

Short version of the Öko-Institut study



## Recycling is the future – ecological achievements and potential of the dual system



**DerGrünePunkt**

## Core statements

The dual system makes an important contribution to protecting the climate and the natural environment. Nonetheless, there is plenty of potential as yet untapped, which can be accessed by opting for the right strategic agenda.

The Öko-Institut study maps out and quantifies the benefits of the dual system for collecting and recovering sales packaging. One thing emerges quite clearly: there is additional major potential in the dual system waiting to be harnessed. By purposeful upgrading and optimizing the dual system, this potential can be effectively unlocked and the benefits of the dual system can be increased even further.



## Achievements

### 1. The dual system makes a relevant contribution to climate protection

This applies particularly to lightweight packaging made of plastics, metals and composites. Their collection and recovery by the dual system alone reduces environmental impact today by 1.9 million tons of CO<sub>2</sub> equivalents per annum. The total contribution to climate protection made by recycling lightweight packaging, glass, paper, cardboard and carton is running at 3.1 million tons of CO<sub>2</sub> equivalents.

### 2. The dual system ensures a substantial reduction in environmental impact and greatly enhances resource economy

Recycling lightweight packaging reduces the environmental impact in numerous respects. Soil acidification is reduced just as significantly as the impact caused by phosphate equivalents, known as terrestrial eutrophication. In addition, the dual system enables the reduced consumption of fossil fuels such as coal and oil.

### 3. The recycling of lightweight packaging has the best climate footprint of all municipal waste categories

The recycling of lightweight packaging makes an overproportional contribution to climate protection compared to the recovery of other waste fractions: for example, 19 times more per ton than disposal of residual waste, most of which is burned in refuse incineration plants. More than half the contribution to climate protection made by waste recovery is attributable to the dual system.

### 4. Material recycling is superior to energy recovery

In terms of the environmental aspects involved, recycling is superior to processes for energy recovery. This applies particularly to the totality of all environmental criteria and whenever, in addition to the classical impact categories of the lifecycle assessment, aspects such as resource economy and environmental impact from raw material extraction are also factored in.

## Outlook

### 5. Environmental impact could be substantially reduced

By increasing the quantities collected, optimizing the separation concept, and deploying a complete-coverage sorting scheme utilizing present-day state-of-the-art technology, the dual system could make an even greater contribution to protecting the natural environment. This could, given optimal development and inclusion of the credits for glass and paper, cardboard and cartons, add up to more than 4.7 million tons of CO<sub>2</sub> equivalents per annum. The expansion of the dual system would also lead to a definite reduction in acidification, eutrophication and the consumption of fossil fuels.

### 6. In the future, the ecological superiority of recycling over incineration will increase even further

All trends foreseeable at present will cause the superiority of recycling over energy recovery to increase still further in the future. For instance, greener power and heat mixes as part of the energy transition will reduce the ecological added value of power and heat generation based on energy recovery.

### 7. Politicians have significant options for upgrading the dual system and tapping its potential

Higher targets for plastics recycling, easier sorting in households (by introducing the Recyclables Bin, for example), incentives for using packaging materials more amenable to recycling (Design4Recycling), plus security with regard to the requisite capital investments in innovations and technical progress, constitute efficacious levers, particularly in conjunction with each other.

Recycling of  
lightweight  
packages

Best climate  
footprint of all  
fractions

More than 4.7  
million tons of  
CO<sub>2</sub>  
equivalents

Additional  
climate  
protection  
potential

## Background

In view of climate change, environmental pollution, population growth and resource-dependency, the transition from a linear to a closed-cycle economy is essential for both ecological and economic reasons. However, as uncontentious as the goal of a closed-cycle economy is in the business community, academia, politics and society as a whole, the road map for achieving it is equally contentious and unclear. When it comes to developing sustainable solutional approaches, the paramount question involved is the efficacy of existing instruments and structures.

