



Waste and resource management in Germany and EU





O ProteGEEr é um projeto de cooperação técnica entre o Brasil e a Alemanha para promover uma gestão sustentável e integrada dos resíduos sólidos urbanos, articulada com as políticas de proteção do clima.

www.protegeer.gov.br
www.teach4waste.com



UNIVERSIDADE FEDERAL
DE SANTA CATARINA



POR ORDEM DO



Ministério Federal
do Ambiente, Proteção da Natu
e Segurança Nuclear



Driving forces:

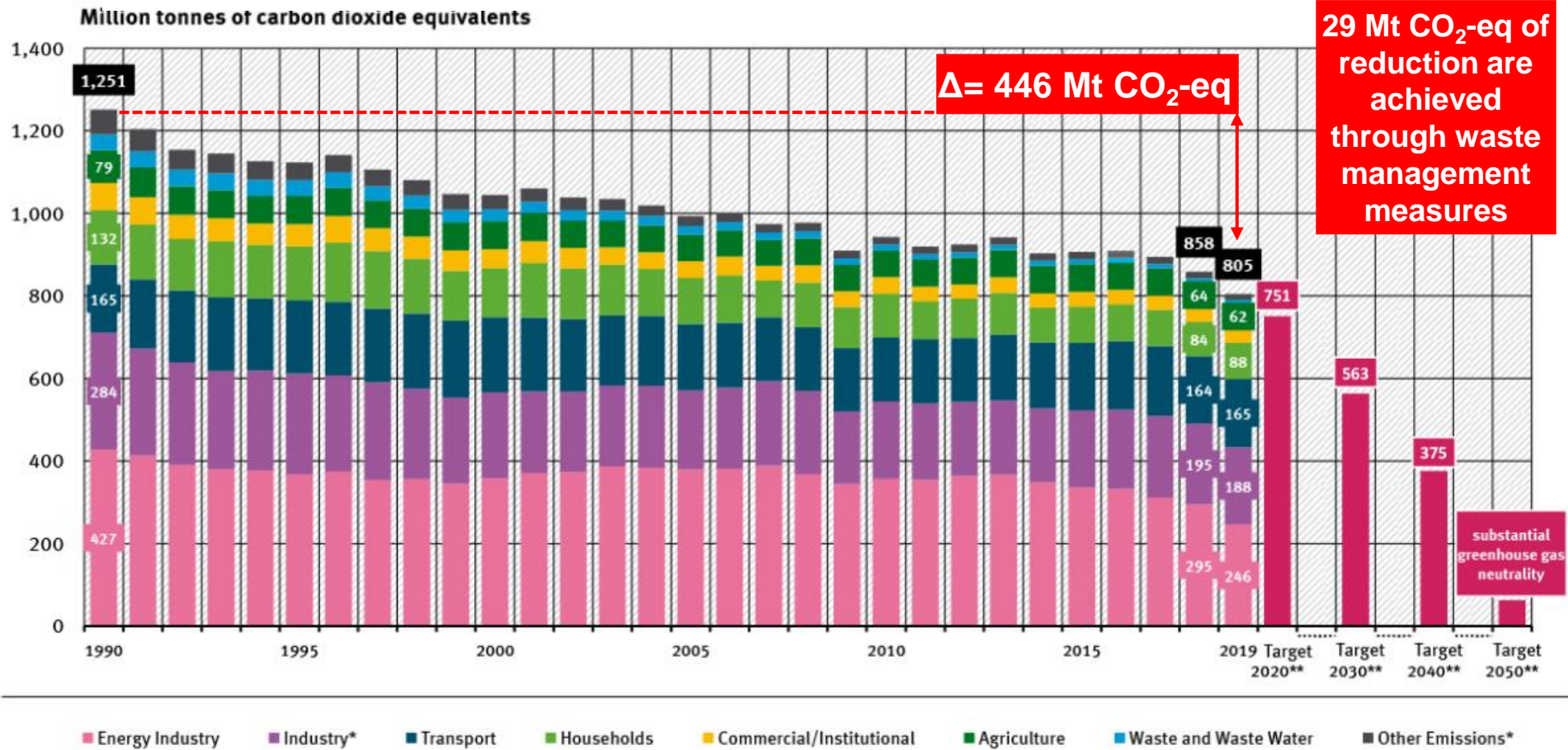
- **Resource protection:** Positive trends for secondary resources due to increasing costs of primary resources
- **Environment protection: Measures against climate change, marine litter**

Strategies:

- Avoidance, reuse and recycling
- Energy recovery from waste of non-material-recycling
- Minimizing/prohibition of landfilling of non pre-treated waste
- Minimizing transport effort by decentralization measures



Development GHG emissions in Germany 1990 - 2019



Source: UBA, 2020

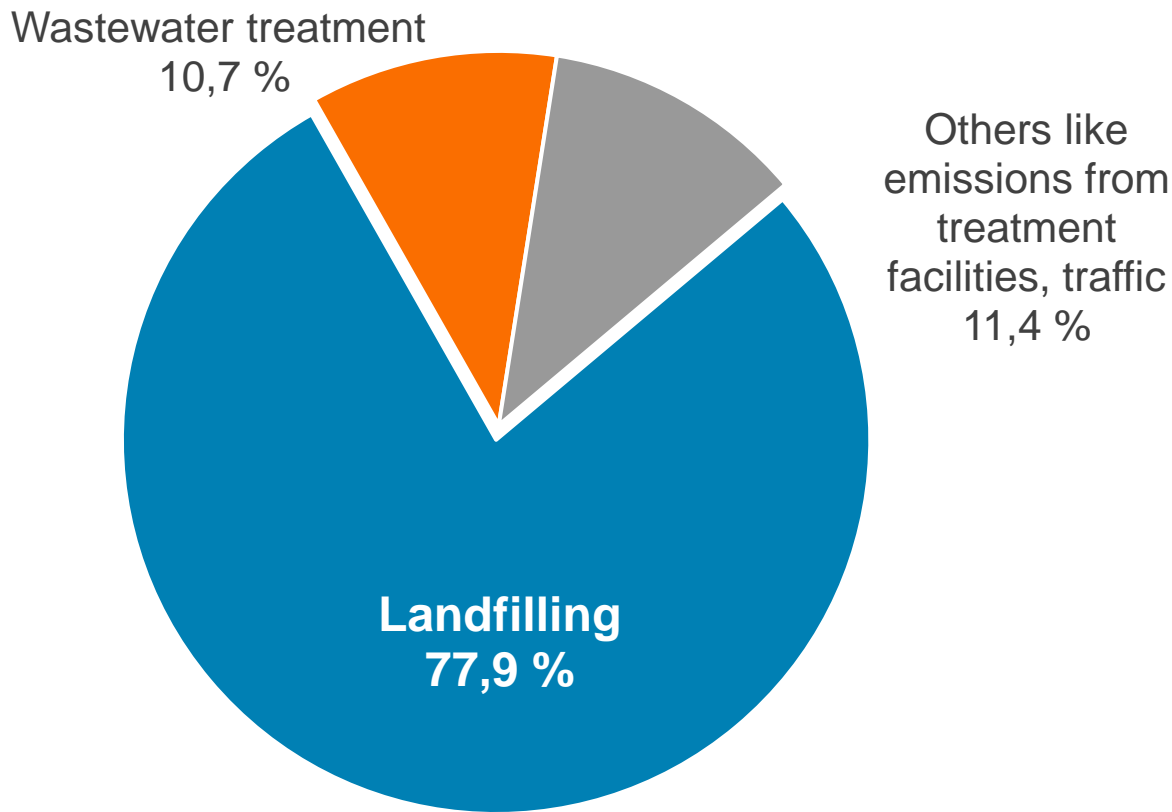
The total effect of waste management measures results from the sum of GHG credits and GHG emissions:

$$CO_{2,eq,total} = \sum_{i=1}^n Emissions_i - \sum_{k=1}^n Emissions\ Credits_k$$

GHG mitigation in Germany from the sector of waste management from 1990 up to 2018:

- By GHG emissions 29 Mio. t CO₂-eq/a
- By GHG credits through recycling and energy recovery 20 Mio. t CO₂-eq/a
- GHG avoidance through waste management measures **0.61 t CO₂-eq/person*a**

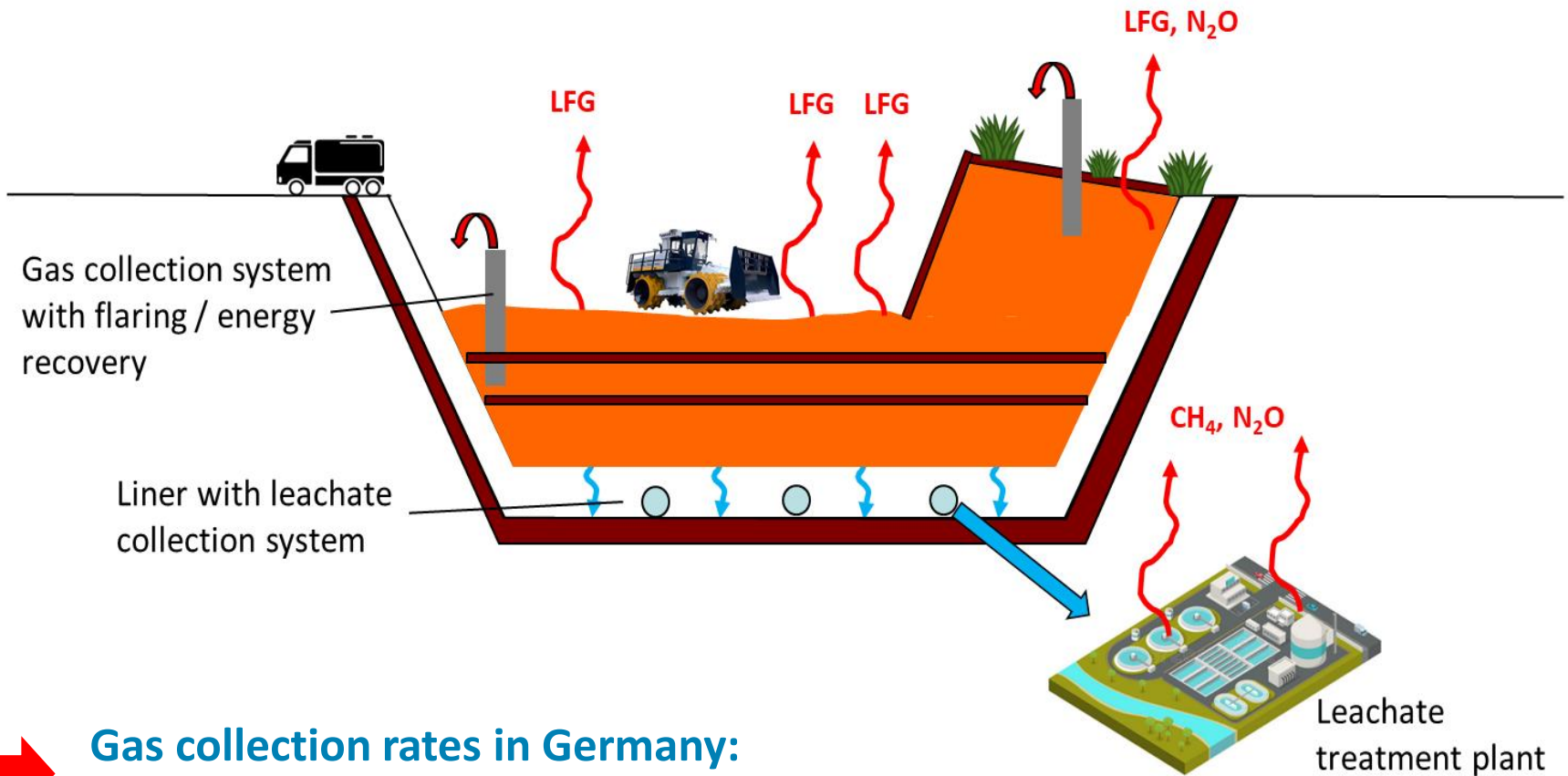
GHG sources from the sector waste and wastewater treatment in 2018
- without CO₂ from biomass use



