
LIFE CYCLE ENGINEERING OF MINING AND INDUSTRIAL SITES

Barthel, L.-P.¹; Wolf, M.-A.¹; Will, M.; Baitz, M.² and Eyerer, P.¹

1 Dept. For Life Cycle Engineering; IKP, University of Stuttgart

barthel@ikp2.uni-stuttgart.de

2 PE Europe GmbH



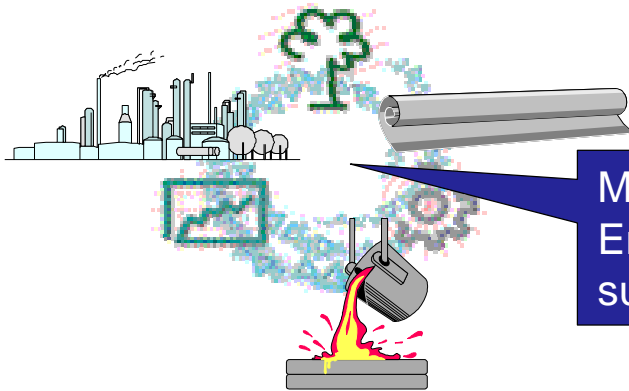
- The Department Life Cycle Engineering
- Introduction to LCA
- Acid Drainage/Leaching
- Land-use
- Summary



IKP, Department Life Cycle Engineering Overview

- Dept. LCE founded in 1989 by Prof. Dr.-Ing. Peter Eyerer
- Interdisciplinary team of 10 full time academic staff (Chemical, mechanical, environmental and process engineers; geo-ecologist)

Industry and research projects on ecological-economic-technical analysis and decision-support of products, processes and services



Methodology development (Life Cycle Engineering and Sustainability, substance flow analysis, Indicators)

Software and database development and maintenance (GaBi software, DfE-tools)



International Conference
4 – 6 November 2004, Kraków, Poland

“Sustainable Post-Industrial Land Management”



IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde

- ▶ **Automotive industry** e.g. DaimlerChrysler, Porsche, Renault, Delphi,...
- ▶ **Material industry** e.g. Alcan, Borax, Falconbridge, Amplats, ThyssenKrupp ...
- ▶ **Construction industry** e.g. Maxit, Heidelberger, Saint Gobain, STO,...
- ▶ **Electronics industry** e.g. Motorola, Nokia, Bosch, LG Electronics, Sony, ...
- ▶ **Chemical industry** e.g. DOW Chemicals, BASF, DSM, PPG, ...
- ▶ **Surface technology** e.g. BASF, PPG, Dürr, DuPont...
- ▶ **Renewable resources** as energy carriers, for automotive applications etc.
- ▶ **Energy Supply** e.g. NWS, NIRE/MITI, NorskHydro, Icelandic NewEnergy, ...
- ▶ **End of Life / Recycling** e.g. DGfH, ECVI, Siemens, Noell, Thermoselect, ...

Development of world-wide leading **GaBi Software-System and databases**
together with partner PE Europe GmbH

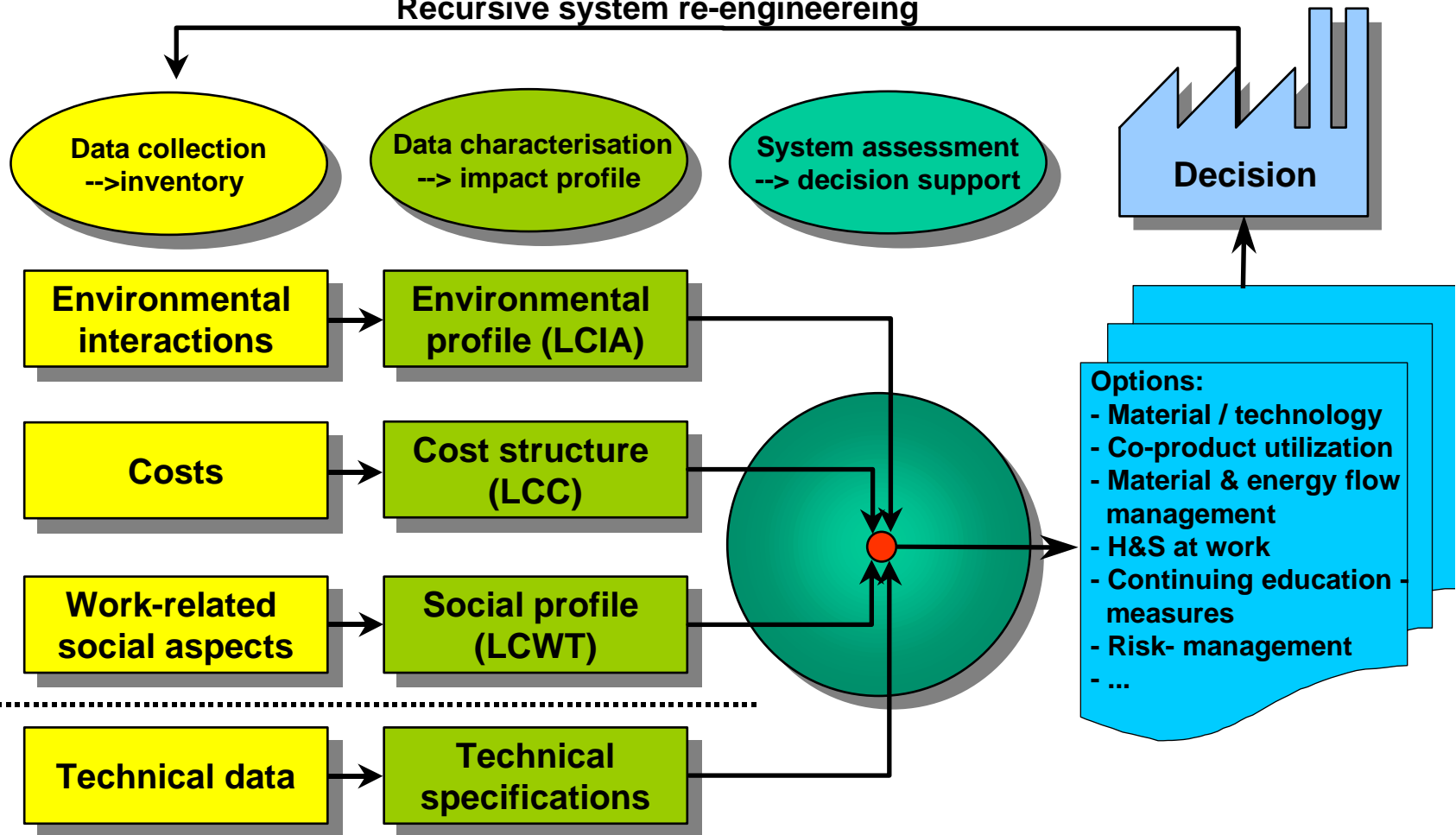
IKP and PE form together the world's largest LCA/LCE working group



