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Precious Metals Recycling in a Global Perspective

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PGM are crucial in modern industrial societies

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- PGM usage in today's key technologies
  (chemical catalysis, emission purification, electronics, fuel cells, ...)
- 85% of mankind's cumulative PGM-mine production (> 7000 t) took place from 1980 onwards
- German PGM-gross demand will rise by 30% until 2020
- Germany today: gross usage 40 t/a (1.2 Billion $),
  inventory > 250 t (> 7.5 Billion $)
- High price volatility severely impacts demand segments
- PGM-recycling shows significant ecological benefits compared to PGM-mining (about 10 times better in the case of CO_2 equiv.)
- Global dependence on South Africa and Russia,
  no PGM mining in Europe

The research report

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Authors: Hagelüken, Buchert, Stahl

“Stoffströme der Platingruppenmetalle”

GDMB Medienverlag, Clausthal Zellerfeld 2005

ISBN 3-935797-20-6

234 S., über 70 Abbildungen und Tabellen, 45 €

“ Materials Flow of PGM in Germany”

English edition with introduction by GFMS

GFMS Ltd, London 2005

ISBN 0-9543293-7-6

300 pages, 100 €

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umicore
Precious Metals
Refining

G F M S

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Material flows of PGM

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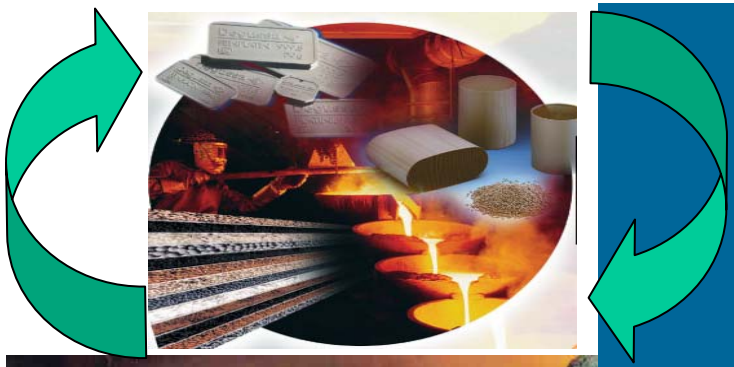

Significance of PGM

Secondary material flows & PGM-lifecycle efficiencies

- Results of a research project
  - oil refining & chemical catalysts
  - automotive catalysts
  - Other applications
- Summary & conclusions
- Consequences for the recycling industry

Global mine production of PGM

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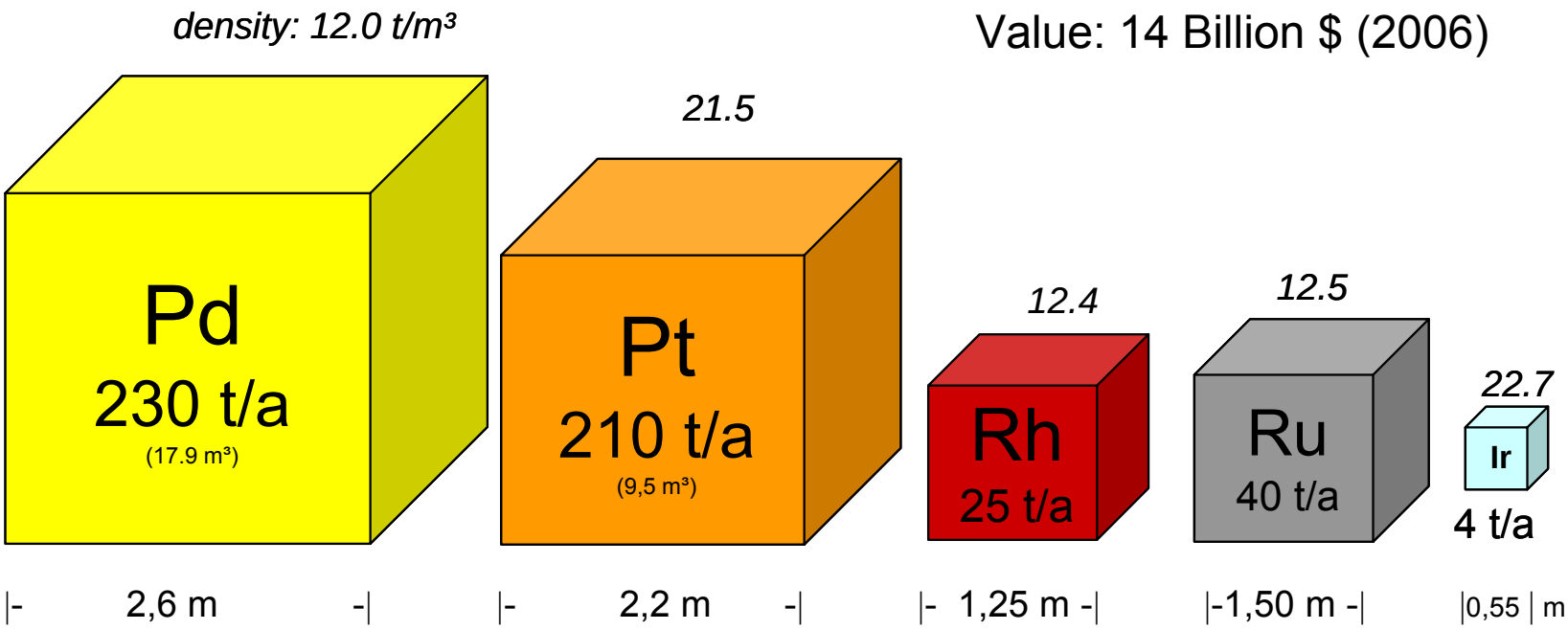
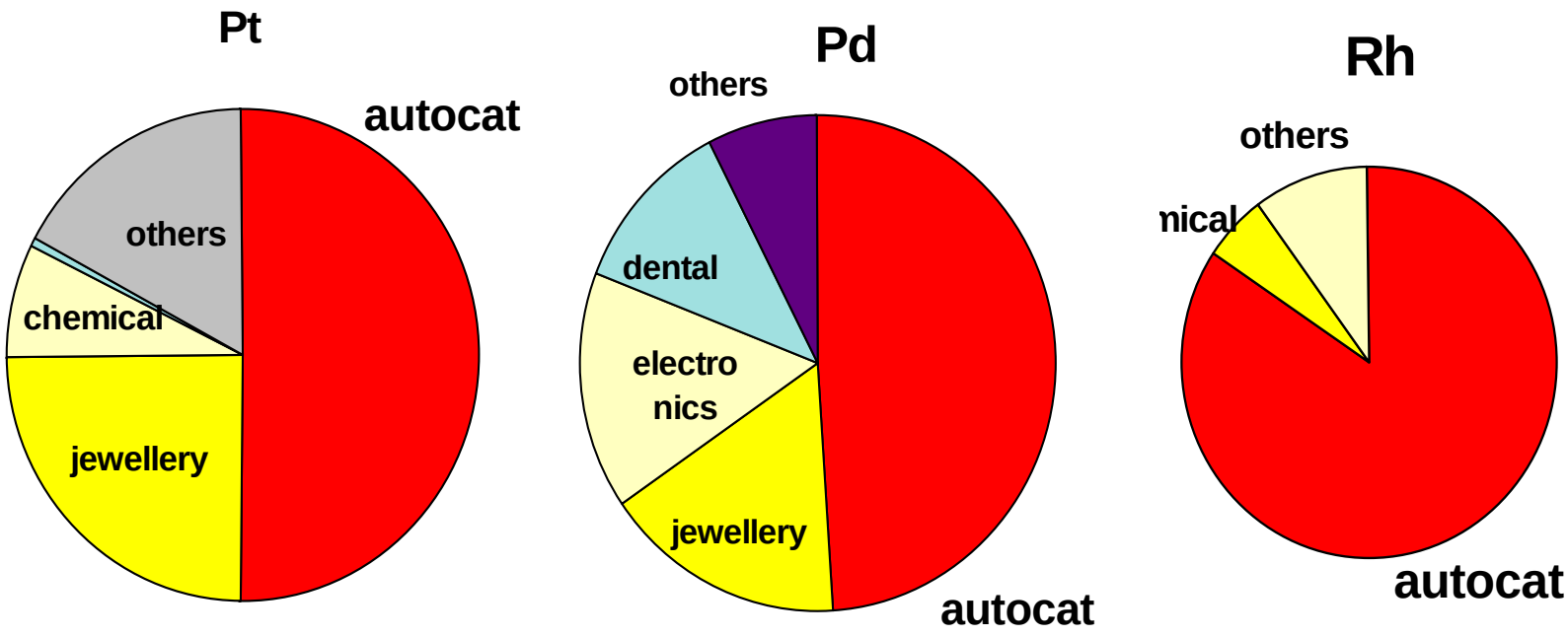
The global mine production of Platinum Group Metals (PGM) fits into a small room

