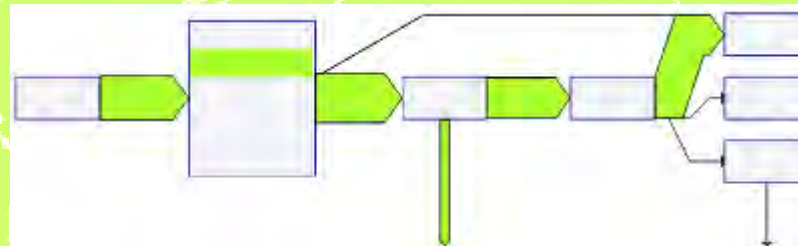


# Material flows linked to electric and electronic equipment in Switzerland



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- Introduction
- Method
- Results
- Outlook



- Federal Office for the Environment (FOEN) would like to have an overview over selected materials, products and services > Atlas/map of material stocks & flows
- Identification of fields of activities
- So far investigated
  - Plastics (specific material)
  - Electrical and Electronic Equipment (EEE) (specific products)
- Next step: "Internet Switzerland" (specific service)
- Development of a method which allows a modular assembly of the atlas

# Method

Classification of electrical and electronic equipment:

■ I: Large Household Appliances (LHA)

■ II: Small Household Appliances (SHA)

■ III/IV: Information- & Communication Technologies and Consumer Electronics (ICT/CE)

■ V: Lamps and Lighting Equipment (LA und LE)

■ VI: Electric and Electronic Tools (EET)

■ VII: Toys



## Definition of relevant fractions:

### ■ 'Bulk' material:



- Iron (Fe), Aluminium (Al), Copper (Cu), Plastics (PI), Glass

### ■ 'Valuable' material:



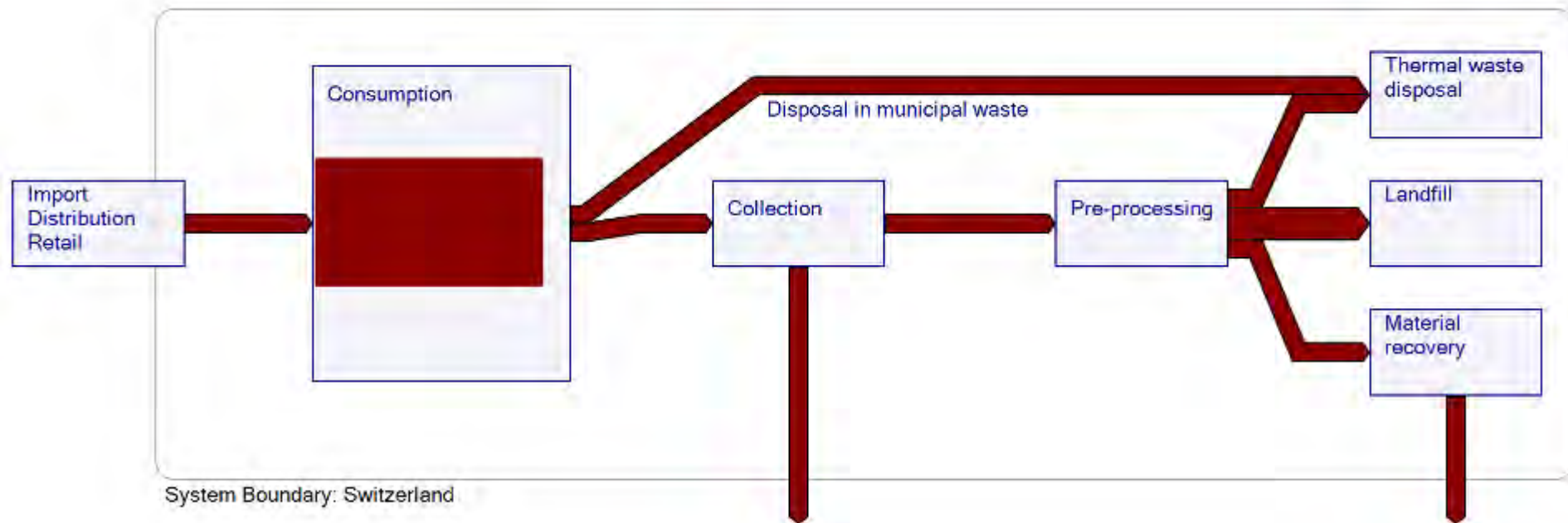
- Gold (Au), Silver (Ag), Palladium (Pd), Indium (In)

### ■ 'Toxic' material:



- Lead (Pb), Cadmium (Cd), Mercury (Hg), Plastics with brominated flame retardants (PI brominated), leaded glass

Life cycle system of EEE within the Swiss border:

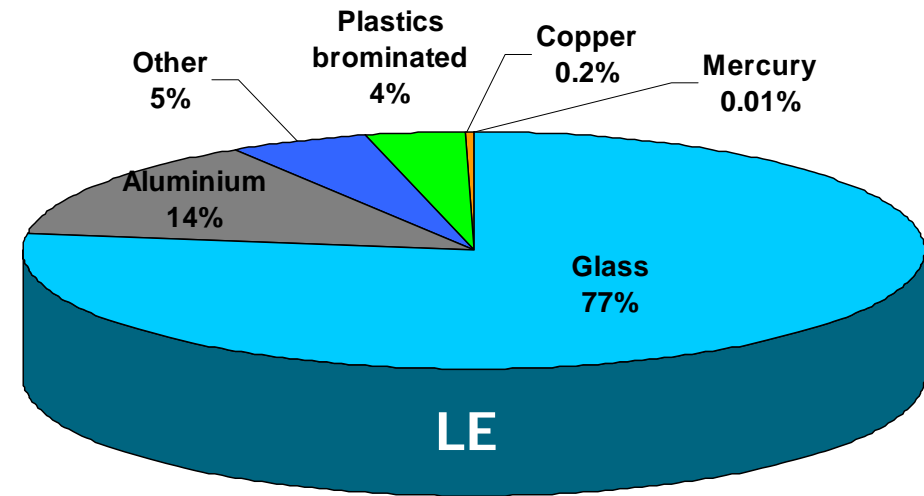
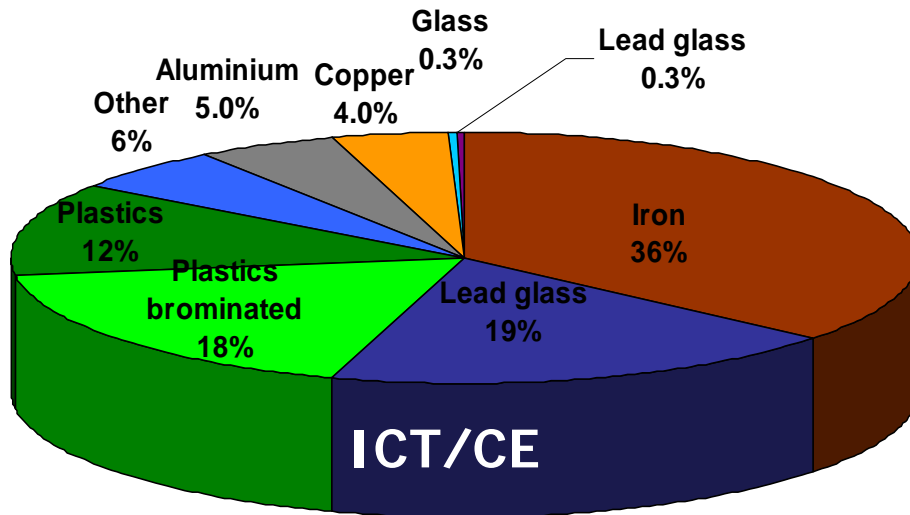
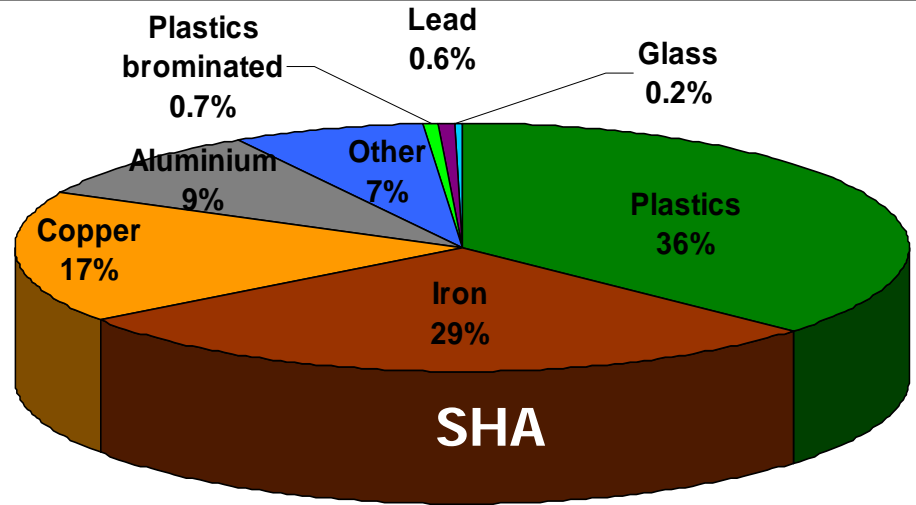
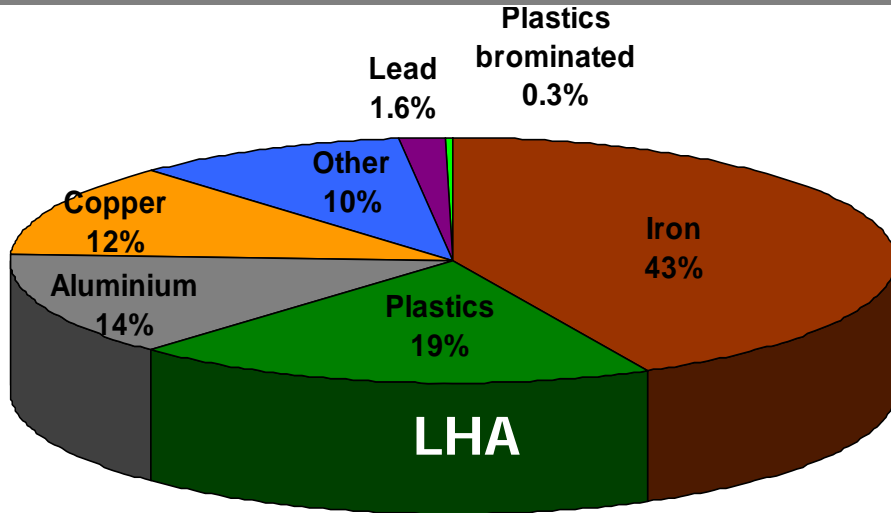