From LCE to LCS

Implementation of Life Cycle Sustainability methodology into GaBi 4 software

Recursive system re-engineering



International Conference
4 – 6 November 2004, Kraków, Poland

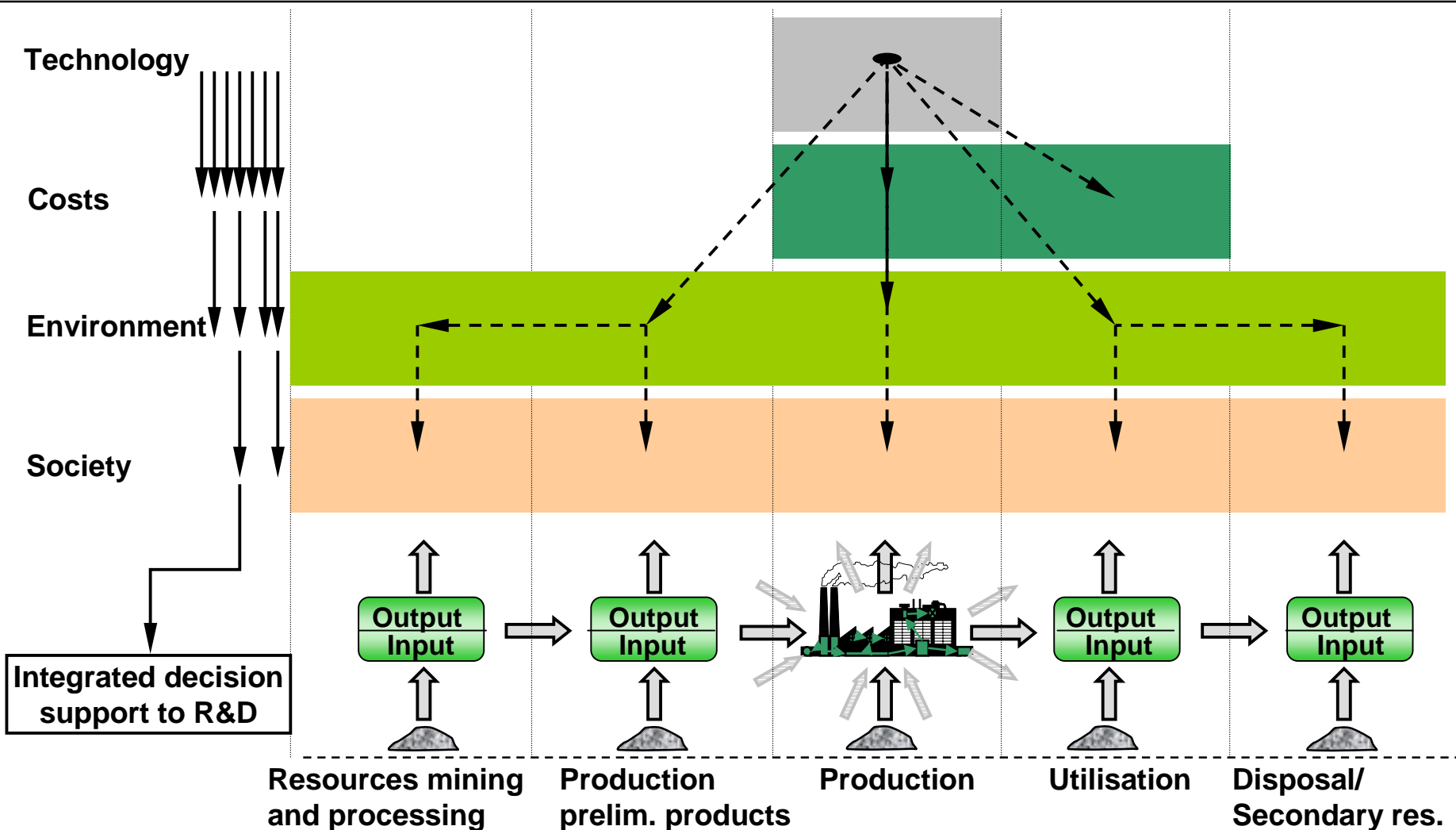
“Sustainable Post-Industrial Land Management”



IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde

Life Cycle Sustainability in product development

Step-wise procedure in parallel to development achieves best feasible solution



International Conference
4 – 6 November 2004, Kraków, Poland

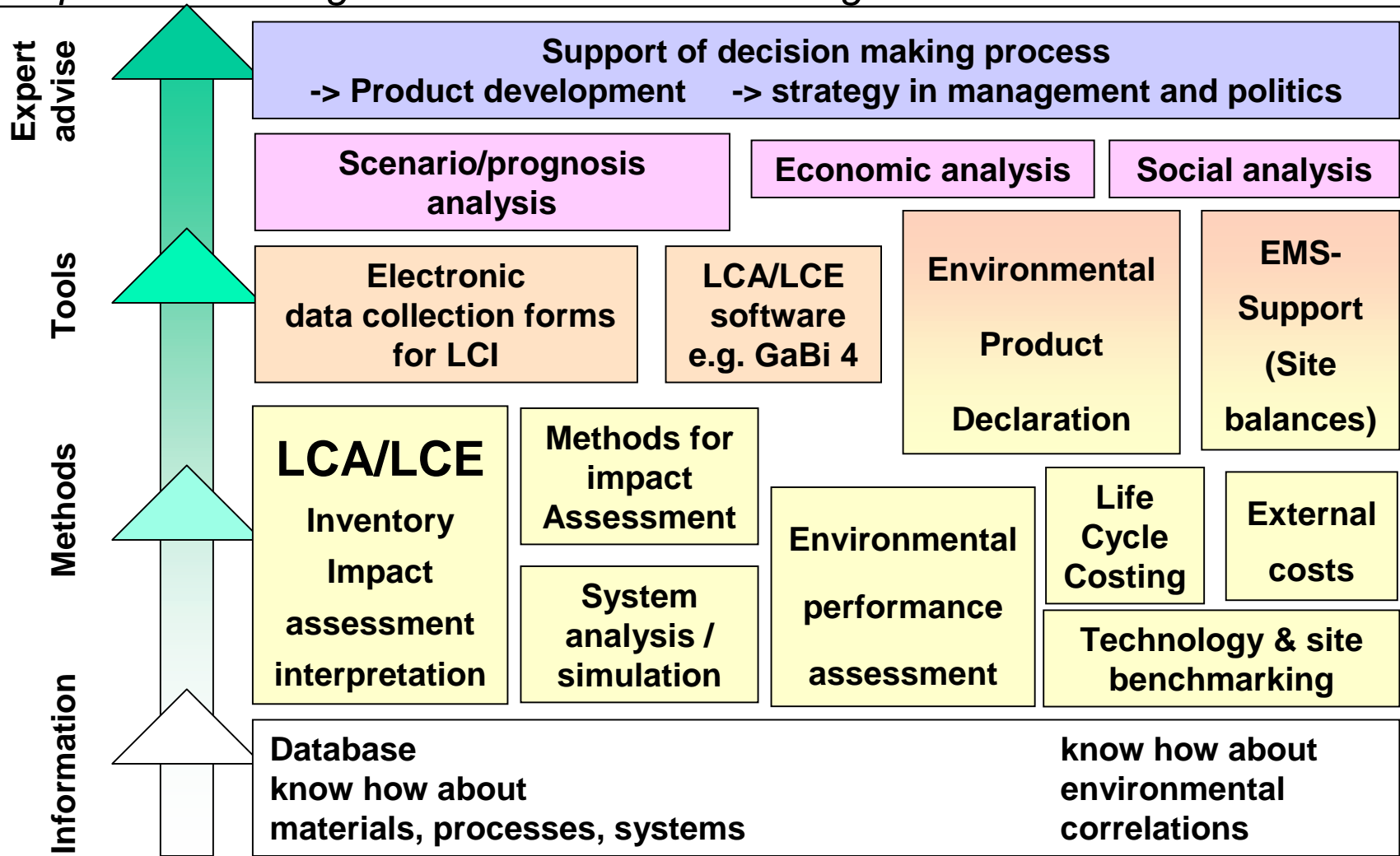


IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde

“Sustainable Post-Industrial Land Management”

The Life Cycle Approach

as a part of the integrated Environmental Management



International Conference
4 – 6 November 2004, Kraków, Poland

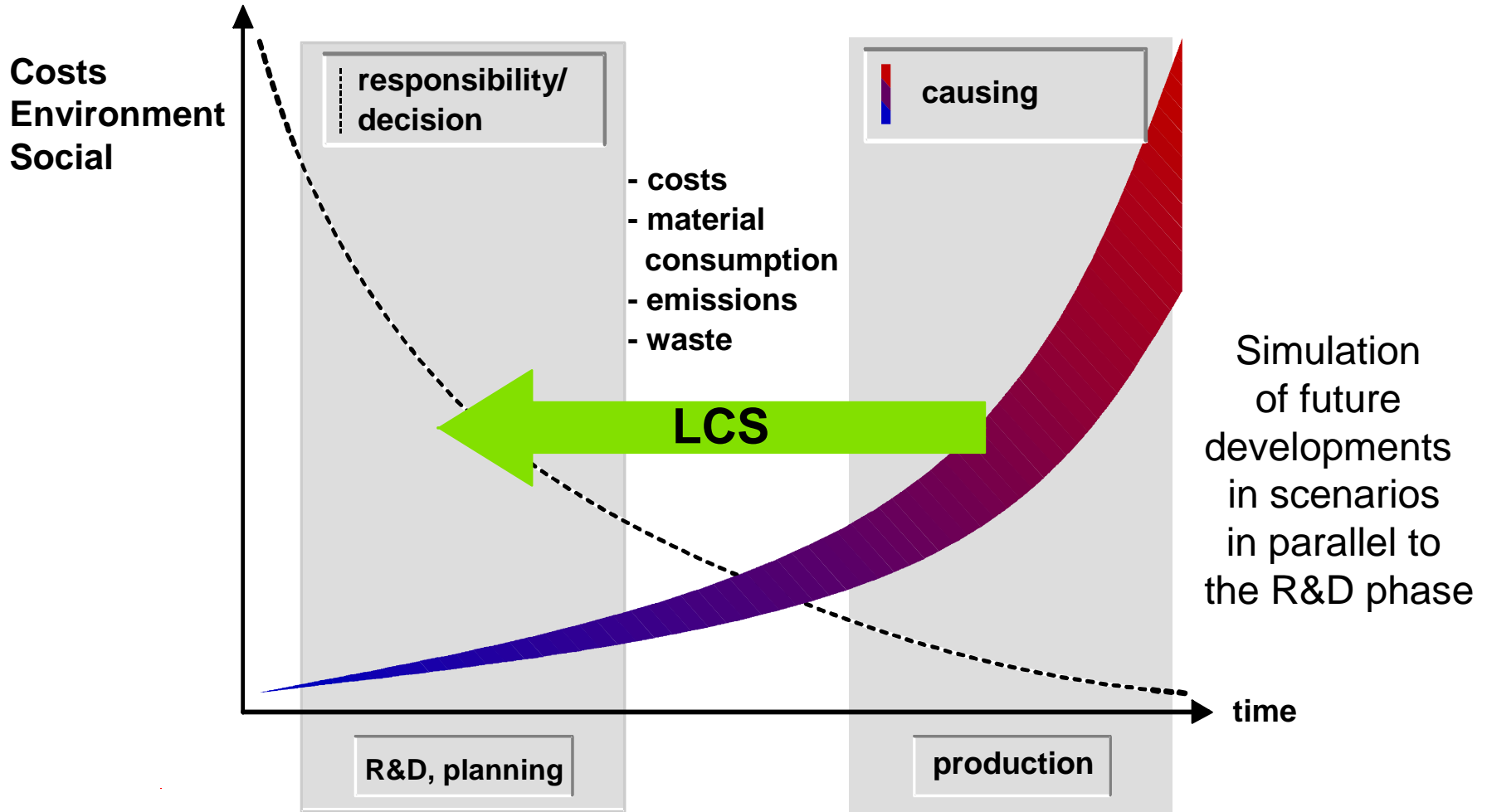
“Sustainable Post-Industrial Land Management”



IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde

Life Cycle Engineering

Development of Life-Cycle Simulation (LCS)



Current Difficulties

Environmental Management-related Questions

- Energy efficiency
- Resource efficiency
- EU Directive on Mining Waste
- Responsibility towards stakeholders
- Environmental-related questions of customers



Current Difficulties

Environment-related Questions

- Tailings- and mine waste management
- Water and waste water management
- Acid drainage
- Land-use



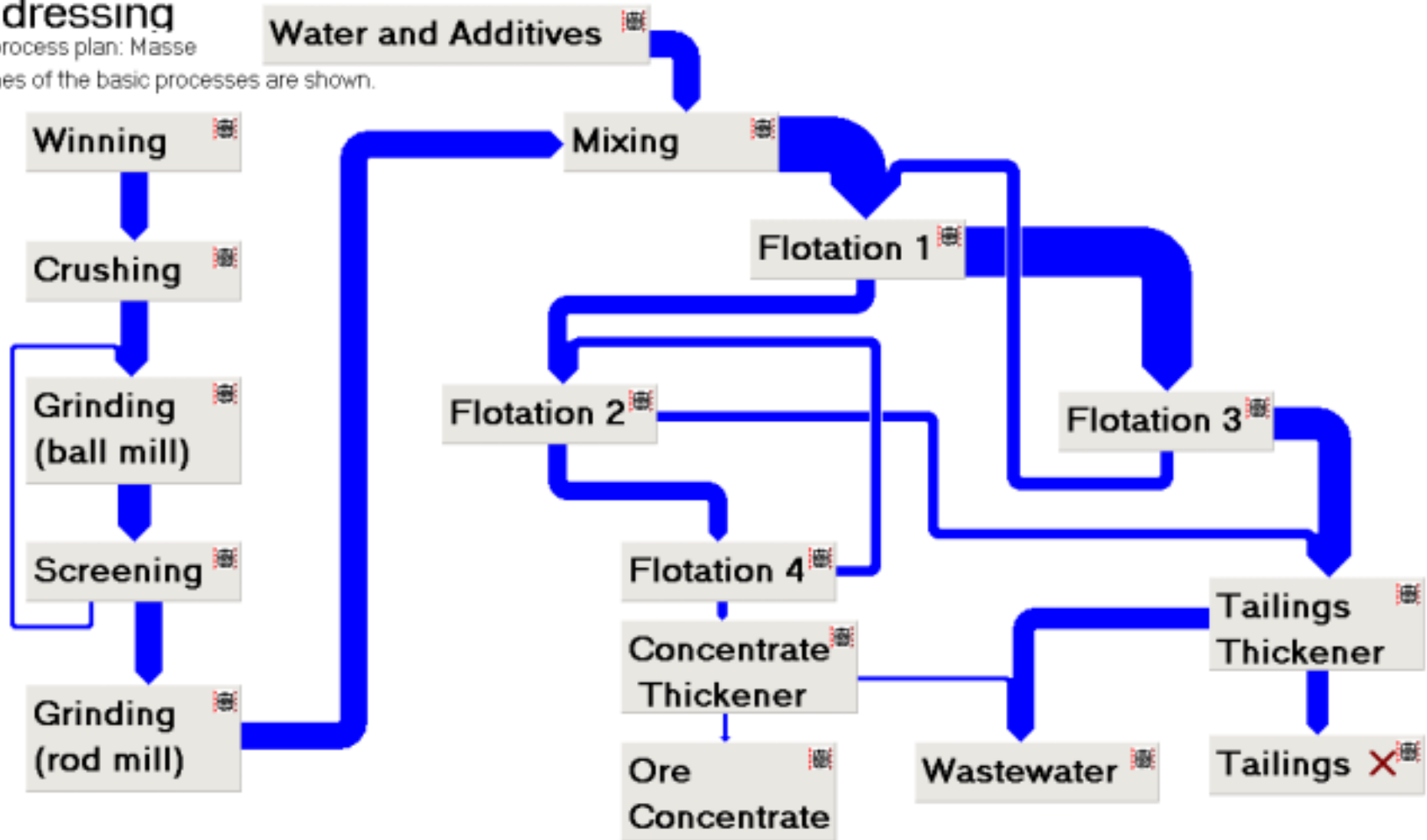
The LCA-Model

Modeling an Ore Concentrator

Ore dressing

GaBi 4 process plan: Masse

The names of the basic processes are shown.



