Environmental, economical, social & technical assessment of possible future waste management scenarios for Mogilev

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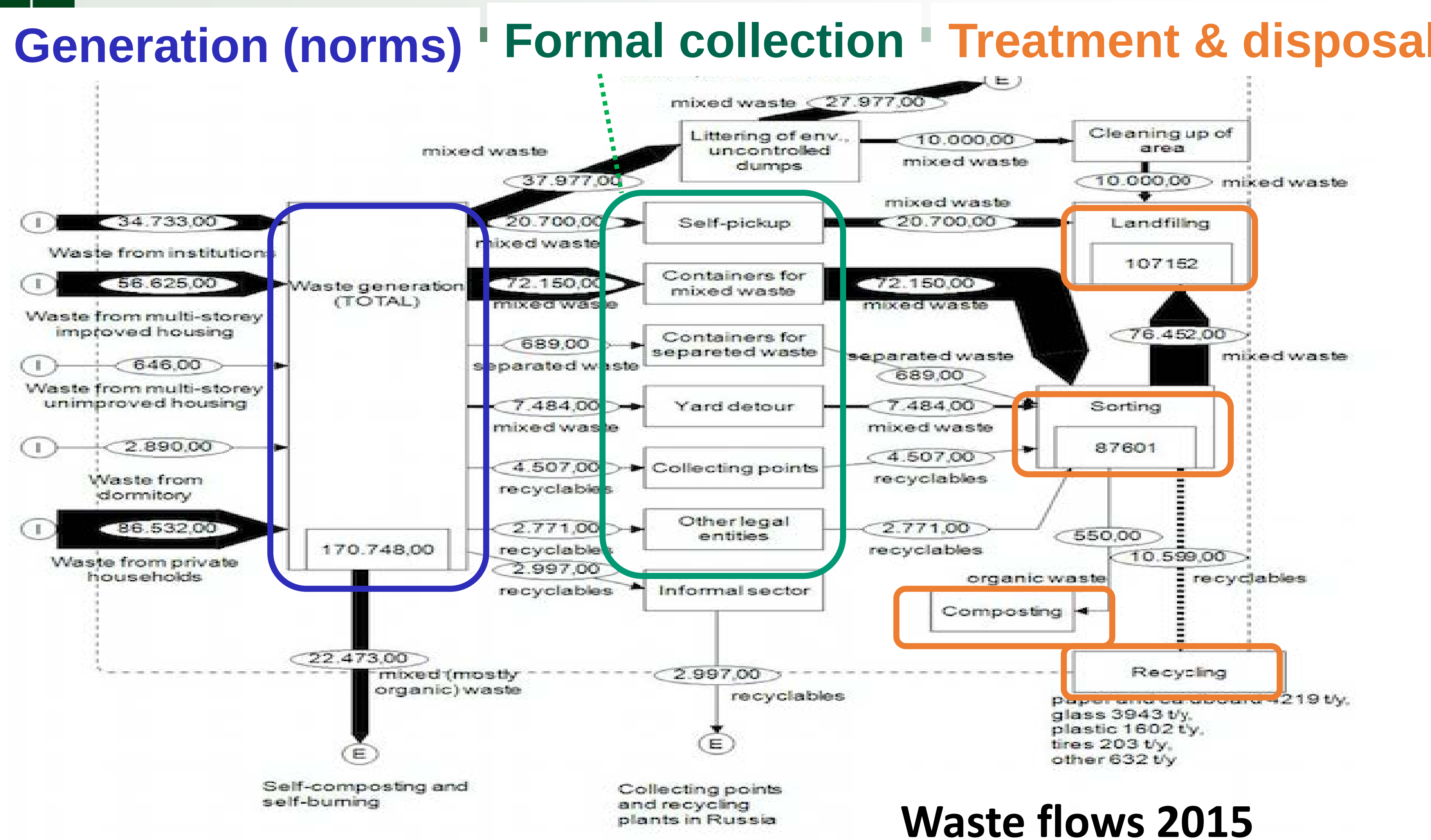
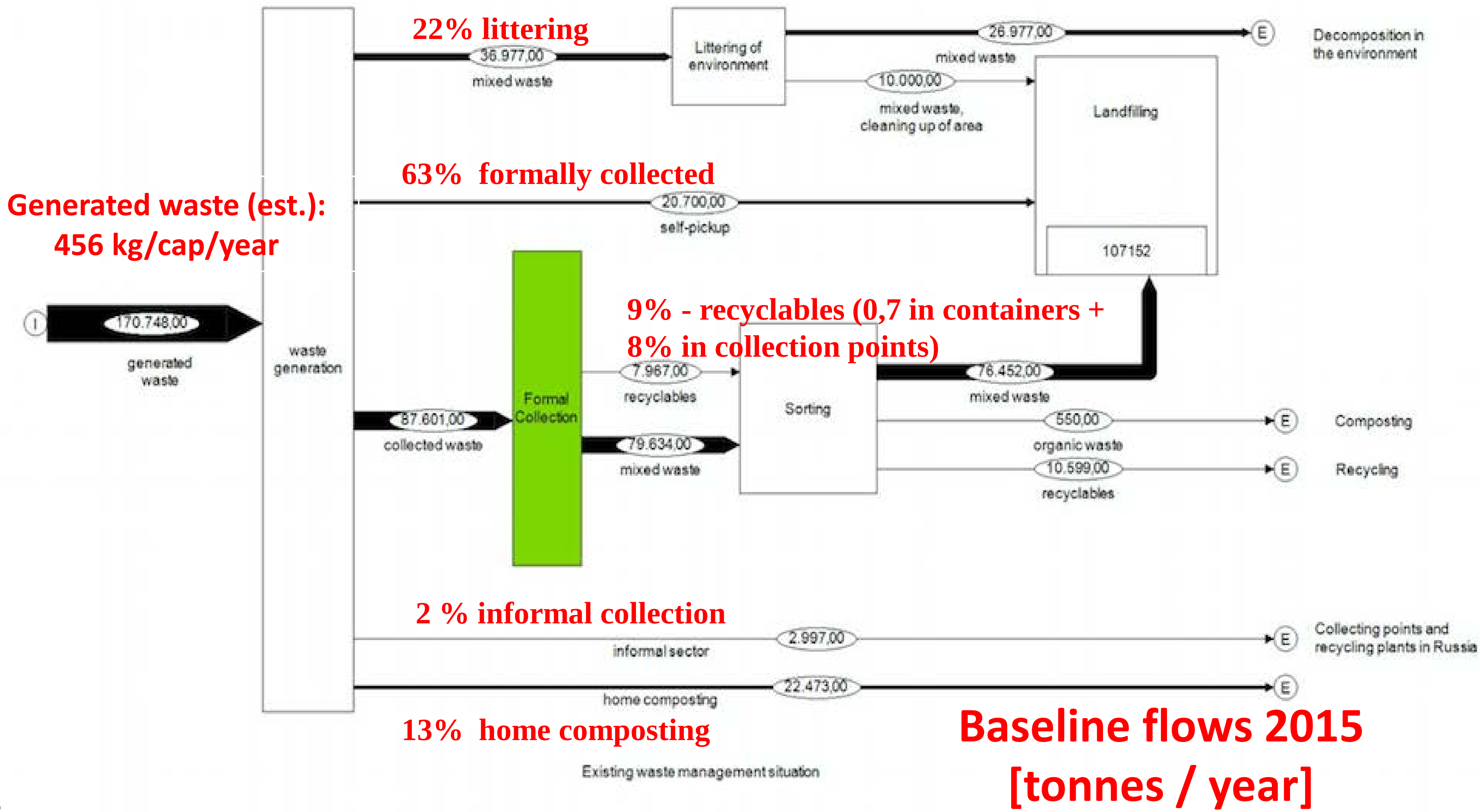
Current waste management in Mogilev



Waste flows 2015 [tonnes / year]

Current waste management in Mogilev -2



Mogilev waste composition

Component	Waste composition (residual waste only ?)
Organics	30%
Paper/Cardboard	8%
Glass	7%
Plastics	3%
Fe/Ne-Metals	2%
Wood	5%
Textiles	3%
Minerals	8%
Composites	3%
Pollutants (Hazardous & WEEE)	3%
Other: contains bones leather rubber and residuals over 10mm, WEEE	18%
Fine fraction <10mm	10%
Total	**100**

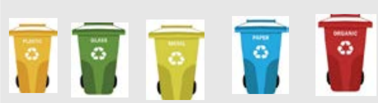
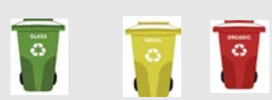
Source: SAP (2015) – „waste composition in containers“

Standard assumptions for all scenarios

Parameter	2015 t/year	2025 t/year	Source
Waste generation (est.)	170,748 456 kg/cap.yr	197,870 529 kg/cap.yr	waste forecast tool
Formally collected waste	87,601 234 kg/cap.yr = 63%	172,400 461 kg/cap.yr= 89%	waste forecast tool
Home composting	22,473	22,473	Estimated
Informal collection	2,997	2,997	Estimated based on literature
WEEE & hazardous waste		2,500	waste progn. tool

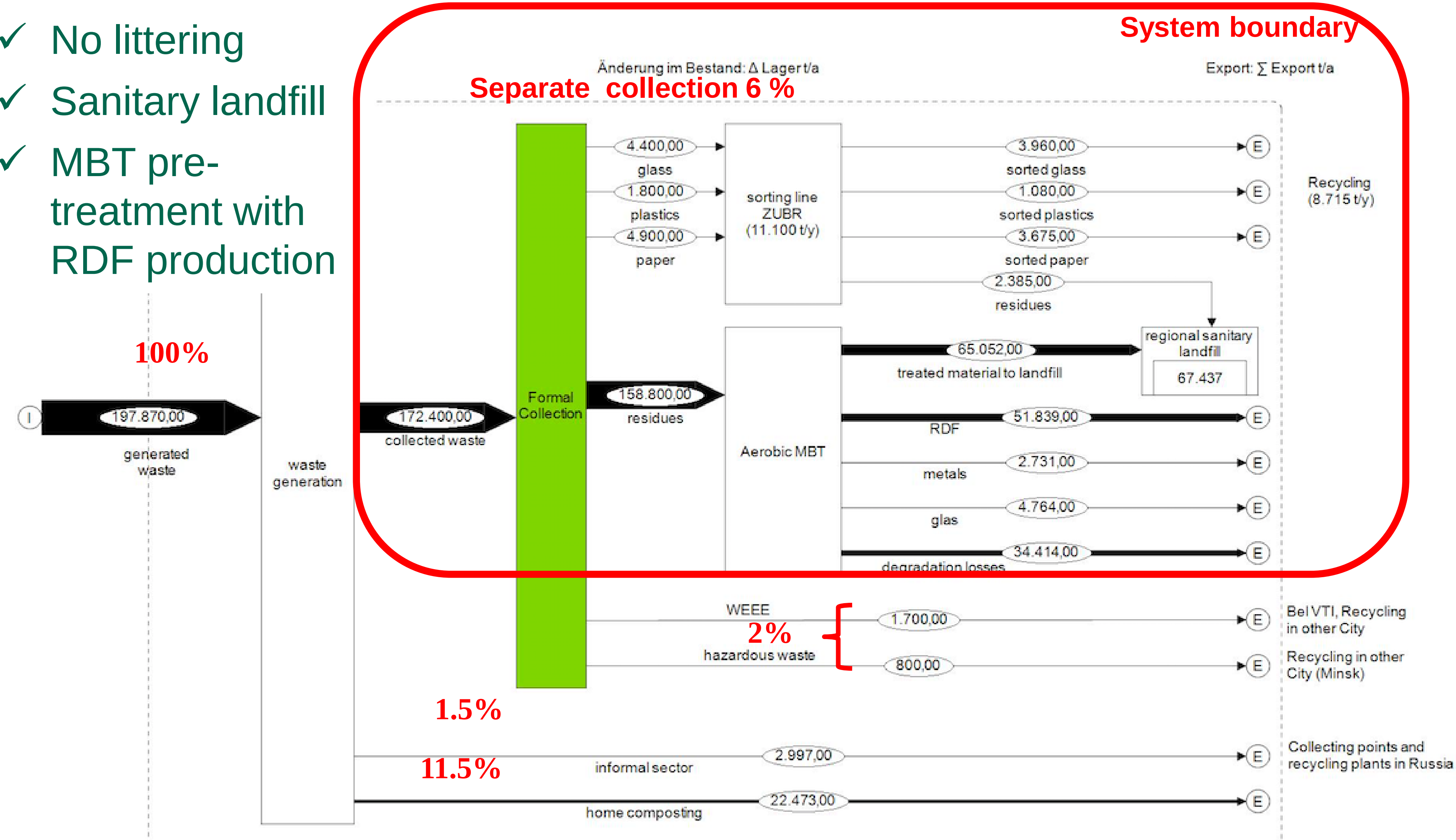
Outside system boundaries

Future WM-scenarios

Scenario	Separate Collection (%)	Separate collected recyclables	Separately collected fractions	Treatment Technology
Sc.**0** - Sanitary LF+MBT	**6**		Glass Paper Plastic	Sorting line ZUBR + MBT, landfill
Sc **1** **Partly recycling** (dry/wet bin) + MBT	**14**		Glass Paper Plastic Metals	Sorting line ZUBR + MBT, landfill
Sc **2** - **Full recycling** + MBT+composting	**<u>29</u>**		Glass Paper Plastic Metals Organics	Sorting line ZUBR + MBT, composting, landfill
Sc **3** - **Full recycling, energy recovery** (inciner.), composting	**<u>29</u>**		Glass Paper Plastic Metal Organics	Sorting line ZUBR, incineration, composting, landfill
Sc **4** - **Full energy recovery** (incin. & anaerobic digestion)	**21**		Glass Metals Organics	Sorting line ZUBR, incineration, biogas plant, landfill

