Waste and resource management in Germany and EU

Waste management - Over all challenges

Present and future challenges

- Climate change
- Resource shortage
- Marine litter and pollution of aquatic systems
- Species extinction and human health

…. all of these areas interact with waste management – driving forces

Mass flow MSW Germany - Household waste

Source , BMU, 2021

100 % MSW 38 Mio. t in 2019

Recycling

Treatment before landfill

EU Circular Economy Package 2018 - Key elements of recycling

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		
Biowaste, required rates in preparation 2023			

EU Circular Economy Package 2018 - Key elements of landfill

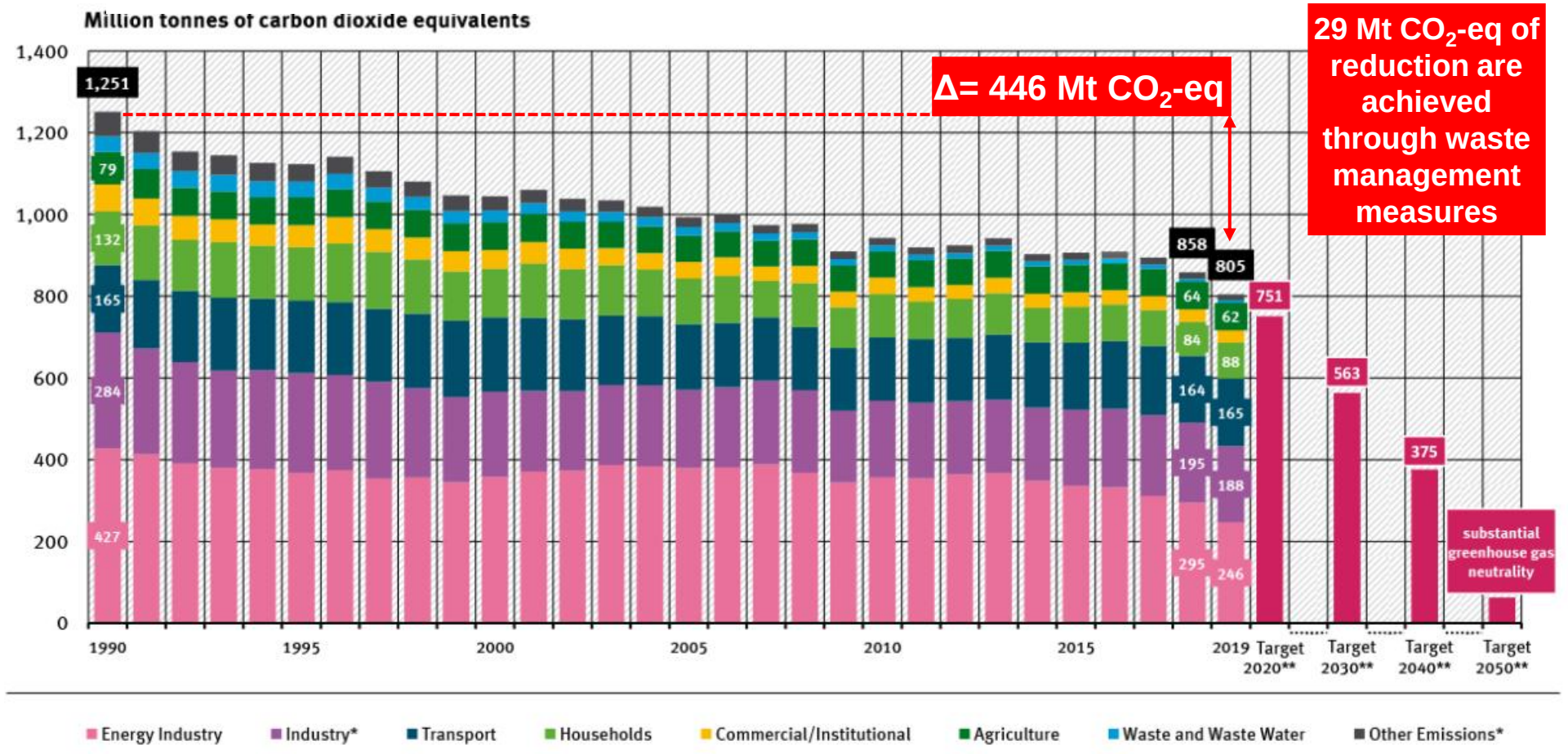
Binding recycling targets

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

*Exceptions for certain countries

Mitigation of GHG emissions in Germany - Sector waste management

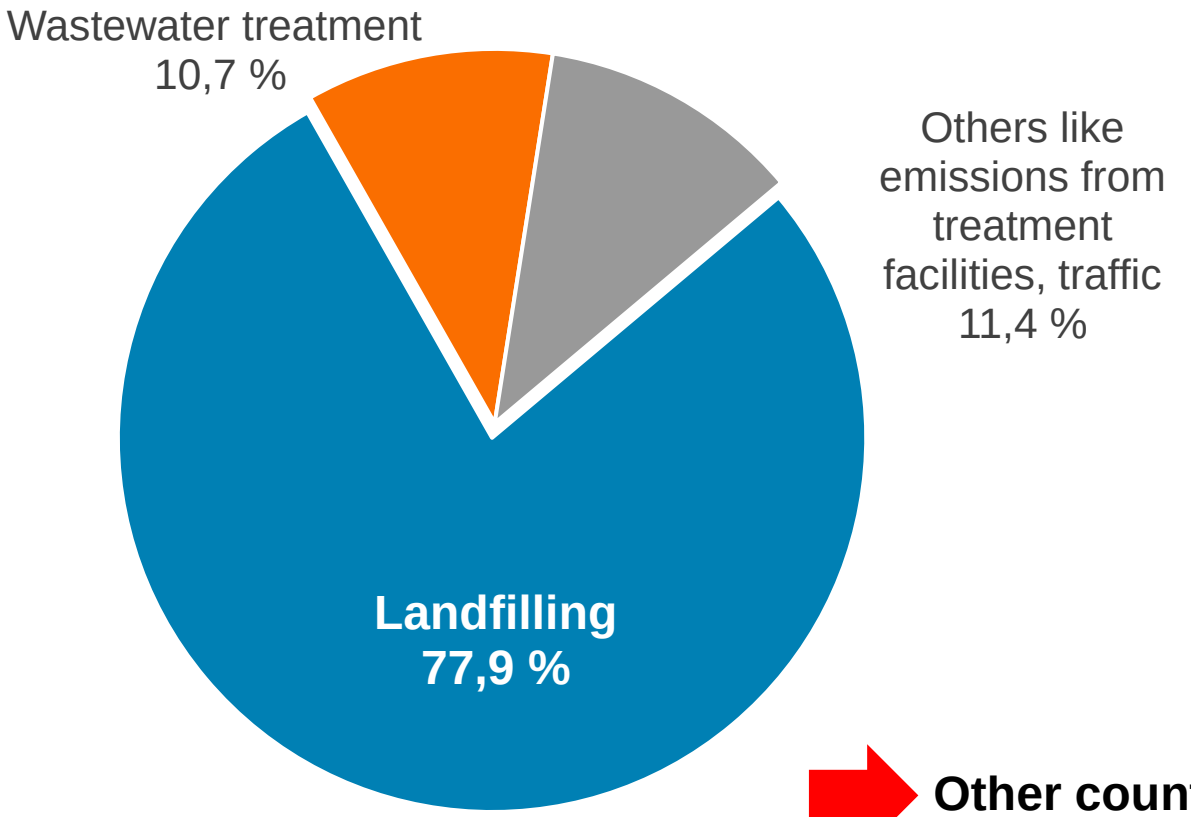
Development GHG emissions in Germany 1990 - 2019



Source: UBA, 2020

GHG emissions in Germany
- Waste and wastewater treatment

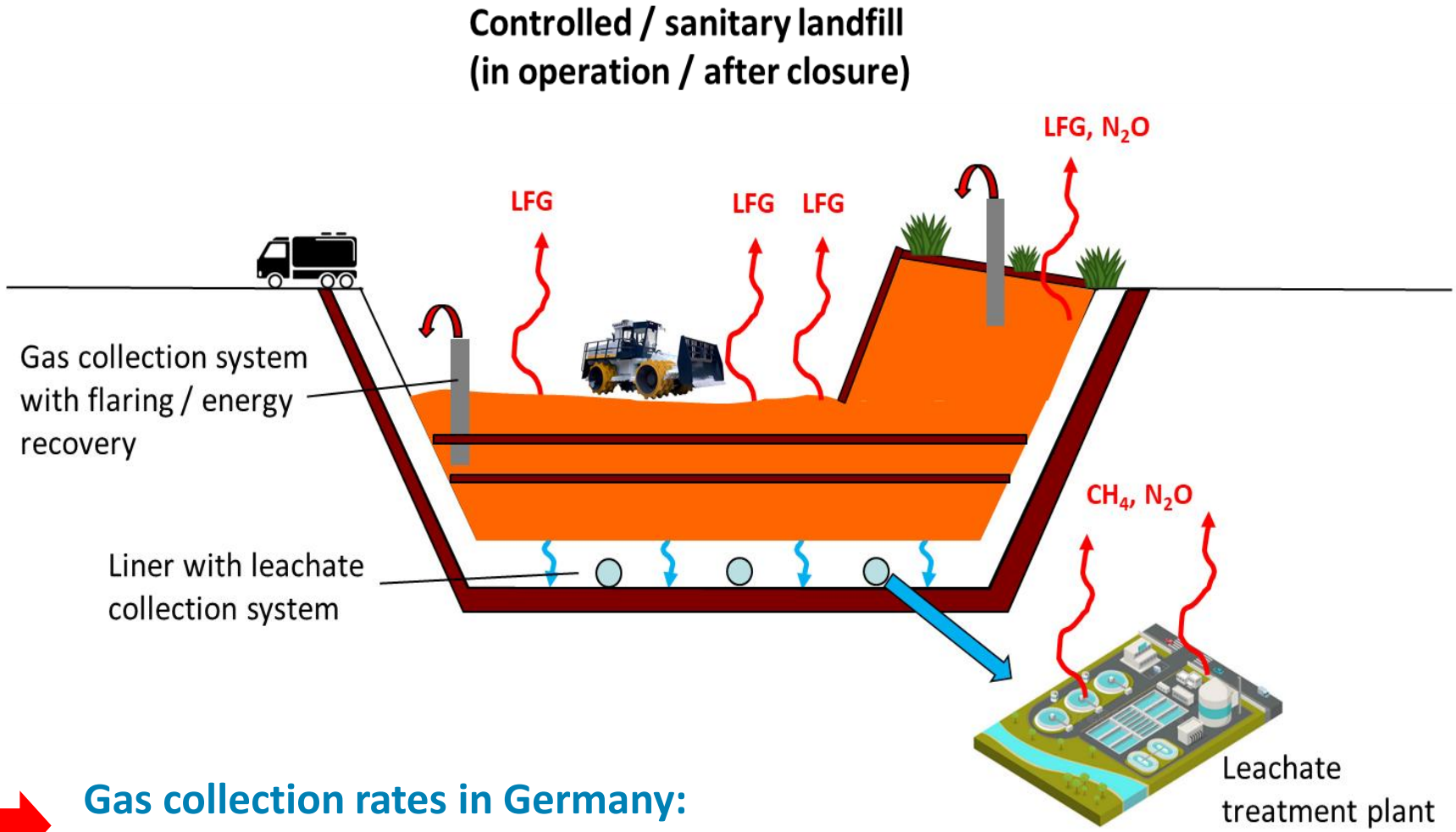
GHG sources from the sector waste and wastewater treatment in 2018 - without CO_2 from biomass use



