

# Inteligentna uporaba reciklirane plastike lahko zagotovi ekonomičnost

*Janez Navodnik*

*Laško, 15. oktober 2015*



**GIZ GROZD PLASTTEHNIKA  
SLOVENIJA**

# Hierarhija ravnanja z odpadki in realnost v Sloveniji



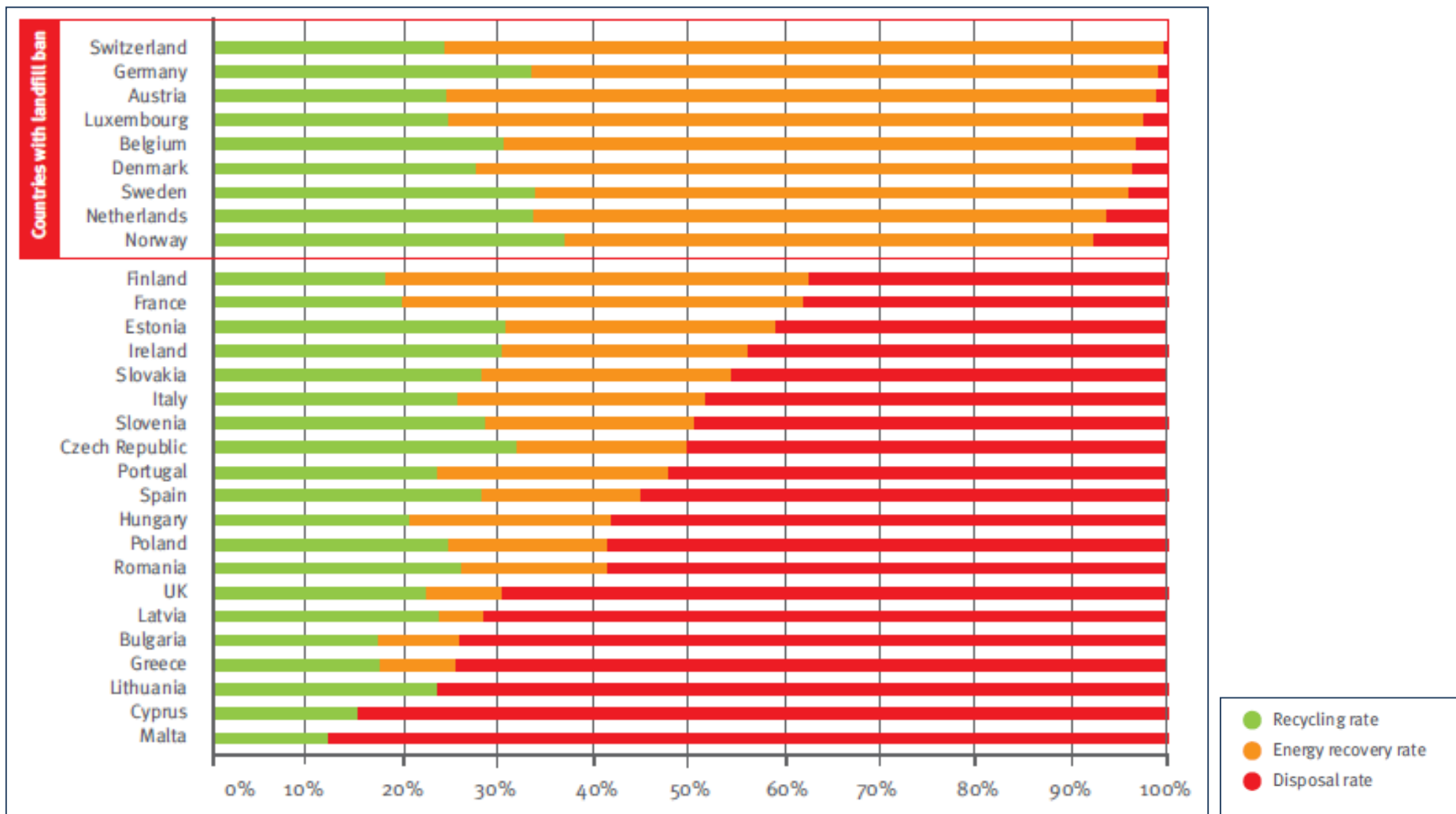
## Ali ima večina vedno prav?

Oblast:	1 ✓	2 ✓	<del>3</del>
	Kadija	Jernej	Krpan

### Sodelovanje:

- V “španoviji” (reciklaža)
- Zlata ribica (dve očesi, na črno)
- Žaba v turški kopeli (les, viri)
- Ribnik znanja (radovednost)

# Recikliranje in energetska predelava v letu 2012



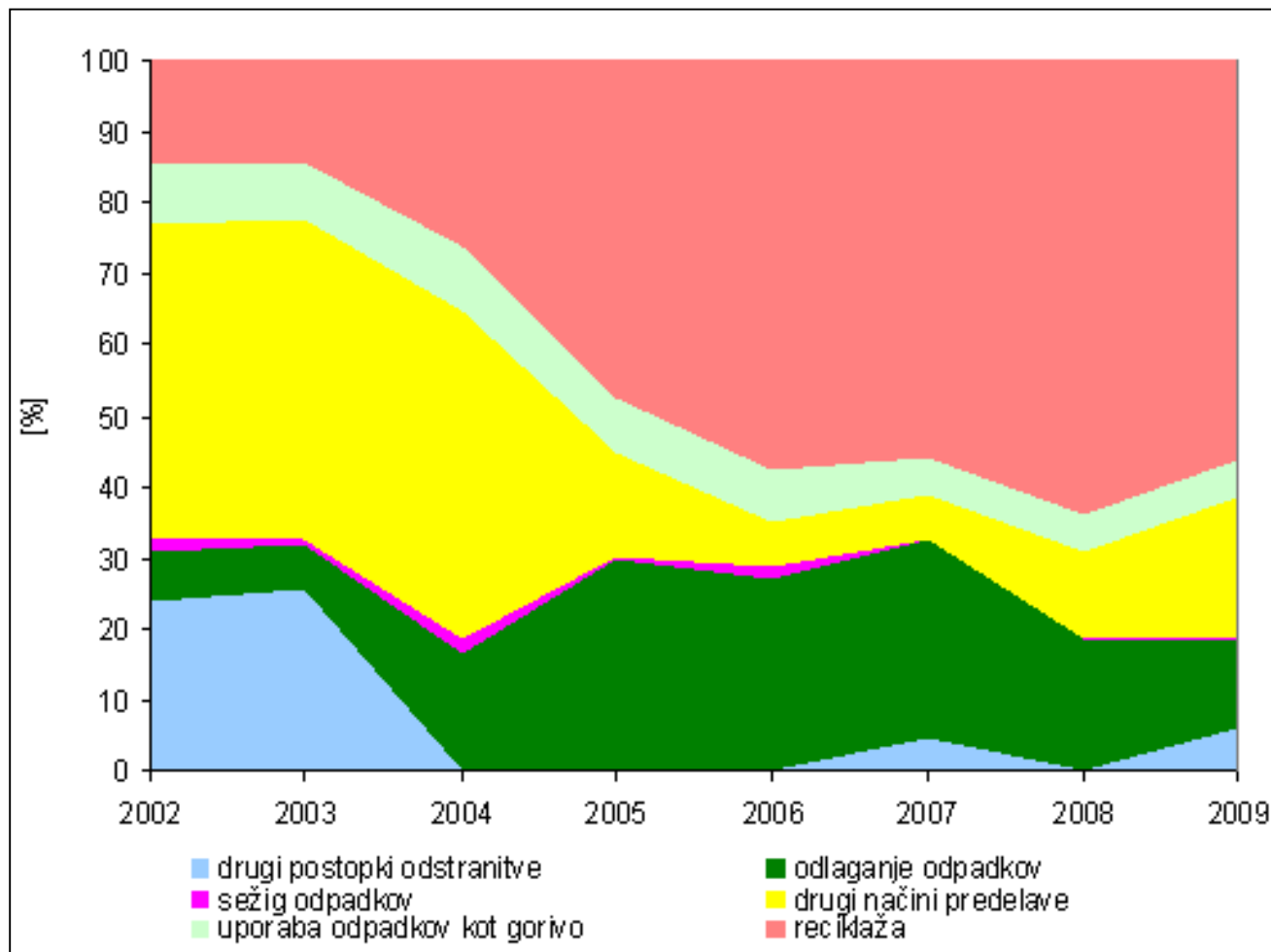
(Vir: Plastics Europe)



**The push for a circular recycling market.**

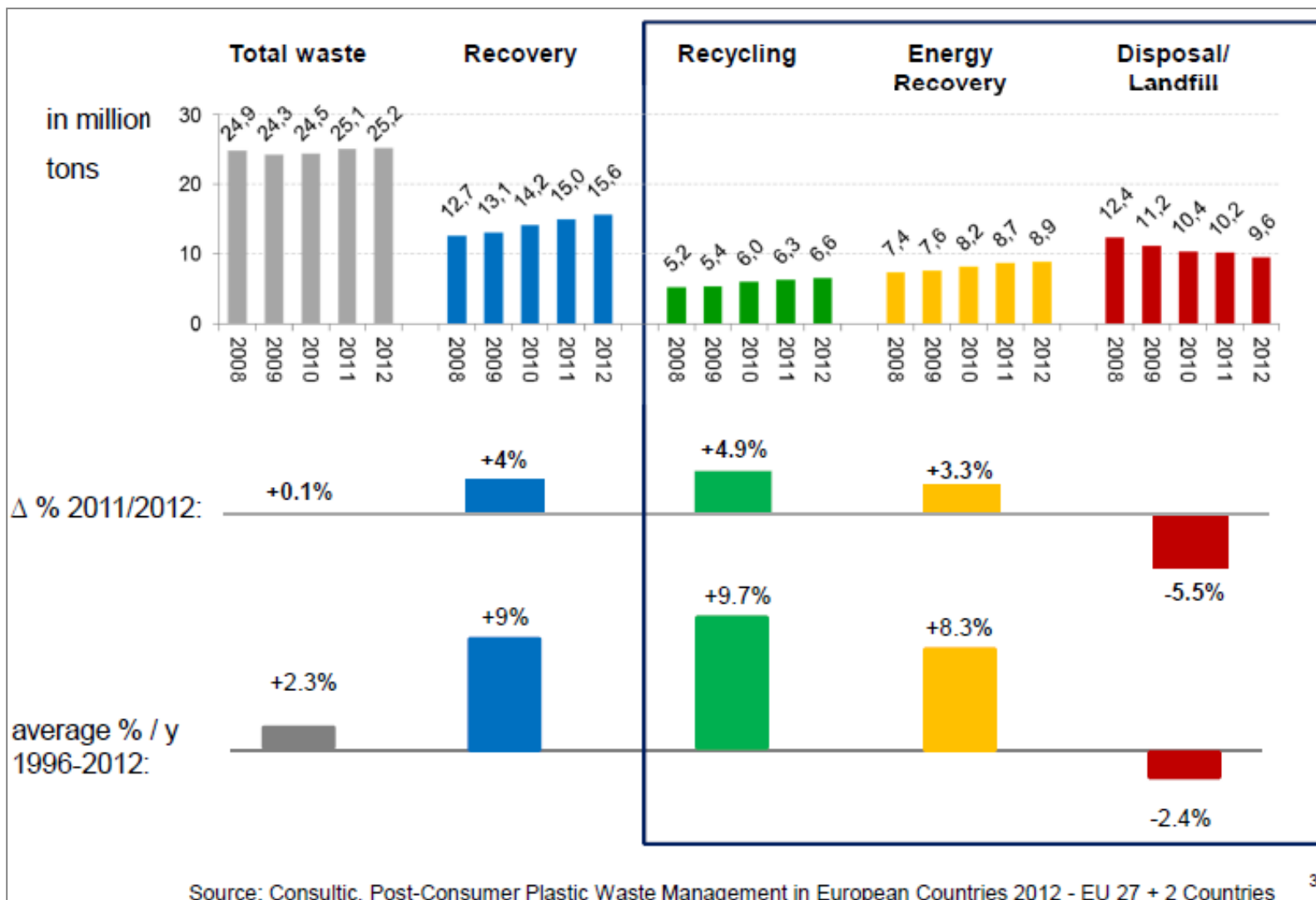
This life cycle loop shows how design thinking for an entire process can help create non-linear products (Sustainable Packaging Coalition).

## Hierarhija ravnanja z odpadki in realnost v Sloveniji



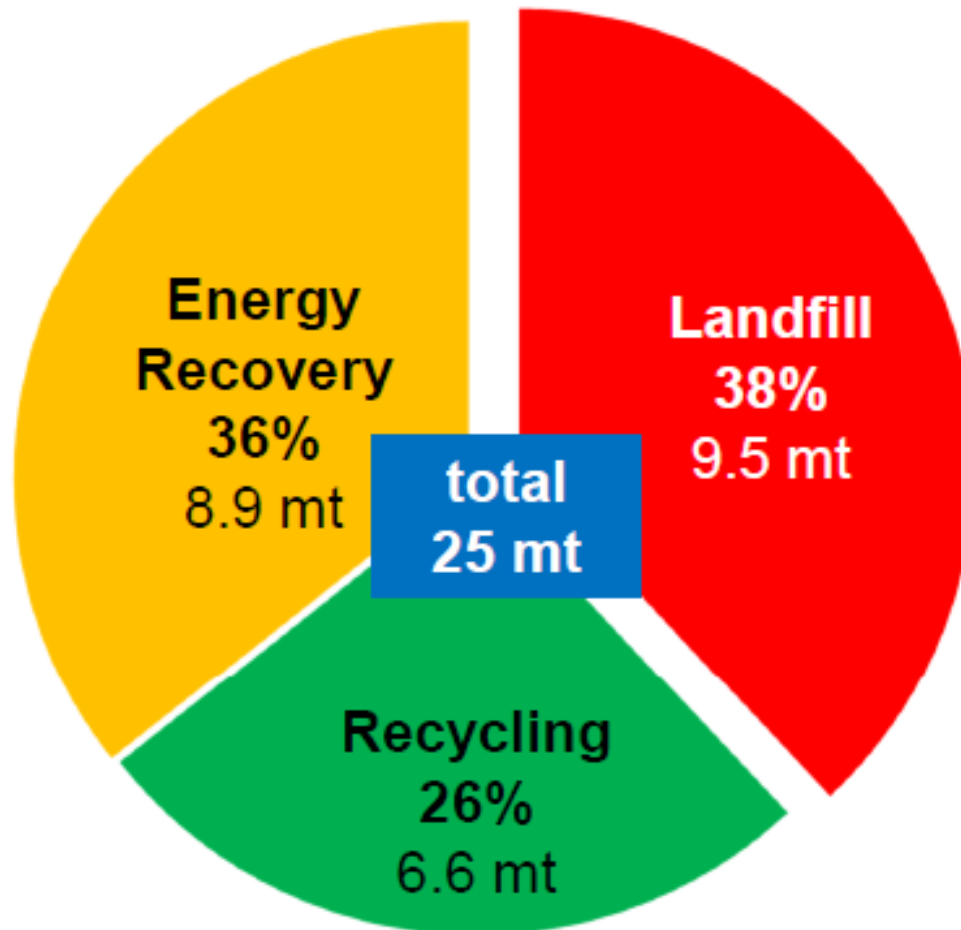
Vir: ARSO

# Obdelava plastičnih odpadkov v Evropi





## Obdelava plastičnih odpadkov v Evropi

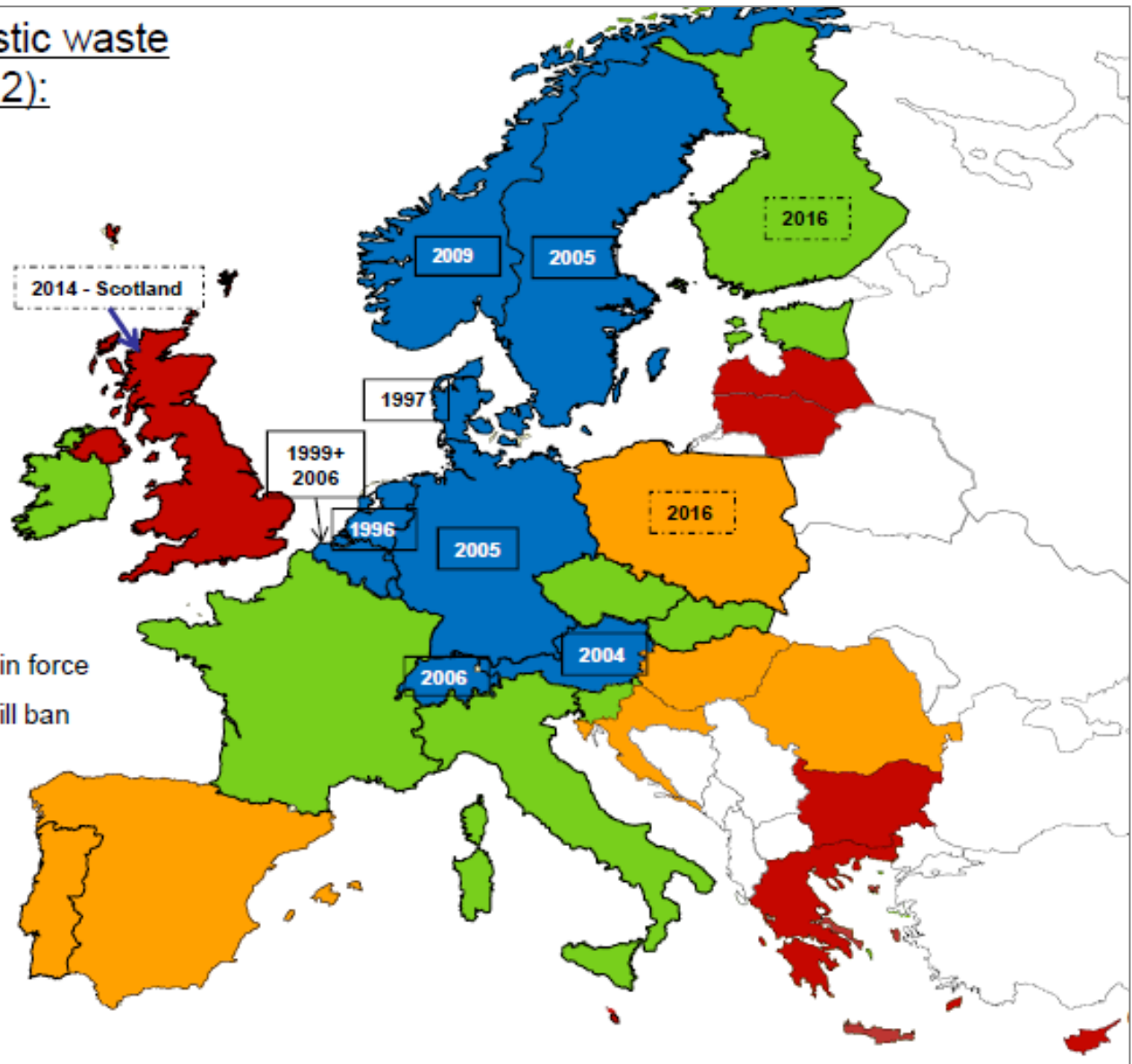




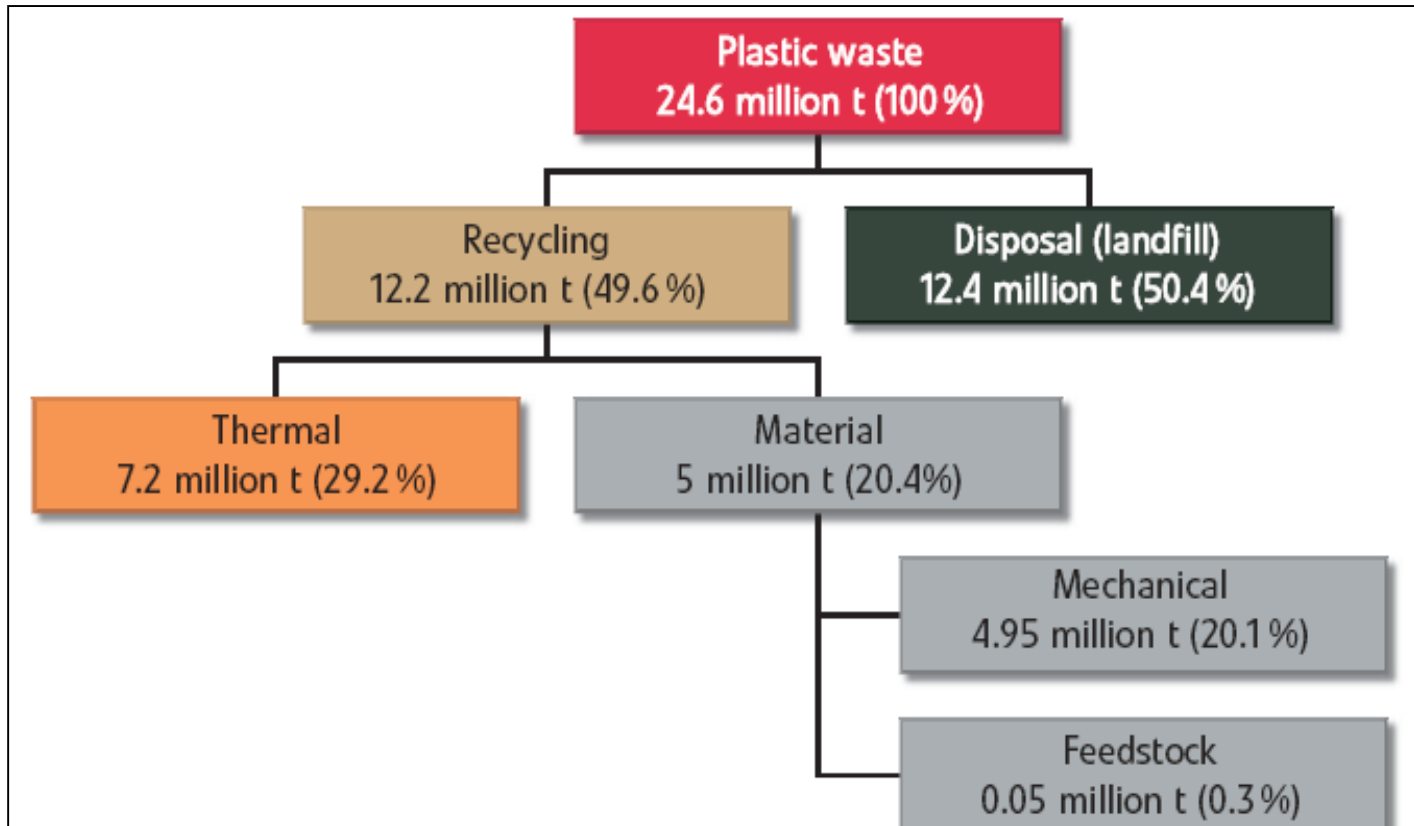
# Post-Consumer Plastic waste going to landfill (2012):

