European Commission

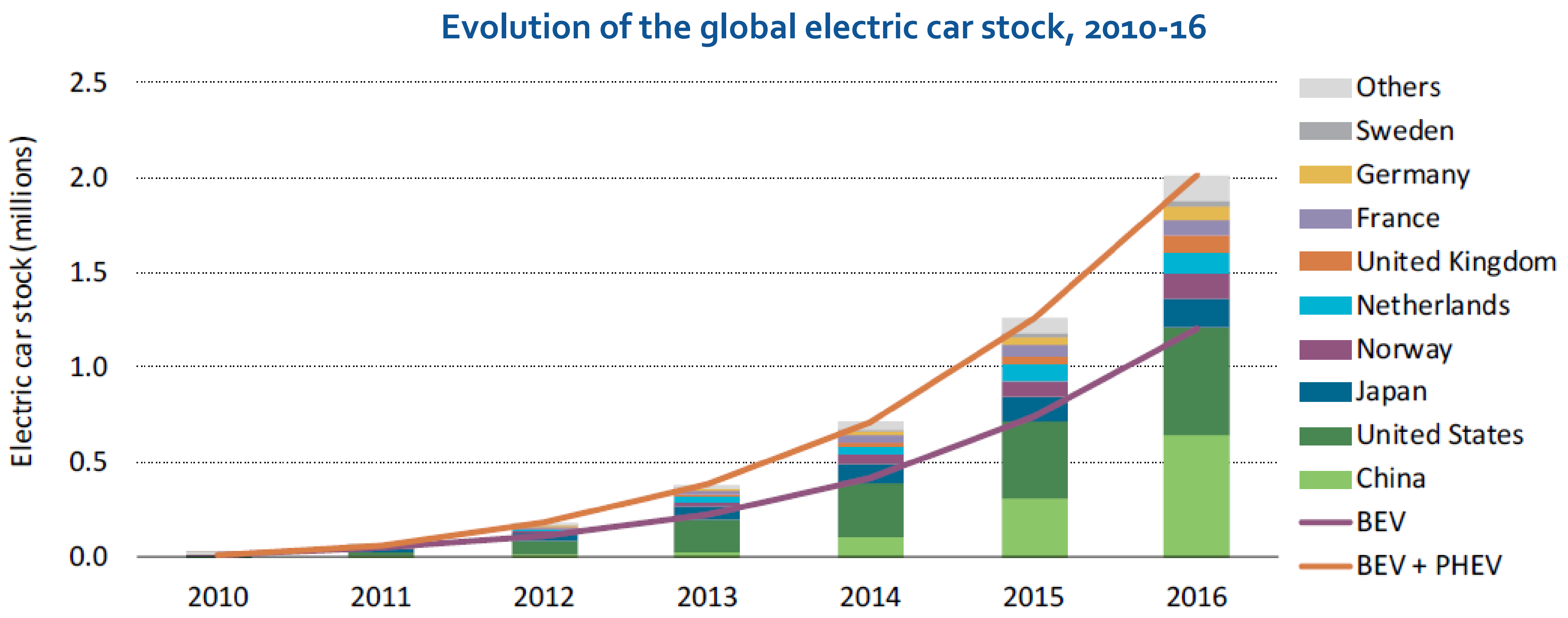
Circular economy perspectives for future end-of-life EV batteries

