EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre
Institute for Environment and Sustainability
Soil and Waste Unit

Joint Research Centre

Municipal Waste Management Pilot Studies Based on Life Cycle Approaches

Karol Koneczny, David W. Pennington

(Karol.koneczny@jrc.it)

CURRENT SITUATION

	Karlovo (BG)	Cyprus	Czech Republic	Kokeny (HU)	Riga (LV)	Malta	Krakow (PL)	Iasi (RO)	Topolcany (SK)
Population (cap)	46.081	730.000	10.203.269	205.000	737.000	400.420	758.500	400.420	28.968
MSW generated (Mg)	17.280	420.300	4.388.426	66.638	270.222	182.447	256.200	183.945	7.833
MSW generated (kg/cap)	375	576	430	325	367	456	338	459	270
sent for recycling (%)	*0,0%*	*7,5%*	*7,0%*	*13,0%*	*5,0%*	*0,0%*	*8,0%*	*0,0%*	*1,0%*
sent for composting (%)	*0,0%*	*0,0%*	*7,0%*	*9,0%*	*20,0%*	*25,0%*	*2,0%*	*0,0%*	*13,5%*
sent for incineration (%)	*0,0%*	*0,0%*	*23,0%*	*0,0%*	*0,0%*	*0,0%*	*0,0%*	*0,0%*	*0,0%*
without pre-treatment (%)	*100,0%*	*92,5%*	*63,0%*	*78,0%*	*75,0%*	*75,0%*	*90,0%*	*100,0%*	*85,5%*
MSW landfilled (Mg)	17.280	388.328	3.209.876	55.736	219.929	161.567	231.137	183.495	7.036
MSW landfilled (kg/cap)	375	532	315	272	298	403	305	458	243

SCENARIOS

Scenario #0 – Baseline (reference)

Existing waste management system (usually in 2002-2003), where most of the MSW are landfilled without pre-treatment, and the rest is usually subject of recycling or composting. Typical composition of MSW stream is as follows:

- Sent for recycling: 5-8% at average (0% in Karlovo, Iasi, and Malta, 13% in Kokeny)
- Sent for composting: 7-13% at average (0% in Karlovo, Cyprus, and Iasi, 20-25% in Riga and Malta, but capacity of composting facilities is limited)
- Sent for incineration: marginal or non-existence (exception: 23% in Czech Republic)
- Landfilling without pre-treatment: usually 75-85% (63% in Czech Rep., 100% in Karlovo and Iasi)
- Standard landfill facilities: with landfill gas collection, but without energy recovered form gas and leachate collection.

SCENARIOS – modelling alternatives

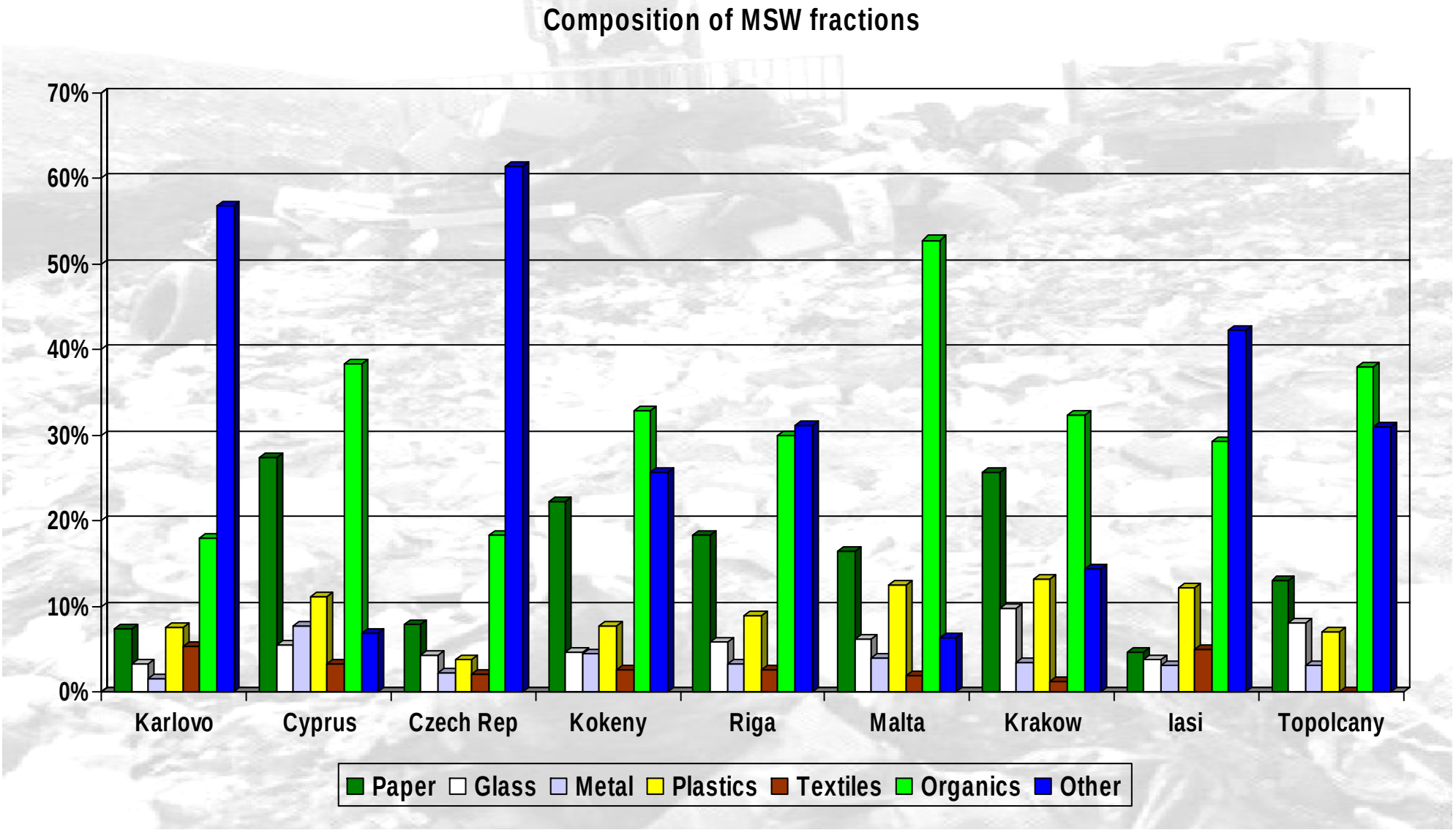
Considered issues:

- Compliance with EU Directives:
  - Packaging Directive **2004/12/EC** (minimum overall recycling target – 55% of packaging and detailed targets for specified materials).
  - Landfill Directive **1999/31/EC** (target amount of biodegradable municipal waste going to landfills must be reduced to 35% of the total amount [by weight] produced in 1995).
- Sanitary landfill (leachate collection, landfill gas collection, and 30% energy recovered form gas)
- New incineration plants are equipped with a state of the art pollution control
- When Refuse Derived Fuel facilities are added, all restwaste is sent to RDF burning facilities; then residues/fines are sent for biological treatment – certain share of MSW is directed for RDF conversion, where incineration is done with energy recovery
- Gross efficiency of energy recovery from incineration process is 60%.
- Transport is generally not considered

SCENARIOS – waste distribution

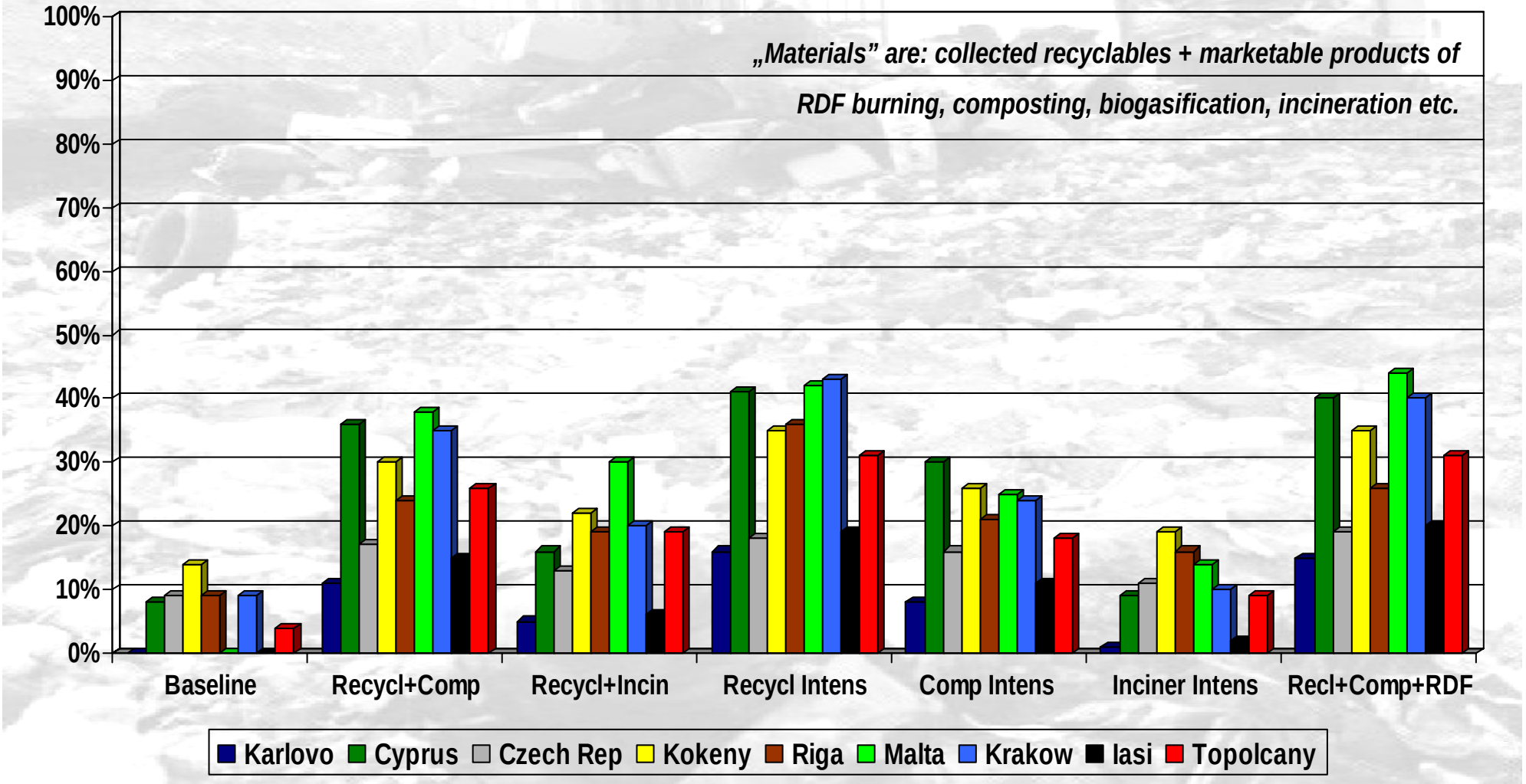
	Recycling	Composting	Incineration	Restwaste	Directives' Compliance
#0 Baseline	av: 5-8% of MSW 0%: BG, RO, MT 13%: HU	av: 7-13% of MSW 0%: BG, CY, RO 20% LV, 25% MT	Marginal except CZ – 23%	75-85% of MSW 63%: CZ 100%: BG, RO	none
#1 Recycl+Comp	to meet PD targets usually 9-18% of MSW in BG, RO only ~5% is enough	from ~15%: BG, CZ to ~44%: CY, MT	baseline	40-60% of MSW 72%: RO, 80%: BG	both
#2 Recycl+Inciner		baseline	50-60% of MSW 27% MT, 32% LV, 35% HU, SK	from 25% (PL, CZ) to 40% (BG, SK)	both
#3 Intens Recycl	80% of recyclables 20-30% of MSW 15%: BG, CZ, 42%: CY, PL	baseline	baseline	50-60% of MSW 44% MT 80%: BG, RO	Packaging
#4 Intens Comp	baseline	80% of organics, 10-70% of paper => 20-30% of MSW 17% in BG, 54% in MT	baseline	from 45% (CY, MT) to 75% (RO) and 83% (BG)	Landfill
#5 Intens Inciner	baseline	baseline	80% of avail.SW 60% MSW: HU, MT 80% MSW: BG, RO	Final landfill of MSW: from 29% (MT) to 47% (BG)	Landfill
#6 #1+RDF	No waste landfilled without pre-treatment From 40% (CY, MT) to 80% of MSW (BG) is directed for RDF conversion				both

