Label

Eco-Efficiency Analysis

Propylene Carbonate

January, 26th, 2004

Validated
Eco-Efficiency
Analysis Methodology

The Label

An eco-efficiency analysis was performed in order to compare the environmental impacts and the costs from all life cycle stages of two copper wire enamel solvents, cresol and propylene carbonate.

Wire coatings, especially those based on polyester imides, are traditionally produced with cresol as the solvent. Propylene carbonate can also be used as an alternative solvent.

The eco-efficiency analysis showed that the environmental impacts between the two solvents are more striking than the differences in the life-cycle costs. Propylene carbonate is the most eco-efficient copper wire enamel solvent.

Requirements met

1. Accomplished Eco-Efficiency Analysis according to the methodology certified by TÜV Rheinland/ Berlin-Brandenburg, Germany.

2. Verification of propylene carbonate to be more eco-efficient for the use as a solvent in wire coatings than other alternatives.

3. Third party evaluation by Prof. Shonnard, Michigan Tech University (USA) (so-called Critical Review according ISO 14040 ff.).

4. Publication of the results via internet on website www.oeea.de, which is referred to on the label.

5. Payment of the licence fee for the duration of three years.

Certificate

CERTIFICATE

ÖKOEFFIZIENZ-ANALYSE
ECO-EFFICIENCY ANALYSIS
1st place
in an environmental and economic evaluation according to the BASF method for use as a solvent in wire coatings
www.oeea.de

Eco-Efficiency Analysis
"Solvents in Wire Coatings"

The evaluation of environmental and economic effects of "Solvents in Wire Coatings" by using an eco-efficiency analysis according to the validated method is certified.

BASF AG, CZD/MG

is granted the right to use the Eco-Efficiency Label in the presented form for

Propylenecarbonate

for a duration of three years.

The main results are published under www.oeea.de .

Ludwigshafen, 12.01.2004

Dr. M. Kayser
Vice President Product Safety

Dr. A. Kicherer
Group Leader Eco-Efficiency

BASF

BASF

Eco-efficiency analysis

Comparison of alternative solvents for the production of wire enamels

Silke Schmidt, GUP/CE
Hansjörg Nickel, E-CZD/MG
Dominik Born, E-CZD/MG

Ludwigshafen, January 2003

MichiganTech

Michigan Technological University
Critical Reviewed Eco-Efficiency Analysis by
David R. Shonnard, Prof., Ph.D.
Department of Chemical Engineering
Michigan-Technological University
Houghton, MI 49931 USA

Validated eco-efficiency analysis method

Objectives and planned use of the study

Objective of the study

A comparison was carried out between the use of propylene carbonate and cresol as solvents in the coating of wires.

The application properties of propylene carbonate are comparable to those of cresol. All quantitative and qualitative differences will be included if possible.