Circular Impacts Workshop

J Rizo

EC DG Environment

Two million and counting



IEA: Global EV Outlook 2017, limited to BEVs and PHEVs

avicenne ENERGY

INFORMATION FOR GROWTH

www.avicenne.com

Battery market for Hybrid, Plug-in & Electric vehicles

JUNE 2016

25th Edition

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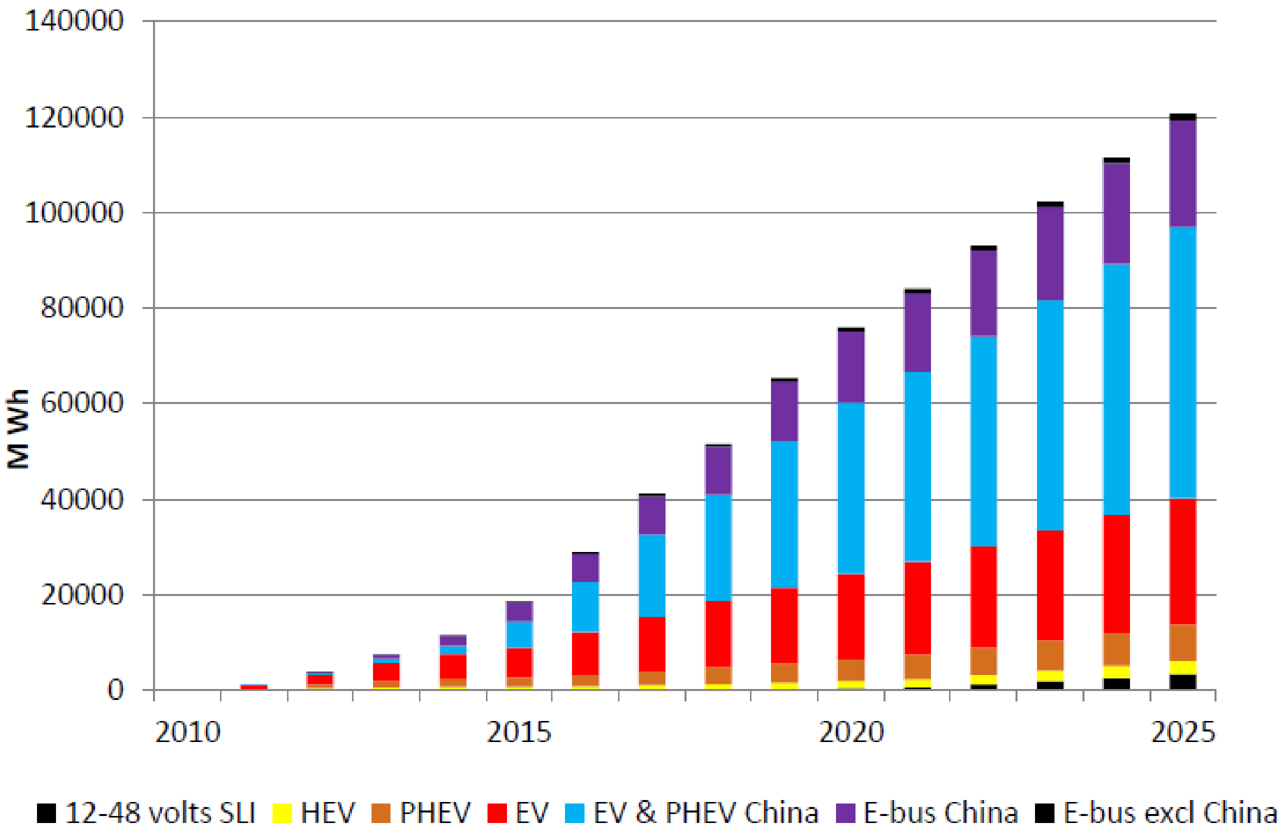
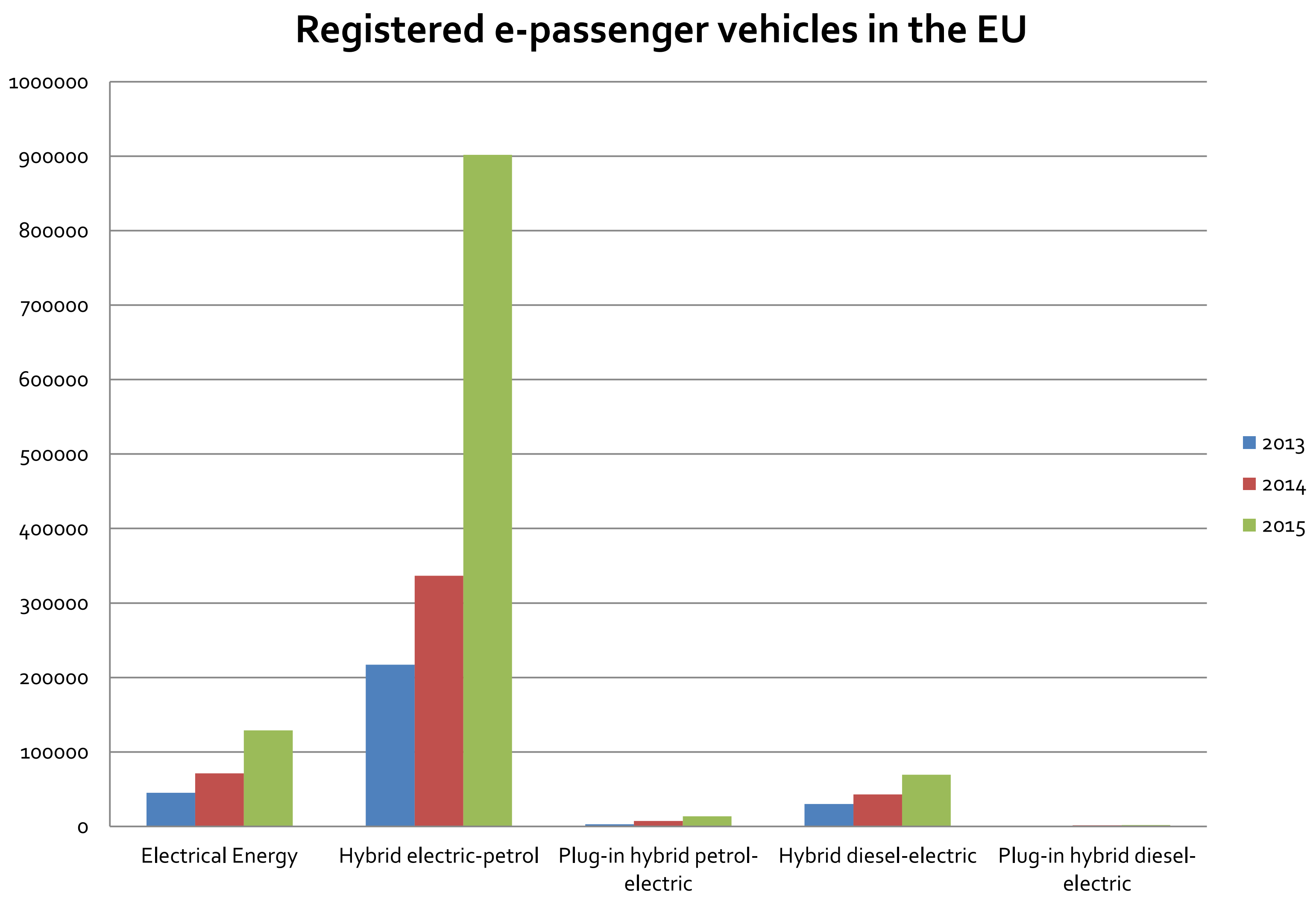
LIB BATTERY FOR X-EV DEMAND 2005-2025

EV, HEV & P-HEV Battery needs (M Wh) 2005 – 2025

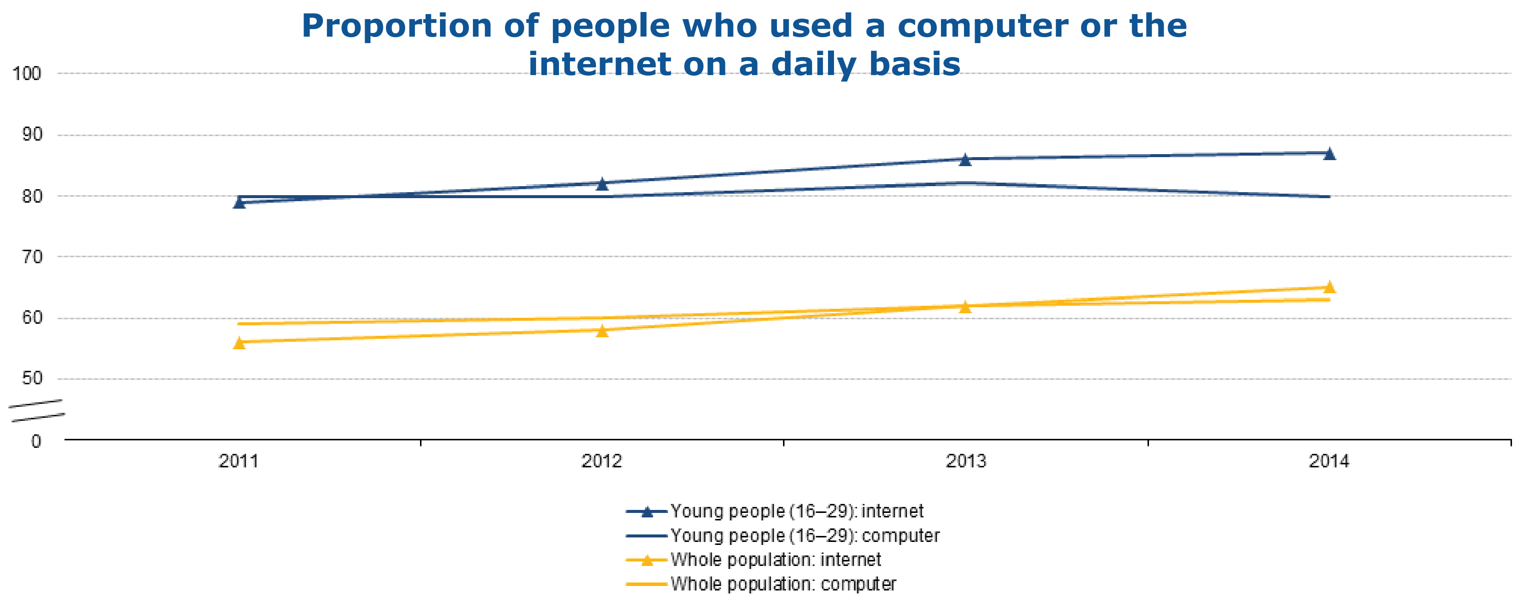


EU too



EUROSTAT

Connectivity



Source: Eurostat (online data codes: isoc_ci_ifp_fu and isoc_ci_cfp_fu)