Scenario 0 - Sanitary LF+MBT

- ✓ No littering
- ✓ Sanitary landfill
- ✓ MBT pre-treatment with RDF production



Scenario 1 - MBT + partly recycling (gl, pl, me, pa)

- **Glass, plastic, metal, paper** in one bin

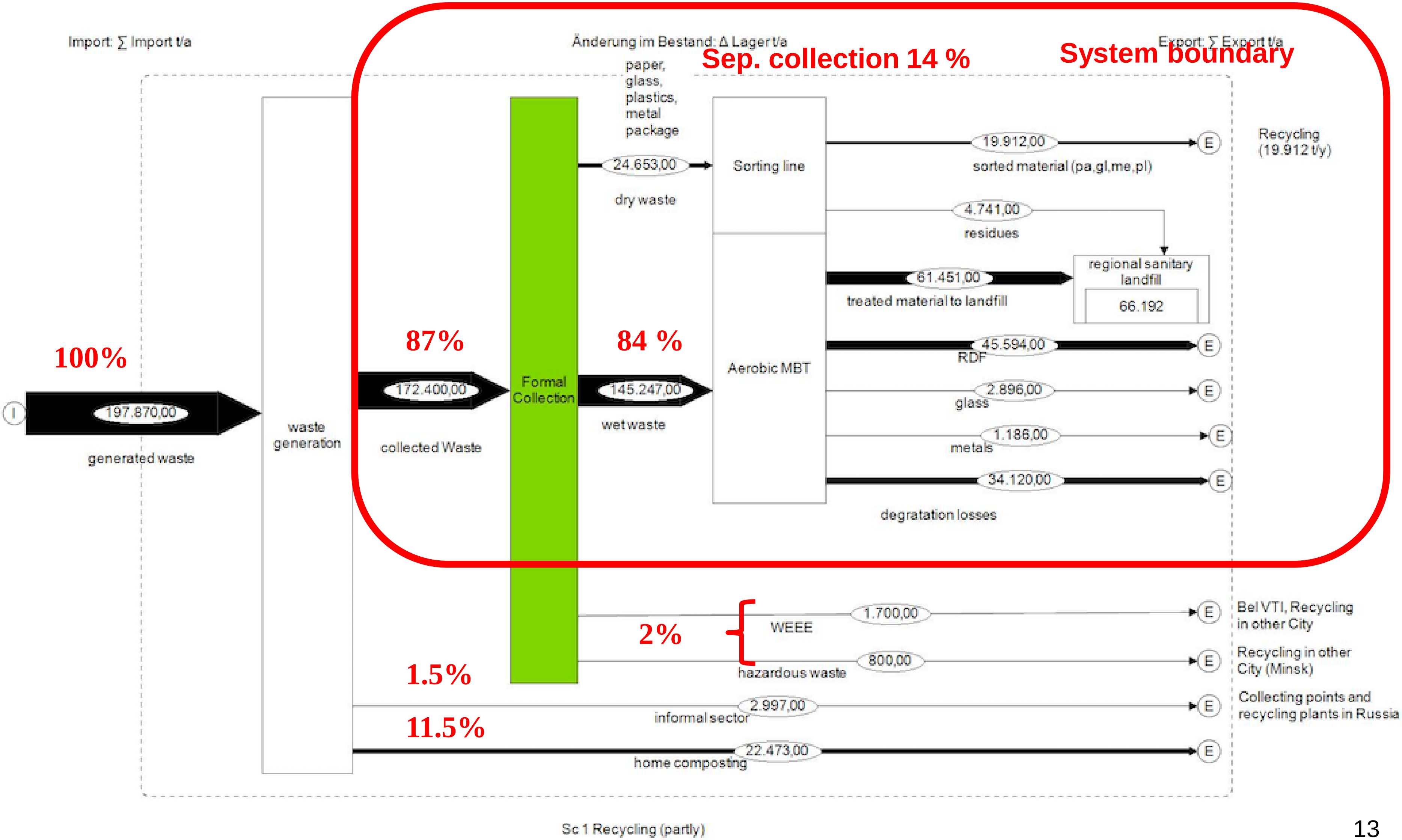
Example dry-wet-bin in DE (Trenntmagazin, 2014)

- Treatment & disposal infrastructure
  - after-sorting of dry-wet bin recyclables
  - MBT for wet fraction with RDF production
  - sanitary landfill

Fraction	Targets$_{dry\text{-}wet}$%
Glass	71
Plastics	60 (input into recycling)
Metals	81
Paper	60 (input into recycling)

Tab.: Collection Targets of dry-wet-bin (Pöttschacher (2016)

Scenario 1 - MBT + partly recycling (gl, pl, me, pa)



Scenario 2 - Full recycling + MBT + composting

- Separately collection for **glass, plastic, paper, metals, organics** in separate bins

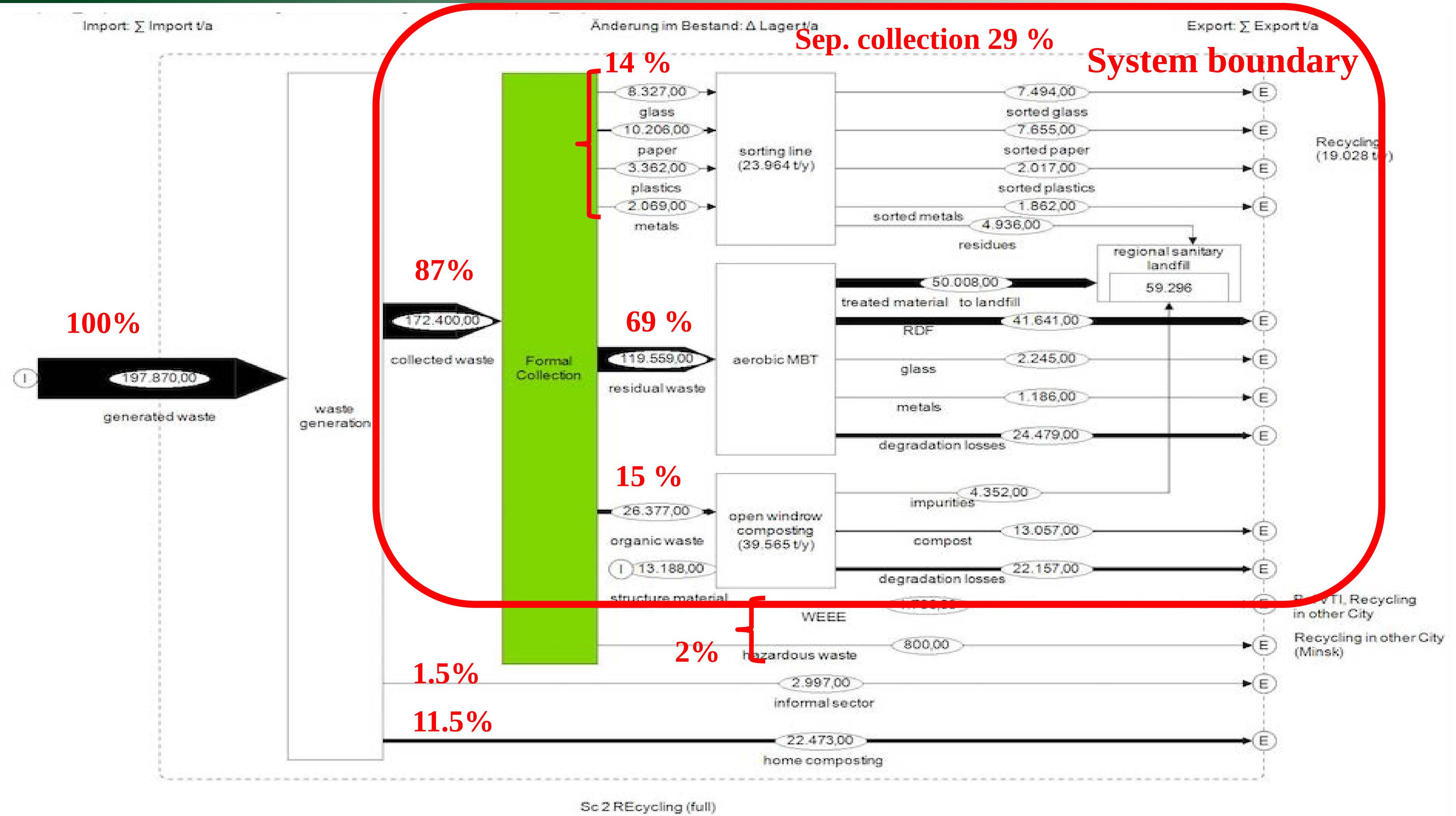
- Treatment & disposal infrastructure
  - Sorting line for afer-sorting of recyclables
  - MBT for residual waste with RDF production
  - Sanitary landfill
  - Composting plant

Fraction	$Targets_{high}$%
Glass	69
Plastics	65
Paper	74
Metals	60
Organics	51

Tab.: High separate collection targets (Boer, 2005)

Fig. .: Example of windrow composting in lower Austria (Huemer 2008, photo Binner)

Scenario 2 - Full recycling + MBT + composting



Sc 3 - Full recycling, energy recovery (incineration), composting

- Separate collection for glass, plastic, paper, metals, organics in separate bins

Fraction	Targets_{high}%
Glass	69
Plastics	65
Paper	74
Metals	60
Organics	51

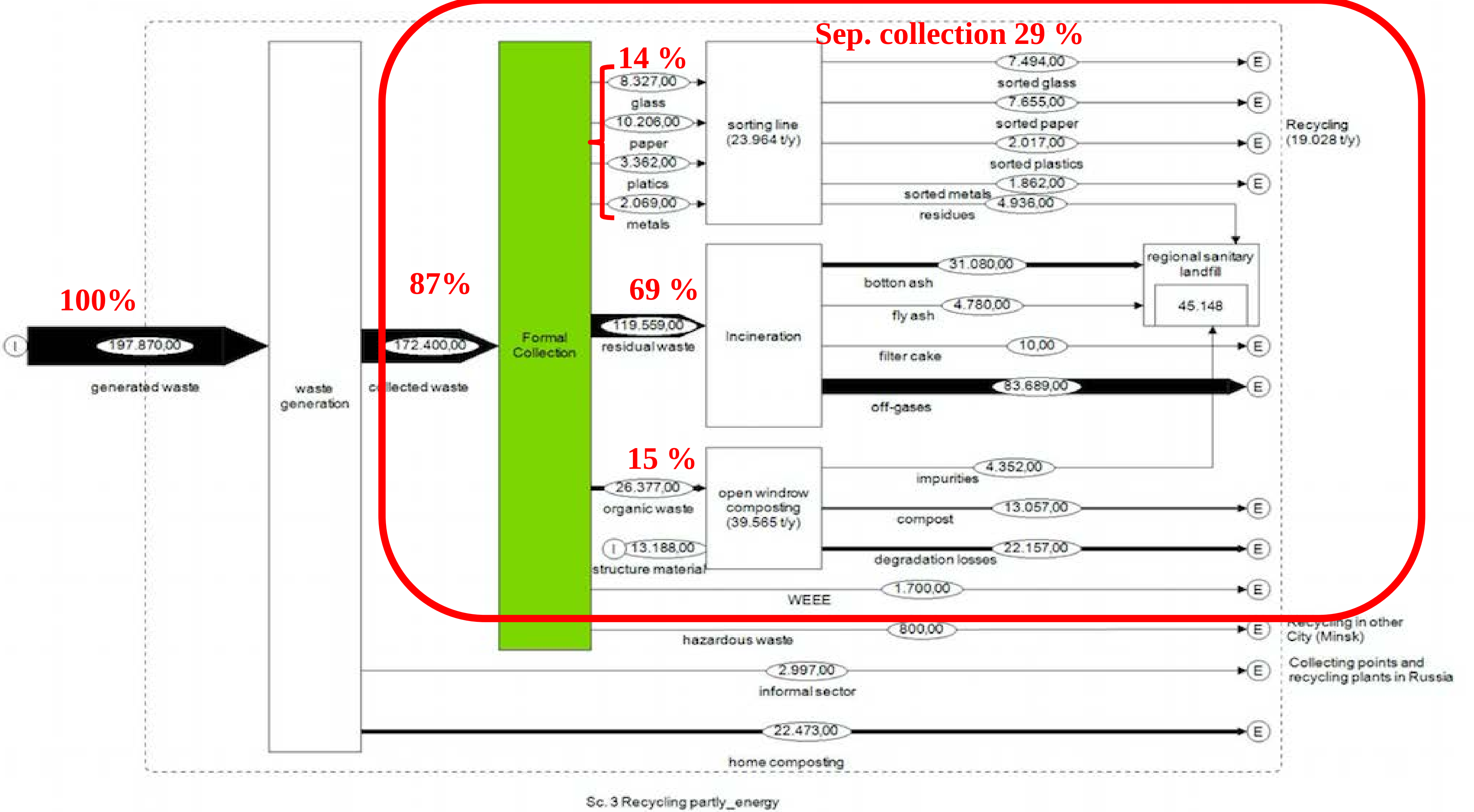
Tab.: High separate collection targets (Boer, 2005)