- Consideration of the whole life cycle (except transport)
- Calculation of environmental impact with ecoinvent data and SimaPro
- ecoinvent currently includes only a few ICT-appliances  
→ limit comparison to a desktop-PC with CRT- or LCD monitor and a laptop-PC
- Applied indicators: ecological scarcity (UBP) and cumulated energy demand



# Results

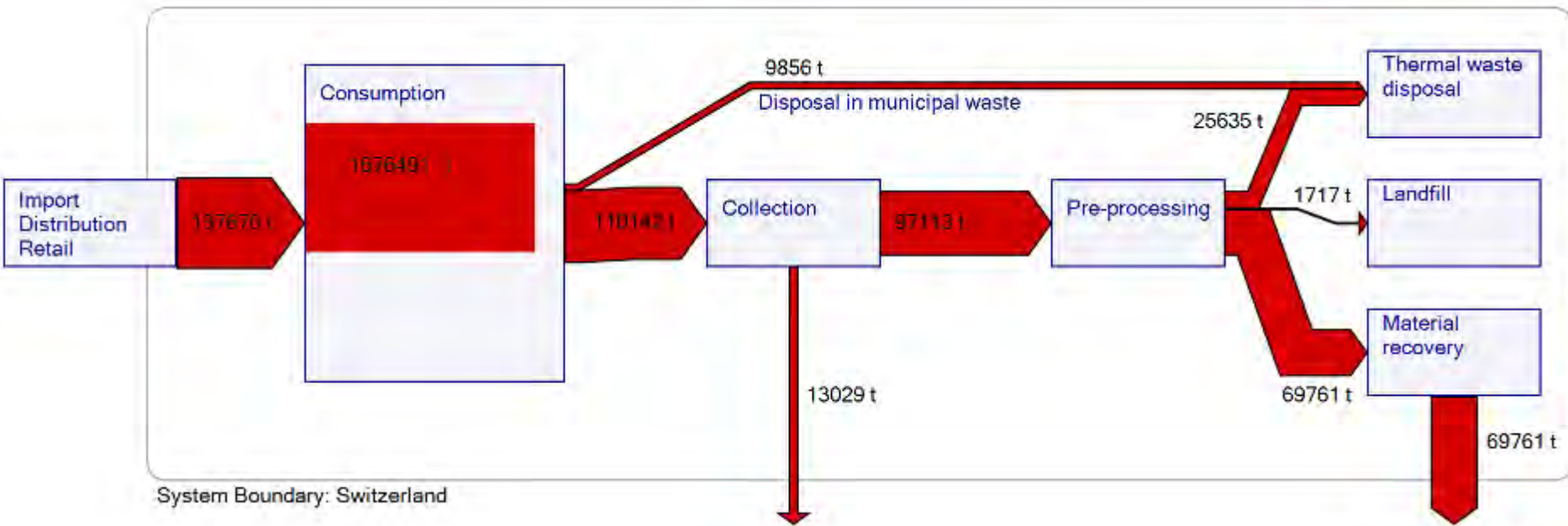
# Composition in Weight-%

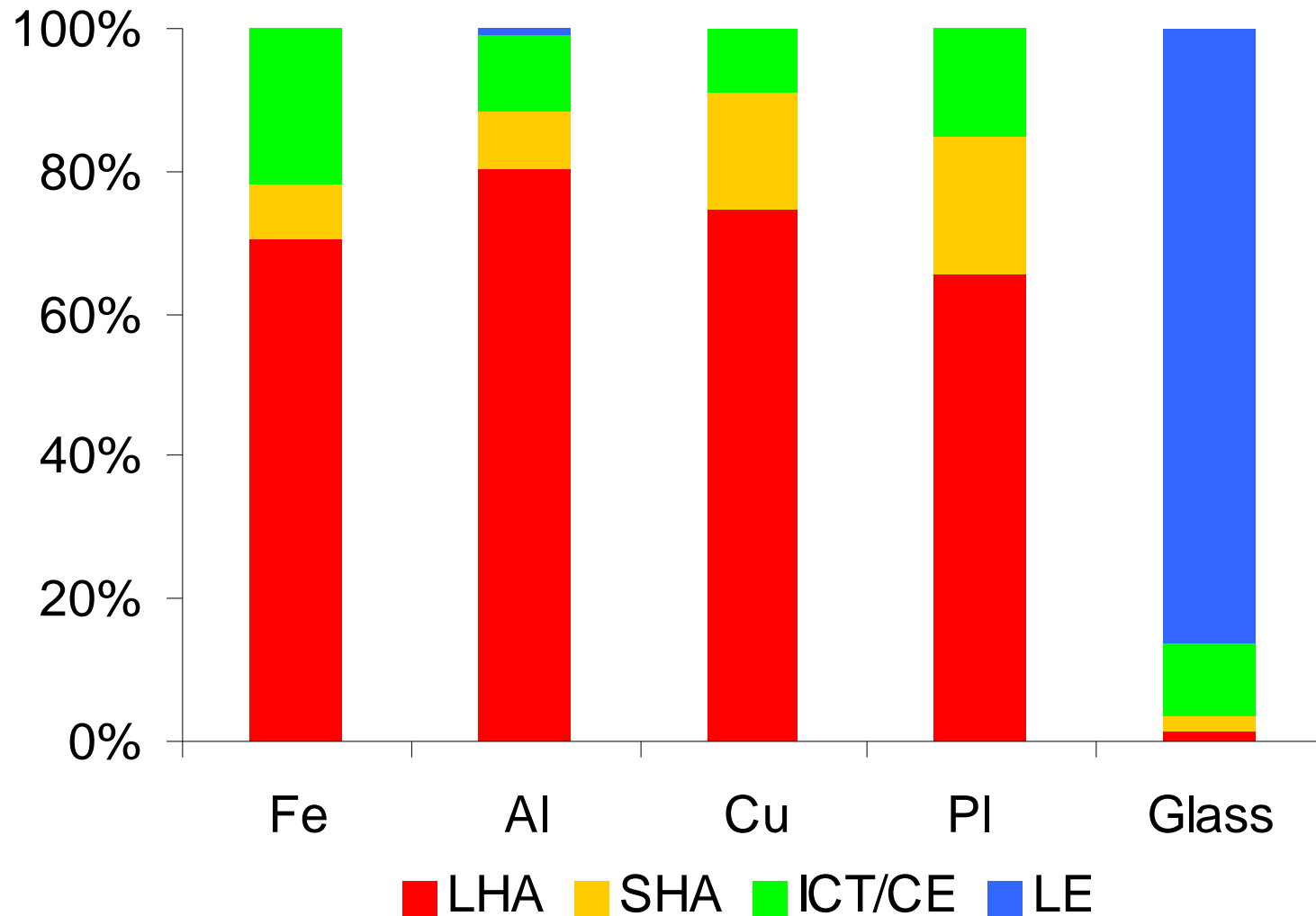


# Composition in %: valuables und toxics

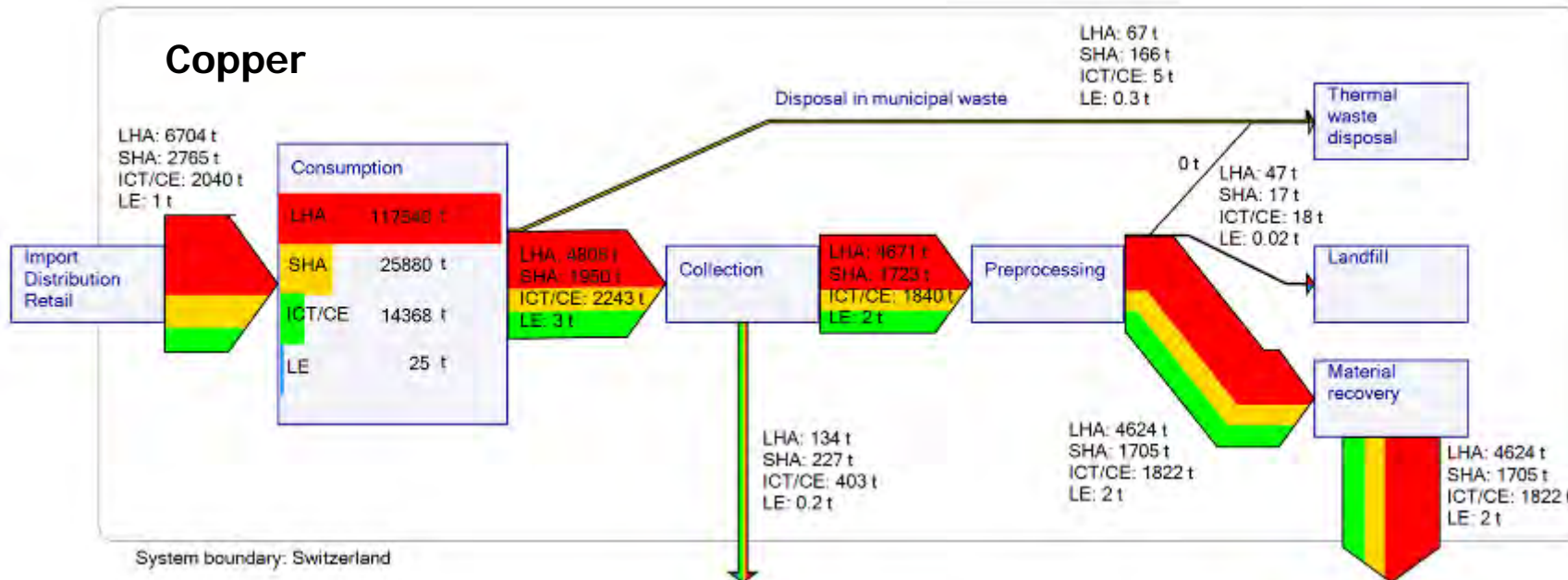
Material	Large household appliances (LHA)	Small household appliances (SHA)	ICT and Consumer electronics (ICT/CE)	Lighting equipment (LE)
Iron	43	29	36	n.a.
Aluminium	14	9.3	5.0	14
Copper	12	17	4.0	0.22
Plastics	19	37	12	n.a.
Glass	0.017	0.16	0.30	77
Gold	6.7E-07	6.1E-07	2.4E-04	n.a.
Silver	7.7E-06	7.0E-06	1.2E-03	n.a.
Palladium	3.0E-07	2.4E-07	6.0E-05	n.a.
Indium	0	0	5.0E-04	5.0E-04
Lead	1.6	0.57	0.29	n.a.
Cadmium	0.014	8.3E-03	0.018	n.a.
Mercury	3.8E-05	1.9E-05	7.0E-05	0.020
Plastics „brominated“	0.29	0.75	18	3.7
Lead glass	0	0	19	0
Other	10	6.9	5.7	5.0