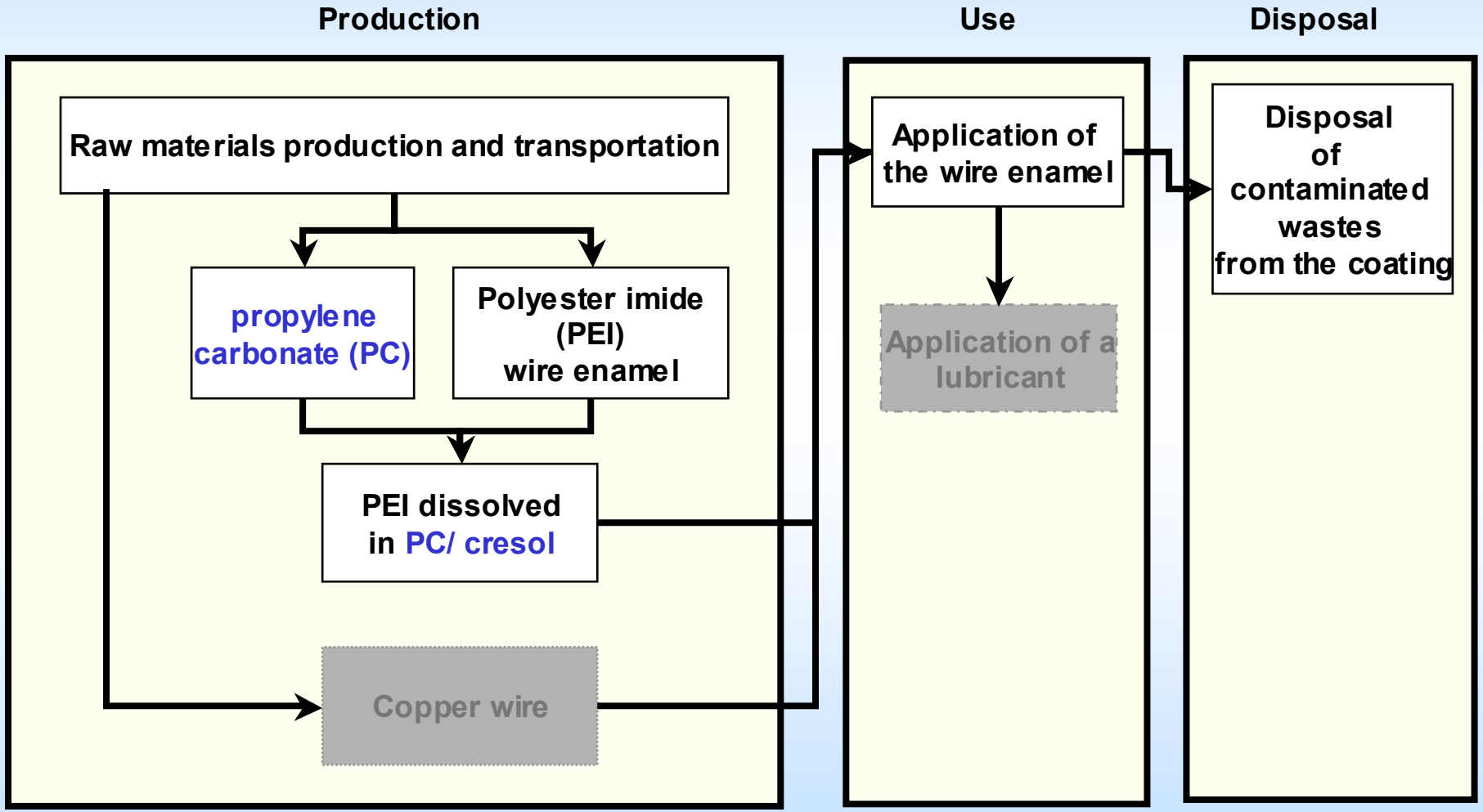
Use of the study

- Internal strategy finding
- Opening up of a new market for propylene carbonate

Target groups of the study

- BASF Research
- Decision-maker BASF
- Decision-maker CZD/MG
- Customers

System boundaries



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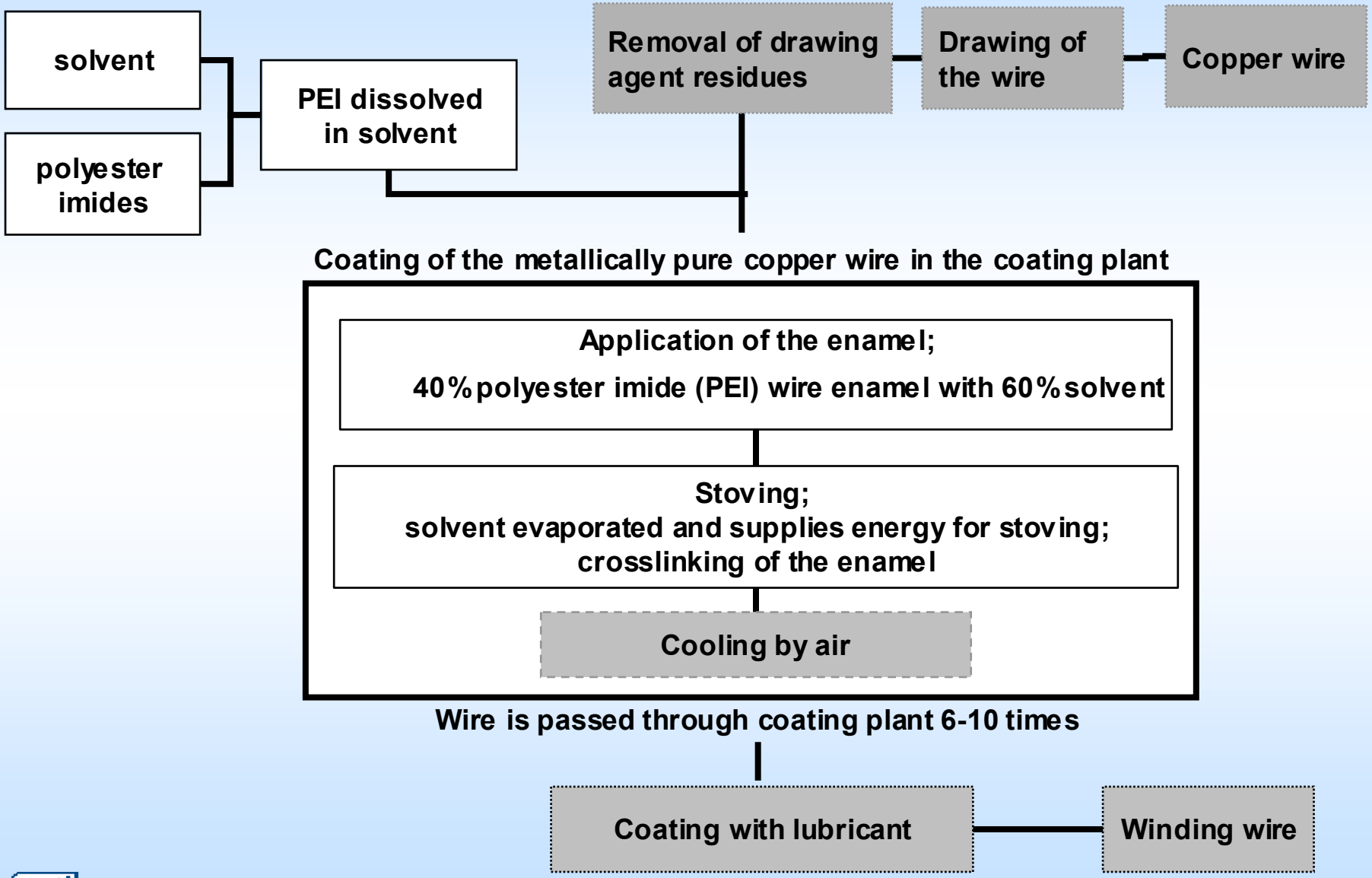
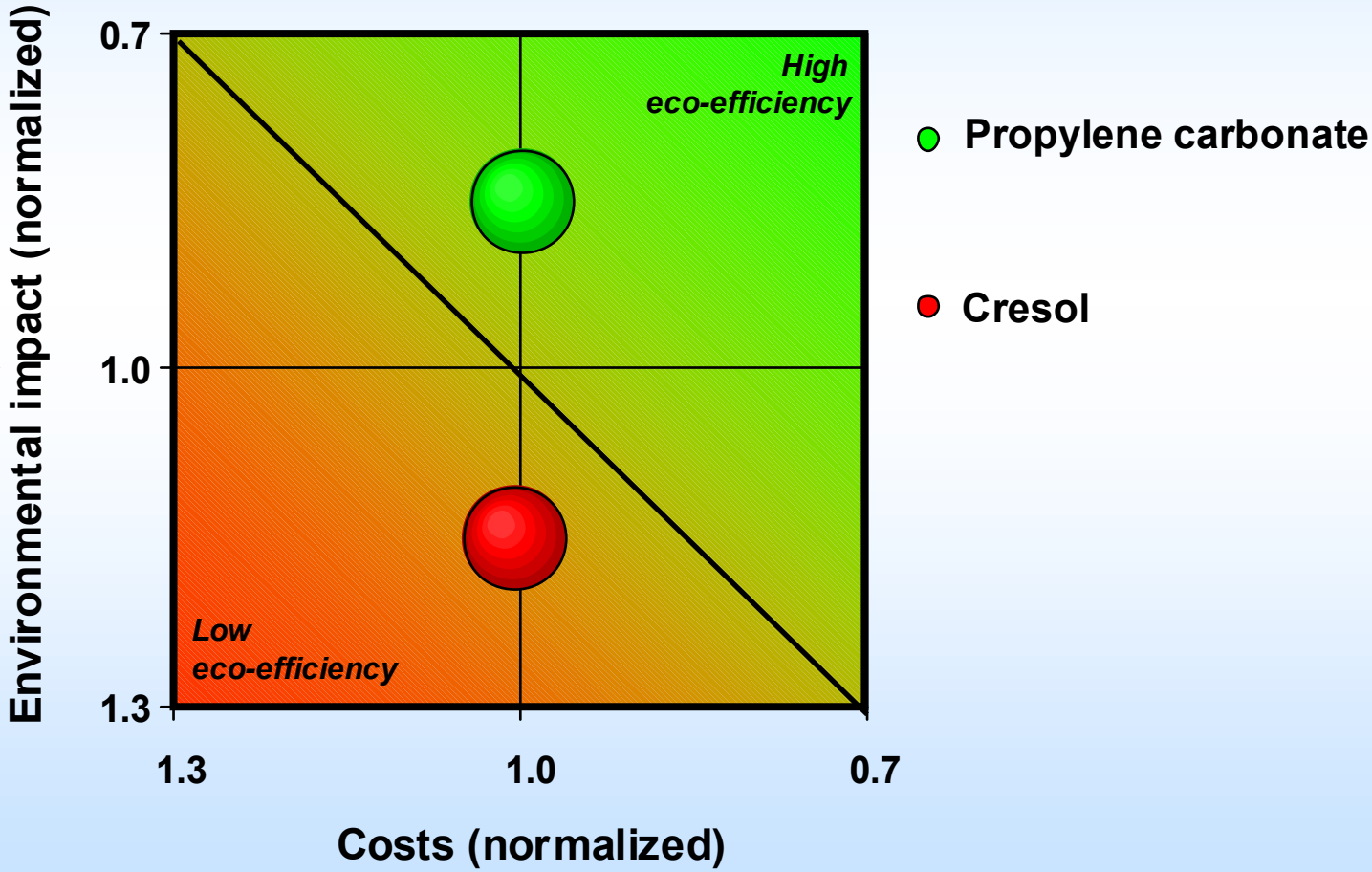
Process scheme



Comparison of alternative solvents for the production of wire enamels

Customer-related benefit:

Production of solvents for the manufacture of wire enamels for the coating of 1,000 m of winding wire (∅ 0.71 mm) (winding wire for use in motors)



Interpretation of the eco-efficiency portfolio

- Propylene carbonate is the most eco-efficient alternative for the coating of wires (distance from the diagonal is a measure for the eco-efficiency).

- The high environmental impact of cresol is due mainly to the high toxicity potential and the high risk potential of the solvent. Energy consumption, materials consumption and emissions only show slight differences between the individual alternatives.

- The costs for the two alternatives are about the same (propylene carbonate 0,588 Euro/CB; cresol 0,6 Euro/CB). The slight difference is due to the amount of solvent naphtha which is a little bit higher when cresol is used and the more expensive disposal of the residues from the cresolic alternative.

