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End-of-life vehicles recycling in Germany and recent developments

International Workshop on 3R Strategy and ELV Recycling
September, 19 to 21, 2012, in Nagoya, Japan

Regina Kohlmeyer,
UBA – Federal Environment Agency, Germany, Dessau

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Overview

1. **Waste management in Germany**
2. **ELV Recycling: German Legislation**
3. **Statistical information on ELVs and car export**
4. **ELV Recycling and Dismantling; Recycling Rates**
5. **Recent challenges and research projects**

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UBA - German Federal Environment Agency

- Largest scientific agency in the field of environmental protection in Germany.
- More than 1000 employees.
- Wide range of environmental issues, from e.g. noise and drinking water to climate change and waste management.

Main tasks

- Scientific support for the German Federal Ministry for the Environment
- Collecting and assessing data on the environment
- Informing the public on environmental issues

Federal Environment Agency in Dessau, Germany
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1.Waste management in Germany

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Waste Management in Germany: Legal Framework

European level: EU

- Waste Framework Directive: 1975 first WFD
  2008 new WFD (2008/98/EC)
- Further waste provisions, e.g. landfill sites, waste incineration, hazardous waste, transboundary shipment of waste, recovery of product waste

National level: Germany

- Development of legislation:
  1972 Waste Disposal Act
  1986 Waste Act
  1996 Recycling Management and Waste Act
  2012 Recycling Management Act
- Further waste laws and ordinances.

Regional level: 16 Federal States

- Implementation and **enforcement** of national law

Local level: Municipalities

- Self administration, e.g. Statutes of the local authority waste management services (collection, …)

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Waste Legislation: Objectives and Main Aspects

EU Waste Framework Directive: Objective

Protect the environment and human health by
- preventing or reducing the adverse impacts of the generation and management of waste
- reducing overall impacts of resource use and improving the efficiency of resource use.

→ *German Recycling Management Act: Similar scope*

German Recycling Management Act: Some general aspects

- Five-step **waste hierarchy**
- **Precautionary principle**, application of best available techniques (**BAT**) in waste management
- **Permit** for waste treatment plants under Federal Immission Control Act
- **Landfill ban** for untreated waste
- General responsibility for waste: domestic waste → municipality
  other waste → private sector
- **Extended producer responsibility**
- Recyclables bin for packaging extended to non-packaging (metal, plastics)

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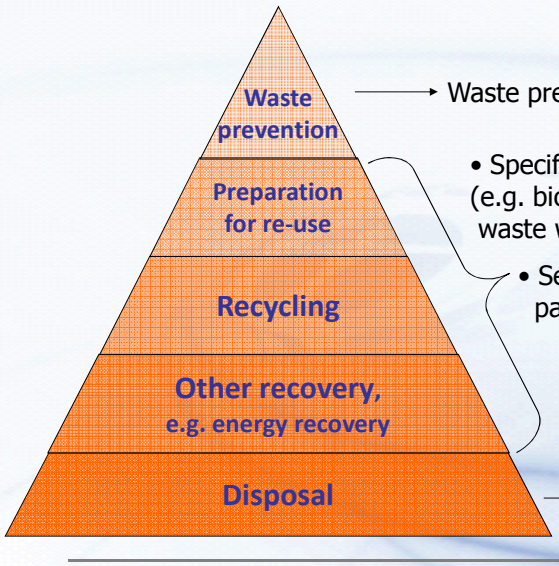
Five step waste hierarchy



→ Waste prevention programme by 2013

- Specific laws and ordinances on recycling (e.g. biowaste, commercial waste, waste oil, waste wood, ELVs, packaging, WEEE, batteries)
- Separate collection by 2015: paper, metal, plastics, glass.
- Recovery rates by 2020:
  - 65 % domestic waste
  - 70 % construction and demolition waste

→ Landfill Ordinance.
E.g. BAT standards for landfill sites; landfill ban for untreated waste.

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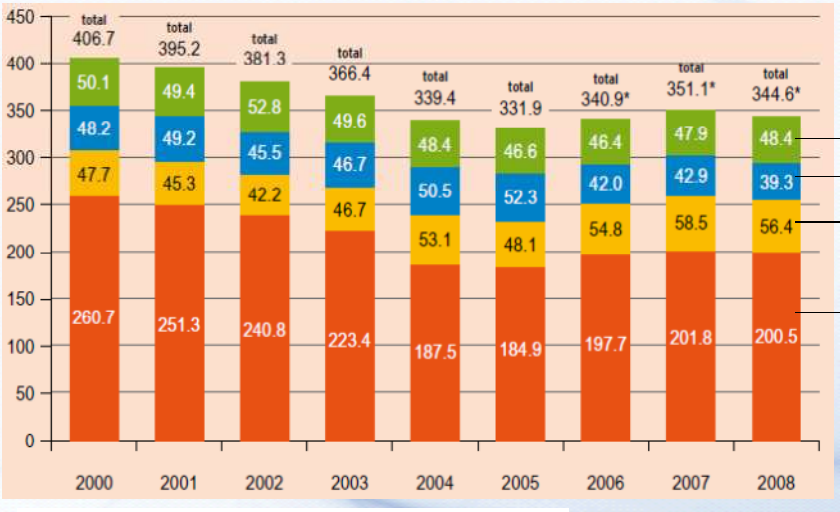
Waste Arisings in Germany (in million tonnes)



Municipal waste
Mining tailings
Manufacturing and commercial waste
Construction and demolition waste

Including 17 million tonnes hazardous wastes

Data source: Federal Statistical Office 2010.
Figure taken from: BMU: Closed-loop waste management. Brochure, 2011

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Household waste – More recyclables than residues