Germany is a pioneer when it comes to developing a closed-cycle economy. With the introduction of product responsibility and the creation of the dual system for collecting and recovering packaging waste more than 25 years ago, a road map has been followed that has meanwhile been recognized as being exemplary by many countries inside and outside Europe. Following deregulation to permit competition, the dual system in Germany consists of eleven system operators, with Der Grüne Punkt being used far beyond the country's borders. It is acknowledged as one of the best known trademarks, and symbolizes resource economy and environmental protection.

**But what has the dual system achieved in Germany since 1990? What benefits does it have for the natural environment and the climate? And above all: what potential can be unlocked by upgrading the system?**

These questions have so far been scientifically answered to only a limited extent. What the studies on the dual system have failed to fully illuminate until today is primarily the effects of the situational framework involved – from the extension of product responsibility to other material flows all the way through to increased deployment of renewable energies and the use of better sorting technology – plus their interdependencies.

In its study, "Recycling is the future – ecological achievements and potential of the dual system", Öko-Institut has drawn up not only a comprehensive lifecycle assessment in order to determine the extent of both the increase and the decrease of the burden to the climate and the natural environment attributable to the dual system for the collection and recovery of sales packaging in Germany. In the study, audited by an independent referee, Öko-Institut also focuses on the future, and adduces relevant scenarios to examine the potential of the dual system. For the first time, this analysis of the scenarios concerned enables important conclusions to be drawn for the political and economic decisions involved.

How do different situational frameworks influence the development of the dual system?

A look into the dual system's future

## Approach and methodology

The benefits and potential of the dual system are examined in two steps. First of all, the period from 1990 to 2014 is analyzed in order to determine what contribution the dual system is already making today to protecting the climate and the natural environment. The status quo (2014) is for this purpose referenced to the waste management sector as it was in 1990, i.e. before the termination of landfilling and before the introduction of the dual system (see pages 6 ff.). To enable the potential of a design-enhanced dual system to be estimated up to 2030, political and economic situational frameworks are then varied in three different scenarios, and further foreseeable changes are incorporated in sensitivity analyses.

### The method: lifecycle assessment

This examination of the dual system is based on the lifecycle assessment method as laid out in ISO 14040/14044. For the questions addressed by this study, however, the detailed assessment of individual products is replaced by a higher order examination of entire sectors or fields of action, in this case the German dual system.

The study examines both the additional and reduced impact on the environment caused by the collection and recovery or disposal of packaging waste in Germany. The data involved relate to the total quantity collected in the system, and accordingly to the performative capabilities of the entire dual system, comprising collection, sorting and recovery of the materials involved. The focus here lies on lightweight packaging. The study covers the path of the waste from collection at the place of origin (e.g. in households), sorting and treatment, all the way through to the manufacture of secondary products. Factors incorporated include transportation, externally purchased energy and consumables (e.g. caustic soda for neutralizing the chlorine input in the waste), and the disposal of the waste (e.g. sorting and treating residues).

Besides mean values, e.g. for consumption of raw materials and energy, most of them taken from the ecoinvent<sup>1</sup> database, specific data are additionally determined. Some of these data, e.g. on material flows and energy consumption values, come from DSD, and have in these cases been reconciled with experts' estimates, so as to assure the representative nature of the data for the dual system as a whole.