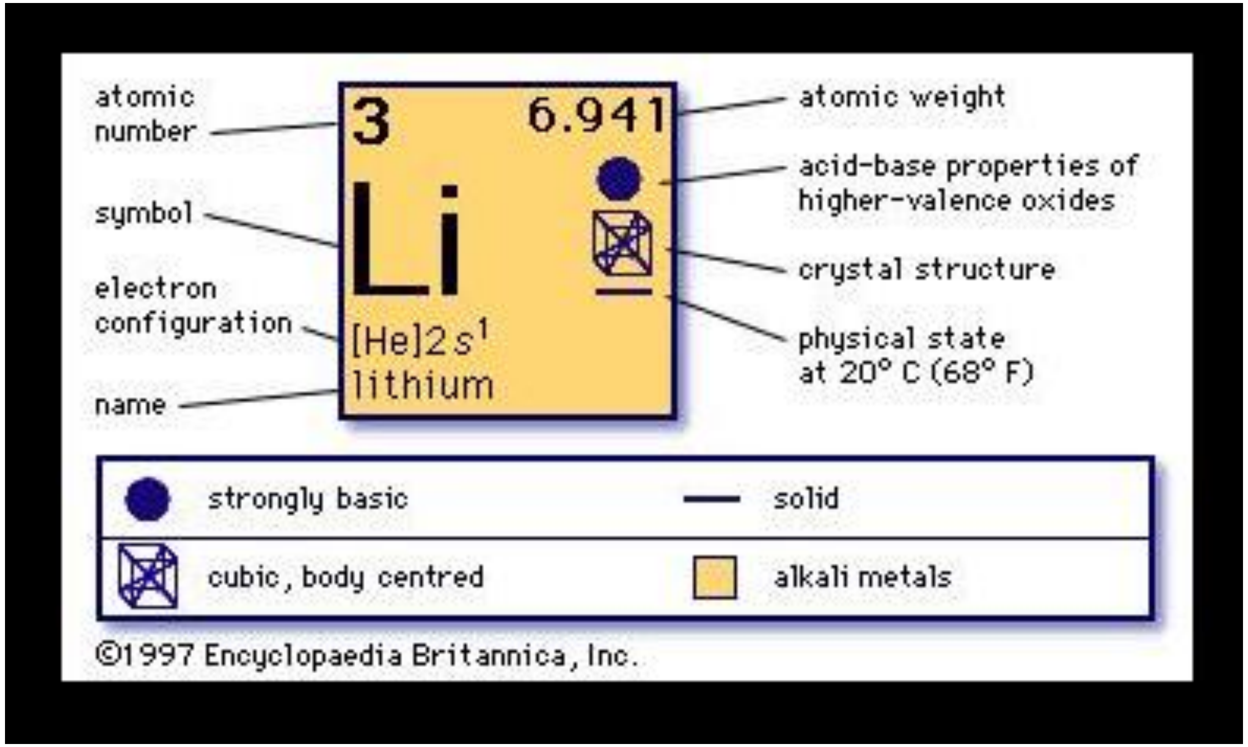
The number of devices connected to IP networks will be more than three times the global population by 2021:

- 3.5 networked devices per capita by 2021 (2.3 in 2016)
- 27.1 billion networked devices in 2021 (17.1 billion in 2016)

(The Zettabyte Era: Trends and Analysis. Cisco June 2017)