Separate collection

- organic waste
- packaging waste
- glass
- waste paper
- waste batteries
- electronic waste
- waste oil

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Landfilling

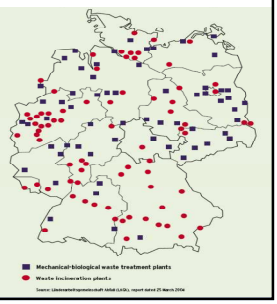
Objective: No disposal of municipal waste by 2020

Landfilling of **residual waste** has been reduced in Germany by combining

→ **material recycling**
(see previous slide)

→ **biological treatment**
50 mechanical-biological waste treatment plants
(capacity: about 7 million tonnes)

→ **waste to energy**
70 waste incineration plants:
(capacity: about 20 million tonnes)



Source:
Länderarbeitsgemeinschaft Abfall (LAGA), 2004

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Extended Producer Responsibility: The 4 Main Waste Streams

	Waste Electrical and Electronic Equipment	End-of-life vehicles (ELV)	Waste Batteries	Packaging
EU Legislation	WEEE 2002/96/EC new: WEEE II 2012/19/EU ROHS 2011/65/EU	ELV Directive 2000/53/EC	Batteries Directive 2006/66/EC	Packaging Dir. 94/62/EC
German legislation	Electrical and Electronic Equipment Act (2005)	ELV Ordinance (2002)	Batteries Act (2009)	Packaging Ordinance (1991)
Design for Recycling	yes	yes	yes	yes
Heavy metal ban	Hg, Cd, Pb, Cr(VI) + organ.	Hg, Cd, Pb, Cr(VI)	Hg, Cd	Hg, Cd, Pb, Cr(VI)
Financing (Germany)	Shared: municipalities (take back), producers (recycling)	Producer: free take back. In fact: ELV value	Producers (take back systems)	Producers (take back systems)
Take back (Germany)	Communal collection points, (+ retailers, producers)	Dismantlers for producers (50 km) + free dismantlers	Retail stores (+ municipalities); car + indust. batt: further options	Retail stores
Collection target	Now: 4 kg/a per capita in 4 y: 45 % / in 7 y: 65 %	-	2012: EU: 25 % / D: 35 % 2016: 45 %	
Deposit (Germany)	-	-	automotive batteries	beverage packaging
Recovery rate	e.g. large equipment: 75/80 %, in 3 years: 80/85 %	2006: 80 % / 85% 2015: 85 % / 95 %	Recycling efficiency: Pb – 65%, Cd – 75 %, other – 50 %	55%/65% of all pack. + material specif. rates
Treatment requirem.	yes	yes	yes	

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2. ELV Recycling: German Legislation

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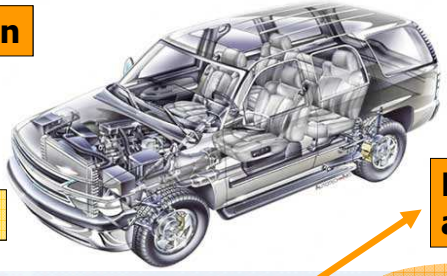
Extended Producer Responsibility in the German ELV Ordinance

Design for dismantling and recycling

Car design

Heavy metal ban Pb, Hg, Cd, CrVI (with exemptions)



Recovery targetsl

Dismantling and Recovery

Production

Recycled material

Take back

Use phase

End-of-life vehicle, (Waste)

Export of Used Vehicle

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Producer Responsibility: Take back of ELVs

- Responsible: 7 vehicle manufacturers in Germany + importers
- Take back the end-of-life vehicle free of charge
- Network of collection: sufficiently comprehensive, if ...

Last owner ELV **< 50 km** Collection point / dismantler

<u>Take back in practice</u>:

- Free of charge or even payment to last owner (scrap price)
- Dismantlers: contract with producer(s) or independent
- In practice ELV treatment not financed by car manufacturers, but ELV value

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Dismantlers' Obligations

ELV Ordinance, Annex, no. 3

- **Requirements with regard to structure, equipment and operation**
  - e.g. mineral oil proof pavement; drain by light fluid trap, if no roof.
  - e.g. no more than 3 ELV may be stack on top of one another without special securing devices
- **Pre-treatment, depollution**
  - e.g. removal of batteries, airbags, liquids, …, applying BAT
- **Dismantling of components for reuse and recycling**
  - e.g. car glass, catalytic converter, tires, (larger plastic components)
- **Facility-related recycling target**
  - 10 % non-metal components for reuse/ recycling
- **Documentation**
- **Annual certification by external expert**

Source: RETEK, M. Knode

Guidance document: ELV treatment, working with hazardous substances (2011)

Federal Immission Control Act

- **Permit** (if 5 ELVs per week or more) **/ notification needed**

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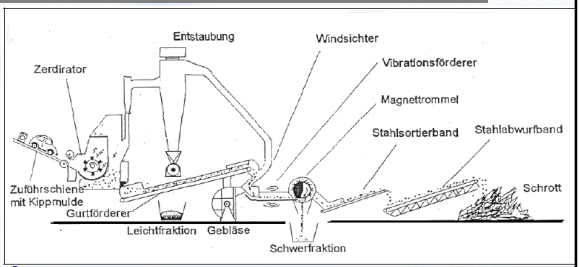
Shredding Facilities' Obligations

Waste related obligations

ELV Ordinance, Annex, no. 4

- General requirements
- Facility-related recycling targets
- Documentation



Emissions, environmental protection

Germany: Federal Immission Control Act

- To operate facility: permit needed, application of BAT
- **Emission limit values for exhaust gases (TA Luft)**
  - → e.g. dust = 20 mg/m³ (in general)
  - → e.g. organic substances = 50 mg/m³ (as total carbon) (in general)

