

Results

Stocks, Waste and Life Cycle Emissions in Scenarios

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Content

- Data coverage and pre-conditions
- Scenario implementation
- Accumulated stocks in EU27 in 2003
- Waste generation in EU27 in 2003
- Waste generation in EU27 in future scenarios
- Life cycle emissions from different waste treatment options
- Concluding remarks

Data coverage and pre-conditions

- **Data collection coverage**

- Covers 38% of EU27 economy (missing Germany, Austria, Slovenia, UK, Ireland, Spain, Italy)
- Assumption: $EU27 = EU20 / 0.38$

- **Historical time series**

- 1971-2003: GDP (Eurostat), Physical flows (Relationship between GDP and TMR)
- 1903-1970: Extrapolation (exponential) of 1971-1990

- **Life cycle emissions from imported products**

- Assumed that rest of world (ROW) is equal to EU27

Data coverage and pre-conditions

- **Data collection coverage**

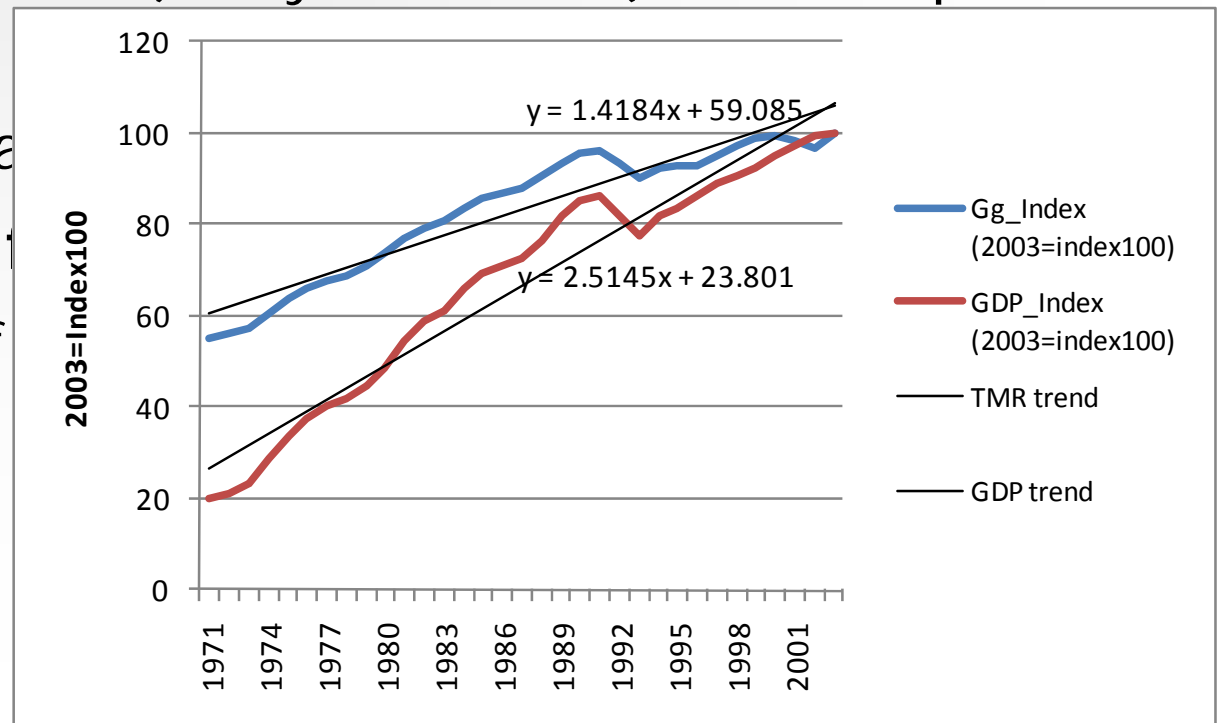
- Covers 38% of EU27 economy (missing Germany, Austria, Slovenia, UK, Ireland, Spain, Italy)
- Assumption: $EU27 = EU20 / 0.38$

- **Historical time series**

- 1971-2003: GDP (Eurostat), Physical flows (Relationship between GDP and TMR)
- 1903-1970: Extrapolation