Novelties

European Commission



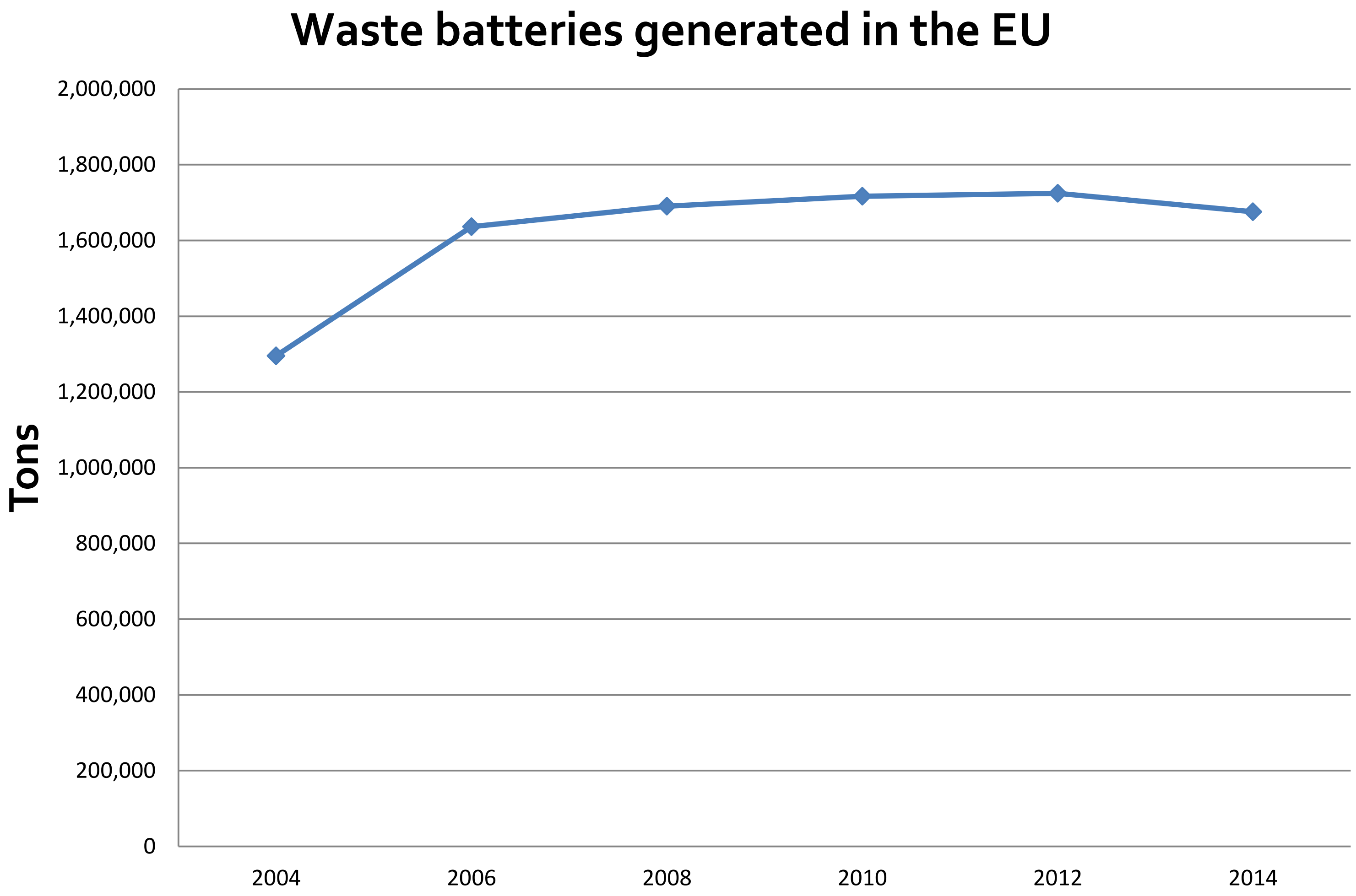
Novelties

Repurposed second-life EV battery volumes will rise dramatically. By the mid-2020s a large quantity of used EV batteries will become available for stationary applications. They will be deployed for grid-scale, commercial, and residential storage applications and will enable higher levels of renewables to be integrated onto the grid. They may also be used to reduce peak demand charges for public fast-charging infrastructure, so improving the business model. (*McKinsey & Bloomberg 2016)*

- Price
- Performance
- Safety
- Guarantees and liability

- No specific provision in EU legislation, general rules apply.
    - *Waste or not waste?*
    - *Repurposing? Refurbishing?*
    - *EPR?*
    - *End of waste criteria?*

Problems remain



EUROSTAT

A circular framework

Reuse, Recovery & Recycling

- *Recycling efficiencies for Pb, Ni*

Collection & Treatment

- *Levels of collection for portables*
- *Take back*
- *No incineration*
- *No disposal*

- *Classification*
- *E.P.R*
- *Reporting*

Design & Manufacturing

- *Prohibition of Hg, Cd*
- *Removability*

Placing on the Market

- *Information to end users*
- *Labelling*
- *Removability*

Use & comsumption

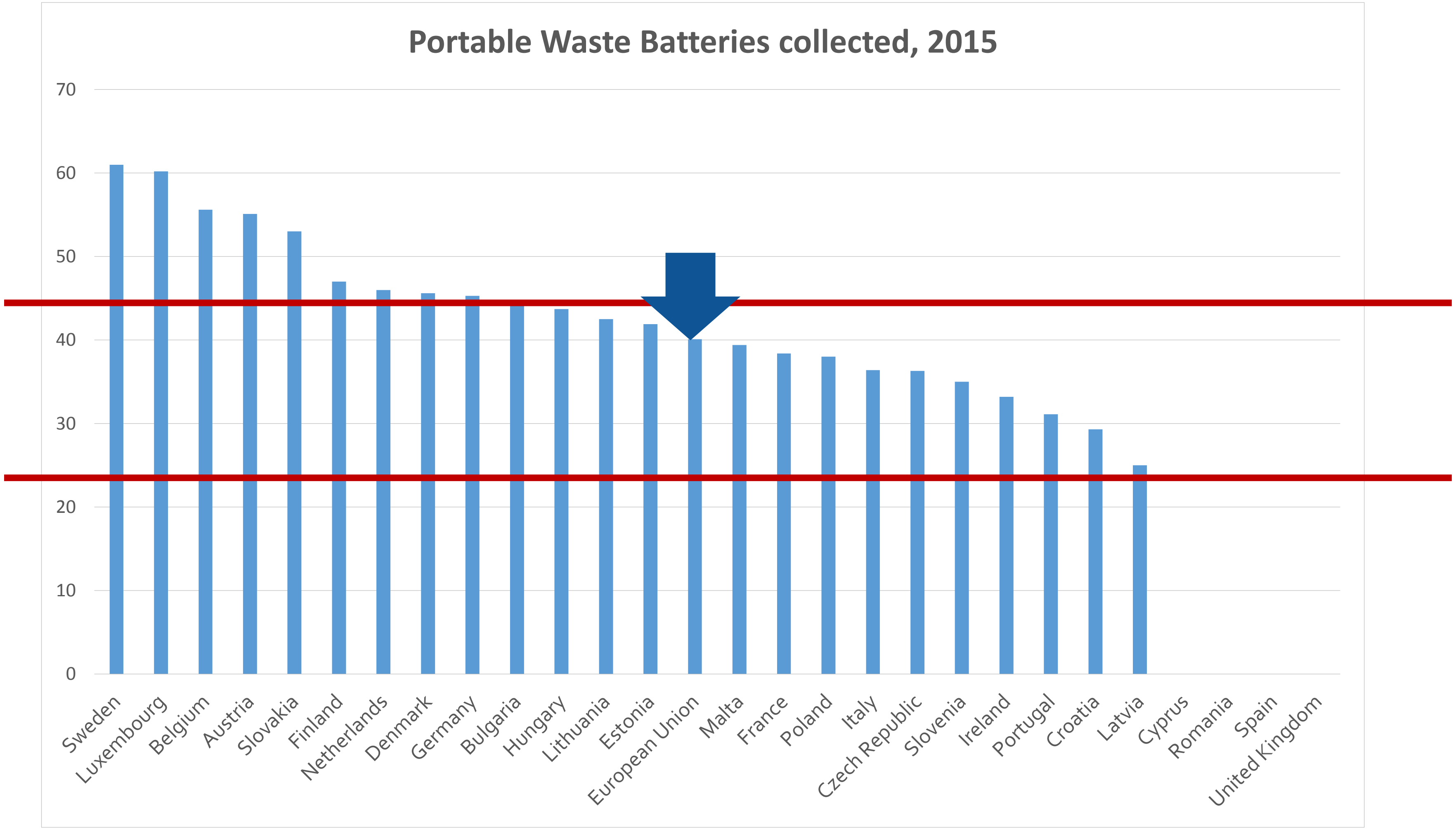
The logic

- Collection of spent batteries:
  - 45% for portables (collecting schemes)
  - No target as such for automotive (collecting schemes) or industrial (take back), but landfilling and incineration of industrial and automotive batteries are prohibited

- All batteries collected shall undergo recycling
  - The level of recycling should be 100%

- Targets are established for the recycling efficiency of recycling processes
  - Pb, Cd, and general
  - To the highest degree of metal recovery that is technically feasible while avoiding excessive costs