CURRENT SITUATION

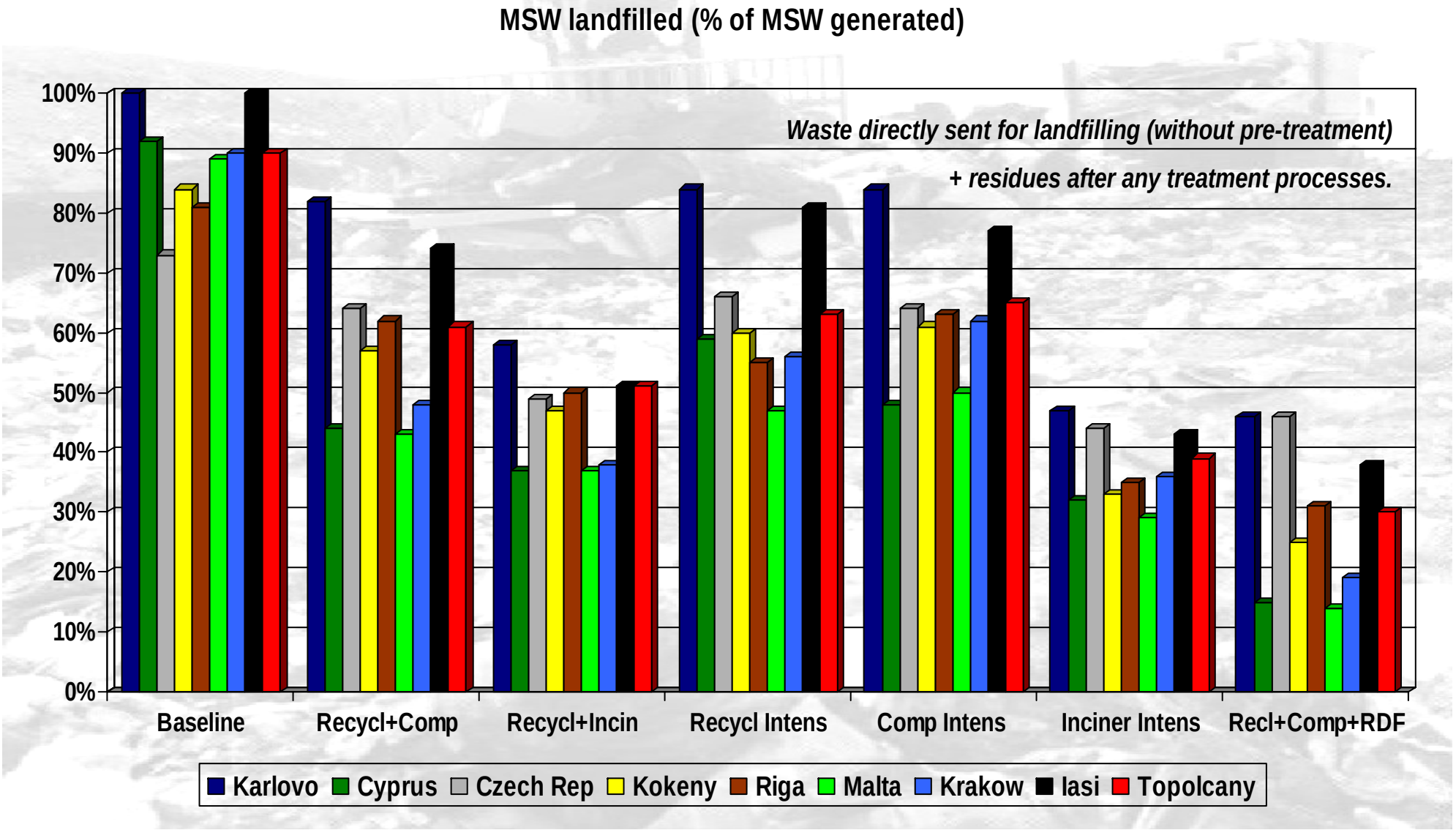


STATISTICS RESULTS

Overall Material Recovery Rate (% of MSW generated)