Source: BMU, 2020

GHG emissions from landfill - Sources

Controlled / sanitary landfill (in operation / after closure)



**➔ Gas collection rates in Germany:
up to 45 % only!!!**

GHG credits of individual waste management measures as of 2011 and projected for 2030

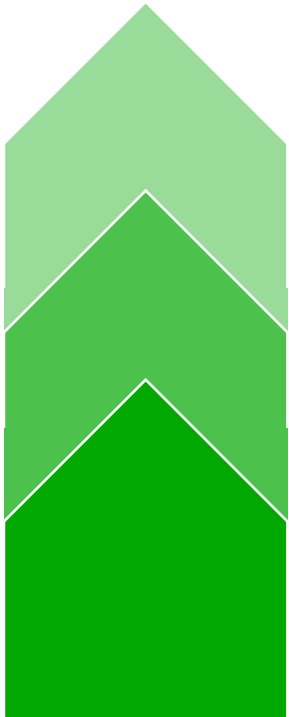
Waste management measures	2011	2030	2030
	Status quo	Status quo	optimised
[1,000 t CO ₂ -eq/a]			
Landfill	163	0	0
Waste incineration	-1,691	-14	-2
MBT	-951	-1,246	-5,473
Recycling			
• Biowaste	-180*	-180*	2,600*
• Greenwaste	-14	61	-183
• Paper and cardboard	-6,120	-7,457	-9,290
• Glass	-1,232	-1,155	-1,155
• Light packages	-2,100	-2,840	-5,301
• Metals	-1,781	-1,842	-1,842
• Electronic waste	-764	-764	1,076
Wood (biomass power plants)	-5,060	-3,108	-5,624
Total	-19.731	-18,188	-32,546

(Ökonostut, 2014, * Own data)

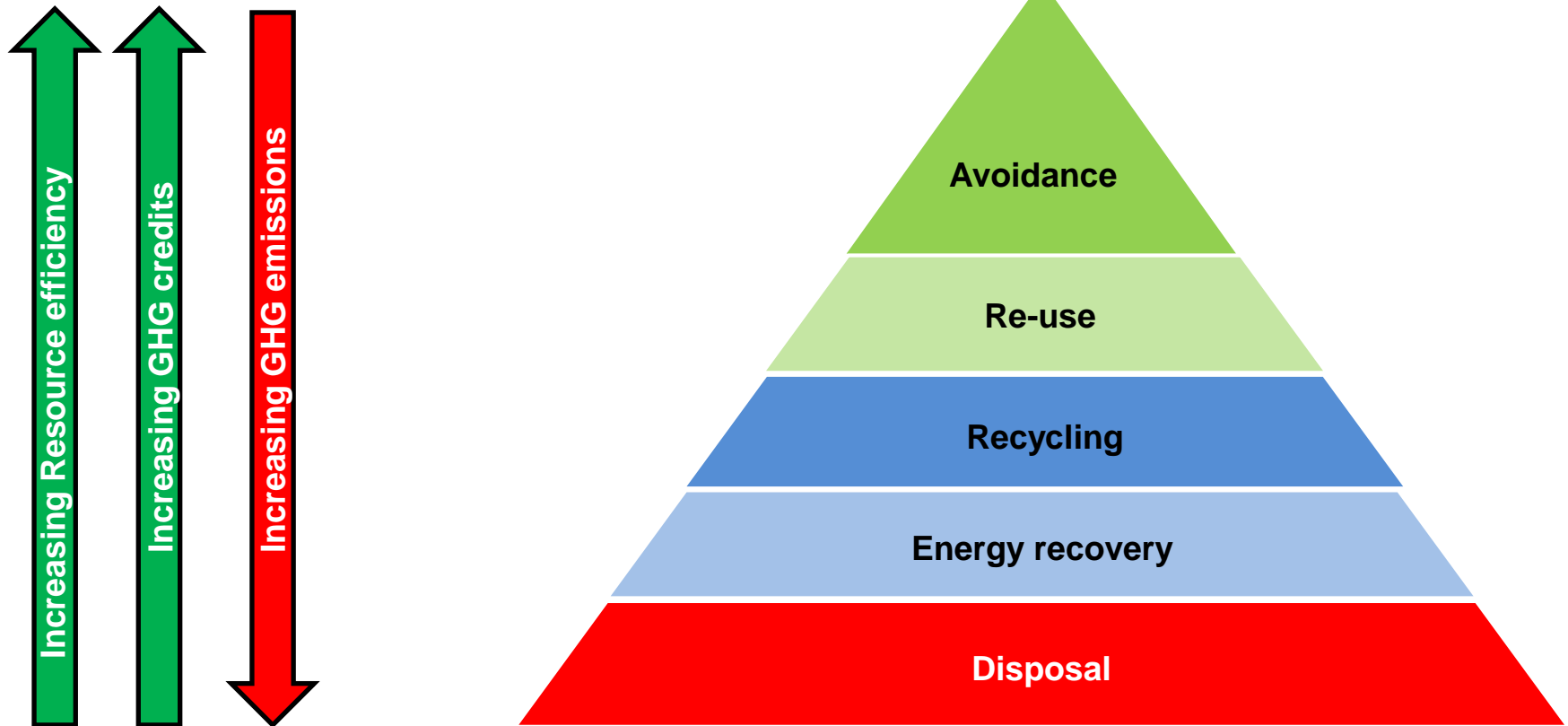
Dependency of credits from the reference system:

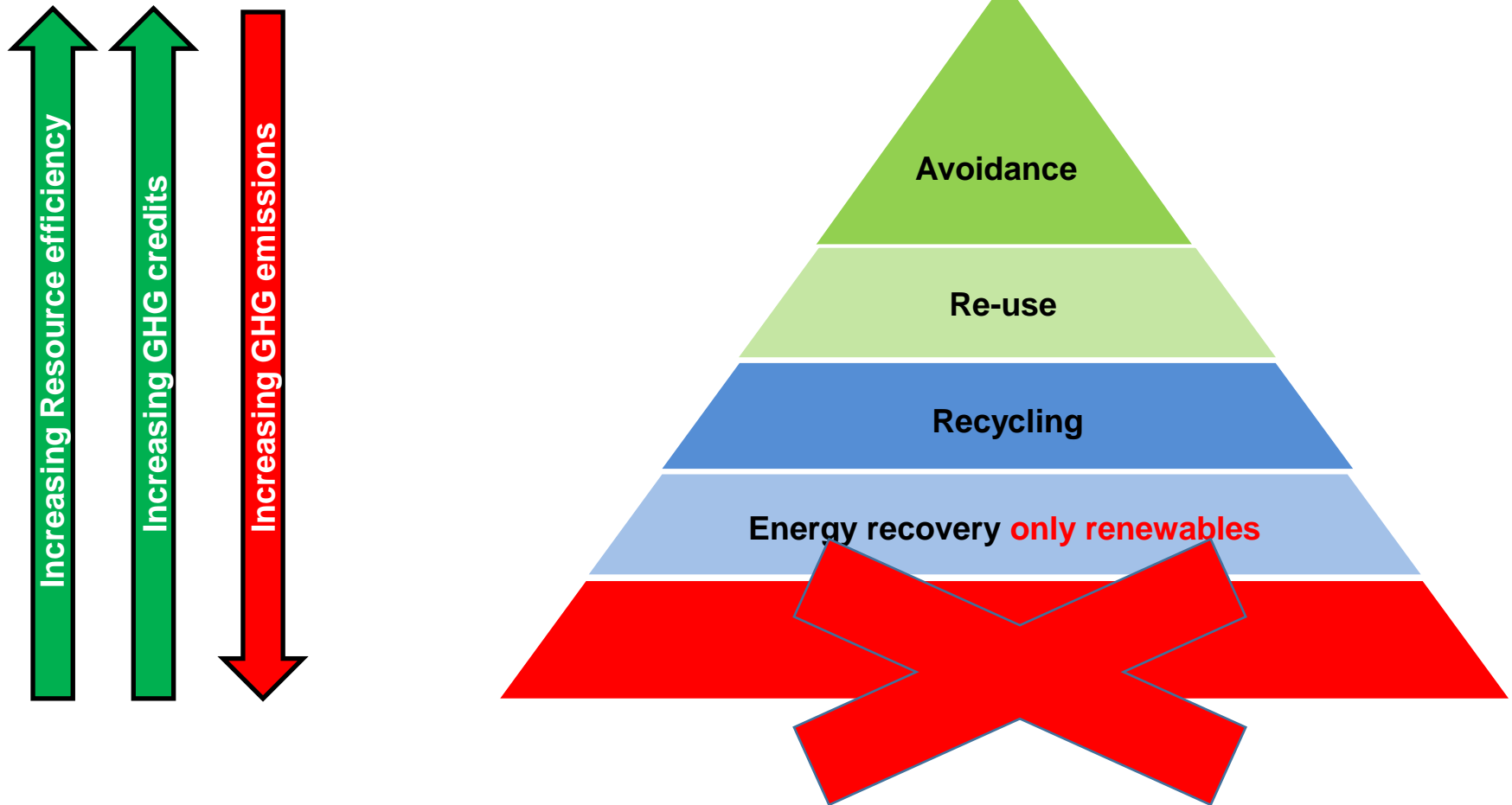
- Depending on which electricity (heat) is substituted, different credits result.
- The lower the emissions from substituted electricity (heat), the lower the credits for electricity (heat) from incineration.
- That means for a decarbonized world, in which the most of the electricity (heat) comes from regenerative energy: Incineration gains less and less credits for electricity (heat)

Electricity	Credits for 1 kWh
Unit	[kg CO ₂ -eq]
German electricity mix	0.40
French electricity mix	0.06
Brazilian electricity mix	0.29
Lignite-based electricity	1.22



Legal framework





Bans: From 07-2021 on, disposable, **non-returnable plastic products** for which alternatives are available, will be banned

Products made of **oxo-degradable plastics** are completely banned.



