

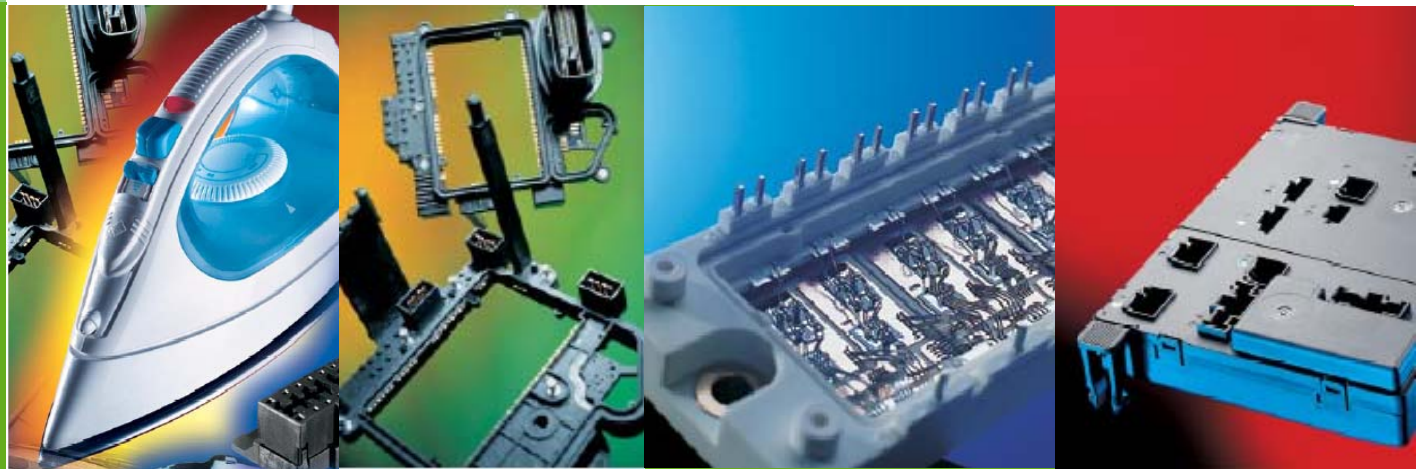
# Label Eco-Efficiency Analysis



## *Ultradur<sup>®</sup> High Speed*

BASF Aktiengesellschaft  
Ludwigshafen, Dezember, 2005

 **BASF**  
The Chemical Company



# Summary (I)

- This eco-efficiency analysis compares the production of injection molding components using standard *Ultradur*<sup>®</sup> and the new BASF product *Ultradur*<sup>®</sup> *High Speed*
- In all cases the use of *Ultradur*<sup>®</sup> *High Speed* leads to an **increase in the overall eco-efficiency**.
- Both the costs over the entire life cycle and the environmental impact are more favorable when substituting standard *Ultradur*<sup>®</sup> with *Ultradur*<sup>®</sup> *High Speed*.

continued

# Summary (II)

- The environmental and economic advantages of the *Ultradur<sup>®</sup> High Speed* relative to the standard *Ultradur<sup>®</sup>* are due to its modified rheological properties. The addition of specially developed organic nano particles reduces the melt viscosity. As a result, the molding temperature and the injection and holding pressure decrease, leading to:
  - Approx. 20% **energy savings**
  - **simplified** mold design and construction
  - significant **material savings** when designing thin wall parts
  - better surface properties and **less pieces out of specification**
  - up to 10-30% **shorter cycle times**

# The Eco-Efficiency Label



## Requirements

1. Accomplished Eco-Efficiency Analysis according to the methodology certified by TÜV Rhineland/ Berlin-Brandenburg, Germany.
2. Verification of the investigated product to be more eco-efficient for the defined customer benefit than other alternatives as result of the analysis.
3. Presentation of a third party evaluation (so-called Critical Review according ISO 14040 ff.).
4. Publication of the results via internet on website [www.oeea.de](http://www.oeea.de), which is referred to on the label.
5. Payment of the license fee for the duration of three years (s. price list).