- above 66%
- >50% to 66%
- 33% to 50%
- below 10%,  
i.e. landfill ban

- Date of landfill ban in force
- Date of future landfill ban

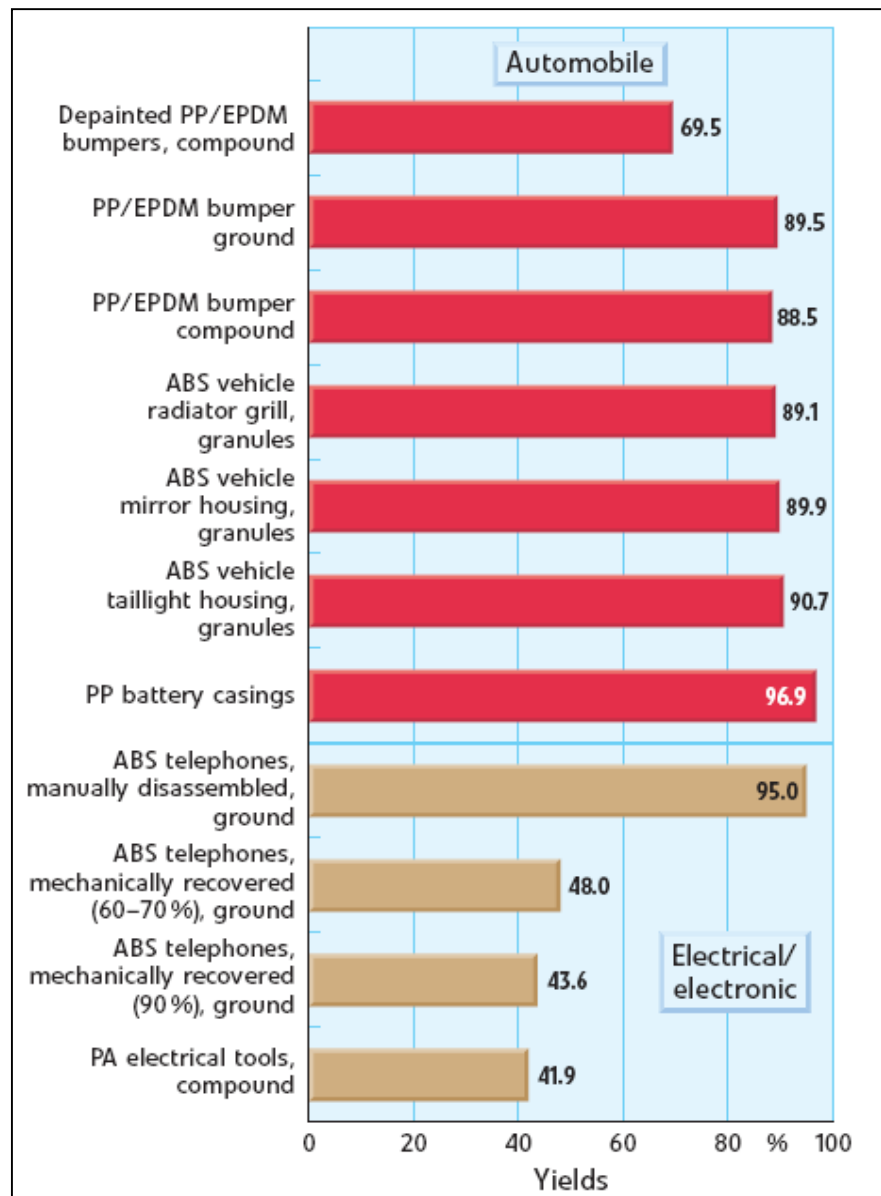


# Količina plastičnih odpadkov v Evropi in načini recikliranja



*Plastični odpadki v Evropi*

**Največ se reciklirajo PP-baterije in blatniki, ABS, radiatorji, ogledala, luči in telefoni.**



**Comparisons of the yields for EE and auto**

# Večino še vedno zavržemo ali podarimo, celo industrijsko embalažo

Slovenia 2011 Applications	Total Generation			Recovery in kt				Disposal in kt		
	kt	kg/cap.	%	Total	Mechanical Recycling	Feedstock Recycling	Energy Recovery	Total	Landfill	Incineration without efw
Packaging	54	26	63,6%	25	20	0	5	29	29	0
Building/Construction	4	2	4,7%	0	0	0	0	4	4	0
Automotive	3	1	3,3%	1	1	0	0	2	2	0
Electrical/ Electronics (WEEE)	5	3	6,2%	1	0	0	1	4	4	0
House wares, Leisure, Sports etc.	5	2	5,5%	0	0	0	0	4	4	0
Agriculture	2	1	2,8%	0	0	0	0	2	2	0
Others (Furniture etc.)	12	6	13,8%	1	0	0	1	10	10	0
<b>Total</b>	<b>84</b>	<b>41</b>	<b>100%</b>	<b>29</b>	<b>22</b>	<b>0</b>	<b>7</b>	<b>56</b>	<b>56</b>	<b>0</b>
				34%	26%	0%	8%	66%	66%	0%

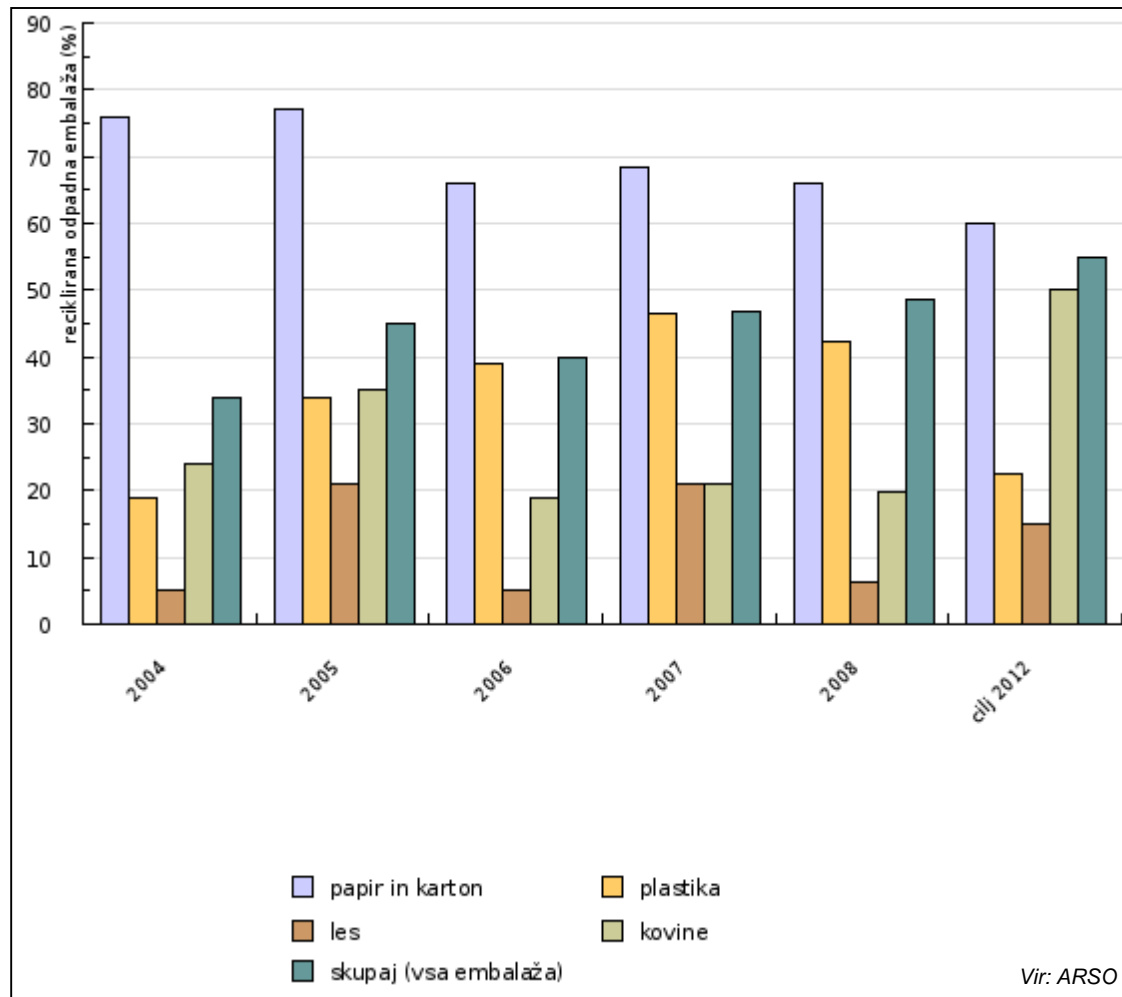


<b>Recovery Rate:</b>	<b>34%</b>
• <b>Recycling Rate</b>	<b>26%</b>
- Mechanical Recycling	26%
- Feedstock Recycling	0%
• <b>Energy Recovery</b>	<b>8%</b>
<b>Disposal Rate:</b>	<b>66%</b>
• <b>Landfill</b>	<b>66%</b>

Slovenia 2011 Applications	Total Generation	Recovery in kt				Disposal in kt		
	in kt	Total	Mechanical Recycling	Feed stock Recycling	Energy Recovery	Total	Landfill	Incineration without EfW
Packaging	54	25	20	0	5	29	29	0
Household Packaging	34	10	7	0	3	24	24	0
Industrial Packaging	19	15	13	0	2	4	4	0

- Plastic waste grew by 2,8 %.
- The landfilling of mixed waste is not allowed without pretreatment or sorting.
- Still the majority of the plastic waste is going to landfill.
- Two plants have the permission to (co-)incinerate plastic waste.

# Recikliramo predvsem papir in kovine



# Prednosti recikliranja

## Advantages of Recycling

*Energy savings:*

**Iron and Steel:** requires 74% less energy. 2/3rds of steel is recycled.

**Non-Ferrous Metals:** 96% less energy, 60% of metals from scrap.

**Paper:** 36% less energy

**Plastic:** 80% less energy, only 17% is currently recovered.

*Environmental Advantages:*

**Less pollution**

**Reduced greenhouse gas emissions**

**Conserves natural resources** wood, water, and minerals. With a recycling rate of 30%, we save *about 256 billion barrels of crude oil*, the equivalent of 22 million cars per year.

*Economic Advantages:*

**Dramatic energy savings**

**Job creation:** 1.1 million U.S. payroll of \$37 billion.

**Supports vital industries:** paper and steel, plastics converters.

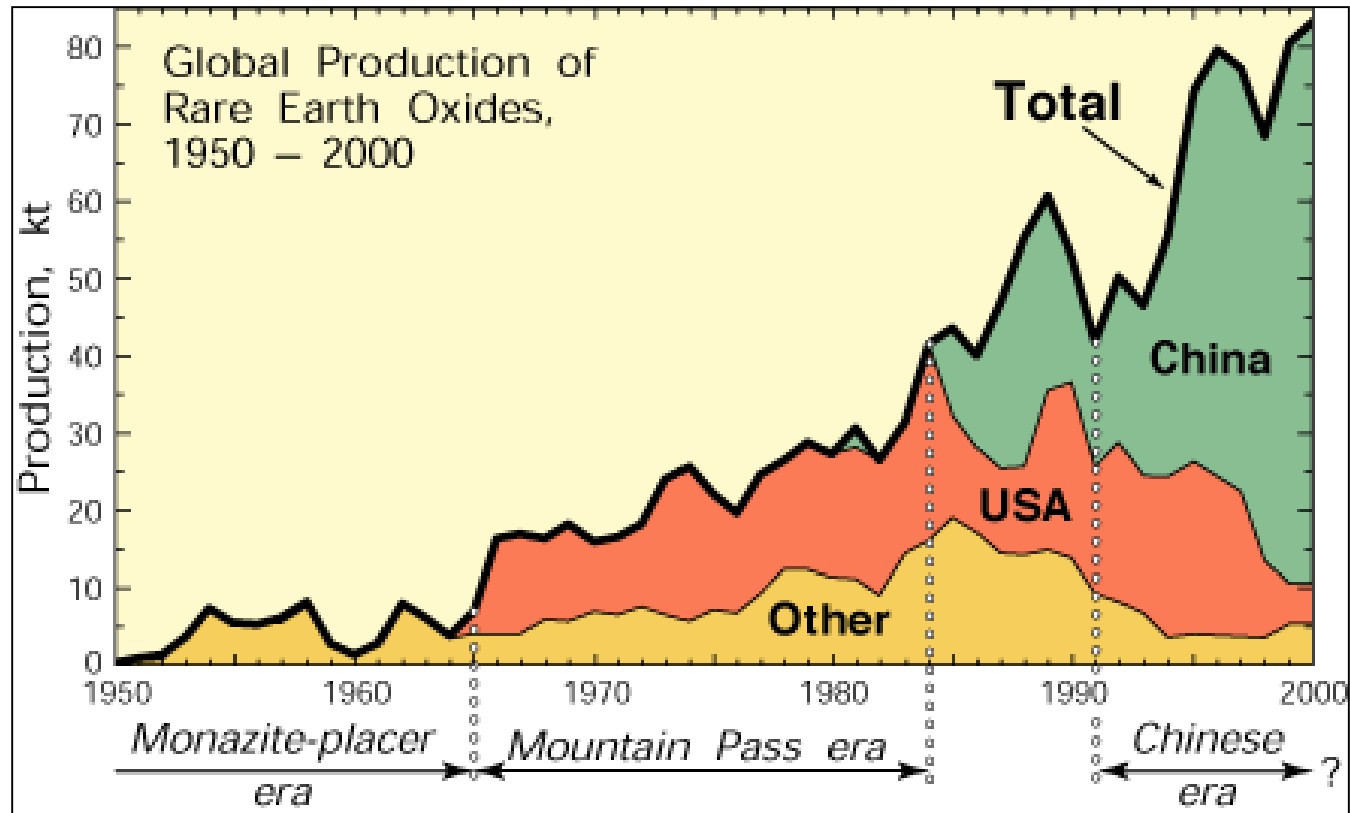
**Saves money:** selling recycled materials, towns reduce the use of fuels.



Advanced materials  
Recycling

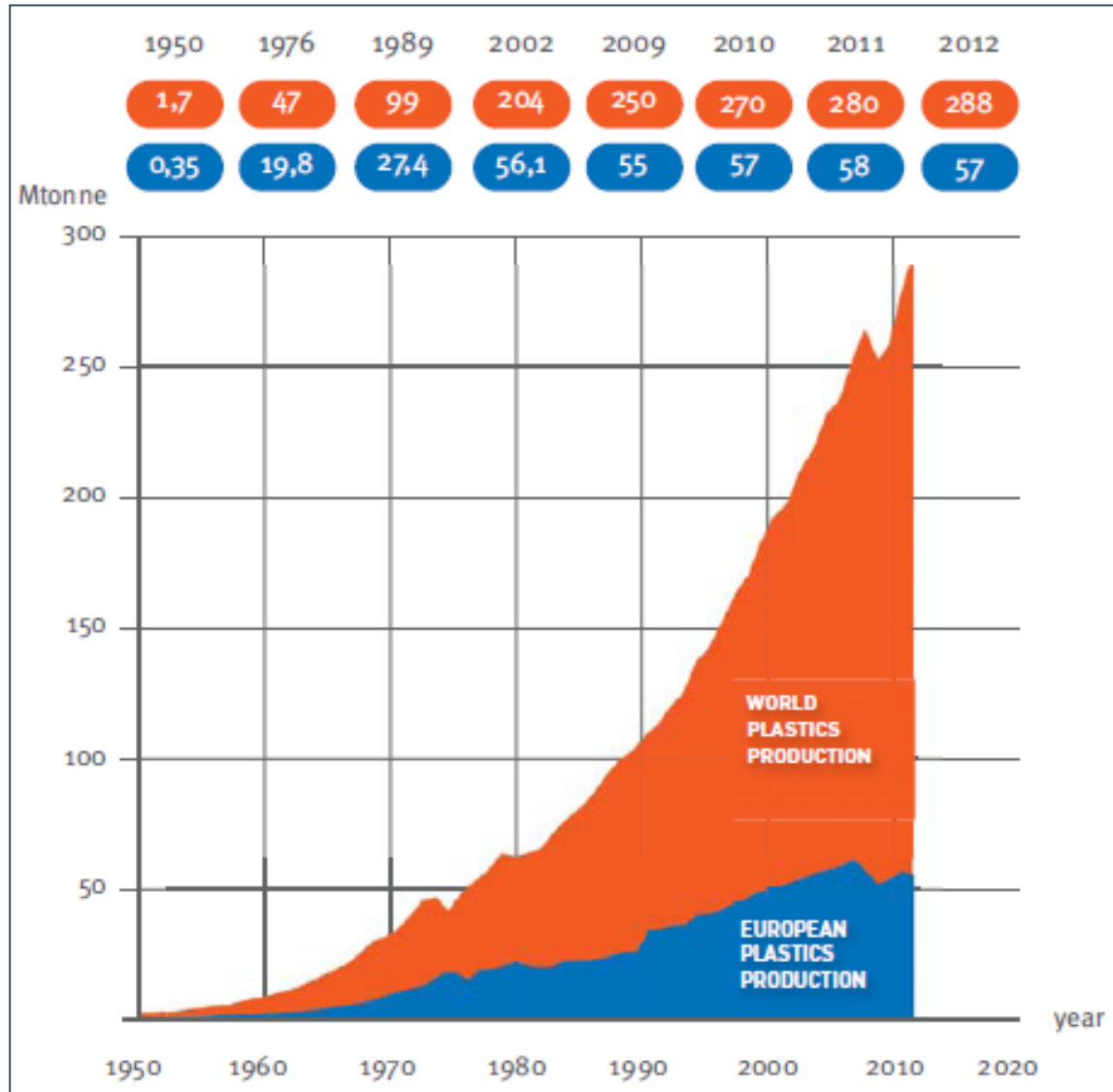
# Kitajska nam prodaja iste drage materiale po večkrat.