- **Life cycle emissions**

- Assumed that rest of



Scenario implementation

- Prevention

Activity	Changed parameter		2003	2015	2035
Household	Use	Meat use	100	85	81
	Use	Flour use	increased correspondingly by dry mass		
Food industry	Use, waste	Fruit and veg. Use & waste	100	85	81
	Use, waste	Grain crops & waste	100	97.6	97
	Use, waste	Crops nec & waste	100	85	81
Beverages	Use, waste	Use of plastic & waste	100	90	88
	Use, waste	Use of glass & waste	100	90	88
Household	Use, waste	Textiles, wearing and apparel, leather & waste	100	94	93
All, except household	Use, waste	Printed matter	100	92	90
All, except refinery industry	Use, waste, emissions	Use of refined petroleum, waste, and emissions	100	94	93
All, except machinery product activities	Use, waste	Machinery and equipment n.e.c.	100	94	93
	Use, waste	Office machinery and computers	100	94	93
	Use, waste	Electrical machinery n.e.c.	100	94	93
	Use, waste	Radio, television and communication equipment	100	94	93
	Use, waste	Instruments, medical, precision, optical, clocks	100	94	93

Scenario implementation

- Recycling

Activity	Changed parameter		2003	2015	2035
Beveages industry	Waste to recycling	paper and paper products	20%	30%	50%
		Plastic and rubber products	25%	70%	85%
		Glass	60%	90%	95%
		Fabricated metal products	59%	80%	90%
Construction industry	Waste to recycling	Sand, gravel and stone	15%	40%	80%
		Forest products and wood products	15%	20%	40%
		Plastic and rubber products	3%	7%	14%
		Bricks	15%	40%	70%
		Fabricated metal products	20%	85%	95%
Agriculture	Waste to biogas	Manure	0%	70%	70%
All	Waste to biogas	Food waste	0%	40%	60%
All	Waste to recycling	Paper waste	59%	67%	77%
Motor vehicles and trailers	ELV to recycling	Iron waste	95%	95%	95%
		Alu waste	95%	95%	95%
		Copper waste	61%	61%	61%
		Metals nec waste	61%	61%	61%
		Fabricated metal products, except machinery waste	60%	95%	95%
		Machinery and equipment n.e.c. waste	60%	95%	95%
All	WEEE waste to trecycling	Office machinery and computers waste	24%	75%	90%
		Radio, television and communication equipment waste	25%	75%	90%
		Instruments, medical, precision, optical, clocks waste	20%	75%	90%

Assumption: Increased recycling affects landfill

Scenario implementation

- Treatment

Activity	Changed parameter		2003	2015
Agriculture	Waste to biogas	Manure	0%	100%
All	Waste to incineratin	Food waste	43%	80%
		Textile waste	55%	80%
		Paper waste	15%	35%
All	Waste to recycling	Inert waste	1%	5%
All	Waste to recycling	Iron waste	46%	52%
		Alu waste	41%	50%
		Copper waste	40%	50%
		Metals nec waste	41%	50%

- Assumption:**
- Increased recycling affects landfill
 - Increased incineration affects landfill

Accumulated stocks in EU27 in 2003

Stock category	Quantity, dry weight (Million t)
Stocks in the economy	
Construction materials (minerals)	150,077
Textile	105
Wood	3,280
Paper products	210
Plastic	139
Glass	558
Metal products	3,214
Total	157,583
Stocks not in use	
Stock in landfill	
Landfill of waste: Food	5,922
Landfill of waste: Paper	1,317
Landfill of waste: Plastic	1,247
Landfill of waste: Metals	2,249
Landfill of waste: Glass/inert	186,695
Landfill of waste: Mine waste	3,954
Landfill of waste: Textiles	223
Landfill of waste: Wood	2,568
Landfill of waste: Oil/Hazardous waste	8,665
Landfill of waste: Slag/ash	32,550
Total	245,388

For comparison:

Ressource extraction in 2003	Quantity, dry weight (Million t)
Agriculture	1,133
Forestry	317
Coal	761
Oil and gas	355
Metal ores	88
Minerals	3,610
Total	6,263

Accumulated stocks in EU27 in 2003

- Detailed

Accumulated stocks in:

Region: EU27

Year: 2003

Stock category	Quantity, dry weight (Million t)	Sector											All sectors	
		Agriculture and fishery	Forestry	Ressource extraction	Food industry	Industry	Construction	Refineries and gas	Electricity and heat	Service	Waste treatment	Household		
Stocks in the economy														
Construction materials	Sand, stone, clay	116,345	1%	0%	6%	1%	19%	52%	0%	0%	11%	7%	1%	100%
	Concrete, asphalt	30,647	0%	0%	0%	2%	6%	80%	0%	0%	5%	2%	5%	100%
	Bricks	3,086	0%	0%	0%	0%	8%	73%	0%	0%	8%	2%	8%	100%
Textile	Textile, wearing apparel, footwear	105	1%	0%	0%	1%	24%	3%	0%	0%	13%	2%	57%	100%
Wood	Wood products	3,280	2%	0%	0%	2%	29%	40%	0%	1%	12%	2%	10%	100%
Paper products	Paper and printed/recorded media	210	0%	0%	0%	4%	15%	1%	0%	0%	45%	4%	29%	100%
Plastic	Plastic and rubber products	139	2%	0%	0%	7%	25%	19%	1%	0%	18%	2%	24%	100%
Glass	Glass products	558	2%	0%	2%	27%	22%	23%	0%	0%	12%	6%	5%	100%
Metal products	Iron products	948	0%	0%	1%	1%	64%	26%	0%	0%	6%	1%	1%	100%
	Aluminium products	39	0%	0%	0%	3%	74%	16%	0%	0%	4%	1%	0%	100%
	Copper products	21	0%	0%	0%	2%	86%	9%	0%	0%	2%	0%	1%	100%
	Metals nec products	11	0%	0%	0%	2%	70%	15%	0%	0%	10%	2%	1%	100%
	Fabricated metal products, except ma	624	1%	0%	1%	4%	29%	27%	1%	0%	18%	12%	7%	100%
	Machinery and equipment n.e.c.	723	6%	0%	2%	4%	32%	9%	1%	0%	27%	5%	14%	100%
	Office machinery and computers	5	0%	0%	0%	1%	13%	1%	0%	0%	63%	7%	15%	100%
	Electrical machinery n.e.c.	335	1%	0%	0%	1%	26%	19%	1%	1%	29%	3%	18%	100%
	Radio, television and communication e	69	0%	0%	0%	0%	31%	2%	0%	1%	37%	2%	26%	100%
	Instruments, medical, precision, optica	30	0%	0%	0%	0%	16%	3%	0%	1%	48%	1%	30%	100%
Furniture and other manufactured good	408	0%	0%	0%	0%	10%	2%	0%	0%	24%	3%	60%	100%	
Total		157,583												
Stocks not in use														
Stock in landfill	Landfill of waste: Food	5,922	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Paper	1,317	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Plastic	1,247	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Metals	2,249	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Glass/inert	186,695	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Mine waste	3,954	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Textiles	223	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Wood	2,568	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Oil/Hazardous waste	8,665	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
	Landfill of waste: Slag/ash	32,550	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%
Total		245,388												

Waste generation in EU27 in 2003

Waste category	Waste fraction	Quantity, dry weight (Million t)
Organic	Food waste	526
	Food waste to WWT	4
	Manure	157
	Wood waste	82
Textile	Textile waste	18
Paper	Paper waste	113
Plastic	Plastic waste	167
Glass	Glass waste	60
Construction and inert	Sand, stone, clay	1,657
	Cement, concrete, asphalt	566
	Bricks waste	38
	Ash and slag waste	762
	Metal ore waste	90
Metal	Iron waste	218
	Aluminium waste	20
	Copper waste	6
	Metals nec waste	7
	Other materials (non metal)	34
Special fractions	Special fractions	378
Total		4,904

