Results from the SEES Project:

Recyclability and Sustainability of Automotive Electrical and Electronic Systems

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Contents

- Introduction to the SEES Project
- SEES Work Structure & Interim Results
- LCA/LCC Studies
- Results from Software Analysis
- Conclusions & Outlook

SEES Project & Partners

Funded by the European Commission

(contract no. TST3-CT-2003-506075)

Project full title:

Sustainable **E**lectrical & **E**lectronic **S**ystem for the Automotive Sector (SEES)

Project duration:

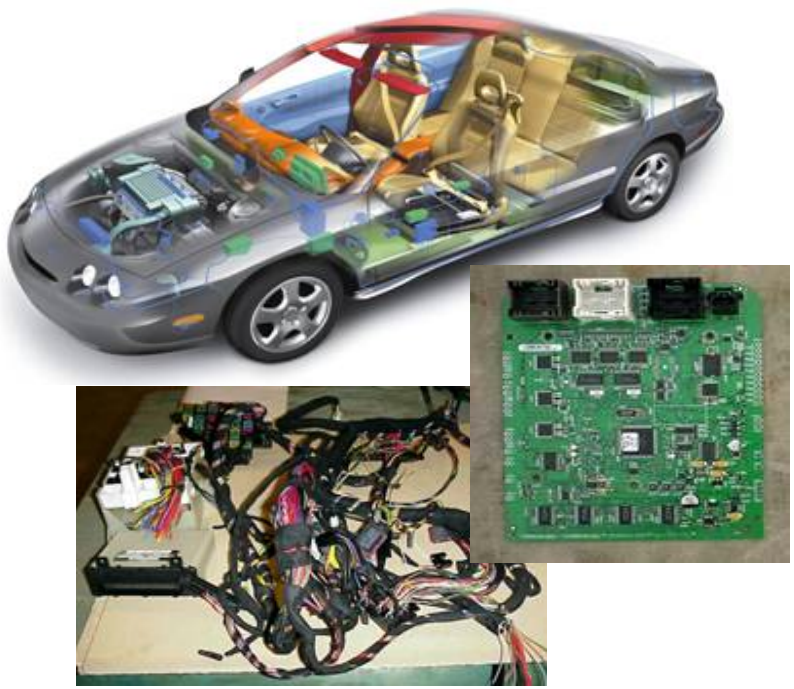
1 Feb 2004 – 31 Jan 2007

Homepage:

www.sees-project.net

The partners cover the entire life cycle of automotive electrics/electronics!

Automotive Electrical & Electronic System (EES)



The **electrical system** and the **electronic systems** of a car are closely interlinked and become increasingly important in modern cars
→ **Electrical & Electronic System (EES)**

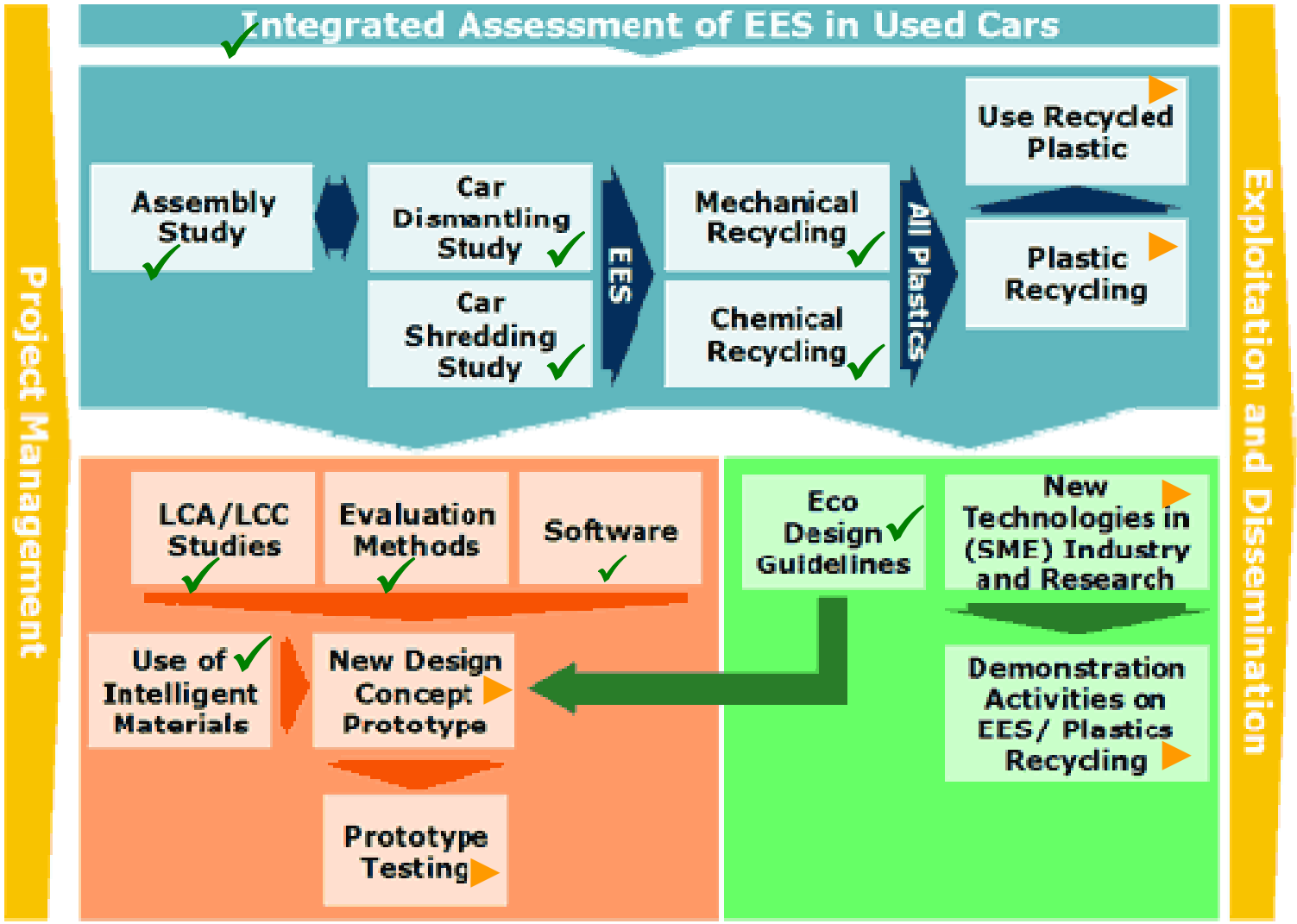
WHAT does it contain?