The EU has identified 10 plastic products that together make up **70 % of Marine Litter ?!**

(Source: Picture, Verbraucherzentrale NRW)

From 01-2021 on, this is to amount to **80 Euro cents/kg of non-recycled plastic** waste from packaging waste – 800 €/t



Environmental associations demand tax on the marketing of plastic packaging at €2/kg of virgin plastic used

German new Package Act - Deposit and Minimum of recycle content

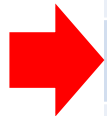
- The German amendment to the Packaging Act extends the **mandatory deposit**. From January 1, 2022, all non-refillable plastic beverage bottles and beverage cans **must have a deposit**. Minimum recycle content for single-use plastic bottles
- From January 1, 2025 at the latest, PET beverage bottles must consist of at least **25% recycle** (= recycled plastic). From January 1, 2030, the proportion will increase **to 30% recycle** use in the production of single-use plastic bottles.



Binding recycling rates

Type of waste	2025 [%]	2030 [%]	2035 [%]
MSW	55	60	65
Packaging	65	70	
Plastic	50	55	
Wood	25	30	
Ferrous metals	70	80	
Aluminium	50	60	
Glass	70	75	
Paper and cardboard	75		

Plastics	Amount to recycling	Proportion	Amount of Recycling	Proportion
Unit	[Mg]	[%]	[Mg]	[%]
Fools	152.664	13,5	150.334	98,5
Plastics high purity	193.001	17,1	185.016	95,9
Mixed polyolifines	37.881	3,3	37.166	98,1
Mixed plastics	733.249	64,8	39.044	5,3
3D-plastics	14.328	1,3	13.155	91,8
Plastics total	1.131.123	100	424.715	37,5



Binding recycling targets

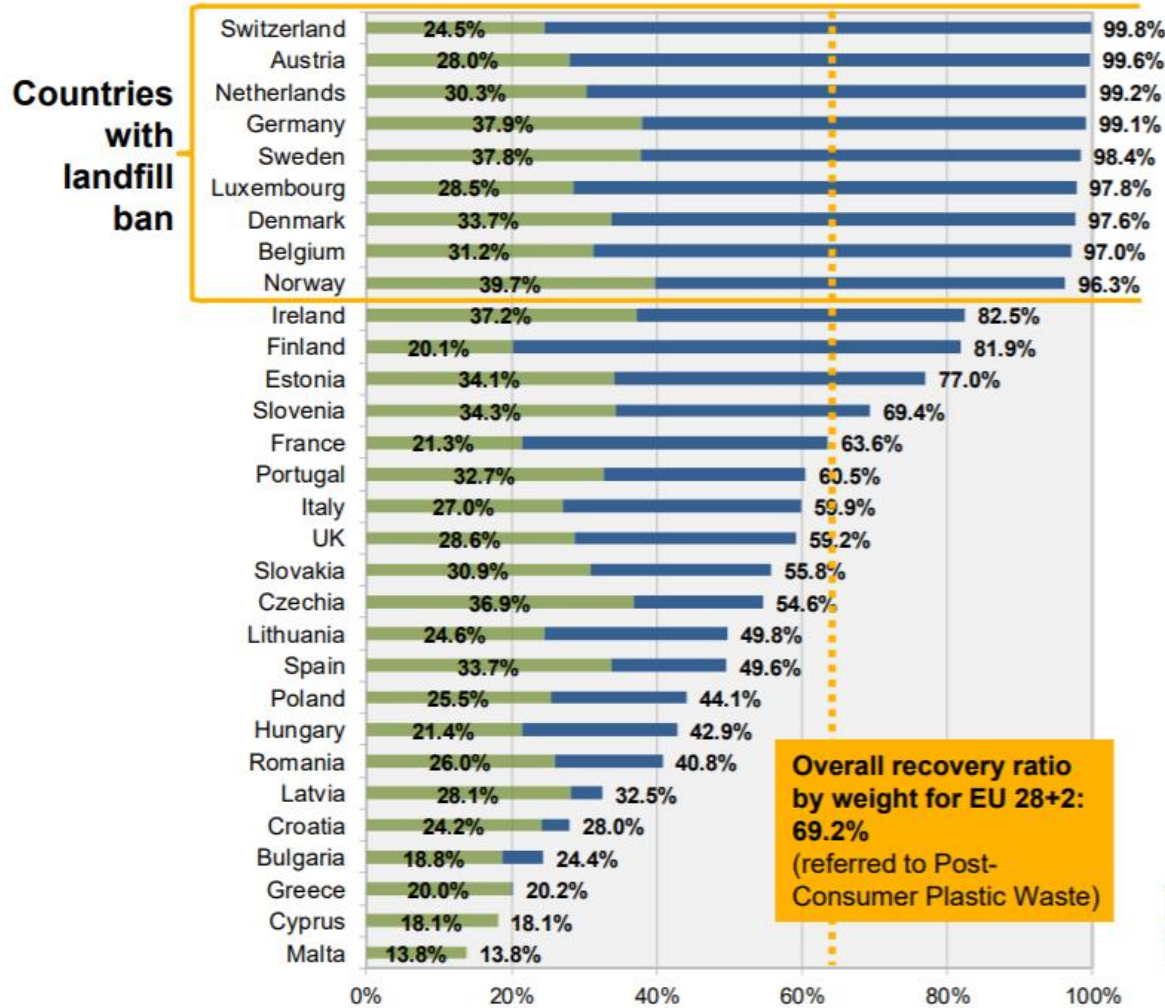
	2022	2035*	2040*
Reduce disposal on landfills to		10 %	10 %*
Prohibition on disposal of untreated waste	X		

*Exceptions for certain countries



MBT Landfill

Recovery of plastics waste - EU-status 2014



9 countries in Europe reached a recovery ratio of more than 95% of the Post-consumer Plastic Waste.

These countries have a landfill ban.

Also 6 of these countries are amongst the 11 countries with the highest recycling rates (>30%).



Therefore „divert from landfill“ boosts higher recovery and recycling quantities, also of waste streams, which have not been recovered so far.

Source: Plastic Europe, <https://committee.iso.org/files/live/sites/tc61/files/The%20Plastic%20Industry%20Berlin%20Aug%202016%20-%20Copy.pdf>

United Nations Food and Agriculture Organization (FAO) estimates:

- Around 1/3 of the **food produced for human consumption** is lost or thrown away worldwide – **app. 1.3 billion t/a**
- 11 mill. t of food waste in Germany with a value of 25 billion Euros. Of those, private households produced 6.67 mill. t (**61 %**)

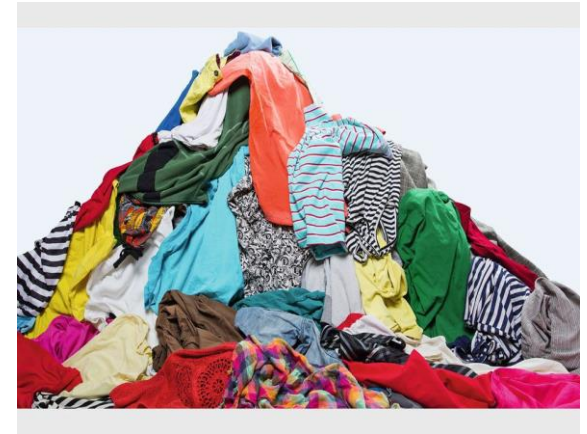


Binding separate collection obligations are strengthened and extended to:

- Hazardous household waste (by end 2022)
- **Biowaste (by end 2023)**
- Textiles (by end 2025)



(Source: Copyright by Andreas Caspari)