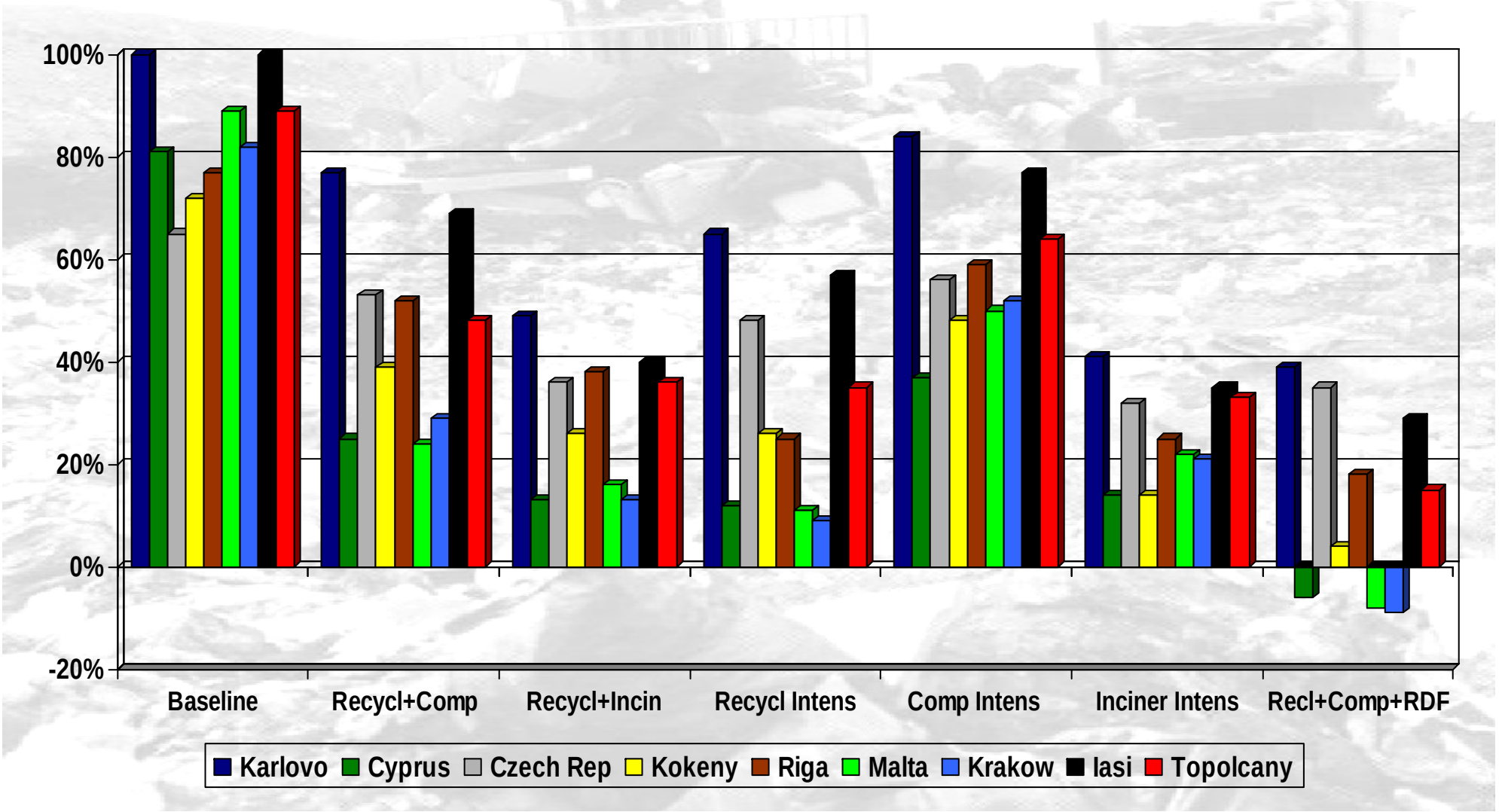


STATISTICS RESULTS

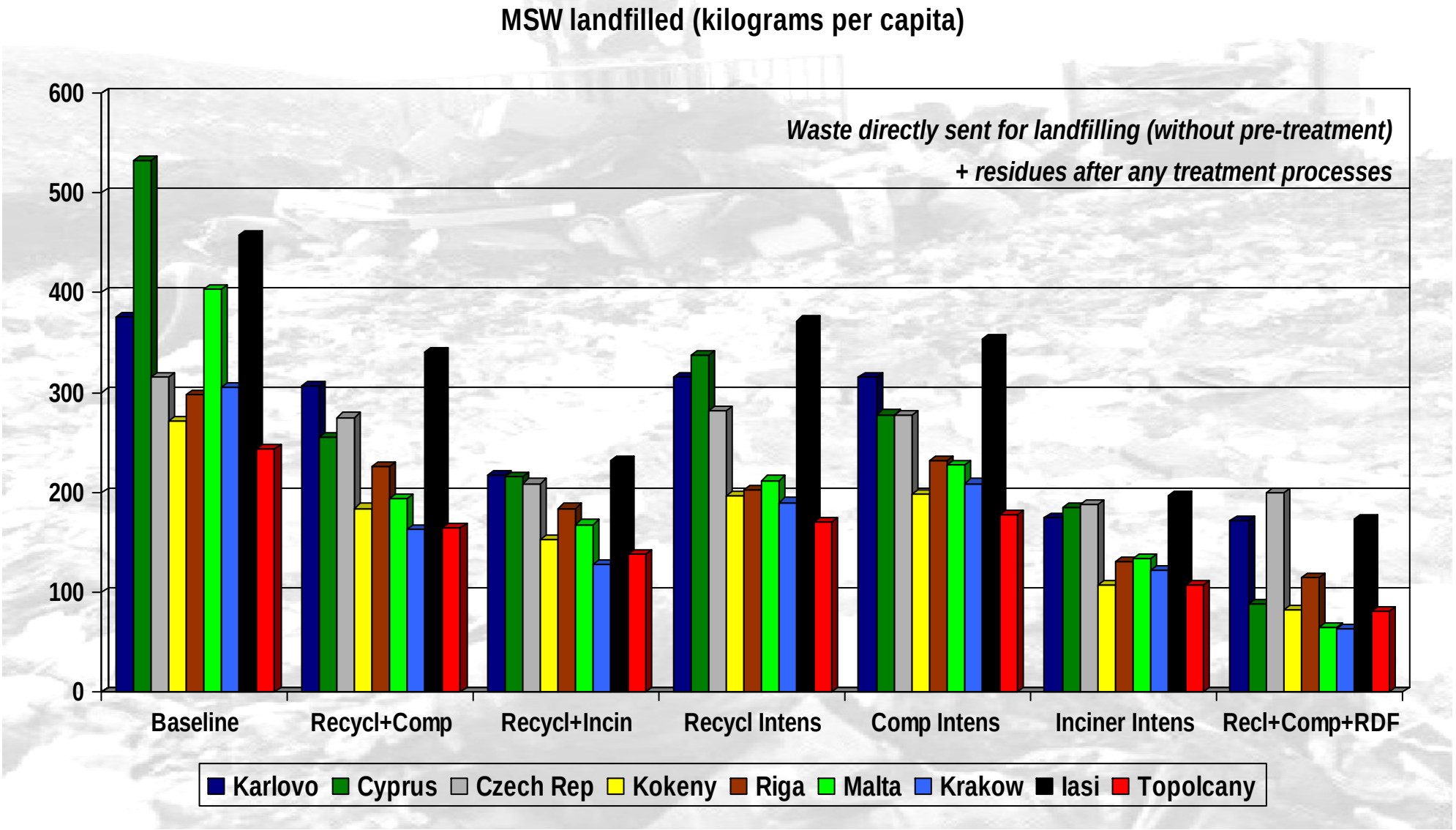


LCI RESULTS

Final Solid Waste destined for landfill (considering global offset, % of waste generated)