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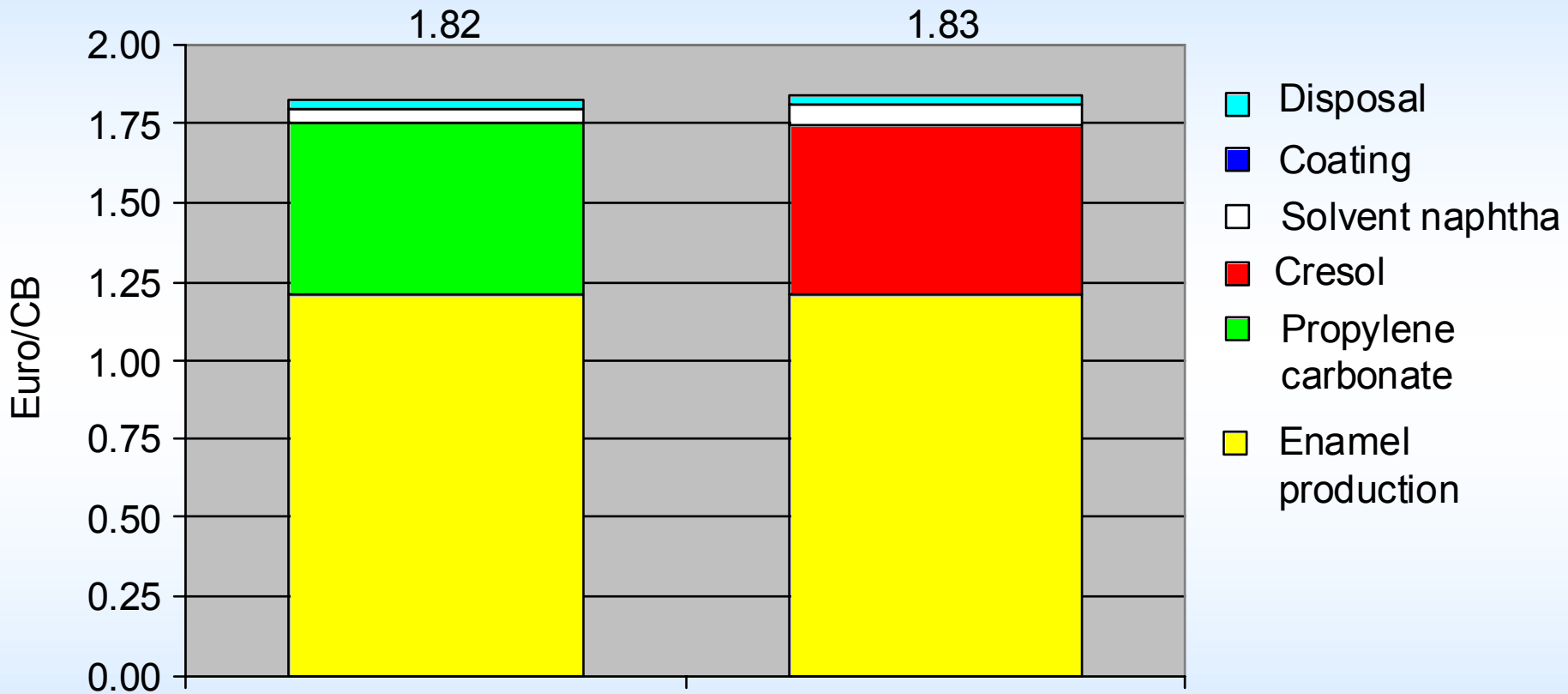
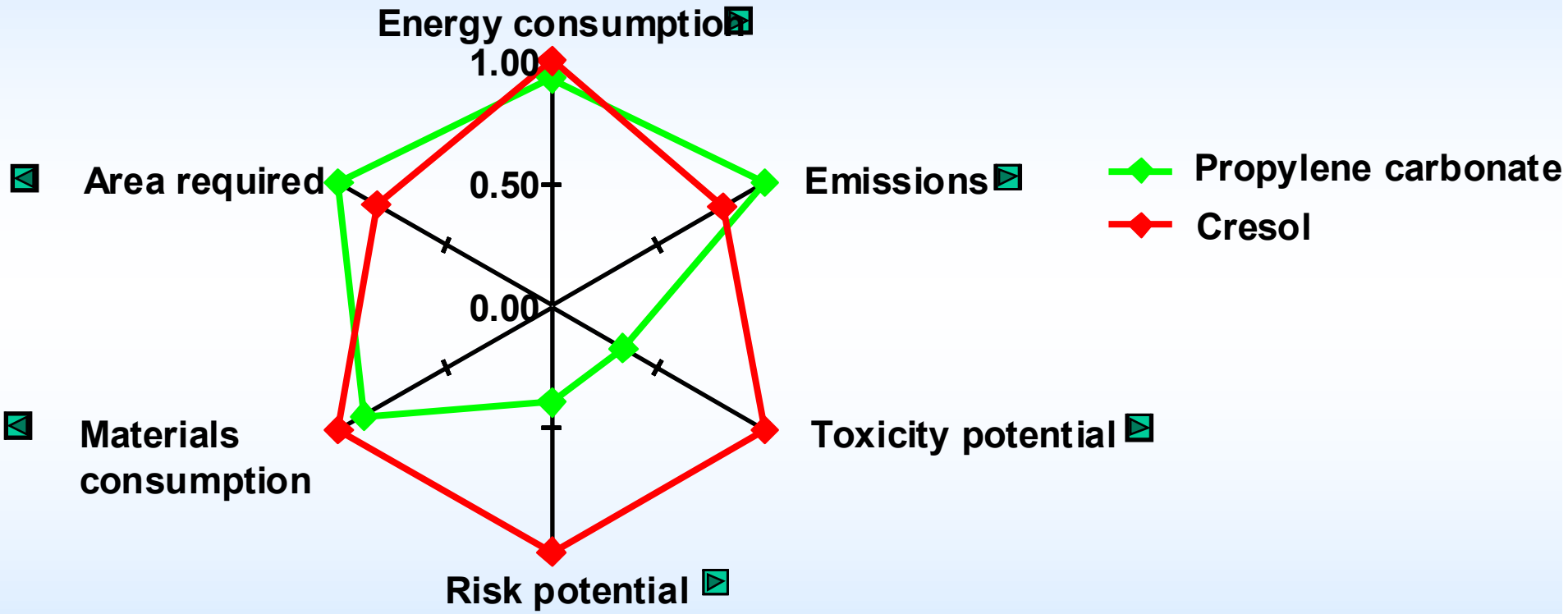
Total costs