Data: Christian Hagelüken, Umicore

Mine Production PGM:
> 85% South Africa & Russia
PGM Concentration < 10 g/t
Value: 14 Billion $ (2006)



Global PGM net demand 2006



global net demand 2006

Data: Christian Hagelüken, Umicore, Numbers based on JM

PGM-flows of Pt/Pd catalysts used in the oil refining industry

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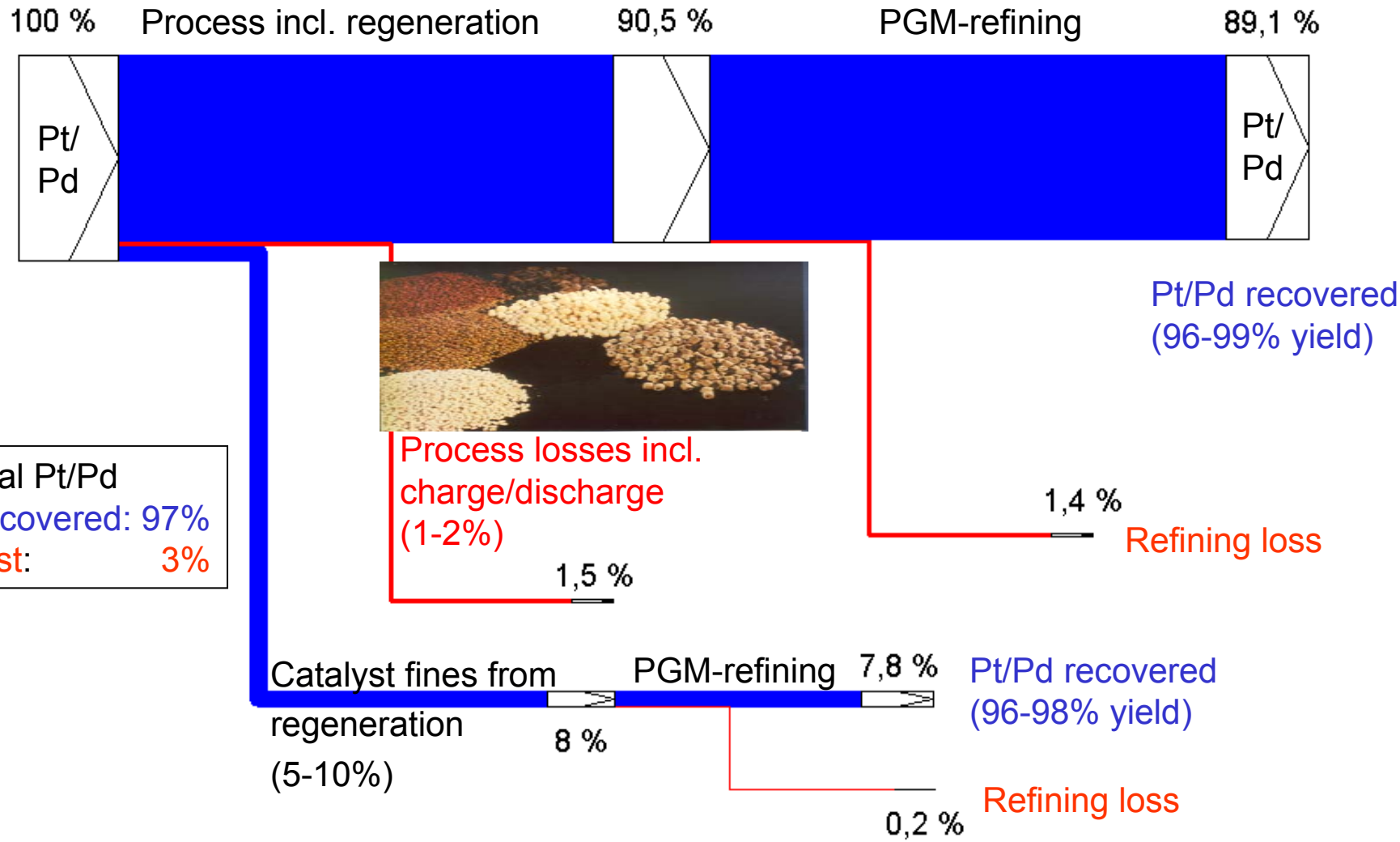

all %-numbers at single flows refer to 100% initial material; refining yields on input into PGM refinery