# Certificate

## CERTIFICATE



### Eco-Efficiency Analysis “Injection Molding Ultradur® High Speed”

The evaluation of environmental and economic effects of “Injection Molding with Ultradur® High Speed” by using an eco-efficiency analysis according to the validated method is certified.

*BASF Aktiengesellschaft,  
E-KTE/MD Engineering Plastics*

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

*Ultradur® High Speed*

for a duration of three years.

The main results are published under [www.oeea.de](http://www.oeea.de).

Ludwigshafen, 19.12.2005

Dr. M. Kayser  
Senior Vice President Product Safety

Dr. A. Kicherer  
Group Leader Eco-Efficiency



# Final result

- The Eco-Efficiency label can be awarded to the *Ultradur<sup>®</sup> High Speed*. It was shown that it is much more favourable and eco-efficient than the alternative system.



# Expert opinion: Critical Review (I)

by Prof. Hungerbühler, Swiss Federal Institute of  
Technology (ETH Zürich), CH-8093 Zürich-Switzerland



## General impression

The report of the eco-efficiency analysis has been drawn up as a presentation for target groups within the company. So the report focuses on the illustration of results and not on specifications of the method. Therefore many assumptions are described in the appendices.

## Methodology and Data

**The methodology and the assumptions made along the project are logical and scientifically valid and have been performed according to all main requirements of ISO 14040. They are consistent with the goal and scope of the project.**

**The allocation rules have been clearly described.**

## Goal and Scope

In the eco-efficiency analysis two processes for the production of injection molding components have been compared: the standard Ultradur<sup>®</sup> process and the new Ultradur<sup>®</sup> High Speed process.

Goal and scope of the project are clearly displayed in the report. It is stated that this study could be used to show the advantages of the alternative product.

Target groups of the study are identified as potential customers of the BASF.

The limitations and restrictions are also clearly stated. The study is limited to the special Ultradur<sup>®</sup> process and cannot be transferred to other regions or extraction processes.

The geographical scope of the study is Western Europe; the time-related coverage is about 2000 – 2005, depending on the data available.

The system boundaries are correctly described in the report. The use and the recycling of disposal of the products are identical for the two processes and have therefore been neglected. Because of the lower material use (10%) this doesn't seem to be consequential in this study, but if these steps would be included, the advantages for the High Speed product would be even bigger, so this neglect does not change something in the total conclusions.

# Expert opinion: Critical Review (II)

by Prof. Hungerbühler, Swiss Federal Institute of  
Technology (ETH Zürich), CH-8093 Zürich-Switzerland



## Inventory analysis

The inventory analysis has been done in accordance with the requirements of ISO 14041, and in line with the goal and scope.

The basic data were listed in a separate database, which is not open to the public. As the reviewers have not been involved in the data collection and data processing phases the validation of the calculation has been done only in a sample survey.

**The basic data and the assumptions for the inventory are valid and in line with the goal and the scope.**

**A remarkable point is the high quality of the basic data, because most of them are directly measured (a) at the plant for production of the product and (b) in experiments at the BASF-Technikum for the application.**

## Impact assessment

The impact assessment has been done in accordance to the requirements of ISO 14042.

## Interpretation

The interpretation has been done in accordance with the requirements of ISO 14043, and in line with the goal and scope framework. A formal completeness check according to ISO 14043 has not been performed and documented. A consistency check has been made for the relevant data sources.

**As sensitivity analysis 7 scenarios have been calculated. The relevant input and weighting factors have been analysed in the sensitivity analysis. The results show that the eco-efficiency of the two processes is hardly affected by the relevant sensitivities. The outcome of this is that the results of the eco-efficiency analysis are very stable. The conclusions are drawn in line with the goal and scope.**

## Eco-efficiency Study

The calculations for building the eco-efficiency portfolio are consistent and in line with the eco-efficiency method, which is described in the literature (P. Saling, A. Kicherer et al., Int. J. LCA 7 (4), 203-218 (2002)).



# Expert opinion: Critical Review (III)

by Prof. Hungerbühler, Swiss Federal Institute of  
Technology (ETH Zürich), CH-8093 Zürich-Switzerland



## Overall Conclusion

The LCA part of the project was in general conducted in compliance with the recommendations of the ISO 14040ff standards. The study is consistent and scientifically valid. A restricting point is that the report is not always clearly arranged, as it is a presentation for the target groups like customers. It would be clearer to write two reports: a report on the eco-efficiency study with a clear methodological description and another report as a presentation.