- **Energy sources** (battery, alternator)
- **Wire harness** (power and signal distribution)
- **Sensors and actuators**
- **Passive and electronic junction boxes** and other control units
- **Different devices** (lights, motors, heatings, comfort and infotainment devices, safety devices, etc.)

SEES Main Objective:

Development of prototypes and dismantling/recycling processes
for a sustainable, clean, cost- and eco-effective EES
in order to increase the recovery and reuse rate of vehicles

SEES Work Structure



✓= finished

▶= ongoing

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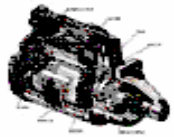
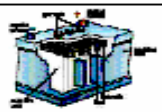
Some Interim Results

- **Integrated EES assessment**: EES evaluation and classification according to their legal, environmental and economic relevance
  - ➔ 14 representative groups of EES components
- **Disassembly & Shredding Studies:**
  - ➔ Limited influence of Design for Disassembly on actual disassembly time
  - ➔ Disassembly for material recycling is currently not cost-efficient for studied components
- **EES and plastic recycling:**
  - ➔ Developed schemes for recycling of dismantled EES components, mixed materials from shredding residues and mixed plastics

Integrated Assessment of EES

→ Public Report D1 on th SEES website

- Classification of EES components into 14 groups
- Collection of information about them (materials, future trends…)
- Integrated assessment of their legal, environmental and economic aspects

Sensors		Electr. motors and generators	
Actuators		Lighting devices	
Wire Harness and Cables		Heating Units	
Connection and protection devices		Displays	
Electronic Control Units		Entertainment devices	
Integ. Mechatronic Components		Comm. and navigation dev.	
Batteries		Other devices	

Assembly, Disassembly and Shredding Studies

→ **Public Reports D3+D6 on the SEES website**

- **Disassembly Tests:**
  - New vs. end-of-life vehicles, different car segments and types, destructive vs. non-destructive approach, different tools
    → Disassembly time and cost, logistics, optimisation
- **Shredding Tests:**
  - Whole vehicles vs. vehicles with dismantled EES
    → Distribution of EES materials to output fractions, recovery/recycling potential, process optimisation

Some Results:

- Disassembly for material recycling is currently not cost-efficient
- Small portion of disassembly time can be addressed by Design for Disassembly
- Separation of copper from the ferrous shredder fraction (handpicking) is currently more economical than EES dismantling

EES and Plastic Recycling

→ Upcoming Public Reports D4+D5

- Mechanical and chemical recycling of dismantled EES components, mixed EES materials and automotive shredding residues (ASR)
- Plastic separation/recycling of mixed plastic fractions from mechanical recycling and pre-treated ASR
- Identification of value added applications for recycled fractions

Dismantled/Shredded EES

Mechanical Recycling

PCB fraction,

Mixed Plastics,

Copper,

...

Others

Dismantled PCBs

Chemical Recycling

(Precious Metals)

Plastic Recycling

(Value added applications)

Pre-treated ASR

Goal and Scope of LCA and LCC Studies

- Determination and comparison of potential environmental and economical impacts of alternative scenarios for EES → to assess the significance of improvement potentials in design and recycling.
- Components under study: Engine Wire Harness (WH) & Passenger Smart Junction Box (PSJB)
- Functional Unit: One component, assembled in a middle class Ford car model, assumed use phase 150.000 km in 12 years.
- Allocation of fuel consumption based on an incremental approach, diesel (44 %) and gasoline (56 %) mix.

Environmental & Economic Studies

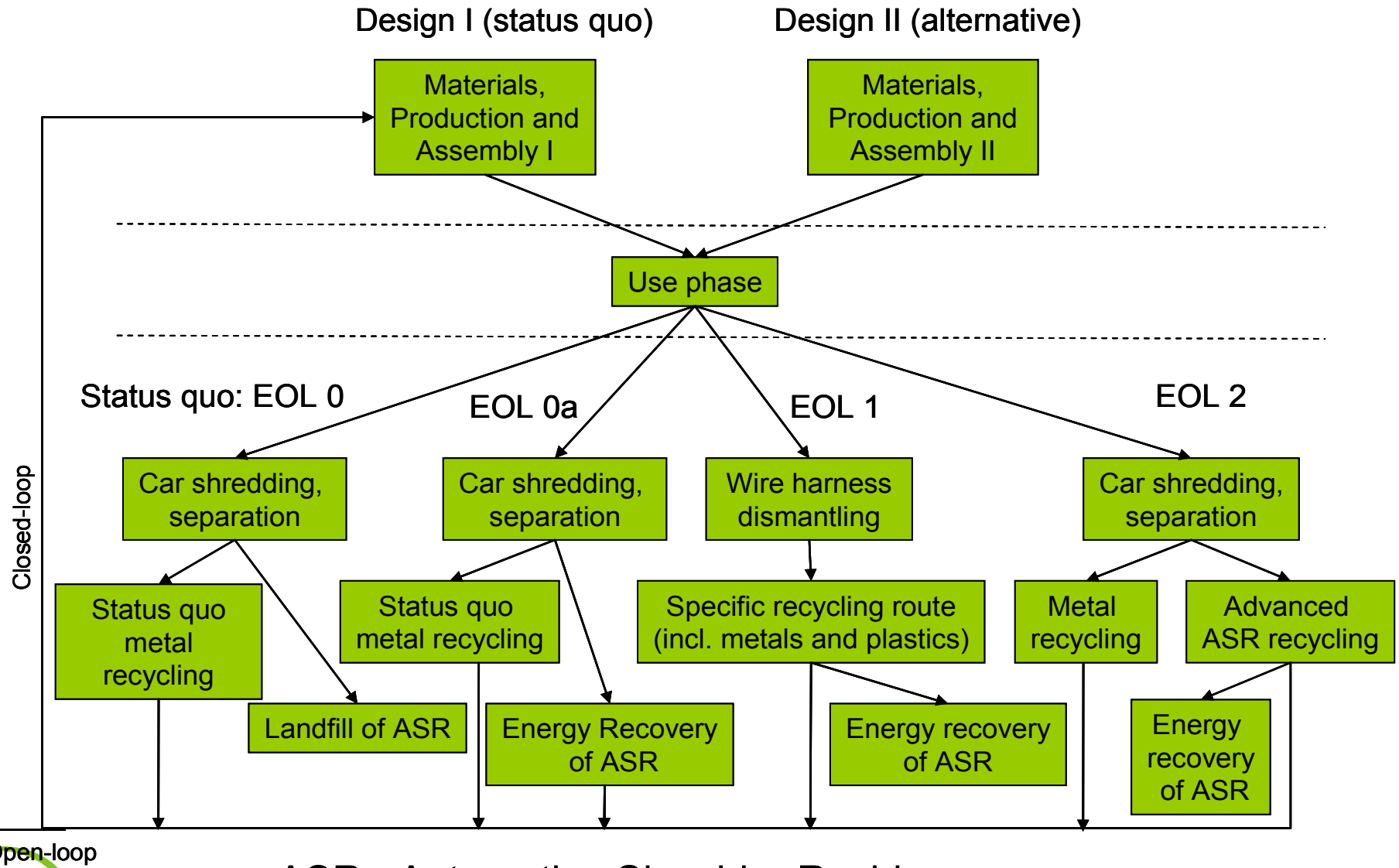
→ **Public Report D7 available from the SEES website**

