processing of light packaging materials. In recent times, many efforts are being made to also recover metals from emission control dusts. If this succeeds, waste incineration plants can be developed into ideal recycling plants, that would be way ahead of many mechanical systems – including the sorting facilities for light packaging.

Third aspect: The employees working in the sorting facilities of the dual system only receive minimum wage in many cases. Generally this does not suffice for a family to make a living. If the employee then has to claim additional public benefits, the taxpayer is once again indirectly paying up for the disposal of light packaging. In comparison, the employees in municipal companies are paid under a tariff that adequately covers the costs of living.

Conclusion: If the responsibility for the disposal of light packaging was handed back to the municipalities and the recovery itself was to be carried out organisationally and using techniques that were selected under ecological and economical conditions, then the whole system could be made more cost effective and environmentally friendly, whilst keeping up payment under the current public law tariff. Financial regulation that takes account of product responsibility would however have to be introduced.

Due to the reasons presented herein in short format, it would be more effective to bring the responsibility for the disposal of light packaging back to the municipalities and to treat them together with residual waste where a higher-quality use through other processes is not possible.

6. Recyclables bin

The topic of disposal of packaging gained further interest through the discussion surrounding the recyclables bin, in which **non-packaging materials** made up from the same materials as the light packaging materials – so mainly non-packaging waste made up of the same material such as for example plastics, metal and suitable compounds – are collected together with the packaging. Waste of this type is already landing inside the yellow bins and bags, even though under legal and economical aspects they do not belong there; they constitute *incorrect sorting*.

Electrical and electronic equipment and batteries are to be exempt from the recyclables bin. The aim of the recyclables bin, is to reduce the residual waste volume by seven per cent, i.e. around 570,000 tonnes per year. These numbers are not resilient though. There is no need for new plant capacity for this new task, because there are surplus capacities amongst the sorting facilities for light packaging, too. Nevertheless there would be new obstacles during the implementation of the recyclables bin. While packaging waste is mainly two-dimensional, the additional non-packaging materials are mainly three-dimensional. Furthermore the plastics in non-packaging materials partially have a different quality to the ones in packaging; this has to be considered, when the aim is the production of high-quality, i.e. particularly unmixed, plastics granules.

7. Disposal of packaging: back into the municipalities

Bringing the disposal of packaging back into the municipalities would bring substantial technical, economical, ecological and social advantages with it. The administrative and logistical effort could be reduced considerably. The way of treatment of packaging waste would not necessarily have to be changed. It would be the municipalities' responsibility to decide on the best way of use.

Both the municipalities and the private waste management companies claim the running of the recyclables bin system. The federal government seems to rely on a concept of competition as an effective way of cost-reduction and the building of efficient structures. From the current perspective, this seems like an illusion, i.a. because after all it is about a business transaction for both sides and there are plant capacities that are not put to full use that can be used better with the volumes coming from the recyclables bin. An assessment of the impact on processing techniques and product quality seems to be more purposeful right now. Only then can there be a decision about the optimal method with regard to economy efficiency and the protection of the environment and resources.

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Grundlagen der Bioabfallwirtschaft

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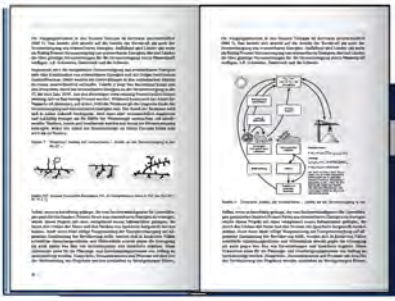
In den letzten zwanzig Jahren sind biologische Verfahren im Aufwind. Dies startete mit der Einführung der getrennten Sammlung von Bioabfällen zu Beginn der zwanziger Jahre des zwanzigsten Jahrhunderts. Heute werden etwa sechzig Prozent der Küchen- und Gartenabfälle in Deutschland kompostiert - eine Erfolgsgeschichte. Derzeit stagniert diese Entwicklung zugunsten der Anaerobtechnologien, da diese auch solche Abfallarten erschließen, die aufgrund ihrer Konsistenz meist aerob nicht behandelt werden können sowie aufgrund der Situation auf dem Energiemarkt. Diese in Deutschland, den Niederlanden und Österreich vollzogene Entwicklung weitet sich derzeit europaweit aus, speziell auf den Süden.

Zu biologischen Prozessen in der Abfallwirtschaft gibt es unzählige Publikationen, eine Internetrecherche zeigt rund zwanzigtausend und dies ist sicher nur ein Teil. Doch eine Gesamtschau, ein Lehrbuch fehlt. Ansätze sind vorhanden: Golouke, de Bertoldi, Diaz, das Müllhandbuch, aber die Zeit ist darüber hingegangen, sie blieben alle lückenhaft, unvollendet eben - Tempus edax rerum.

Um so höher ist der Verdienst der Autorin des vorliegenden Werkes, Ulrike Stadtmüller, einzuschätzen, die diese Lücke gefüllt hat. Sie hat die Zeit angehalten, wenn sicher auch nur für eine Sekunde in der Weltenzeit, um Kompostierung und Vergärung in ihrer Ganzheit darzustellen. Hier lässt sich aufbauen! Hier lässt sich erfahren, wo biologische Verfahren einzusetzen sind und wo nicht, damit zukünftig ihre gezielte, sinnvolle Anwendung ihnen zur weiteren Verbreitung verhilft.

Professor Dr.-Ing. habil. Werner Bidlingmaier



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