The critical review process was very constructive, and significant efforts for improvements were successfully dedicated along this validation process.

# Contact



For more information about *Ultradur® High Speed* please contact:

Mark Voelkel  
BASF Aktiengesellschaft  
KTE/MD-F206  
+49 621 60-42928  
[mark.voelkel@basf.com](mailto:mark.voelkel@basf.com)

For more information about the Eco-Efficiency Analysis please contact:

Dr. Ana Alba Pérez  
BASF Aktiengesellschaft  
GUP/CE  
+49 621 60-58359  
[ana.alba-perez@basf.com](mailto:ana.alba-perez@basf.com)

# Objectives of the Eco-Efficiency Study



The study aims to quantify the economical and ecological advantages of BASF innovation *Ultradur® High Speed* compared to its standard product *Ultradur®*

The study used the methodology of the eco-efficiency analysis, developed by BASF as a life cycle tool to show and assess different parts of the life cycle of the raw material production and the processing of the plastic via injection moulding. Use and disposal phase have been left out of the balance since they are identical to both alternatives.

The ecological calculations belonging to the ISO-rules 14040 ff.

The methodology has been approved by the German TUV. It is used by the Eco-Institute in Freiburg Germany, TNO in the Netherlands. The Wuppertal Institute accepts the method. It was developed by BASF and Roland Berger Consulting, Munich.

Another aim was to show the customer the relative advantages of using the most eco-efficient alternative.

# Limits and Restriction for the Use of the Results



The LCA-calculations were set up according to the rules and principles of the DIN EN ISO 14040 to 14043. The eco-efficiency analysis goes beyond the ISO rules, for example with the consideration of life cycle costs and use of the eco-efficiency portfolio for presentation of aggregated results.

The results are valid for the defined products and customer benefit (CB) only.

# ***Ultradur<sup>®</sup> and Ultradur<sup>®</sup> High Speed***

# *Ultradur<sup>®</sup> and Ultradur<sup>®</sup> High Speed*



- *Ultradur<sup>®</sup>* is BASF commercial tradename for Polybutylene Terephthalate (PBT). It is a semi - crystalline thermoplastic, saturated polyester. It is used due to it's high stiffness and strength, high resistance to heat, low water absorbtion, high dimensional stability and good resistance to a variety of chemicals.
- PBT is made by the polycondensation of terephthalic acid or dimethyl terephthalate with 1,4 butanediol in the presence of catalysts.
- Typical applications are connectors, housings, switches, wipers, door handles, external mirrors, sunroof frames, optical fibre cladding etc.
- PBT world market reached 640.000 metric tons in 2004, 92% of which is processed by injection molding
- *Ultradur<sup>®</sup> High Speed* is BASF newest PBT grade which offers highly improved flow- and processing properties. Thanks to a specific nano particles additive system. Other characteristics of the polymer – like mechanical properties, shrinkage and heat distort resistance – are scarcely affected by the modification