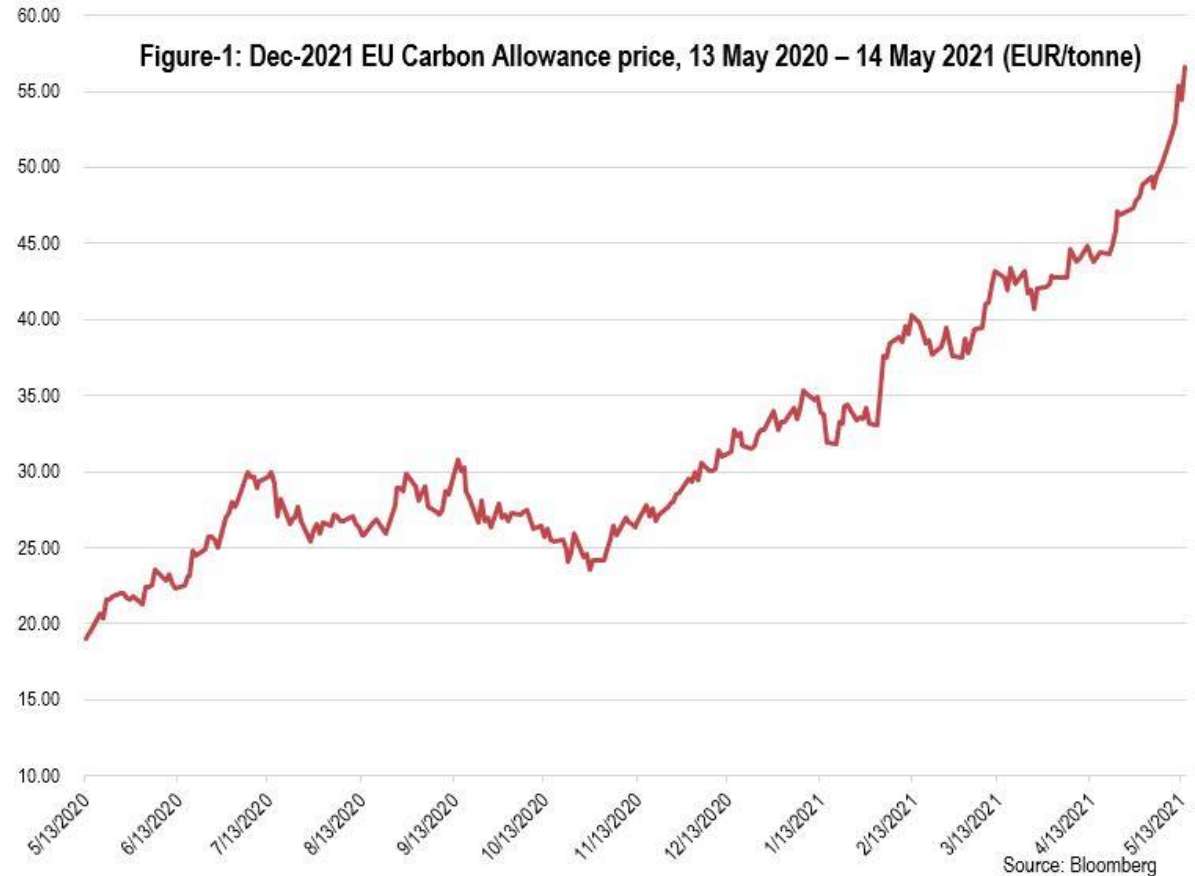


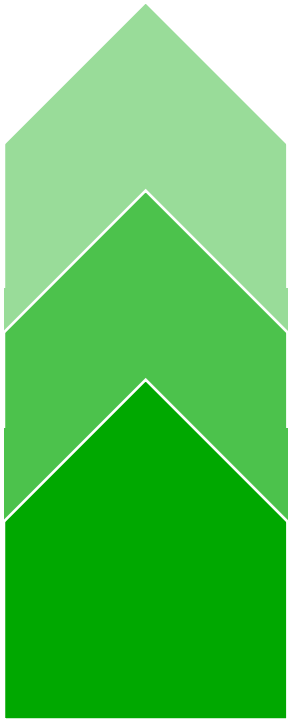
(Source: Nomad_Soul, Fotolia.com)

The European Emissions Trading System (EU ETS) is the **central climate change mitigation instrument**



- BIOBASED FUELS -





Waste amount and composition

Waste composition

- Relevance for waste management

Waste fraction	Germany [%]	China [%]	Brazil [%]	Thailand [%]	India [%]	Java [%]
Paper/cardboard	15.7	15.0	13.1	7.7	1.5	3.5
Glass	6.4	2.0	2.4	2.0	0.2	1.7
Organic	46.9	63.9	51.4	62.0	75.2	78.5
Plastic	9.8	16.9	13.5	12.0	0.9	2.6
Textiles	4.0	1.4	3		3.1	1.0
Metals	4.6	0.7	2.9	0.5	0.1	
Rests	16.8	3.2	13.7	16.0	19.0	13.7
Water content [%]						
Calorific value [kJ/kg]						

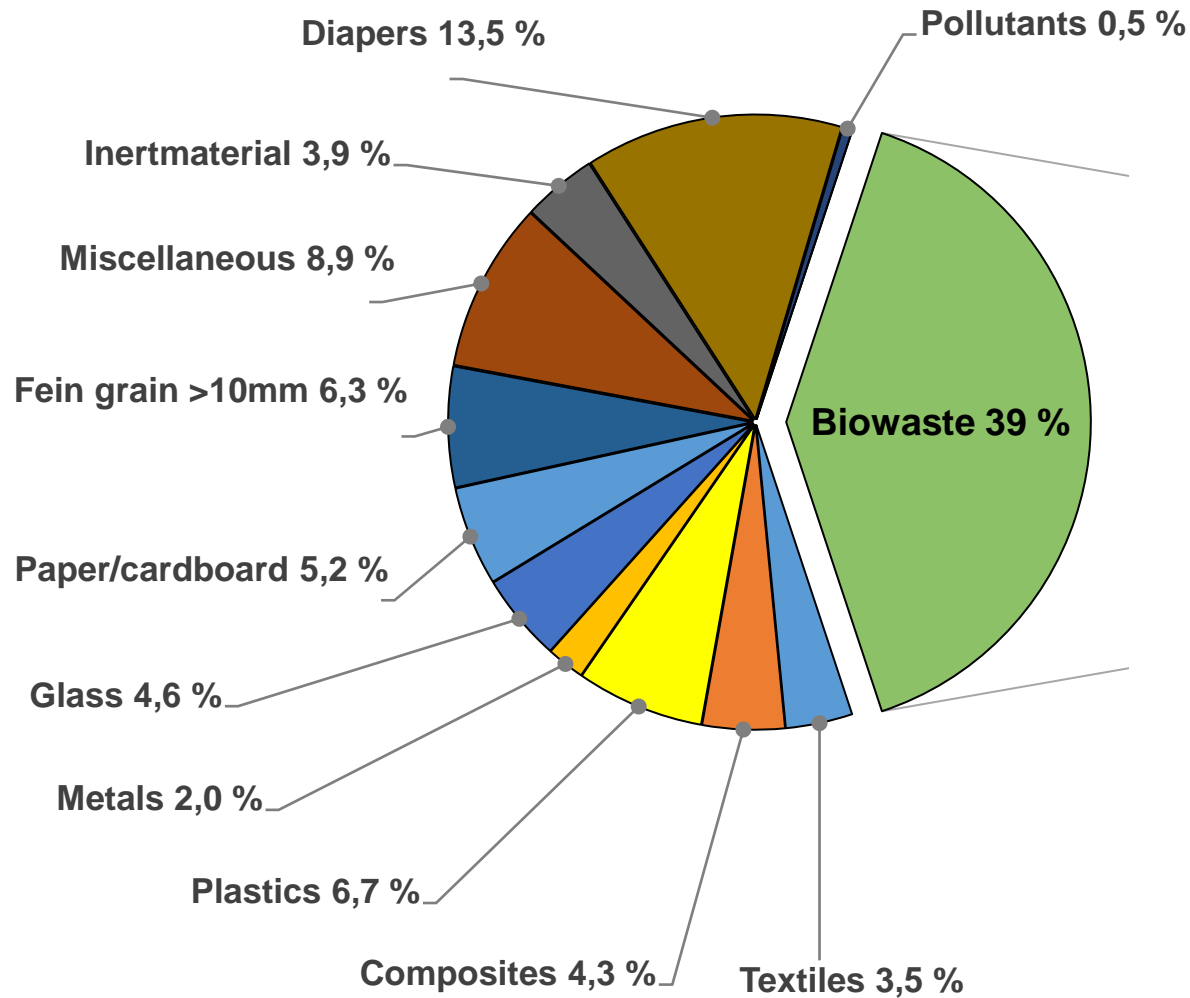
* Average before separate collection

Waste composition - Relevance for waste management

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Paper/cardboard	15.7	15.0	13.1	7.7	1.5	3.5
Glass	64.	2.0	2.4	2.0	0.2	1.7
Organic	46.9	63.9	51.4	62.0	75.2	78.5
Plastic	9.8	16.9	13.5	12.0	0.9	2.6
Textiles	4.0	1.4	3		3.1	1.0
Metals	4.6	0.7	2.9	0.5	0.1	
Rests	16,8	3.2	13.7	16.0	19.0	13.7
Water content [%]	35 – 45	42 - 60	42 - 55	41 - 53	42 - 60	49 - 63
Calorific value [kJ/kg]	8 – 9,000	4 – 7,300	6 – 8,200	4 – 7,500	< 4,000	< 4,000

* Average before separate collection

Waste with a calorific value lower **3,500 – 4,000 kJ/kg** needs additional fuel for combustion – theoretically. Practically :Minimum **6,000 kJ/kg** - practically



Waste components	Development in the past 10 years (UBA, 2018)	Future developments (own data)
Paper	↓	↓
Cardboard packaging	↑	↑ ↑
Plastic packaging – fossil basis	↑	↑ ↑
Plastic packaging – biolog. basis	↑	→ ?
Tinplate packaging	↓ ↓	→
Aluminum packaging	↑	↑
Glass packaging	↓ ↓	↓
Biowaste	→	→
Diapers	↑	↑ ↑ ↑

➔ Future effects due to measures taken against marine litter?

Packaging law (GER)

- Deposit regulation, valid since 01.2019

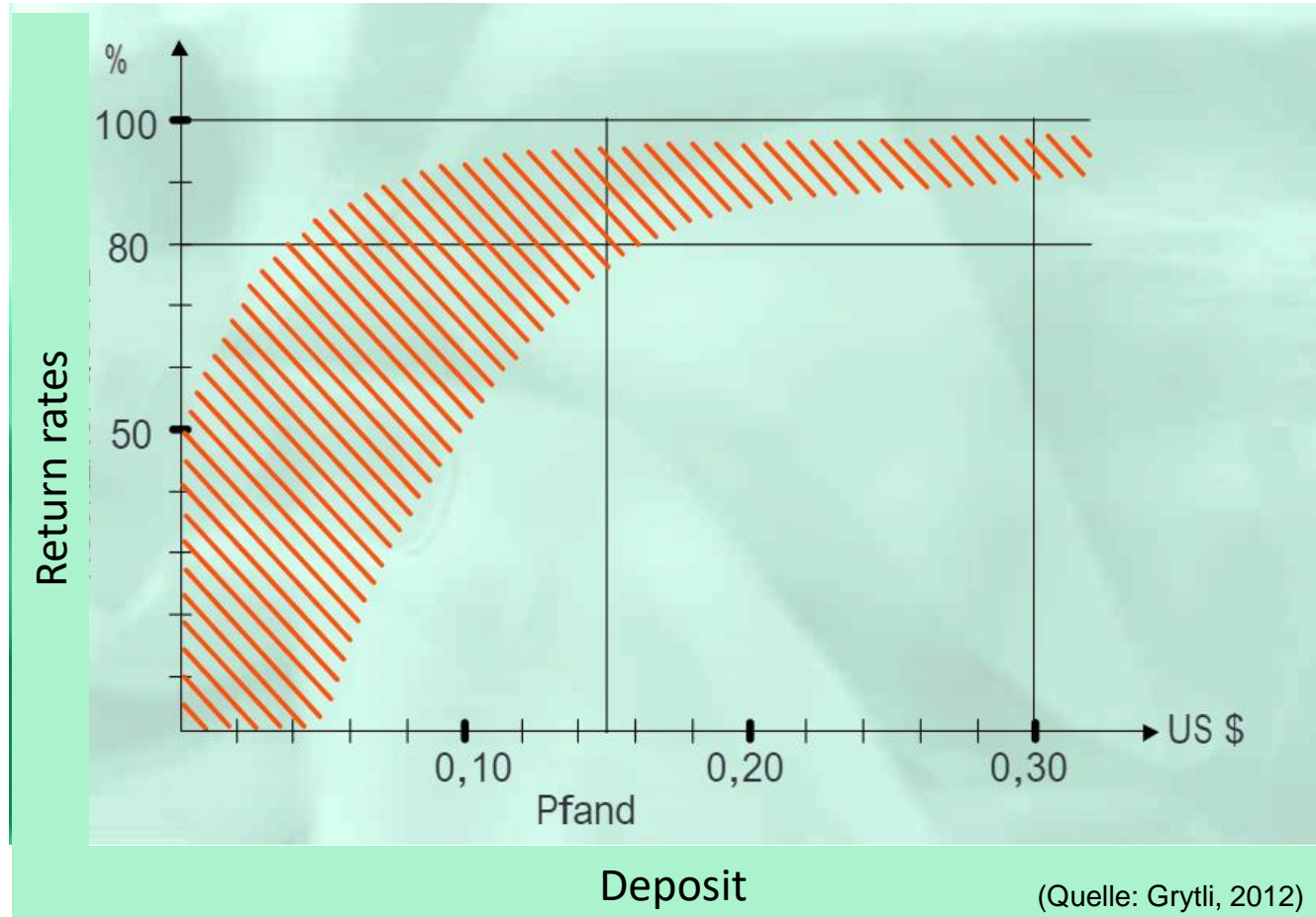
Beverage bottle	Deposit
Returnable beer bottles from glass (all sizes)	8 Cent
Returnable beer bottles with clip lock	15 Cent
Returnable mineral water bottle (Glass or PET)	15 Cent*
Returnable bottle for juice or soft drinks	15 Cent
Some 1,0-Liter-Wine bottles	2 or 3 Cent
All disposable bottles or cans	25 Cent