## “Our Green Economy is ‘Made in China’”



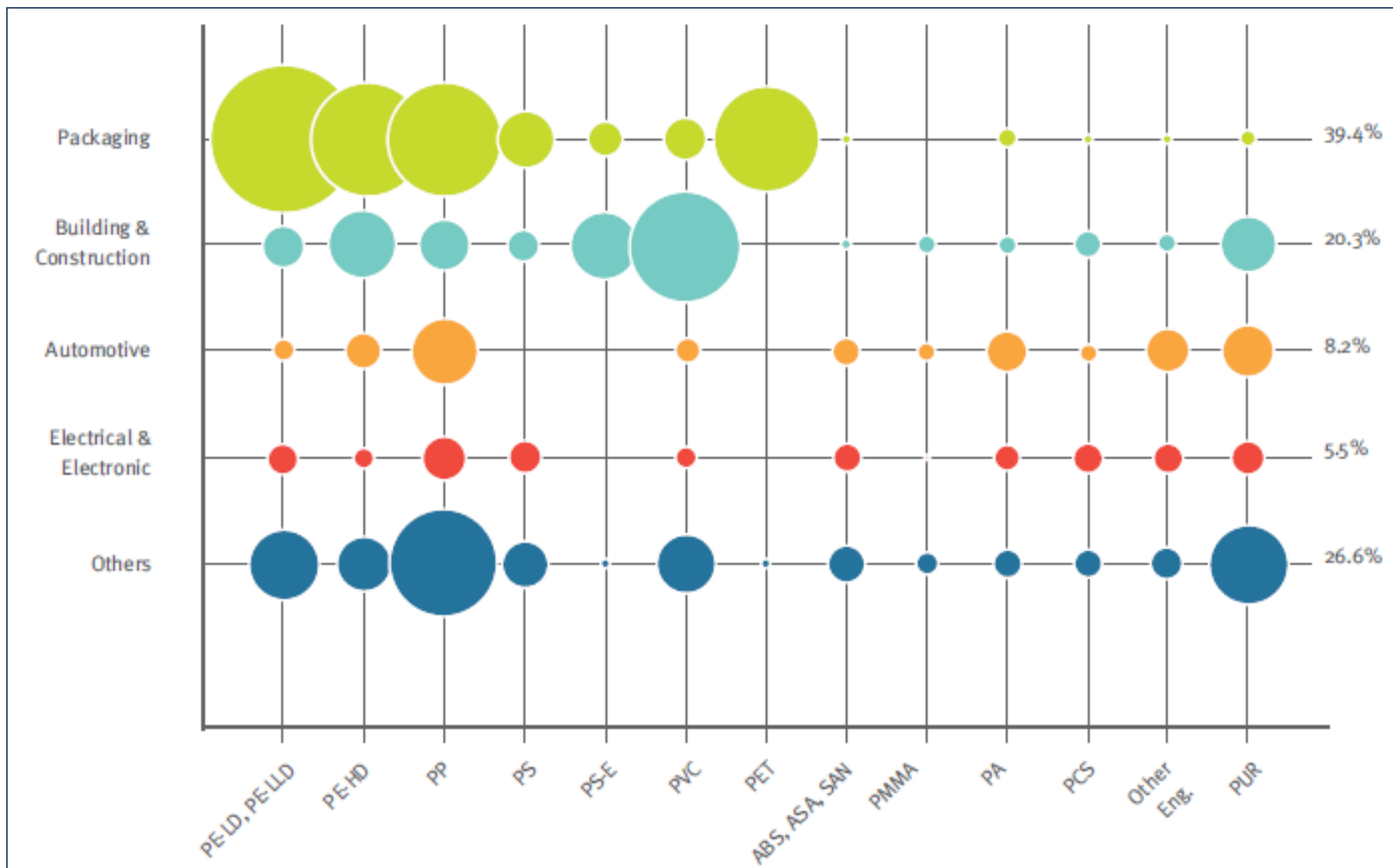
# Svetovna proizvodnja plastike 1950-2012

Neprekinjena rast več kot 60 let (150 mio ton v letu 1950, 288 mio ton v letu 2012)

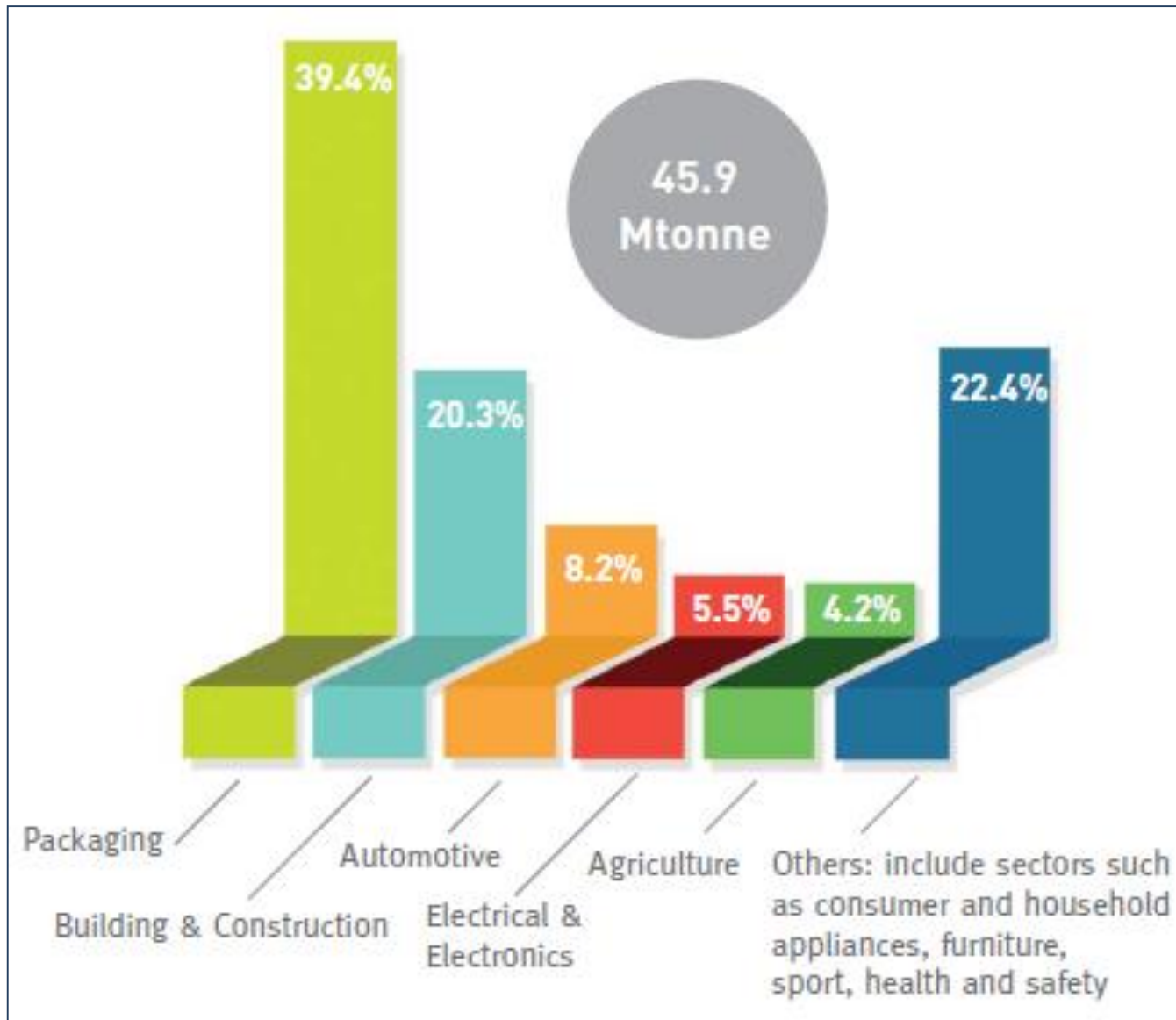




# Evropska poraba plastike po področjih in materialih (Vir: Plastics Europe)

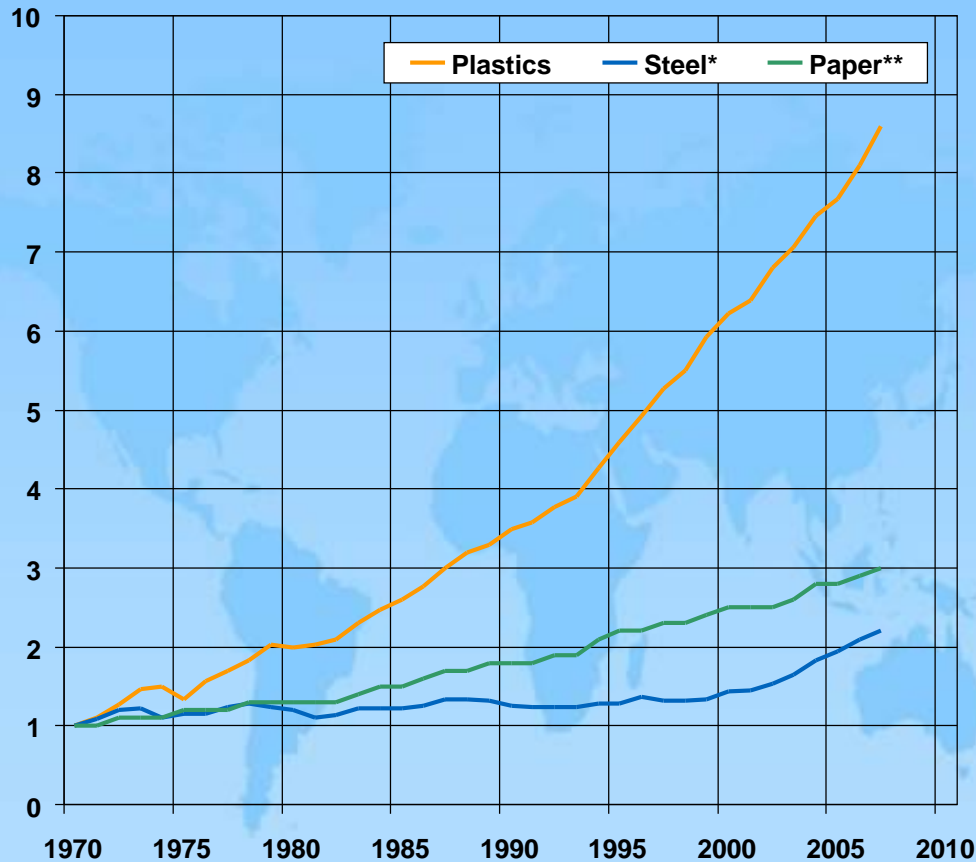


## Evropska poraba plastike po področjih, 2012 (Vir: Plastics Europe)



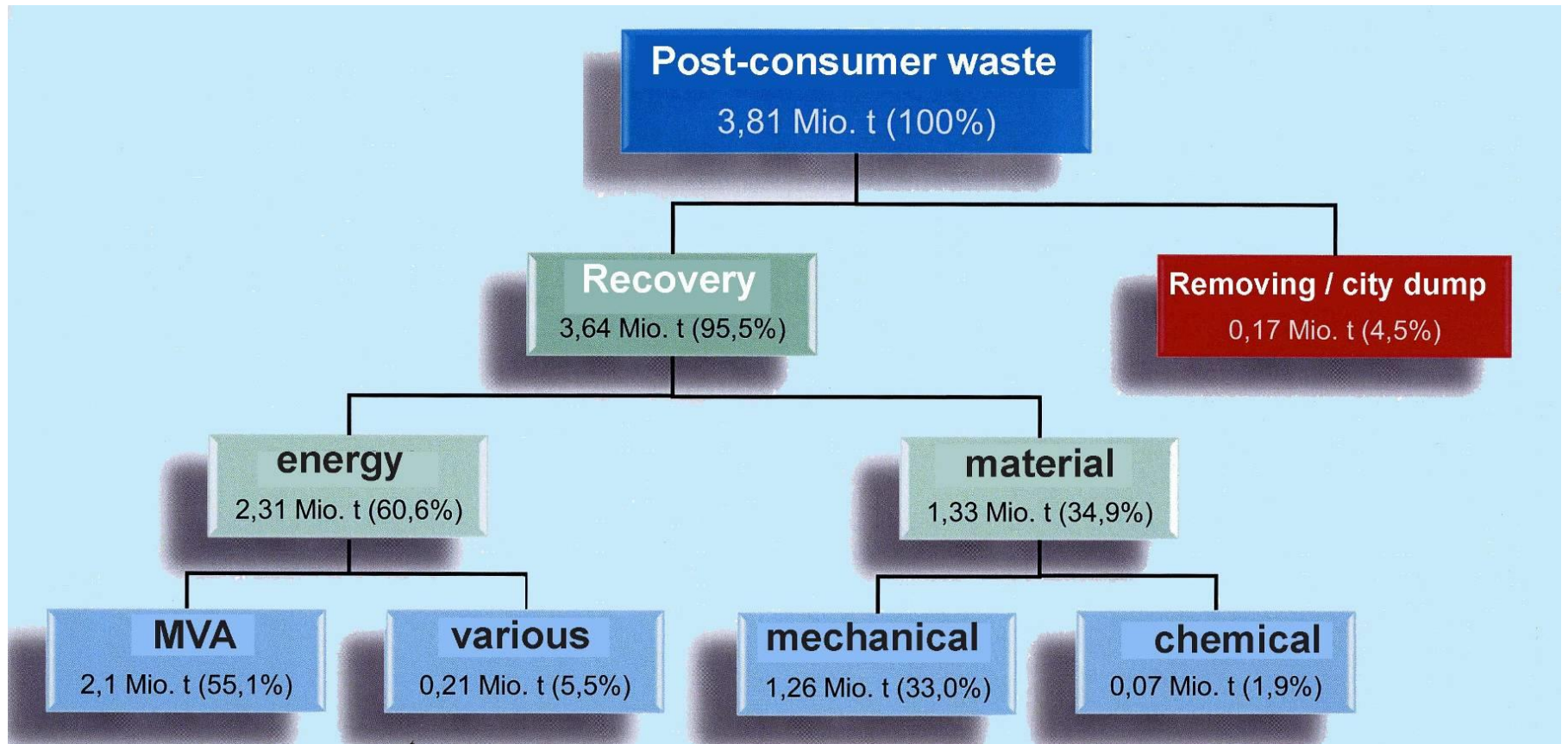
# World Benchmarking Plastics

Index: 1970 = 100

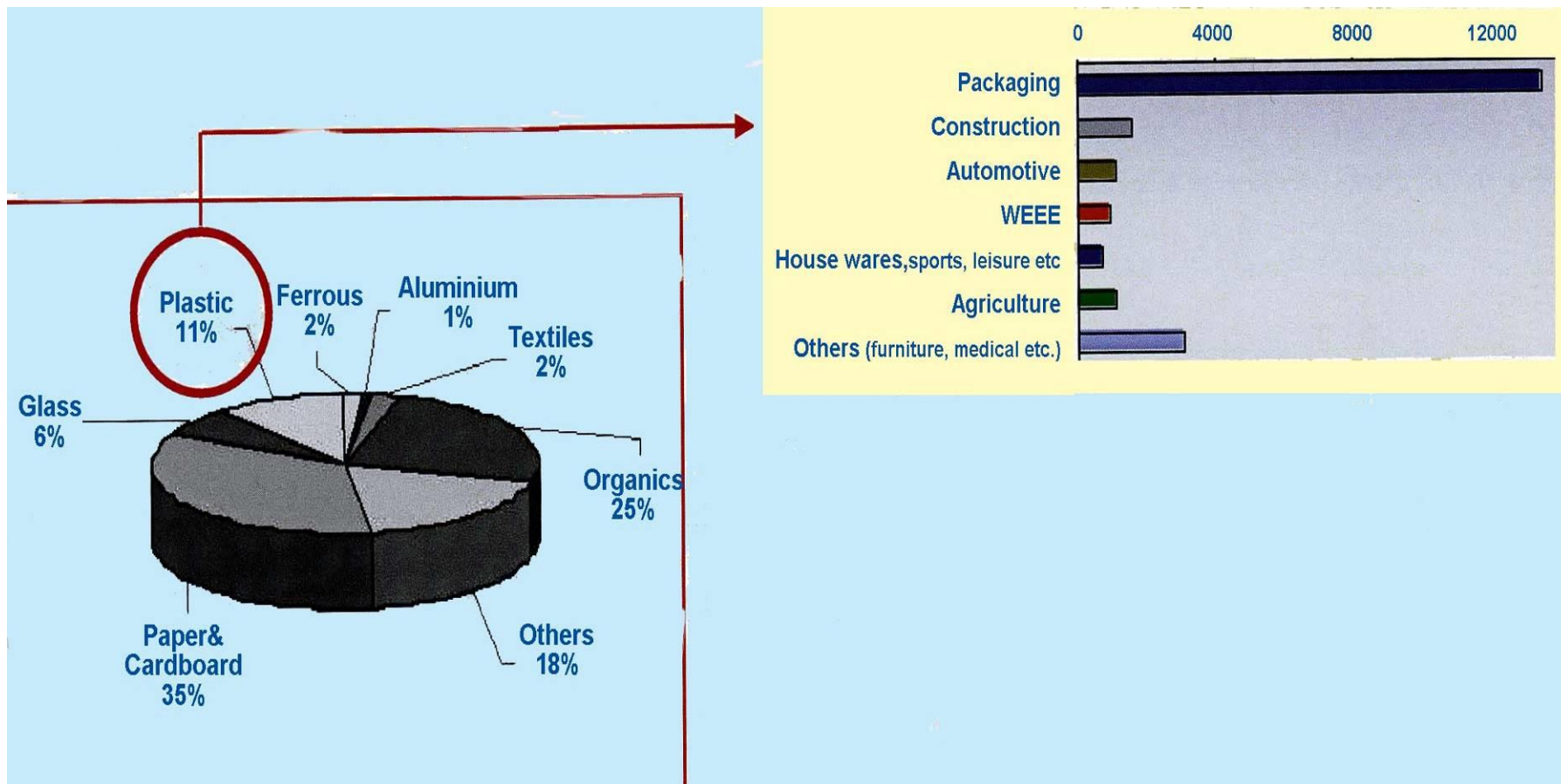


- **Plastics** have outgrown competing materials such as steel and paper
- **Compound Annual Growth Rates (CAGR):**  
Plastics 6%  
Steel 2%  
Paper 3%
- **However** – in the most recent years growth rates for steel have taken ground and increased