## ■ Total mass flows and stocks of all EEE in 2006

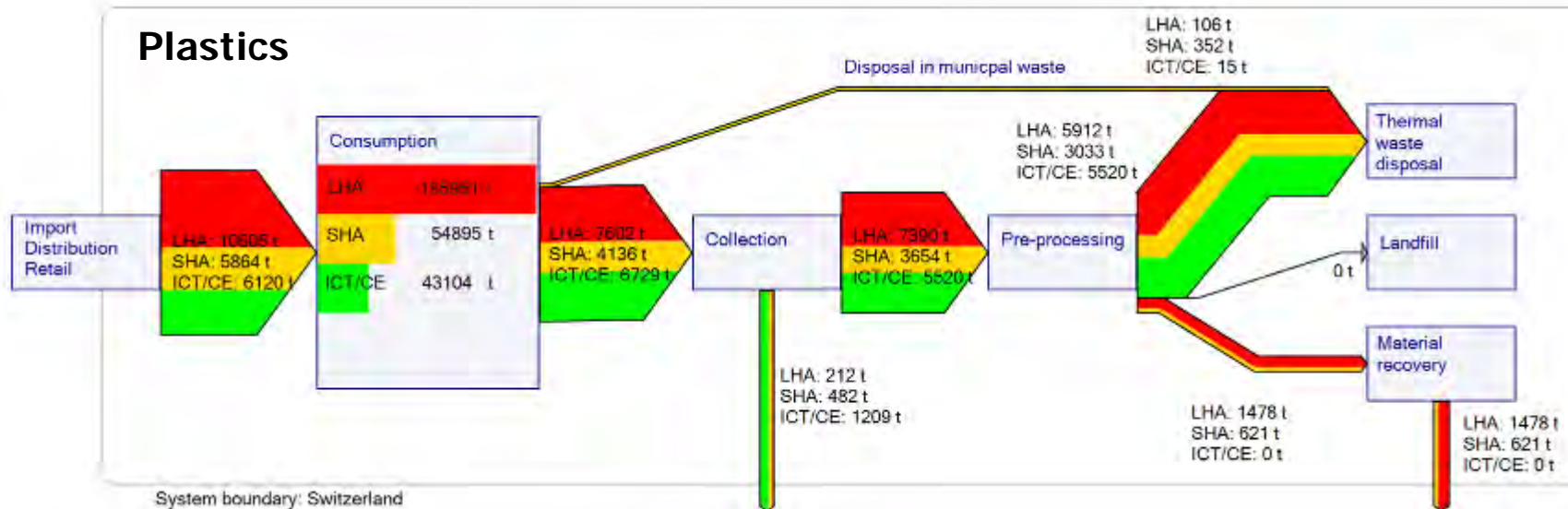


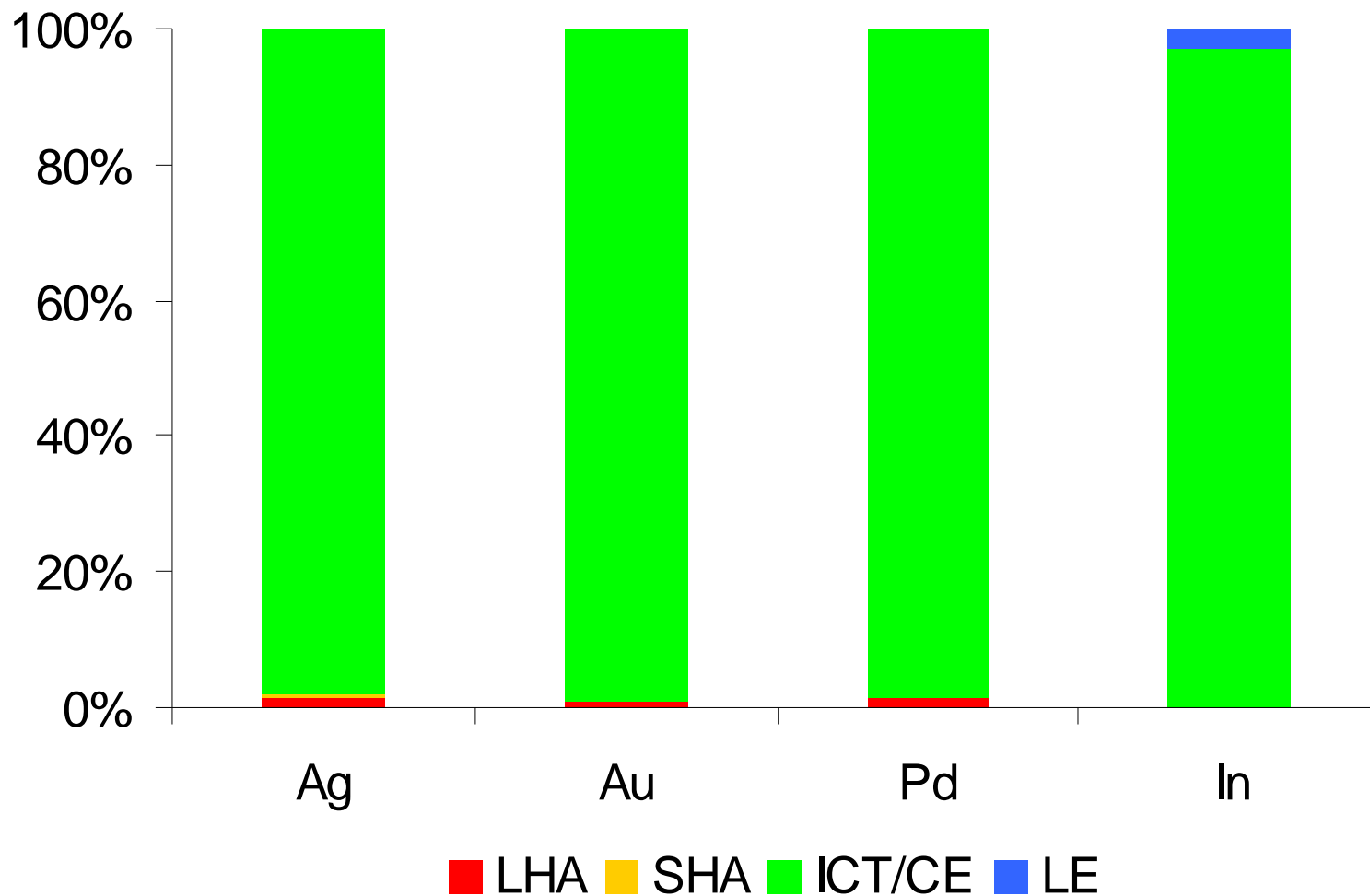


## Copper

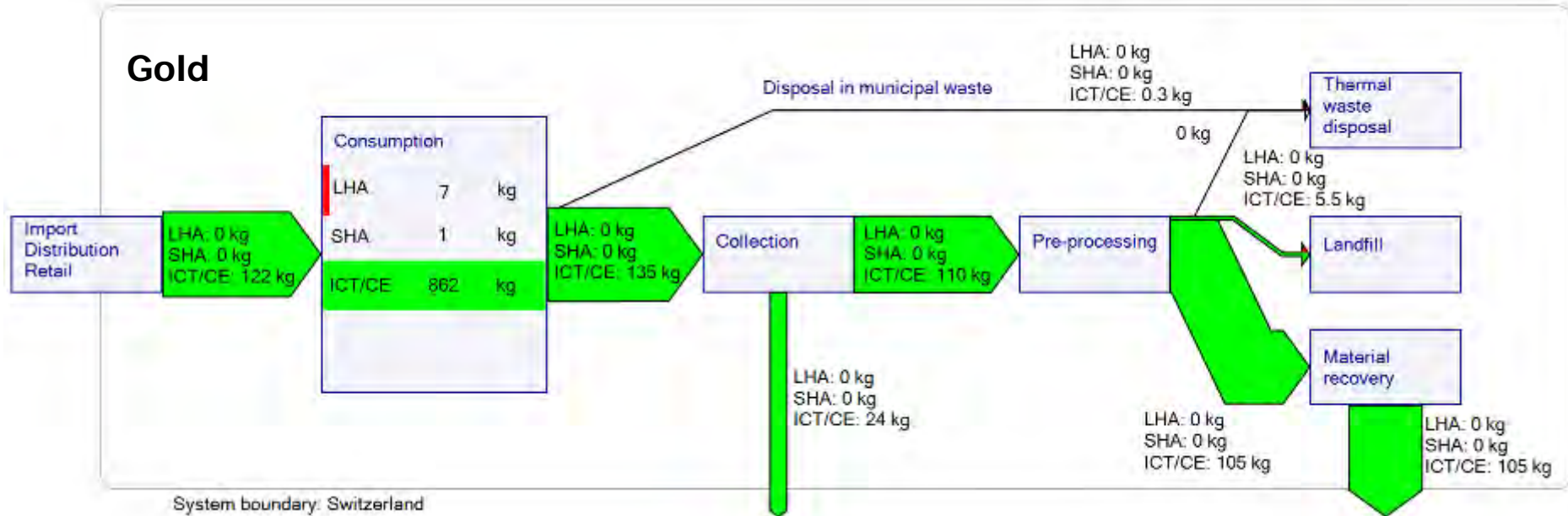


## Plastics



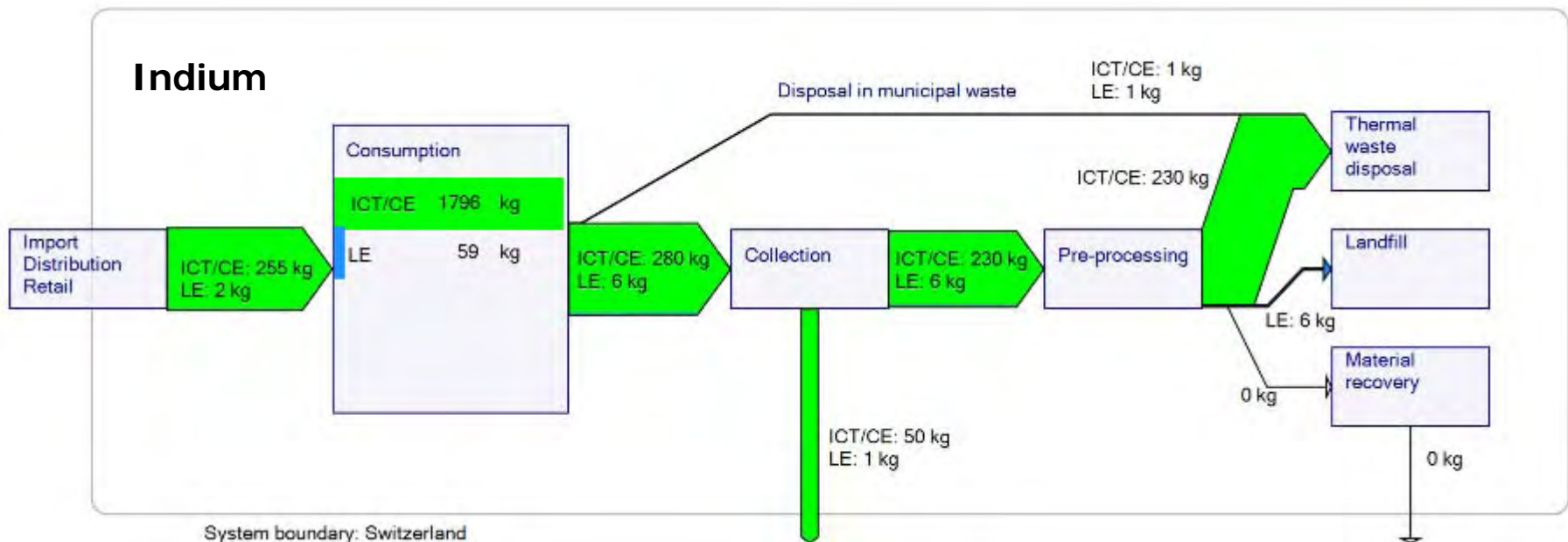


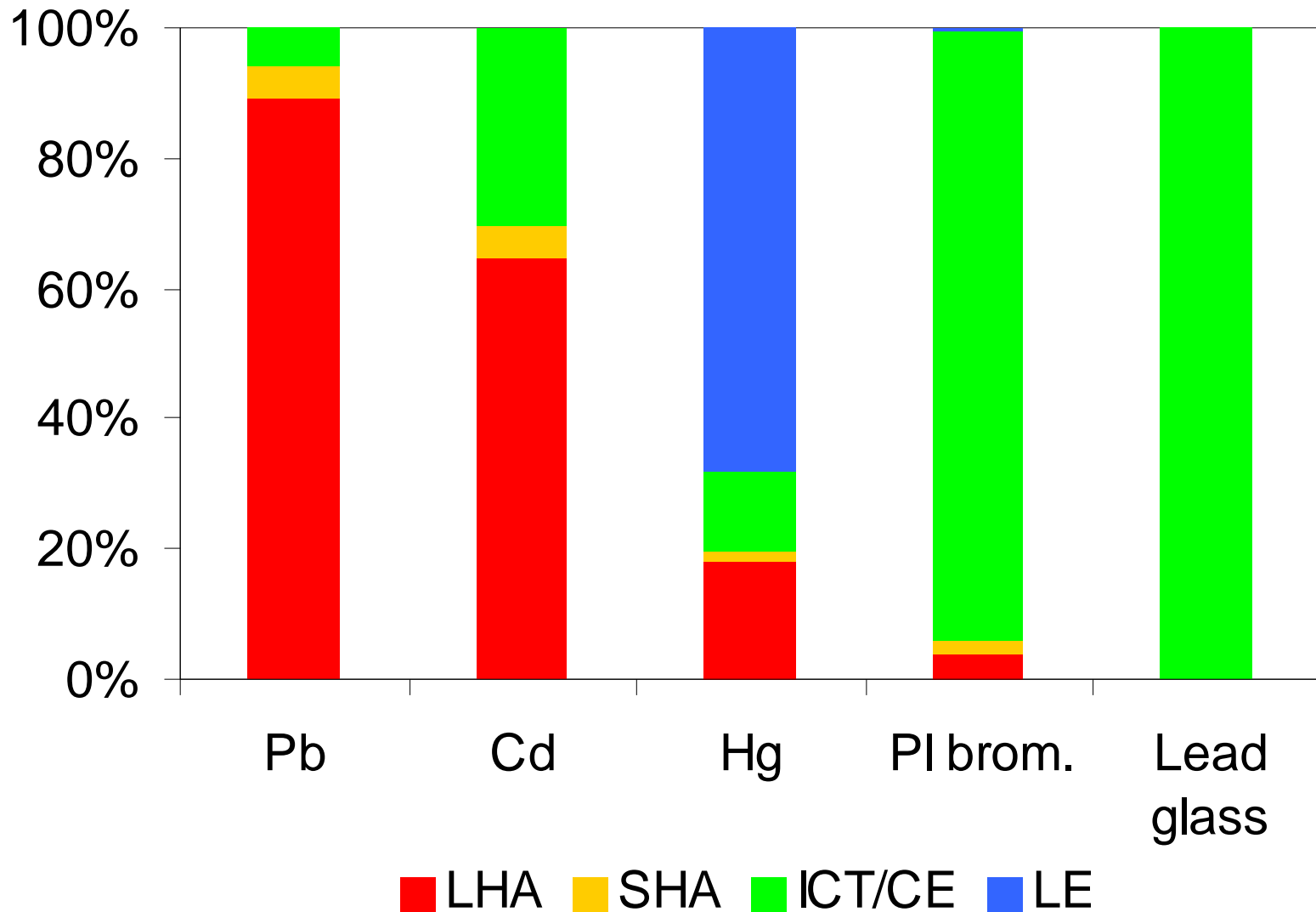