* in exception also 25 Cent



Deposits

- Return rates and deposit amounts



The return rates are in average over 80 %, in some countries over 95 %

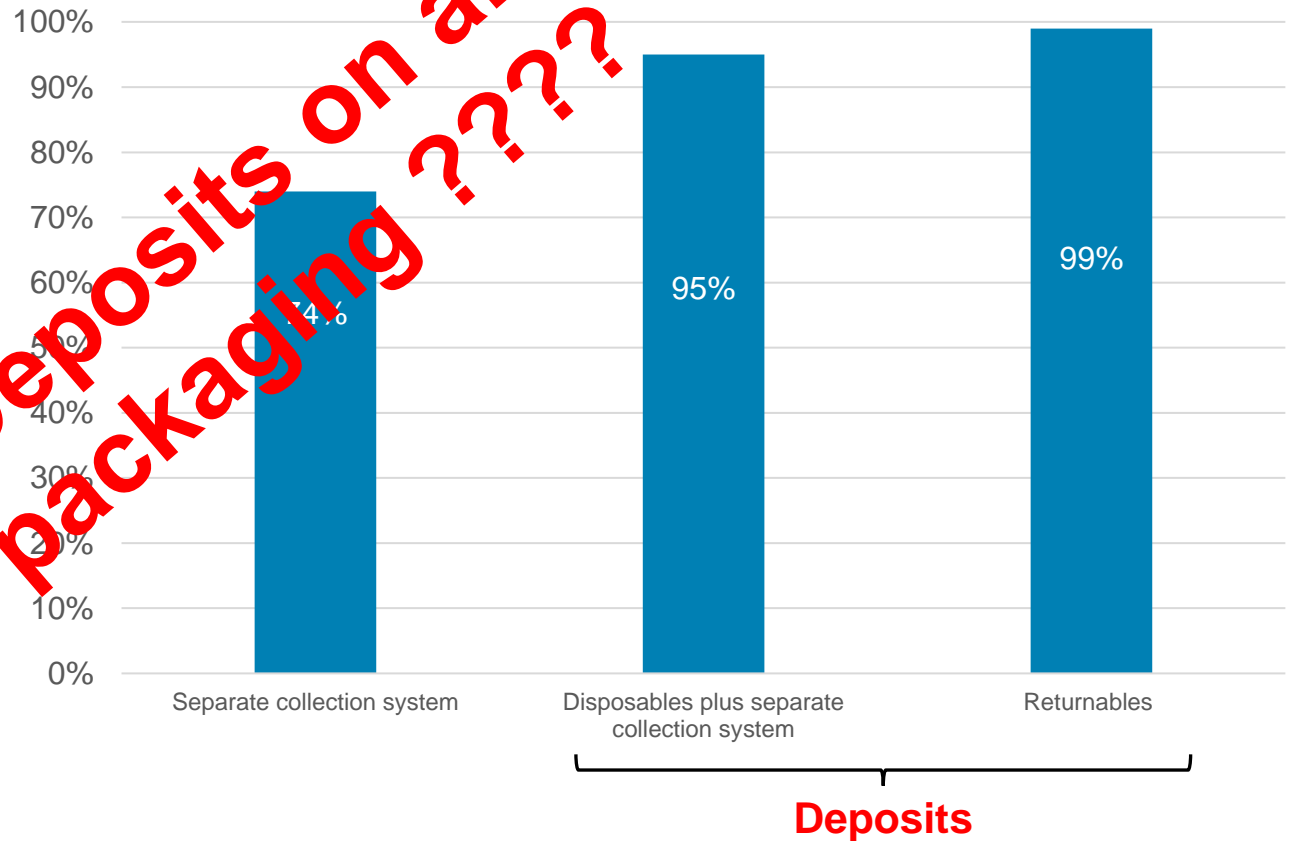
Return rates

- Deposit for returnable and disposable bottles



Deposits on all packaging ????

Return rates of different Systems



Recommendation Brazil:

Deposits on packagings e.g.

- beverage packagings
- packaging from online trading

Deposit and returnable systems payed by retail trade or online trading companies

**100 %
MSW 44 Mio t
In 2016**



Total generated waste in 2018 in Brasil:

- **62,78 million tons per year** (SNIS 2018) for 62 % of the Brazilian cities
- **79 million tons per year** (ABRELPE 2018)