Collection


Portable Waste Batteries collected, 2015
70
60
50
40
30
20
10
0
Sweden
Luxembourg
Belgium
Austria
Slovakia
Finland
Netherlands
Denmark
Germany
Bulgaria
Hungary
Lithuania
Estonia
European Union
Malta
France
Poland
Italy
Czech Republic
Slovenia
Ireland
Portugal
Croatia
Latvia
Cyprus
Romania
Spain
United Kingdom

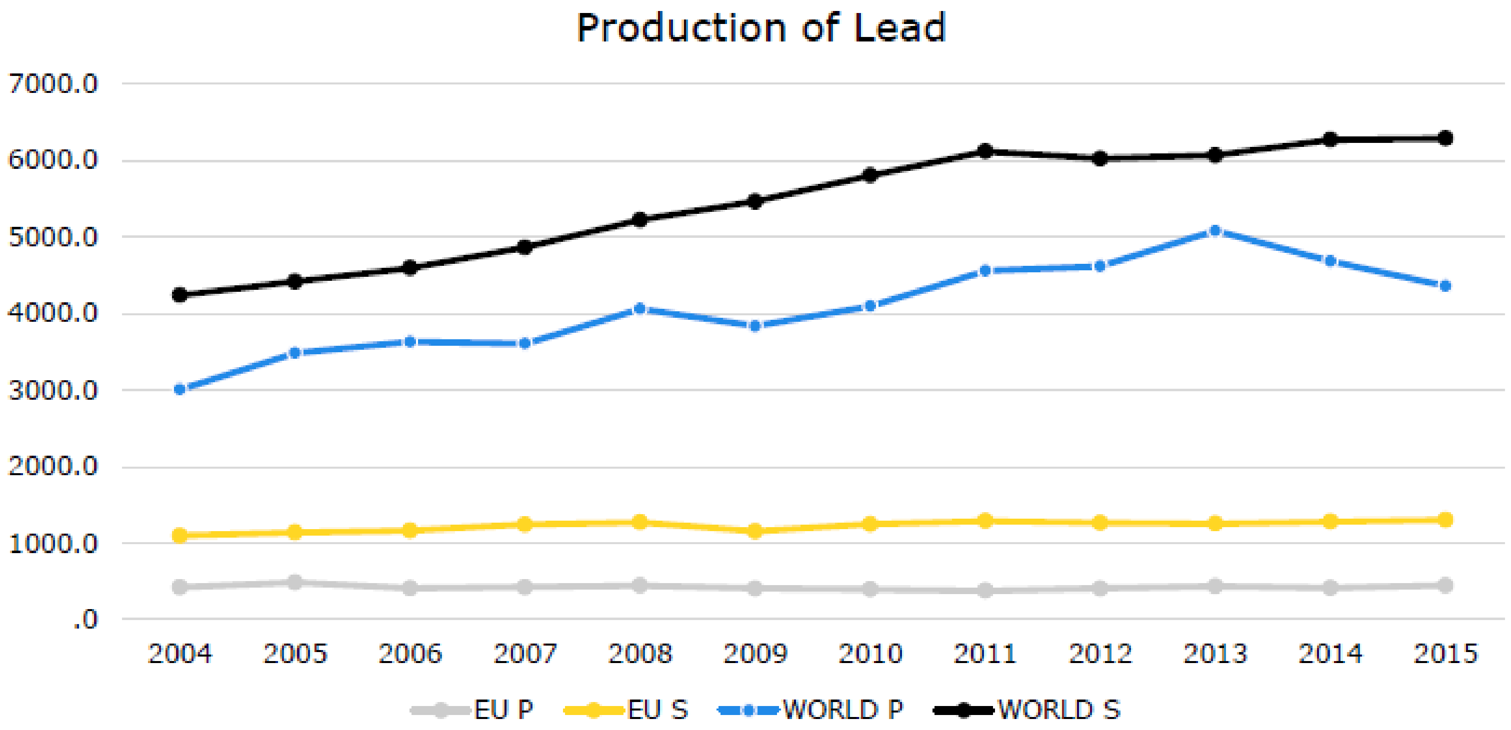
Lead-acid Batteries

European Commission

2010 - 2012	EU
Light vehicles	254,819,906
Batteries available for collection (Units)	54,099,093
Batteries available for collection (Tonnes)	945,123
Heavy vehicles	6,494,415
Batteries available for collection (Units)	3,680,168
Batteries available for collection (Tonnes)	165,608
Total Batteries available for collection (Units)	57,779,261
Total Batteries available for collection (Tonnes)	1,110,730
Automotive batteries collected (Tonnes)	1,145,043
Other applications / Misclassification	36,529
Automotive lead-based battery collection and recycling rate	**99%**

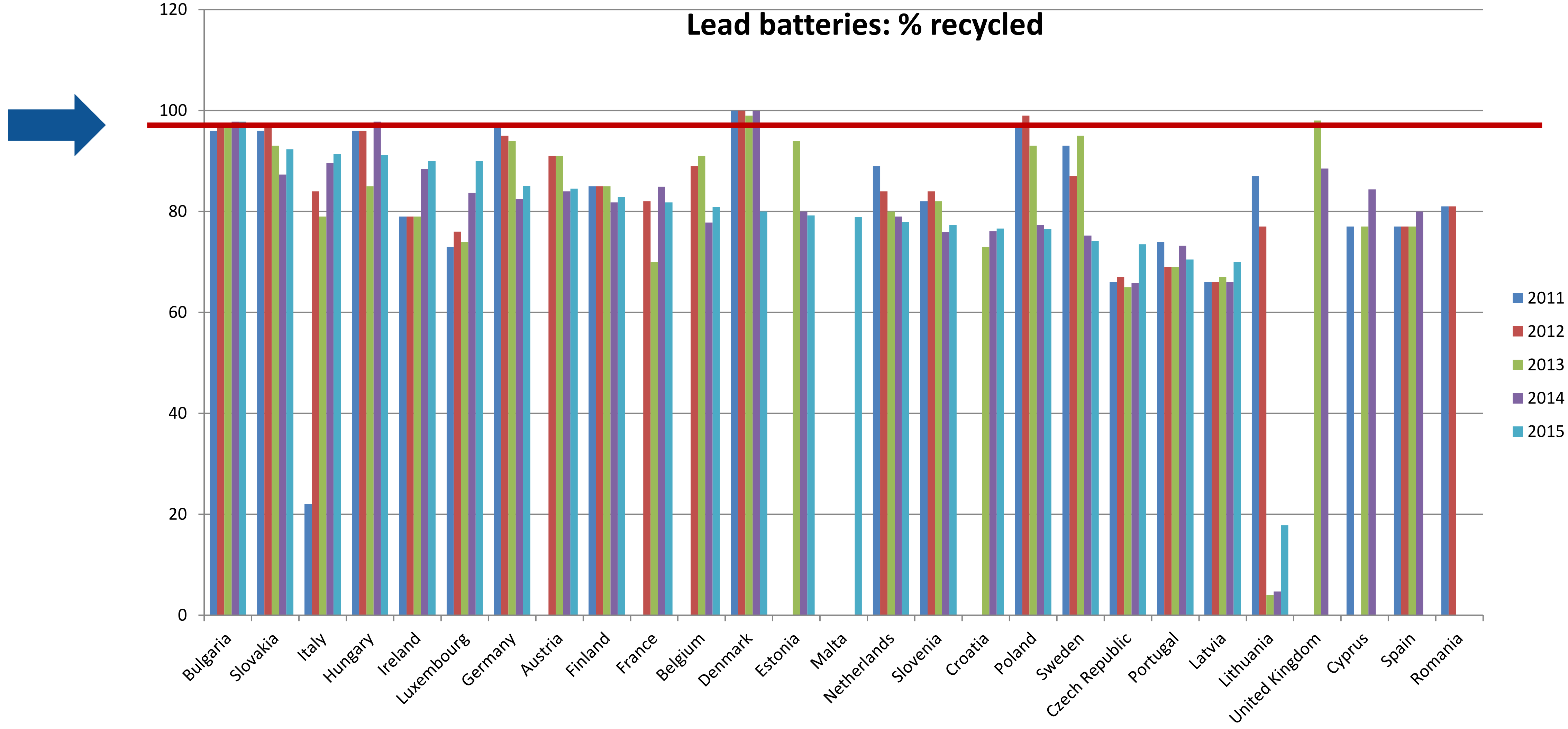
EUROBAT (2015)