- In components on printed circuit boards
- Special smelting and refining technique: over 95% material recovery



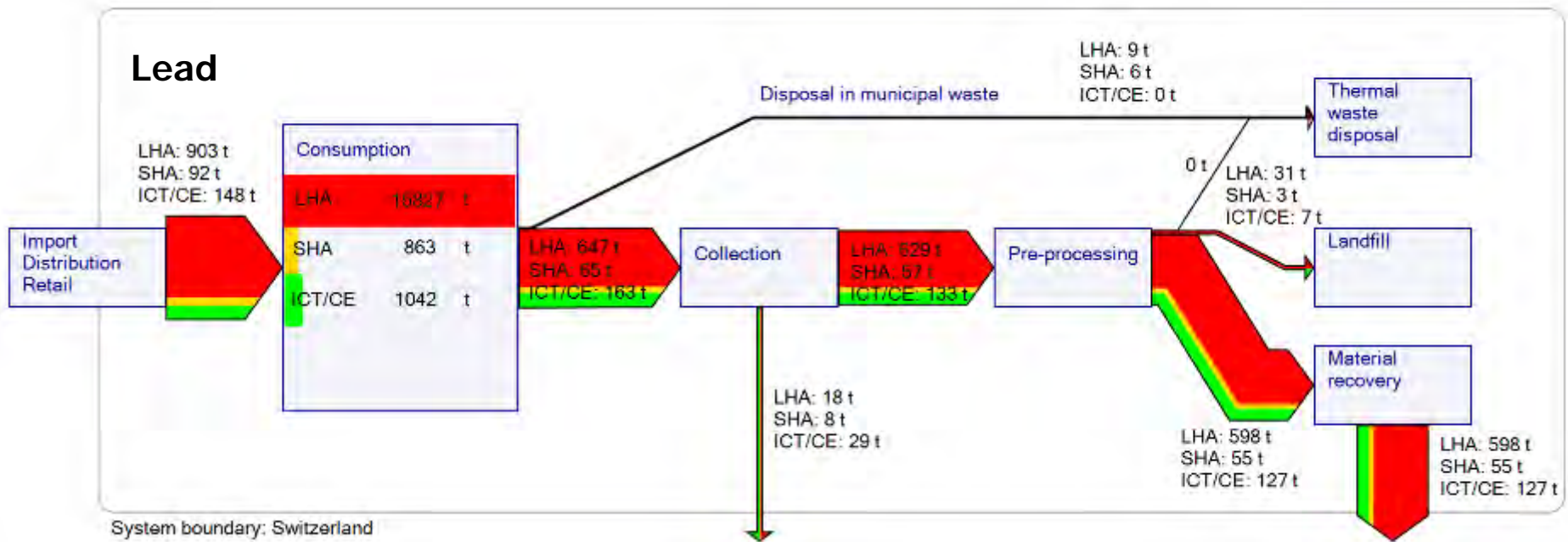


- Belongs to the scarcest elements of the lithosphere
- ICT/CE: flat screens, Displays
- LE: fluorescent layer
- Until now: no recycling in Switzerland