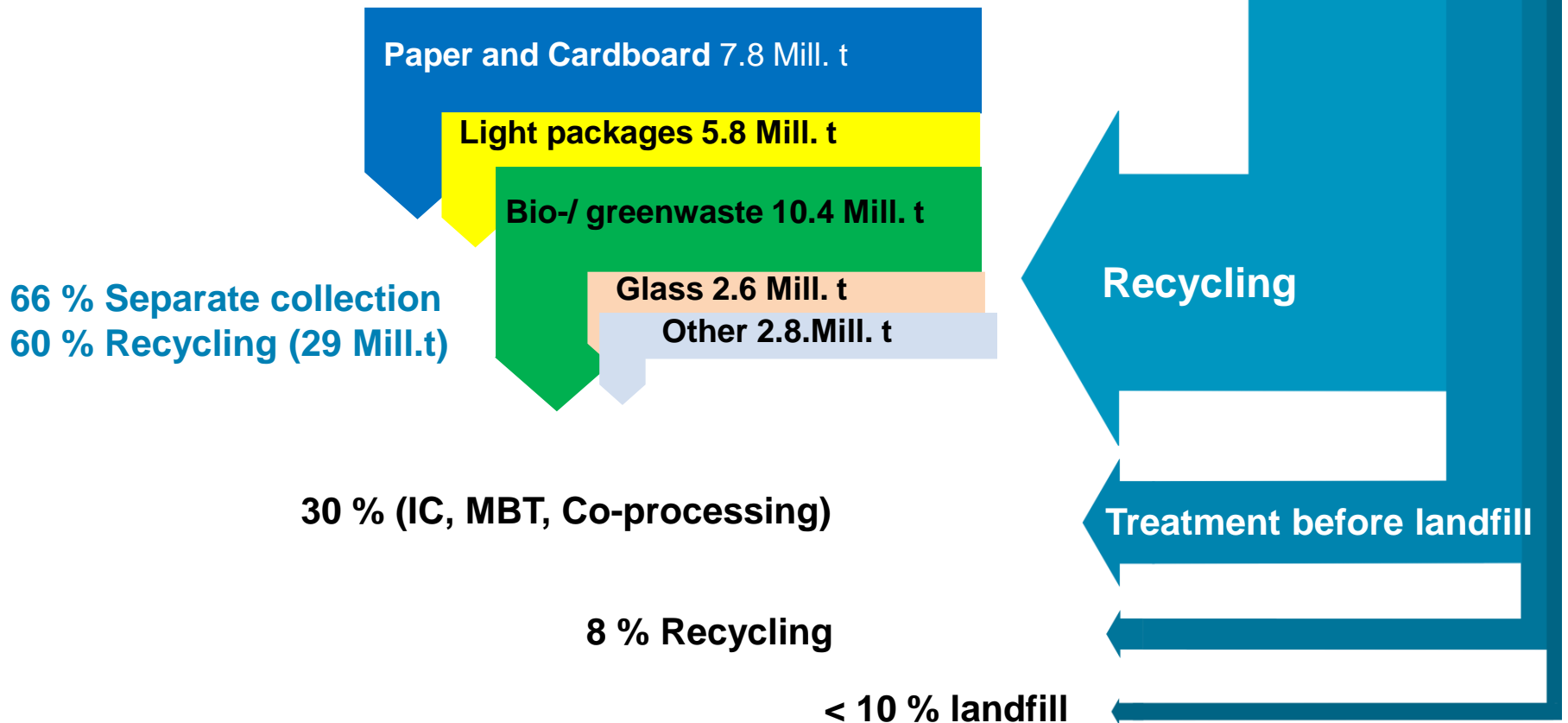
Recycling

Treatment before landfill



Mass flow MSW Germany - Separate collection

**100 %
MSW 44 Mio t
In 2016**



100 %
MSW 44 Mio t
In 2016



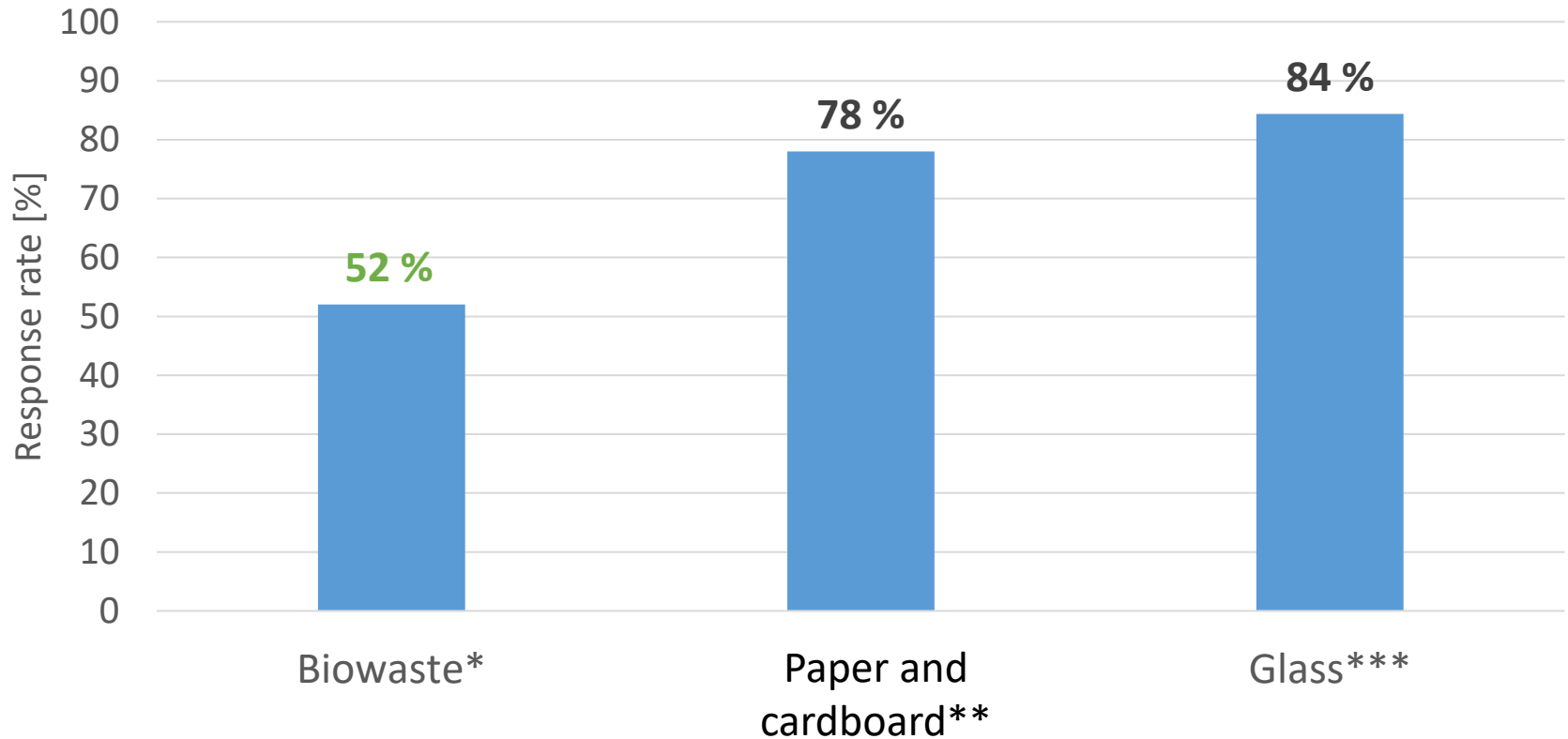
Considering 100 % formal sector –
3.100.000 t/a and 50 % informal sector –
• **9.475.000 t/a, resp. 12 %** of the total
generated waste of 79 million t/a

8 % Recycling

< 10 % landfill



Collecting rates

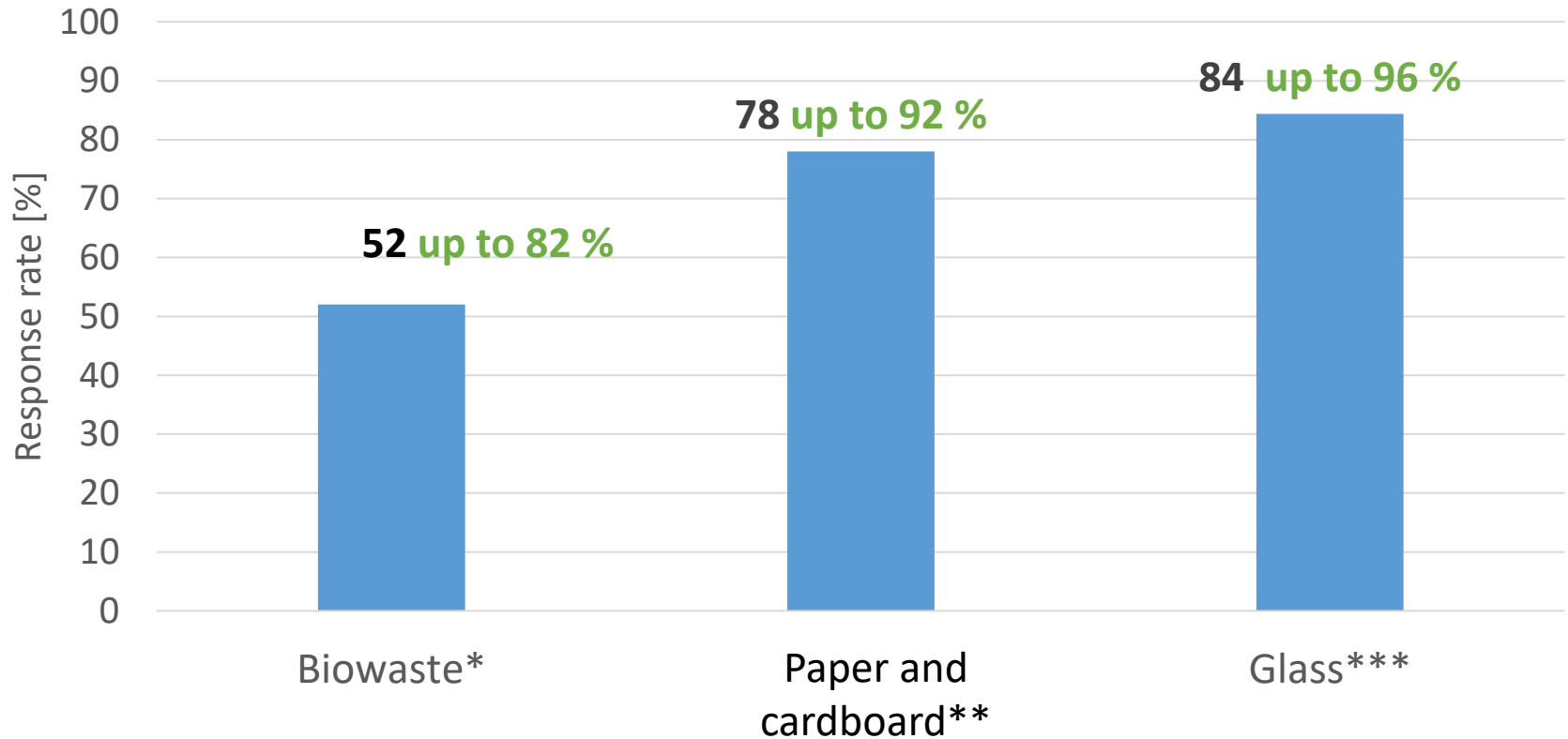


* own data 2020; status 2020

** UBA, 2020; as of 2019

*** UBA, 2020; as of 2017

Collecting rates

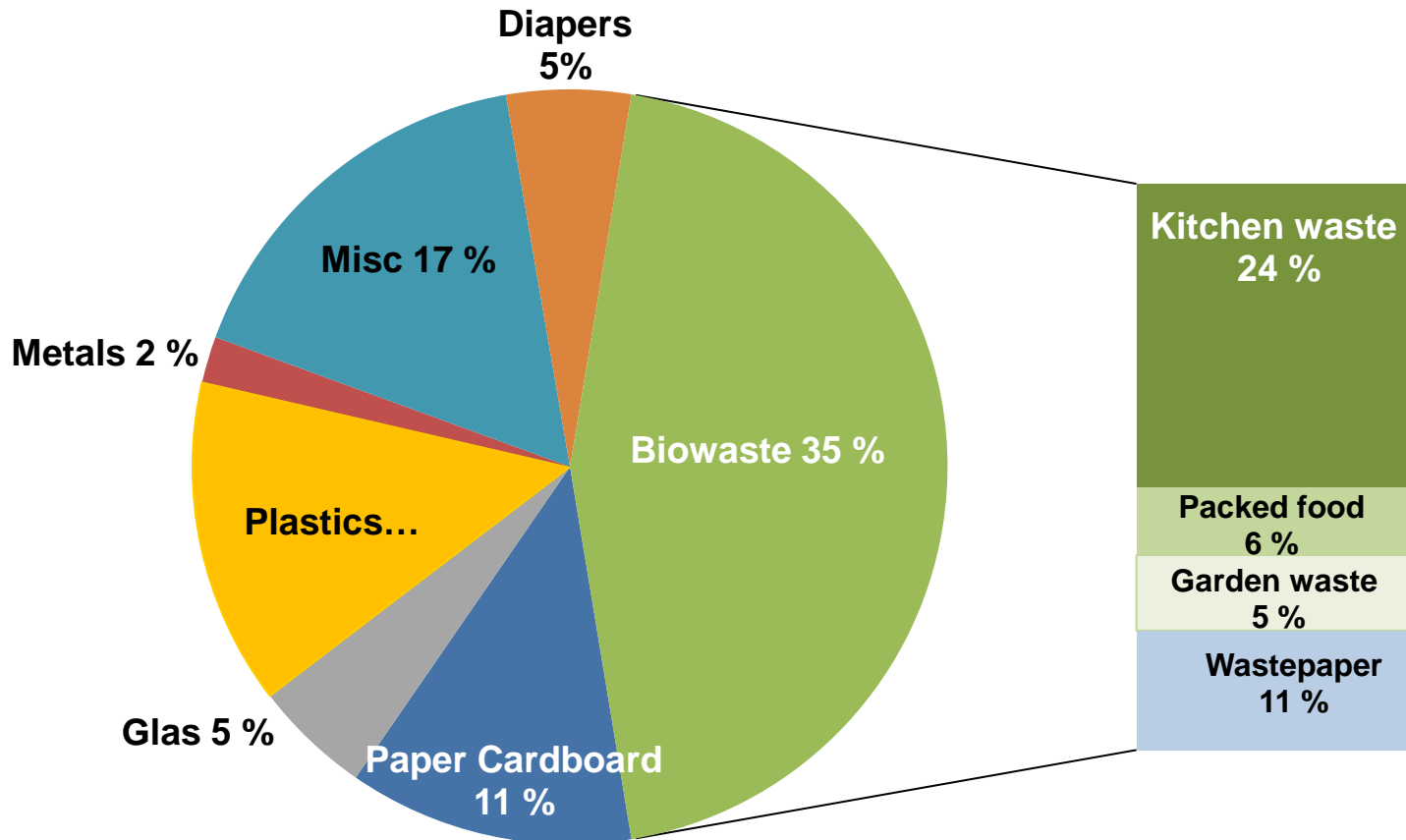


* own data 2020; status 2020

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Waste composition Braunschweig (GER)