Treatment & disposal infrastructure:

- Sorting line for after-sorting of recyclables
- Composting plant
- Incineration plant
- Sanitary landfill

Fig. .: Example of windrow composting in lower Austria (Huemer 2008, photo Binner)

Sc 3 - Full recycling, energy recovery (incineration), composting



Scenario 4 - Full energy recovery (incin. & anaerobic digestion)

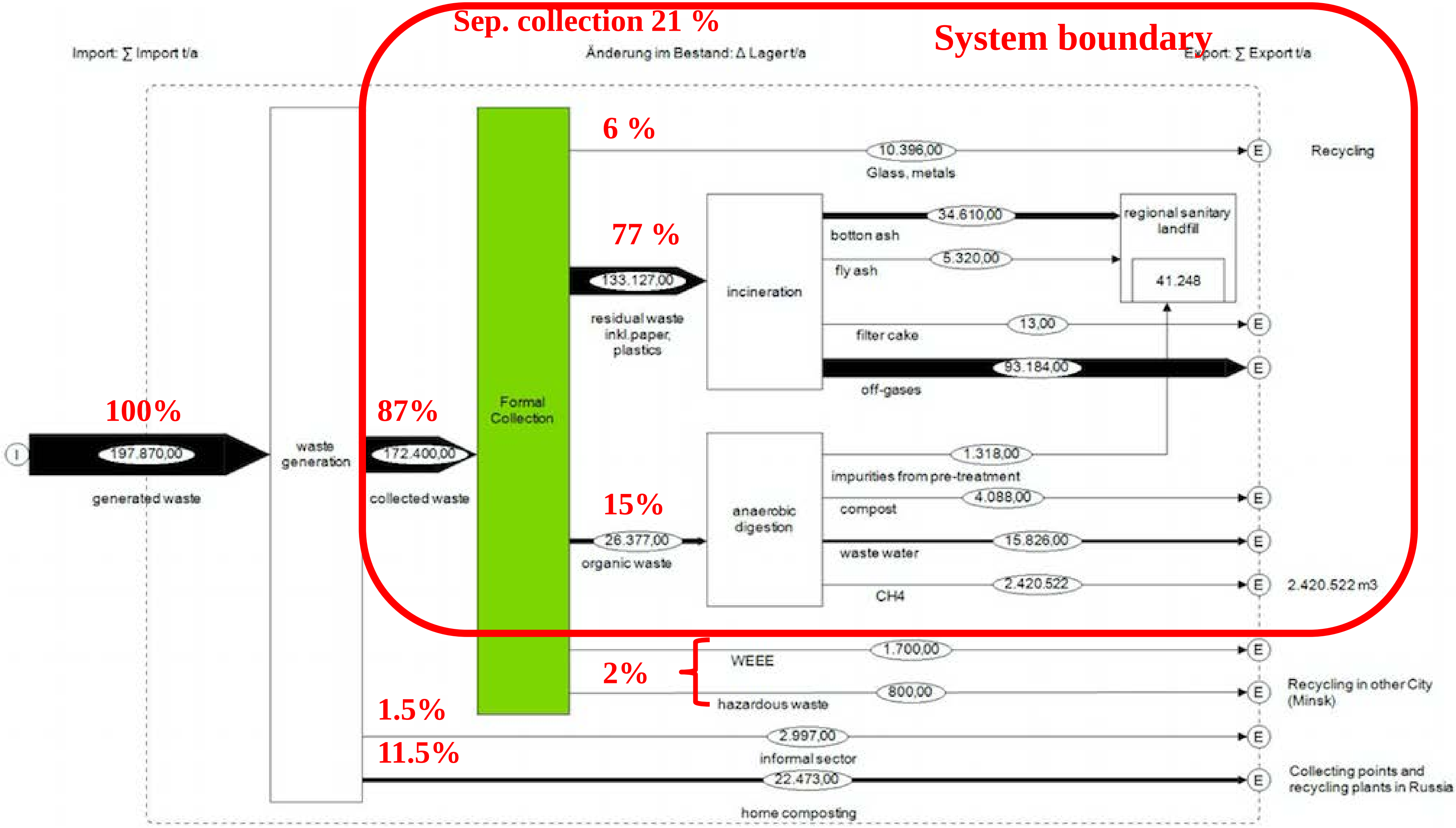
- Separate collection for **glass and metals, organics to increase calorific value of incinerated waste**
- Recyclables **(gl, me)** go directly to recycling plants (no after-sorting)

- Treatment & disposal infrastructure:
  - Incineration
  - Anaerobic digestion
  - Sanitary landfill

Fraction	$Targets_{high}$ %
Glass	69
Metals	60
Organics	51

Tab. High separate collection targets (Boer, 2005)

Scenario 4 - Full energy recovery (incin. & anaerobic digestion)



Main outputs of scenarios

Main outputs (ths t/yr)	Base-line	Sc 0: sanitary landfill, aerobic MBT	Sc. 1: MBT-Recy (wet/dry-bin)	Sc.2: MBT - (separ.col. gl, pl, pa, me, org$_{comp}$)	Sc.3: Incin. - (separ.col. gl, pl, pa, me, org$_{comp}$)	Sc.4: Incin. - (separ. col. gl, me, org$_{biogas}$)
Separate collection: - recyclables	10,6	11,1	**24,7**	23,9	23,9	**10,3**
- organics		-	-	26,4	26,3	26,3
Recyclables (from ZUBR + glass & metals from MBT)		16,2	23,9	**35,5**	32,0	**14,4**
RDF from MBT	-	**51,8**	45,5	**41,6**	-	-
Compost	-	-	-	**13,0**	**13,0**	**4,0**
Energy (incineration): Electricity (MWh)	-				23 366 MWh 294 415 GJ	**29 380 MWh** **370 184 GJ**

Assessment of scenarios

I. Economic assessment (6 quantitative indicators)

II. Environmental assessment (6 quantitative indicators)

III. Social Assessment (6 qualitative + 1 quantitative indicator)

IV. Technical assessment (4 qualitative indicators)

I. Economic assessment - indicators

1. Total costs of waste management (WM)
   - Investment costs [€]
   - Annual operation costs [€/year]
   - Annual total discounted costs [€/year]
2. WM costs per tonne [€/t formally collected waste]
3. Revenues generated [€/year]
4. Ratio of fees & revenues and total annual costs of the WM-system [%]
5. Costs as % of approved city income & expenditure [%]
6. Costs as % of minimum wage 2016 [%]

Total costs of WM system

Total costs considered for 3 subsystems:

1 2 3

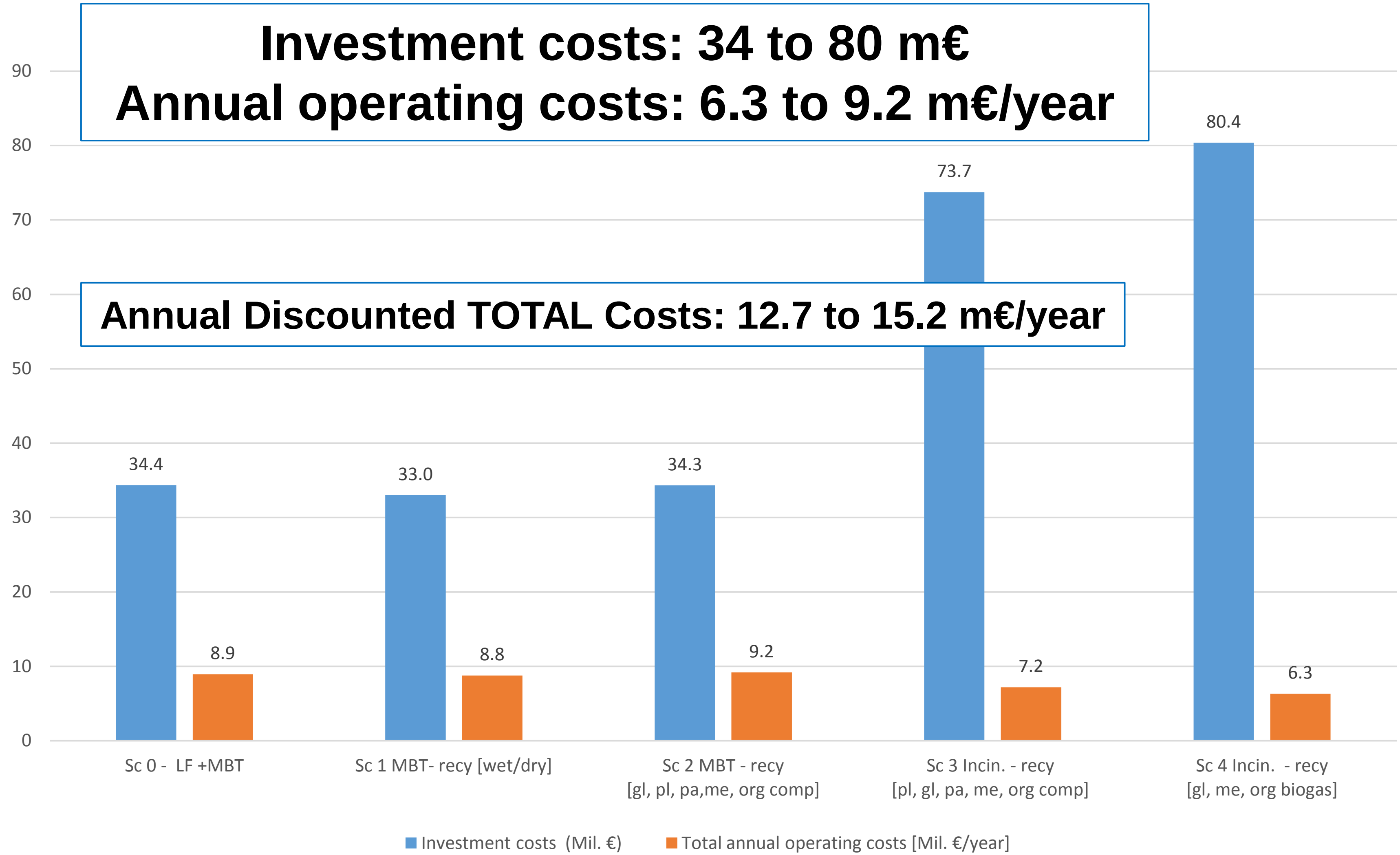
- SS 1 and SS 2: calculated with local (real) costs; SS 3: sorting plants with real costs, other facilities with cost curves (price level 2003);
- **Main goal: We want to show DIFFERENCES between the scenarios (local costs might be cheaper in Belarusian reality)!**

Local costs considered | **Local costs considered** | **Costs curves based on EU facilities**