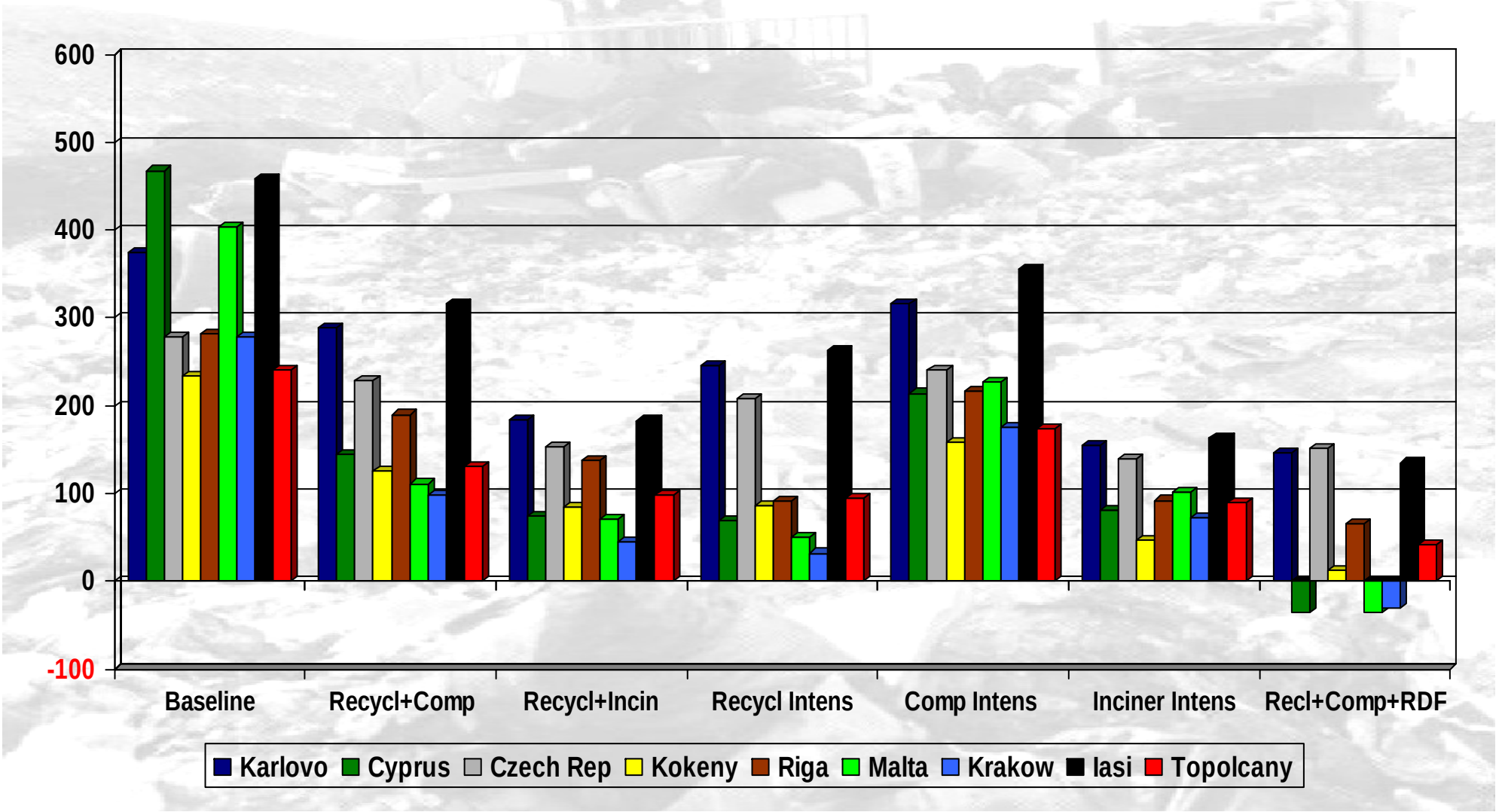


STATISTICS RESULTS



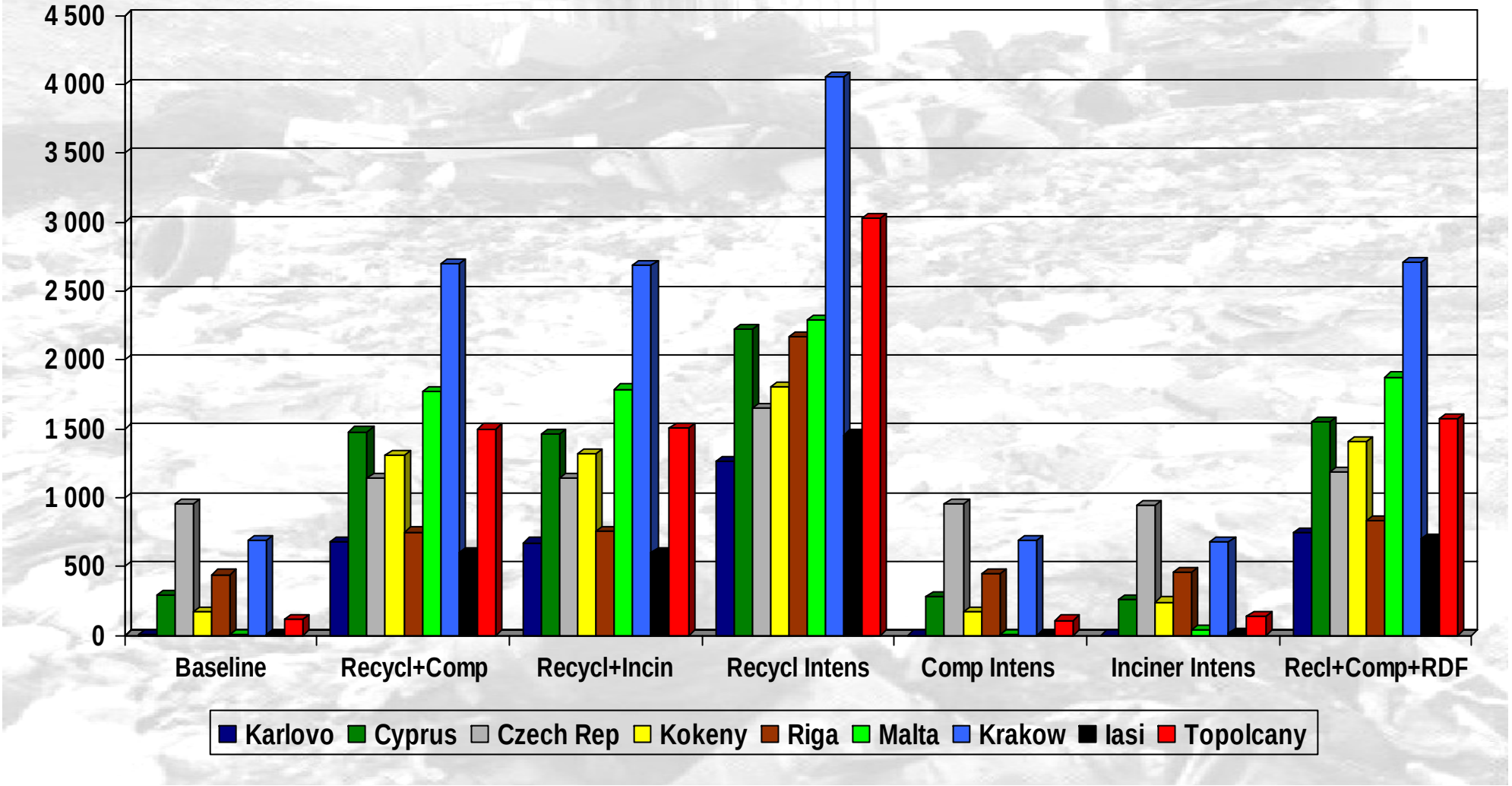
LCI RESULTS

Final Solid Waste destined for landfill (considering global