Other countries???!!!

Source: BMU, 2020

GHG emissions from landfill - Sources



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

Mitigation of GHG emissions in Germany - CO_2 emissions and credits

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

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

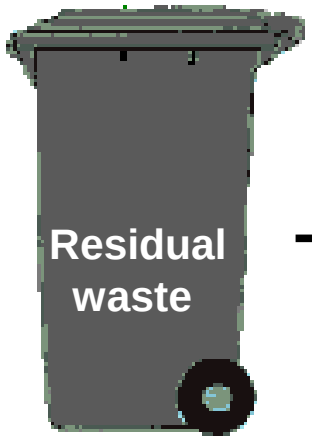
GHG mitigation in Germany from the sector of waste management 2018

- GHG emissions **29 Mio. t CO_2-eq**
- GHG credits through recycling and energy recovery **20 Mio. t CO_2-eq**

- Total GHG avoidance **49 t CO_2-eq/a**
  0.61 t CO_2-eq/cap

Source: UBA 2018 (modified)

Collection systems - Germany



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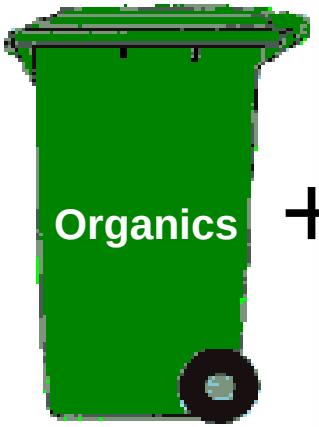