EU: Industrial Emissions Directive 2010/75/EU

- New categorie in Annex I: no. 5.3 (a)(v) and 5.3 (b)(iv):
  „treatment in shredders of metal waste, including WEEE and ELV and their components"
  → Permit needed for shredders in all EU countries.
  → Shredder BAT will be in BAT reference document for "Waste treatment" (2013-2015)

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Recyling/ Recovery targets

1) Recovery targets on national level

(responsibility: all economic operators)

	as of 2006	as of 2015
→ Reuse and **Recycling**	80 %	85 %
→ Reuse and **Recovery**	85 %	95 %

2) Additional facility related recovery targets

→ Assumption: Metal recovery	70 %	
→ Dismantling facilities (non-metal components and materials)	10 % Recy	
→ Shredding facilities (from shr. residue)	5 % Recov	10 % Recov 5 % Recy

3) (Additional: landfill ordinance)

Landfill ban for untreated waste

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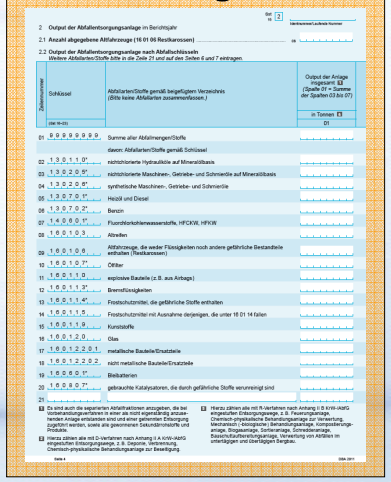
Monitoring of the Recycling/ Recovery Targets

Statistical data collection

- Basis: Waste statistics survey
- Annual reporting by
  all dismantling and shredding facilities
  - ELV input
  - Waste/ product output
- Information flows
  → Statistical offices of regions
  → Federal Statistical Office
  → UBA – Federal Environment Agency
  → Recovery rates to EU Commission

Monitoring sheet



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3. Number of ELVs and car export

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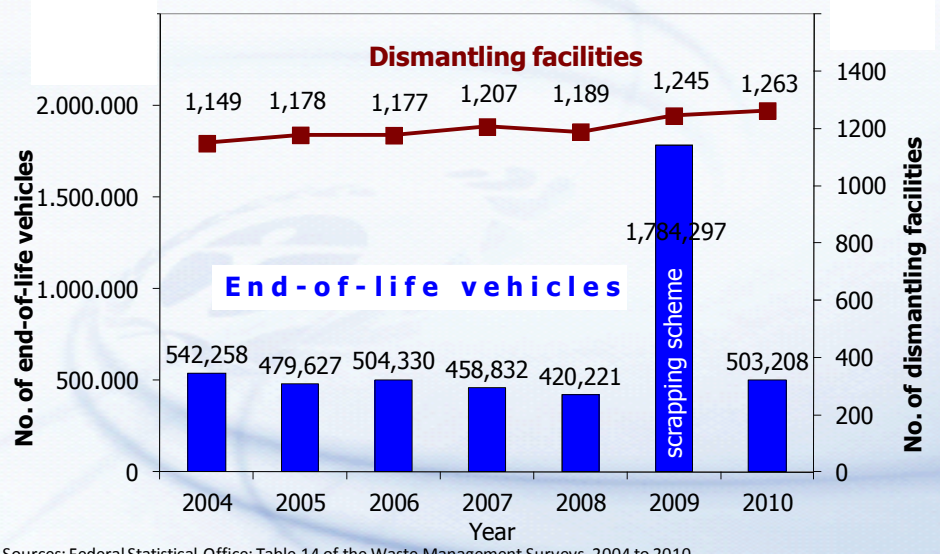
End-of-life vehicles in Germany



Sources: Federal Statistical Office: Table 14 of the Waste Management Surveys, 2004 to 2010

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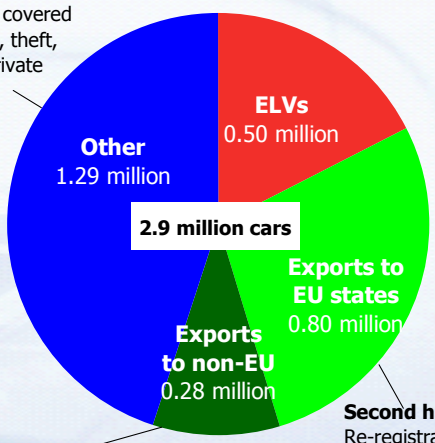
Fate of deregistered cars in Germany, 2010



Sources: Federal Motor Transport Authority: Off-road notifications 2010 and re-registrations 2010.
Federal Statistical Office: Waste Management Survey 2010 and Foreign Trade Statistics 2010.

Second hand cars
Re-registrations and foreign trade statistics
- Poland 397 000
- Romania 46 000
- Netherlands 59 000

Foreign trade statistics
- Former Soviet Union 77 000
- West Africa 102 000

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Correspondents' Guidelines No. 9 Shipment of Waste Vehicles

- **Non-binding guideline under EU Waste Shipment Regulation 1013/2006/EG**
- **Objective: Clear distinction between**
  - → **waste vehicle**: not depolluted or depolluted (stripped vehicle)
  - → **used vehicle**: operational or repairable (or vintage vehicle)
- **Several strong criteria for „waste vehicle"**

  e.g. → Existence of a certificate of destruction.
  → Vehicle destined for dismantling or for scrapping.
  → Vehicle with parts prohibited to be exported (e.g. CFC or HCFC containing a
  → Vehicle is a write-off /has badly damaged essential parts / cut in 2 pieces

Source: H. Junker

- **Several "indications" for "waste vehicle"**

  e.g. → Vehicle without identification number and owner unknown.
  → Vehicle is welded up or closed by insulating foam.
  → Vehicle poses safety risk or a risk to the environment.
- In case of doubt, competent authority may require evidence, certificate.