offset, % of waste generated)



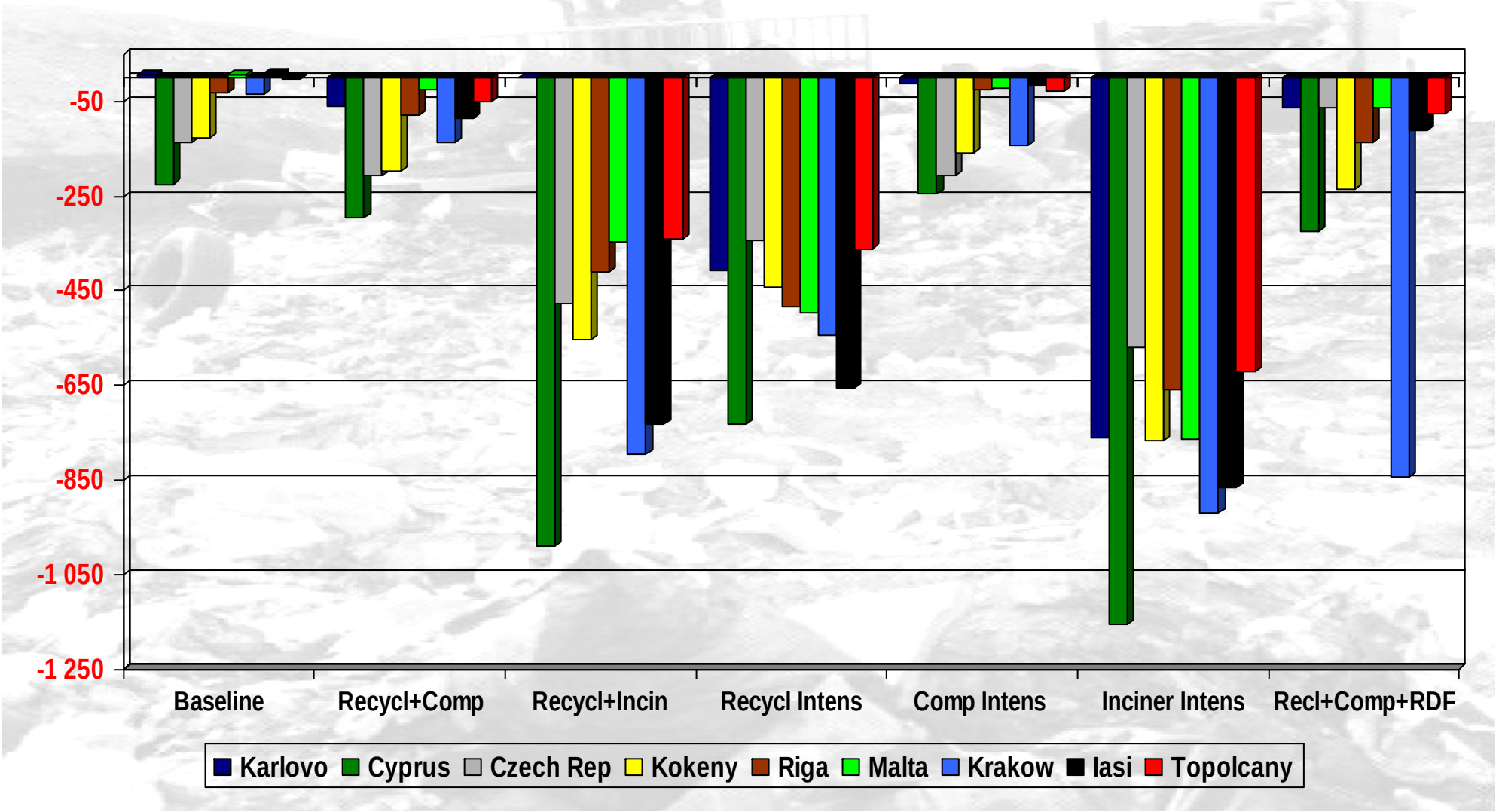
LCI RESULTS

Air Emission of Lead (milligrams / tonnes of MSW generated, considering global offset)