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MBT or Incineration

Anaerobic digestion and composting facility

Paper mill

Sorting facility

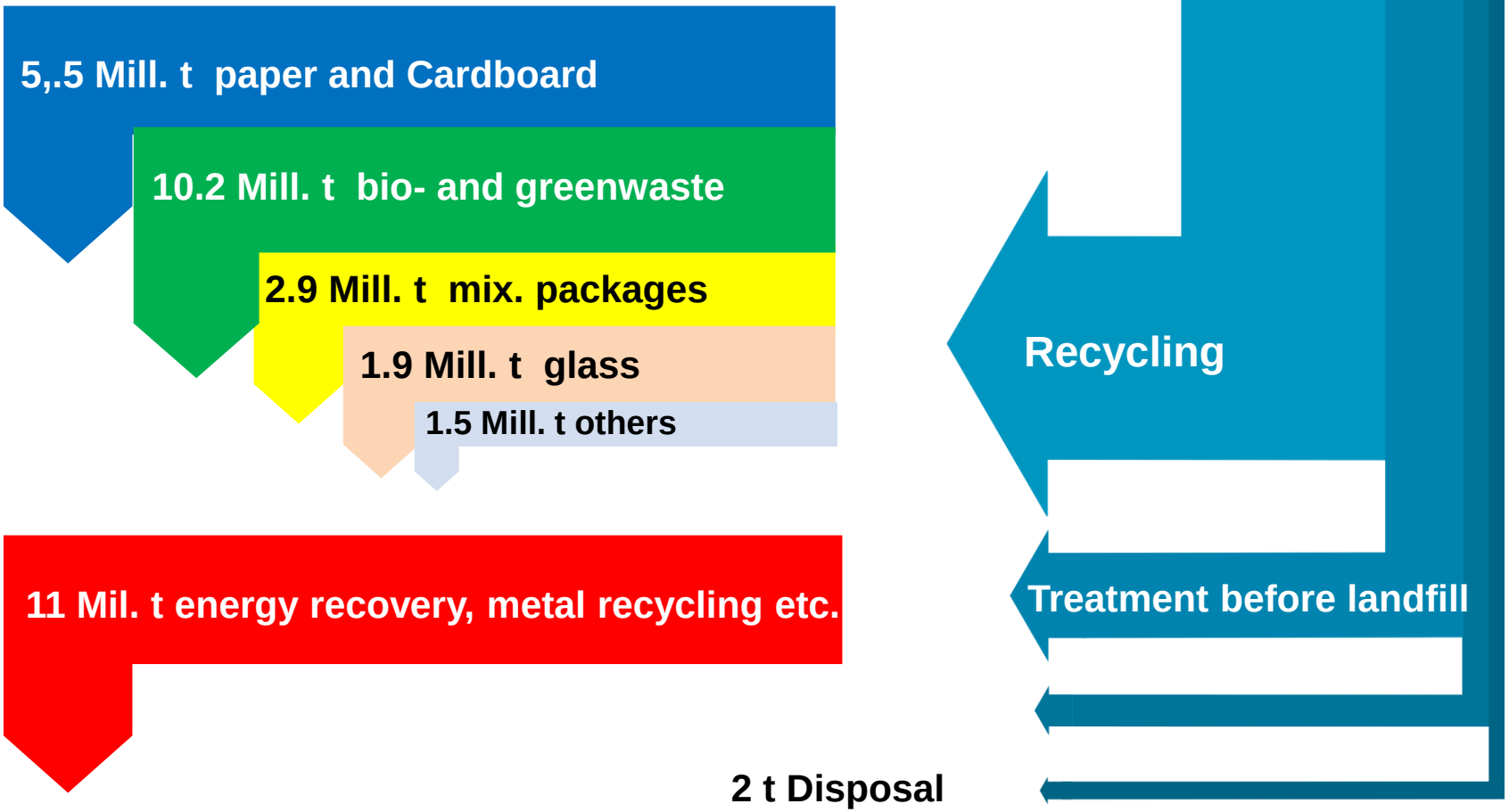
Glass manufacturing

Mass flow MSW Germany - Household waste 2019

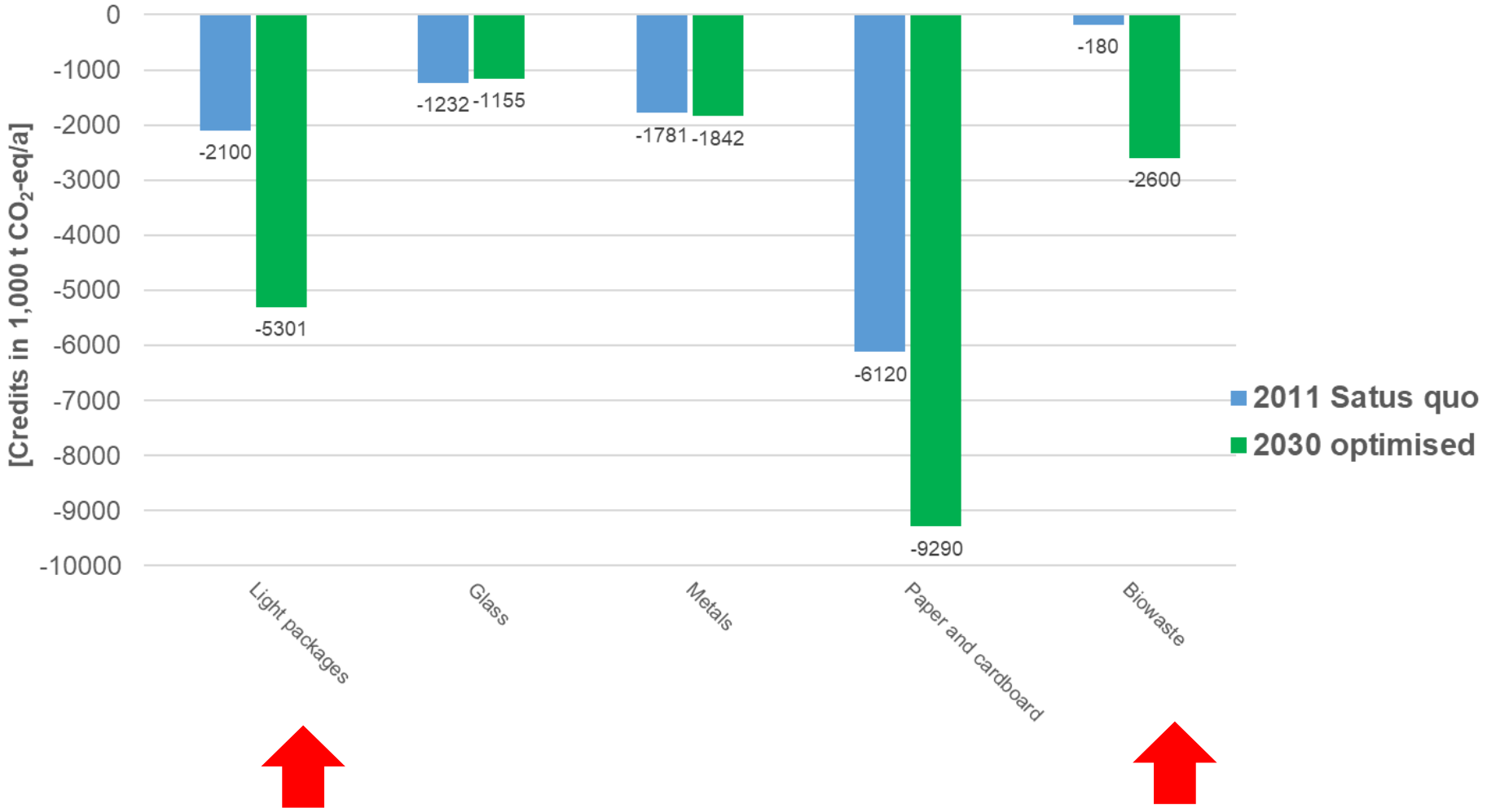
MSW 38 Mill t In 2019

(Source BfS, 2021)