Propylene carbonate: **1,30 Euro/kg**
Cresol: **1,50 Euro/kg**

Ecological fingerprint according to BASF

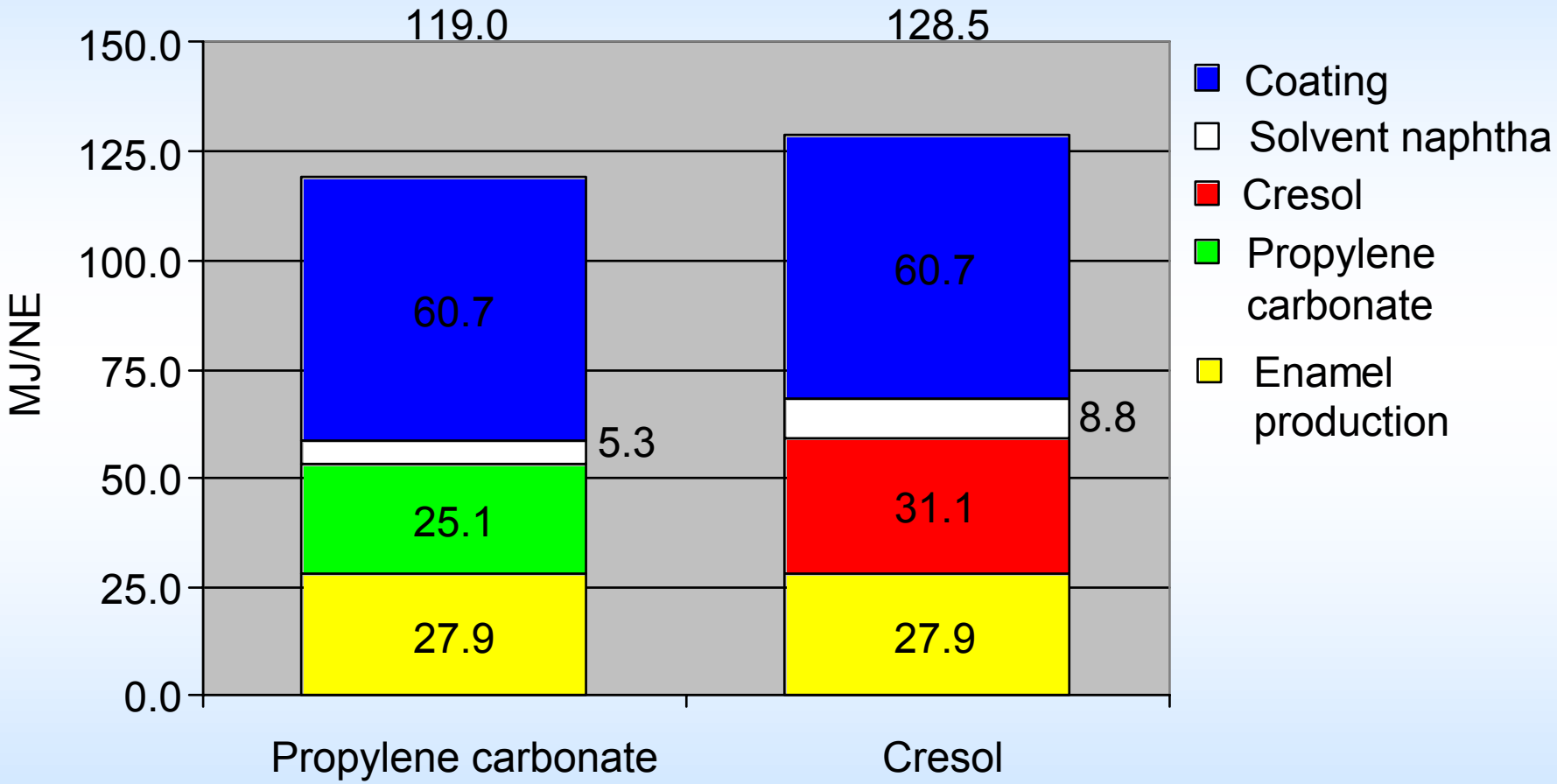


Least favorable alternative = 1; all others evaluated relative to this

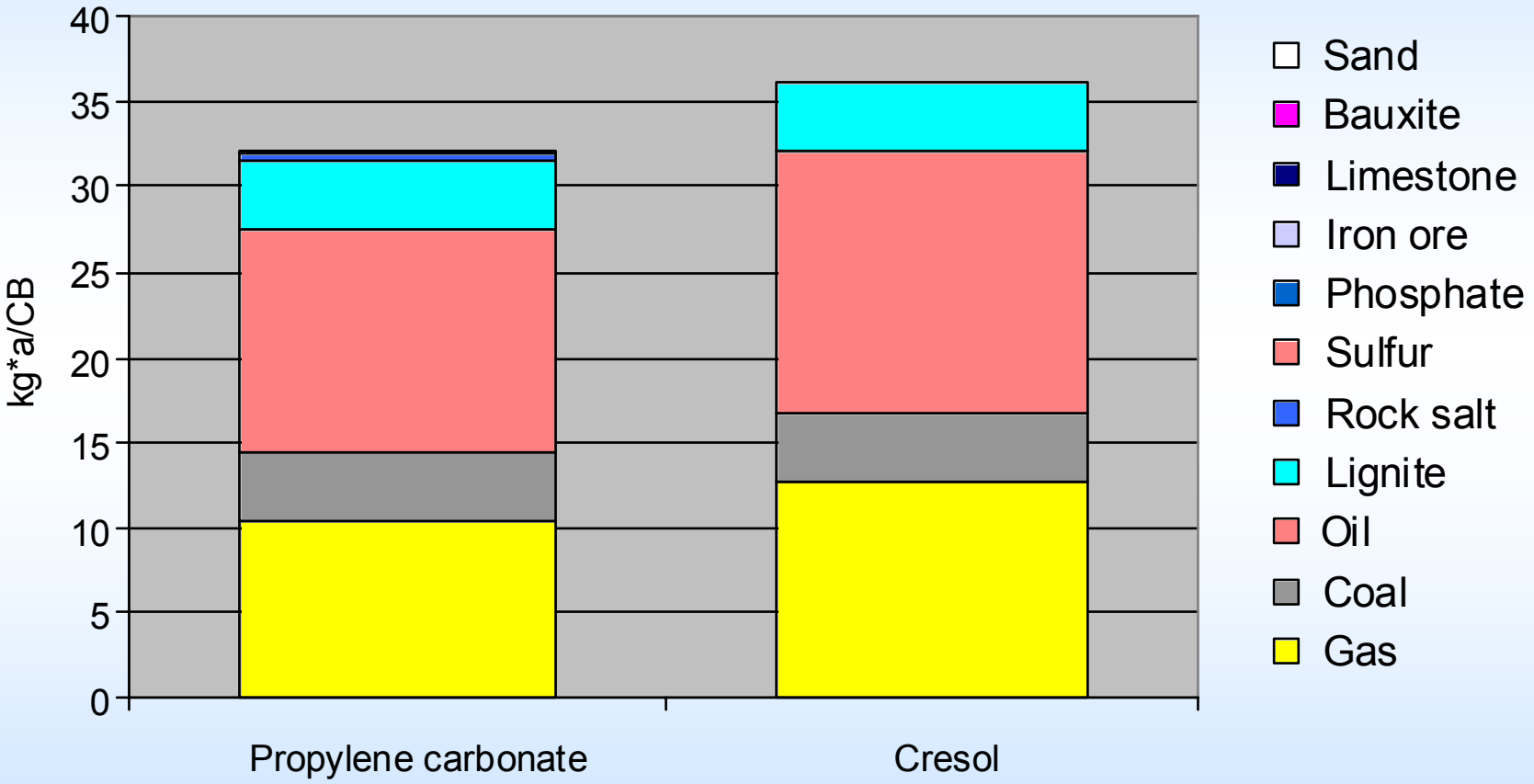
Interpretation of the ecological fingerprint

- There are no major differences in energy consumption, materials consumption and emissions between the alternatives considered.
- The different area required by the alternatives is due to the amount of solvent necessary for the customer's benefit.
- The main differences in the ecological fingerprint are obvious from the toxicity and risk potentials; cresol has both a high toxicity potential and a high risk potential.

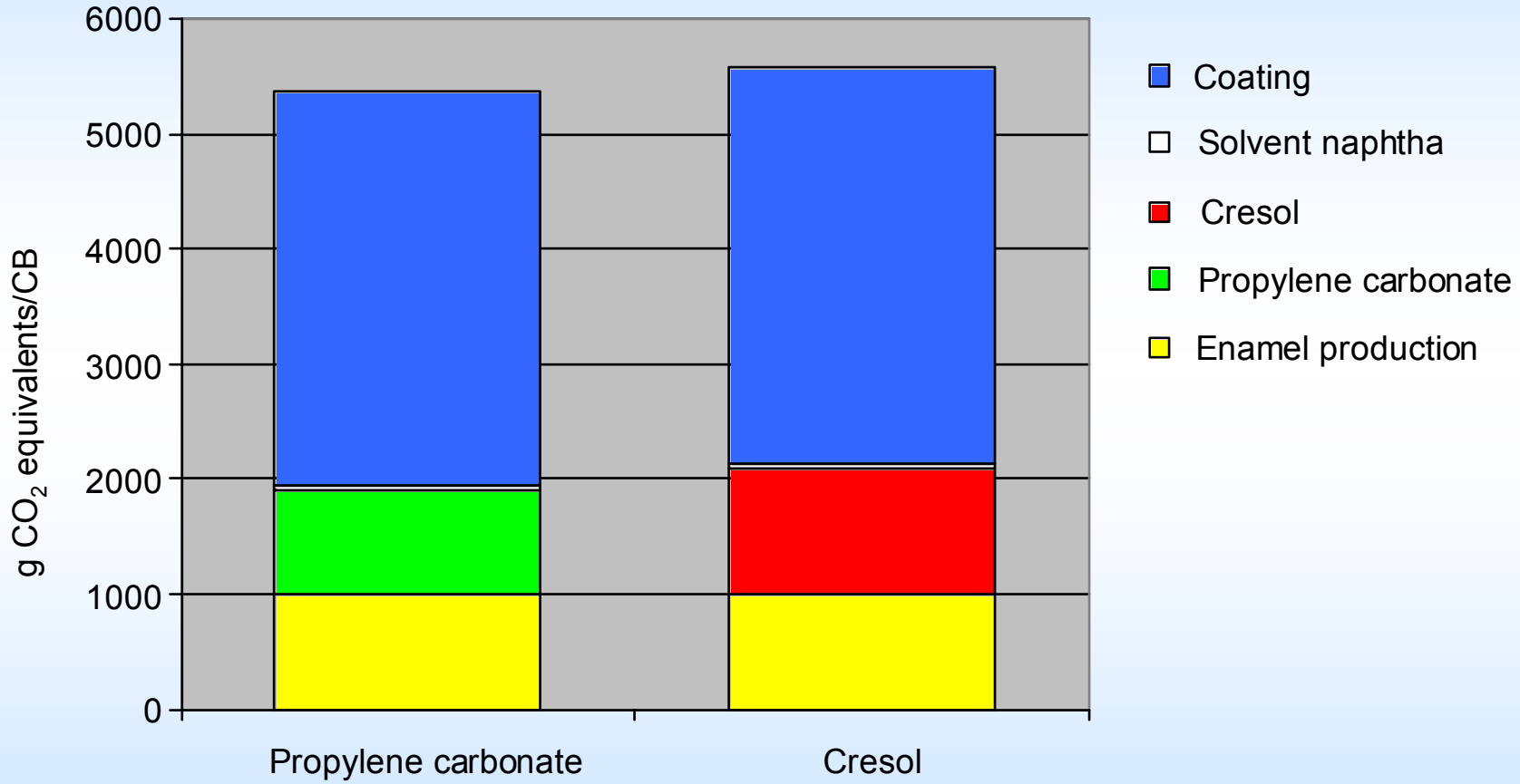
Energy consumption of the alternatives



Comparison of the normalized materials consumption figures

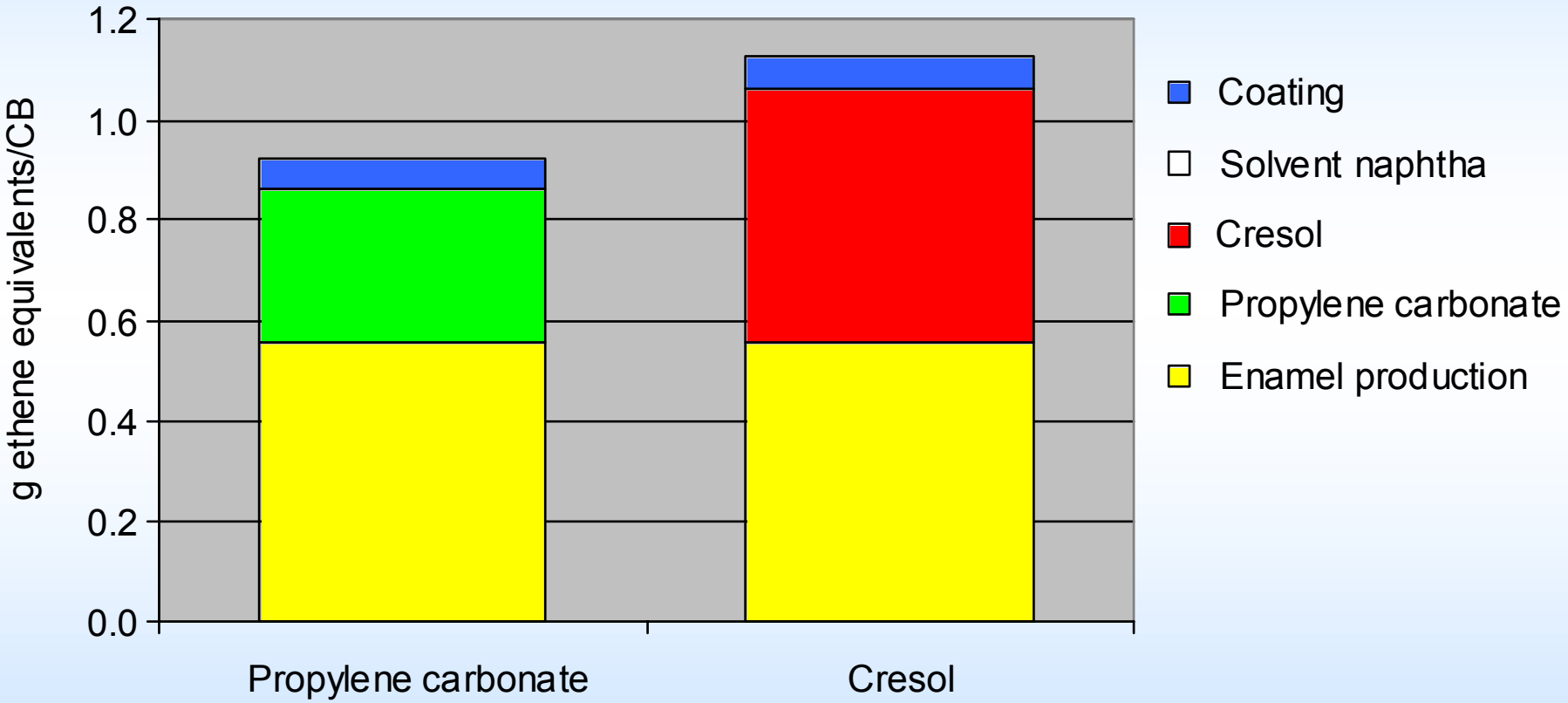


Comparison of the global warming potentials (GWP)