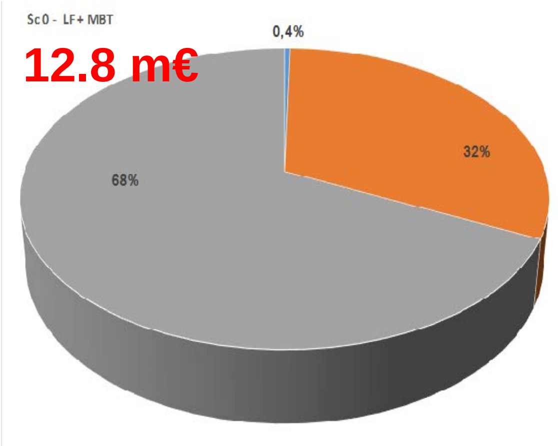
1. Total costs of WM system

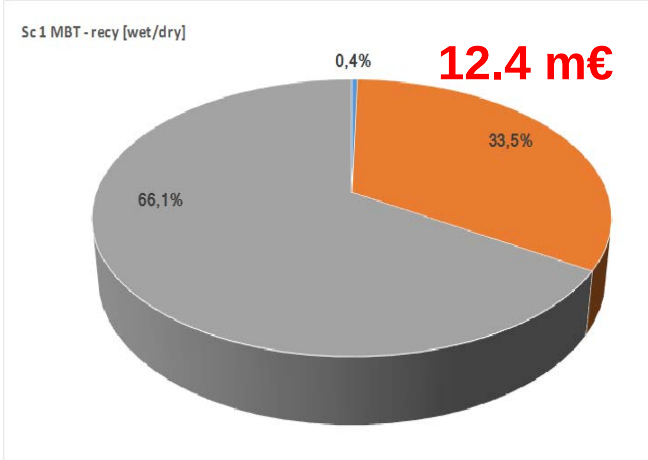
	Cost type	Sc 0 - LF +MBT	Sc 1 MBT-recy [wet/dry]	Sc 2 MBT – recy [gl, pl, pa,me, org comp]	Sc 3 Incin. - recy [pl, gl, pa, me, org comp]	Sc 4 Incin. - recy [gl, me, org biogas]
[1]	**Investment costs [m€]**	34.4	33.1	34.3	73.7	80.4
[2]	Annual discounted investment costs [m€/year]	3.8	3.7	3.8	8.1	8.9
[3]	Annual operating costs [m€/year]	8.9	8.8	9.2	7.2	6.3
[4]= [2]+[3]	**Total annual discounted costs [m€/year]**	**12.8**	**12.4**	**13**	**15.3**	**15.2**
SS1	*Total ann. costs bins & containers [%]*	*0.4*	*0.4*	*0.8*	*0.8*	*0.6*
SS2	*Total ann. costs collection & transport [%]*	*31.7*	*33.5*	*37.2*	*36.5*	*32.4*
SS3	*Total ann. costs Treatment & disposal [%]*	*68.0*	*66.1*	*61.9*	*62.7*	*67.0*

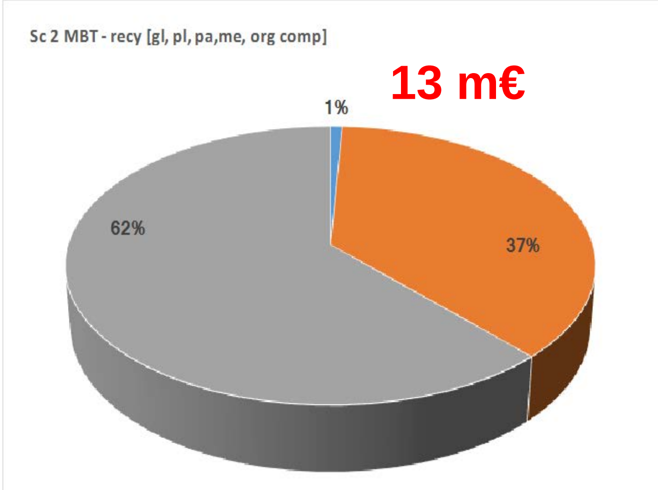
Ad 1. Investment costs [m€] & Annual operating costs [m€/year]

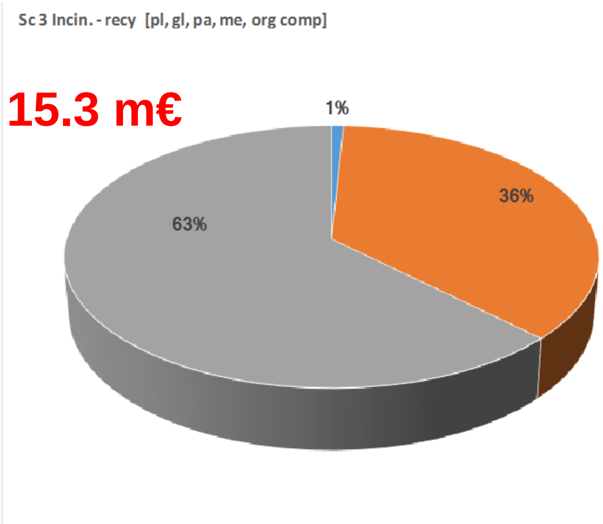


Ad 1. Total annual costs per subsystem for scenarios [%]

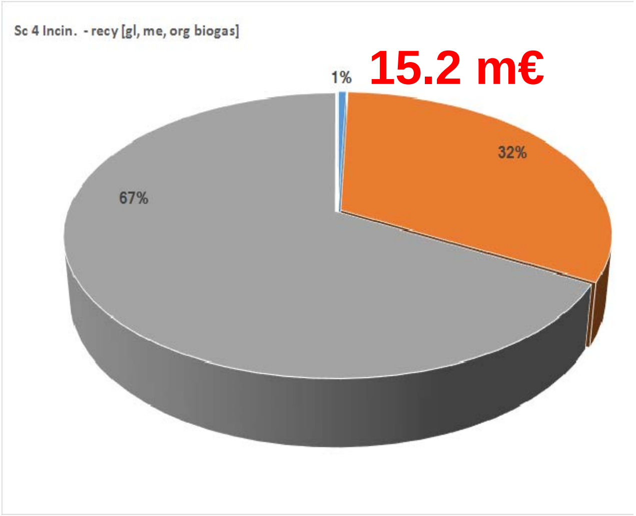




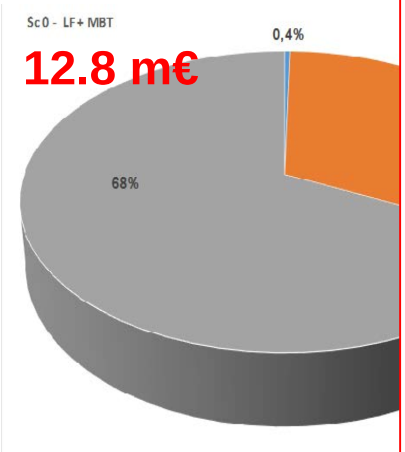


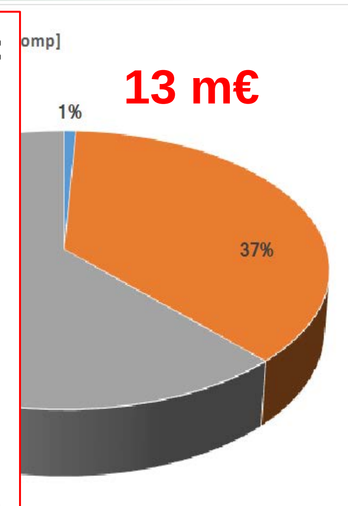


- Total annualized costs Subsystem Treatment & Disposal [%]
- Total annual Costs Subsytsme collection & transport [%]
- Total annual costs Subsystem bins & container system [%]



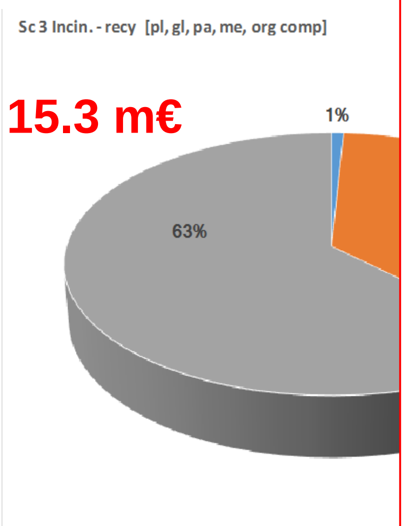
Ad 1. Total annual costs per subsystem for scenarios [%]

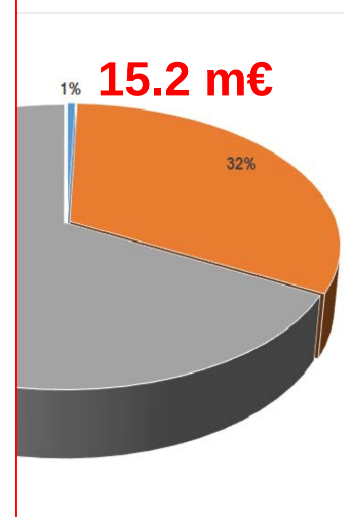




Reasons for **lower costs** of subsystem collection & higher costs of subsystem treatment:

- Level of wages lower in BY
- Treatment facilities in established WM system already amortized
- Investment costs based on European level
- Operating costs for collection based on Belarussian price levels





2. Total annual costs of WM per ton of formally collected waste [€/t]

Subsystem	Sc 0 - LF +MBT	Sc 1 MBT- recy [wet/dry]	Sc 2 MBT – recy [gl, pl, pa,me, org comp]	Sc 3 Incin. - recy [pl, gl, pa, me, org comp]	Sc 4 Incin. - recy [gl, me, org biogas]
Total an. costs [€/t coll.]	63.7	**62.2**	66.0	**67.3**	64.5
Total annual costs per subsystem: [€/t collected]					
Bins & container	0.24	0.26	**1**	**1**	0.36
Collection & transport	20	21	**25**	**25**	**21**
Treatment & disposal	**43**	**41**	**41**	42	**43**

Formally collected waste: prognosis (2025)	
172,400	t/yr

3. Revenues [m€/year]

Assumed selling price	
Paper average	89 €/t
Plastics average	149 €/t
Metals average	426 €/t
Glass	30 €/t
Compost	10 €/t
RDF	10 €/t
Heat	0.011 €/MJ
Electricity from incineration	96.42 €/Mwh
Electricity from biogas	160.10 €/Mwh

	Sc 0 - LF +MBT	Sc 1 MBT- recy [wet/dry]	Sc 2 MBT – recy [gl, pl, pa,me, org comp]	Sc 3 Incin. - recy [pl, gl, pa, me, org comp]	Sc 4 Incin. - recy [gl, me, org biogas]
Revenues sep. coll.+MBT(gl,me) [m€/year]	1.2	2.4	2.4	2.4	1.5
Total Revenue Energy Recovery [m€/year]	0	0	0	5.3	7.6
RDF selling [€/year]	518,390	455,940	416,410	0	0
TOTAL revenues [m€/year]	1.7	2.9	2.8	7.7	9.1

4. Relation between financed and non-financed part of WM-system of total an. costs [€/cap. yr]

Self financing rate in % (revenues (2025) + fees (2025))

5. & 6. Total annual costs as % of city income & expenditures and wages

Indicator	Sc 0 - LF +MBT	Sc 1 MBT- recy [wet/dry]	Sc 2 MBT – recy [gl, pl, pa,me, org comp]	Sc 3 Incin. - recy [pl, gl, pa, me, org comp]	Sc 4 Incin. - recy [gl, me, org biogas]
Costs as % of approved city income	10.0	9.7	10.1	12.0	11.9
Costs as % of approved city expenditures	10.0	9.7	10.2	12.0	11.9
Cost as % of minimum wage	2.5	2.4	2.5	3.0	3.0

Infrastructure for WM = **public service in post-socialistic countries**
For improving WM-system, the **increase of fees** is necessary!

II. Environmental assessment - indicators

1. Source separated collection rate [%]
2. Recycling Rate [%]
3. Energy Recovery Rate [%]
4. Landfilling rate [%]
5. Biodegradable waste diversion rate [%]
6. Greenhouse Gas Emissions [t CO_2-eq.]