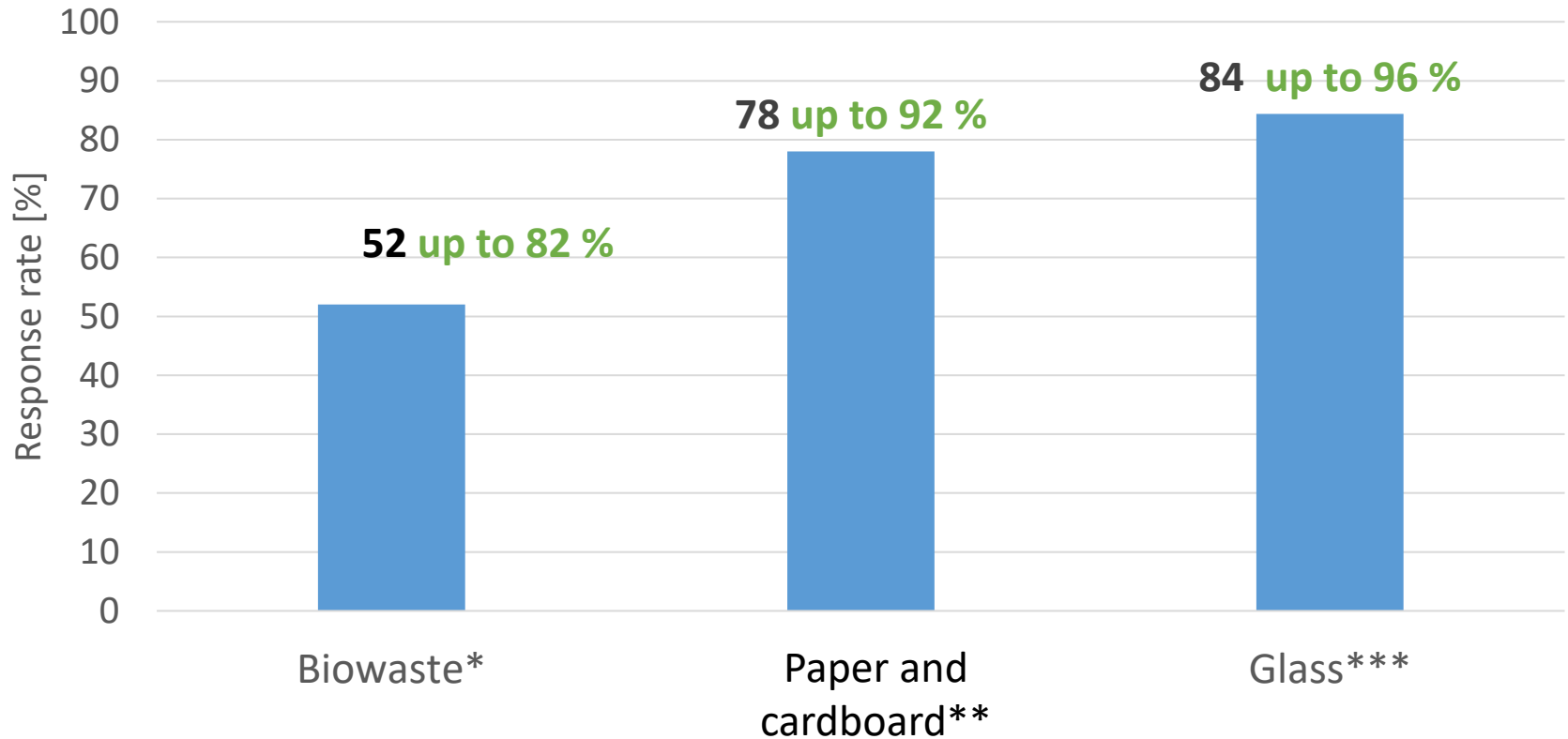
Bio-waste volucollecting rate - Status 2018/2019

Proportion of biowaste in residual waste	Residual waste quantity	Biowaste in residual waste*	Collection via the organic waste bin	Total potential of biowaste	Collecting rate
[%]	[t/a]	[t/a]	[t/a]	[t/a]	[%]
39.3*	11,097,000*	4,372,000	4,667,878*	9,039,878	52 (48**)
16.3	8,532,976	1,807,976	7,231,902		80

* UBA, 2020; as of 2019

**Under consideration of impurities

Collecting rates



* own data 2020; status 2020

** UBA, 2020; as of 2019

*** UBA, 2020; as of 2017

- 90 % of contaminants / impurities are entered via kitchen waste
- 80 % are carried in via approx. 5 % heavily polluted bio bins
- Low collection rates and high levels of contamination originate from problematic socio-urban settlement structures



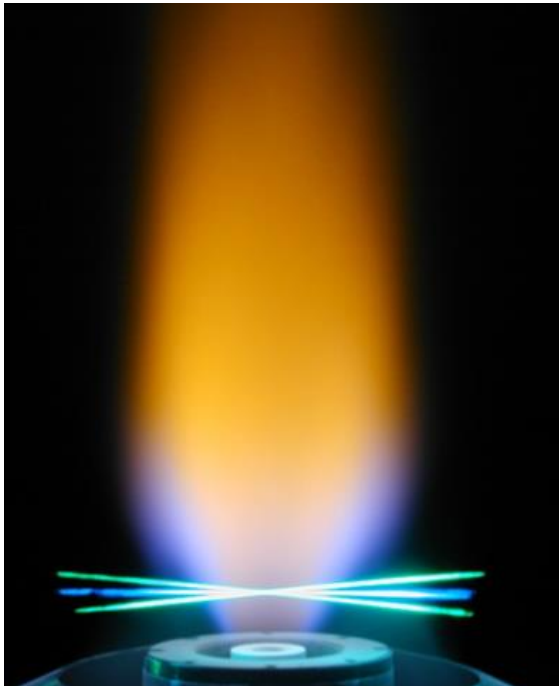
Heavy metal concentrations in waste compost with limiting values (GER, BRA)



[mg/kg DM]	Compost from mixed waste (SCT, 2014)	Compost from separate collection (BGK 2017)	German Biowaste Ordinance	Brazil MAPA (2016)
	Average	Average	20 t/3a application	
Cd	1.4	0.35	1.5	3
Cr	111	44	100	n.v.
Cu	158	55	100	n.v.
Hg	0.3	0.3	1	1
Ni	29	20	50	70
Pb	97	40	150	150
Zn	351	165	400	n.v.

Biotechnology

Anaerobic process

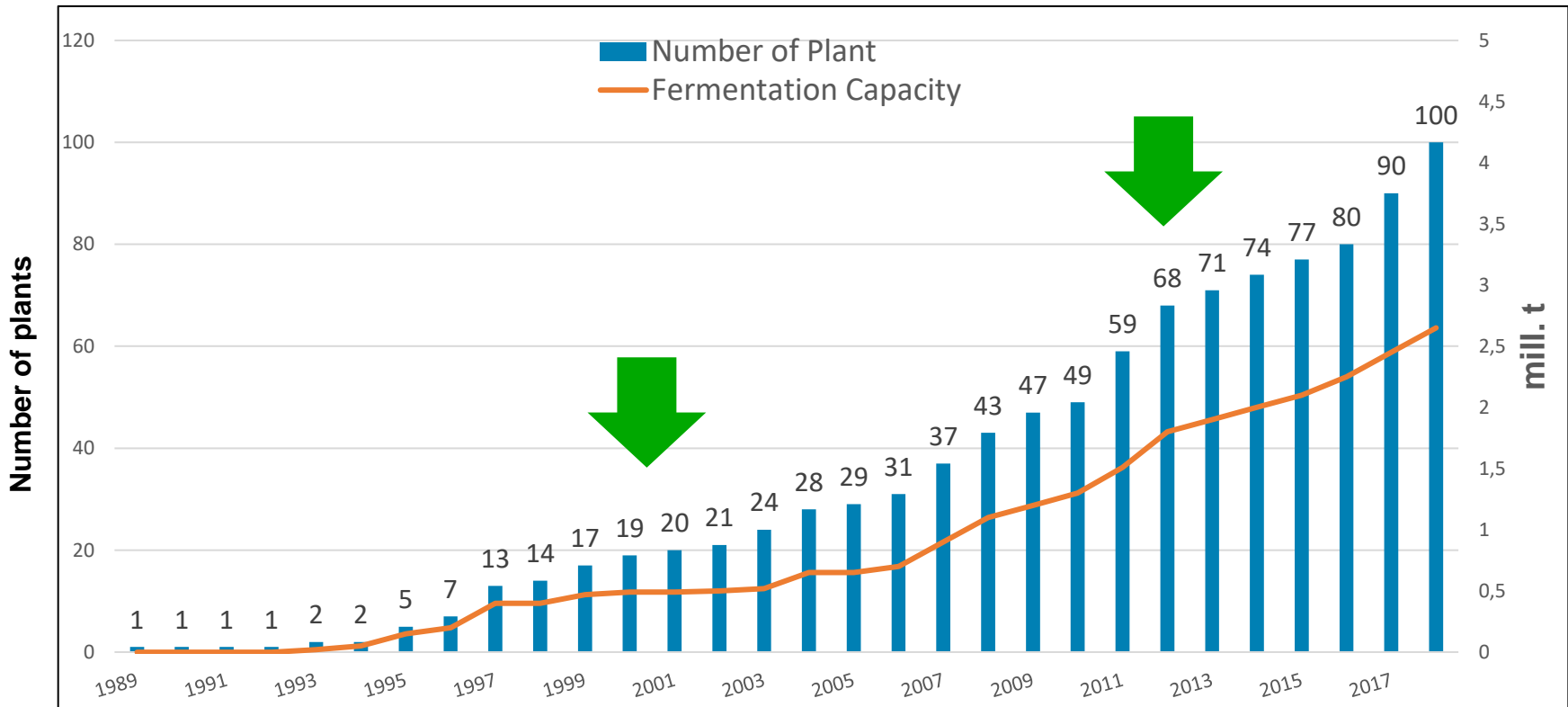


Aerobic process



Development of fermentation in Germany

- Push effects



Push effects:

- Renewable Energy Act (2000) and further amendments, funding instrument of renewable energies
- KrWG (2012): Mandatory separate collection of biowaste since 2014

Source: Fachverband Biogas, 2018, 2018 data based on forecasts

Recommendation Brazil:

- **Starting with decentralised green waste composting**
- and**
- **industrial biowaste composting and fermentation**
 - **Check mixed waste composting with special view on heavy metals and micro plastics content**

**100 %
MSW 44 Mio t
In 2016**

60 % Recycling (29 Mill.t)

**30 % (IC, MBT, Co-processing)
Lost CO₂ and Water**

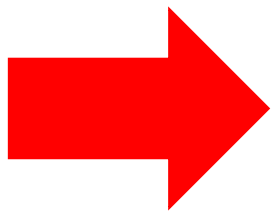
**8 % Recycling and energy production
< 10 % landfill**

**Recycling of
separate collected
waste fractions**

Treatment before landfill

Waste treatment - Treatment before landfill

- 66 Waste incineration plants *
 - 20,0 Mill. t cap.
- 46 MBT plants
 - 4,8 Mill. t cap.
- 32 RDF plants**
 - 6,3 Mill. t cap.