# Plastična embalaža

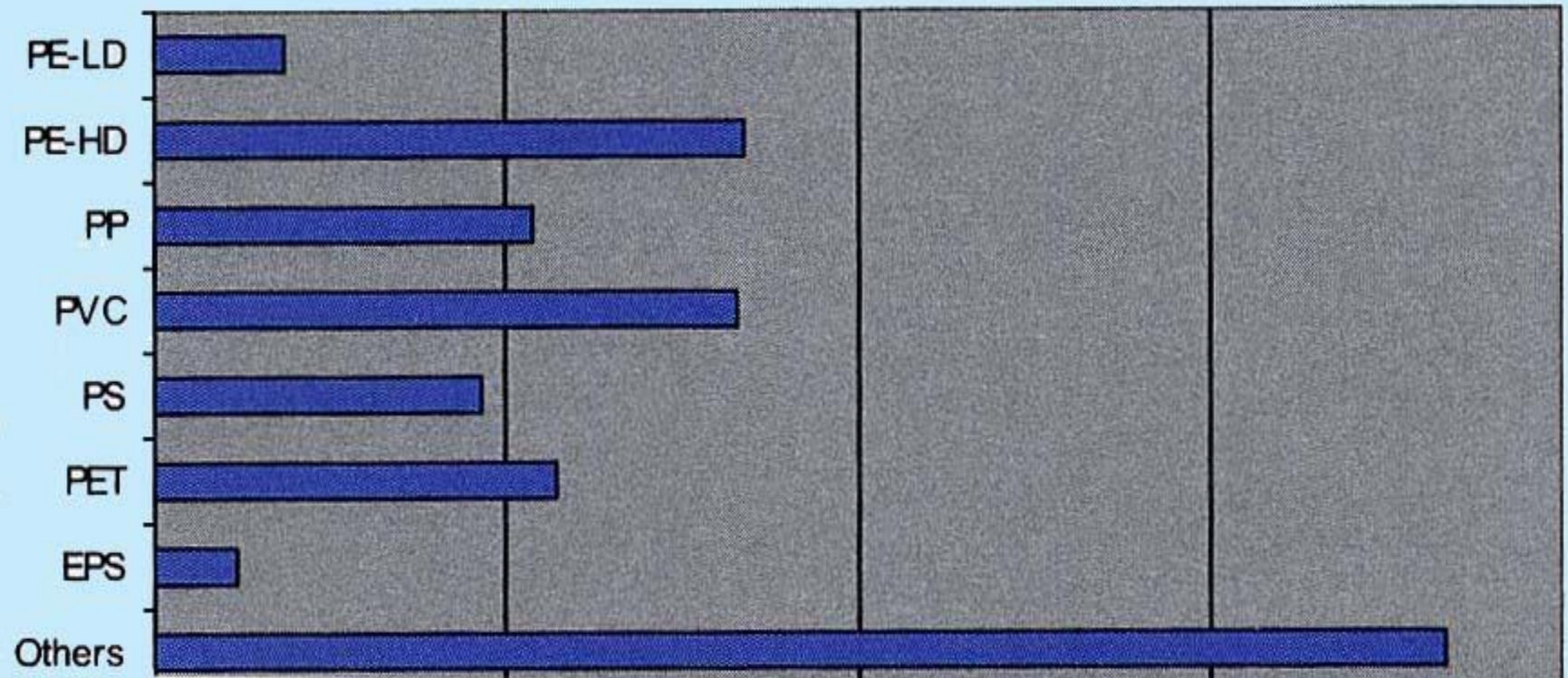


## Količine zbranih plastičnih izdelkov

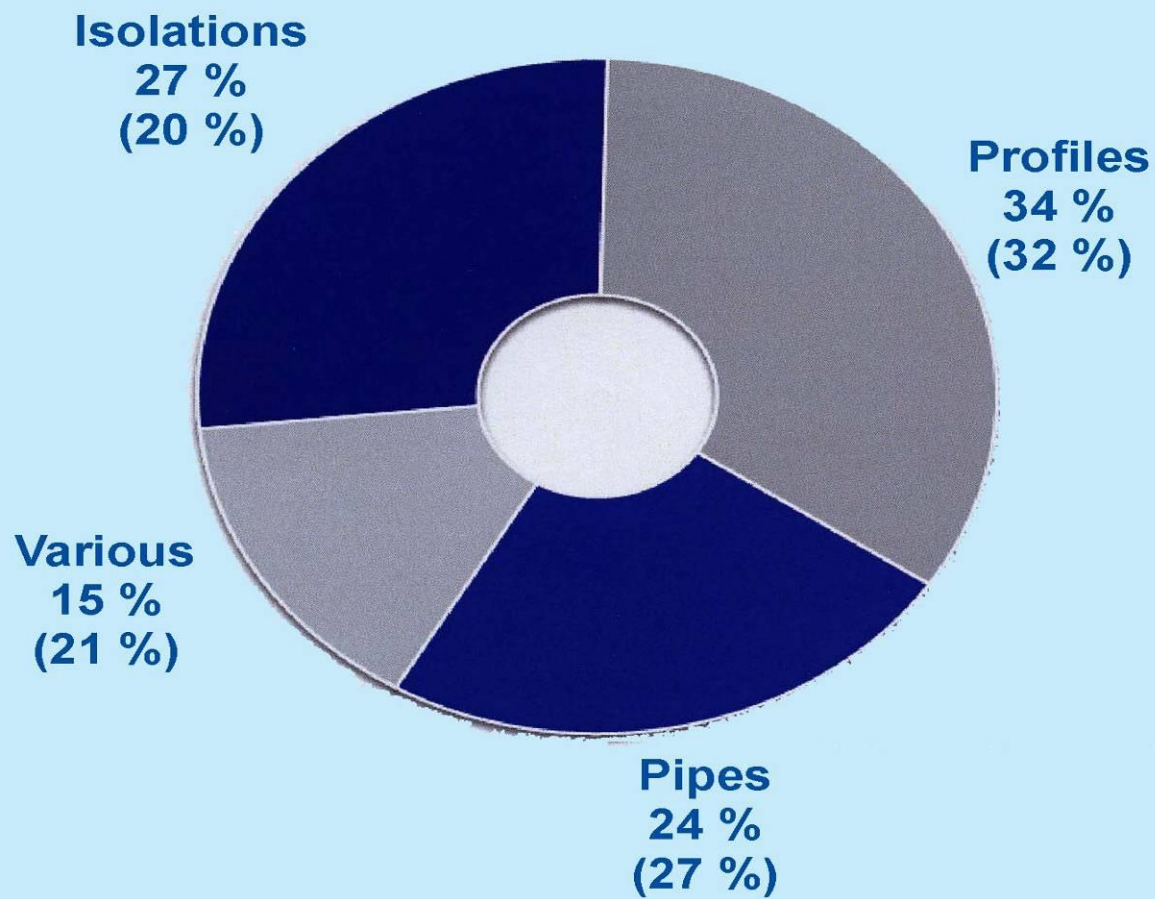




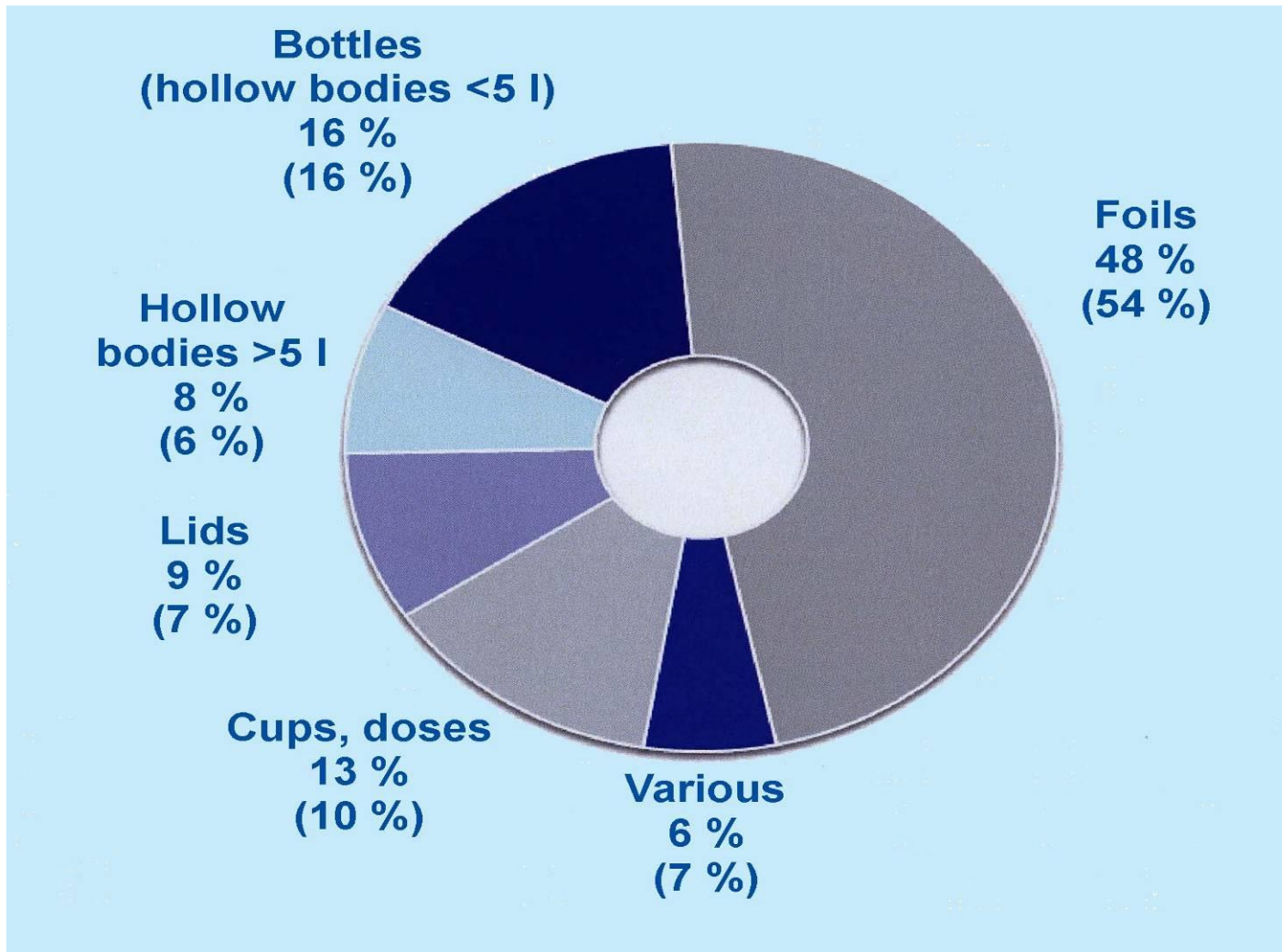
## Plastični odpadki glede na tip materiala



## Uporaba plastike v gradbeništvu

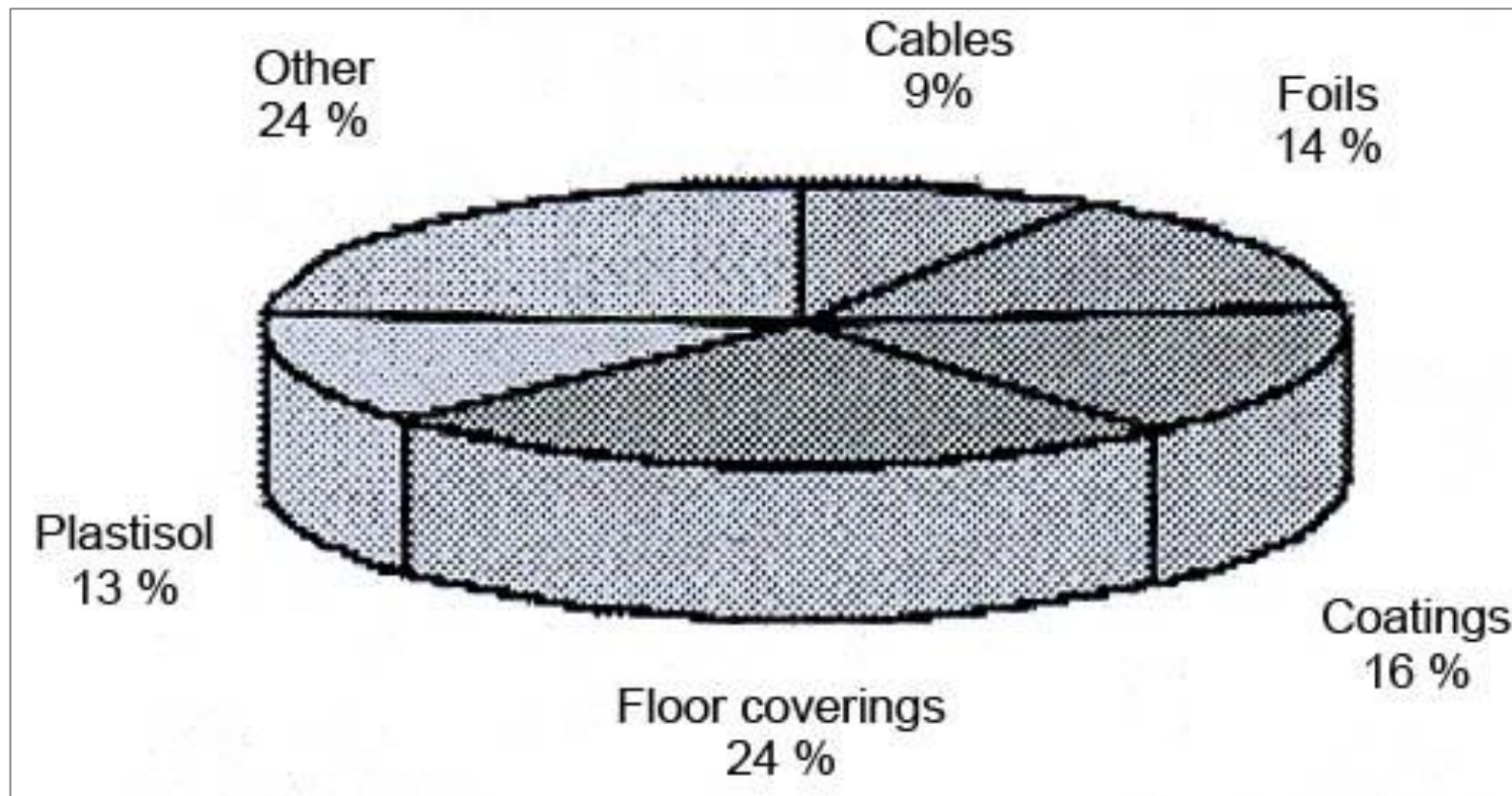


## Uporaba plastike v embalaži

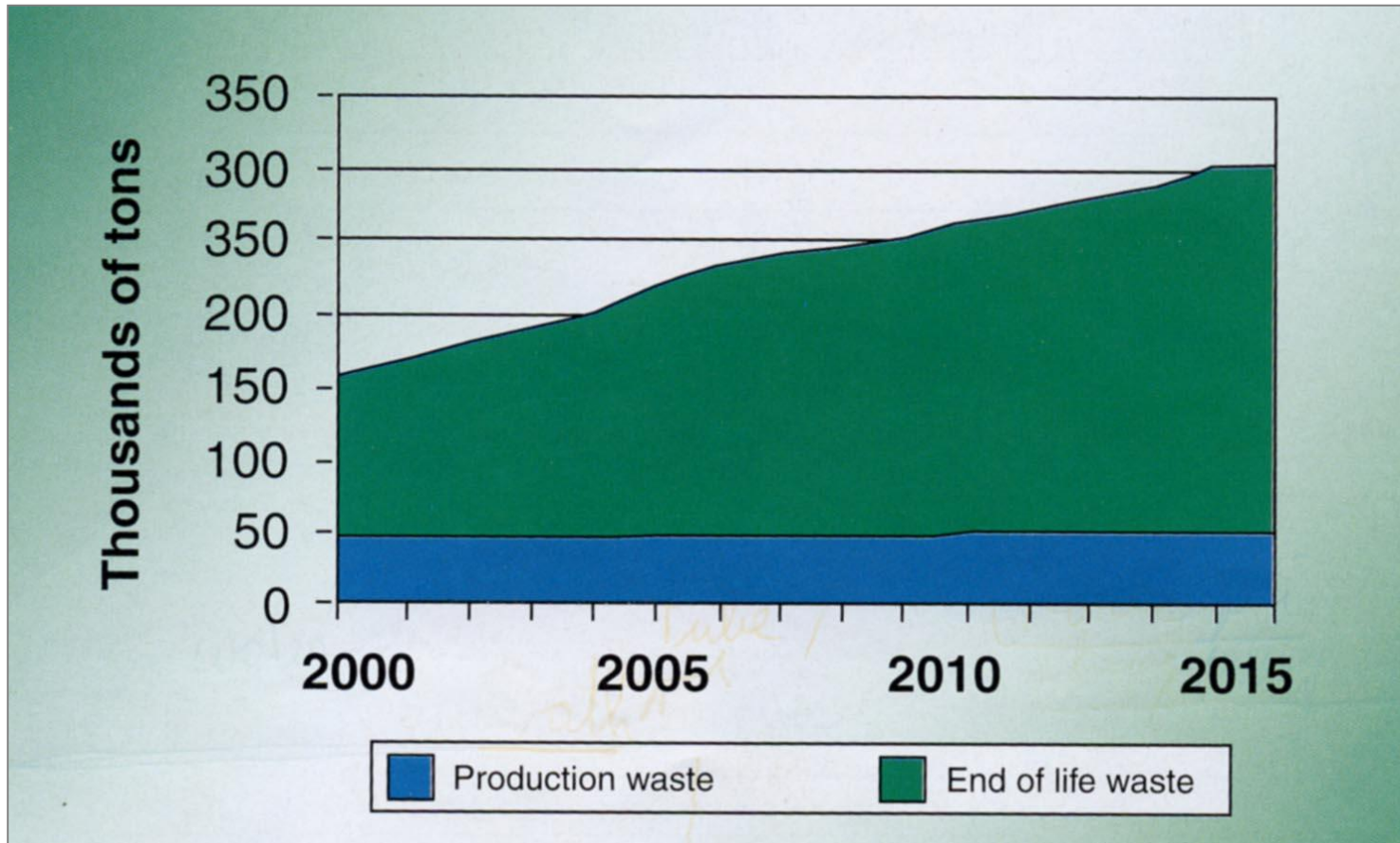




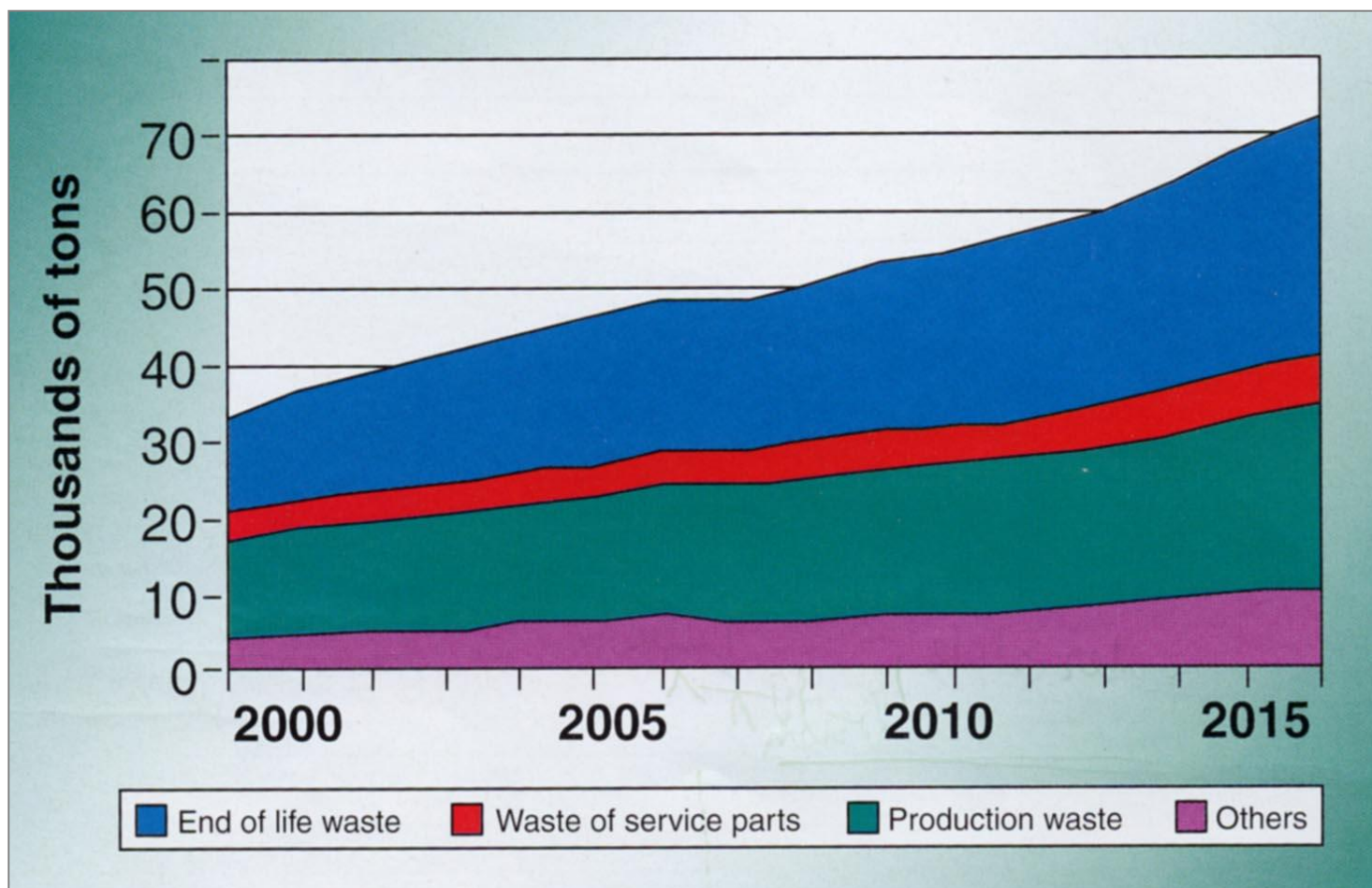
## PVC odpadki v Evropi (2.000 kt/leto)