1. Source separated collection rate [%]

Separate collection quantities of each waste fraction in [%] of formally collected waste

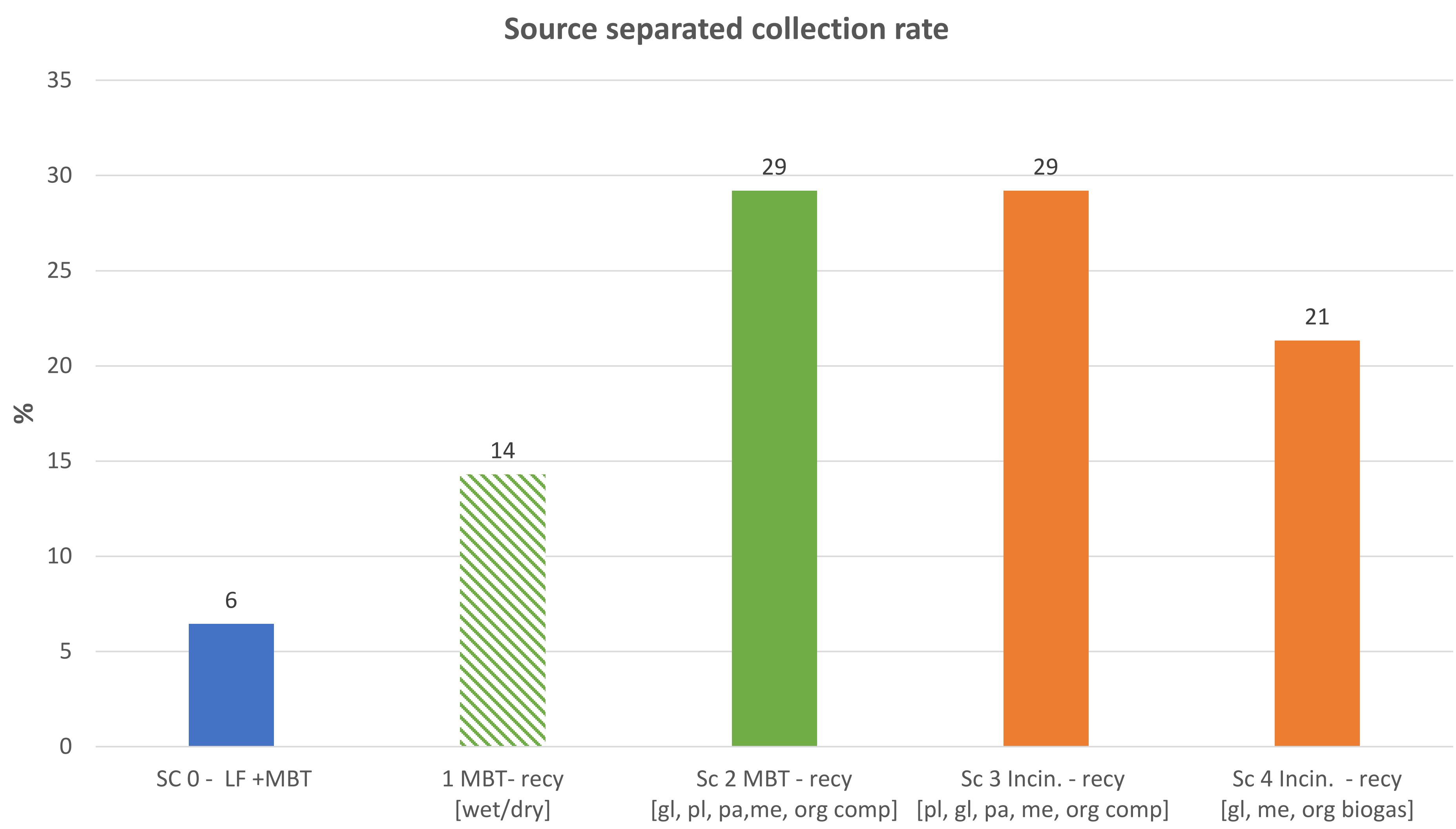
- Residual waste is pre-treated in an MBT-plant
- Hazardous waste and WEEE are not considered (outside system boundary)

Separate collection efficiency

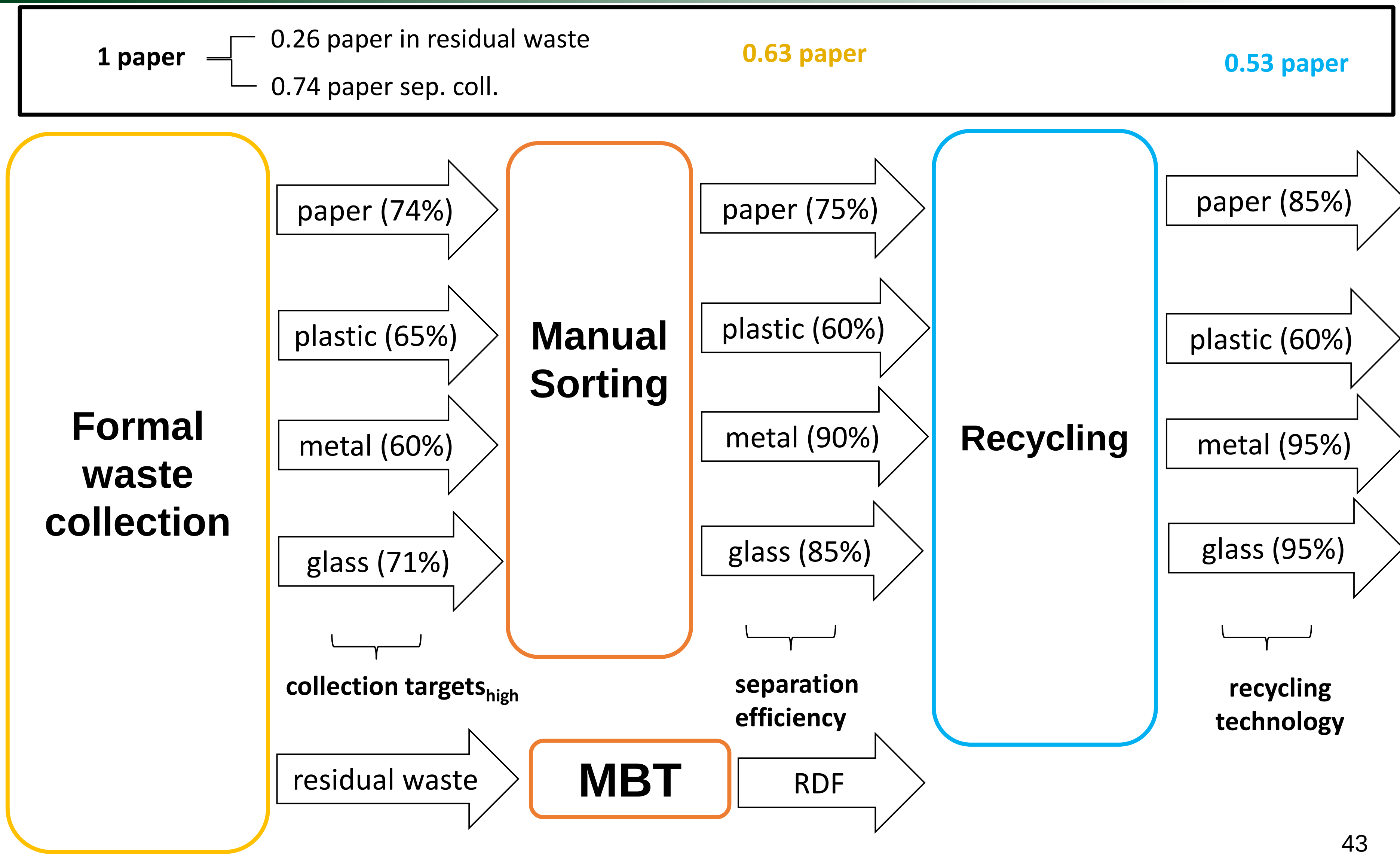
Fraction	Low	High	Dry-Wet
Plastics	33%	65%	70%
Glass	50%	69%	60% (input into recycling)
Paper	45%	74%	85%
Metals	60%	60%	60% (input into recycling)
Organic	-	51%	-

Source: Boer et al. 2005 & Pöttschacher, 2016

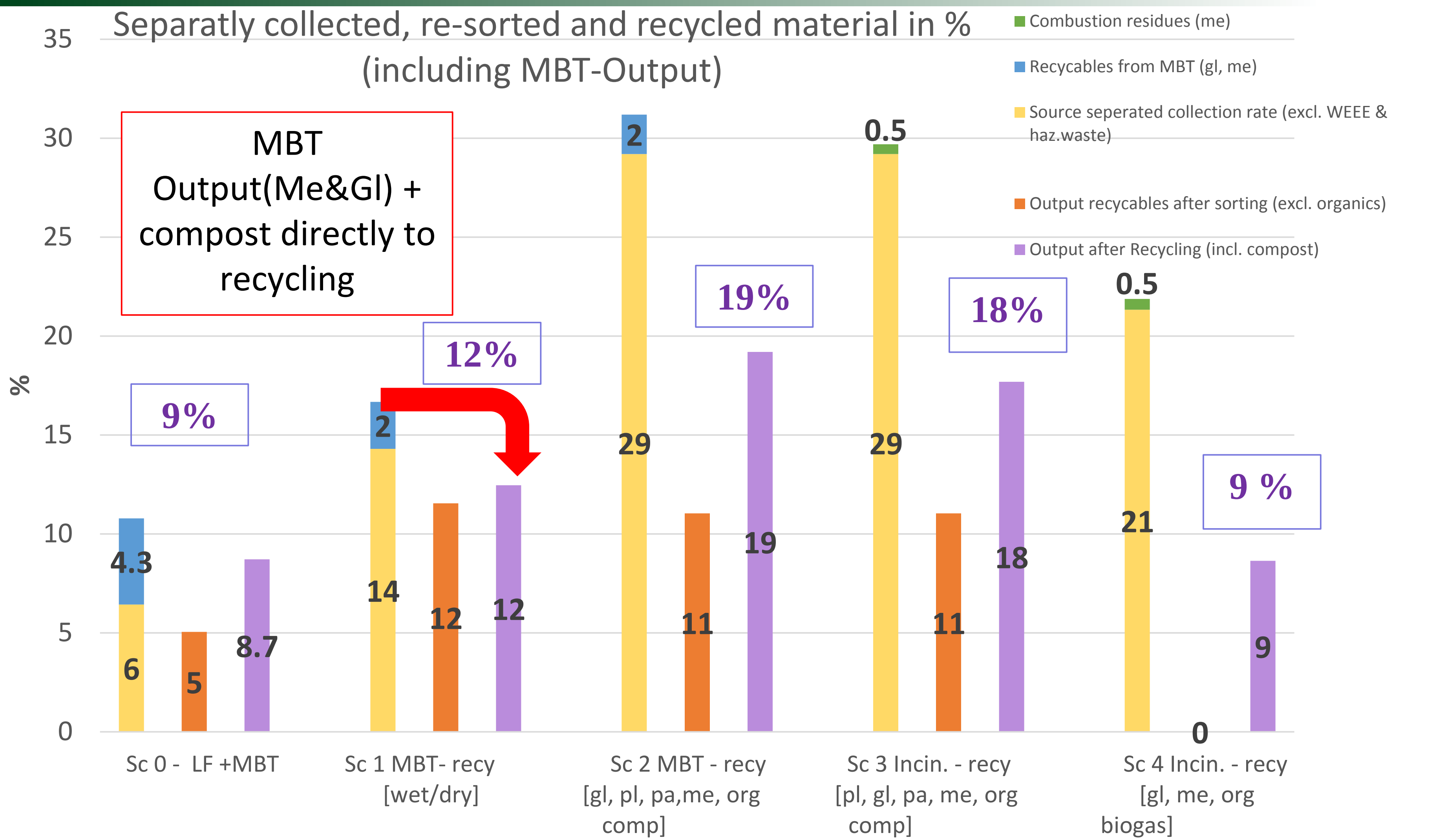
1. Source separated collection rate [%]



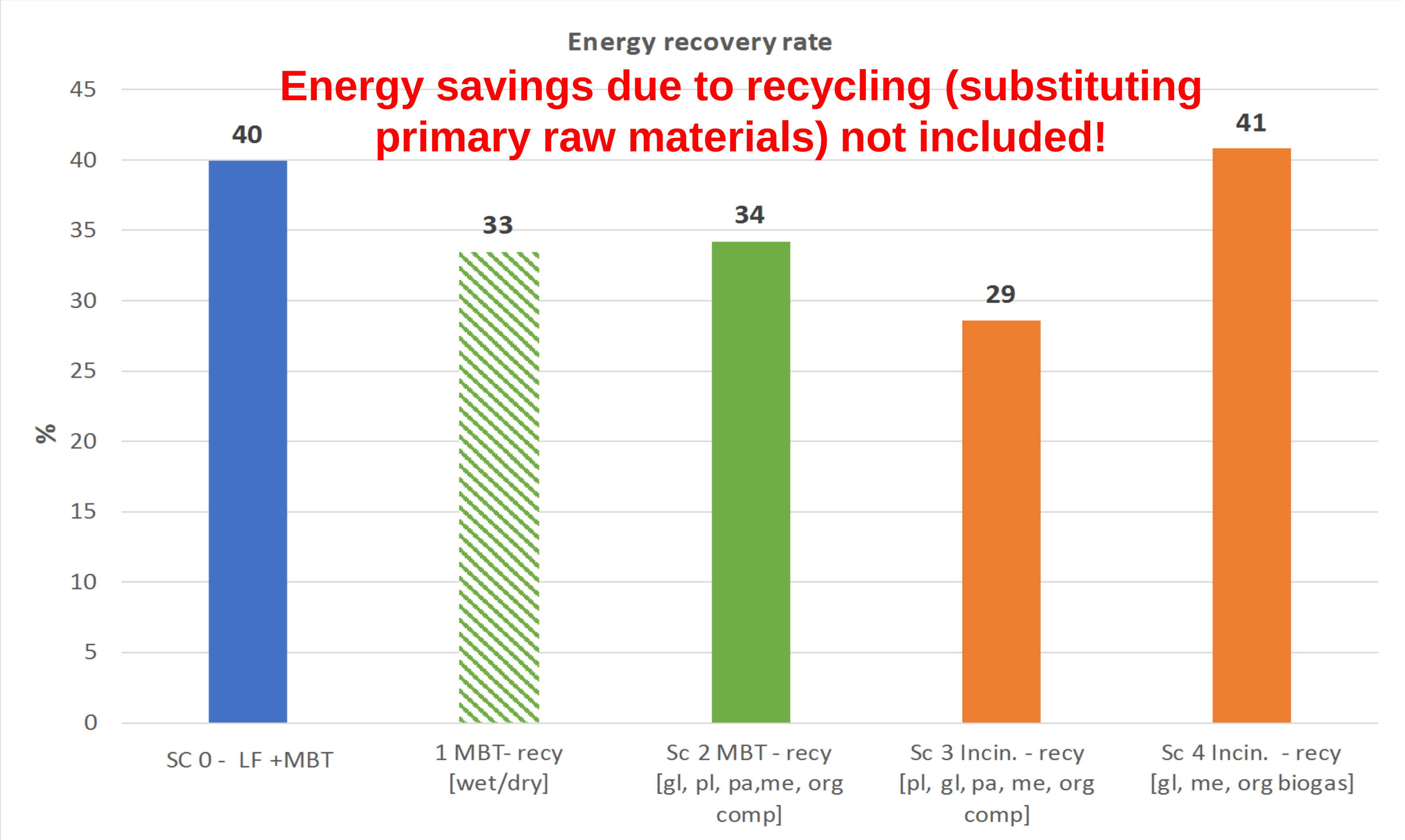
Separate collection vs. manual sorting vs. Recycling Rate