> 500 million tonne

> 100 million tonne

Waste generation in EU27 in 2003

- Detailed

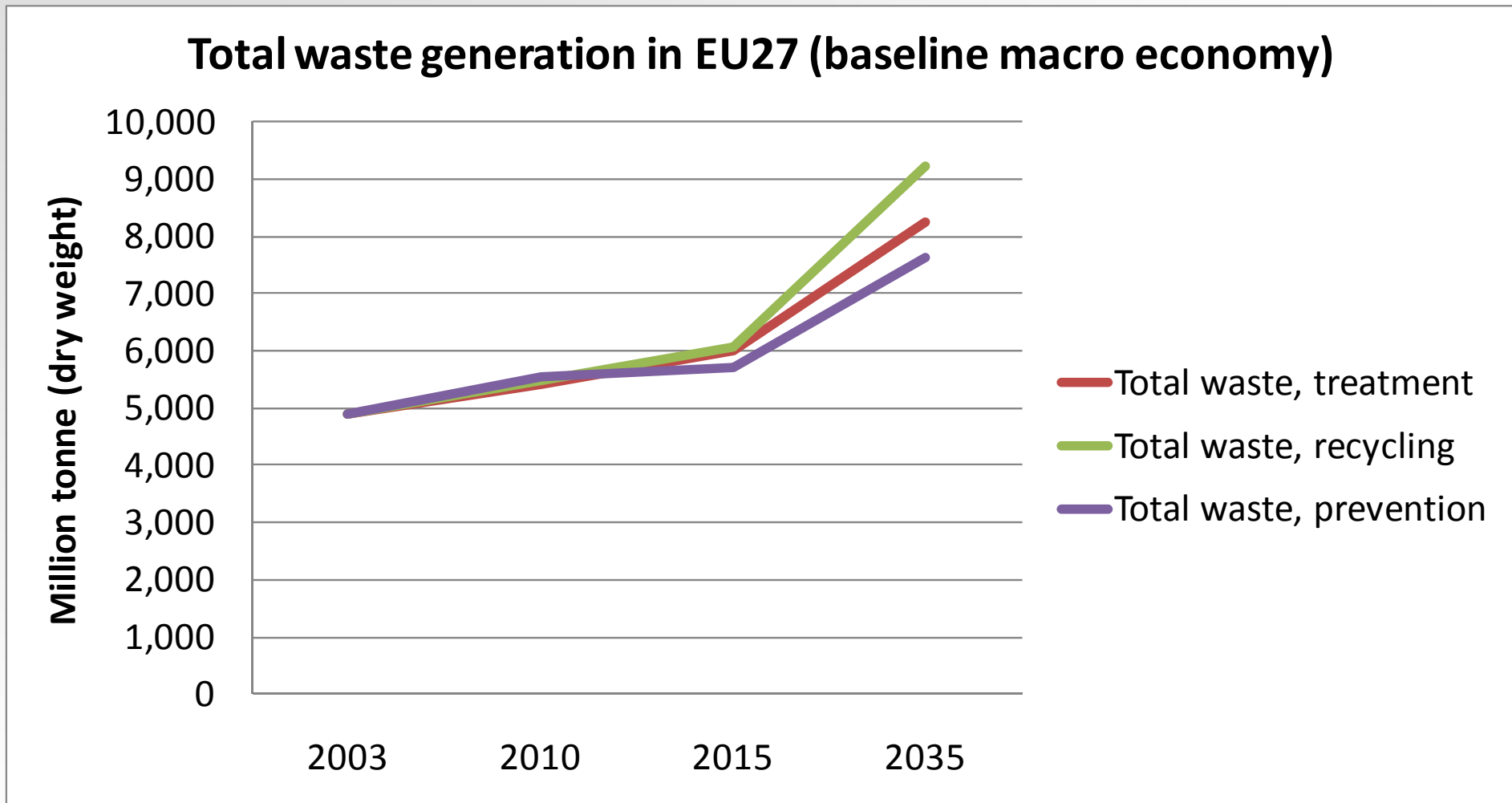
Waste generation in:

Region: EU27

Year: 2003

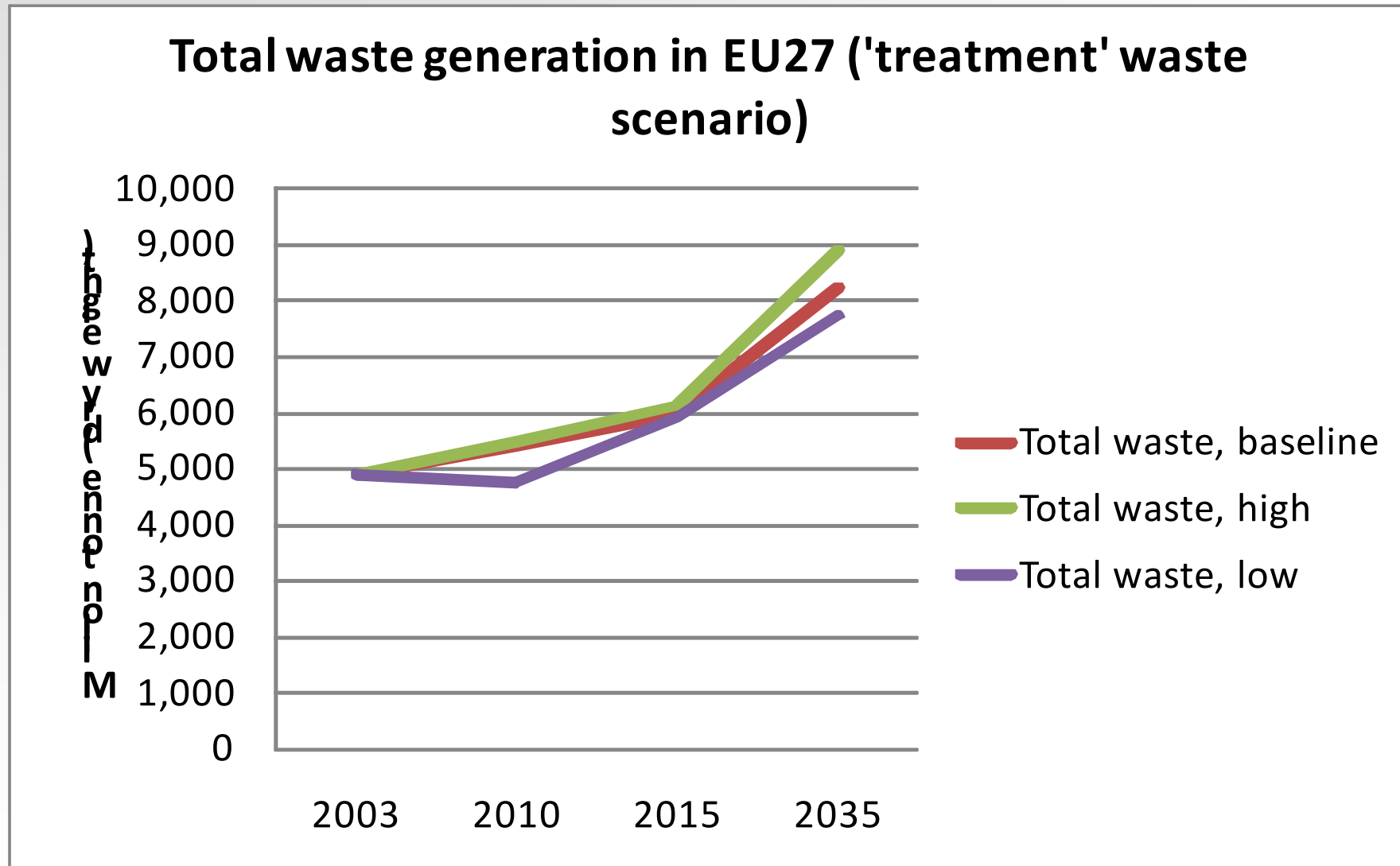
Waste category	Waste fraction	Quantity, dry weight (Million t)	Sector											All sectors	
			Agriculture and fishery	Forestry	Ressource extraction	Food industry	Industry	Construction	Refineries and gas	Electricity and heat	Service	Waste treatment	Household		
Organic	Food waste	526	4%	0%	0%	32%	3%	0%	0%	0%	0%	11%	1%	50%	100%
	Food waste to WWT	4	0%	0%	0%	1%	2%	0%	0%	0%	18%	0%	77%	100%	
	Manure	157	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
	Wood waste	82	1%	12%	1%	2%	25%	21%	0%	11%	9%	2%	16%	100%	
Textile	Textile waste	18	1%	0%	0%	1%	16%	2%	0%	0%	11%	2%	68%	100%	
Paper	Paper waste	113	0%	0%	0%	8%	27%	1%	0%	0%	39%	3%	20%	100%	
Plastic	Plastic waste	167	2%	0%	0%	8%	24%	24%	1%	0%	19%	3%	19%	100%	
Glass	Glass waste	60	2%	0%	2%	27%	22%	23%	0%	0%	12%	6%	5%	100%	
Construction and inert	Sand, stone, clay	1,657	1%	0%	6%	1%	23%	50%	0%	0%	10%	6%	2%	100%	
	Cement, concrete, asphalt	566	0%	0%	0%	2%	10%	75%	0%	0%	5%	2%	5%	100%	
	Bricks waste	38	0%	0%	0%	0%	8%	73%	0%	0%	8%	2%	8%	100%	
	Ash and slag waste	762	0%	0%	1%	0%	3%	0%	1%	7%	2%	83%	2%	100%	
	Metal ore waste	90	0%	0%	3%	0%	80%	2%	0%	0%	14%	1%	0%	100%	
Metal	Iron waste	218	2%	0%	1%	2%	46%	19%	1%	0%	16%	5%	9%	100%	
	Aluminium waste	20	2%	0%	1%	3%	44%	17%	1%	0%	17%	5%	10%	100%	
	Copper waste	6	1%	0%	0%	2%	53%	12%	0%	0%	18%	3%	11%	100%	
	Metals nec waste	7	2%	0%	1%	2%	38%	16%	1%	0%	21%	6%	12%	100%	
	Other materials (non metal)	34	0%	0%	0%	1%	17%	7%	0%	1%	30%	3%	42%	100%	
Special fractions	Special fractions	378	11%	0%	0%	1%	28%	2%	17%	0%	12%	2%	26%	100%	