## Kompozitni odpadki v Evropi (2000-2015)

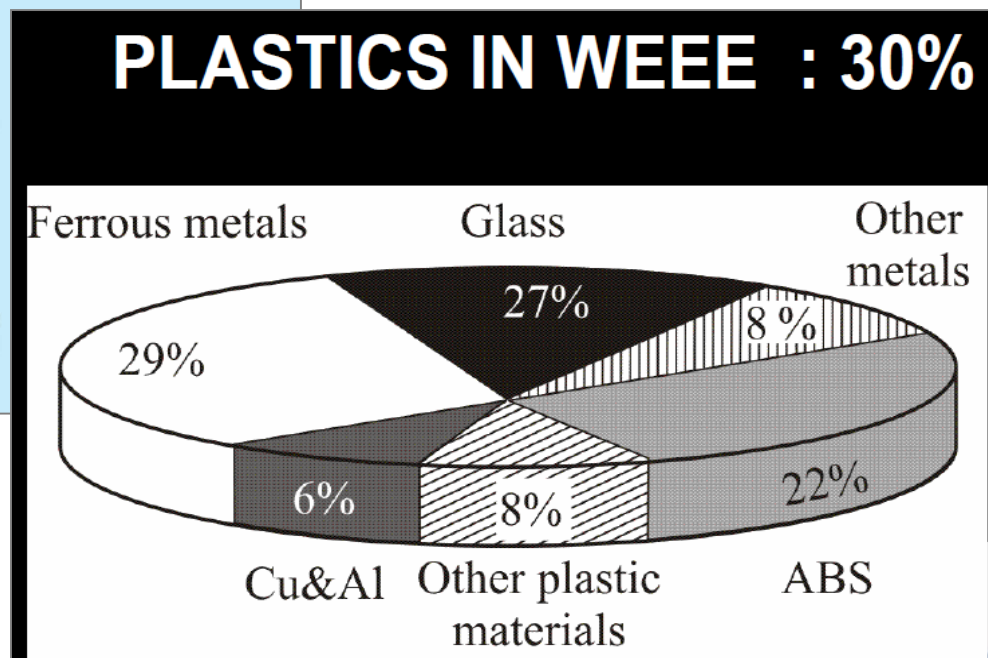
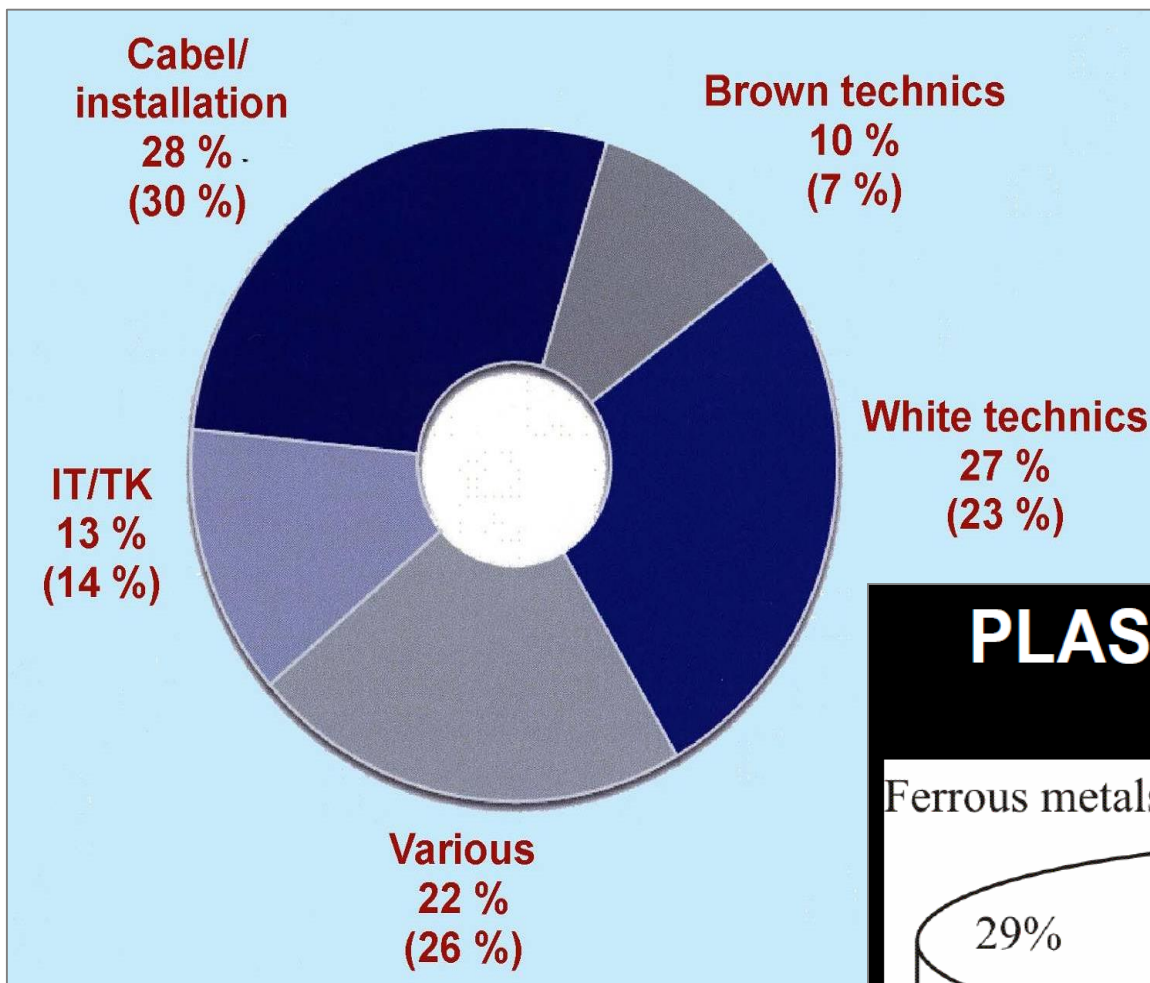


## Kompozitni odpadki v avtomobilski industriji





## Uporaba plastike v elektro/elektroniki (920 kt)



## Redke kovine

# What Can I Recycle?

### Allowed:

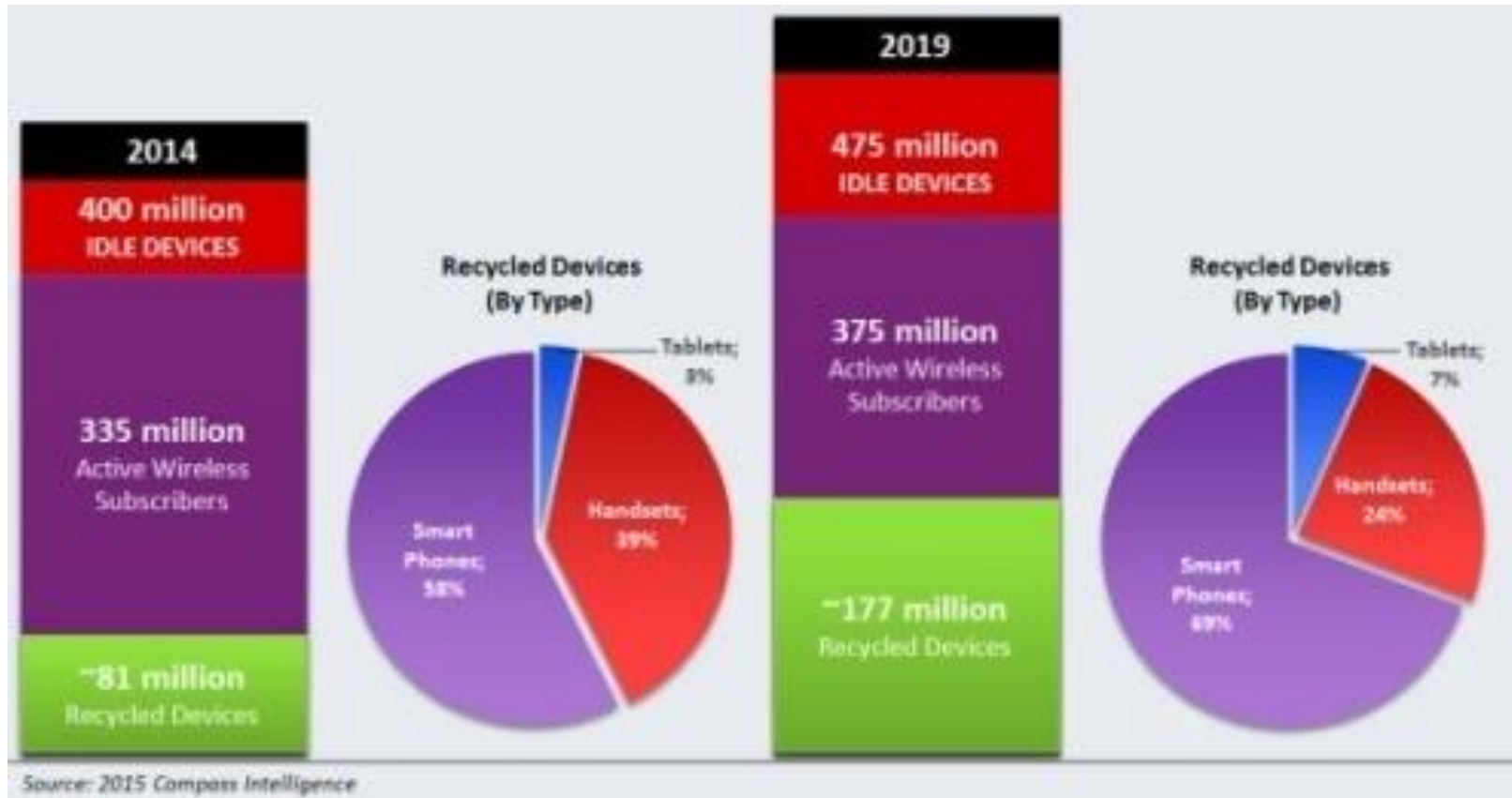
- ✓ Computers
- ✓ Monitors
- ✓ Print & Fax Machines
- ✓ Copiers
- ✓ Televisions
- ✓ DVD Players
- ✓ VCRs
- ✓ Radios & Stereos
- ✓ Telephones
- ✓ Cameras

### Not Allowed:

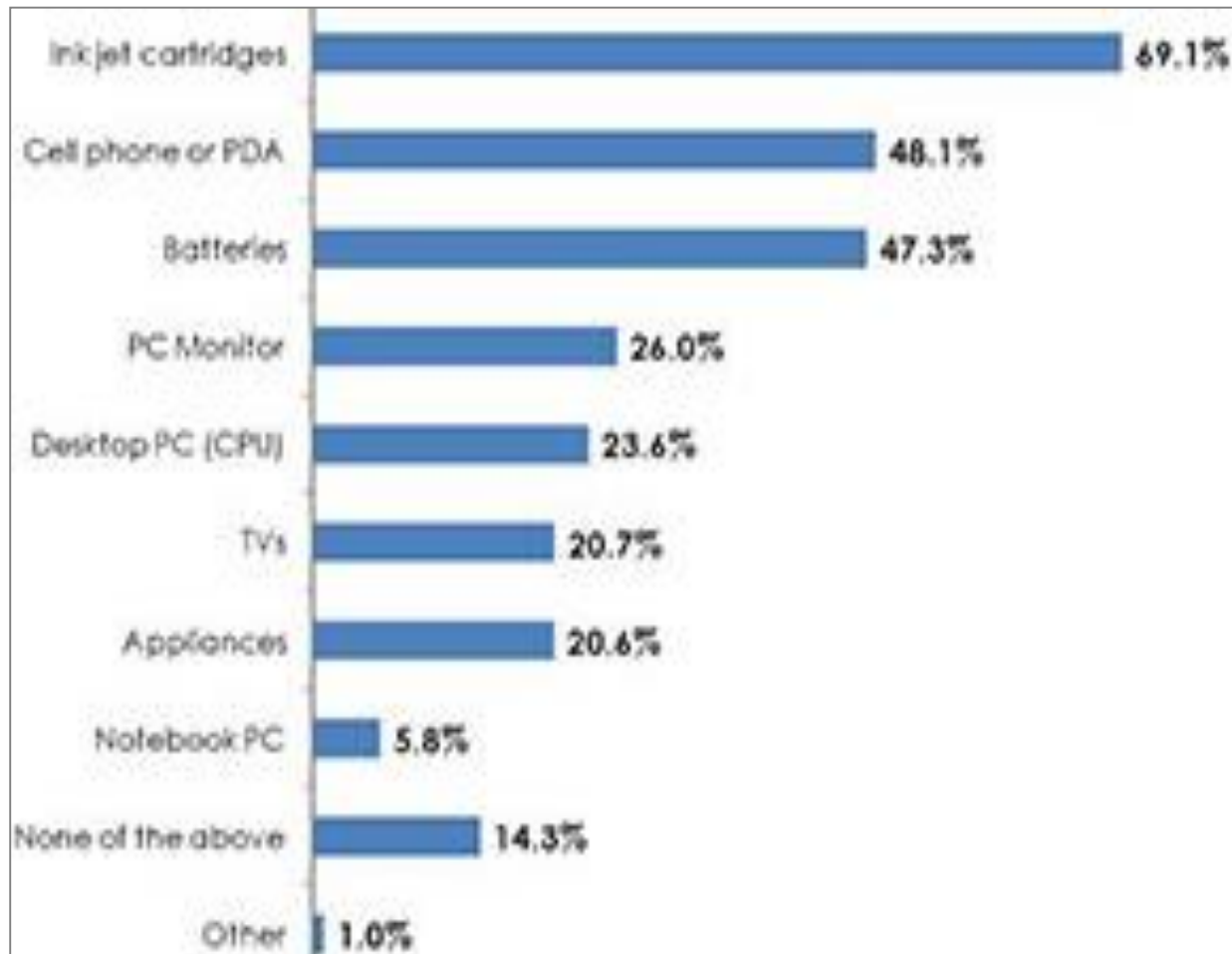
- ✗ Home Appliances
- ✗ Microwaves
- ✗ Stoves
- ✗ Refrigerators
- ✗ Air Conditioners

# Elektro/elektronika

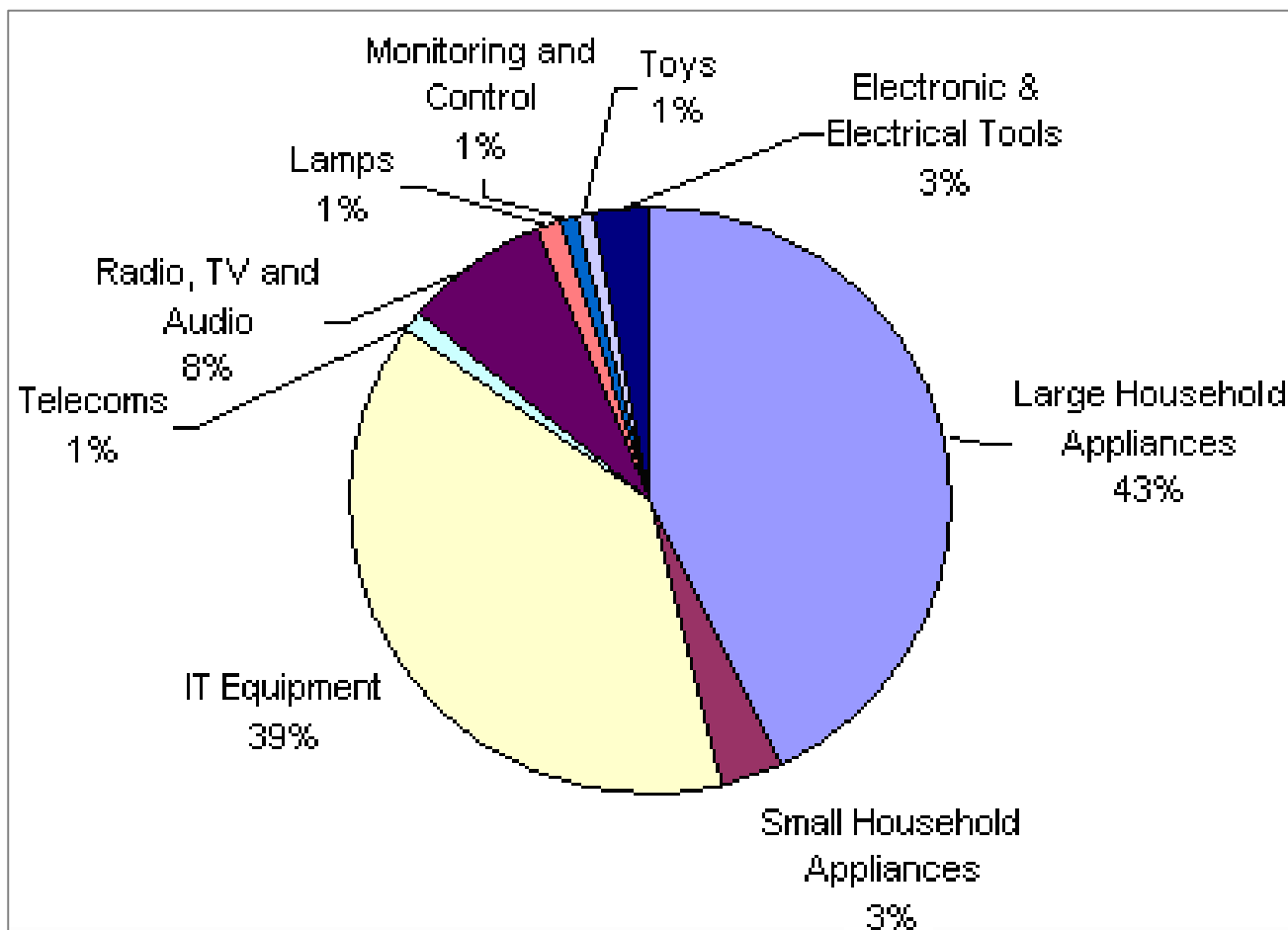
*Compass Intelligence Report Finds Mobile Device Recycling Growing Rapidly with Nearly 81 million Devices Recycled in the US in 2014*



## Potrošna elektronika- recikliranje



## Sestava EE-odpadkov





## Sestava EE-odpadkov

Equipment	Weight (t)	% of Total
Large Household Appliances	392'000	43%
Small Household Appliances	30'000	3%
IT Equipment	357'000	39%
Telecoms	8'000	1%
Radio, TV and Audio	72'000	8%
Lamps	12'000	1%
Monitoring and Control	8'000	1%
Toys	8'000	1%
Electronic & Electrical Tools	28'000	3%
<b>Total</b>	<b>915'000</b>	<b>100%</b>

# Recikliranje zahtevnih/sestavljenih materialov

Complex materials to recycle		
<u>Electronic:</u>	<u>Cars:</u>	<u>Packaging/consumption:</u>
<ul style="list-style-type: none"> <li>• Li, Ni, Cd (batteries)</li> </ul>	<ul style="list-style-type: none"> <li>• mixed PUR/textile (seats)</li> </ul>	<ul style="list-style-type: none"> <li>• Laminate PE/Al/paper (tetrapak)</li> </ul>
<ul style="list-style-type: none"> <li>• In, Sn, Ga, Se (displays)</li> </ul>	<ul style="list-style-type: none"> <li>• CRP, GRP (RTM parts)</li> </ul>	<ul style="list-style-type: none"> <li>• PVC/textile (carpets)</li> </ul>
<ul style="list-style-type: none"> <li>• Nb, La, Sa, B, Ba (magnets, EMI absorbers)</li> </ul>	<ul style="list-style-type: none"> <li>• PUR/thermoplasts (skin-, slush-, moulding)</li> </ul>	<ul style="list-style-type: none"> <li>• PVC/wax (candels)</li> </ul>
<ul style="list-style-type: none"> <li>• Si, In, Ru, Ti, Os, Pt (fotovoltic)</li> </ul>	<ul style="list-style-type: none"> <li>• Nanocomposites (MMT, CNT)</li> </ul>	<ul style="list-style-type: none"> <li>• PVC/Cu (cables)</li> </ul>
<ul style="list-style-type: none"> <li>• C/Ni, CNT, Sn, Cu (conductors)</li> </ul>	<ul style="list-style-type: none"> <li>• Rubber/textile</li> </ul>	<ul style="list-style-type: none"> <li>• GRP/thermoplast (sanitary cells)</li> </ul>
	<ul style="list-style-type: none"> <li>• Pb/thermoplasts</li> </ul>	<ul style="list-style-type: none"> <li>• Mixed textile</li> </ul>