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4. ELV Recycling and Dismantling and Recycling Rates

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Dismantling and Recycling of ELVs in Germany

About 500 000 ELVs per year (about 900 kg each)

1200 Dismantling facilities (Dismantling, depollution)

- spare parts
- fluids
- recyclable materials

Other scrap

Stripped vehicles

50 Shredding facilities

Shredder light fraction

Shredding scrap

Shredder heavy fraction with non-Fe metal (Al, Cu) → Further treatment (e.g. float-sink separation)

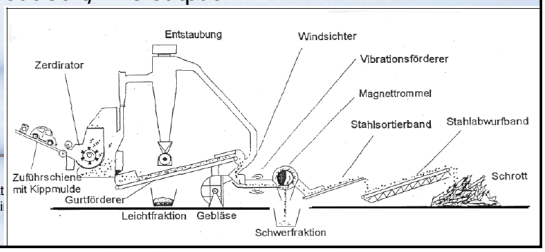
Source: http://www.preuer.de/de/zerkleinerung-von-karossen-jegleicher-art-2.html

ELV industry

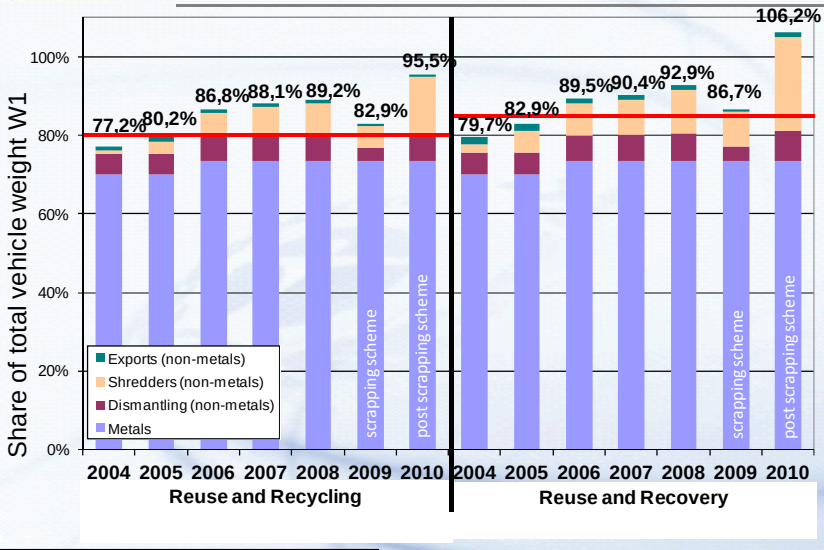
- **Dismantlers**
  - → mainly small businesses, family businesses, partly < 100 ELVs per year
  - → contract with producer or independent facility
  - → tasks: depollution, dismantling, selling spare parts
  - → positive economic value: spare parts, stripped vehicle and e.g. catalytic converter, battery
  - → German practice: few dismantling of glass and plastic parts

Source: RETEK, M. Knode

- **Shredding facilities**
  - → medium or large enterprises
  - → 21 shredders < 750 kW about 15 t/h Fe output
    15 shredders 750 to 1470 kW about 28 t/h Fe output
    15 shredders > 1470 kW about 50 t/h Fe output
    (Source: BDSV, 2007)
  - → input: iron and steel scrap, about 10-15 % ELVs



ELV reuse/recycling and reuse/recovery rates Germany 2004 to 2010



2009:
Scrapping scheme
1.8 million ELV (total)
1.3 million ELV treated
→ lower recycling rates in relation to total number

2010:
„Post" scrapping scheme
0.5 million ELV (total)
0.7 million ELV treated
→ higher recycling rates

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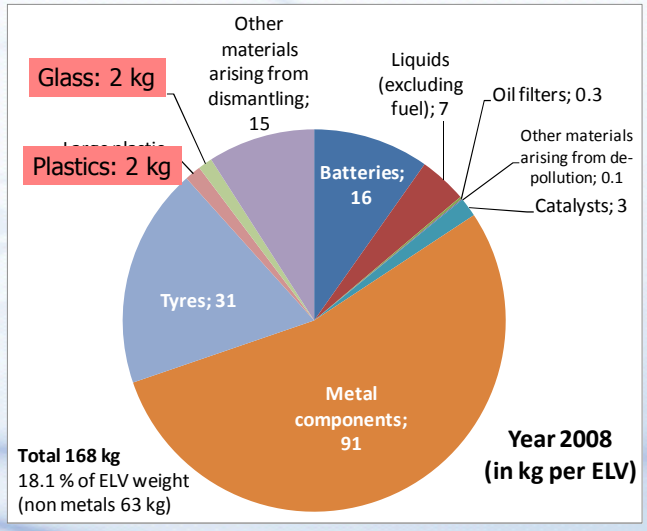
Reuse and Recovery from ELV Dismantling

Average ELV weight (2008): 929 kg

Reuse and Recovery:
18.1% of ELV weight
(non metals 6.8 %)



Source: Federal Statistical Office; UBA

Remark:
2009 and 2010 not fully representative due to scrapping scheme

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Shredder light fraction

- **about 500 000 tonnes per year in Germany, 20 % from ELVs**

Disposal routes

- Waste incineration
- Landfill construction, backfilling of mines (for mainly fine, mineral fraction)
- Landfill ban for untreated waste (since 2009)
- Post-shredder treatment (PST)