Mine above ground

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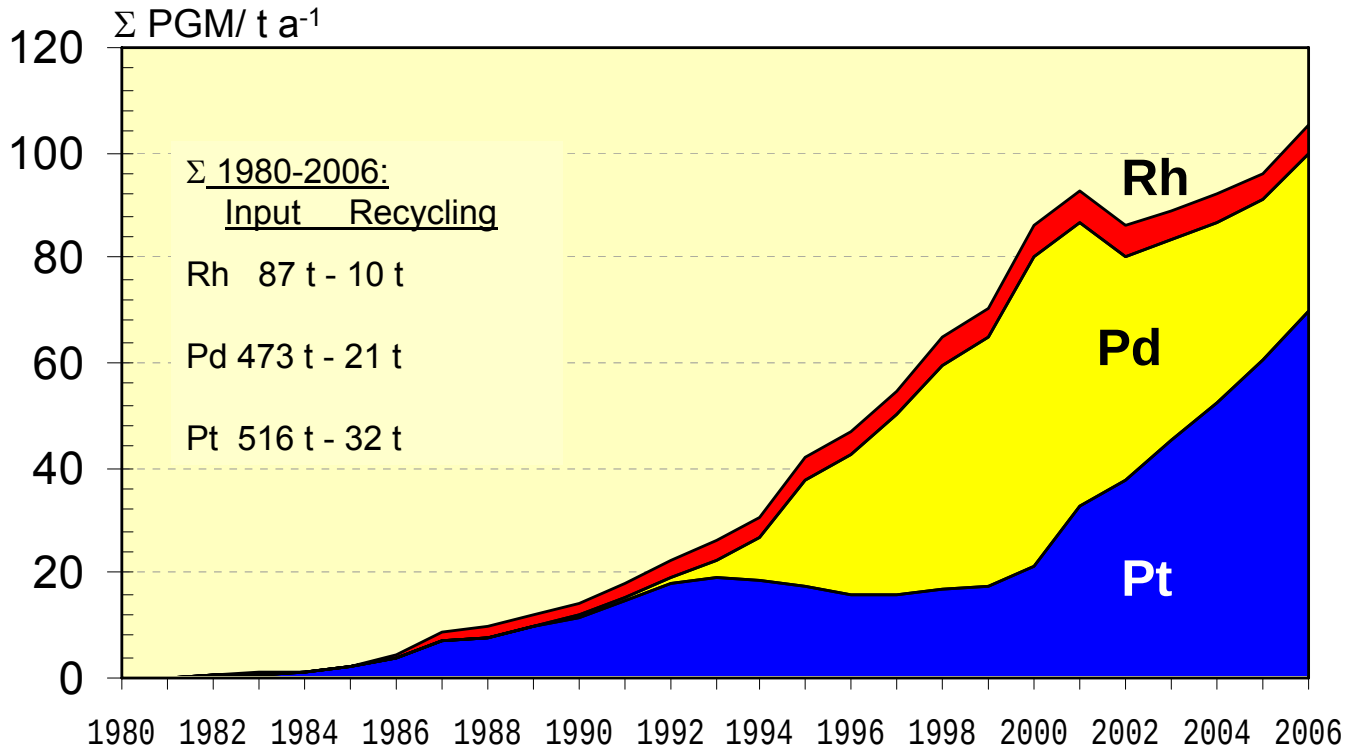
Automotive catalysts: gross demand Pt,Pd,Rh in Europe



Data: Christian Hagelüken, Umicore, Numbers based on JM

Motivation to use this "Mine above ground"

Catalyst recycling ....

... secures a sustainable supply of PGM

... contributes to stabilise PGM-prices

... decreases the dependence on primary producers
(mainly South Africa and Russia)

... has a much lower ecological impact than
PGM-mining

PGM-flow and loss distribution for ELV- auto catalysts in Germany, 2002

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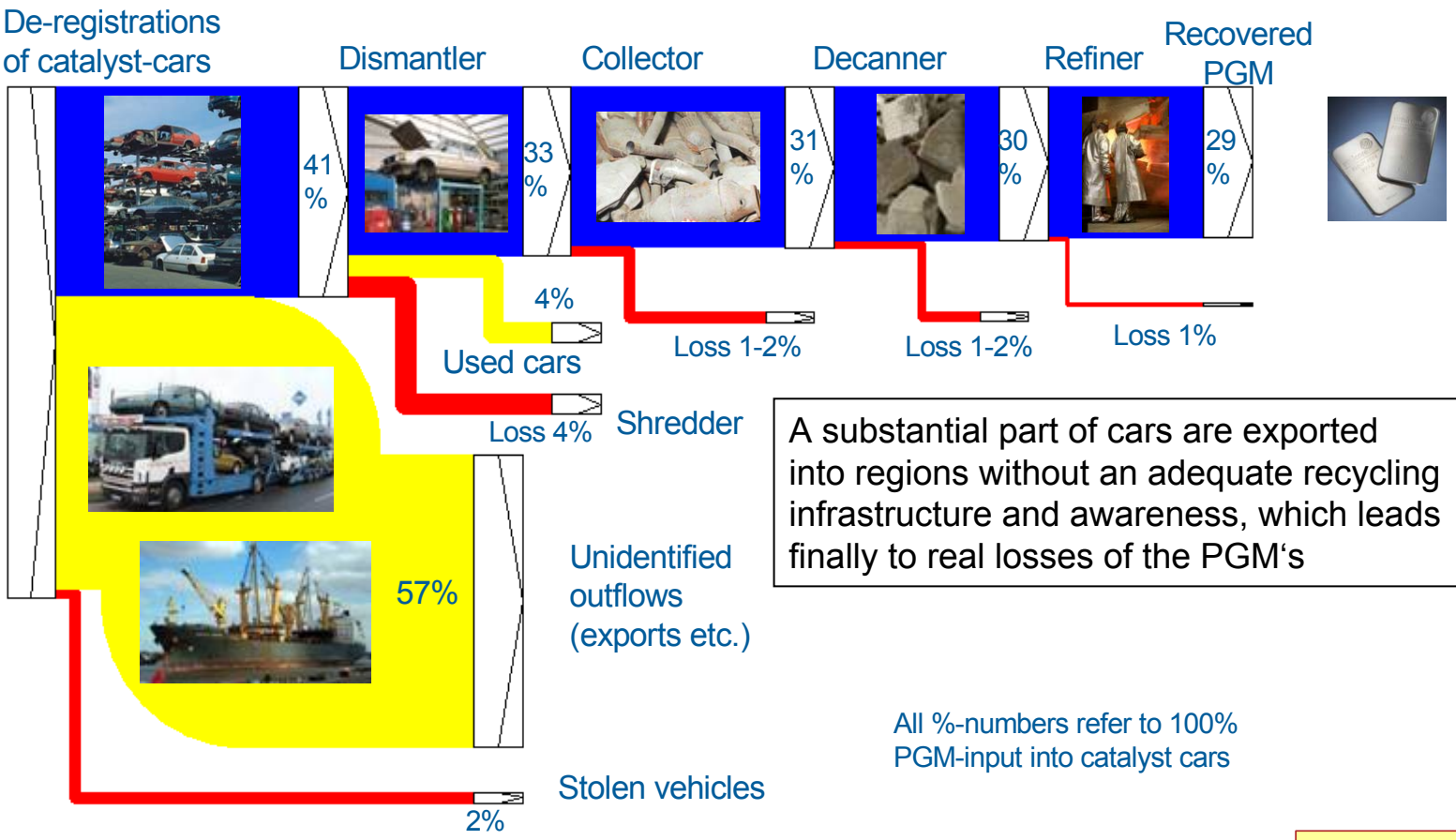