- Life Cycle Assessment (**LCA**) and Life Cycle Costing (**LCC**) case studies for a wire harness and a smart junction box
- Comparison of different **design alternatives** (lead-free solders; flat flexible cables; improved fasteners) and **end-of-life scenarios** (status quo car shredder; disassembly for recycling; post-shredder-recycling)

Some Results:

- High relevance of the production phase (incl. material production) and the use phase in the total life cycle
- Improvement potential of design alternatives is higher than for different end-of-life scenarios
- Disassembly and post-shredder-recycling both perform better than status quo car recycling
  → preferred option depends on component

Schematic Representation of Design and EOL-Scenarios



ASR= Automotive Shredder Residue

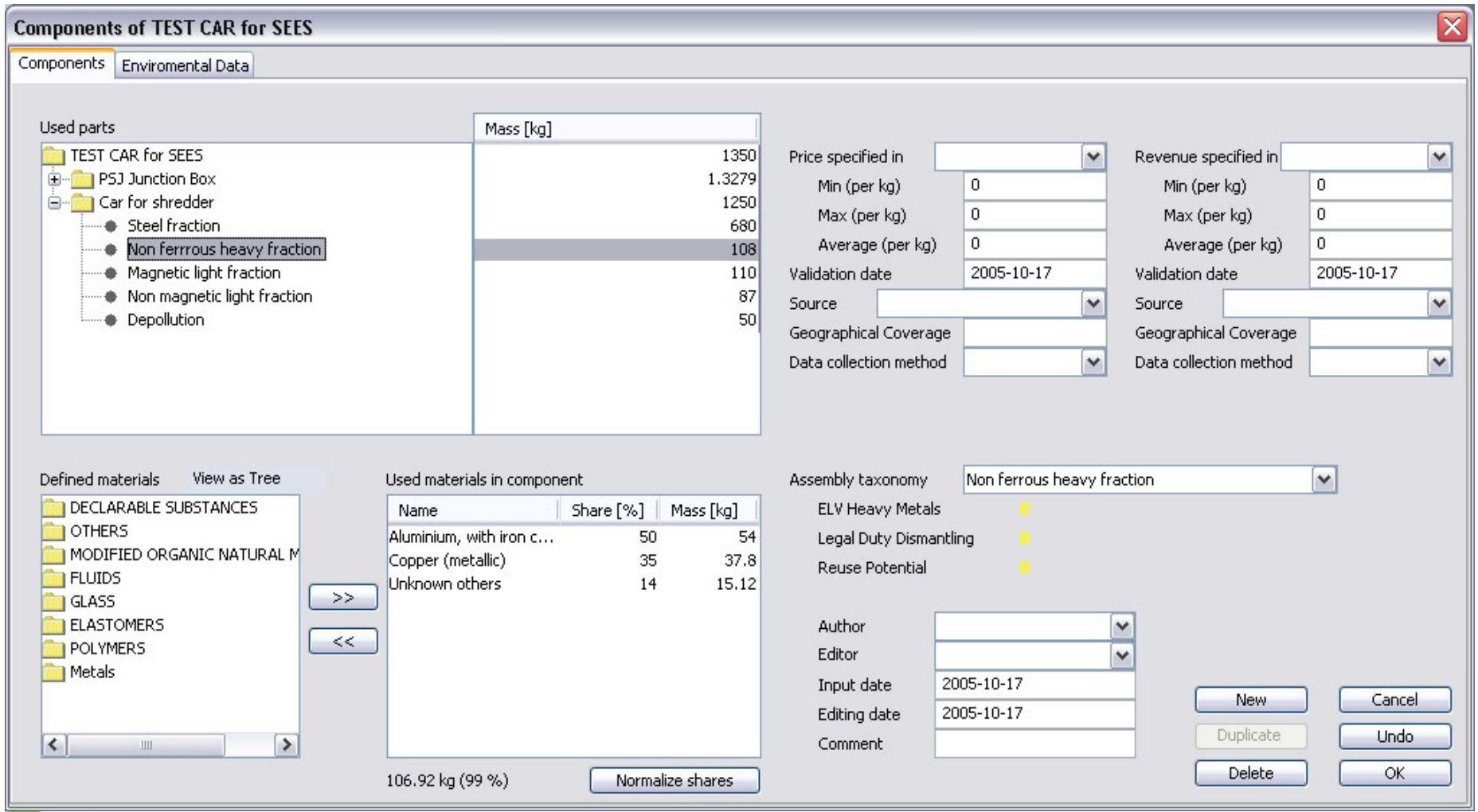
Results of LCA and LCC case studies for WH