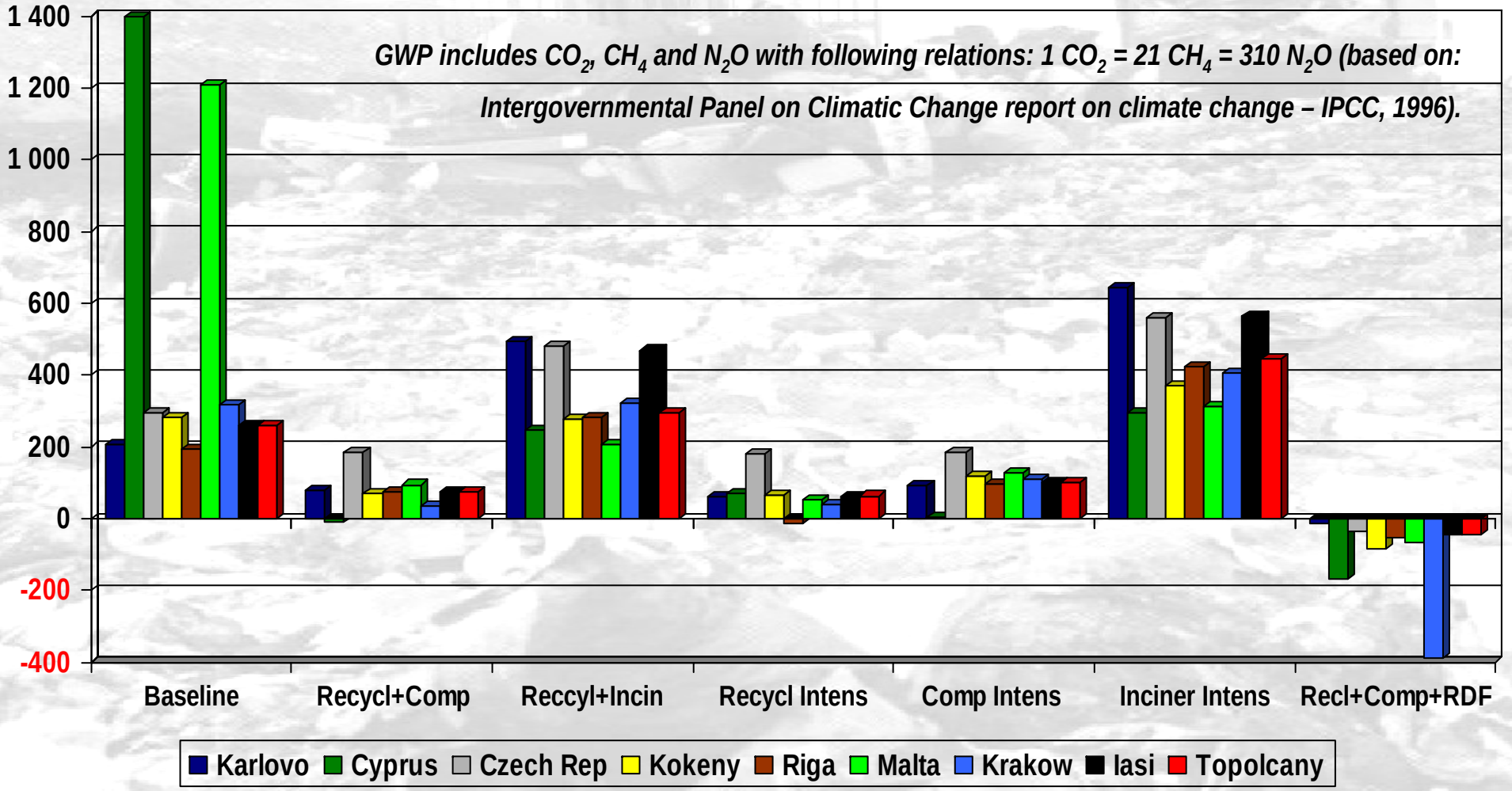
LCI RESULTS

Air Emission of NOx (grams / tonnes of MSW generated, considering global offset)



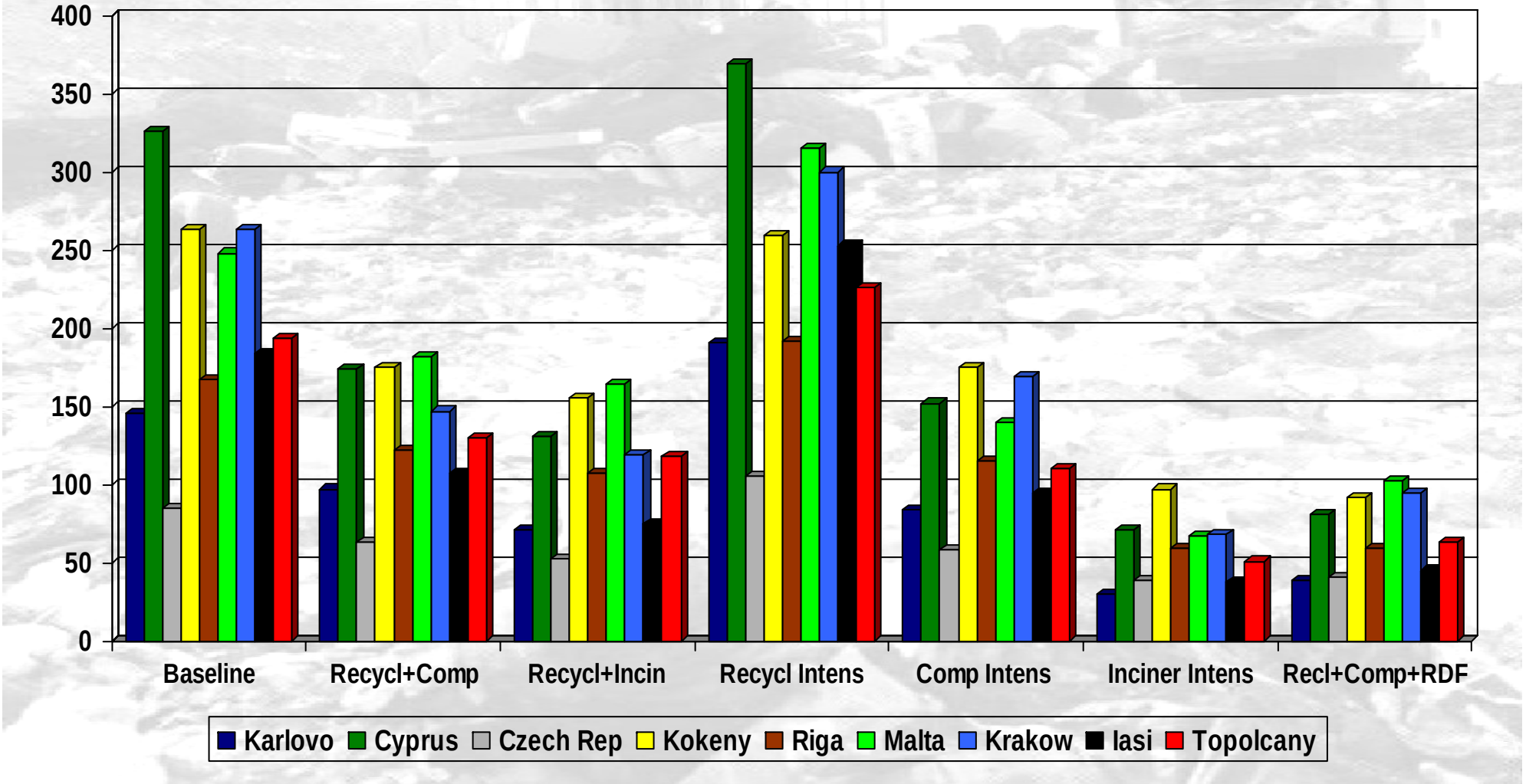
LCI RESULTS

GWP (kilograms of CO2 equivalent / tonnes of MSW generated, considering global offset)