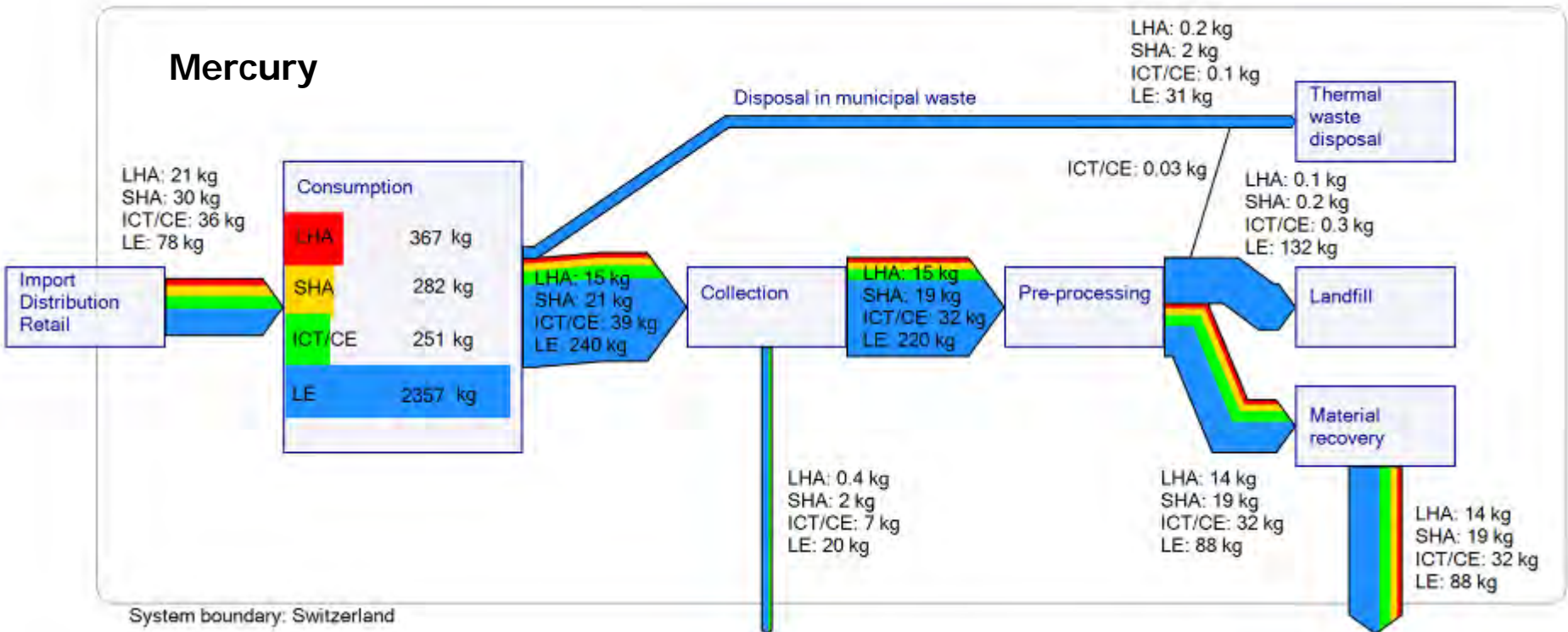




- Lead in metallic fraction: >95% material recovery
- Lead glass: complete material recovery
- Stock: lead glass 60%, metallic lead 40%



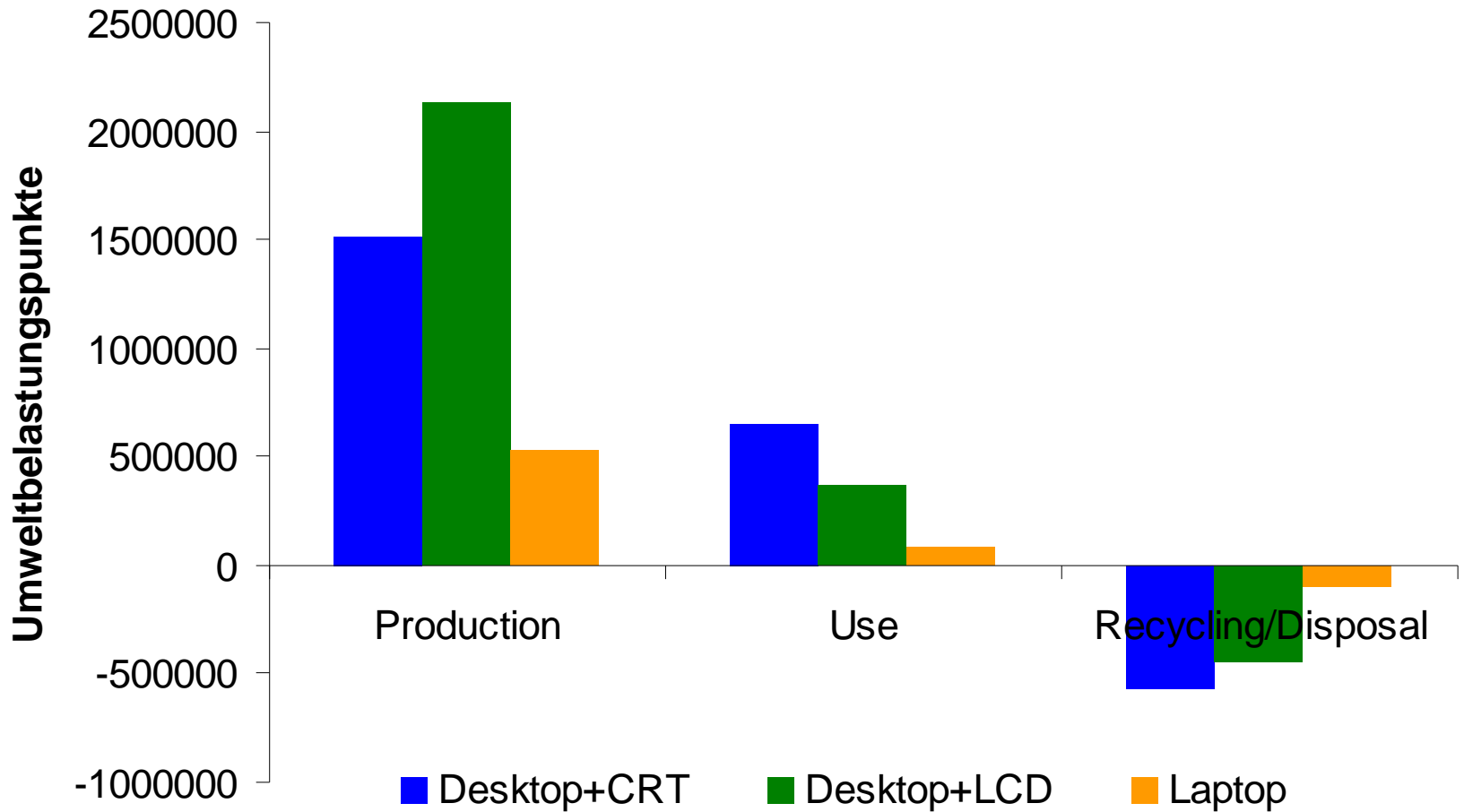
- LE: gas filling and fluorescent layer
- Household appliances: switches and batteries



Material	Stock [t]	Value [CHF/t]	Total Value [CHF]
Gold	0.87	26'200'000	2'300'000
Silver	4.4	525'000	22'800'000
Indium	1.9	940'000	2'800'000
Palladium	0.22	12'900'000	1'700'000
Copper	157'814	8'000	1'264'700'000
Aluminium	170'749	3'500	458'000'000
Iron	588'539	300	176'600'000
<b>Total</b>			<b>1'929'600'000</b>