A substantial part of cars are exported into regions without an adequate recycling infrastructure and awareness, which leads finally to real losses of the PGM‘s

All %-numbers refer to 100% PGM-input into catalyst cars

- yellow: outflow from system boundary (e.g. export of ELV); recycling abroad or re-import of catalyst is theoretically possible

ELV monitoring 2004, D

- 3,1 Mio car de-registrations
- 1,2 Mio out of these collected/first treated in D
- 540 000 only final treatment in D

Auto catalyst - methodology

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Statistical data by year, emission level and engine size

Transfer into an „Excel“-model

Project findings, actual market data and forecast

Car inventory

New registrations

De-registrations

Calculation model

De-registered catalyst cars → PGM potential from catalyst recycling

PGM-loading by emission level and engine size

Field study

Losses

PGM recovered from catalysts in Germany

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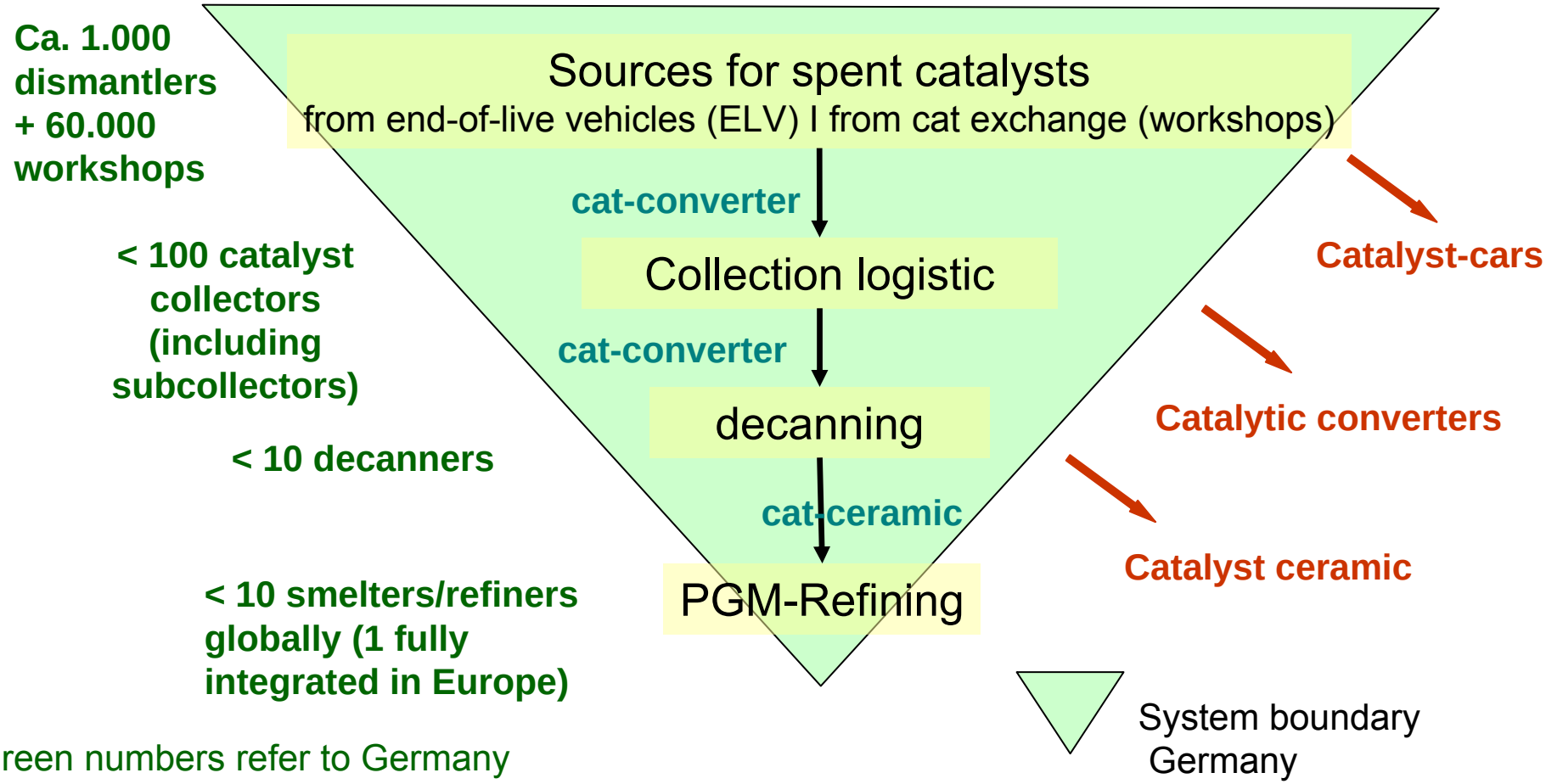
Recycling chain for automotive catalysts