Waste generation in 3 waste treatment scenarios



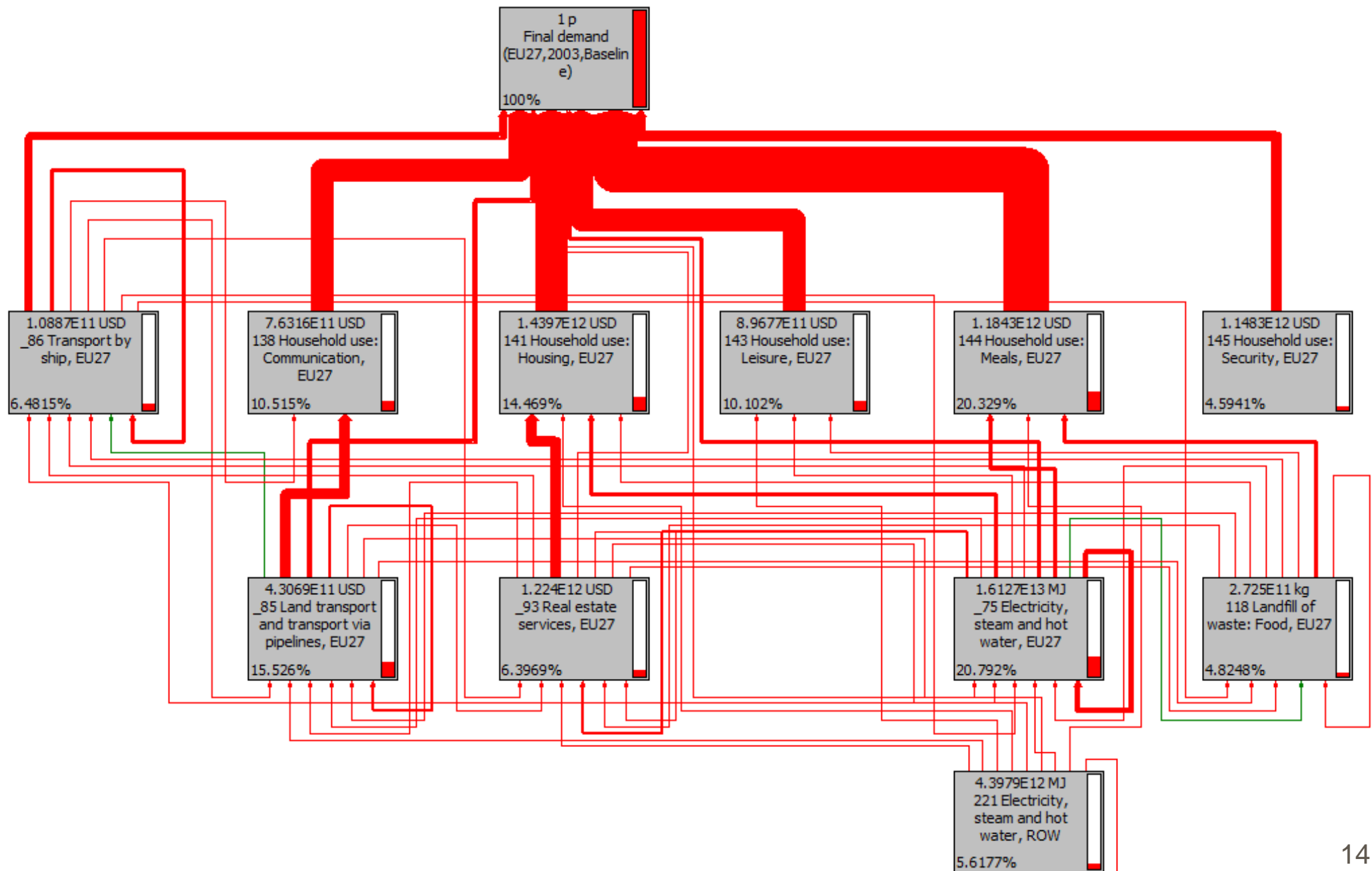
**Recycling scenario leads to most waste because of larger material turnover
(some building waste material becomes waste twice)**