Commodity prices: end of 2006

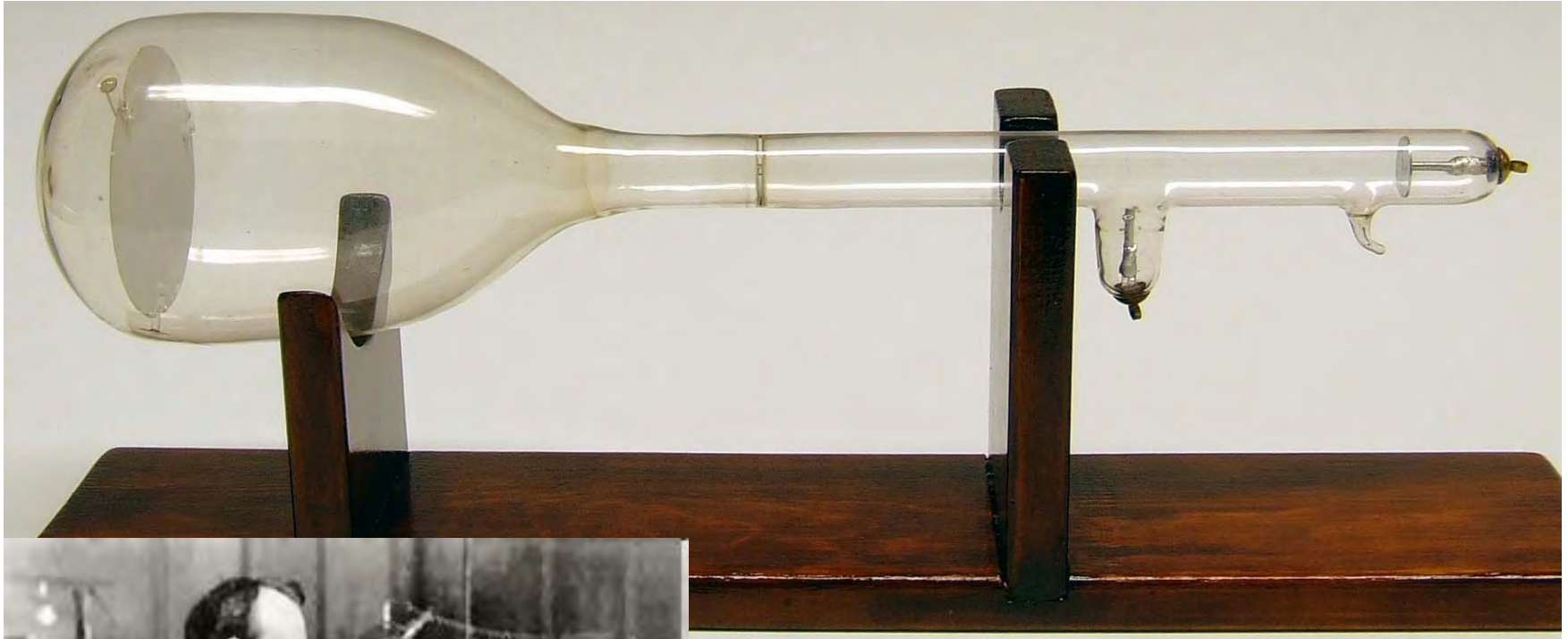
## Total Environmental Impact



Umweltbelastungspunkte (UBP) = ecological scarcity

- mined minerals and metals are not 'lost' immediately = they change the stock (lithosphere > technosphere)
- through 'system leaks' > dissipation to biosphere
- the above study tries to get an overview of this stocks & flows for certain materials in the Swiss society
- technology changes might render entire stocks useless
- following an example: "The End of the Cathode Ray Tube (CRT)"

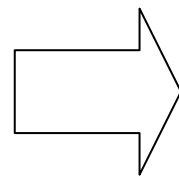
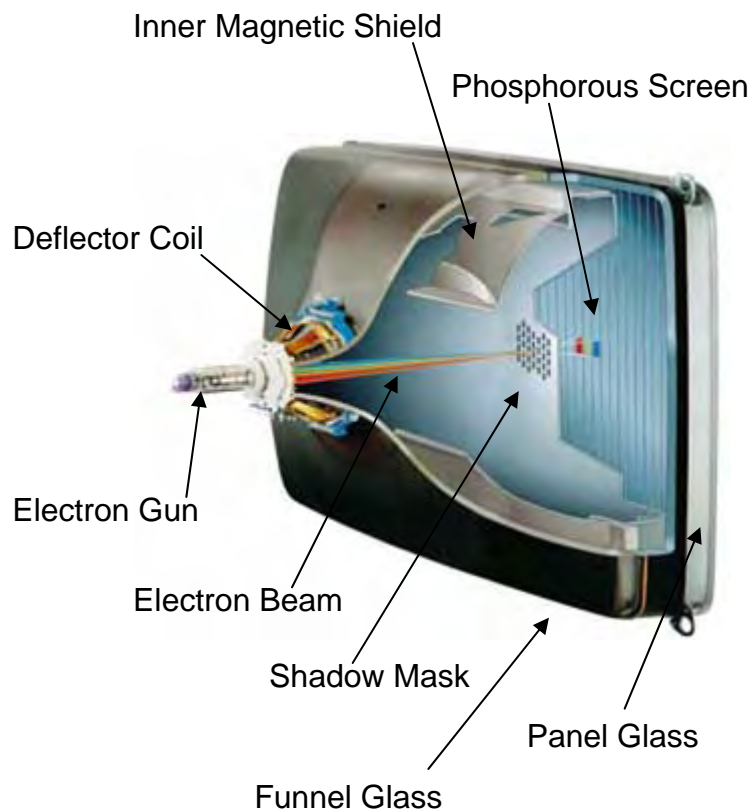
# The beginning of the CRT



**1897** Prof. JJ Thomson used a CRT to measure the electron mass

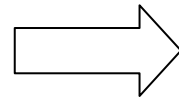


# Modern CRT-Display



**PANEL GLASS (2/3)**

(Barium-Strontium glass)

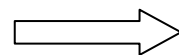


**FUNNEL GLASS (1/3)**

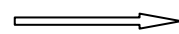
(Lead glass 18 – 22% PbO)

(Neck glass 30% PbO)

(Solder glass 80% PbO)