## Redke kovine – tržni deleži

Application	2004	2005	2010	2005-2010 AAGR%
Permanent Magnets	14,509	18,093	32,178	12.2
NiMH batteries	6,200	7,200	27,300	30.5
Auto Catalysts	5,541	5,831	7,573	5.4
Fluid Cracking Catalysts	14,900	15,400	18,400	3.6
Phosphors	3,652	4,007	7,512	13.4
Glass and Ceramics	16,200	16,490	17,800	1.5
Metallurgy	9,400	10,660	16,725	9.4
Polishing Compounds	14,100	15,150	23,500	9.2
Other	3190	3,330	4,300	5.2
<b>Total</b>	<b>87,692</b>	<b>96,161</b>	<b>155,288</b>	<b>10.1</b>

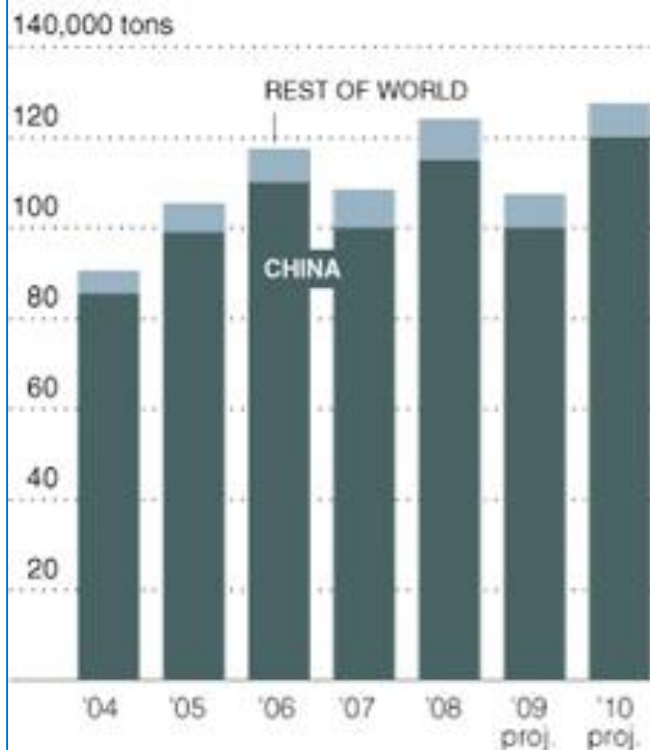
*Source: BCC Research*

# Brez (kitajskih!) naprednih materialov ni nobene industrije.

## Rare Wealth

China accounts for the vast majority of the world's production of rare earths — 17 elements — which are used in a wide array of products.

### RARE EARTH MINERAL PRODUCTION

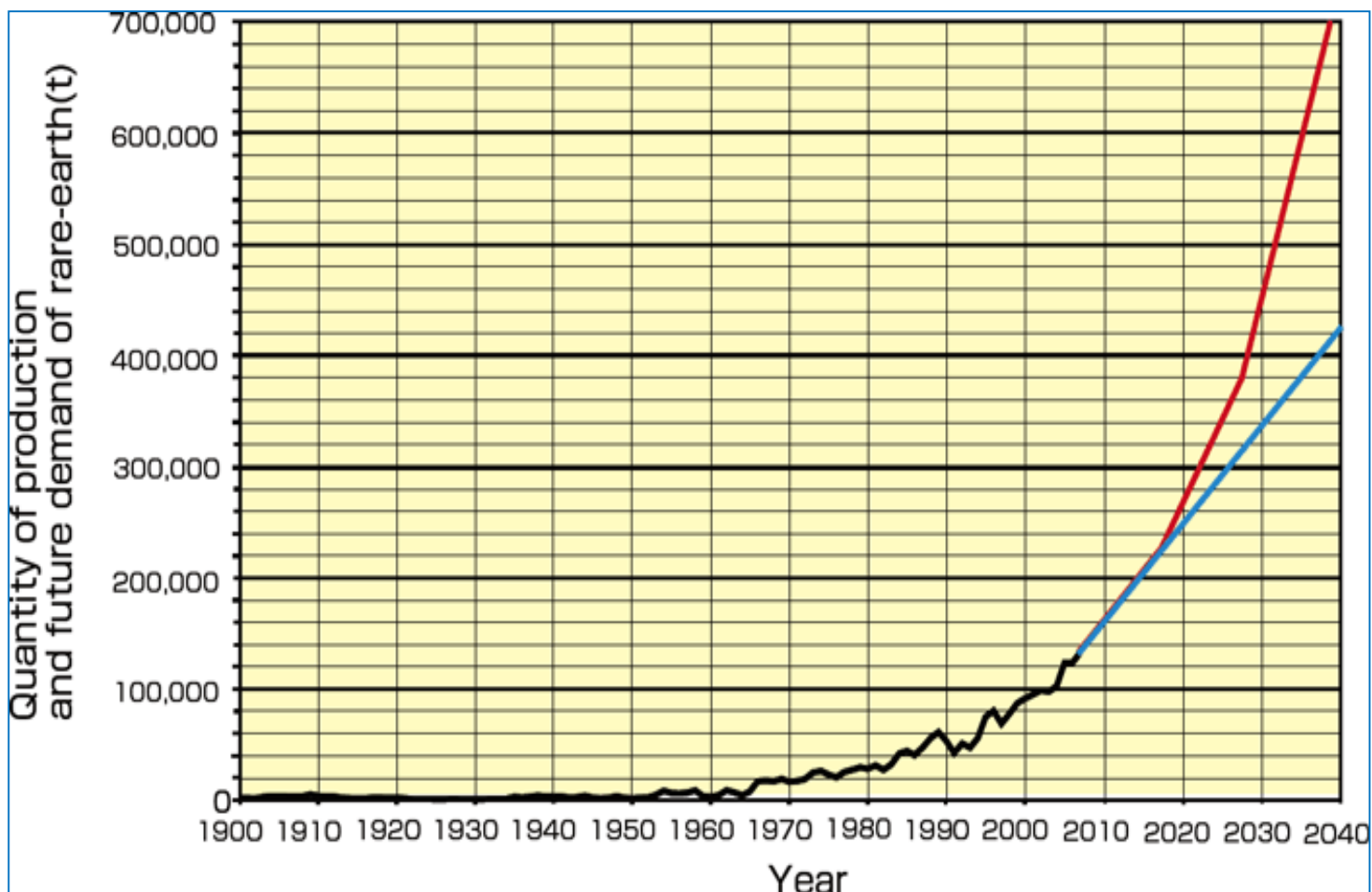


Source: Dudley J. Kingsnorth (production)

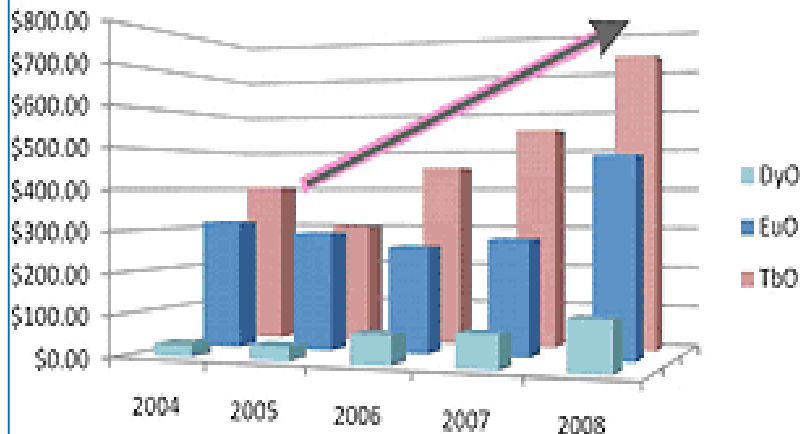
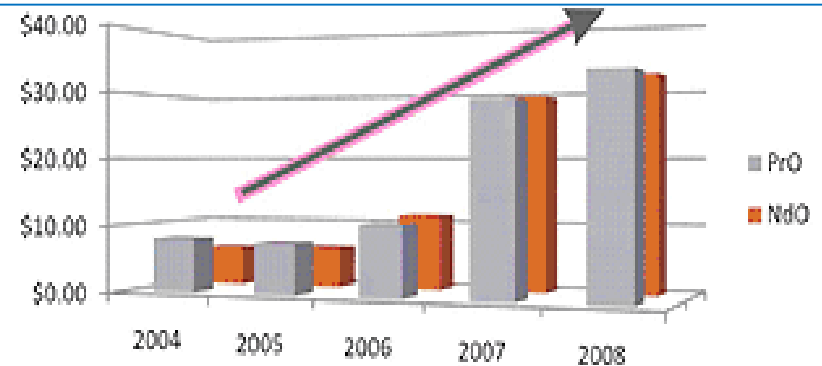
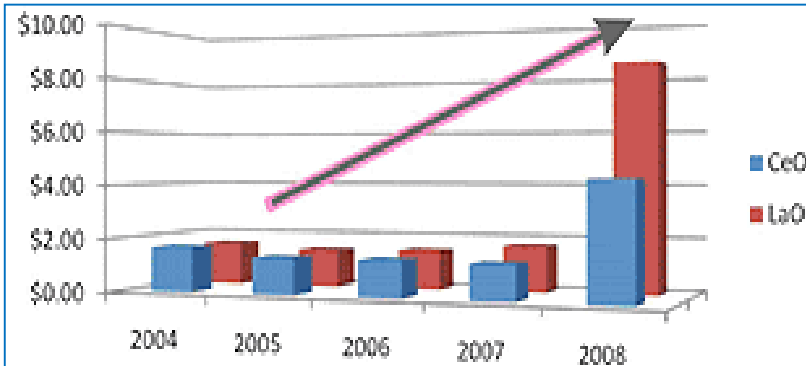
RARE EARTHS	ATOMIC NO.	COMMERICAL USE
Scandium	21	Stadium lights
Yttrium	39	Lasers
Lanthanum	57	Electric car batteries
Cerium	58	Lens polishes
Praseodymium	59	Searchlights, aircraft parts
Neodymium	60	High-strength magnets
Promethium	61	Portable X-ray units
Samarium	62	Glass
Europium	63	Compact fluorescent bulbs
Gadolinium	64	Neutron radiography
Terbium	65	High-strength magnets
Dysprosium	66	High-strength magnets
Holmium	67	Glass tint
Erbium	68	Metal alloys
Thulium	69	Lasers
Ytterbium	70	Stainless steel
Lutetium	71	None

THE NEW YORK TIMES

# Skokovita poraba redkih naprednih materialov



## Cene redkih kovin grede v nebo.

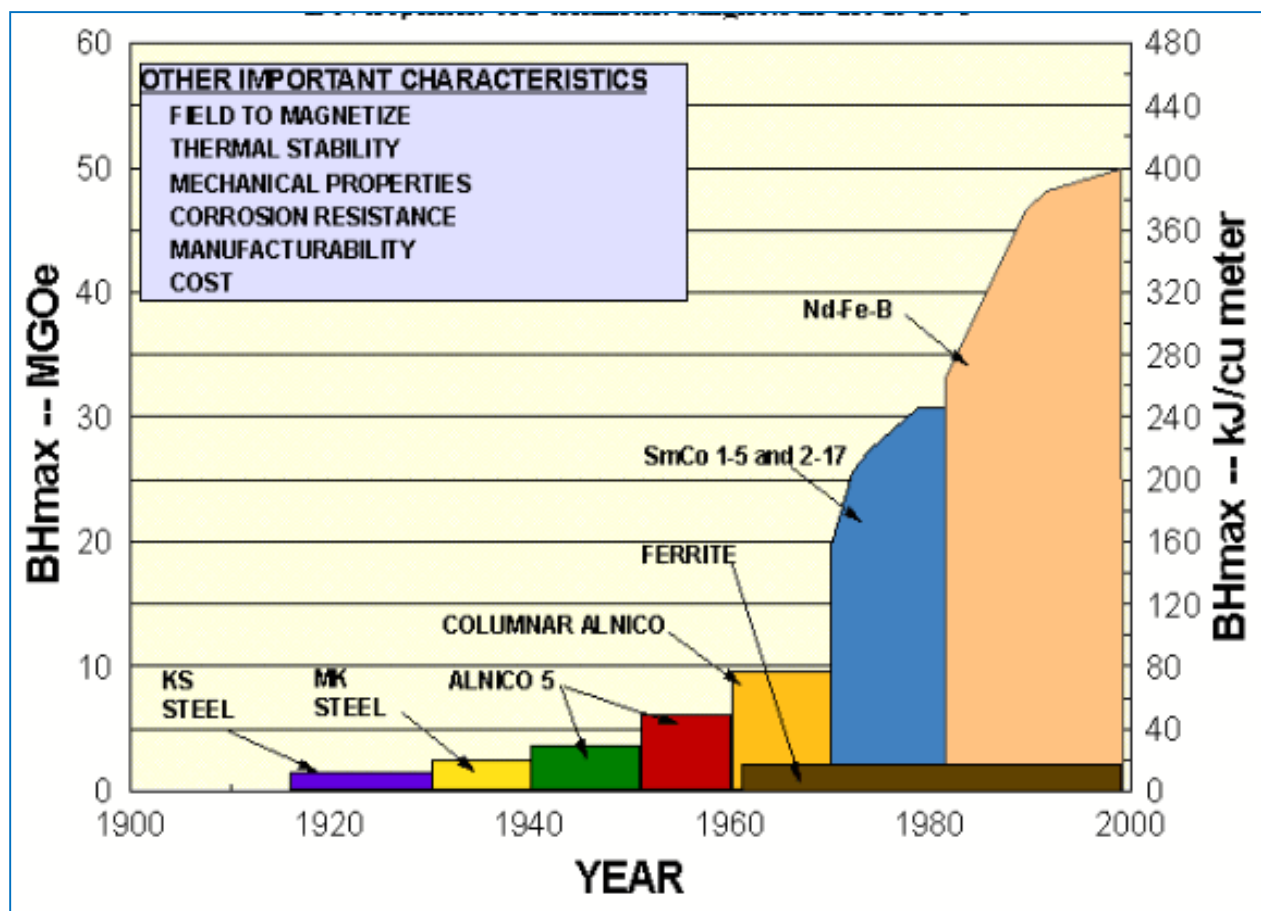


### **Recent price history for selected rare earth oxides (prices in US\$/kg)**

(CeO = Cerium oxide, LaO = Lanthanum oxide, DyO = Dysprosium oxide, EuO = Europium oxide, TbO = Terbium oxide, PrO = Praseodymium oxide, NdO = Neodymium oxide)

Source - Metal Pages, IMCOA

## Elektromotorji, aktuatorji in senzorji bazirajo na modernih magnetih.



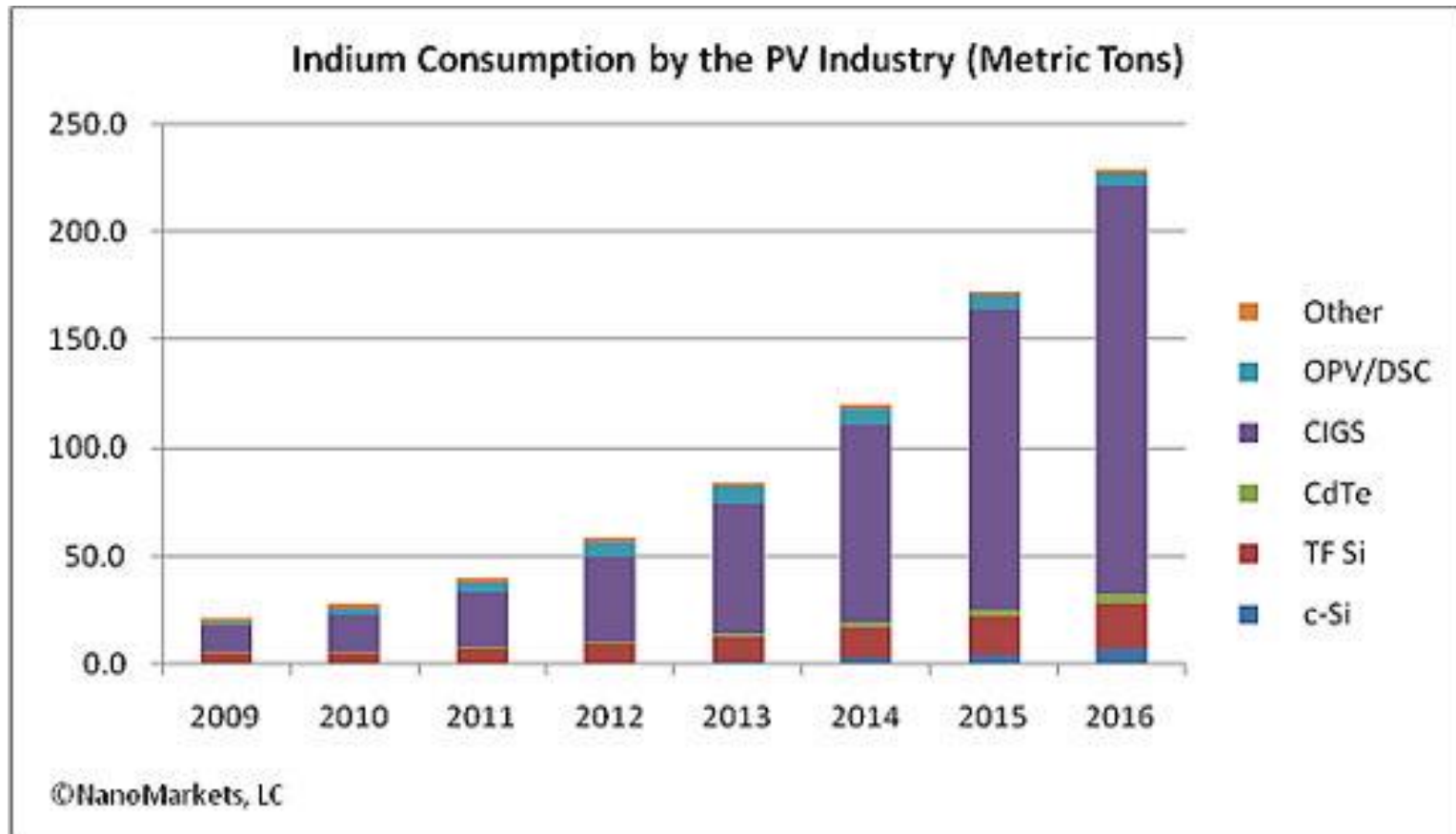
## Večji % zlata v telefonih kot v rudnikih



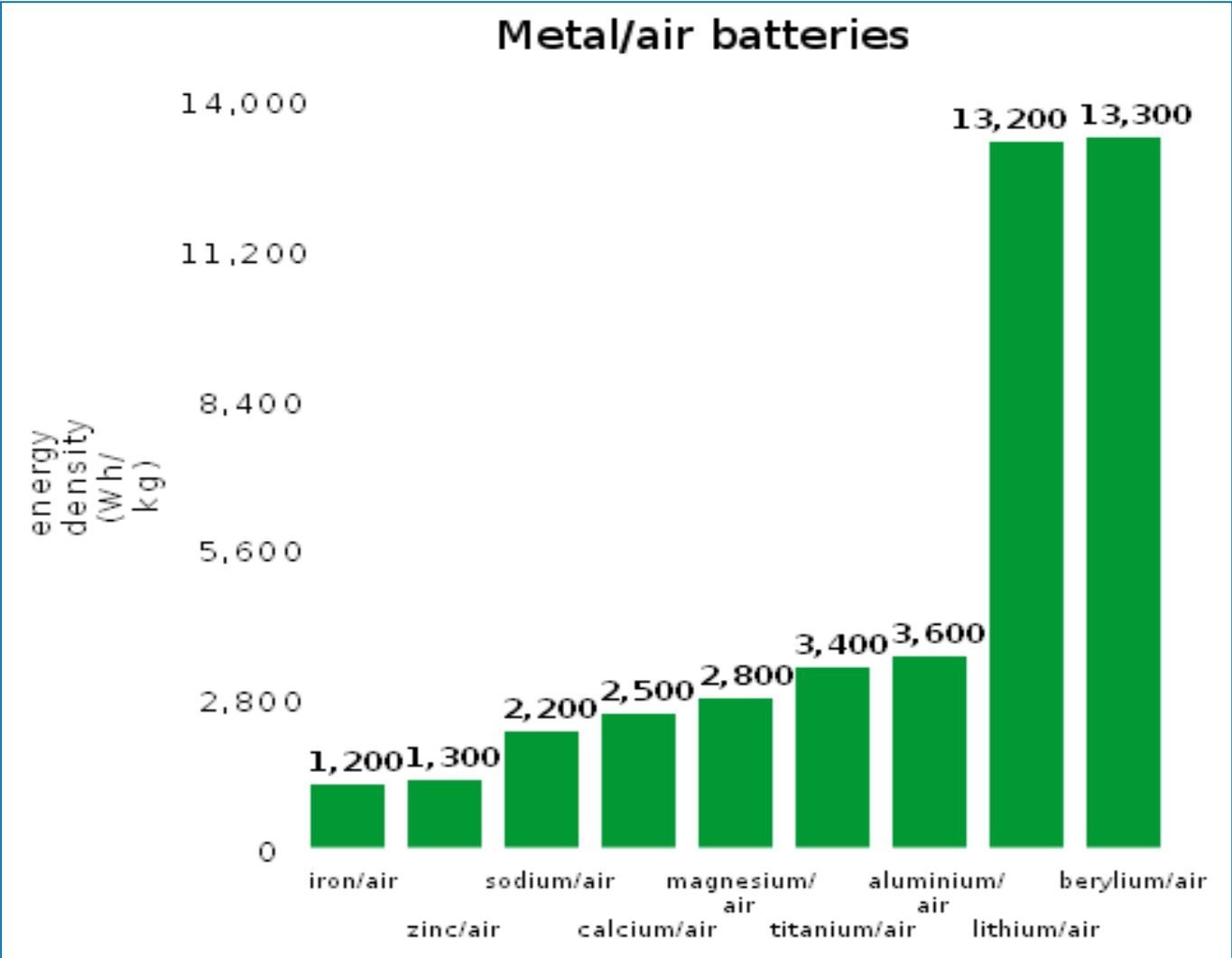
A tonne of ore from a gold mine produces just 5g of gold on average, whereas a tonne of discarded mobile phones can yield 150-400g along with 500 grams of **silver** and 4 grams of **palladium**.