- **59 % (22 Mill. t) Separate collection**
- **App. 53 % Recycling rate**



GHG credits of recycling measures as of 2011 and projected for 2030 "optimised"

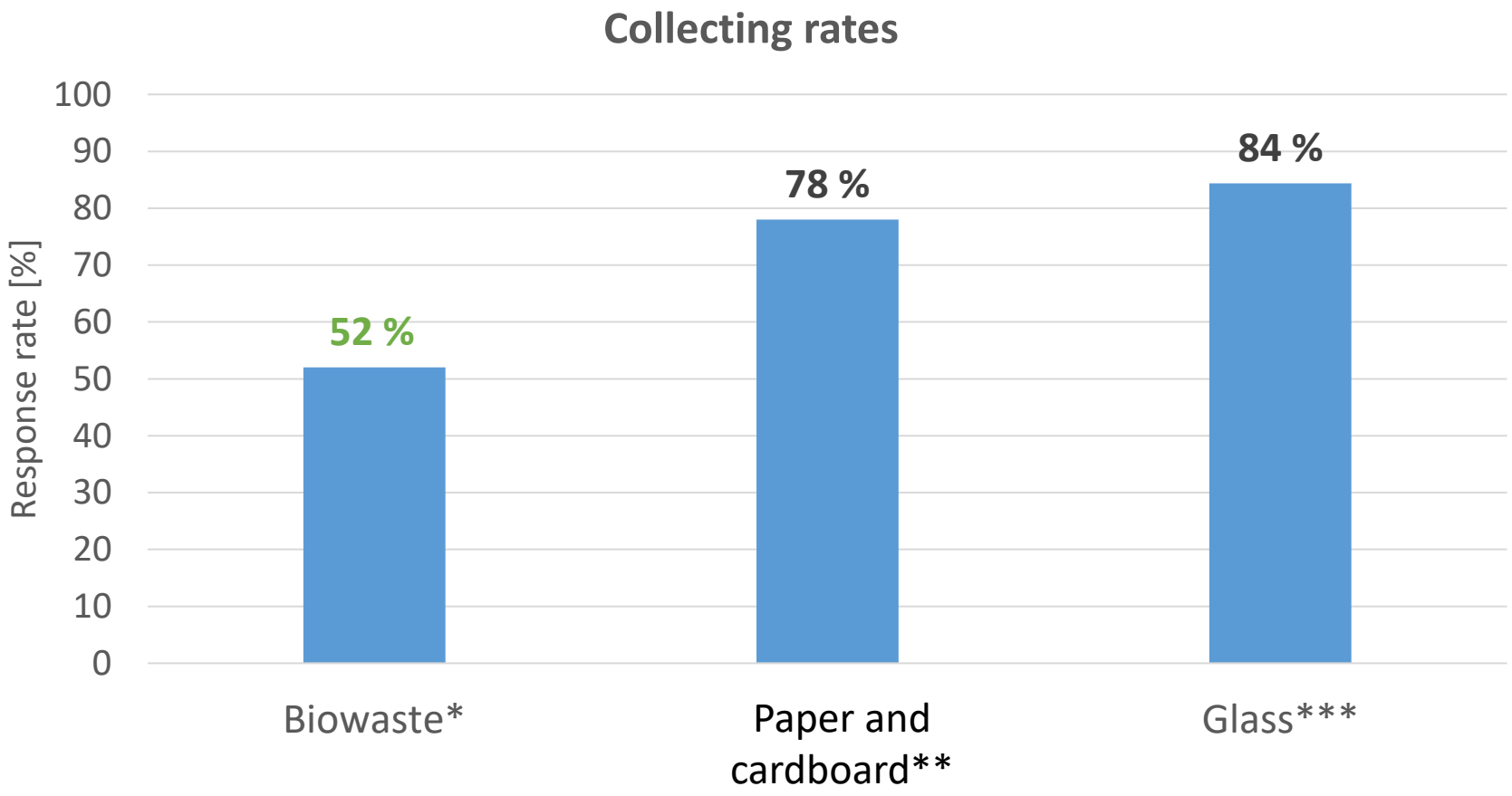


Sources: Öko-Institut, GER; 2014, * Own data

Recovery of plastics waste - GER reality 2019

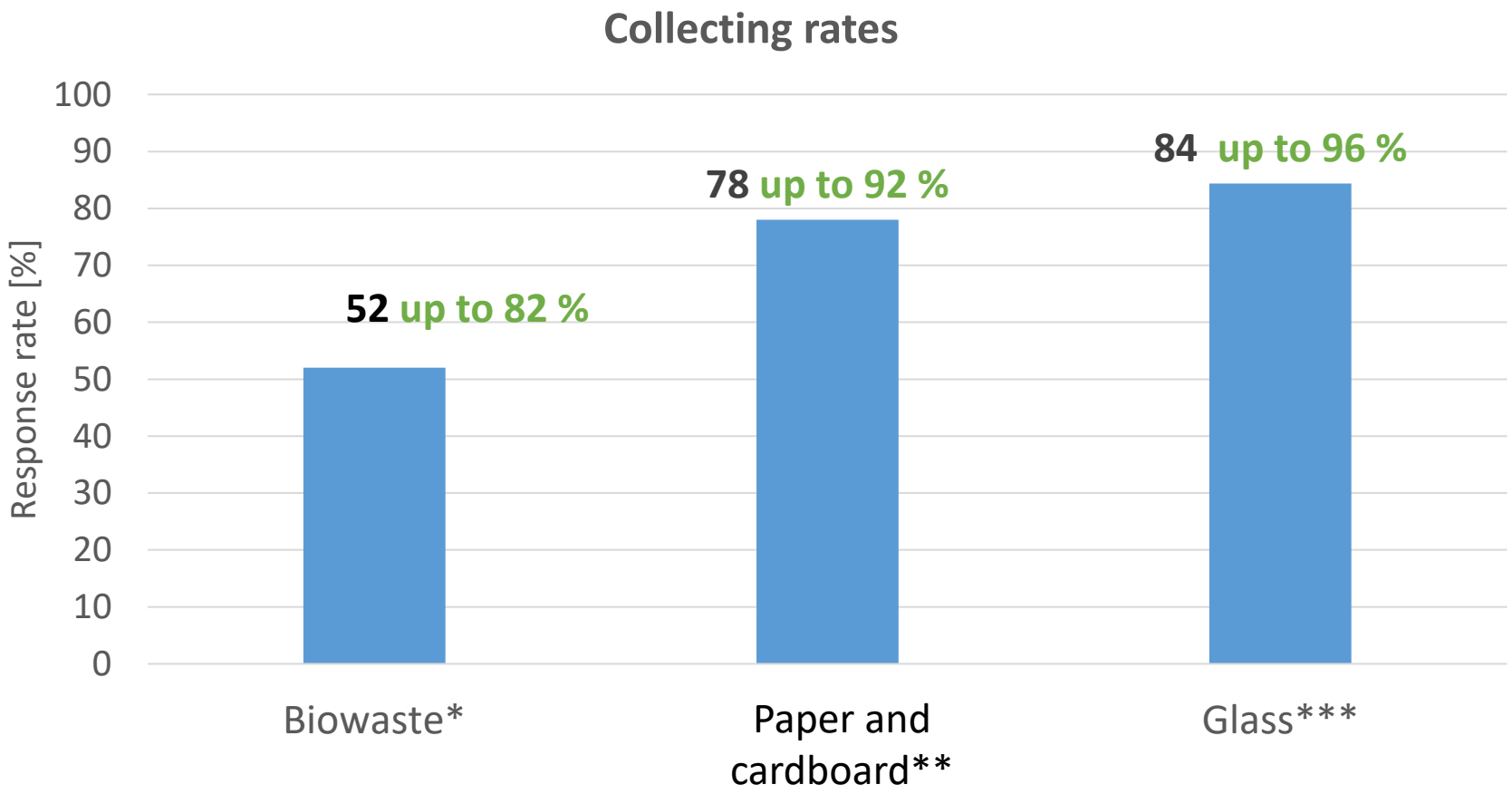
Plastics	Amount to recycling	Proportion	Amount of Recycling	Proportion Of Recycling
Unit	[Mg]	[%]	[Mg]	[%]
Foils	152.664	13,5	150.334	98,5
Plastics high purity	193.001	17,1	185.016	95,9
Mixed polyolefins	37.881	3,3	37.166	98,1
Mixed plastics	**733.249**	**64,8**	**39.044**	**5,3**
3D-plastics	14.328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