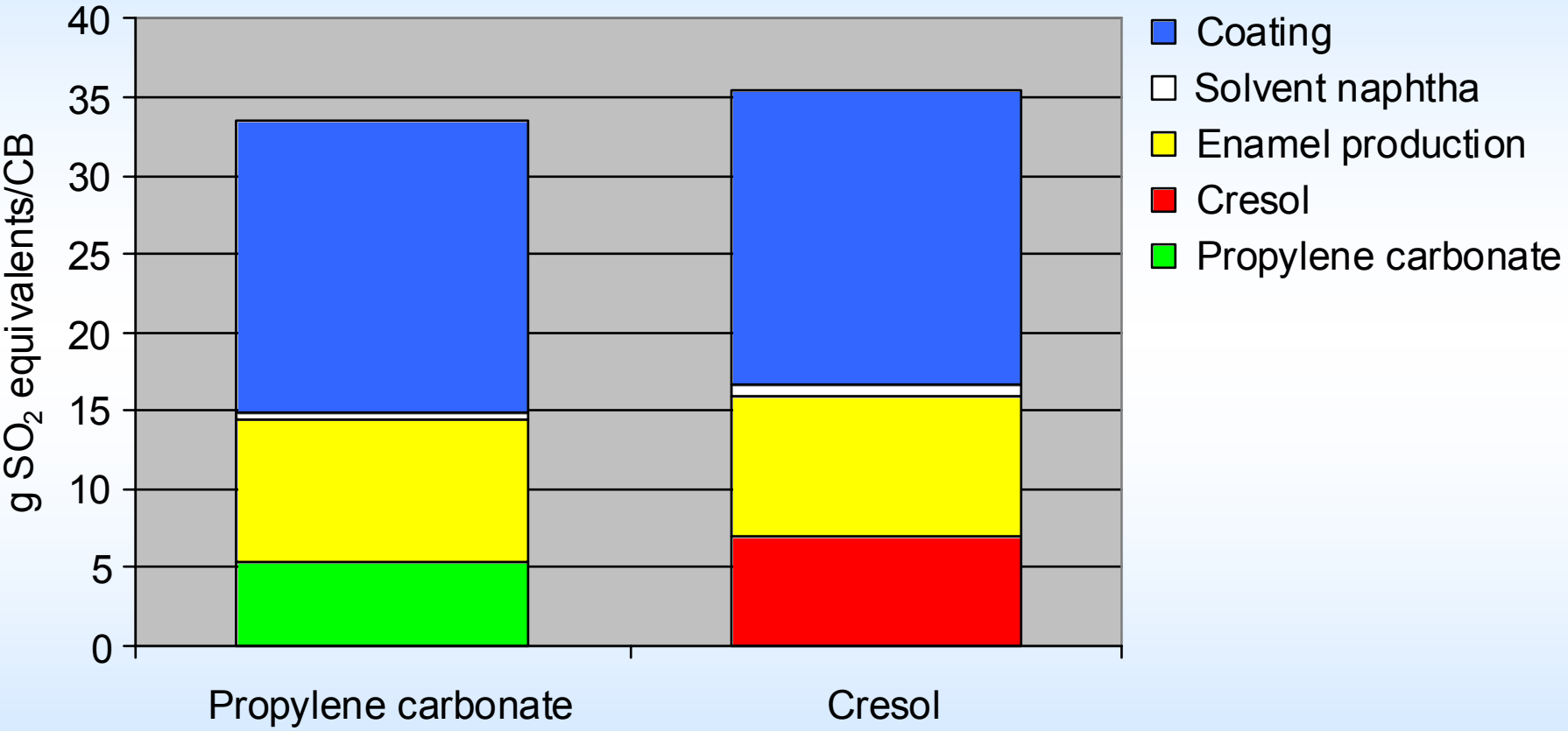
The emissions of CO_2, CH_4, HHC and N_2O are weighted according to their greenhouse potential.

Comparison of the photochemical ozone creation potentials (POCP)



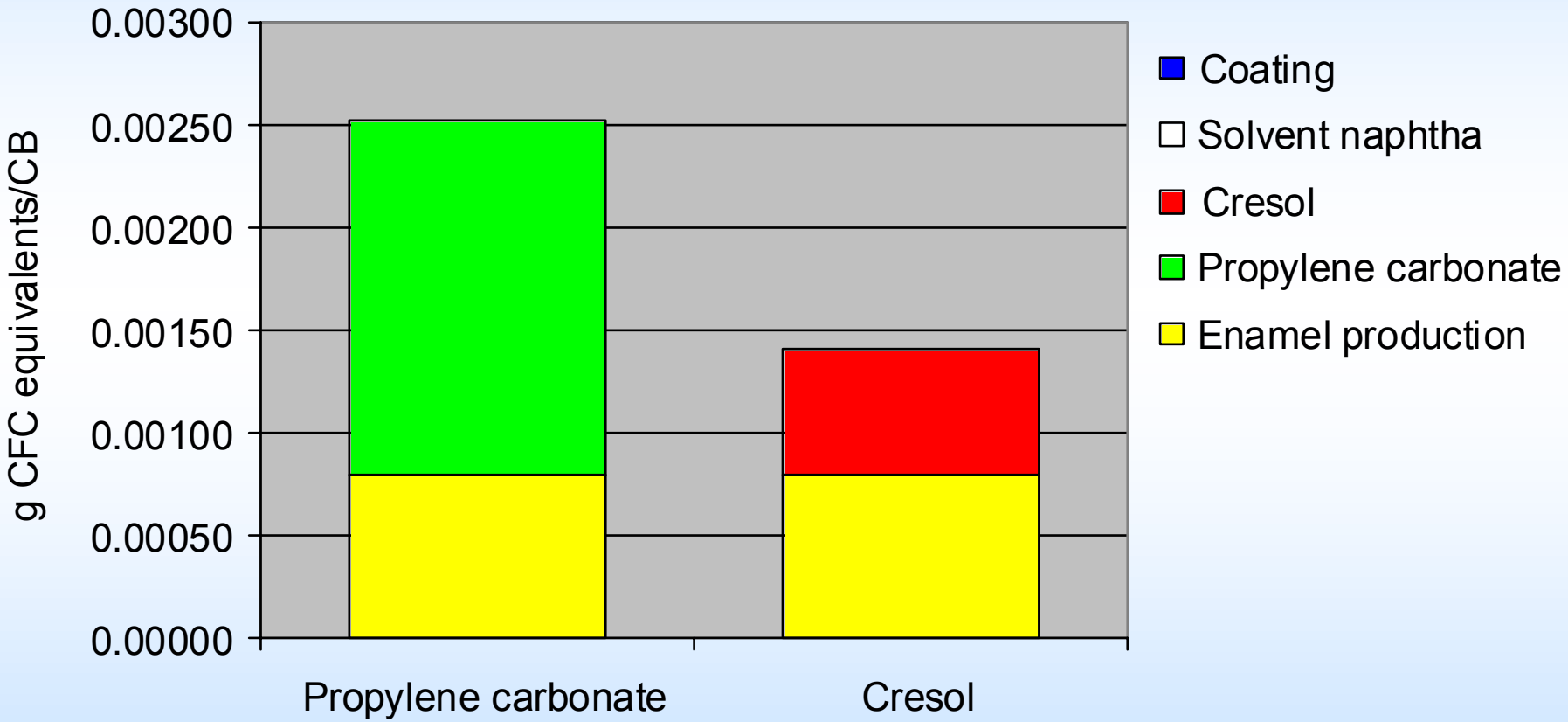
The emissions of CH_4 and NM VOCs are weighted according to their impact .

Comparison of the acidification potentials (AP)



NO_x, SO_2, HCl and NH_3 emissions are weighted according to their potential.

Comparison of the ozone depletion potential (ODP)



The emissions of halogenated hydrocarbons are weighted according to their impact.