- the physical PGM recovery is limited to a few specialists worldwide



Green numbers refer to Germany

Challenge for PGM-recycling from many export cars

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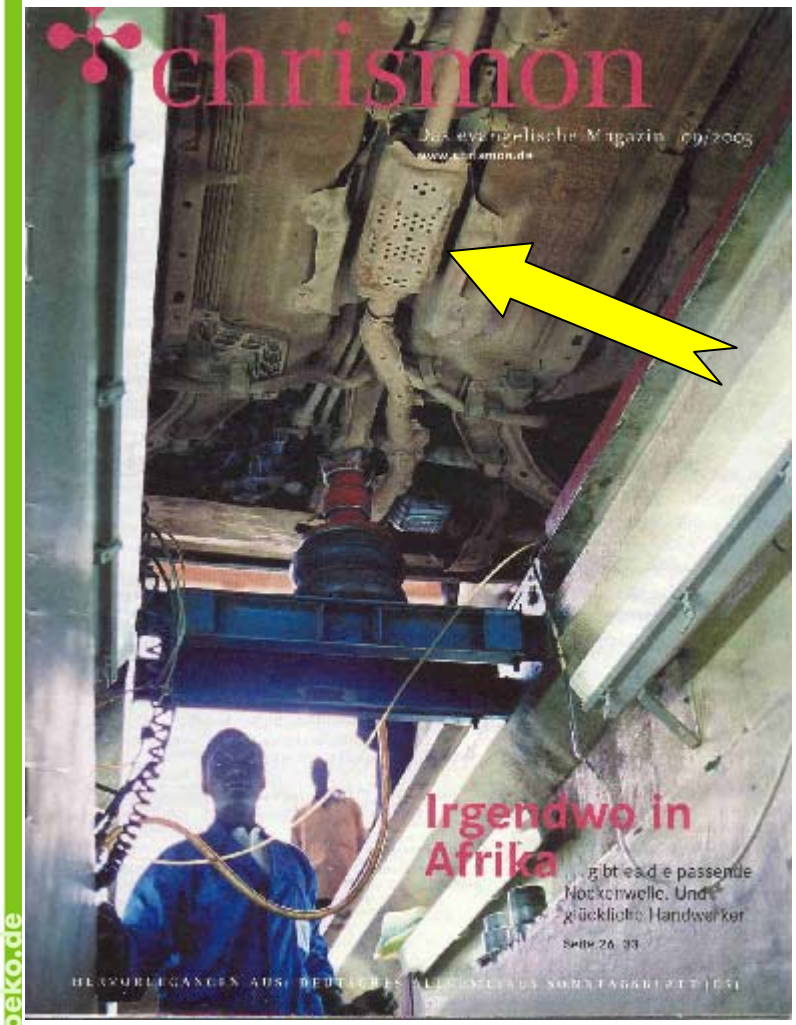
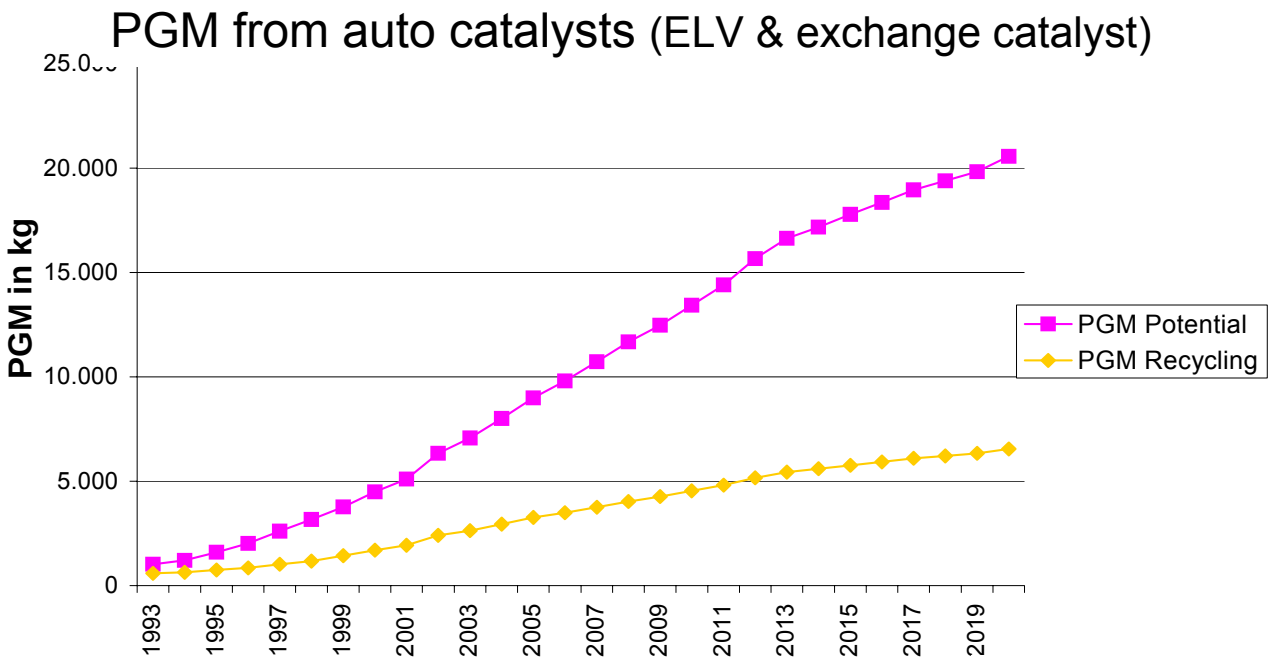


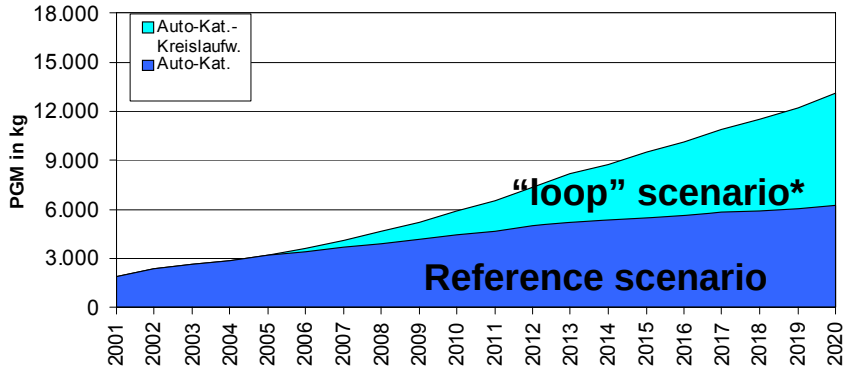
- exports mainly to Eastern Europe (& beyond) & Africa; Middle East
- in many of these countries no emission legislation /-control in place
- insufficient car maintenance, bad road conditions
- high probability for destruction of catalyst
  → emission of ceramic/PGM
  (misfire, bumps on converter ...)
- Usually high vehicle lifetime, catalyst has rather no significance (as long as car is still driving)
- insufficient recycling infrastructure, missing awareness for catalyst recycling
- difficult logistical frame conditions

PGM-recycling potential from automotive catalysts in D until 2020

(„reference scenario“)



A linear increase of the dynamic recycling rate to 70% (“loop scenario”) would double the PGM recycling volumes