Post-shredder treatment (PST)

- Large PST plant operating in Saxony (Scholz AG in Espenhain): 100 000 t/a
  - Mechanical treatment (sorting, classification).
  - Outputs: mineral fraction (< 2mm), 3 light fractions, heavy fraction, metal fraction.
- Treatment activities on shredder site
  e.g. classification in fine grain (mineral) and coarse grain (high-caloric)
  e.g. metal separation (eddy current separator, sensor based)

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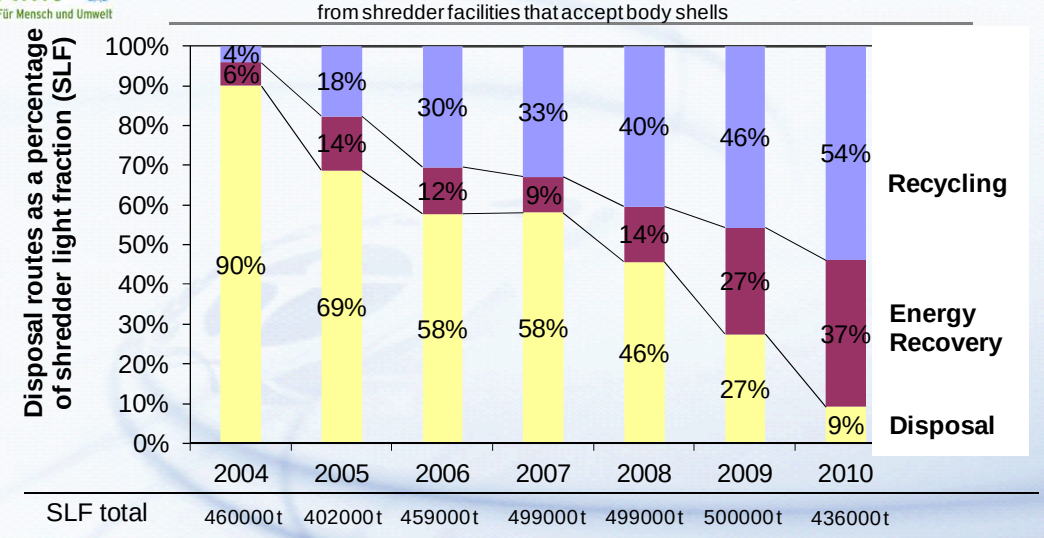
Disposal of shredder light fraction

from shredder facilities that accept body shells



Source: Federal Statistical Office: Table 15 of the Waste Management Surveys, 2004 to 2010.
Final fate of shredder light fraction

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VW Sicon - Post-shredder Treatment Process

→ Complex mechanical process with
Pre-treatment, Treatment and "Refining" of output fractions.

→ No VW Sicon plant operating in Germany, but large scale plants in other EU countries
(Netherlands; pilot plant: Belgium; similar concept: Austria)

Output fractions	Fraction (circa) (1)	Recycling/ Recovery Options
Ferrous and non-ferrous metals	5 % 3 %	Metal recycling
Shredder granulate (plastic, low chlorine, low metal)	33%	Reducing agent in blast furnaces
Plastic fraction (high PVC content)	3 %	PVC recycling
Shredder fibres (textile fibres and seat foam)	31 %	Dewatering agent for sewage sludge
Shredder sand + other (glass, residual metal, dust)	26 %	Disposal (Recovery ?)

Sources:
(1) GHK: A Study to Examine the Costs and Benefits of the ELV Directive – Final Report, Annex 3 (2006)
(2) JRC: Environmental Improvement of Passenger Cars (IMPRO-car) (2008)

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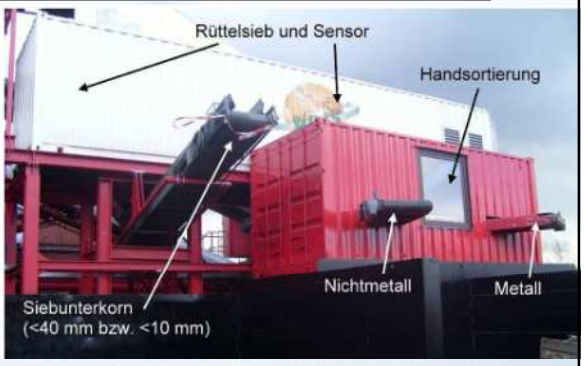
Metal separation from SLF

Compact sorting plant at the shredding facility of „LSH Lübecker Schrotthandel"

- Metal separation from SLF > 20 mm
- Container design, suitable for retrofitting
- Input: 24 000 t SLF
  metal content: about 8 %
- Outputs:
  - → metal recovery at least 6 %
    (40% Al, 40 % stainless steel,
    20 % other non-ferrous metals)
  - → metal „free" output (< 1 % metal)
- Rough flow chart



Source: LSH Lübeck
Final Report on
Compact Sorting Plant

Metering drum → Air separator → Sorting unit:
3D-vibrating sieve and innovative sensor

Project information http://www.cleaner-production.de/en/projects-publications/projects/waste-avoidance-recycling/compact-sorting-plant-for-metal-extraction-from-shredder-lightfractions.html

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5. Recent challenges and research projects

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Challenge: High Grade Recycling

	Dismantling	versus	Post-shredder treatment
Plastic components	Material recycling (e.g. of bumpers)	⟷	Energy recovery
Glass	Material recycling, e.g. container glass, glass wool	⟷	Landfill construction, backfilling
Metal residues in SLF	More comprehensive dismantling	⟷	Metal separation from shredder leight fraction