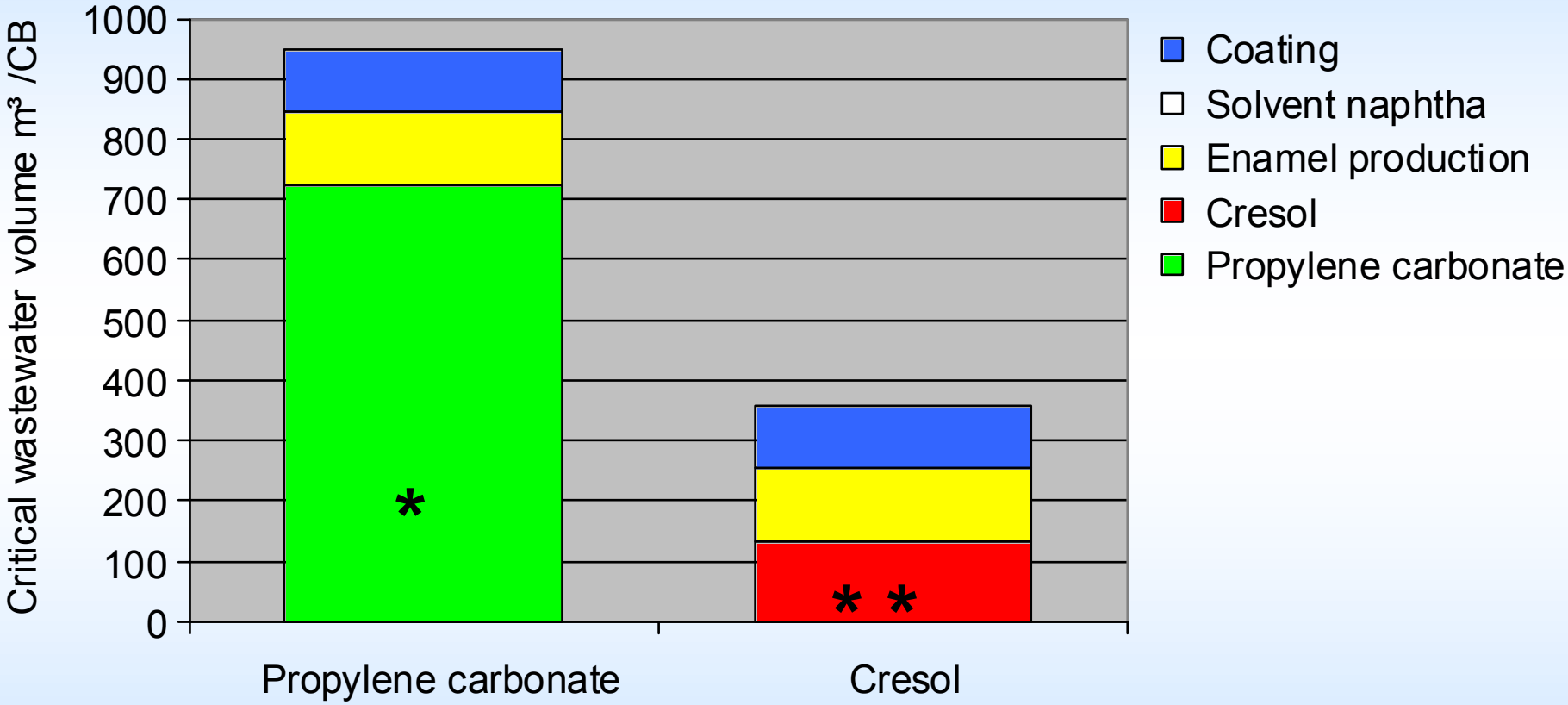
Notes on the air emissions

The energy required for the coating process is the major contributor to global warming and acidification potential, however, these contributions are the same for both solvent alternatives. Since the energy required is independent of the solvent needed, the main differences of the individual potentials are due almost exclusively to the production of the solvents themselves.

The high ozone depletion potential of the production of propylene carbonate is caused by the release of a relatively high amount of halogenated hydrocarbons. However, the ODP altogether has no impact on the emissions (cf. page 61; share of the ODP in the relevance of the air emissions: 2%).

The production of cresol generally has a high impact on the air emissions considered.

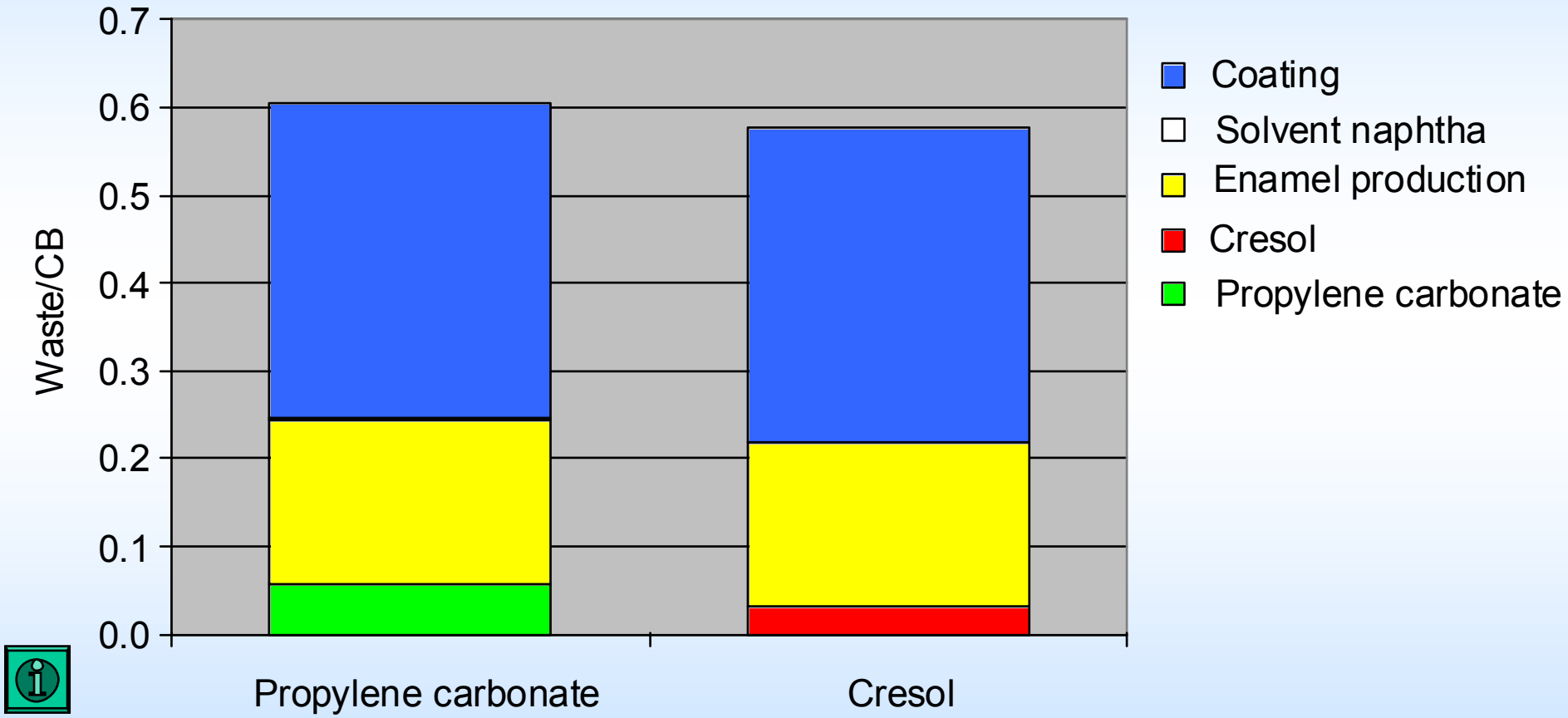
Comparison of the normalized water emissions



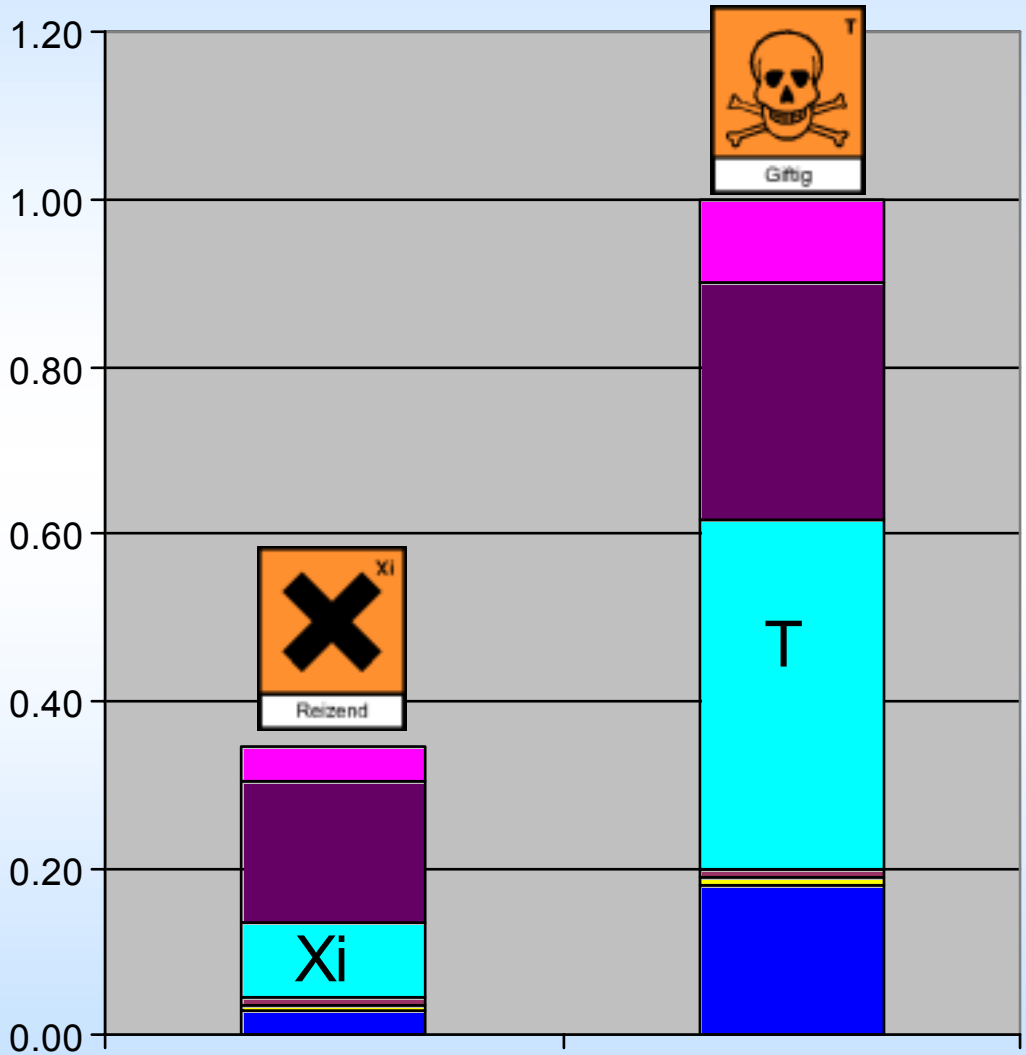
* **Release of a high amount of chloride in the production of the starting material propylene oxide.**