Deficit analysis: PGM lifecycle efficiencies for main segments

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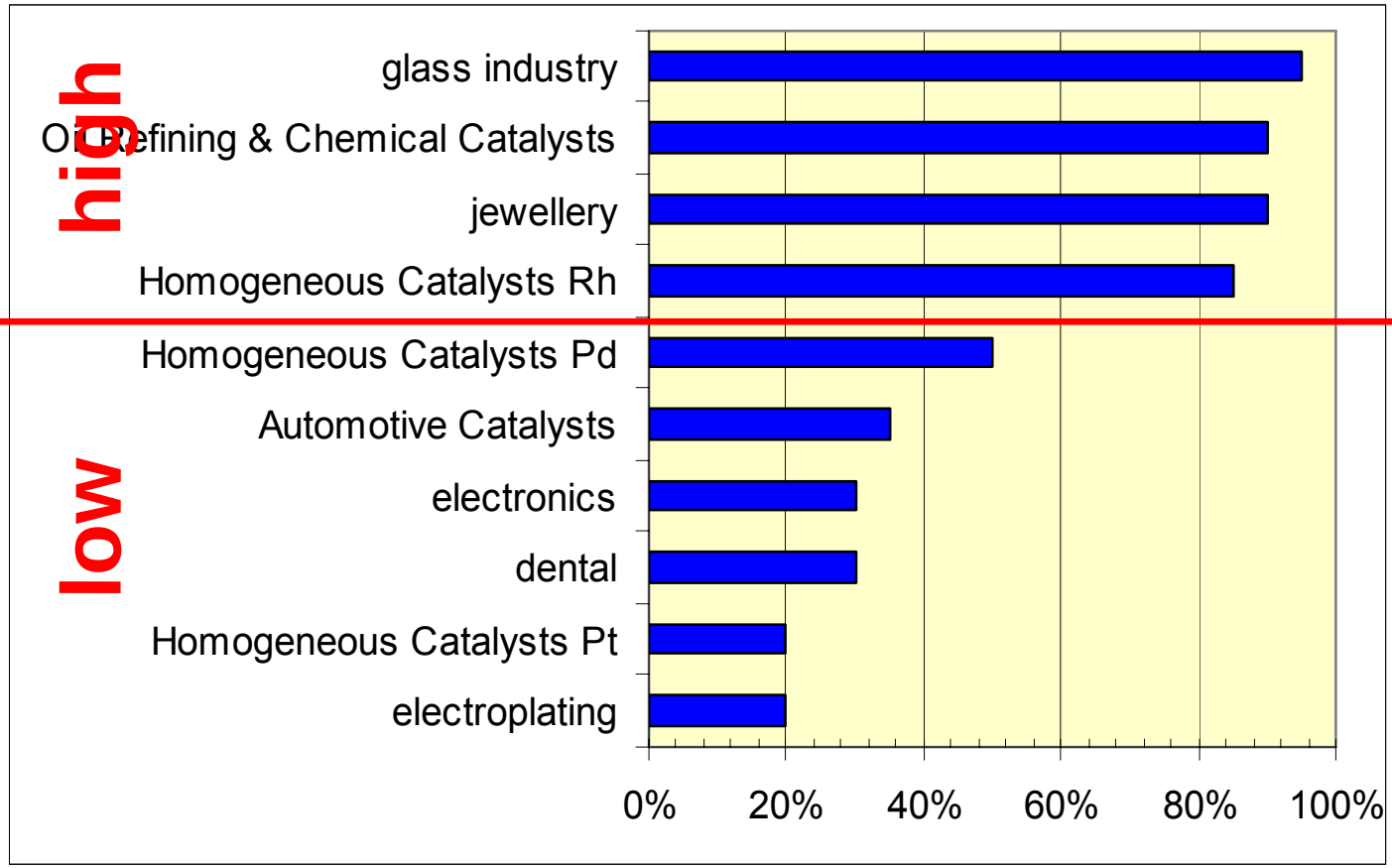
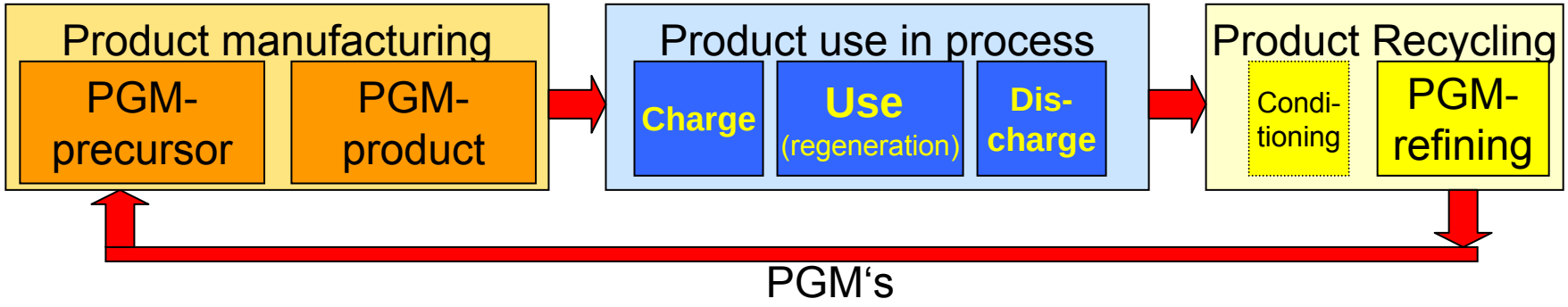


	Gross-demand t/a	Lifecyle loss t/a
glass industry	5,0	0,2
Oil Refining & Chemical Catalysts	6,4	0,5
jewellery	3,5	0,2
Homogeneous Catalysts Rh	0,4	0,06
Homogeneous Catalysts Pd	0,1	0,04
Automotive Catalysts	15,0	9,8
electronics	2,4	1,7
dental	2,5	1,8
Homogeneous Catalysts Pt	1,5	1,2
electroplating	0,4	0,1
	Σ 37,2	**15,6**

?? What makes the difference ??