- LCA results are dominated by the manufacturing (including material production) and use stage, LCC results are dominated by the manufacturing costs (90%).
- A clear environmental improvement in the case of Design II1 (FFC) due to reduced weight (-18%) for manufacturing and use stage, but with some increased costs.
- No significant environmental improvement in the case of Design II2 (hook-loop-tapes), but a slight cost reduction (< 1 %) which becomes more relevant for disassembly (EOL 1).
- Better LCA results for EOL 1 and EOL 2 due to higher credits given for material recovery.
- EOL 2 would be more recommendable, since in EOL 1 only partly disassembly of WH is possible.
- LCC results are better for EOL 2 and EOL 1 due to increased revenues and saved costs for reduced ASR amount.

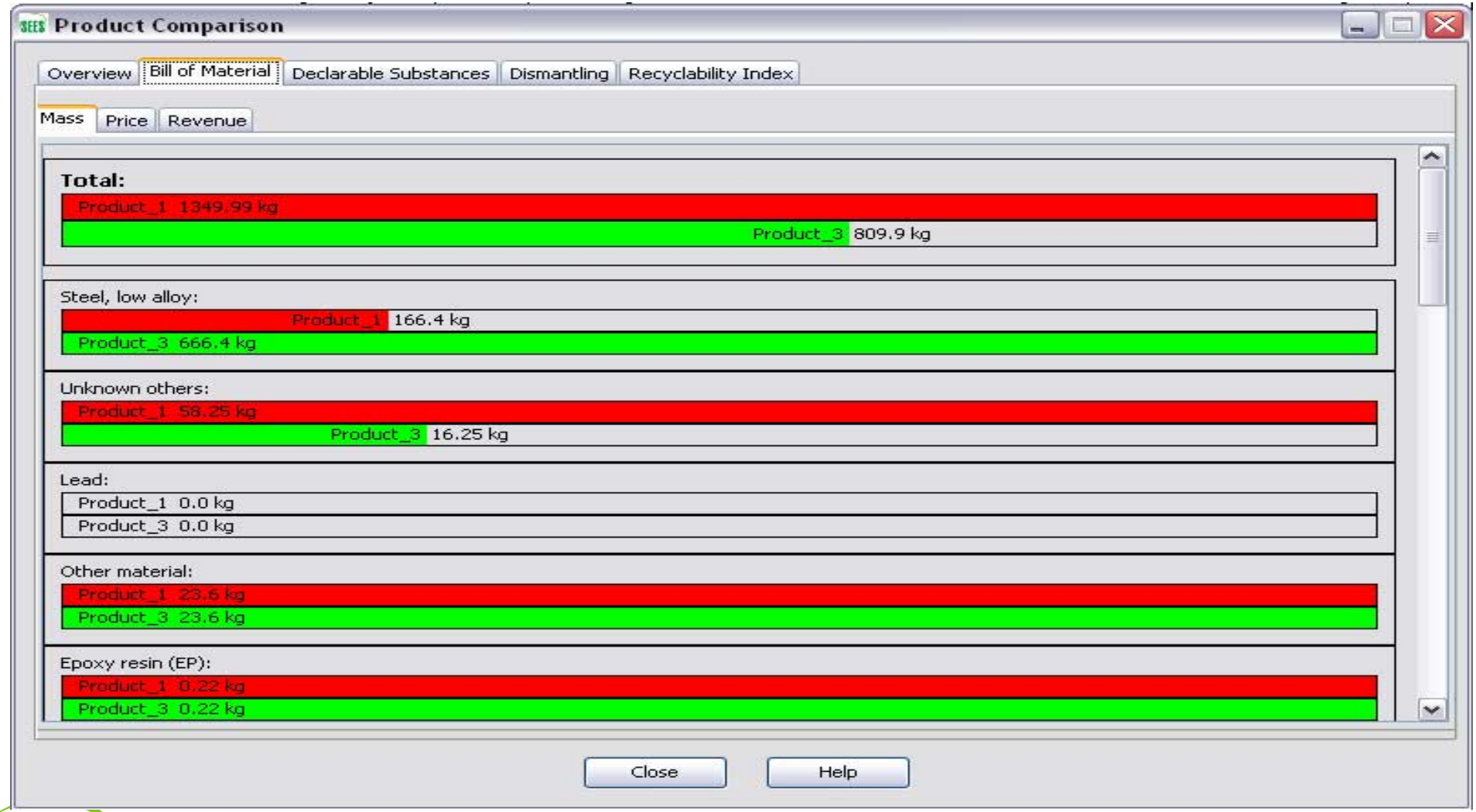
Structure of the SEES software

- The software is intended for use by EES designers and end-of- life operators for support in decision making.
- Using the software, a simplified model of a product can be created and process related aspects of the model can be analysed. In this way, different design and end-of-life scenarios can be quantitatively compared.
- The first part of the software covers product related analysis of recyclability, recoverability and disassembly effort to support EES designers. A product comparsion shows the differences.
- The second part has additional functions like scenario management, process flow analysis of recycling process technologies, life cycle costing, life cycle phase analysis and process comparison.