**Greenhouse effect** Global Warming Potential, GWP



**Acidification** Acidification Potential, AP  
**Eutrophication** Eutrophication Potential, EP



**Savings/consumption of fossil fuels** accumulated fossil energy demand, KEA<sub>fossil</sub>

### The criteria: environmental impact categories

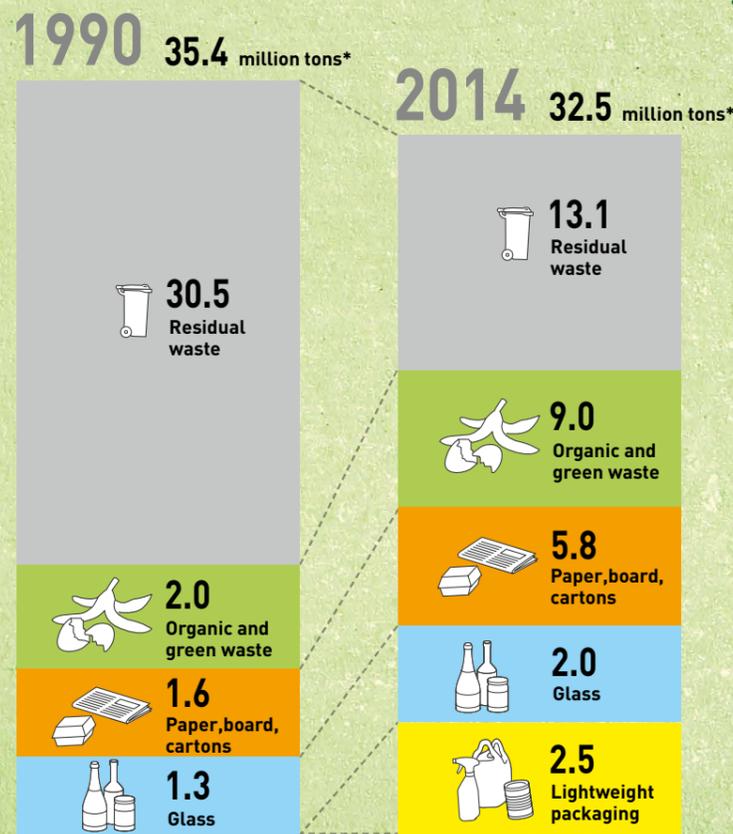
For calculating the global warming potential (GWP), the savings and climatic impact are examined in terms of CO<sub>2</sub> equivalents, while for the environmental category of acidification (AP) the emissions of acid-forming exhaust gases are adduced. Eutrophication denotes an excessive amount of nutrient intake, both for bodies of water and for soil. In view of the data available, only the terrestrial eutrophication is examined in this study, and the nutrient emissions are calculated by aggregation of phosphate equivalents. The savings in and consumption of fossil fuels are determined using an indicator called "Accumulated fossil energy demand" (KEA<sub>fossil</sub>). The KEA<sub>fossil</sub> is a measure for the total consumption of the energy resources required for providing a product or a service. The total resource consumption entailed by energy consumption is added together here.

<sup>1</sup>The ecoinvent database is the leading data system for central acquisition, calculation and management of lifecycle assessment data. It is provided by the Swiss ecoinvent Center. This study has utilized ecoinvent V3.1.

# Benefits of the dual system – lifecycle assessment from 1990 to date

From 1990 to 2014, the quantity of residual waste fell substantially, whereas there was a significant rise in the quantity of separately collected recyclables.

In this period, the total quantity of waste fell by about one-tenth, and is currently running at around 32 million tons, of which approximately 2.5 million tons can be categorized as lightweight packaging. 70 percent of residual waste, the quantity of which has fallen by 57 percent over the past 25 years, is nowadays disposed of in refuse incineration plants. 30 percent are disposed of in facilities for mechanical and mechanical-biological treatment. In 1990, 70 percent of the total waste quantity was still being landfilled without any pretreatment.



\* Rounded value

By contrast, the quantities of recyclables that are collected separately and recovered, namely paper, board and cartons, glass and lightweight packaging, have shown a significant, 3.5-fold increase. However, more packaging is also being consumed: in all, the quantity of packaging grew by 6.2 per cent between 1990 and 2014. The reasons involved here include the rising number of single households, urbanization trends, and the growing prevalence of internet trading.