Direct recycling loops



E.g. Oil-refining catalysts, chemical catalysts, glass-equipment

Direct relationship along lifecycle
(manufacturer, industrial user, PGM-refiner)

No change of PGM-ownership after initial delivery to end user
(weight account transfer)

Industrial parties, professional handling, transparent material flows

PGM content of product is known through entire cycle

High PGM recycling ratio (usually > 90%)

Indirect recycling loops

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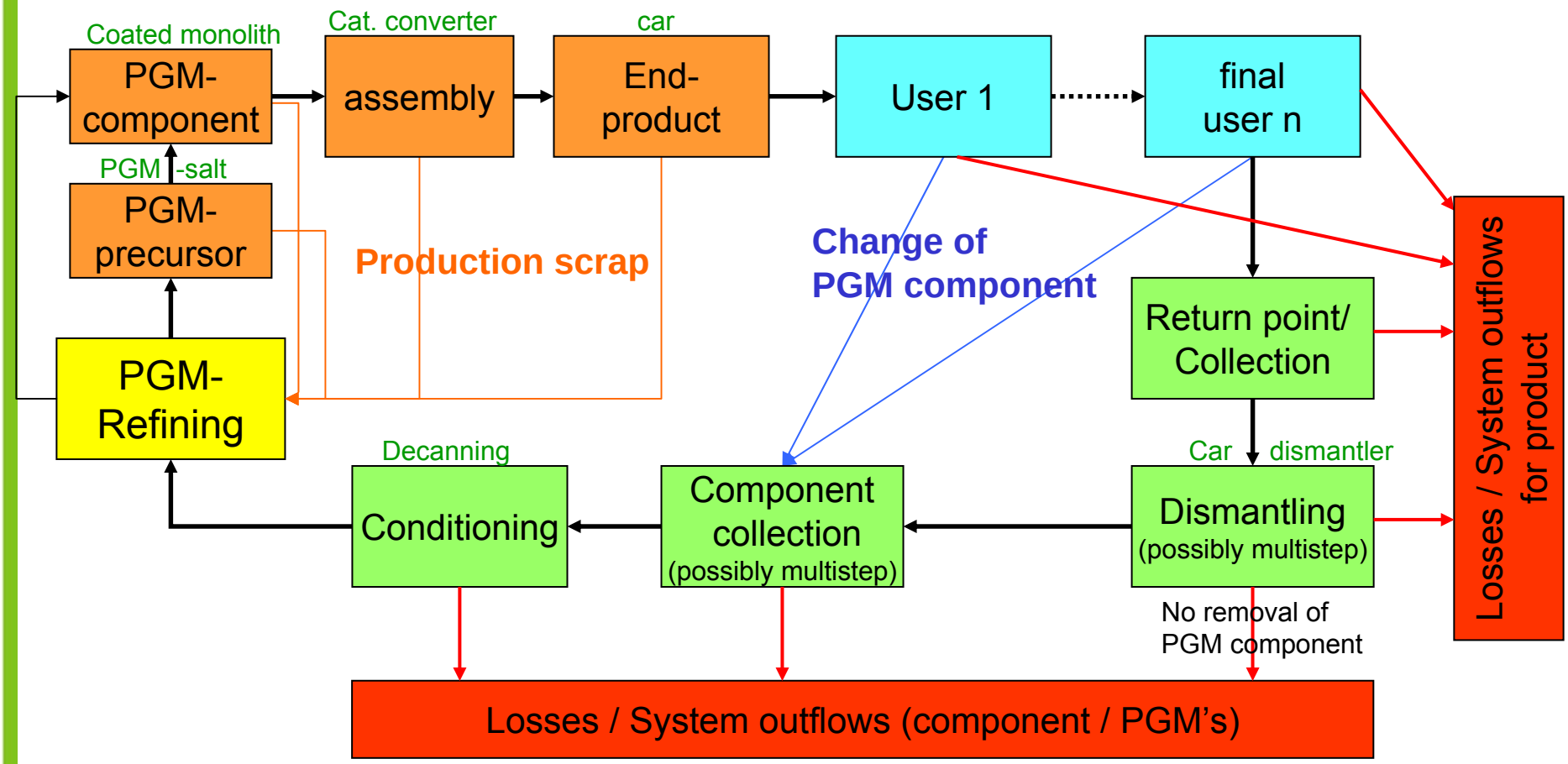
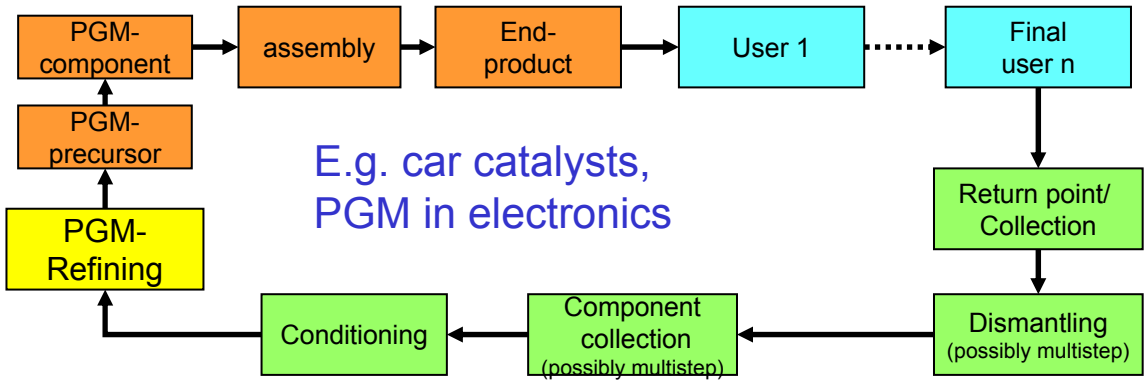


E.g. car catalysts, PGM in electronics, (dental)

Manufacturing | Use | Recycling-Logistics | physical Recycling / Refining

Indirect recycling loops II



No direct business relations between industrial parties involved, loop is broken by private end-users and non-industrial parties.

Multiple changes of PGM-ownership, component value fluctuates with PGM-prices.

No professional handling along entire chain, in-transparent material flows after production, “grey and black channels” occur in end-of-life and scrap chain.

PGM lifecycle losses difficult to detect, information on PGM-content gets lost.

In certain areas dilution of PGM in end product to an extend, that recycling is not economically viable by itself (electronics).

Low PGM recycling ratio (usually < 50%).