Lead



ILZSG Data

Lead Acid Batteries (ELV)



Recycling (2015)

	Re Pb	Pb Mc	Re Ni-Cd	Cd Mc	Re Other
Belgium	80,9	98	81,6	100	63,4
Bulgaria	97,8	69,3			68,9
Czech Repub	73,5	98,1	94,6	98,5	60,4
Denmark	80		78,9		59,3
Germany	85,1	98,6	78,5	100	76,3
Estonia	79,2	99	0	0	54,3
Ireland	90	99,8	78,5	100	83,4
Spain					
France	81,8	99	80,9		64,1
Croatia	76,6	98,4	74,6	100	66,6
Italy	91,4	97,1	78,3		60
Cyprus					
Latvia	70	90	76	85	52
Lithuania					
Luxembourg	90	90	80,6	80,6	58,9
Hungary	91,2	87,2	0	0	60,2
Malta	78,9	90,9	0	0	0
Netherlands	78		79		56
Austria	84,5	96,8	81,6	100	82,2
Poland	76,5	96,9	99,5	100	67,4
Portugal	70,5	98,6	94,2	100	81,4
Romania					
Slovenia	77,3	98			
Slovakia	92,3	98,1	80,2	46,7	61,1
Finland	82,9	96,8	79,7	100	96
Sweden	74,2	97,1	76,5	100	67,4
U.K.					

European Commission

Re Pb: recycling efficiency Lead acid batteries (65%)

Pb Mc: highest degree of recovery for Lead

Re Ni-Cd: recycling efficiency Nickel Cadmium batteries (75%)

Cd Mc: highest degree of recovery for Cadmium

Re Other: recycling efficiency for other batteries (50%)

Commission Regulation (EU) No 493/2012

Cost and Benefits

"Recycling is an alternative to disposal. The good reason for recycling is that it is a better alternative than disposal – better in the sense that the net social cost of recycling is lower than the net social cost of disposal, once all the social benefits and costs of each are properly counted."

The Economics of Waste, R.C. Porter 2002

Cost and Benefits

- The biggest part of the cost is raw materials (for LiB)

Pillot 2006

- Influence of recycling?
  - Recycling creates a second source of supply that helps stabilize the commodity price of lead.
  - Recyclers make a profit when the price of the finished product sold to battery producers is higher than the price recyclers pay for batteries at their end-of-life.