Software: Product Model Input

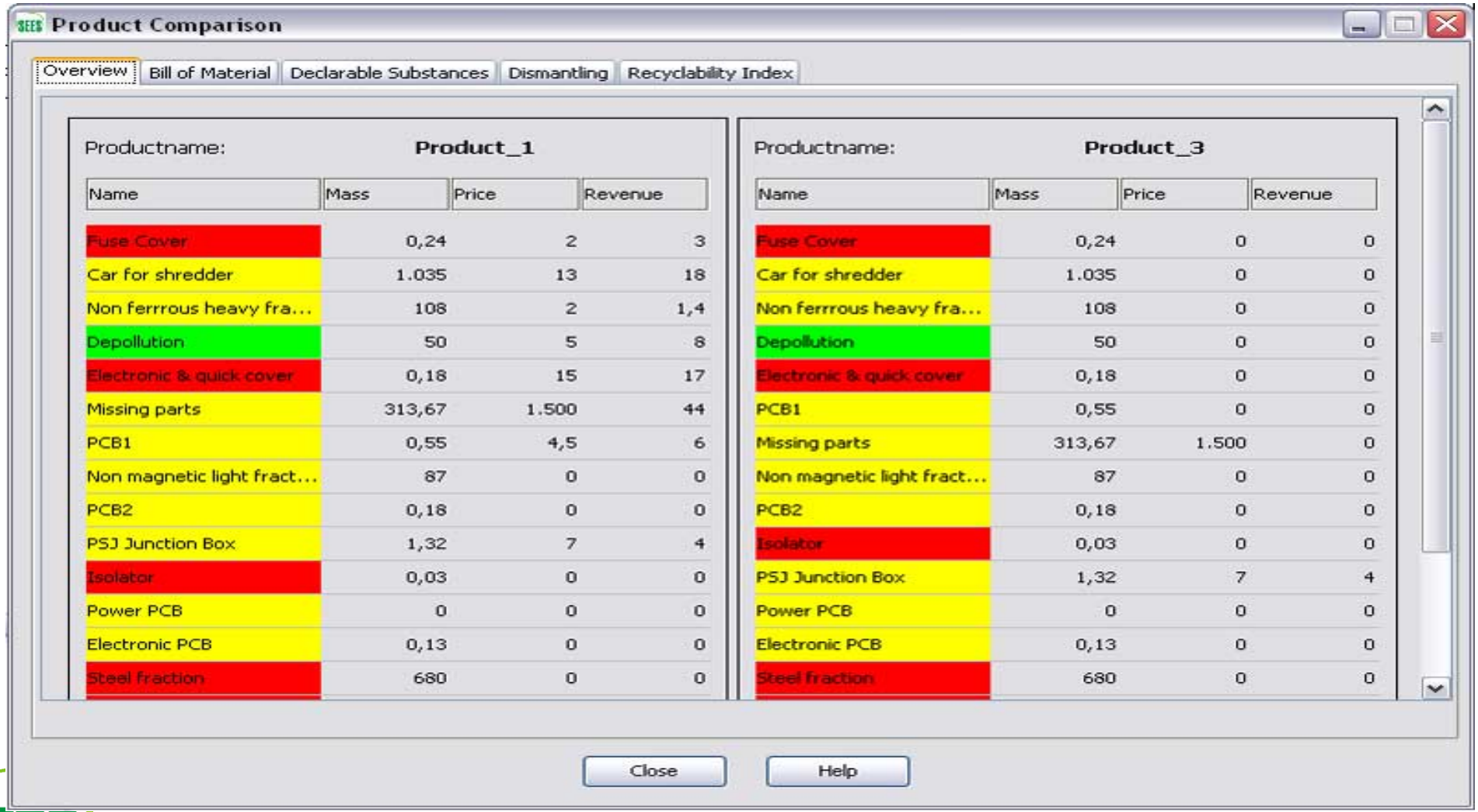


Product calculation (1/2)



AG2 In this screenshot you have large quantity of "unknown others" and "other material". Maybe you can show another list instead which shows more real materials.
André Greif, 9/1/2006

Product calculation (2/2)



Productname: **Product_1**

Name	Mass	Price	Revenue
Fuse Cover	0,24	2	3
Car for shredder	1.035	13	18
Non ferrrous heavy fra...	108	2	1,4
Depollution	50	5	8
Electronic & quick cover	0,18	15	17
Missing parts	313,67	1.500	44
PCB1	0,55	4,5	6
Non magnetic light fract...	87	0	0
PCB2	0,18	0	0
PSJ Junction Box	1,32	7	4
Isolator	0,03	0	0
Power PCB	0	0	0
Electronic PCB	0,13	0	0
Steel fraction	680	0	0