**METALS**

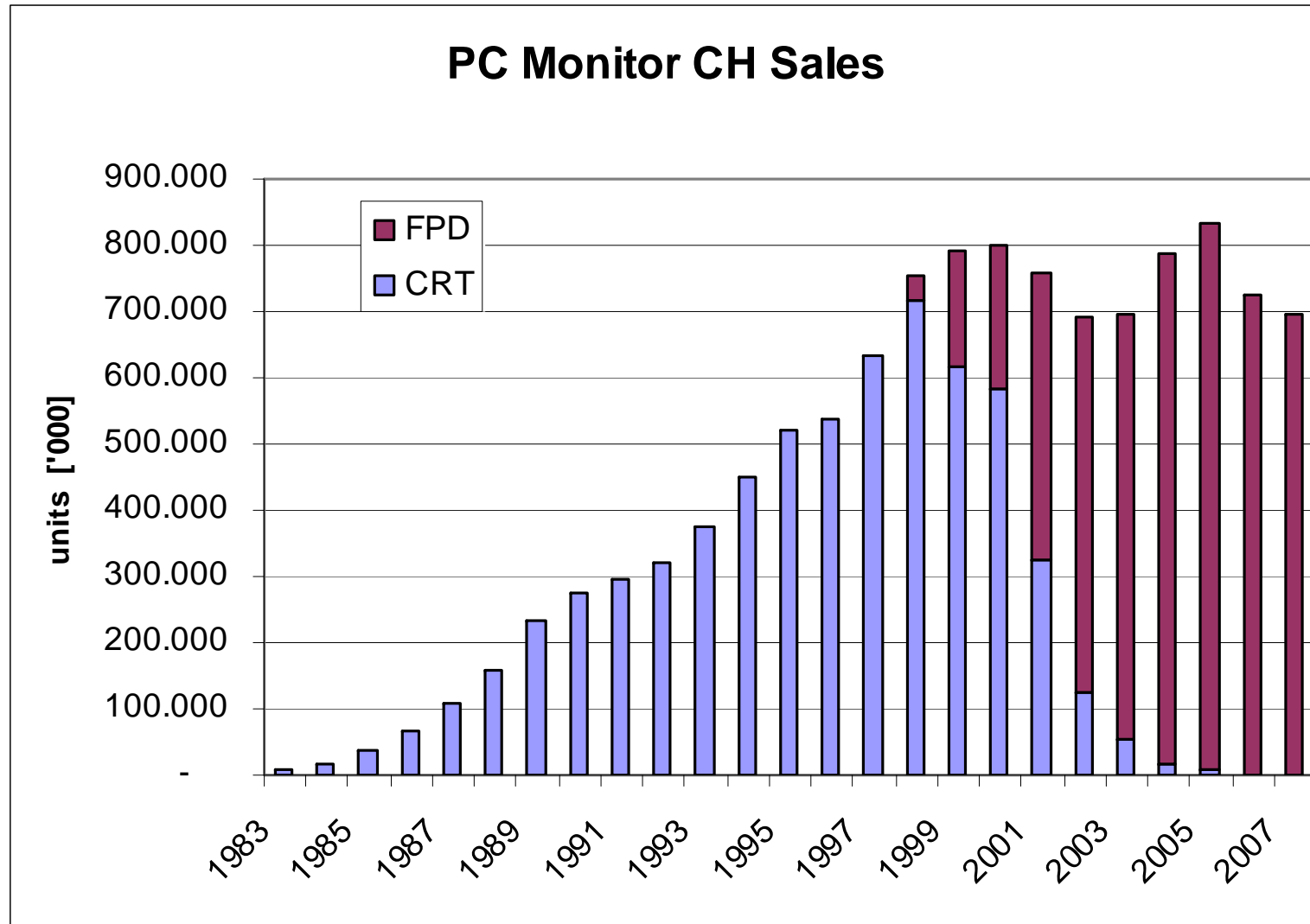


**Phosphorous Layer 3-7g**

} 90%

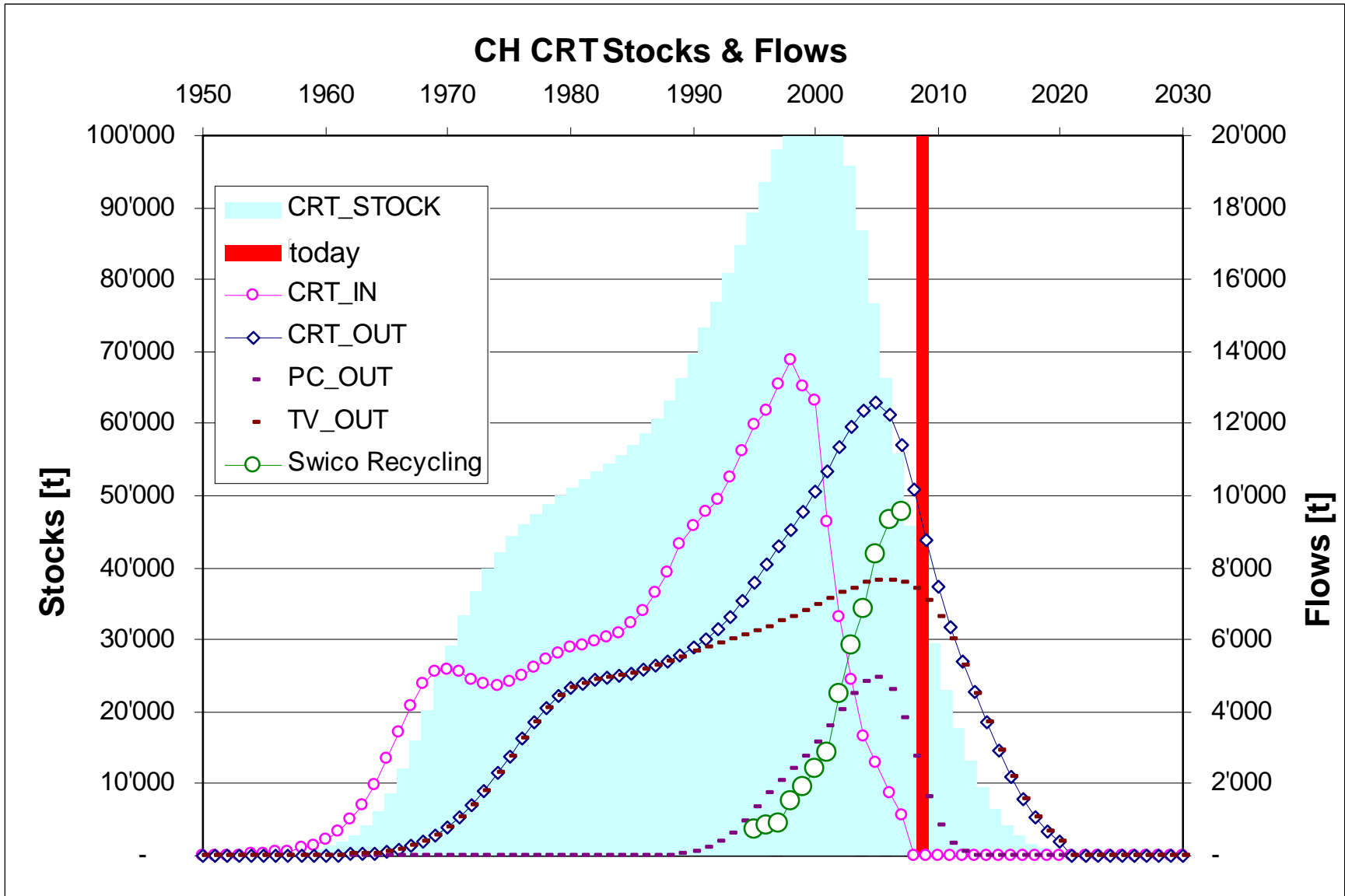


- separating the two glass fractions
- Removing coatings from funnel glass
- Removing shadow mask and phosphorous layer from panel glass
- grinding and melting of panel/funnel glass.



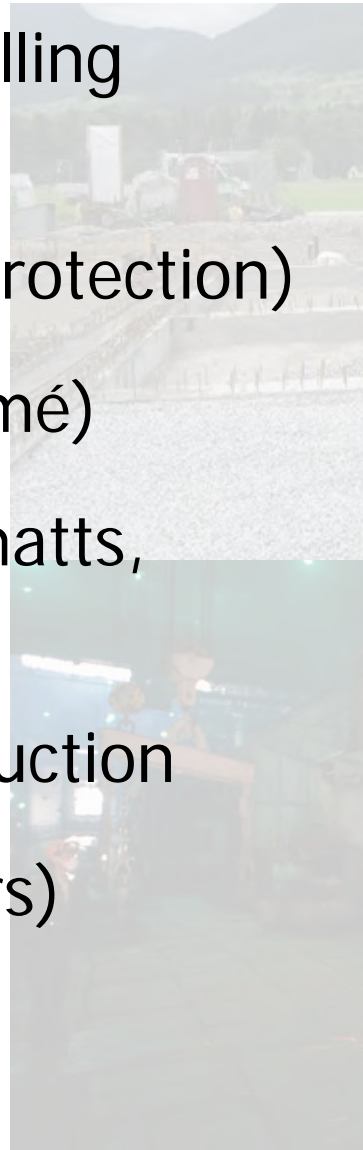
CRT sales collapsed ; Flat Panel Displays (FPD) took over!

- Yes! but the subsequent question is: 'Is it also the end of leaded glass'
- to be answered:
  - how much CRT-Glass still remains in CH?
  - how quickly our society wants to 'bleed' it out?
  - can it be recycled? for how much longer?
  - can it be used for something else?
  - what should we do if not?
  - and what should we do if our grandchildren would need it again?
- the first 2 questions were answered by a model calculation shown below.



- The CH CRT glass stock is already depleted to 1/3 of its max of ca. 110'000t in the year 2000.
- In 8-10 years the CH CRT glass collection will dry up.
- Of the total 300'000t CRT glass which will have entered CH approx. 1/3 will be recycled.
- the bigger rest was disposed of 'unregulatedly' in the the past (<1990).
- the model suggests that even today a considerable amount of CRT glass does not reach the recycling (e.g. leaves CH as 2nd hand TVs).

- foam glass (insulation, filling material, etc)
- special tiles (e.g. x-ray protection)
- table ware / art (glas fumé)
- glass fibres (insulation matts, plastic reinforcement)
- glazing in ceramics production
- flux (mainly lead smelters)



Quelle: Mobiglas



- CRT glass will soon be useless in this form.
- replacements are not in sight.
- CH will probably get rid of its stock as it is a rich, early adopter, however:
- the last CRT users will have to deal with leaded glass (that's probably the rural population in the 3rd world)
- A CH-depot for the final ca. 5'000t (=30x 40-feet container) might be a fairer / better solution

27.02.2003

- Depletion of lithosphere stocks leads to the accumulation of technosphere stocks
- technosphere stocks require management beyond a single technology (e.g. to new technologies, to new depots, ...)
- bleeding to the biosphere (dillution) is rarely an option (pollution), however:
- Energy scarcity might not allow us to build/keep the barrier between techno- and bio-sphere
- in that case future technologies must be restricted to 'elements of hope'.





**Thank you very much for  
your attention!!**