## Indij (ITO) je osnova za vse displeje in PV.



# Drage redke kovine tudi za shranjevanje energije



# Hibridna tehnologija je v celoti odvisna od redkih kovin.

## HYBRID electric motor and generator

- Neodymium
- Praseodymium
- Dysprosium
- Terbium

## HYBRID NiMH battery

- Lanthanum
- Neodymium
- Cerium



# HT so usodno odvisne od redkih naprednih materialov.

		METAL	OXIDE	NAME	USAGE
		<b>Sc</b>		<b>Scandium</b>	X-ray tubes, catalysts for polymerisation, hardened Ni-Cr superalloys, dental porcelain.
		<b>Zr</b>	ZrO <sub>2</sub>	<b>Zirconium</b>	Zirconium is used as an alloying agent due to its high resistance to corrosion.
		<b>Nb</b>	Nb <sub>2</sub> O <sub>3</sub>	<b>Niobium</b>	Niobium is used mostly in alloys, the largest part in special steel such as that used in gas pipelines.
RARE EARTH ELEMENT (LANTHANIDES)	LIGHT REE'S	<b>La</b>	La <sub>2</sub> O <sub>3</sub>	<b>Lanthanum</b>	Ceramic glazes, high quality optical glass, camera lenses, microwave crystals, ceramic capacitors.
		<b>Ce</b>	Ce <sub>2</sub> O <sub>3</sub>	<b>Cerium</b>	Glass polishing, petroleum cracking catalysts, alloys - with iron for sparking flints for lighters, with aluminium, magnesium and steel for improving heat and strength properties, radiation shielding.
		<b>Pr</b>	Pr <sub>2</sub> O <sub>3</sub>	<b>Praseodymium</b>	Yellow ceramic pigments, tiles, ceramic capacitors. With neodymium in combination for goggles to shield glass makers against sodium glare, permanent magnets, cryogenic refrigerant.
		<b>Nd</b>	Nd <sub>2</sub> O <sub>3</sub>	<b>Neodymium</b>	Ceramic capacitors, glazes and coloured glass, lasers, high strength permanent magnets as neodymium-iron-boron alloy, petroleum cracking catalysts.
		<b>Pm</b>	Pm <sub>2</sub> O <sub>3</sub>	<b>Promethium</b>	Radioactive promethium in batteries to power watches, guided missile instruments.
		<b>Sm</b>	Sm <sub>2</sub> O <sub>3</sub>	<b>Samarium</b>	In highly magnetic alloys for permanent magnet as Samarium-Cobalt alloy; probably will be superseded by neodymium. Glass lasers. Reactor control and neutron shielding.
	HEAVY REE'S	<b>Eu</b>	Eu <sub>2</sub> O <sub>3</sub>	<b>Europium</b>	Control rods in nuclear reactors. Coloured lamps, cathode ray tubes. Red phosphor in TV tubes.
		<b>Gd</b>	Gd <sub>2</sub> O <sub>3</sub>	<b>Gadolinium</b>	Solid state lasers, constituent of computer memory chips, high temperature refractories.
		<b>Tb</b>	Tb <sub>2</sub> O <sub>3</sub>	<b>Terbium</b>	Cathode ray tubes, magnets, optical computer memories; hard disk components.
		<b>Dy</b>	Dy <sub>2</sub> O <sub>3</sub>	<b>Dysprosium</b>	Controls nuclear reactors. Alloyed with neodymium for permanent magnets. Catalysts.
		<b>Ho</b>	Ho <sub>2</sub> O <sub>3</sub>	<b>Holmium</b>	Controls nuclear reactors; catalysts; refractories.
		<b>Er</b>	Er <sub>2</sub> O <sub>3</sub>	<b>Erbium</b>	In ceramics to produce a pink glaze; infra-red absorbing glasses.
		<b>Tm</b>	Tm <sub>2</sub> O <sub>3</sub>	<b>Thulium</b>	X-ray source in portable X-ray machines.
		<b>Yb</b>	Yb <sub>2</sub> O <sub>3</sub>	<b>Ytterbium</b>	Practical values presently unknown. Research.
	<b>Lu</b>	Lu <sub>2</sub> O <sub>3</sub>	<b>Lutetium</b>	Deoxidiser in stainless steel production, rechargeable batteries, medical uses, red phosphors for colour television, superconductors.	
	<b>Y</b>	Y <sub>2</sub> O <sub>3</sub>	<b>Yttrium</b>	Deoxidiser in stainless steel production, rechargeable batteries, medical uses, red phosphors for TV.	
	<b>Hf</b>	HfO <sub>2</sub>	<b>Hafnium</b>	Hafnium is used in filaments, electrodes, and semiconductor fabrication processes for circuits	

Table 1: Strategic Metals, including Rare Earth Elements and their common usage

## Nekatere cene grede v nebo.

<b>Metal Oxide</b>	<b>Principal Uses</b>	<b>Price US\$ / kg</b>
Lanthanum Oxide 99% min	Re-chargeable batteries	8.50 - 9.00
Cerium Oxide 99% min	Catalysts, glass, polishing	4.70 - 4.90
Praseodymium Oxide 99% min	Magnets, glass colourant	31.80 - 32.70
Neodymium Oxide 99% min	Magnets, lasers, glass	32.50 - 33.00
Samarium Oxide 99% min	Magnets, lighting, lasers	4.25 - 4.75
Europium Oxide 99% min	TV colour phosphors: red	470.00 - 490.00
Terbium Oxide 99% min	Phosphors: green, magnets	720.00 - 740.00
Dysprosium Oxide 99% min	Magnets, lasers	115.00 - 120.00
Gadolinium Oxide 99% min	Magnets, superconductors	10.00 - 10.50
Yttrium Oxide 99.999% min	Phosphors, ceramics, lasers	15.90 - 16.40
Lutetium Oxide 99.99% min	Ceramics, glass, phosphors and lasers	Up to 2,000 / kg
Thulium Oxide 99.99% min	Superconductors, ceramic magnets, lasers, X-ray devices	Up to 3,000 / kg



<b>KEMIJSKA SESTAVA</b>	
<b>Prenosne odpadne baterije in akumulatorji</b>	<b>v (%)</b>
Alkalne (Al-Mn)	42,15%
Cink-ogljikove (Zn-C)	0,00%
Zrak-cinkove (Zn-air)	0,4870%
Litijeve (Li)	1,0289%
Gumbaste (HgO, AgO, AlMn, Zn-air, Li)	0,4714%
Ostale primarne baterije	18,4835%
Litij-ionske (Li-ion, Li-polimer)	9,3202%
Nikelj-metalhidrid (NiMh)	5,2704%
Nikelj-kadmijeve (NiCd)	6,4754%
Svinčeve (Pb)	15,1733%
Ostale sekundarne baterije	1,1361%
<b>SKUPAJ</b>	<b>100 %</b>

## Avtomobilska plastika

Process/Part/Material	Losses during mechanical recycling [%]	Losses during regranulation/compounding [%]	Source
Blast furnace use	5	5 during agglomeration	[2], p. 33
Secondary raw material incinerators/Cement works	5	–	[2], p. 31
Mechanical recycling	see regranulation	12 in total	[2], p. 34
Bumper	8	3	[5], p. 199 ff
Hub cap	25.4 (25 percentage points of which are sorting errors)	3	[5], p. 199 ff
PU seat upholstery	15	not applicable	[5], p. 199 ff
Dashboard	8	not applicable	[5], p. 199 ff

***Loss rates for recovery processes from the literature***  
*The losses in metal recovery are largely the same as for plastic recovery. Against this background categorizing polymers as “difficult to recycle” is not comprehensible.*

## Reciklaža odbijačev

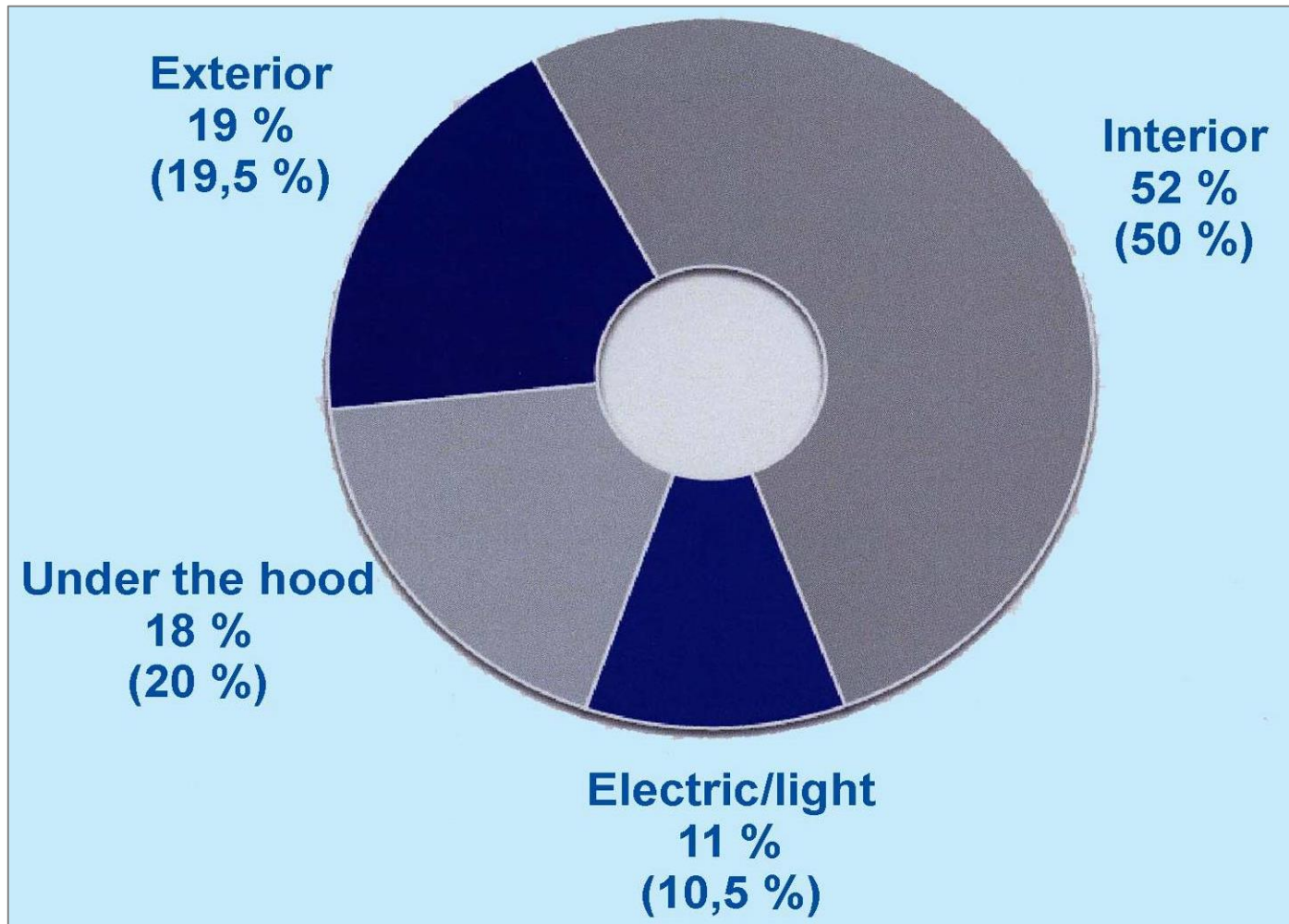
Processing steps (all figures in EUR/t)	[2]	[3]
Disassembly	2,388–3,828	375–4,833
Mechanical processing	1,240	150–250
Compounding	not known	200–300
Transport	80	250–300
Total	3,608–5,148	975–5,683
Selling price	460	180–780

***Cost and returns estimates for the mechanical recycling of automobile bumpers (PP/EPDM)***

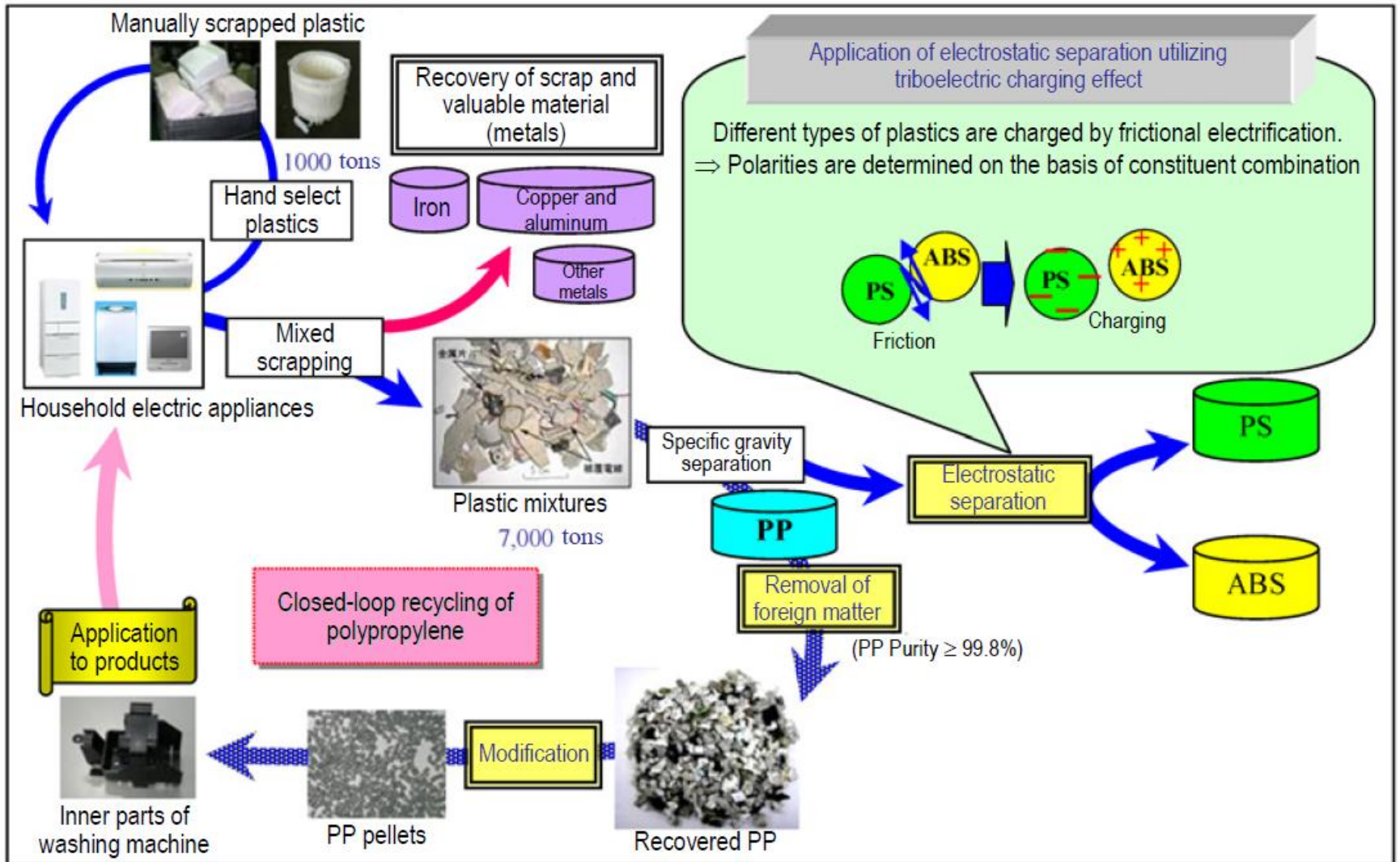
*The disassembly costs make up a significant proportion of the total costs.*