Future challenge

Automobile electronics

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Dismantling of automotive electronics

Mass of electronics parts in ELVs increasing

Challenge: Inventory of automotive electronics, Dismantling time,
Value and demand of control units as spare parts,
Content of valuable material (PCBs, copper, rare earths (?)) for recycling

Example: VW Golf series: Development of the electronic control units

Vehicle	Year of manufacture	Vehicle weight	Potential number of control units	Dismantling time	Potential value (2008) as spare part	as new
Golf 1	1974 - 1983	750 kg	1 Stck.	10 min.	130 €	514 €
Golf 2	1983 – 1992	845 kg	5 Stck.	80 min.	240 €	1.750 €
Golf 3	1991 - 1998	960 kg	9 Stck.	170 min.	487 €	2.379 €
Golf 4	1997 - 2003	1050 kg	16 Stck.	240 min.	1.530 €	3.798 €
Golf 5	2003 - 2008	1155 kg	28 Stck.	360 min.	2.744 €	6.268 €

Source: Martin Knode, RETEK. Presentation on final workshop ReECar, 13.11.2008.
http://www.reecar.org/servlet/is/951/06-Knode-Demontage.pdf?command=downloadContent&filename=06-Knode-Demontage.pdf

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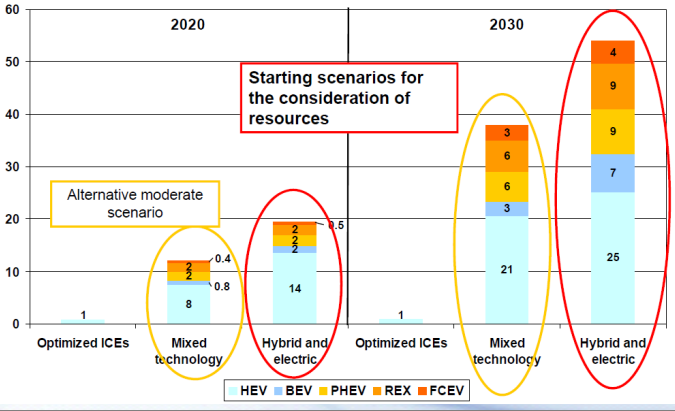
ELV Challenge: Electro-mobility

Three global scenarios (McKinsey 2009)

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

Annual registrations of new passenger vehicles with (partially) electric motor [in million vehicles]



Global outlook 2030:
40 to 50 million new hybrid and electric vehicles per year

Source: Öko-Institut et al: Resource efficiency and resource-policy aspects of the electro-mobility system - Results, 2011
http://www.oeko.de/oekodoc/1354/2011-457-en.pdf

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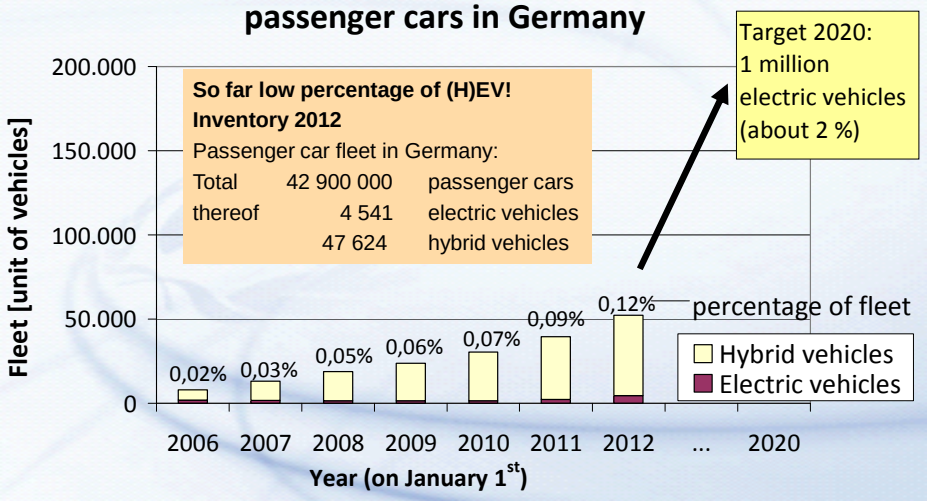
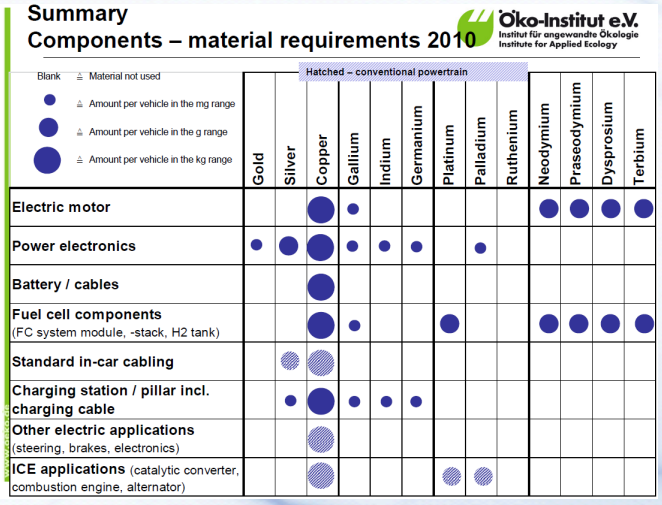
Electric vehicles in Germany

Fleet of electric and hybrid passenger cars in Germany



Raw material demand for electric vehicles



➢**Additionally:**
Traction batteries
- Lithium-ion or
➢Nickel-metal hydrid
→ Increasing damand on
- ➢ cobalt
- ➢ lithium

Source: Öko-Institut et al: Resource efficiency and resource-policy aspects of the electro-mobility system - Results, 2011
http://www.oeko.de/oekodoc/1354/2011-457-en.pdf

Electric vehicles – "Critical" raw materials

Outlook on supply risks 2030

- **Rare Earths** Dysprosium demand 2030 for E-vehicles: 6-time global production. High environmental impact
- **Copper** Up to 70 kg copper instead of about 25 kg per vehicle.
- **Precious metals** Several grammes of silver, 100 mg gold and palladium. But: Less platinum/ palladium, if no more catalysator.
- **Lithium, cobalt** Batteries: LFP: Li, NMC: Li + Co.
- **Gallium, germanium, indium:** Increasing competing applications (LED, photovoltaics). Gallium demand 2030: 1.4-times of global production.