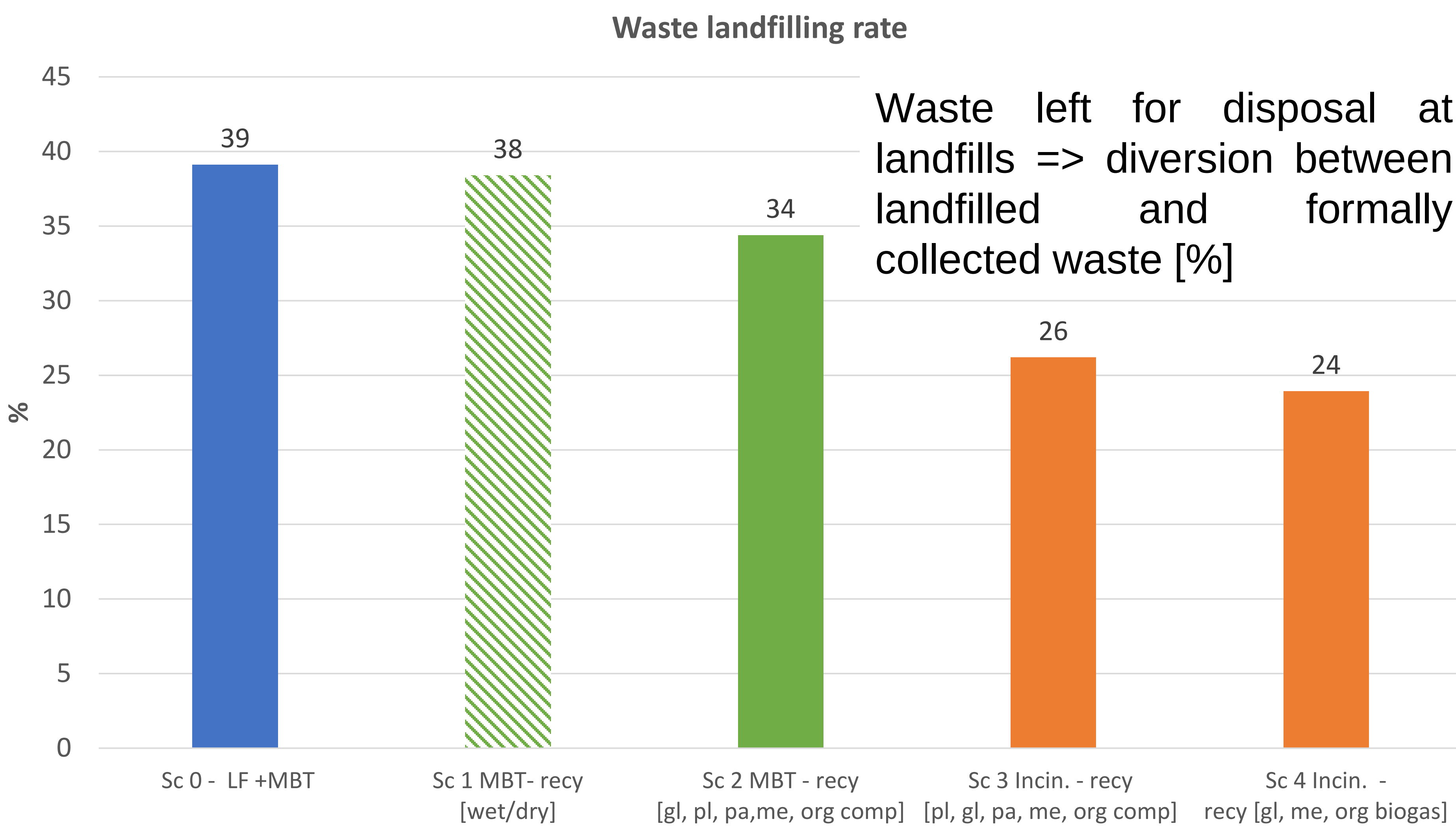
2. Recycling Rate [%]



3. Energy recovery rate [%] - results

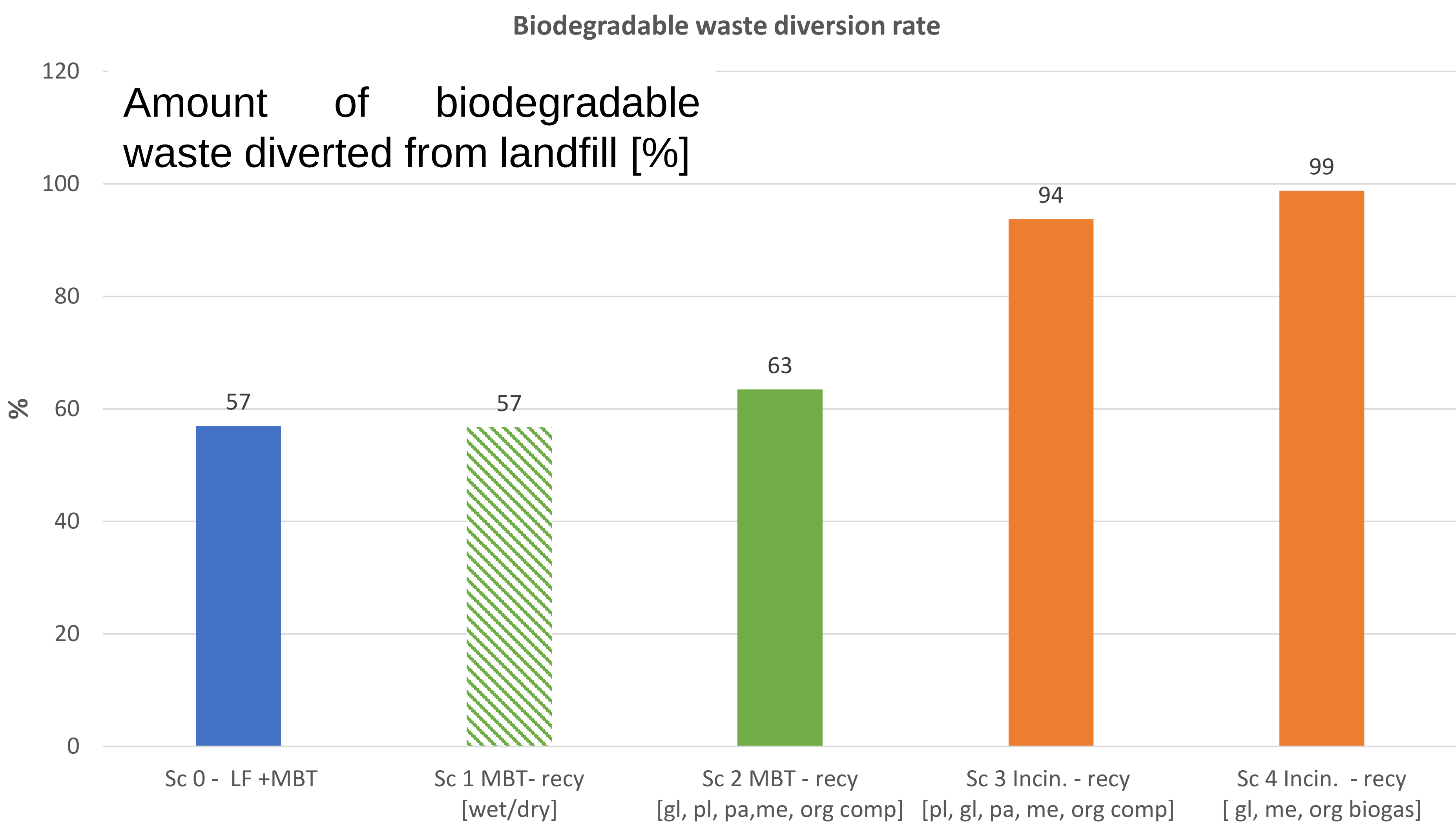


4. Landfilling Rate [%]

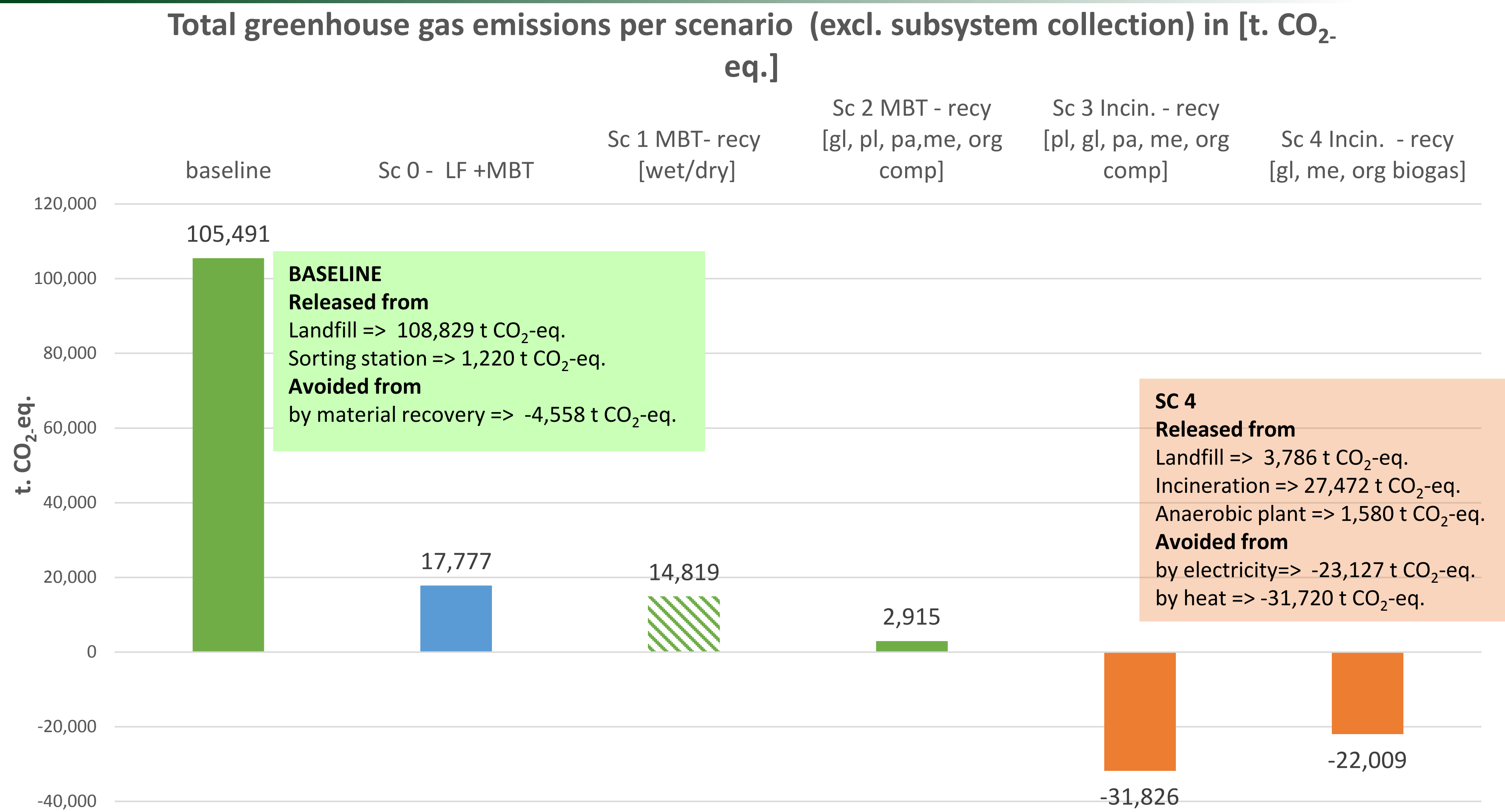


Waste left for disposal at landfills => diversion between landfilled and formally collected waste [%]