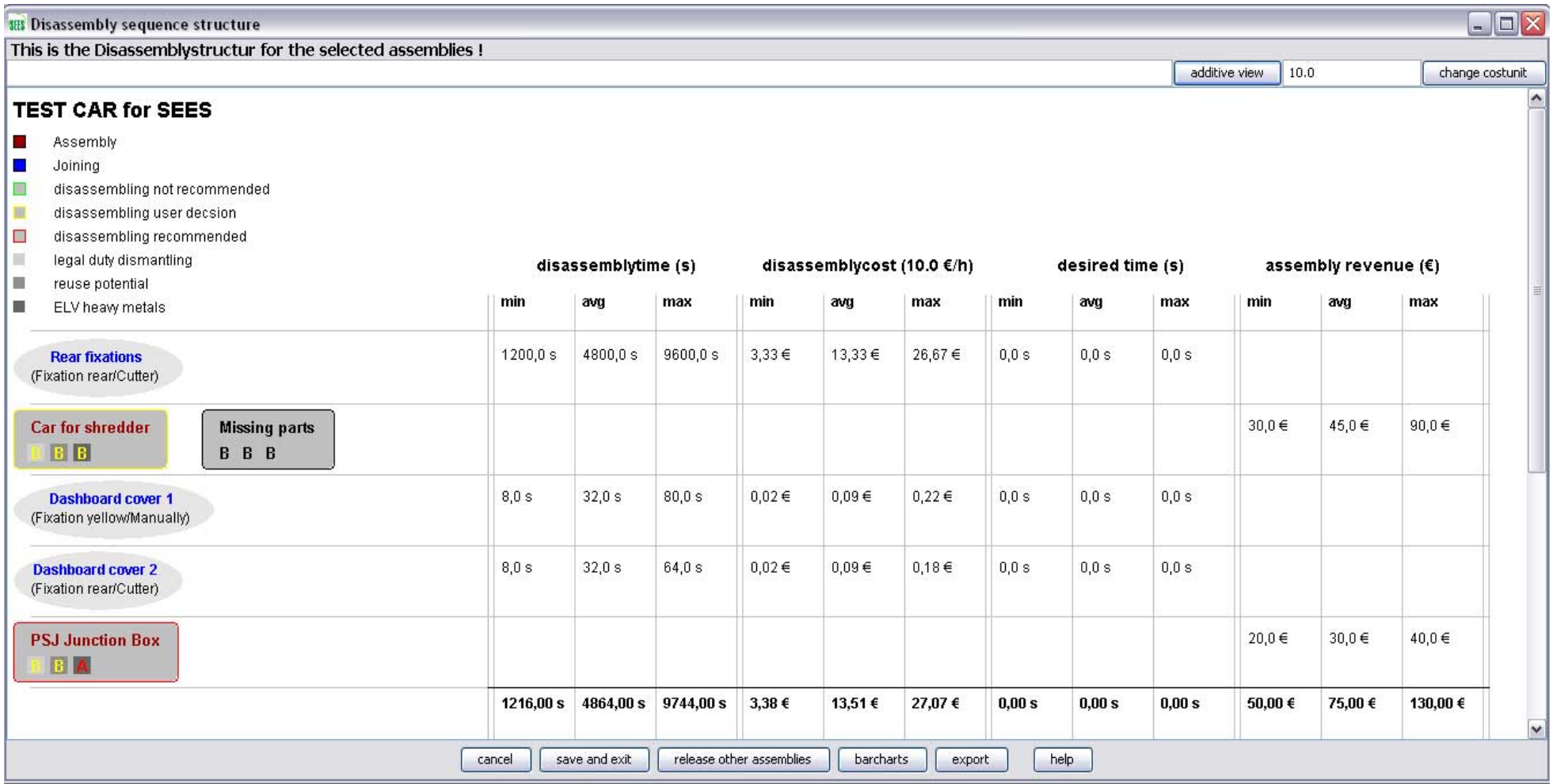
Productname: **Product_3**

Name	Mass	Price	Revenue
Fuse Cover	0,24	0	0
Car for shredder	1.035	0	0
Non ferrrous heavy fra...	108	0	0
Depollution	50	0	0
Electronic & quick cover	0,18	0	0
PCB1	0,55	0	0
Missing parts	313,67	1.500	0
Non magnetic light fract...	87	0	0
PCB2	0,18	0	0
Isolator	0,03	0	0
PSJ Junction Box	1,32	7	4
Power PCB	0	0	0
Electronic PCB	0,13	0	0
Steel fraction	680	0	0

AG3 Comparing "Product_1" and "Product_3" in this screenshot it is a little confusing that some parts, as e.g. the Fuse Cover, have a price and revenue defined in "Product_1" but not in "Product_3". Why? Change Screenshot?

André Greif, 9/1/2006

Disassembly time/costs/revenue



	disassemblytime (s)			disassemblycost (10.0 €/h)			desired time (s)			assembly revenue (€)		
	min	avg	max	min	avg	max	min	avg	max	min	avg	max
Rear fixations (Fixation rear/Cutter)	1200,0 s	4800,0 s	9600,0 s	3,33 €	13,33 €	26,67 €	0,0 s	0,0 s	0,0 s			
Car for shredder B B B / Missing parts B B B										30,0 €	45,0 €	90,0 €
Dashboard cover 1 (Fixation yellow/Manually)	8,0 s	32,0 s	80,0 s	0,02 €	0,09 €	0,22 €	0,0 s	0,0 s	0,0 s			
Dashboard cover 2 (Fixation rear/Cutter)	8,0 s	32,0 s	64,0 s	0,02 €	0,09 €	0,18 €	0,0 s	0,0 s	0,0 s			
PSJ Junction Box B B A										20,0 €	30,0 €	40,0 €
	1216,00 s	**4864,00 s**	**9744,00 s**	**3,38 €**	**13,51 €**	**27,07 €**	**0,00 s**	**0,00 s**	**0,00 s**	**50,00 €**	**75,00 €**	**130,00 €**