Ellis 2016

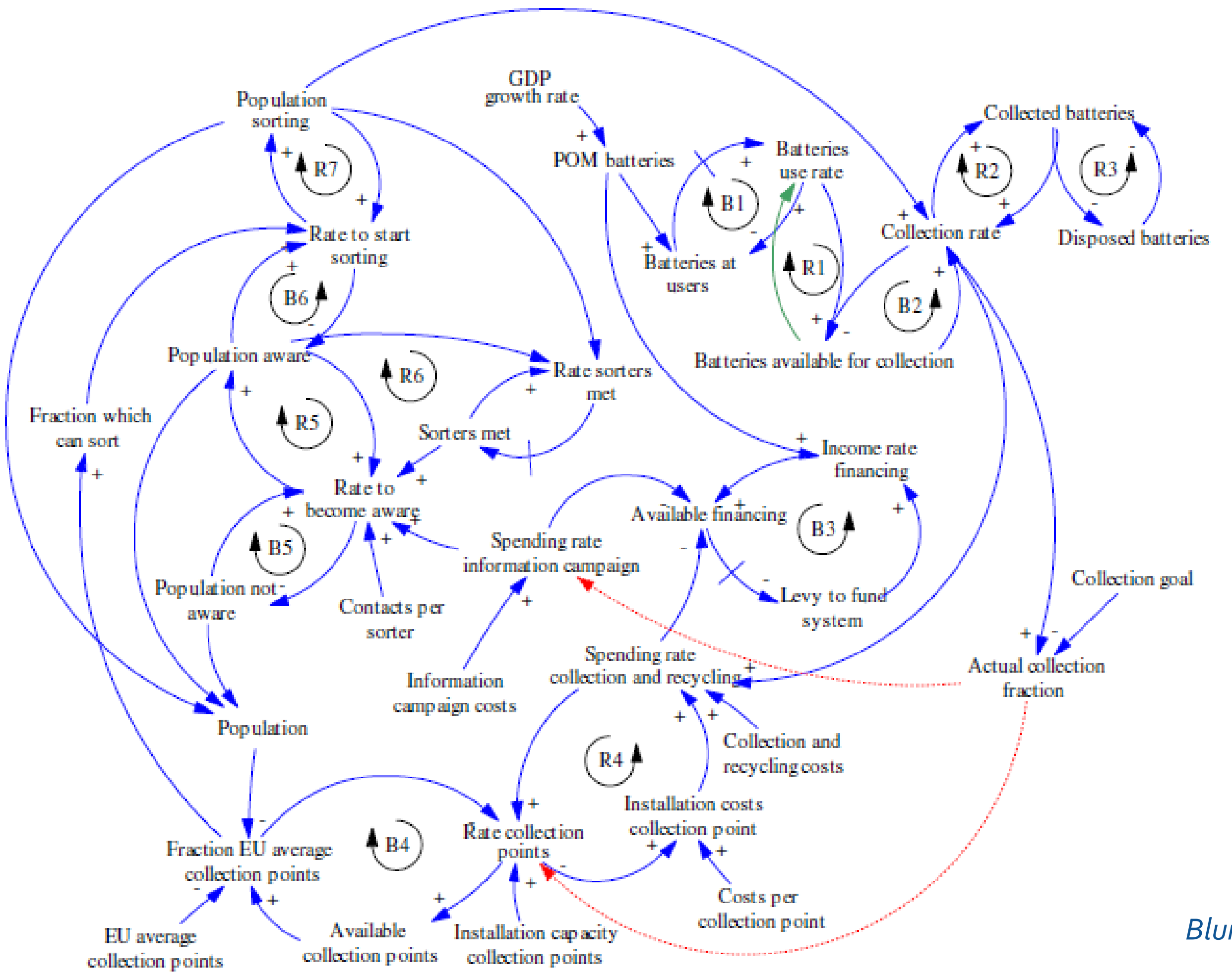
Cost and Benefits

$$\boldsymbol{Cost\ of\ process(es)\ <\ Market\ value\ of\ products}$$

- Energy driven
- Too low volume? Too high fixed costs?
- Few Critical Raw Materials
- Markets volatility
- Quality issues
- Regulatory aspects
- Market failure?