The dual system works

Less residual waste, increased separate collection

Easing the burden on our climate through glass recycling

800,000 tons of CO<sub>2</sub>-equivalents

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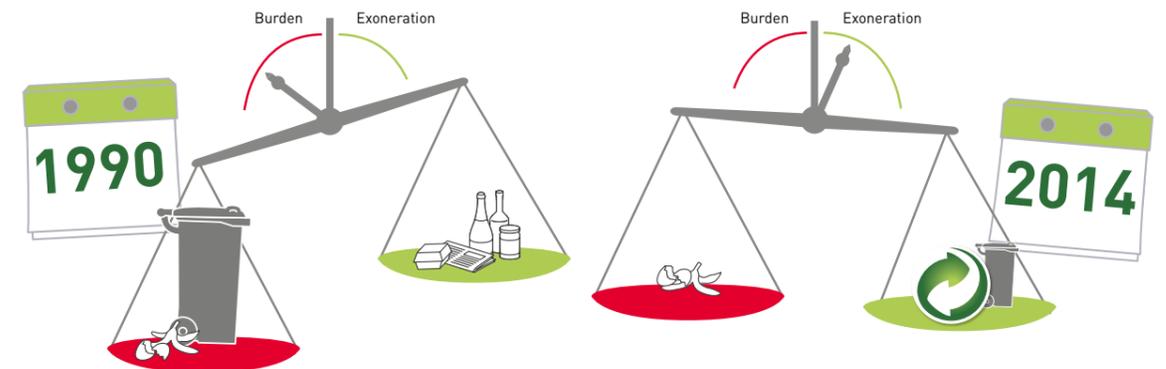
Easing the burden on our climate through recycling of paper, boards and carton

350,000 tons of CO<sub>2</sub>-equivalents

The results of the lifecycle assessment confirm: the dual system makes a relevant contribution towards resource-economy and environmental/climate protection.

In total, by recovering lightweight packaging, the dual system reduces environmental impact by 1.9 million tons of CO<sub>2</sub> equivalents per annum. From 1990 to 2014, moreover, the contribution to climate protection made by recycling paper, cardboard and cartons was upsized by a factor of 7.5, and is nowadays running at a good 350,000 tons of CO<sub>2</sub> equivalents. Glass recycling additionally reduced the environmental impact by almost 800,000 tons of CO<sub>2</sub> equivalents. The total contribution made by recycling lightweight packaging, glass, and paper, cardboard and cartons thus comes to 3.1 million tons of CO<sub>2</sub> equivalents.

The recycling of lightweight packaging has by far the best climate footprint of all fractions, and thus makes an overproportional contribution to climate protection. Although the quantity of residual waste is five times greater than the quantity of lightweight packaging, recycling the latter contributes 19 times more to reducing climatic impact than the disposal of residual waste. Since residual waste is predominantly incinerated, it emerges quite definitely that material recycling is eco-friendlier than energy recovery. So it is unsurprising that in total more than half of the contribution to climate protection made by waste recovery is attributable to the dual system. The dual system thus also makes a crucial contribution to ensuring that Germany can meet its climatic targets. After all, the proportion of German municipal waste management involved in the reduction planned for greenhouse gas emissions in Germany, totaling 40 per cent between 1990 and 2020, lies at a not inconsiderable ten percent.



Depending on how the waste concerned is treated, additional greenhouse gas is produced (increased impact) or it is avoided (reduced impact). In 1990, the waste management sector was adversely impacting the climate primarily by landfilling untreated waste. In 2014, by contrast, impact reduction was preponderant, since almost no waste was being landfilled, but a large proportion was being mechanically recycled or recovered for energy.

The dual system's contribution to resource economy and environmental protection is also clearly discernible for all other environmental categories covered by the lifecycle assessment.

Soil acidification is reduced, the impact attributable to phosphate equivalents, known as terrestrial eutrophication, is substantially reduced, and, in addition, there are savings in terms of fossil fuels such as coal and oil. Recycling is here superior to processes for energy recovery when measured against the totality of all the environmental aspects involved.

## Scenarios for the possible future development of the dual system

To enable statements to be made regarding the possible future development of the dual system and its potential, the Öko-Institut has examined the influence of various relevant situational frameworks in three scenarios extending up to the year 2030. These scenarios for the first time offer a foundation that enables the potential of the dual system to be estimated on a sound basis.

### Scenario 1

In Scenario 1, it is postulated that in the year 2030 the same quantity of lightweight packaging (2.5 million tons) will be collected as in 2014, but that by 2030 the present day state of the art in terms of sorting recyclables has been implemented in all of Germany's sorting plants. This would mean optimum utilization of the entire current potential for material recycling. This scenario features a first, moderate design enhancement of the system.