Forecast PGM-balance D, reference scenario)

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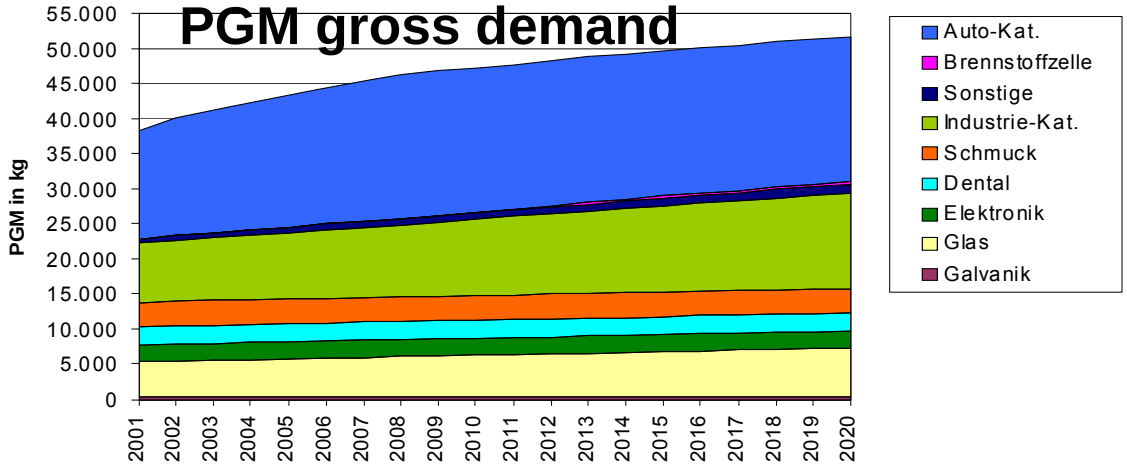

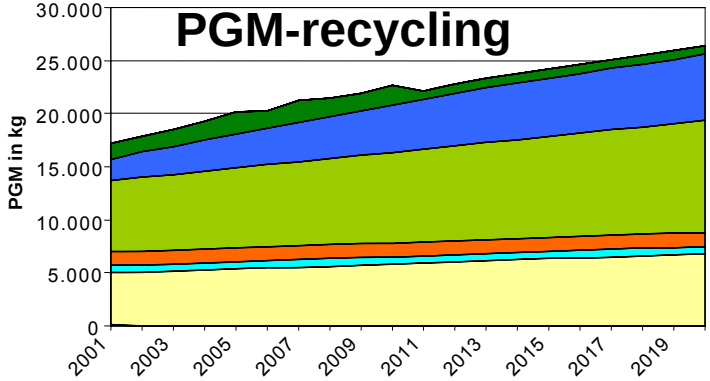

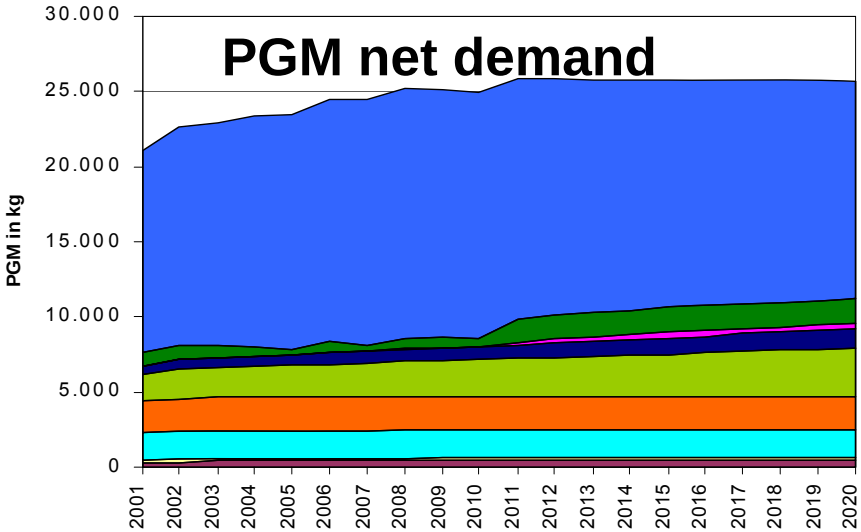

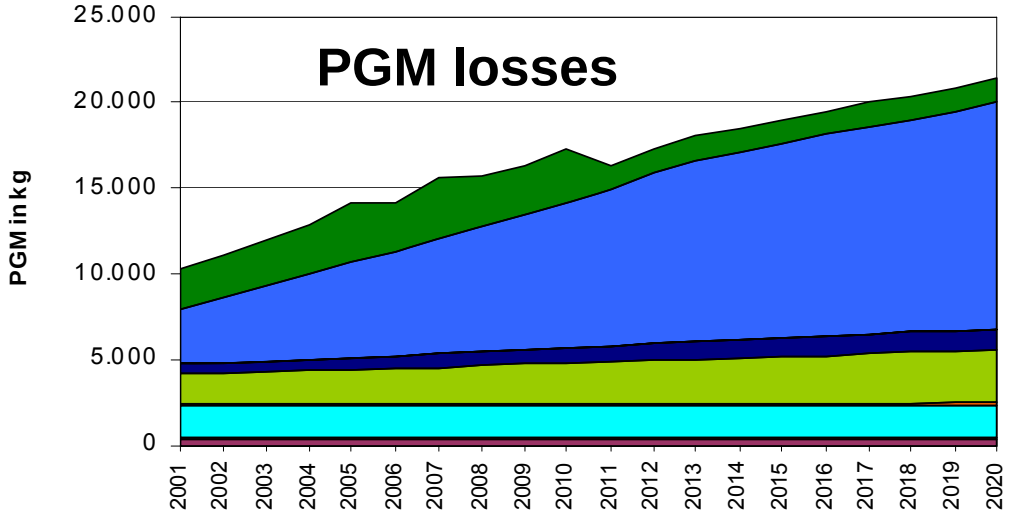

Growth trends per PGM-segment

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Stable

- oil refining catalysts (reforming, isom., hydrocracking)
- gauze & fixed bed catalysts (HNO3, HCN, ...)
- industrial emission catalysts
- dental & jewellery
- electroplating

Moderate

- Glass industry
- Heterogeneous powder catalysts (e.g. Pd/C)
- homogeneous catalysts
- automotive catalysts
- electronics
- sensors & spark plugs

Strong

- niche heterogeneous catalysts
- special homogeneous catalysts
- automotive electronics
- auto catalyst-scrap
- electronic scrap

Project summary & conclusions

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Importance of PGM in industrial societies confirmed, range of applications is further widening

PGM-gross demand will rise significantly, but no significant impact of fuel cells up to 2020

PGM recycling is a necessity (sustainability, price volatility, ecological benefit). ≈ 50% of PGM-gross demand covered by recycling

Efficient PGM-recovery processes & sufficient refining capacity available, some new materials require technical innovations

Industrial PGM-applications achieve high PGM-lifecycle efficiencies (direct loops between professional parties)

Significant PGM-losses occur in consumer applications with indirect loops (not collected; non-professional chains; grey business practises)

Without significant improvements in collection of auto catalysts & electronics a huge PGM-recycling potential will be lost inevitably: export challenge!

Example “low tech” – Gold recycling in Bangalore/India …

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Total Au-recovery efficiency only ≈ 25%, while environmental & health damage is dramatic (Rochat, Keller, EMPA 2007)

foto: EMPA/CH

… this takes place in large parts of the world today!

Let us work for future co-operation in an internationally operating and optimized closed-cycle materials economy!

Thank you for your attention!