Collection rates of different waste fractions



* own data 2020; status 2020
** UBA, 2020; as of 2019
*** UBA, 2020; as of 2017

Collection rates of different waste fractions

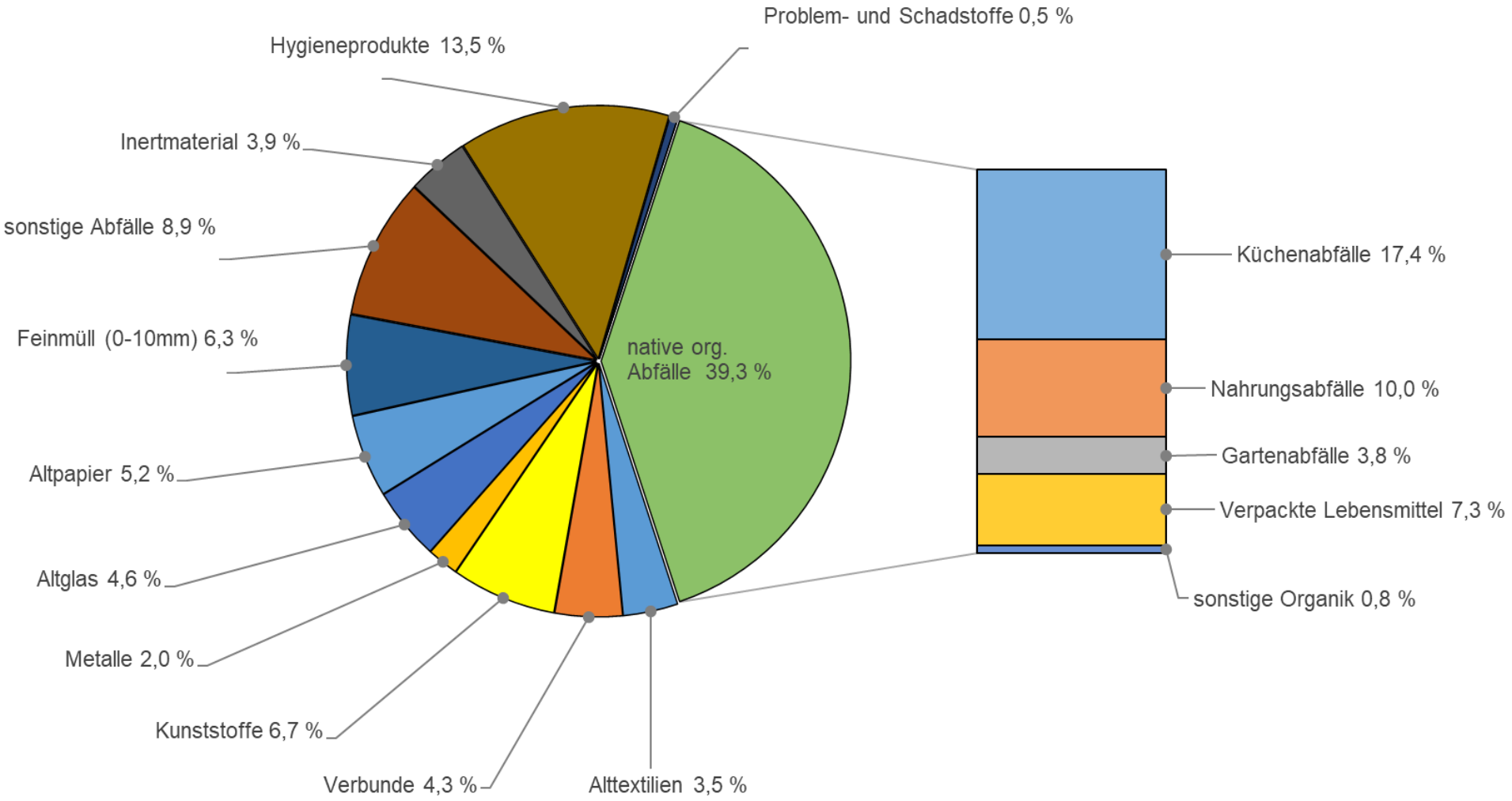


* own data 2020; status 2020
** UBA, 2020; as of 2019
*** UBA, 2020; as of 2017

Sources of impurities and collection rates

- 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

Waste composition - Germany 2018



Source: according to data from Kummer et al. 2020

Food waste - Values

11 Mio. Mg Food waste in Germany

- 52 % from private households
- 16,6 up to 21,6 Mrd. €/a
- 75 kg/cap. and y*

*BMEL, 2021

Foto: UBA

Foto: Welthungerhilfe

Food waste - Avoidance

Qualitative and quantitative avoidance:

Examples:

- Demand driven production
- Kind of
  - Standards
  - Agricultural production
  - Refinement
  - Distribution - local
  - Consumption - creation of a changed consciousness

Food waste - Recycling

Impacts on recycling

Lower:

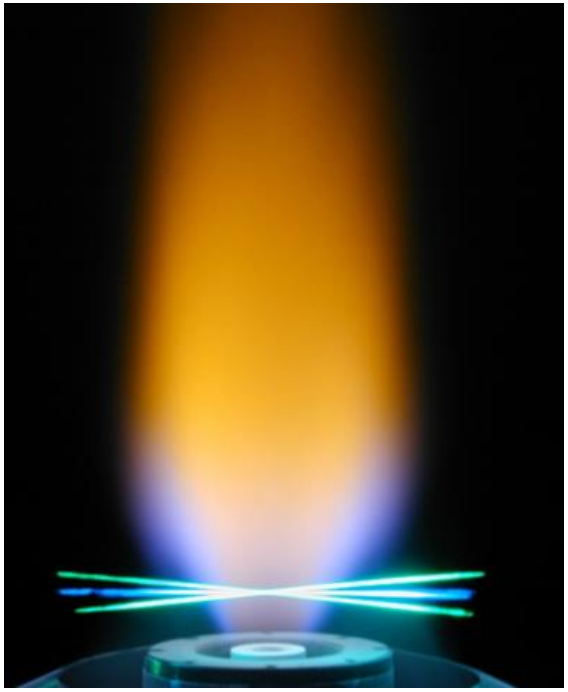
- Transport effort
- Treatment effort
- Lower energy consumption and emissions
  - Composting (aerobic process)
  - Digestion (anaerobic process)
  - Biochar production (pyrolysis process)