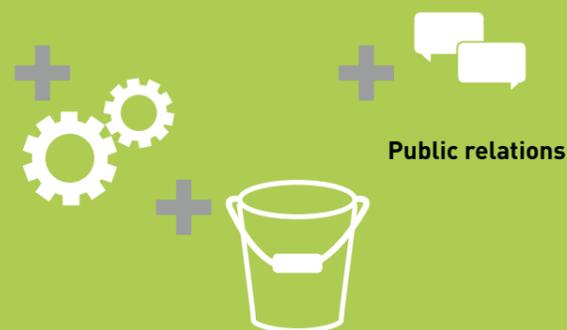
### Scenario 2

In Scenario 2, in addition to the assumption made in Scenario 1 (which is that the present day state of the art is implemented on a broad scale), it is also postulated that the Recyclables Bin (meaning joint collection of packaging and other materials featuring plastics and metal, referred to as "non-packaging made of the same materials") has been introduced. This would entail a corresponding increase in the quantity collected. In Scenario 2, it is estimated that an additional quantity of seven kilograms of non-packaging made of the same materials per resident and year is collected. This produces a total quantity of 3.1 million tons.



### Scenario 3

Scenario 3 is based additionally on the assumption that the collection potential not yet being utilized despite the introduction of the Recyclables Bin will now be tapped to better effect – by a nationwide collection system for lightweight packaging and non-packaging of the same materials, partly to supplement recycling depots. In addition, polluter pays principle based waste charges would have been introduced, also in blocks of flats, and supplemented by intensive waste consultancy. It is assumed that in this way 37.5 kilograms of lightweight packaging per resident and year can be collected from consumers separately from residual waste. This quantity is already being achieved today in about 75 per cent of all counties, and is thus a conservative figure. Moreover, packaging at similar places of origination in the commercial sector would be collected. This would result in a collection quantity totaling four million tons.

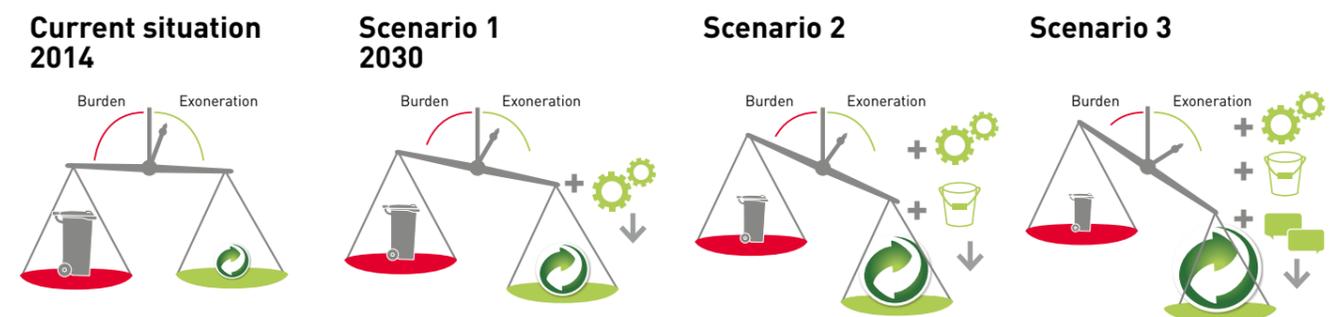


In **sensitivity analyses**, the influence of various foreseeable developments on the dual system is additionally examined, such as increased use of renewable energies. This is because an altered electricity mix will affect the lifecycle assessment of the dual system. Processes that provide electricity thus receive smaller credits when calculating the lifecycle assessment. At the same time, power consumption in those processes that are necessary for treating recyclable fractions from the waste constitutes a less significant factor.