International Conference
4 – 6 November 2004, Kraków, Poland

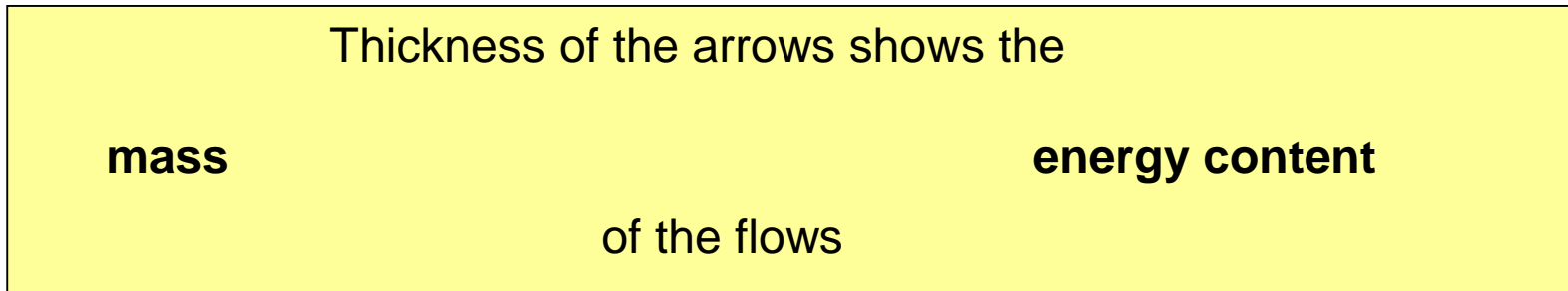
“Sustainable Post-Industrial Land Management”



IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde

The LCA-Model

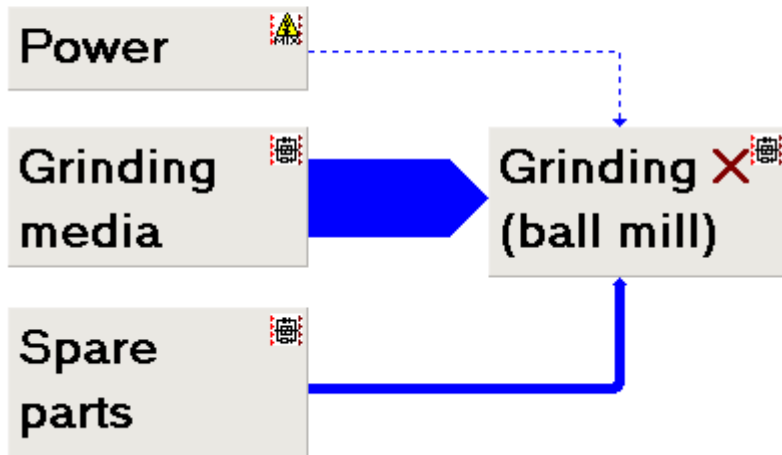
One process-step: The ball mill



Grinding (ball mill)

GaBi 4 process plan: Mass

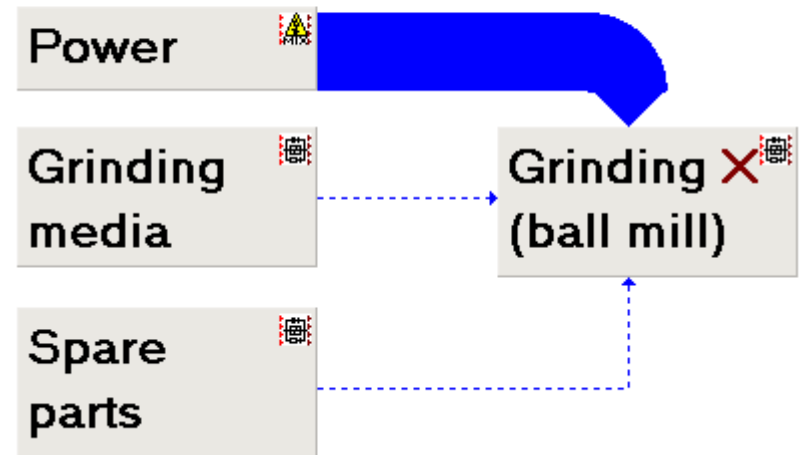
The names of the basic processes are shown.



Grinding (ball mill)

GaBi 4 process plan: Energy (lower calorific heating value)

The names of the basic processes are shown.



The LCA-Model

View of a process

A process in the model basically consists of a list of in- and outputs

The screenshot shows the 'LCA' software interface for a process named 'Power grid mix'. The 'Parameter' section shows 'Year' set to 2000 and 'Completeness' set to 'All relevant flows recorded'. The 'Inputs' table lists various resources, and the 'Outputs' table lists various emissions and products.

Inputs	Quantity	Amount	Unit	Source	Origin
Air [Renewable resource]	Mass	1.8580	kg	0%	(No statement)
Biomethane [Non renewable resource]	Mass	1.462E-5	kg	0%	Literature
Crude oil [Crude oil (resource)]	Mass	0.00897272	kg	0%	Literature
Crude oil Algeria [Crude oil (resource)]	Mass	0.00875272	kg	0%	Literature
Crude oil Angola [Crude oil (resource)]	Mass	0.00876952	kg	0%	Estimated
Crude oil Cameroon [Crude oil (resource)]	Mass	3.1184E-6	kg	0%	Estimated
Crude oil Canada [Crude oil (resource)]	Mass	3.3249E-6	kg	0%	(No statement)