Biotechnological processes - Applied processes

Biotechnology

Anaerobic process

Aerobic process



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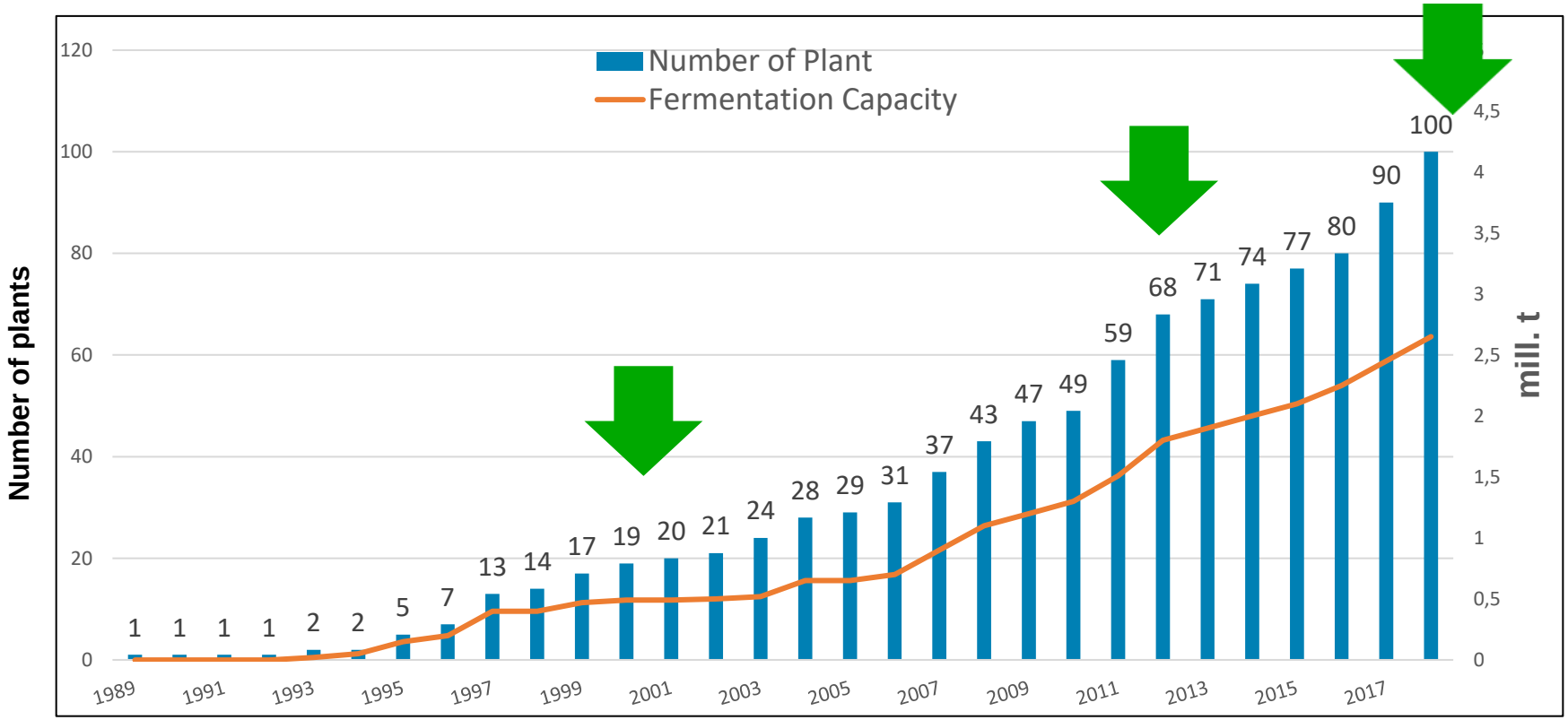
Development of fermentation in Germany - Push effects



Push effects:

- Renewable Energy Act (2000) and further amendments, funding instrument of renewable energies
- KrWG (2012): Mandatory separate collection of biowaste since 2014
- CO_2-Tax

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

Editing

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Comparison of heavy metal contents of selected total waste & biowaste composts

Heavy metals	Germany Total waste compost 1980*	Spain Total waste compost (SCT 2013)**	France Total waste compost (SCT 2007)**	GER Organic waste (BGK 2020)***
Unit	[mg/kg dry matter]			
Cadmium	3,2	1,4	1,7	0,38
Chrome	83	111	70	19,6
Copper	266	158	179	40
Mercury	2	0,3	0,9	0.09
Nickel	55	29	41	11,6
Lead	229	97	162	26,4
Zinc	1.000	351	566	156

*Wallfahrt, 1983; **Carrera mdl. communication, 2013; *** BGK, 2020

Selected organic pollutants in compost of different origin

Organic pollutants	Organic waste compost 1991[3]	Organic waste compost 2002[4]	Organic waste compost 2020[5]	Wet waste compost 1991[3]	Total garbage-compost[3]
PCB [1)] mg/g dry matter	0.26	0.03	n.a.	0.94	1.49
PAH [2)] mg/g dry matter	1.71	2.5	1.00	3.37	4.41
PCDD/F [3)] ng TE BGA/kg TS	12.1	9.2[6]	4.5[6]	50	103

1) DIN, sum of all PCBs
2) 6 PAHs regulated in the Drinking Water Ordinance (Fl, BbFl, BkFl, BaP, BPer, IP).
3) (Fricke et al., 1991)
4) Anonymous (2003)
5) BGK (2020)
6) according to WHO-TEQ 2005, incl. 1/2 BG

Emissions from composting and fermentation

Methane	Unit	Composting	Fermentation
Spec. load	kg CH_4/Mg biowaste	1.4	2.8
GWP	kg $CO_{2,eq/kg}$ CH_4	25	25
$CO_{2,eq}$	kg $CO_{2,eq/t}$ biowaste	35	70
Laughing gas			
Spec. load	kg N_2O/Mg biowaste	0.05	0.05
GWP	kg $CO_{2,eq/kg}$ N_2O	298	298
$CO_{2,eq}$	kg $CO_{2,eq/t}$ biowaste	14.9	14.9
Total	**kg $CO_{2,eq/t}$ biowaste**	**49.9**	**84.9**

Source: Cuhls et al. 2001; 2008

Specific biogas yields for kitchen and garden waste from the organic waste bin

Raw material	Quantity	CH_4 fraction
Units	[m^3/t digester input]	[% by volume]
Biowaste mixture from garden and kitchen waste	75 - 136	53 - 63
Organic waste - kitchen waste	123 - 178	53 - 68
Green waste without tree/shrub cuttings	40 - 90	n.a.

Source: Fricke et al., 2017