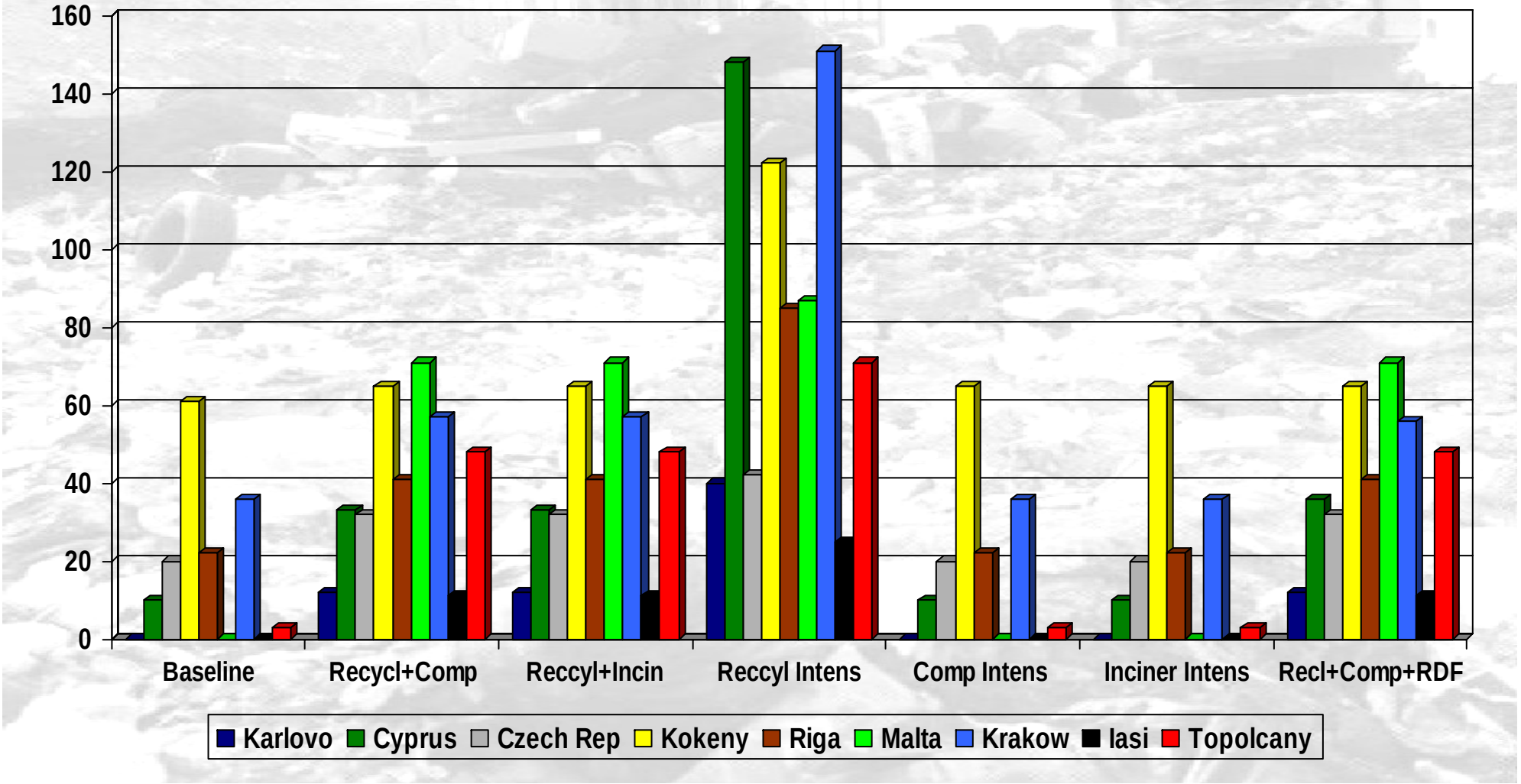
LCI RESULTS

Biological Oxygen Demand (grams / tonnes of MSW generated, considering global offset)



LCI RESULTS

Water Emission of Nitrate (grams / tonnes of MSW generated, considering global offset)



CONCLUSIONS

- Actual stage of the Study is at the midpoint of whole LCA. To achieve final results, LCIA needs to be provided, followed by justified interpretations.
- Presented results are sensitive for quality of data supplied.
- However it's clear that significant benefits can be obtained through reduction of waste going to landfill, particularly those without pre-treatment.
- Regarding that, best results were achieved by scenario #6 (combination of recycling, composting and RDF production), which might not be available in short term for most of analysed regions.
- Intensive incineration (#5) can also provide satisfactory effects (low amounts of waste directed to landfill, low lead emission, highest savings on NOx and low BOD requirements, but with relatively high negative influence on GWP).

CONCLUSIONS

- Intensive composting (#4) gives good figures in lead emission and in case of GWP, but in several other aspects doesn't look promising.
- Intensive recycling (#3) has one of the highest Overall Material Recovery Rates, what reduces final landfilling, especially considering global offsets. However it's influence on GWP is marginal, then lead and nitrate emissions, as well as BOD requirements, are high.
- Compliance with Directives is not enough effective in case of landfill reductions, particularly for countries where share of recyclables and/or biodegradables is low. It's worth to note that complying with Packaging Directive reduces their waste amounts directed to landfill only by ~5%. However applying incineration (#2) gives eventually better outcomes for this matter – as well as eg. for NOx savings – this alternative is less favorable than composting (#1) in case of GWP, and Material Recovery.