## Potential of the dual system – examined up to the year 2030

**The environmental impact can be significantly lessened still further given a favorable development of the situational framework.**

An analysis of the scenarios shows that the nationwide introduction of a joint collection of packaging and non-packaging made of the same materials, and their recovery using the current state of the art, could increase the contribution to climate protection from the recovery of lightweight packaging by another 74 per cent. This corresponds to 1.4 million additional tons of CO<sub>2</sub> equivalents per annum or approximately the quantity of greenhouse gases that would be caused by 385,000 compact class cars in one year. The dual system's contribution to climate protection would thus rise to 3.3 million tons of CO<sub>2</sub> equivalents per annum. The largest increase in a beneficial contribution is obtained here between Scenarios 1 and 2 and between Scenarios 2 and 3.



With higher recycling targets and an expansion of the quantity collected, the recovery of lightweight packaging, in conjunction with efficient energy recovery from the treatment residues left after material recycling, could even save more than 3.5 million tons of CO<sub>2</sub> equivalents a year. If the recycling of paper, cardboard, cartons and glass is additionally factored in, and stable contributions from these fractions to reducing the environmental impact are postulated, the climate protection contributions up to the year 2030 rise to more than 4.7 million tons of CO<sub>2</sub> equivalents per annum.

For the environmental criteria of acidification potential, eutrophication potential, and primary energy requirement, sorting and recovery by the dual system make a definite beneficial contribution to protecting the natural environment. Over all the environmental criteria involved, Scenario 3 entails the greatest reductions in resource consumption and environmental impact. Purposeful expansion of the dual system would thus go hand in hand with further beneficial ecological effects. Considering that this study's calculations are based on relatively conservative models, then given purposeful support and an ambitious expansion of the dual system it can be assumed that even greater potential of the existing system can be tapped, e.g. by additional innovations in terms of sorting technology or by even more efficient material treatment.

It also emerges quite clearly that by altering the electricity mix within the framework of the energy transition, the ecological contribution made by material recycling, particularly in comparison with energy recovery, will continue to rise. The waste hierarchy, which rates material recycling more highly than energy recovery, is unequivocally confirmed by this result.

RECYCLING IS THE  
**FUTURE**   
 25 YEARS OF DER GRÜNE PUNKT

## Conclusions and recommendations

### Germany's pioneering role

With the dual system for collecting and recovering sales packaging, Germany has put in place a system that has tapped into major potential for enhancing climate protection and reducing environmental impact, and is a front-runner on an international scale. The dual system has made a crucial contribution to this. The comprehensive lifecycle assessment of the dual system drawn up by the Öko-Institut makes it clear that the system now in place has proven its worth.

- Since 1990, the emissions of greenhouse gases and acid-forming exhaust gases have been substantially reduced, the eutrophication of soil downsized, and the consumption of fossil fuels scaled down.
- The recycling of lightweight packaging exhibits the best climate footprint of all fractions.
- The dual system, by recovering glass, paper and lightweight packaging, provides more than half of the contribution to climate protection made by recovering municipal waste.
- Material recycling is superior to energy recovery when measured against the totality of all the environmental aspects involved.
- The quantity of residual waste has been substantially reduced since 1990.

### Purposefully upgrading the dual system

An analysis of these scenarios enables the dual system's future to be envisaged, and clearly indicates the major potential it offers. Political decisions play a particularly significant role in determining its further development. On the basis of this study's results, the following approaches would seem especially promising:

- the introduction of more ambitious recycling targets,
- the extension of product responsibility to non-packaging made of the same materials,
- optimizing the collection modalities, e.g. by nationwide introduction of collection systems and a polluter-pays scheme for calculating charges,
- incentives for using recyclable materials in lightweight packaging [Design4Recycling].

All these steps would contribute to encouraging material recycling – to the benefit of the natural environment.

### Giving fresh impetus to the closed-cycle economy – in Germany and in Europe

The principle of closing cycles and recycling re-usable materials instead of incinerating them is central to the vision of a genuine closed-cycle economy. Its purposeful enhancement should be proactively progressed accordingly. For this purpose, on the European level an ambitious higher-order framework is necessary. Too many recyclables are still being land-filled or incinerated. Additionally, on the German level, further steps will be required for additionally upgrading the proven system and for putting in place the right framework to unlock fresh potential for enhancing climate protection and downsizing the environmental impact involved.



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