** **Release of phosphate in the production of the intermediates in cresol production.**

Comparison of the normalized solid waste generation

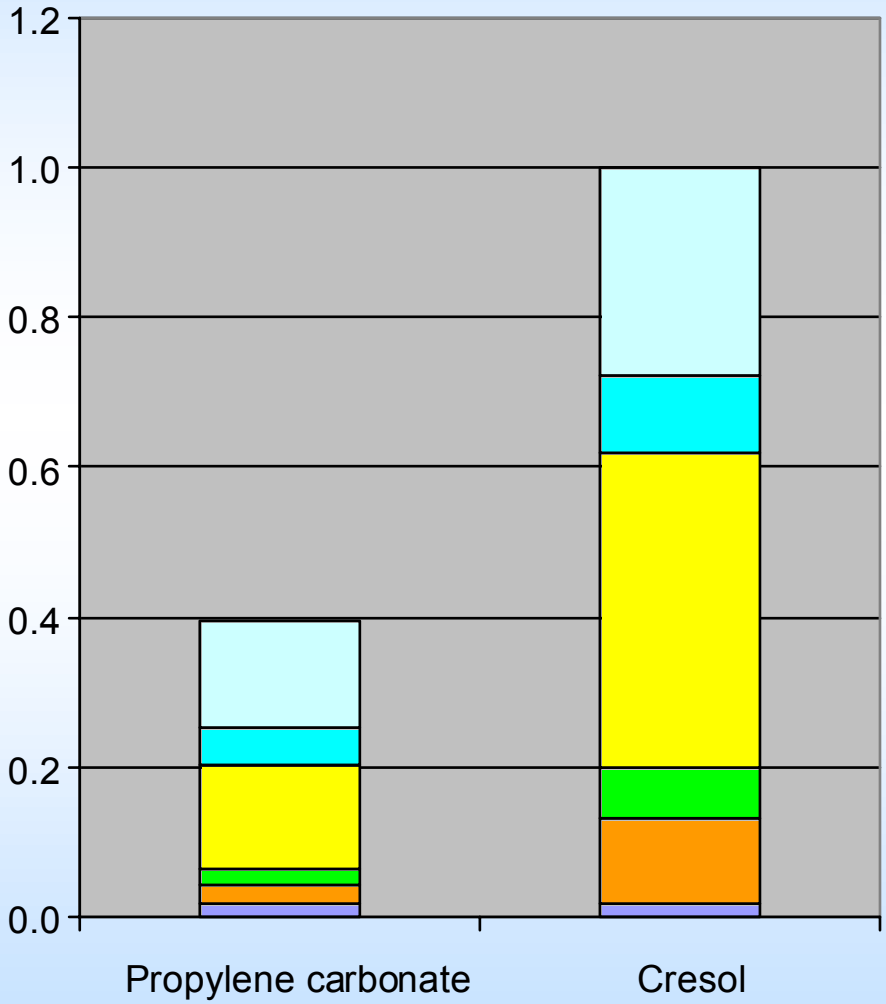


Comparison of the toxicity potentials



- Disposal of wastes from the coating
- Release of solvent naphtha
- Release of the solvent in the application of the wire enamel
- Production of solvent naphtha
- Production of the wire enamel
- Production of the solvent

Comparison of the risk potentials



- Hazards to soil and surface waters by spilling or the like
- Disposal of operating supplies from the coating
- Coating of the wires (included: MAK value of the solvent)
- Risk in transportation
- Shortage of the raw materials required
- Occupational accidents in the chemical industry

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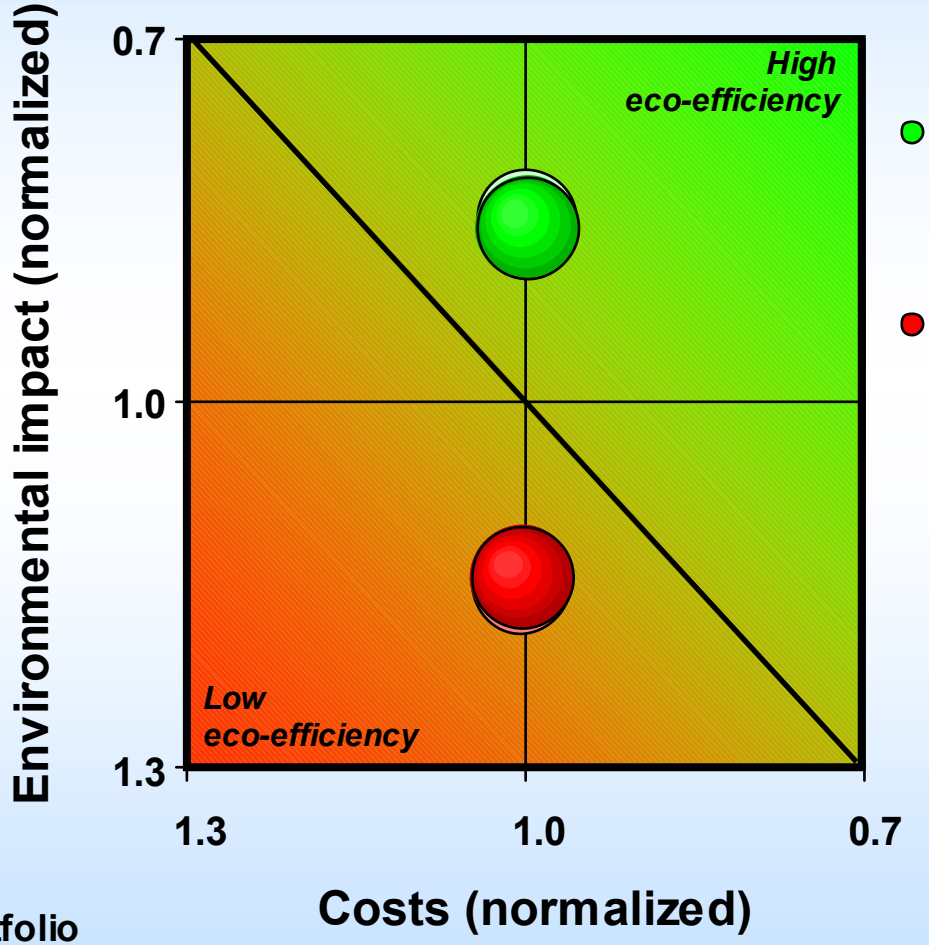
Scenario 1:
The risk of a raw material shortage of cresol no longer exists.

Customer-related benefit:

Production of solvents for the manufacture of wire enamels for the coating of 1,000 m of winding wire (∅ 0.71 mm) (winding wire for use in motors)



Propylene carbonate

Cresol

Conclusion:

Even if the risk of cresol shortage is no longer a realistic risk the propylene carbonate is the more eco-efficient alternative.The risk potential has only a slight influence on the result.

Light balls in the portfolio show the base case.