Challenges for action

- Include electro-mobility in sustainable transportation concept
- Resource efficiecy: electric motors with little or no permanent magnets
- Promotion of more environmentally sound mining of critical metals
- Recycling: effective and important in the medium term.

Research for Recycling in Germany

→ Batteries: e.g. LithoRec and LiBRi → Electric motors: MORE – Recycling of motors

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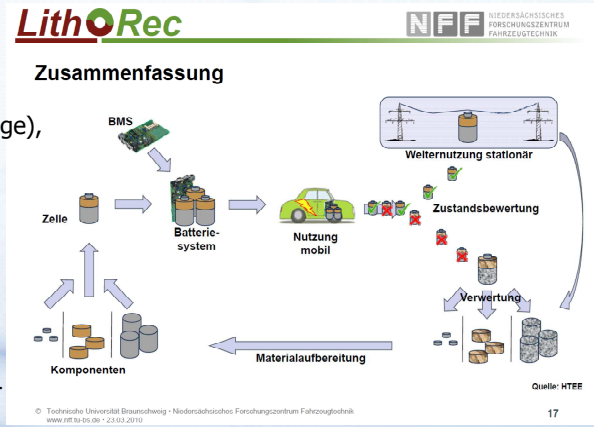
Challenge: Recycling of lithium-ion batteries for EV

German research projects to develop recycling processes

- Lithorec (hydromechanical approach, Chemetall)
- LiBRi (pyrometallurgical approach, Umicore)

Whole recycling chain:

- Collection
- Transport (regulations for dangerous goods, risk of short circuit, explosion, ignition),
- Reuse/ remanufacturing (e.g. for energy storage),
- Dismantling of cells and other components (e.g. casing, BMS, cooling system)
- Recycling of dismantled components, incl. Li.



LCA for LithoRec and LiBRi

- High environmental benefit: recovery of „battery specific" (Co, Ni) and „conventional" raw materials
- Optimisation potentials: e.g. slag treatment or hydrometallurgic Li-recovery

19 Sept Source: Vortrag Prof. Kwade: http://www.lithorec.de/fileadmin/lithorec/Ver%C3%B6ffentlichungen/Vortrag_Hybrid_Kwade_100222.pdf
7. Braunschweiger Symposium Hybrid-, Elektrofahrzeuge und Energiemanagement (Februar 2010, Braunschweig)

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ELV – Further information, useful links

Legislation EU

→ EU: Commission's website (English):
http://ec.europa.eu/environment/waste/elv_index.htm

→ EU: Directive 2000/53/EC on End-of-life Vehicles (as of 2010)
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0053:20101201:EN:PDF

→ Latest version of Annex II (exemptions of heavy metal ban) : Commission Directive 2011/37/EU:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:085:0003:0007:EN:PDF.

→ Guidance Document to the ELV Directive (non-binding), 2005, english):
http://ec.europa.eu/environment/waste/pdf/guidance_doc.pdf

Legislation Germany

→ End-of-life Vehicles Ordinance (German, lastest version, as of 2012):
http://www.gesetze-im-internet.de/bundesrecht/altautov/gesamt.pdf

→ End-of-life Vehicles Ordinance (English, without amendments, as of 2002):
http://www.bmu.de/english/waste_management/downloads/doc/3241.php

→ End-of-life Vehicles Act (English, without amendments, as of 2002)
http://www.bmu.de/english/waste_management/downloads/doc/3240.php

Guidance documents

•Guidance for certification (in German, non-binding): Prüfliste - Altfahrzeugentsorgung / Demontagebetriebe. Vom Institut für Sachverständigenwesen e.V., http://www2.ihk-umkis.de/altauto/ChecklisteAltauto.pdf

•Study on best available techniques of pre-treatment and depollution of ELVs (in German): Beschreibung des Standes der Technik bei der Vorbehandlung, insbesondere der Trockenlegung von Altautos gemäß AltautoV, http://www.umweltdaten.de/publikationen/fpdf-l/2266.pdf

•Guidance document for ELV dismantling: Working with hazardous substances (in German): Handlungsanleitung zur guten Arbeitspraxis Kraftfahrzeugrecycling - Tätigkeiten mit Gefahrstoffen beim Recycling von Kraftfahrzeugen, 2011: http://www.bvse.de/328/564/8__Checkliste_Gefahrstoffe_in_Kfz_Recycling_Betrieben

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ELV – Further information, useful links (2)