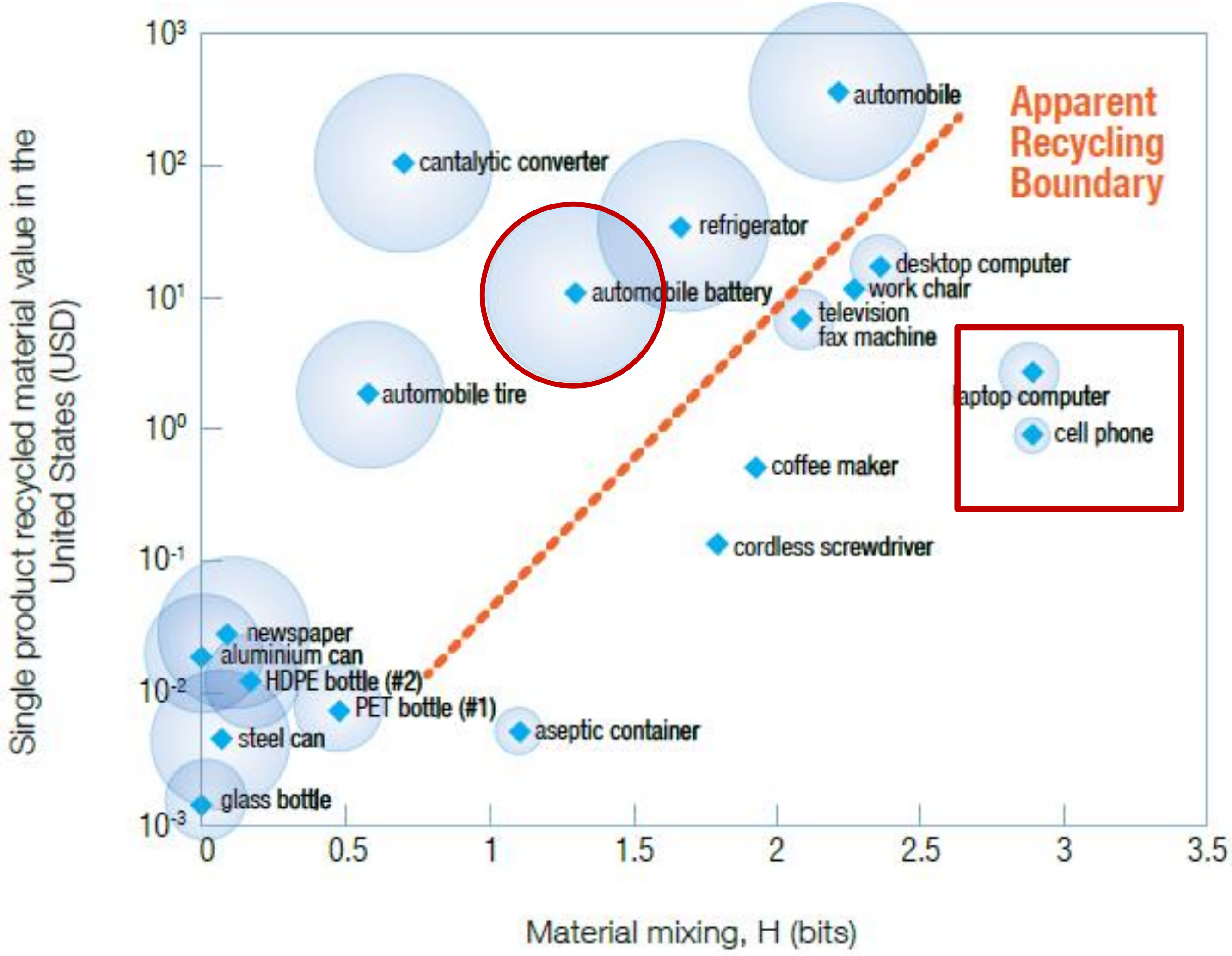
Seeking for a model

Economies of scale and efficiencies



Blumberga et al. 2014

Limits to recycling…

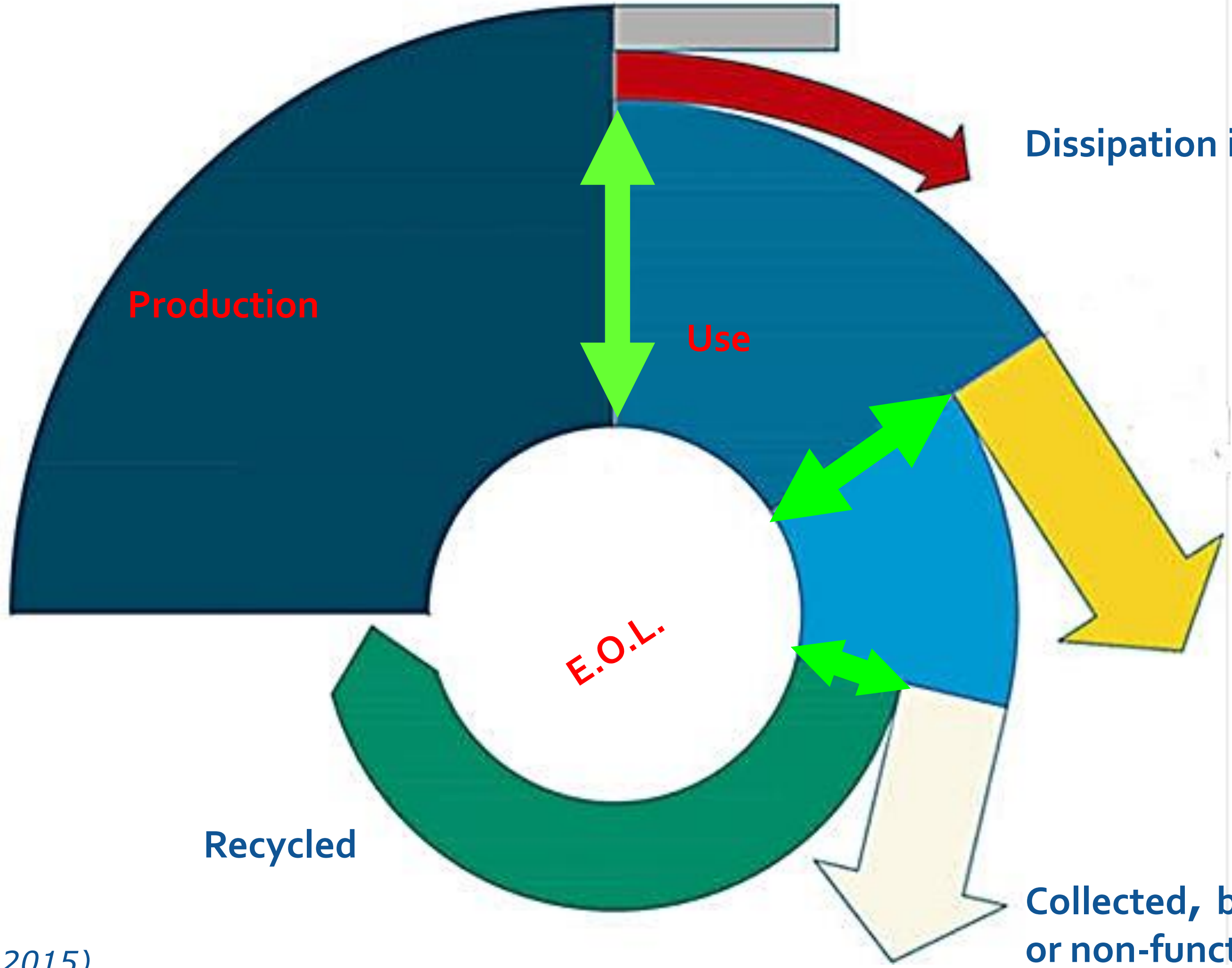


Entropic Backfire:

- **Miniaturizacion**
- **Dilution**

Dahmus & Gutowski (2007).

Always losses

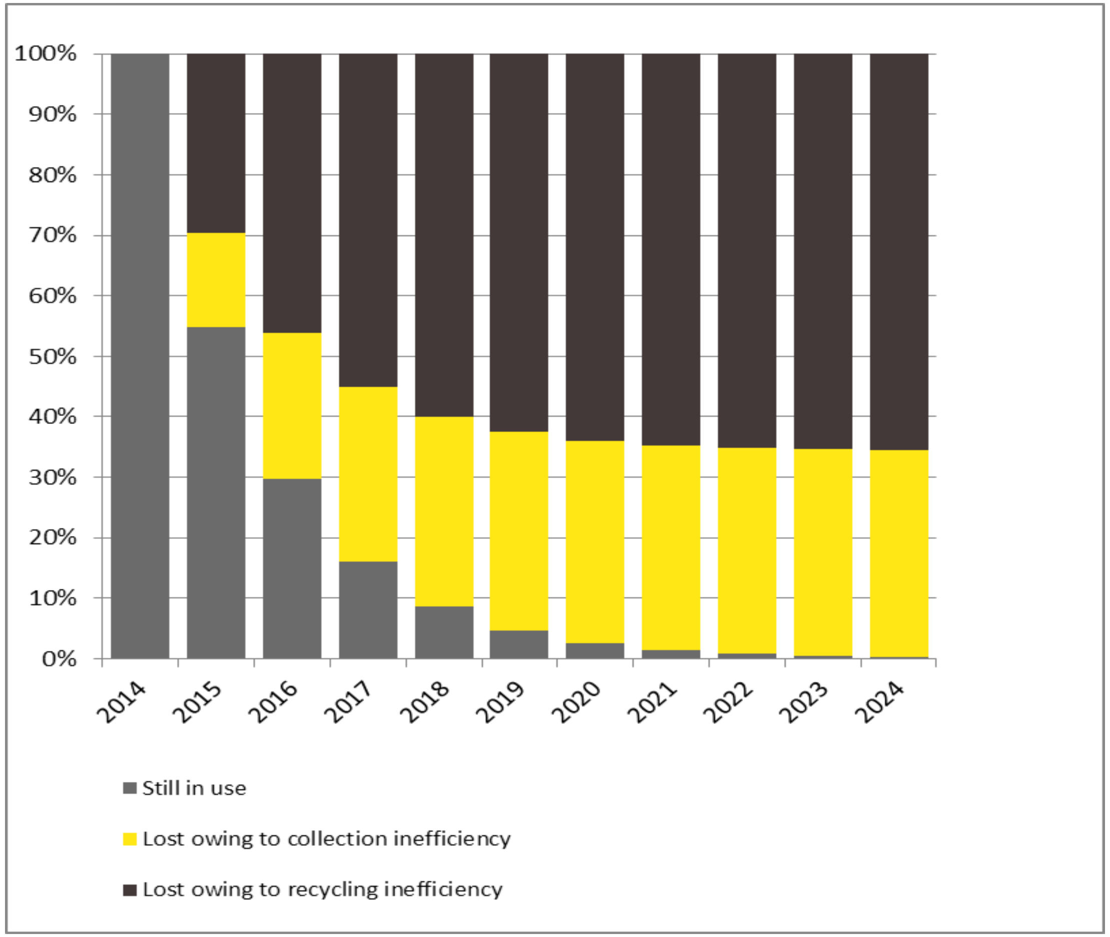


(Adapted and modified from Ciacci et al. 2015)

Products

Al cans

- *Life span of drinking cans = 6 weeks*
- *Collection and pre-processing rates of waste cans = 97%;*
- *Recyling process efficiency= 97%*
- *Collected and recycled aluminum is repeatedly included in the model.*
- *Conclusion:*
  - → After 1 year 45% of the aluminum put in use is lost.
  - → After 5 years only 5% of the aluminum remains.
  - → After ten years only 0,2% is left.



Ways to explore

SUBSTANCES

Increase the level of collection

Increase the level of recycling

Increase the efficiency of recycling

ECODESIGN OF PRODUCTS

Increase lifespan

Address entropic backfire

Promote substitution

Many thanks!

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http://ec.europa.eu/environment