5. Biodegradable waste diversion rate [%]

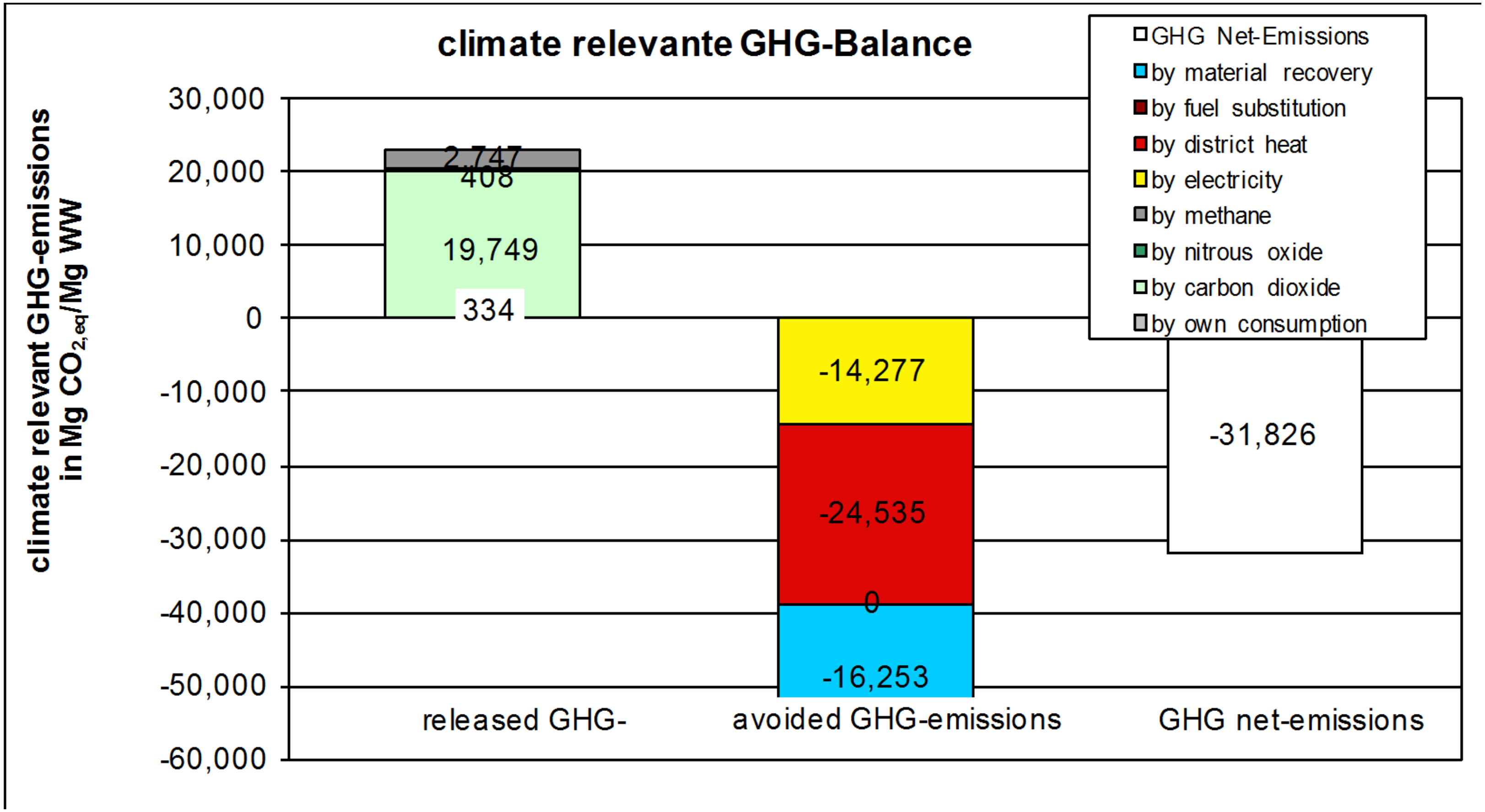


6. Total greenhouse gas emissions (excl. subsystem collection) [t CO_{2}-eq.]



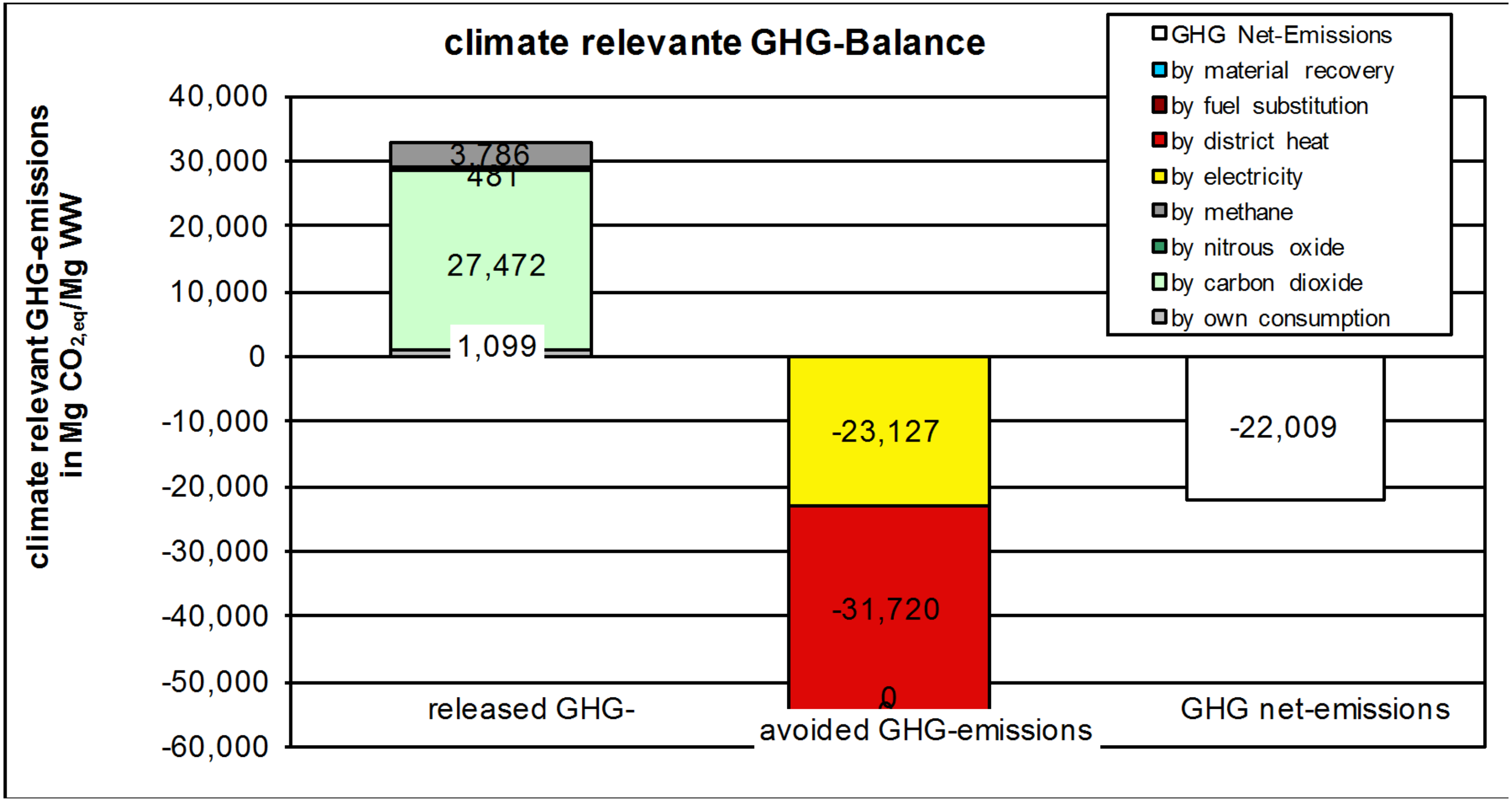
6. Greenhouse Gas Emissions in [t. CO_2-eq. pro formal collected waste]

Sc 3 Incin. - recy [pl, gl, pa, me, org comp]



6. Greenhouse Gas Emissions in [t. CO_2-eq. pro formal collected waste]

Sc 4 Incin. - recy [gl, me, org biogas]