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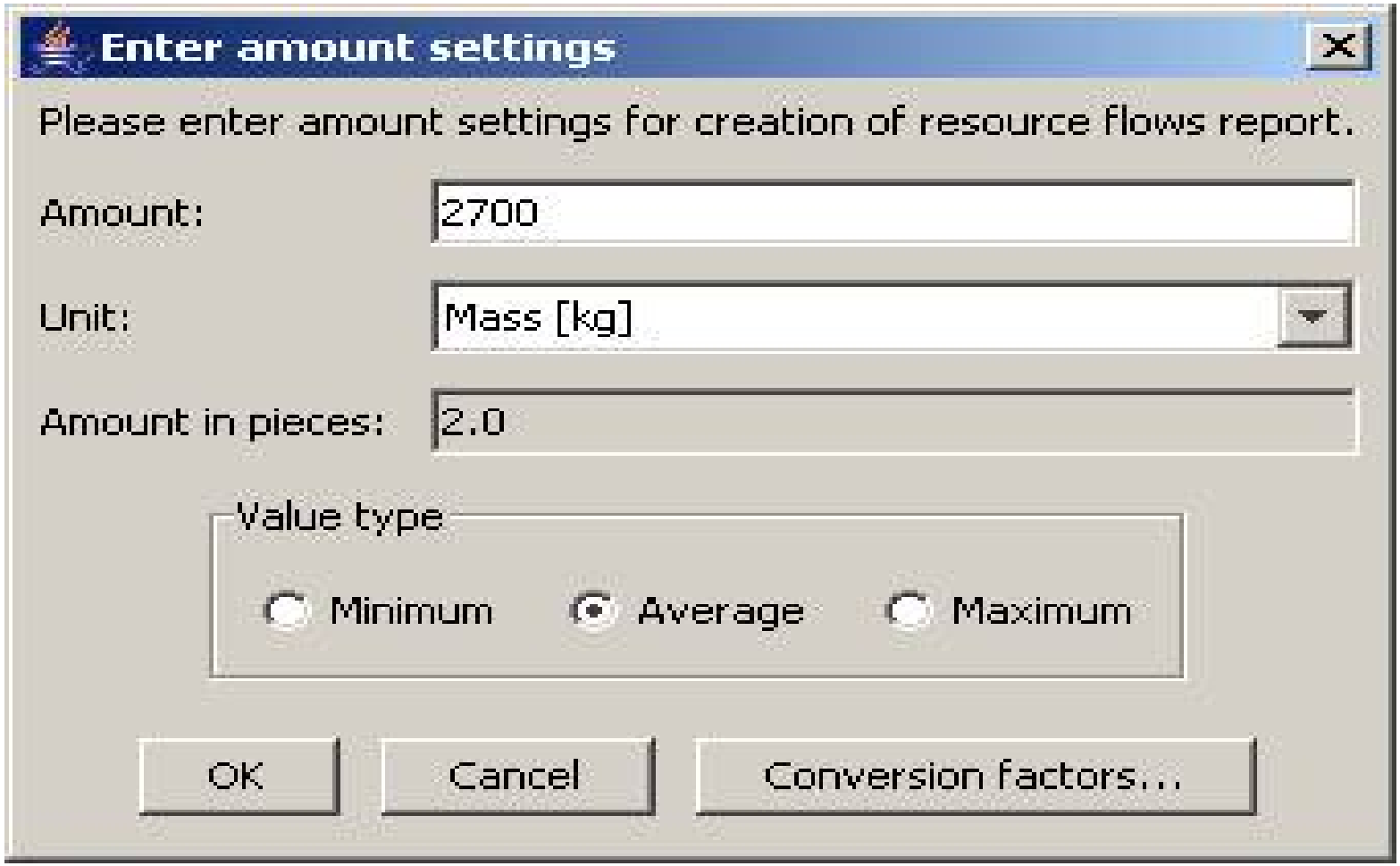
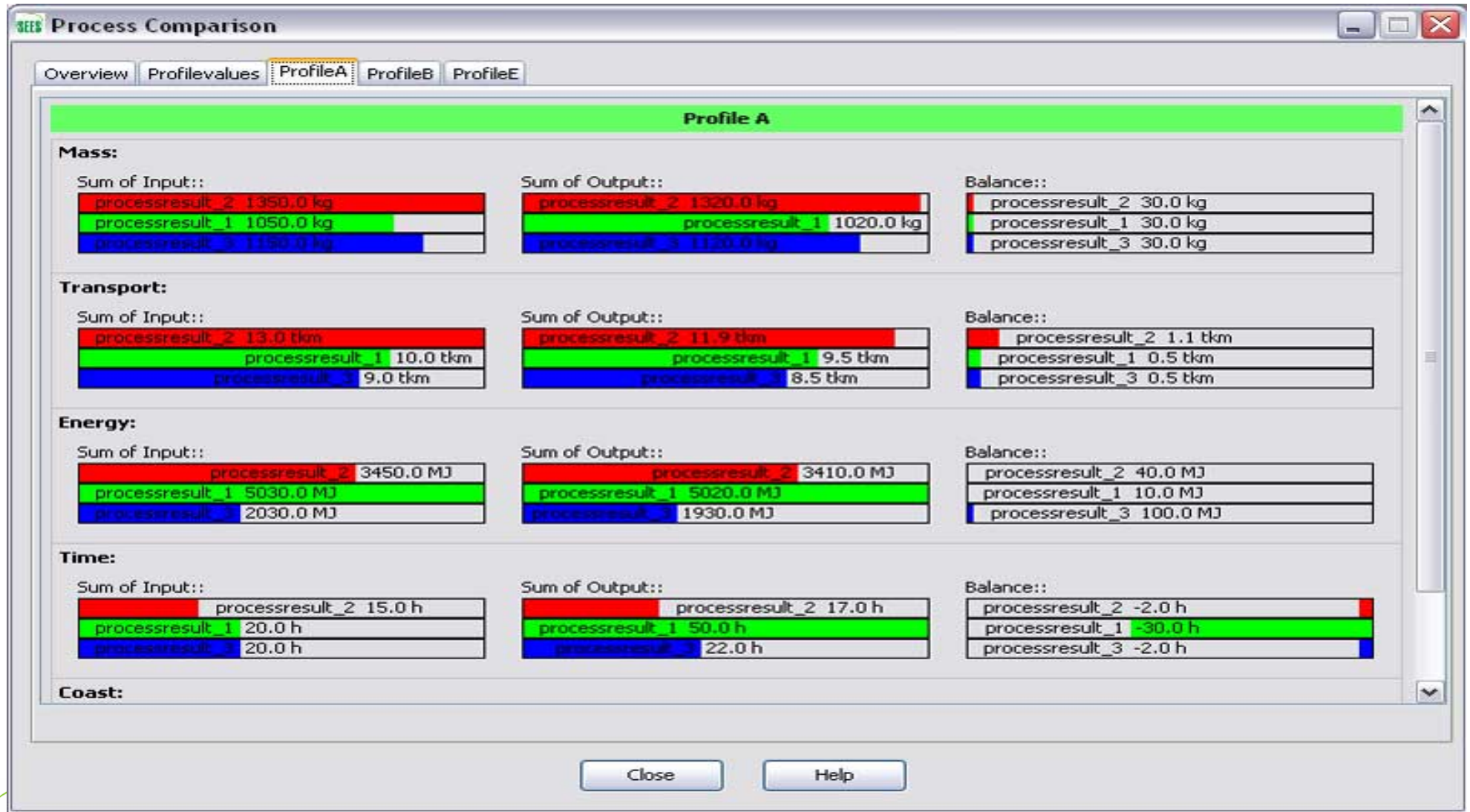
Process calculation (1/4)