Waste generation in 3 macro economic scenarios



Life cycle emissions:

- EU27 production and consumption 2003



Specific life cycle emissions from different waste management options

Waste treatment option	Waste fraction (kg CO ₂ -eq per kg dry waste sent to treatment)								
	Paper waste	Glass waste	Iron waste	Alu waste	Copper waste	Metals nec waste	Food waste	Inert waste	Manure
Recycling	1.24	-1.03	-0.63	-5.22	-2.20	-1.28		0.14	
Incineration	1.21	0.12	0.12	0.12	0.12	0.12	1.76	0.12	
Landfill	1.73	0.07	0.07	0.07	0.07	0.07	2.34	0.07	
Composting							2.11		
Biogasification							0.14		3.13
Land application									4.08

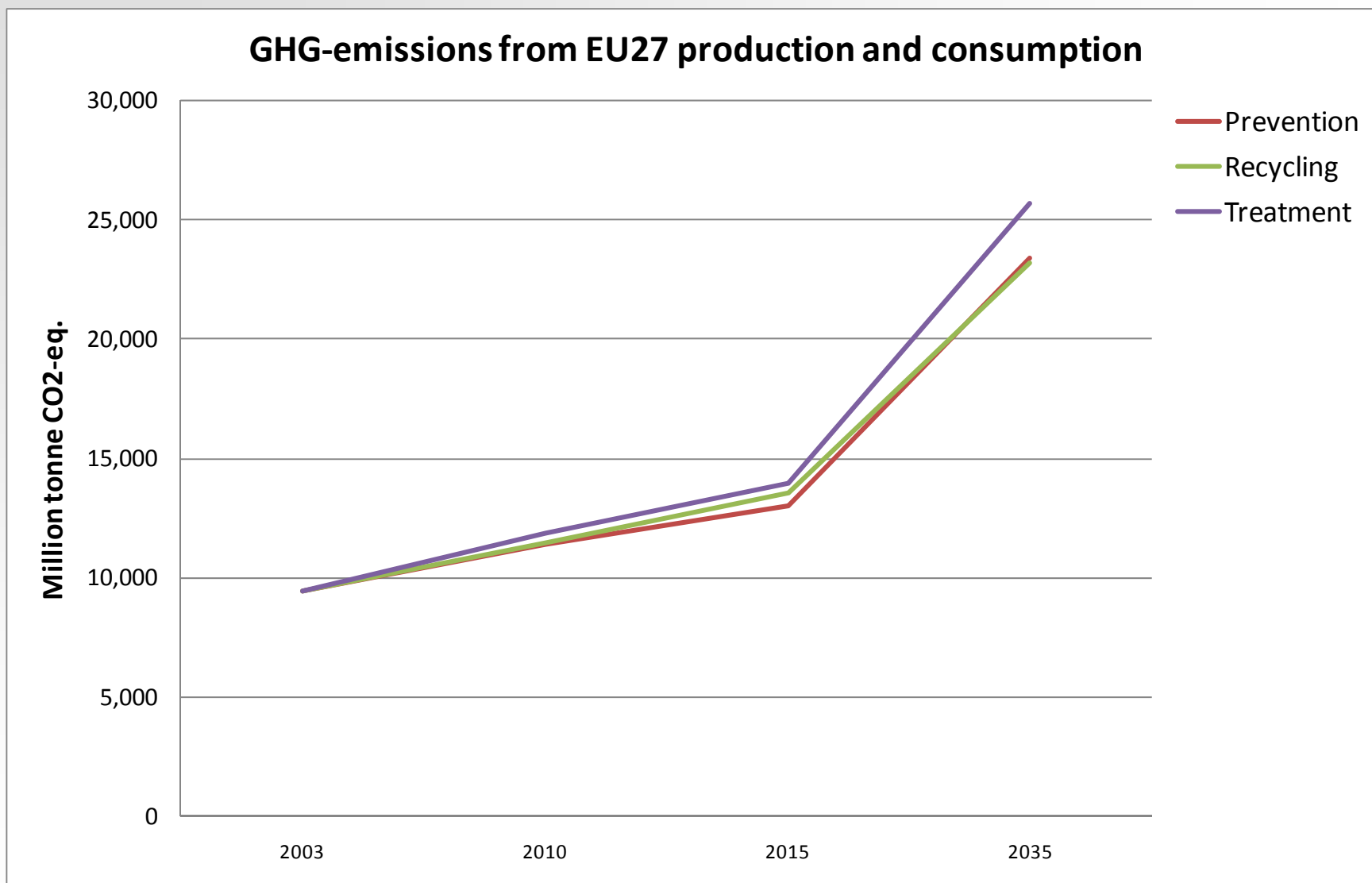
Life cycle emissions different waste treatment scenarios: EU27 production and consumption

million t CO2-eq.	2003	2010	2015	2035
Prevention	9,467	11,379	13,044	23,393
Recycling	9,467	11,499	13,561	23,212
Treatment	9,467	11,849	13,955	25,655

million tonne CO2-eq.		2003	2010	2015	2035
Prevention	EU27	7,622	9,093	10,350	17,694
	ROW	1,845	2,286	2,695	5,699
Recycling	EU27	7,622	9,099	10,559	17,484
	ROW	1,845	2,400	3,002	5,728
Treatment	EU27	7,622	9,404	10,933	19,070
	ROW	1,845	2,445	3,022	6,584

Macro economic scenario: Baseline

Life cycle emissions different waste treatment scenarios: EU27 production and consumption