## Uporaba plastike v avtomobilih



# Zaprta krog sistema recikliranja plastike

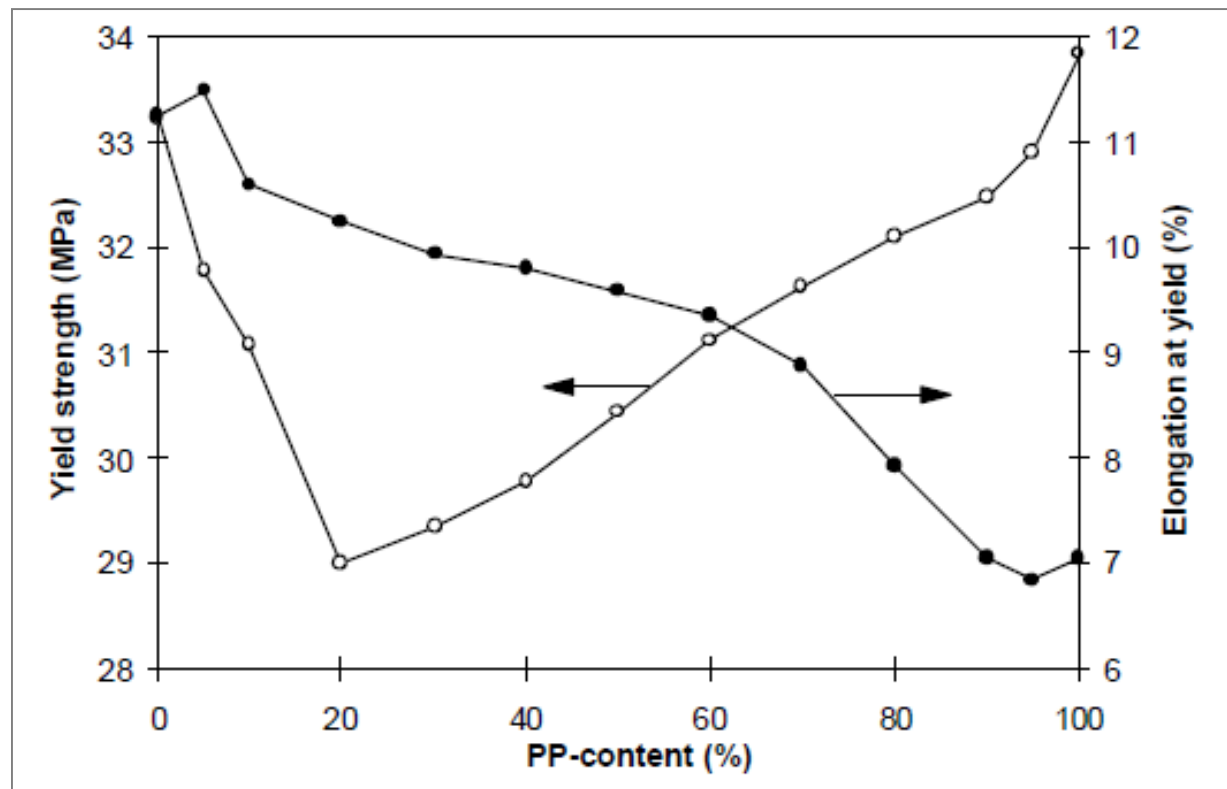


## Embalaža

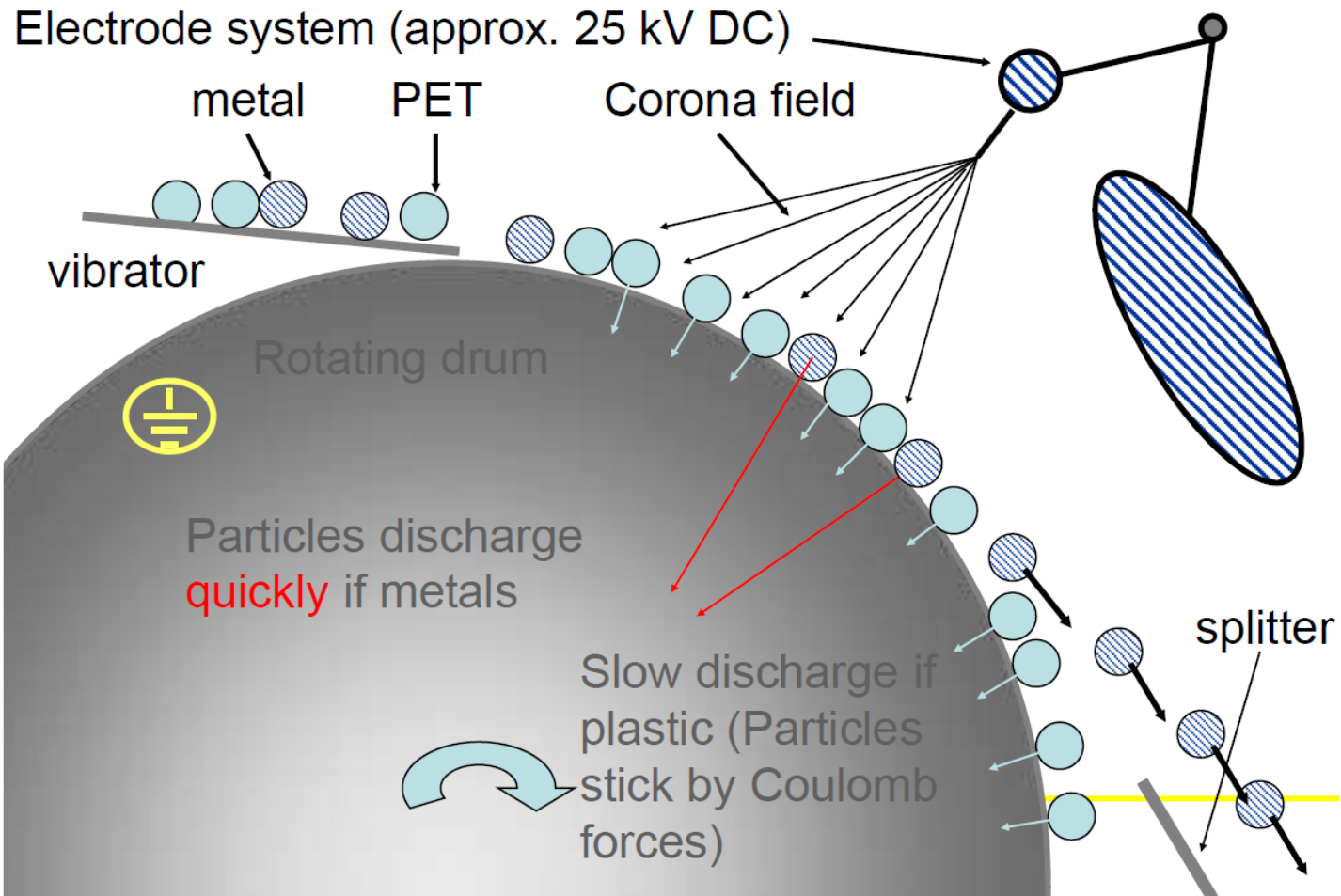
Poliiolefine je težko ločevati celo s **ESS** (elektro separacija).

Frakcija v z embalaži je iz **55% PE in 45% PP**.

Popolna ločitev PE in PP je najboljša za elastičnost, žilavost, trdnost in modul. Najnižja trdnost je pri 80% PE, žilavost pa pri 80% PP. Frakcija HDPE je primernejša za mešanje z PP. **Kristalizacijska** jedra močno vplivajo na mikrostrukturo in lastnosti, ker PP kristalizira pri višji temperaturi kot PE le v PP-bogatih mešanica, ne pa tudi v PE bogatih mešanica.



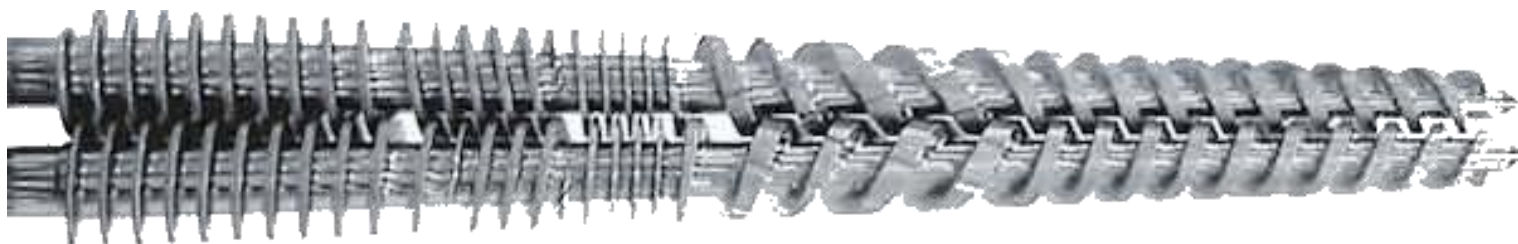
# Električna separacija



**Avtomatizirano ločevanje plastičnih odpadkov, zlasti WEEE in avto frakcij, je povezano z velikimi naložbami.**

**Sestava WEEE** je običajno 29% barvnih kovin, 27% stekla, 6% Cu in Al, 8% drugih kovin, 22% ABS in 8% drugih plastičnih mas. Bistvenega pomena za trajnostno ohranjanje in ponovno uporabo virov je izboljšanje tehnologije ločevanja.

To lahko dosežemo le s poceni ločevanjem in ciljnim mešanjem z dodatkom **kompatibilizerjev, elastomerov, ojačitev, polnil in funkcionalnih** dodatkov.



# Tehnični kompaundi

DODATEK	%	Natezna trdnost	Upogibni modul	Udarna žilavost	Temp.obst. HDTI	Ognjeodpornost	Elektroprevodnost	Obrabna trdnost	Kemijska odp.	Dimenz.stabilnost	Preciznost mer	Odpornost na plast. tečenje	Cena
		↑↑↑	↑↑	↓	↑↑↑↑	↑↑	—	↑↑	↑↑	↑↑↑	↑↑	↑↑↑	↑↑
<b>Ojačala</b>													
Steklena vlakna	10-50	↑↑↑	↑↑↑	↓	↑↑↑↑	↑↑	—	↑↑	↑↑	↑↑↑	↑↑	↑↑↑	↑↑
C vlakna	10-40	↑↑↑↑	↑↑↑↑	↓	↑↑↑↑	↑↑	↑↑↑↑	↑↑↑	↑↑	↑↑↑↑	↑↑	↑↑↑↑	↑↑↑↑
Aramidna vlakna	5-20	↑↑	↑↑	↓	↑↑↑↑	↑	—	↑↑	↑↑	↑↑	↑↑↑	↑↑	↑↑↑
Mineralna vlakna	10-40	↑↑	↑↑	↓↓	↑↑↑	↑↑	—	↑	↑	↑↑	↑↑↑	↑↑	↑
<b>Polnila</b>													
Minerali (talk, kaolin, sljuda, CaCO <sub>3</sub> , silika)	40	↑	↑↑	↓↓	↑↑	↑↑	—	↑	↓↑	↑	↑↑↑↑	↑	↓↓
Kovine (ploščice/vlakna)	10-40	↓	↑↑	↓↓	↑↑↑	↑	↑↑↑	↑	↓↑	↑	↑↑	↑	↑↑↑
Saje	10-20	↓↓	↑↑	↓↓	↑	↓	↑↑↑↑	↓	↑	↑	↑↑	↑	↑
Protivžigni dodatki													
organski	5-20	↓↓	↑↑	↓	↑	↑↑↑↑	—	↓	↓↑	↓	—	↓	↑↑↑
anorganski	5-40	↓↓	↑↑	↓↓	↑	↑↑↑↑	—	↓	↓↑	↑	↑↑↑	↑	↑
Notranja maziva (PTFE, molibdenov .disulfid, silikon)	5-15	↓	↑	↓↓	↑	↑	—	↑↑↑↑	↑	↑	↑↑	↑	↑↑↑
Steklene kroglice	10-40	↓↓	↑↑	↓↓	↑	↑	—	↑	↑	↑	↑↑↑↑	↑	↓↓
Žilavostni dodatki	5-15	↓↓	↓	↑↑↑↑	↓	↓	—	↓	↑	↓	↓	↓	↑
Antistatiki	1-5	↓	↓	↓	↓	—	↑↑	—	—	—	—	—	↑↑↑
UV stabilizatorji	do 1	↓	↓	↓	↓	—	—	—	—	—	—	—	↑↑↑

Vpliv polnil / ojačal na lastnosti termoplastov ( ↑ ugodno, ↓ neugodno)



## Recikliranje PE in PP folij

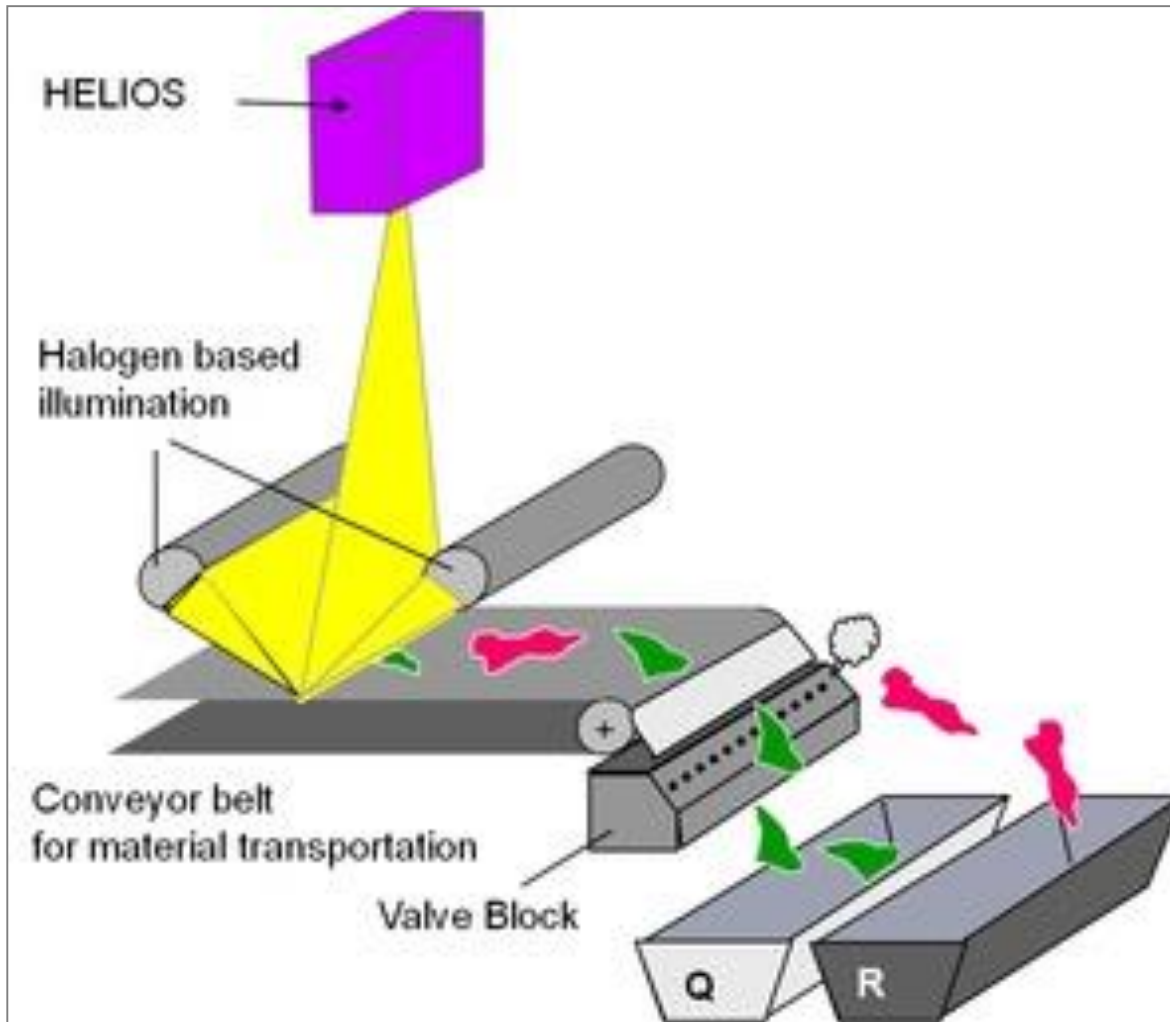
	Industrial film (unprinted)	Domestic retail film, (contaminated, thin, printed)
Energy to recycle polymer	23 – 30 MJ/kg	87 – 117 MJ/kg
Efficiency loss	4 – 5 %	22 – 30%
Total energy	<b>27 – 35</b> MJ/kg	<b>109 – 147</b> MJ/kg

	<b>Priority Group I</b>	<b>Priority Group II</b>
<b>Products</b>	Brown goods, data processing	Office equipments, small appliances, telecommunications, automotive and large domestic appliances (white goods)
<b>Polymeric Matrix</b>	SB, ABS, PC, PC+ABS, SB+PPE, PP, PVC	SAN, PET, PA, PE, POM, PBT, PMMA
<b>Flame Retardants</b>	DBDPE, OBDPE, TBBA, HBCD, Sb <sub>2</sub> O <sub>3</sub>	PBB-MA, halogenated polyolefines, ammonium polyphosphates, melamine compound, Al and Mg hydroxides
<b>Metals</b>	Pb, Cd, Cr, Hg	Mn, Mo, Ni, Co, Cr, Zn, Au, In, Nd
<b>Fillers</b>	Calcite, barite, talcum, glass, Al <sub>2</sub> O <sub>3</sub>	

## **Materiali v običajnih odpadkih**

<b>Kompleksni materiali za recikliranje</b>		
<u>Electronic:</u>	<u>Cars:</u>	<u>Packaging/consumption:</u>
• Li, Ni, Cd (batteries)	• mixed PUR/textile (seats)	• Laminate PE/Al/paper (tetrapak)
• In, Sn, Ga, Se (displays)	• CRP, GRP (RTM parts)	• PVC/textile (carpets)
• Nb, La, Sa, B, Ba (magnets, EMI absorbers)	• PUR/thermoplasts (skin-, slush-, moulding)	• PVC/wax (candels)
• Si, In, Ru, Ti, Os, Pt (fotovoltaic)	• Nanocomposites (MMT, CNT)	• PVC/Cu (cables)
• C/Ni, CNT, Sn, Cu (conductors)	• Rubber/textile	• GRP/thermoplast (sanitary cells)
	• Pb/thermoplasts	• Mixed textile





## Shema sortiranja za reciklažo plastike

*Chemical Imaging system "HELIOS Complete" sorting all wanted or rather unwanted plastics like PVC, PS, PET, PE, PP, by real-time processing of NIR...*

**Identification and pure-fraction separation of standard plastics from household and commercial waste streams**

Plastics from household waste	PE-HD, PE-LD, PP, PET, PS, PVC, and similar
Drinking bottles / hollowware	PET, PET-G, PVC, and similar
Household foils	PE-HD, PE-LD, PP, PS, PVC, and similar
Other	TETRA-PACK, (wood textiles paper & board), and similar
Construction waste	PP, PE, ABS, PA, PC, PS, and more

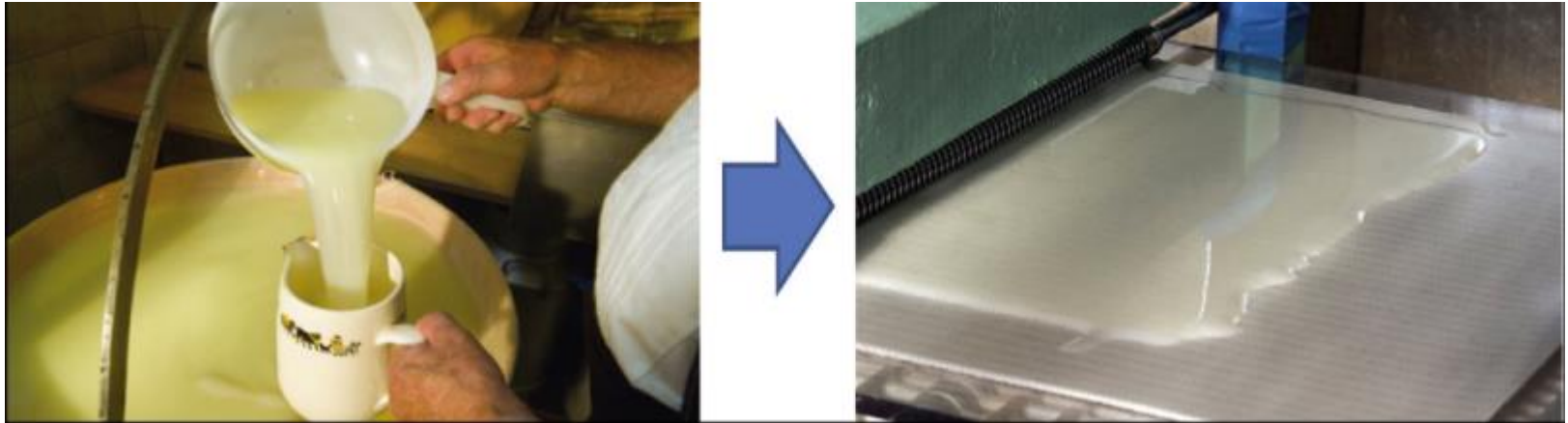
# Uspešni projekti v GP

**Vsak material se da uspešno reciklirati!**

## Zvočnik, 100 % les, proizveden po tehnologiji brizganja



## Barierna embalaža iz sirotke



**Bio-based and biodegradable packaging from whey protein** has the potential to substitute polymer layers in the packing of food.

Development of a technique for the manufacture of **whey-coated plastic films** with excellent oxygen barrier properties, improved water vapour properties and antimicrobial activity.

## The problem ...



... is worldwide!



## Marine debris removal and preventing further litter entry

- 1. Marine litter removing equipment*
- 2. Edible and biodegradable food packaging*
- 3. Smart fishing equipment*

**We have protected the maritime zone (Island Krk).**



An aerial photograph of a city, likely Ljubljana, Slovenia, showing a winding river, a railway line, and a dense urban area with red-tiled roofs. In the background, there are rolling hills and mountains under a clear blue sky. The text "Hvala za pozornost!" is overlaid in the center in a large, bold, blue font.

**Hvala za  
pozornost!**