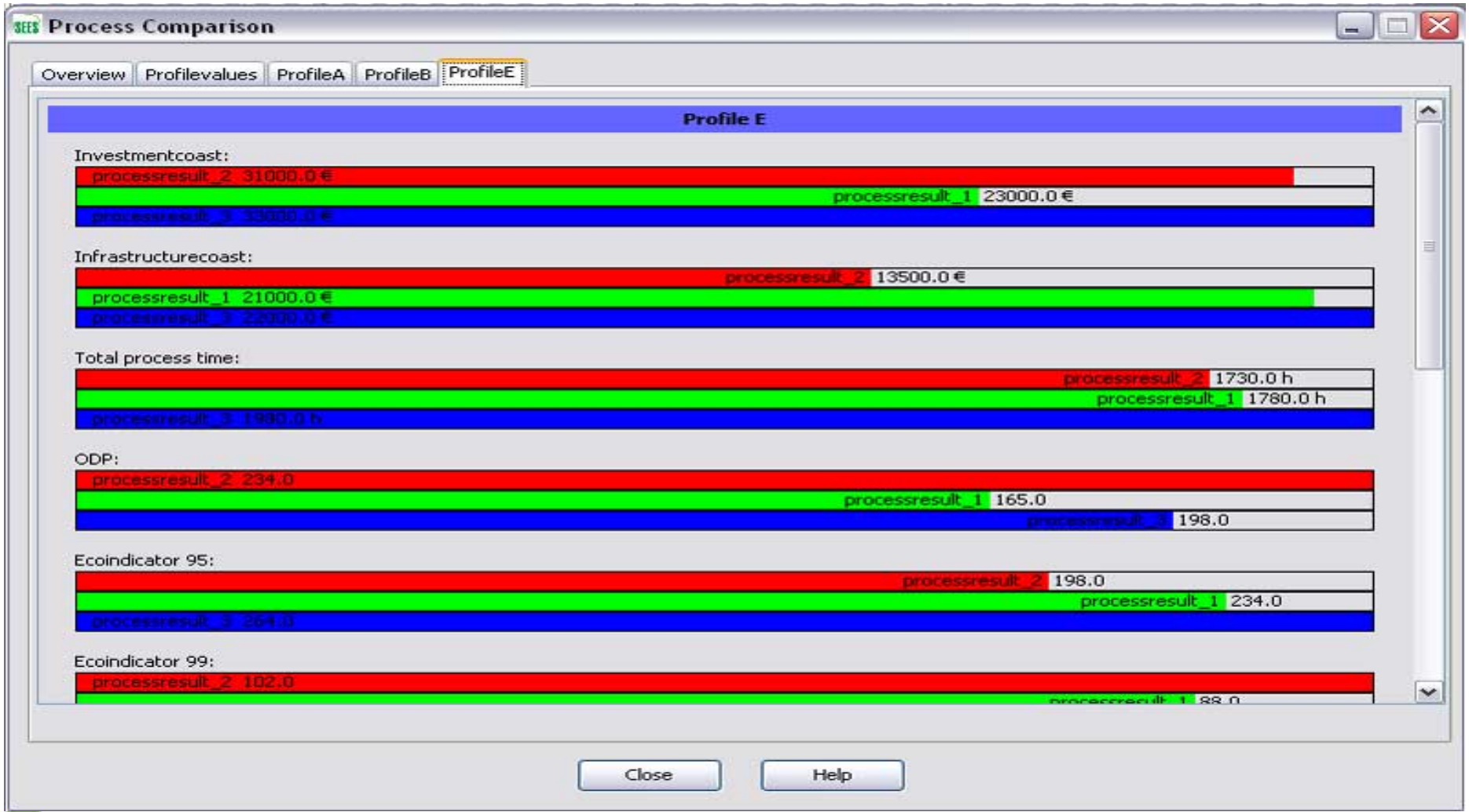
Slide 19

AG1 Not very meaningful screenshot here. I think, this slide could be left out in case you have to shorten your presentation. The results on the next slide are more interesting.
André Greif, 9/1/2006

Process calculation (2/4)



Process calculation (3/4)



Process calculation (4/4)

SEES Eco-Design Guidelines

→ Public Report D8 available from the SEES website

- SEES developed eco-design guidelines to improve the environmental performance of new EES designs
- Covered aspects:
  all life cycle phases from pre-production to end-of-life,
  EES product characteristics, EES design alternatives evaluation

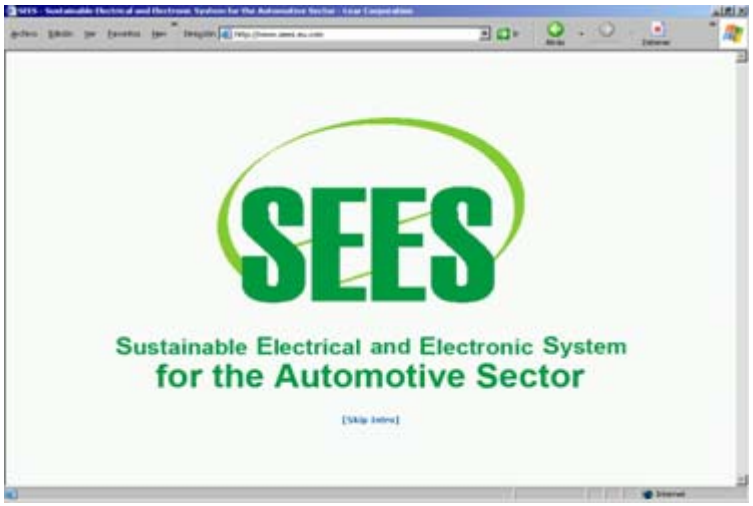
1. Qualitative evaluation of available redesign options
   → Recommendation
2. Determination of priority life cycle phases based on product type and its characteristics
3. Selection of appropriate guidelines for the priority life cycle phases

Outlook on further SEES Activities

- Development of a new EES concept including prototyping of specific functions/parts (e.g. energy management system, natural fibers reinforced plastic covers)
- Testing and validation of the prototypes (technical/functional, environmental and economic aspects)
- Dissemination and exploitation of the results

(SEES workshop planned at the CARE Innovation Congress, Vienna, 13-16 November 2006)

Thank you for your attention!



SEES-Project Homepage: *www.sees-project.net*

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