III. Social assessment - indicators

1. Odour
2. Visual impact
3. User Convenience & Complexity
4. Private space
5. Noise
6. Traffic

Impact on subsystems

- Bin & containers system
- Collection &Transport
- Treatment & Disposal

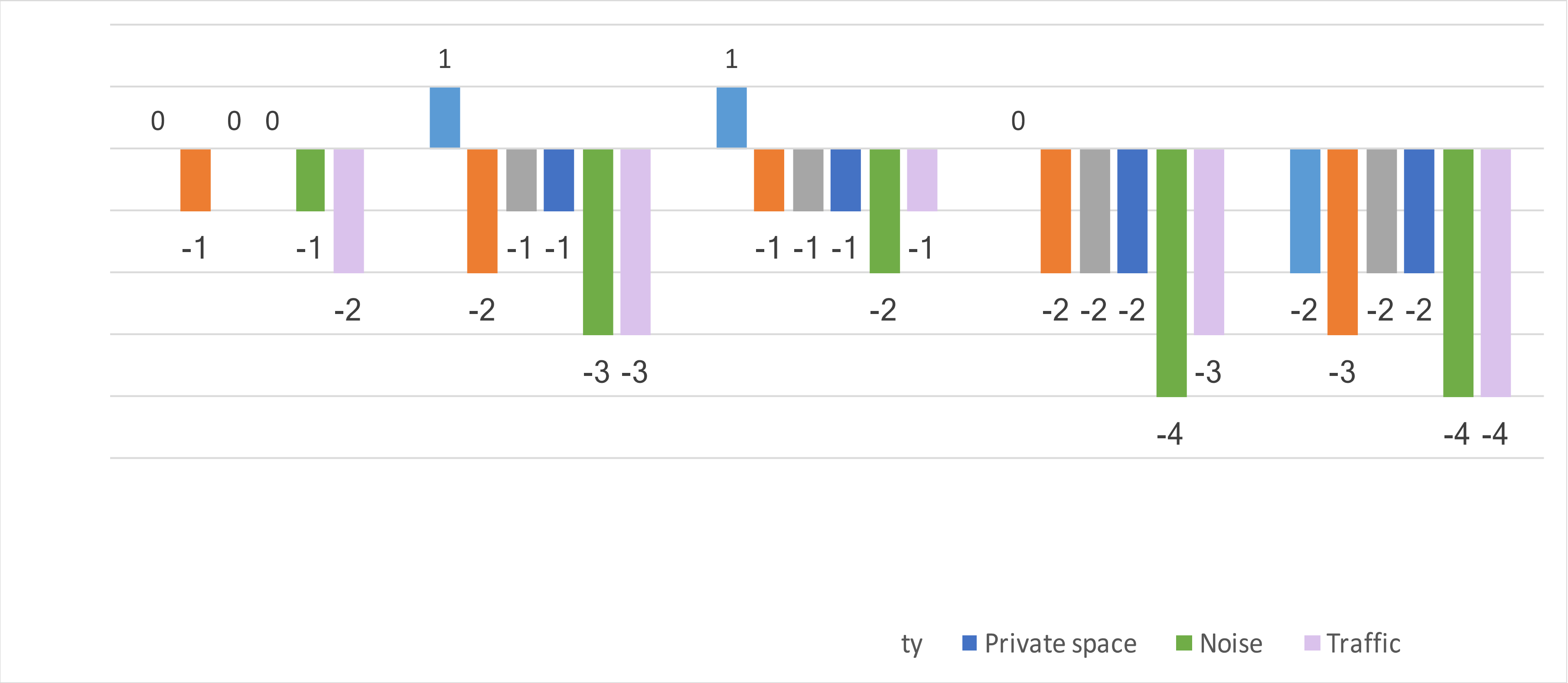
Expert based review

7. Job Creation in total

Quantitative based on literature data

1.-7. Social assessment - results

The higher the score the better



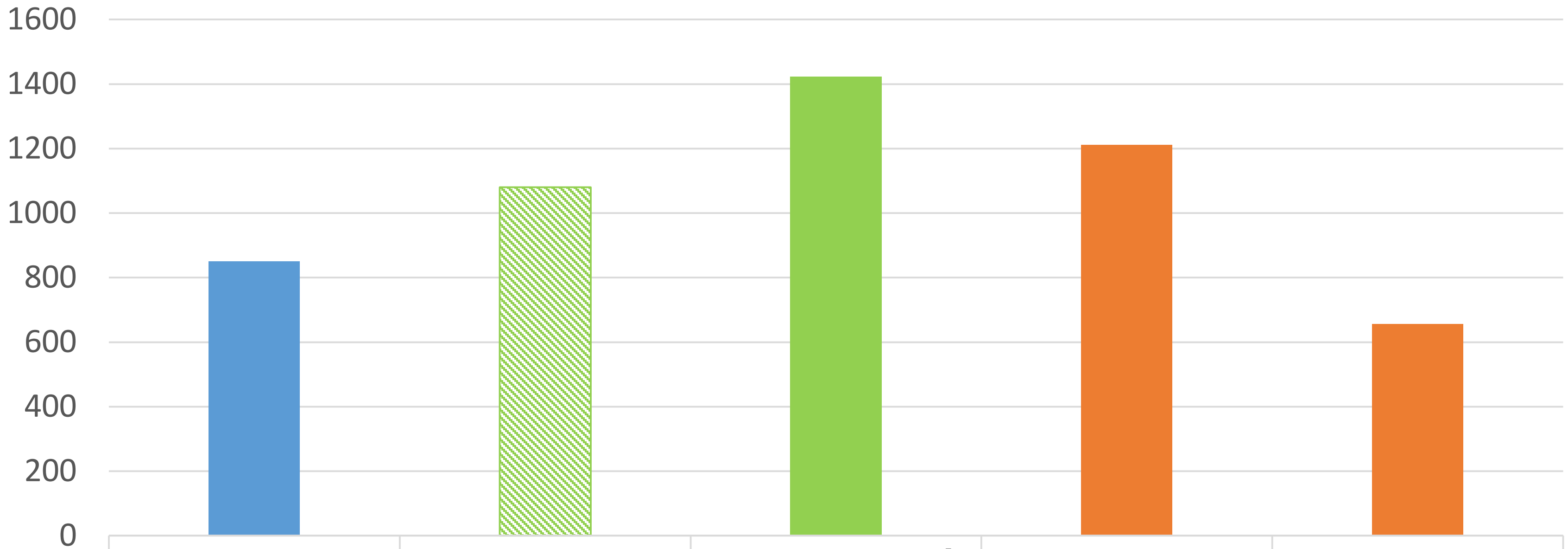
Results of qualitative social assessment based on expert review from BOKU & TUD

1. -7. Social Assesment – drawbacks of qualitative assessments

- The scoring of social indicators is **highly SUBJECTIVE!**
- Depending on the social indicator it happens, that „doing nothing“ (remaining in the status-quo situation) can bring „better“ results, e.g. separate collection and user convenience.
- The **number and stratification of respondents** may have impact on results.
- How to integrate the social results in an overall result (economy, environment, social, technical)?

8. Job creation - results

Job creation: Number of new jobs (excl. admin staff) created as a result of introduction of WM-scenario (including all treatment facilities, recycling activities, collection system)



	Sc 0 - LF +MBT	Sc 1 MBT- recy [wet/dry]	Sc 2 MBT - recy [gl, pl, pa,me, org comp]	Sc 3 Incin. - recy [pl, gl, pa, me, org comp]	Sc 4 Incin. - recy [gl, me, org biogas]
Jobs created	851	1080	1423	1211	656

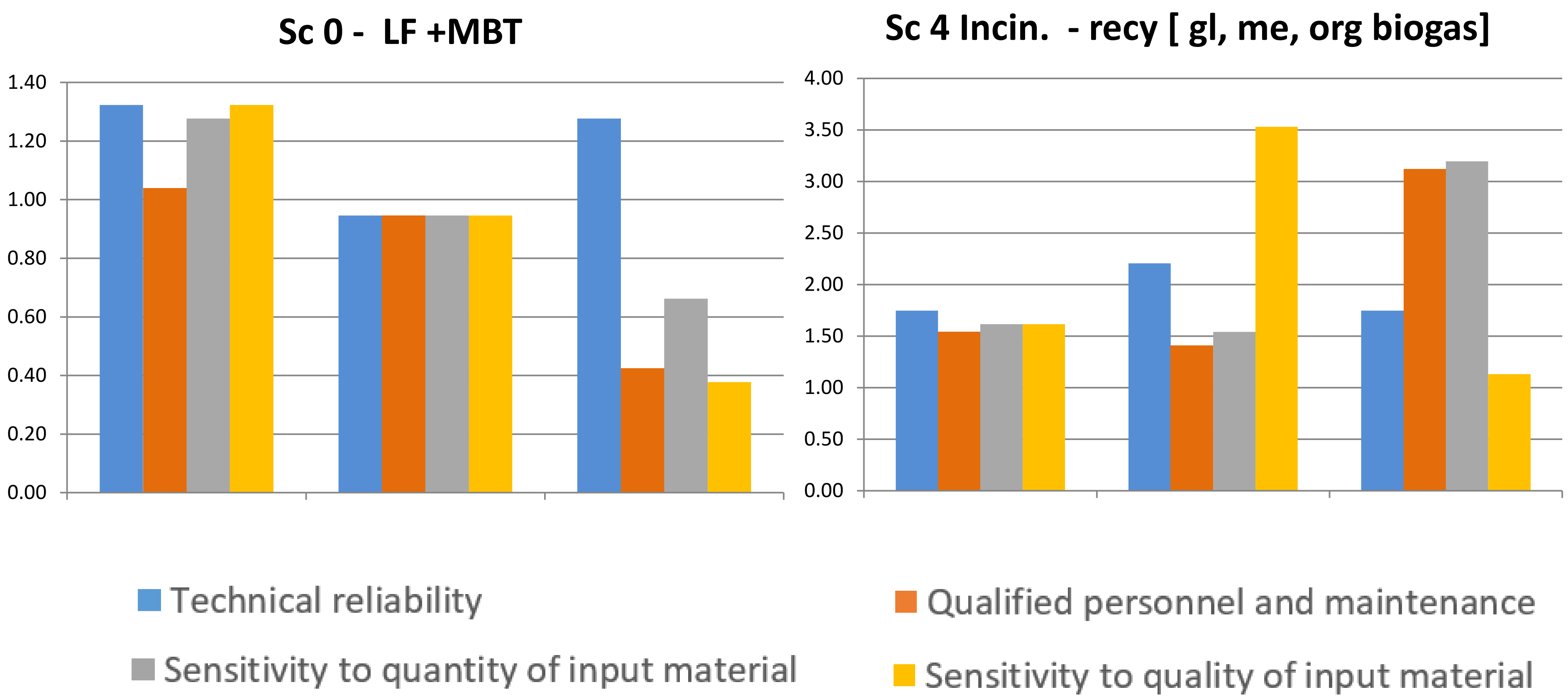
Technical assessment (Methodology)

- Ranking from 4 (applies), 3, 2, 1 (does not apply) to evaluate waste treatment technologies (landfill, composting, sorting, MBT)
- Example:

	Technology			
Indicator	Landfill	MBT	Composting	Incine-ration
Technical reliable				
Qualified personnel and maintenance **not** required				
Not Flexible to quantity of input material				
Quality of input material required				

Technical assessment - remark

Opinions from experts differ => concluding not possible to argue differences in results of scenario



Conclusion I

	Sc 0 - LF +MBT	Sc 1 MBT- recy [wet/dry]	Sc 2 MBT – recy [gl, pl, pa,me, org comp]	Sc 3 Incin. - recy [pl, gl, pa, me, org comp]	Sc 4 Incin. - recy [gl, me, org biogas]
Investment costs [m€]	34.4	33.1	34.3	73.7	80.4
Annual discounted investment costs [m€/year]	3.8	3.7	3.8	8.1	8.9
Annual operating costs [m€/year]	8.9	8.8	9.2	7.2	6.3
Total annual costs [m€/year]	**11**	**10.8**	**11.4**	**11.6**	**11.1**
Self financing rate [%]	47	58	55	78	88
Total revenues [m€/yr]	1.7	2.9	2.8	7.7	9.1
Source sep. rate [%]	6	14	29	29	21
Recycling rate [%]	9	12	19	18	10
Energy recovery rate [%]	40	33	34	29	41
Landfilling rate [%]	39	38	34	26	24
Biodegradable waste diversion rate [%]	57	57	63	94	99

Conclusion I

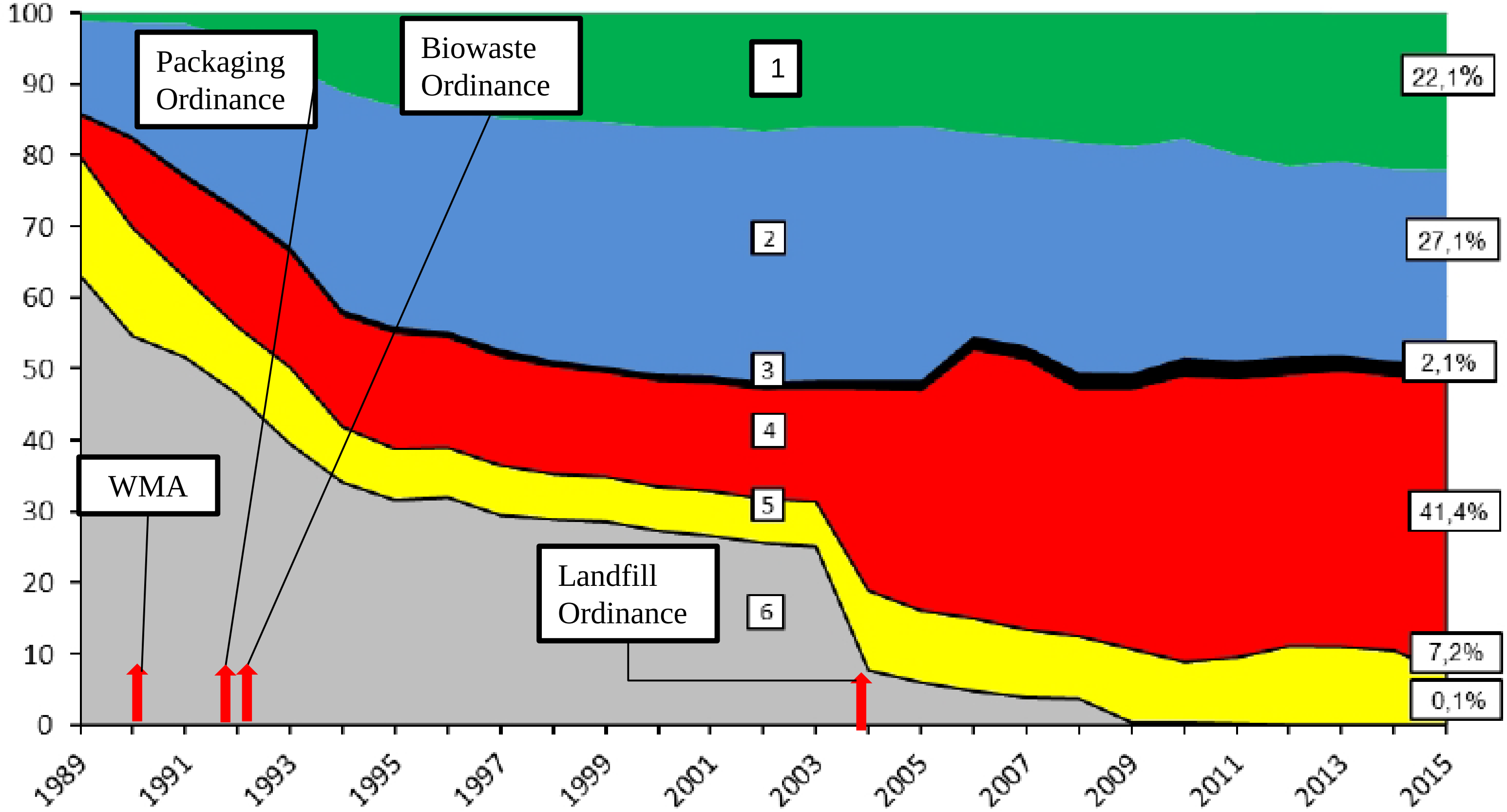
- Keep in mind, that **costs** for subsystem treatment are mainly based on EU-level an will be lower in Belarus.
- Cost-related indicators give a **rough indication**, and show differences in the scenarios, do not take cost information “too seriously”.
- **Job creation** based partly on literature data=> in reality more jobs could be created.
- **Qualitative indicators** (social & technical) are **subjective**, results could change if other experts are included.

Conclusion II

- We presented you a multitude of indicators, **BUT** decision makers have to take decisions for the future!
- We provided you an overview of the **key effects associated with** a decision (**scenario**).
- This information gives you the opportunity to actively address these associated effects (especially the negative).
- Decisions (ranking of scenarios) depend on **YOUR goals and PRIORITIES**.
- Every scenario has pros and cons.
- **Good quality data on waste generation and composition are most important prerequisite for PLANNING!**

Conclusion III

Development of waste management in Austria over time



Source: Austrian – Federal Waste Management Plan - 2017

1 composting 2 recycling 3 WEEE + hazardous waste 4 Thermal treatment (waste to energy) 5 MBT 6 Landfill

Thank you for your attention!

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