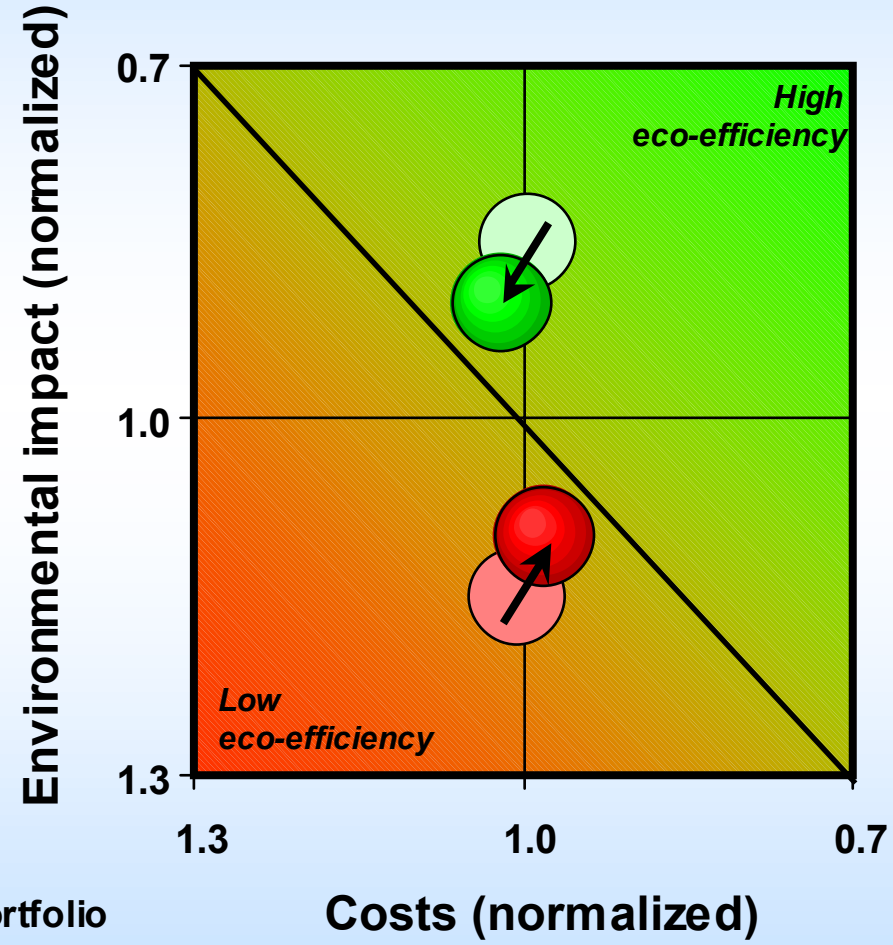
BASF

Scenario 2:

The solid content of the enamels is increased from 40% to 45% for the enamel containing cresol.

Customer-related benefit:

Production of solvents for the manufacture of wire enamels for the coating of 1,000 m of winding wire (∅ 0.71 mm) (winding wire for use in motors)



Conclusion:

If less Cresol is needed, the cresol alternative gets a little bit better concening its bad environmental influence. Propylencarbonat is still the most eco-efficient alternative.

Light balls in the portfolio show the base case.

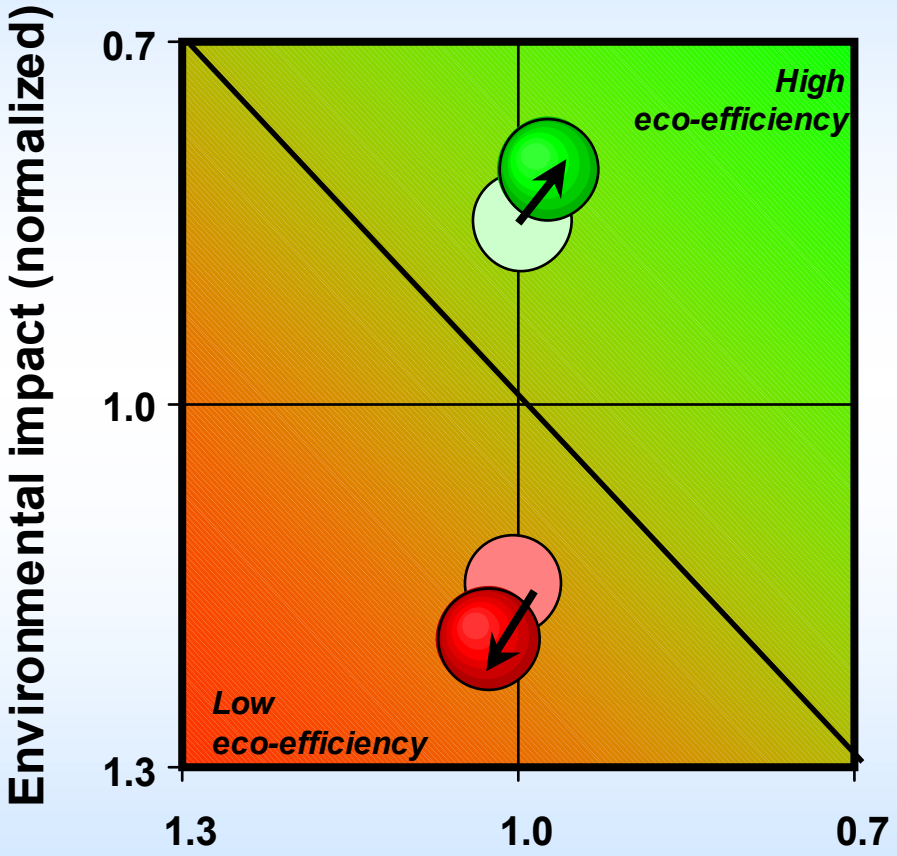
BASF

Scenario 3:

The solid content of the enamels is increased from 40% to 45% for the enamel containing propylene carbonate.

Customer-related benefit:

Production of solvents for the manufacture of wire enamels for the coating of 1,000 m of winding wire (∅ 0.71 mm) (winding wire for use in motors)



Propylene carbonate

Cresol

Light balls in the portfolio show the base case.

Conclusion:

If less Propylencarbonat is needed, the alternative gets a little bit better concening its environmental influence. Propylencarbonat is clearly the most eco-efficient alternative.

Critical Review

Reviewer:
David R. Shonnard, Prof., Ph.D.
Department of Chemical Engineering
Michigan-Technological University
Houghton, MI 49931 USA

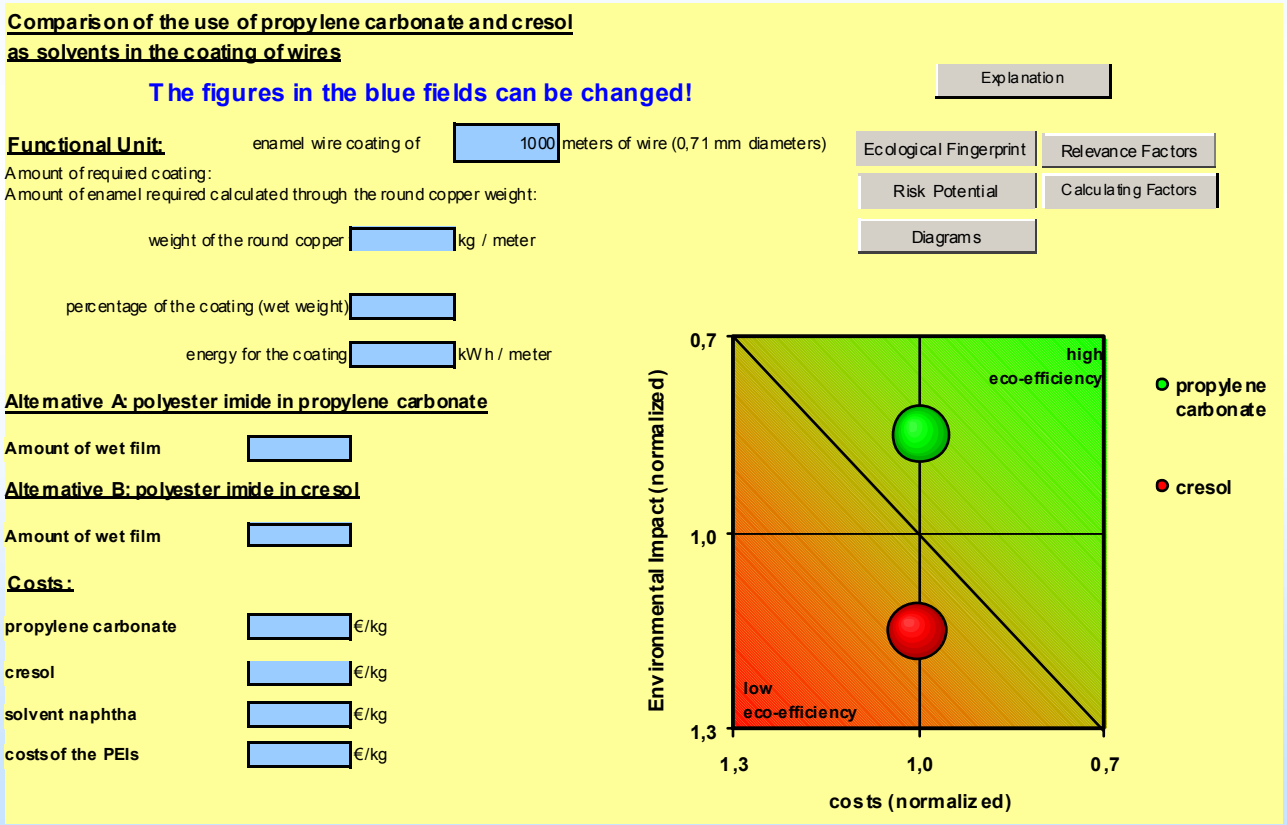
Extract from the summary:

"…Overall, the inventory data for materials utilization and emissions are accurate. No major data inconsistencies with a negative impact on the quality of the study were detected, and the data and methods were presented transparently in the report.

The main conclusion that propylene carbonate is more eco-efficient compared to the cresol as a solvent in this wire coating application is consistent with the goals and assumptions of the study. The results of the study are highly credible.
The entire study has been made in accordance with ISO 14040 - 14043. …"

Eco-Efficiency Manager

BASF Aktiengesellschaft has developed a so-called Eco-Efficiency Manager, an easy-to-use program which enables customers to calculate eco-efficiency for their own specific situation.
The manager is available for customers (see contact).



Contact

For more information about propylene carbonate and the Eco-Efficiency Manager please contact:

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