***Exclusively grate incineration technologies**

****Exclusively grate and fluidized bed incineration technologies**

Pyrolysis and gasification technologies failed in Germany

General aspects

- Use of AF in German cement production

Total mass of solid AF used in German cement production
(status quo)

Max. possible amount

2.2 mill t/a (65 % of TSR*)

3.4 mill t/a (100 % of TSR**)

Proportion of total German waste mass potential:

5.5 %, status quo

8.5 %, max. (theoretical)**



Plant in Schelking (GER)

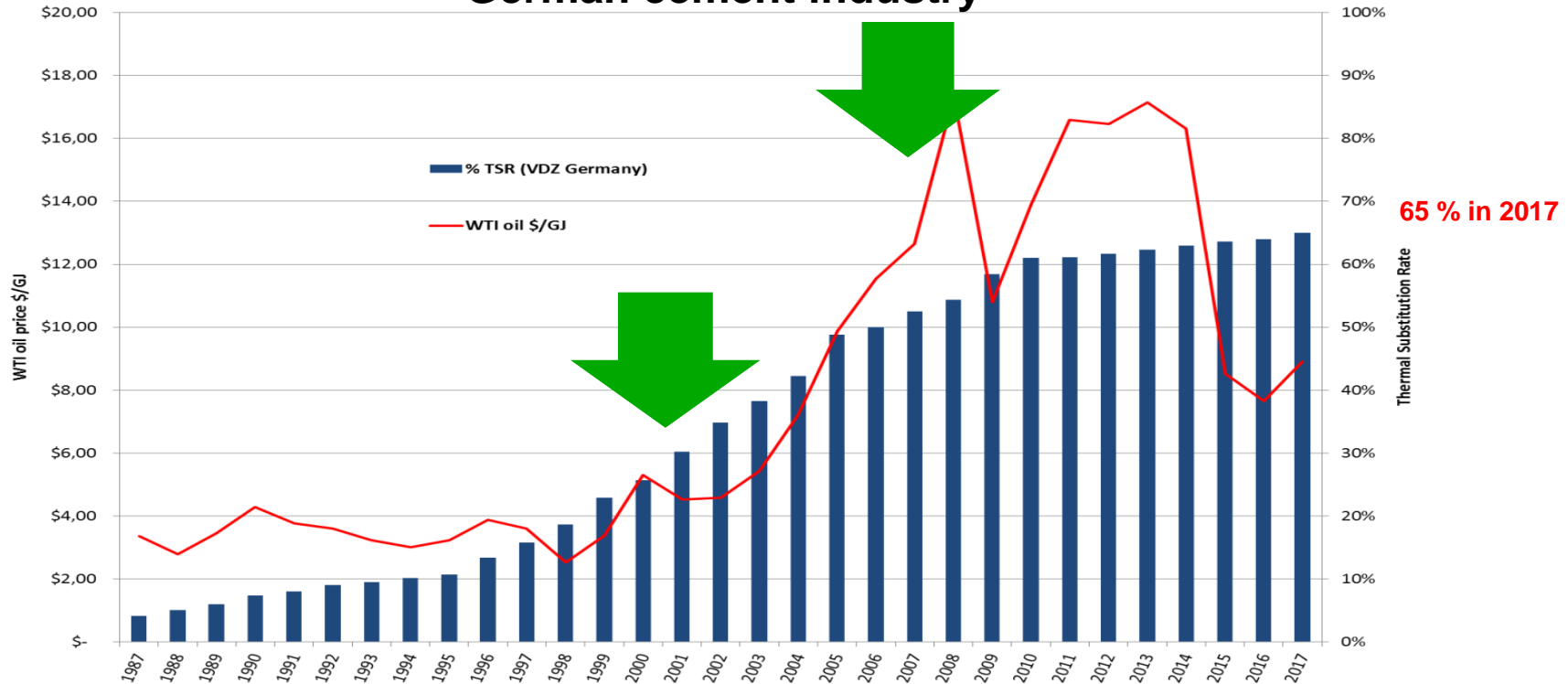


Plant in Lengfurt (GER)

*Thermal substitution rate. The thermal substitution rate is not a fixed rate. TSR is related to the current operational production capacity (load factor)

**Max. technically feasible today approx. 90%

Average thermal substitution rate by AF in the German cement industry

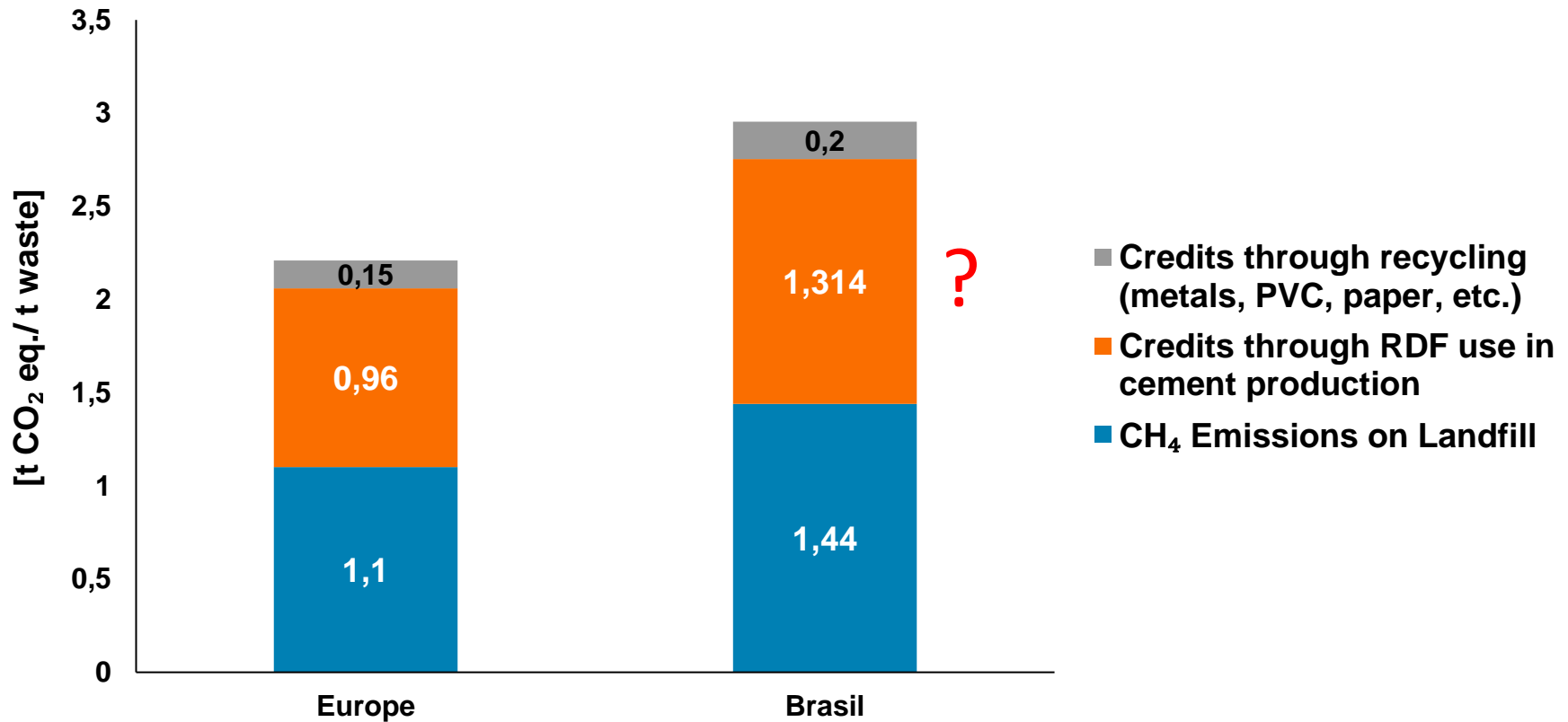


- Pushing effects:**
- Legal enforcement of the ban for disposal of untreated waste (2005)
 - High level of energy price (benchmark WTI oil)
 - Technological development of the MBT

(Source: VDZ 2017 and own data)

- Potential of RDF for Brazilian cement industry 3,5 mill. t per year
- Markets for RDF in the cement industry are available but need to be expanded
- First facilities are available
- Technology adaption is necessary to provide RDF qualities
- More experience in product quality is needed
- Co-financing by revenues from RDF sales (around 100 Reals/t RDF), savings of landfill fees
- Revenues from mixed waste compost are not expected?!
- Self financing is possible?!

GHG reduction by using alternative fuels in the cement manufacturing, considering landfills



Recommendation Brazil:

- **Intensification of measures in RDF-production for cement industry**
- **in combination with compost production!?)**

- Increasing of waste amount
- Changing waste composition
- Shortage of resources - increasing revenues for secondary resources
- Deposits e.g. for different recyclables and toxic waste like batteries
- Increasing material recycling
- Reduction of calorific value due to increasing material recycling
- Separate collection or sorting!?
- Decline in conventional incineration in favor of AF (RDF) use
- Increasing of anaerobic digestion
- Decline in MBT bevor landfill in favor to produce RDF and fuels
- Competition between material recycling and energy recovery
- Landfill ban for untreated waste
- Landfill mining
- Several new technologies

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