Further legal information

- Background paper on German ELV act of 2002 (Englisch, 1 page): http://www.bmu.de/english/waste_management/doc/3443.php
- Report on the ELV Recycling Rates 2009
  German: http://www.bmu.de/abfallwirtschaft/abfallarten_abfallstroeme/altfahrzeuge/doc/47598.php
  English: http://www.bmu.de/english/waste_management/downloads/doc/47844.php
- Report on the ELV Recycling Rates 2010
  German:
  http://www.bmu.de/abfallwirtschaft/downloads/doc/48914.php
  English: to be published soon on www.bmu.de
- Verwertungsquoten für Altfahrzeuge in den EU-Staaten, 2006-2009: http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/key_waste_streams/end_of_life_vehicles_elvs
- Correspondents' Guidelines No. 9 (to Waste Shipment Regulation): Shipment of Waste Vehicles.
  English and German: http://ec.europa.eu/environment/waste/shipments/guidance.htm
- BMU-website ELV (German): http://www.bmu.de/abfallwirtschaft/fb/altfahrzeuge/doc/41157.php
- UBA-website ELV (German): http://www.umweltbundesamt-umwelt-deutschland.de/umweltdaten/public/theme.do?nodeIdent=2304

Emissions

- Federal Immission Control Act BImSchG (German): http://www.gesetze-im-internet.de/bundesrecht/bimschg/gesamt.pdf
  BImSchG (english, amendments until 2007):
  http://www.bmu.de/files/pdfs/allgemein/application/pdf/bimschg_071023_en.pdf
- TA Luft (German): http://www.bmu.de/files/pdfs/allgemein/application/pdf/taluft.pdf
  TA Luft (English): http://www.bmu.de/english/air_pollution_control/ta_luft/doc/36958.php
- EU Industrial Emissions Directive 2010/75/EU: EU commission's website with link to legislation: http://ec.europa.eu/environment/air/pollutants/stationary/index.htm

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Further information on waste batteries (I)

European Union

- **Commission's Website on Waste Batteries**: http://ec.europa.eu/environment/waste/batteries/index.htm (information on legislation, studies)
- **EU Batteries Directive 2006/66/EC**, text of 2006 (all EU-languages)
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006L0066:EN:NOT
  Consolidated version 2008 (English): http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006L0066:20081205:EN:PDF
- **FAQ - Questions and Answers (2011)**: http://ec.europa.eu/environment/waste/batteries/pdf/qa.pdf
- **Commission Decisions/ Regulations**
  - COM Decision 2009/603/EC (requirements for registration) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0603:EN:NOT
  - COM Decision 2009/851/EC (questionnaire for implementation reports) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009D0851:EN:NOT
  - COM Regulation 1103/2010 (EU) (capacity labelling of rechargable batteries) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010R1103:EN:NOT
  - COM Regulation 493/2012/EU (calculation recycling efficiency) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32012R0493:EN:NOT

Recycling of Lead-acid batteries

- Secretariat of the Basel Convention: Technical Guidelines for the environmentally sound management of waste lead-acid batteries (2002) http://www.basel.int/Portals/4/Basel%20Convention/docs/pub/techguid/tech-wasteacid.pdf
- BAT reference document on non ferrous metals industries (2nd draft, 2009): http://eippcb.jrc.es/reference/BREF/nfm_2d_07-2009_public.pdf (chapters on lead)

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Further information on waste batteries (2)

Germany

- **German Batteries Act** (of 2009, English version, without amendments): http://www.bmu.de/english/waste_management/downloads/doc/46810.php
  Batteries Act (latest version 2012, German): http://www.gesetze-im-internet.de/bundesrecht/battg/gesamt.pdf
- Ordinance on the implementation of the Batteries Act (German: http://www.gesetze-im-internet.de/bundesrecht/battgdv/gesamt.pdf
- **BattG-Register for battery producers (UBA):** https://www.battg-melderegister.umweltbundesamt.de/battg/
- **UBA-Booklet on Batteries** (German): http://www.umweltdaten.de/publikationen/fpdf-l/3057.pdf

- German Ministry for the environment (BMU), website: http://www.bmu.de/english/
- Research projects on the recycling of lithium ion batteries for electric vehicles (2011, German): http://www.pt-elektromobilitaet.de/projekte/batterierecycling/lithorec and http://www.pt-elektromobilitaet.de/projekte/batterierecycling/libri

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Extended producer responsibility: Other waste streams

- **Waste electric and electronic equipment**
  → EU Commission's websites: http://ec.europa.eu/environment/waste/weee/index_en.htm
  http://ec.europa.eu/environment/waste/rohs_eee/index_en.htm

  → WEEE Directive 2002/96/EC on Waste Electrical and Electronic Equipment
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2002L0096:20080321:EN:PDF

  → WEEE II Directive 2012/19/EU on Waste Electrical and Electronic Equipment
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:EN:PDF

  → ROHS II Directive 2011/65/EU on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:174:0088:0110:EN:PDF

  → Germany Electrical and Electronic Equipment Act (ElektroG) (as of 2005)
  http://www.bmu.de/english/waste_management/acts_and_ordinances/acts_and_ordinances_in_germany/doc/6554.php
- **Packaging**
  → EU Commission's website: http://ec.europa.eu/environment/waste/packaging/index_en.htm
  → EU Directive 94/62/EC on Packaging and Packaging Waste
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:01994L0062-20050405:EN:NOT
  → Germany Ordinance on the Avoidance and Recovery of Packaging Wastes
  http://www.bmu.de/english/waste_management/downloads/doc/37115.php
- **Waste oil**
  → EU Waste Framework Directive 2008/98/EC, especially Article 21
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF
  → Germany Waste Oil Ordinance (as of 2002)
  http://www.bmu.de/english/waste_management/doc/39581.php
- **Waste in general**
  → Recycling Manament Act (German, 2012): http://www.gesetze-im-internet.de/bundesrecht/krwg/gesamt.pdf
  → German Ministry for the Environment: Booklet on recycling and waste management (English, 2011): http://www.bmu.de/files/pdfs/allgemein/application/pdf/broschuere_kreislaufwirtschaft_en_bf.pdf

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Thank you very much for your attention!

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