Outputs	Quantity	Amount	Unit	Source	Origin
Acetic acid [Group NMVOC to air]	Mass	4.663E-7	kg	0%	(No statement)
Acetone [Methylocetone] [Group NMVOC to air]	Mass	1.0286E-7	kg	0%	(No statement)
Acid [calculated as H+] [Inorganic emissions to fresh water]	Mass	7.8173E-11	kg	0%	Literature
Activatable organic halogen compounds [AOH] [Analytical measure]	Mass	2.8754E-10	kg	0%	Measurement
Aldehyde [unspecified] [Group NMVOC to air]	Mass	9.218E-16	kg	0%	Literature
Alkane [unspecified] [Group NMVOC to air]	Mass	8.2521E-7	kg	0%	Calculated
Alkene [unspecified] [Group NMVOC to air]	Mass	4.8182E-7	kg	0%	Calculated
Aluminum [Inorganic emissions to fresh water]	Mass	4.533E-6	kg	0%	Literature
Amonium [NH ₄ ⁺] [In radioactive emissions to fresh water]	Activity	1.3425E-9	Bq	0%	(No statement)
Amonium [Inorganic emissions to air]	Mass	1.5449E-8	kg	0%	Calculated
Amonium / ammonia [Inorganic emissions to fresh water]	Mass	3.9766E-7	kg	0%	(No statement)
Amonium nitrate [Inorganic emissions to air]	Mass	1.5286E-10	kg	0%	Literature
Antimony [Heavy metals to air]	Mass	5.2795E-10	kg	0%	Calculated
Antimony [Sb128] [Radioactive emissions to air]	Activity	4.7086E-10	Bq	0%	Literature
Antimony [Sb128] [Radioactive emissions to fresh water]	Activity	1.2895E-11	Bq	0%	Literature
Antimony [Sb125] [Radioactive emissions to fresh water]	Activity	9.538E-12	Bq	0%	Literature
Argon [Ar41] [Radioactive emissions to air]	Activity	2.969E-6	Bq	0%	Literature
Aromatic hydrocarbon [unspecified] [Group NMVOC to air]	Mass	4.467E-8	kg	0%	(No statement)
Arsenic [Heavy metals to air]	Mass	3.1386E-9	kg	0%	(No statement)
Arsenic [Heavy metals to fresh water]	Mass	2.603E-9	kg	0%	(No statement)
Ash [Inorganic goods]	Mass	8.9907E-5	kg	0%	(No statement)
Bauxite [Inorganic emissions to air]	Mass	1.528E-7	kg	0%	(No statement)
Bauxite [Inorganic emissions to fresh water]	Mass	2.9517E-8	kg	0%	Literature
Benzene [Group BMVOC to air]	Mass	8.8281E-8	kg	0%	(No statement)
Benzene [Hydrocarbons to fresh water]	Mass	1.8122E-7	kg	0%	Literature
Benzol[a]pyrene [Group PAH to air]	Mass	1.8337E-10	kg	0%	(No statement)
Benzofuran [Inorganic emissions to air]	Mass	1.8077E-10	kg	0%	Calculated

International Conference
4 – 6 November 2004, Kraków, Poland

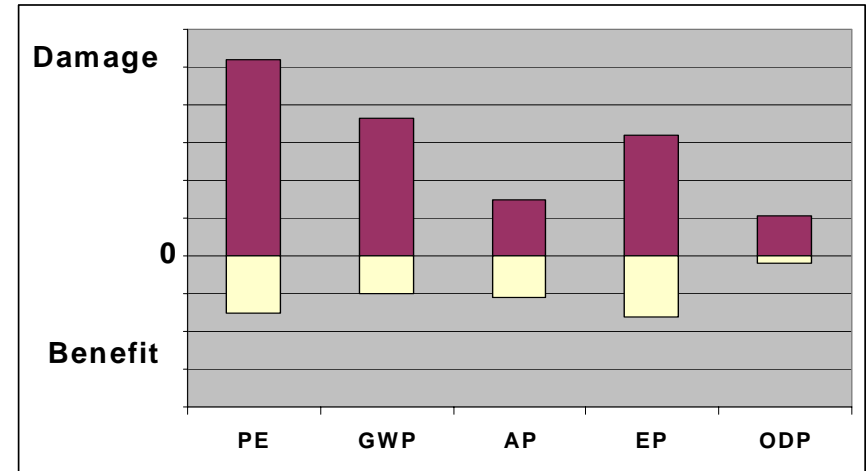
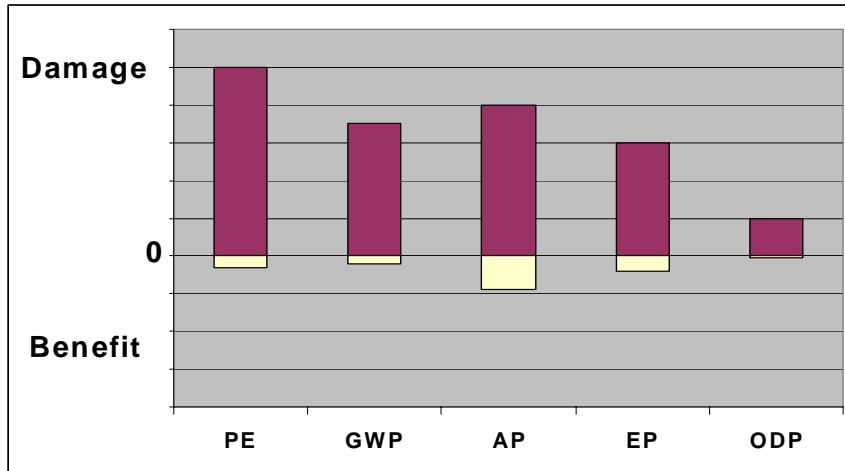
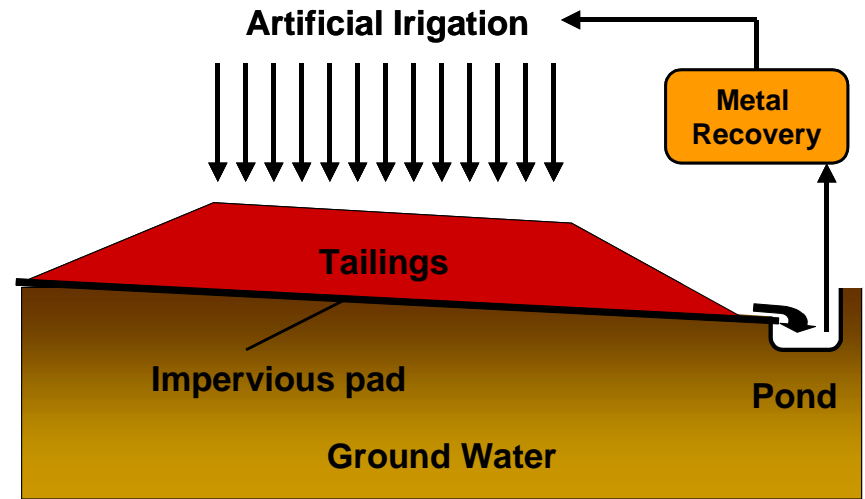
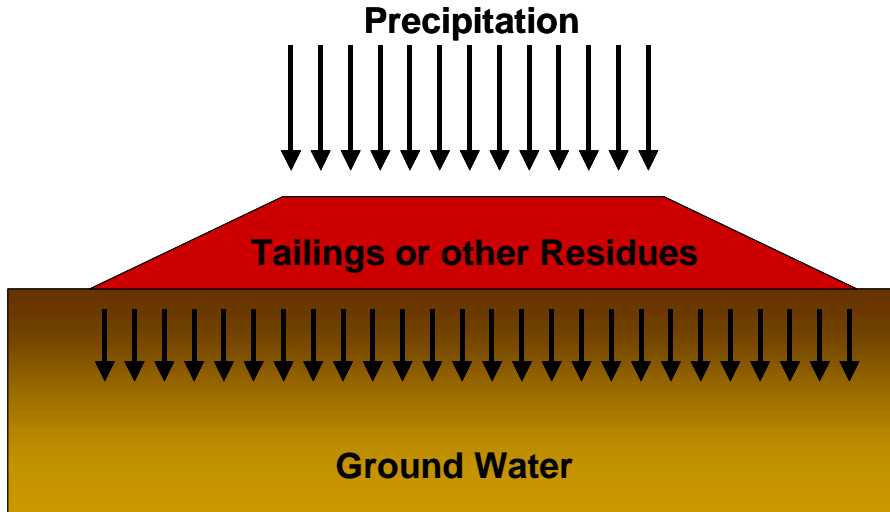
“Sustainable Post-Industrial Land Management”



IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde

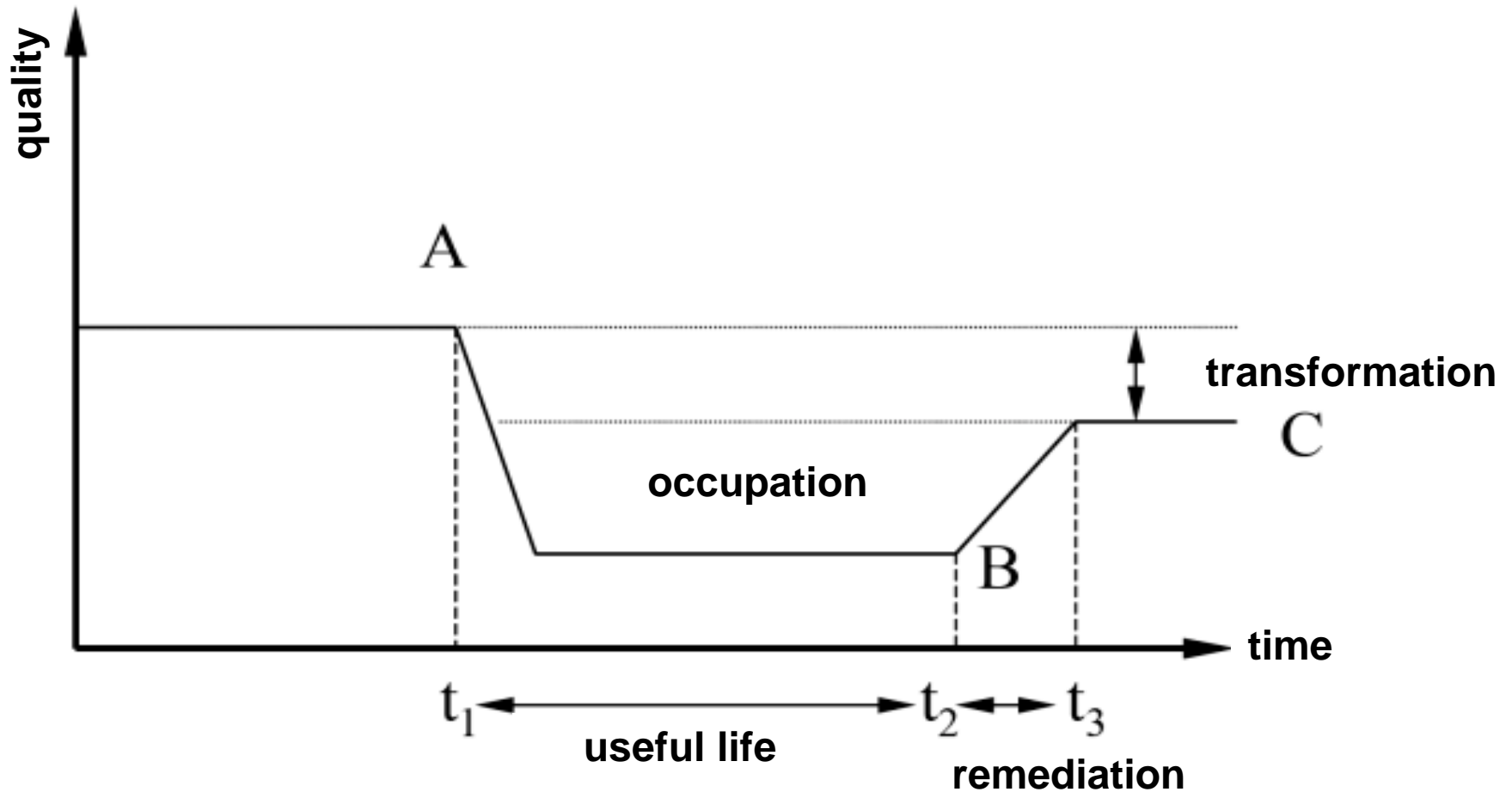
Leaching of Tailings

and Acid Drainage



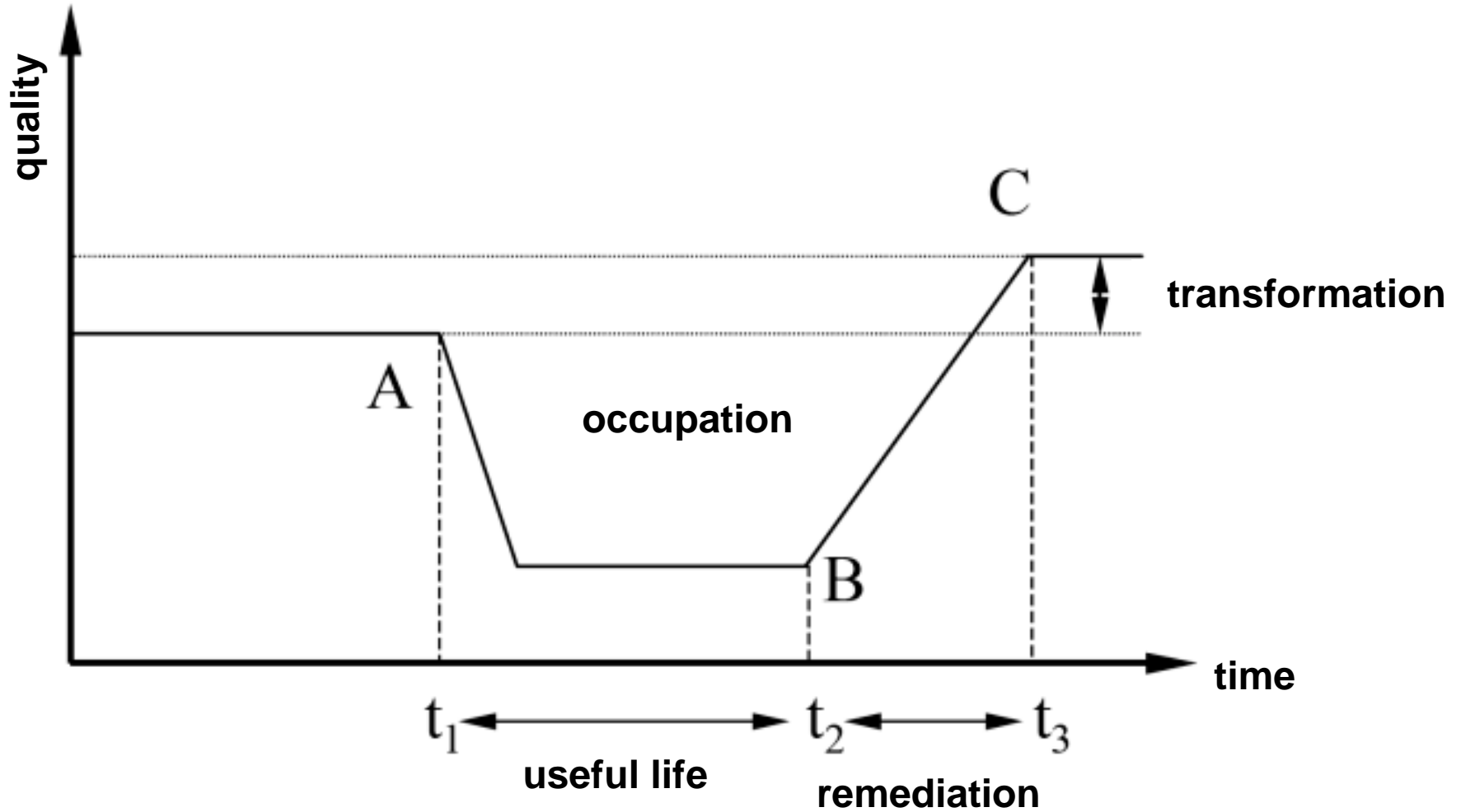
Land use

Occupation and transformation of a land area



Land use

Occupation and transformation of a land area



Considered Effects of Land-use

- Erosion resistance
- Filtering, buffer, and transformation ability
- Ground water building function
- Drainage regulation
- Biotic yield potential
- Immission protection
- Ecotope building potential



Benefits

With a LCA-integrated methodology

- the land-use is quantifiable
- a more differentiated picture of the environmental overall-situation is obtained
- a more precise control and sound management is possible



Sustainable Post-Mining Land Management

Summary

- For Environmental Management a Life Cycle Approach should be employed to avoid neglecting or shifting of problems
- Engineered leaching processes have two effects:
 - Increase of recovery rates
 - Prevention of acid drainage
- Land use effects are important to be considered to make sustainable decisions. It can be done with the provided methodology



Contact

For further questions, information,...

Thank you for your attention !!

Leif Barthel

University of Stuttgart

Institute for Polymer Testing and Polymer Science (IKP),
Department Life Cycle Engineering (LCE)

phone: +49 711 48 9999-32

e-mail: barthel@ikp2.uni-stuttgart.de

www.ikpgabi.de

www.gabi-software.de

International Conference
4 – 6 November 2004, Kraków, Poland

“Sustainable Post-Industrial Land Management”



IKP GaBi
Universität Stuttgart
Institut für Kunststoffprüfung
und Kunststoffkunde