Macro economic scenario: Baseline

Comparison with Danish waste statistics

Model results	1000 tonnes (dry weight)		Waste statistics	1000 tonnes (dry weight)
Food waste, MSW	8,337			
Food waste, Waste water	100	←→		211
Wood waste	745	←→		74
Ash and slag waste	5,541	←→		2,182
Inert waste (sand, stone, cl)	32,743	←→		3,785
Oil waste	785			
Textile waste	211			
Paper waste	1,948	←→		1,367
Plastic waste	3,163			
Hazardous waste	2,384			
Glass waste	665	←→		219
Bricks waste	386	←→		228
Metal waste	2,797	←→		788

DANISH MINISTRY
OF THE ENVIRONMENT
Environmental
Protection Agency

Waste Statistics 2003

Environmental Review No. 4 2006
Orientering fra Miljøstyrelsen

Conclusion

- The FORWAST model leads to significant higher waste generation than existing statistics
- Waste generation in 2035 forecasted to increase 55% - 88% compared to 2003
- Overall waste generation can be reduced by waste prevention
 - not treatment and recycling
- Overall waste generation is affected by high/low economic growth:
 - Low growths scenario leads to 6% less waste in 2035
 - High growth scenario leads to 8% more waste in 2035
- GHG-emissions: Waste treatment scenarios:
 - Recycling scenario leads to 8% less GHG-emissions than treatment sc.
 - Prevention scenario leads to 9% less GHG-emissions than treatment sc.