# Typical applications

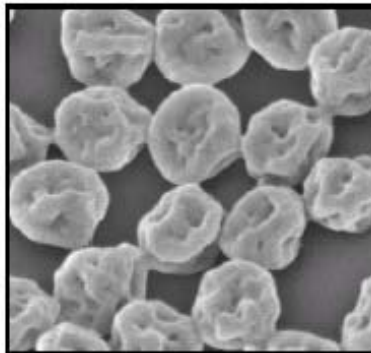
**BASF**  
The Chemical Company



# The additive particles used in *Ultradur*<sup>®</sup>

## Dimensions of nano particles

**Nano Particles**



100 nm

1 : 50 000



5 mm

1 : 50 000



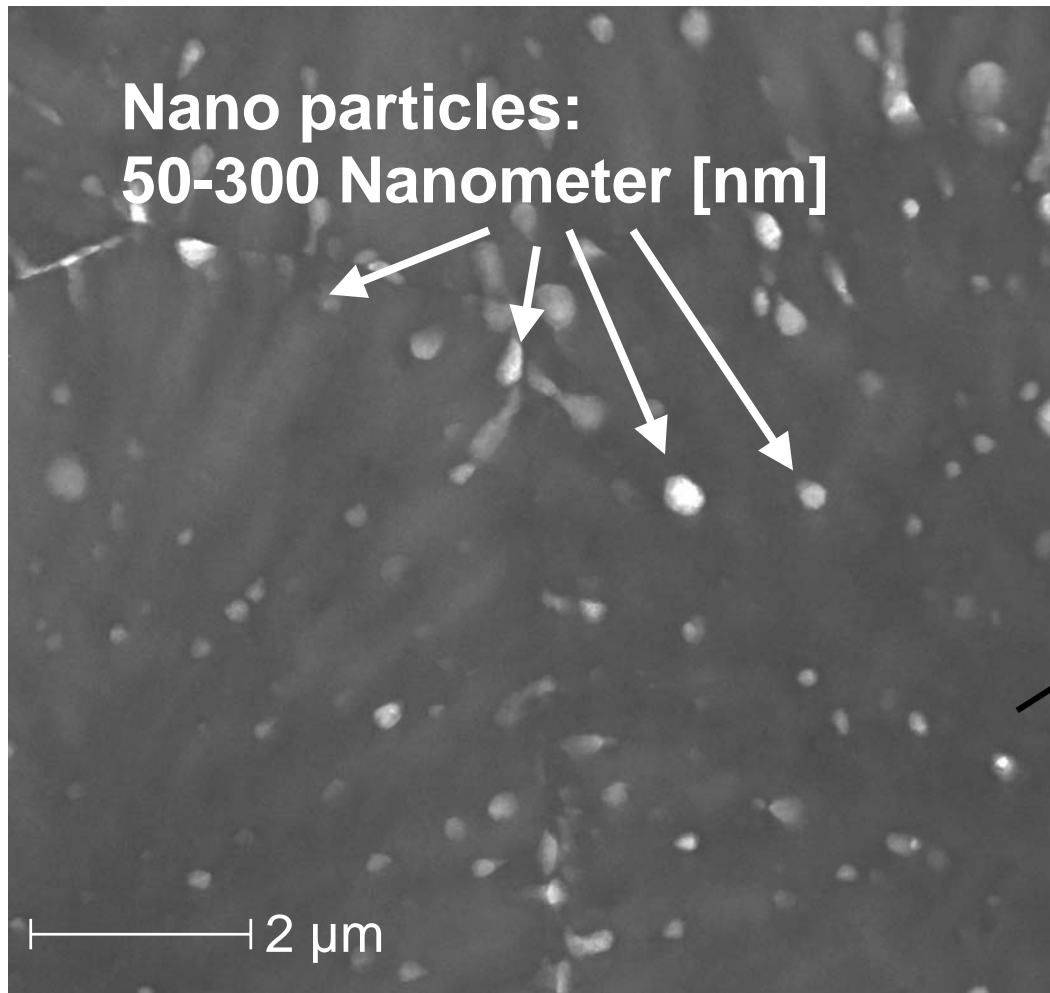
**Tower block**

**Frankfurt**

**257 m**

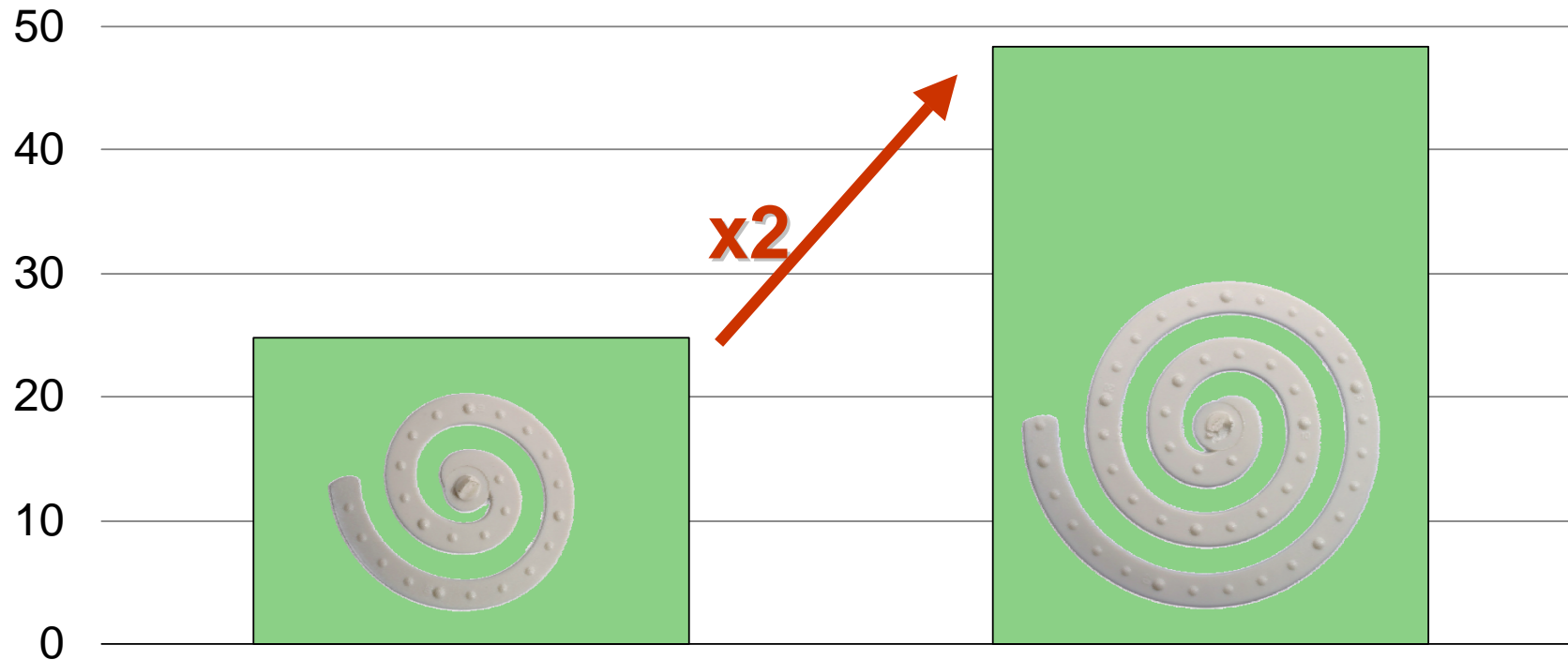


# The additive particles used in *Ultradur*<sup>®</sup>



# The effect: Much easier flow

Length of spiral [cm]



Ultradur<sup>®</sup> B 4300  
30% GF Standard

*Ultradur<sup>®</sup> B 4300  
30% GF High Speed*

# Benefits for our customers

## Benefits for injection molding:

Lowering  
of moulding temperature

+

shorter holding times



faster cooling times



shorter cycle times



**greater output!**



# First customer trials successfully completed

## Test conditions

Comparison:

Ultradur<sup>®</sup> B 4300G6 Ultradur<sup>®</sup> *B 4300G6 High Speed*



**30% faster cycle time  
are attainable !**



# Benefits for our customers

## Advantages in parts design:

Lower molding viscosity  
for the same filler loading  
makes

→ **moulding  
of thin-walled parts  
possible!**



# Potential benefits for the environment worldwide

## Advantages\* in energy consumption:

Electricity and material savings



→ Savings equivalent to driving 75.000 cars\*\* for one year !



## Advantages\* in CO<sub>2</sub> emissions:

Electricity and material savings

→ Reduction of 220.000 metric tons CO<sub>2</sub>- emissions in one year !

\*Calculated for an average energy consumption of injection molding machine of 3 kWh/kg PBT and a Worldwide PBT injection market of about 610.000 metric tons per year.

\*\*Calculated with a gasoline VW Golf 75 HP (emissions: Euro 4)

# System definition

# System Definition: Injection molding components

customer benefit  
(CB)

BASF standard

BASF innovation

Production of 1000  
injection molding  
components

• Ultradur® 4300 G6

• Ultradur® 4300 G6  
High Speed

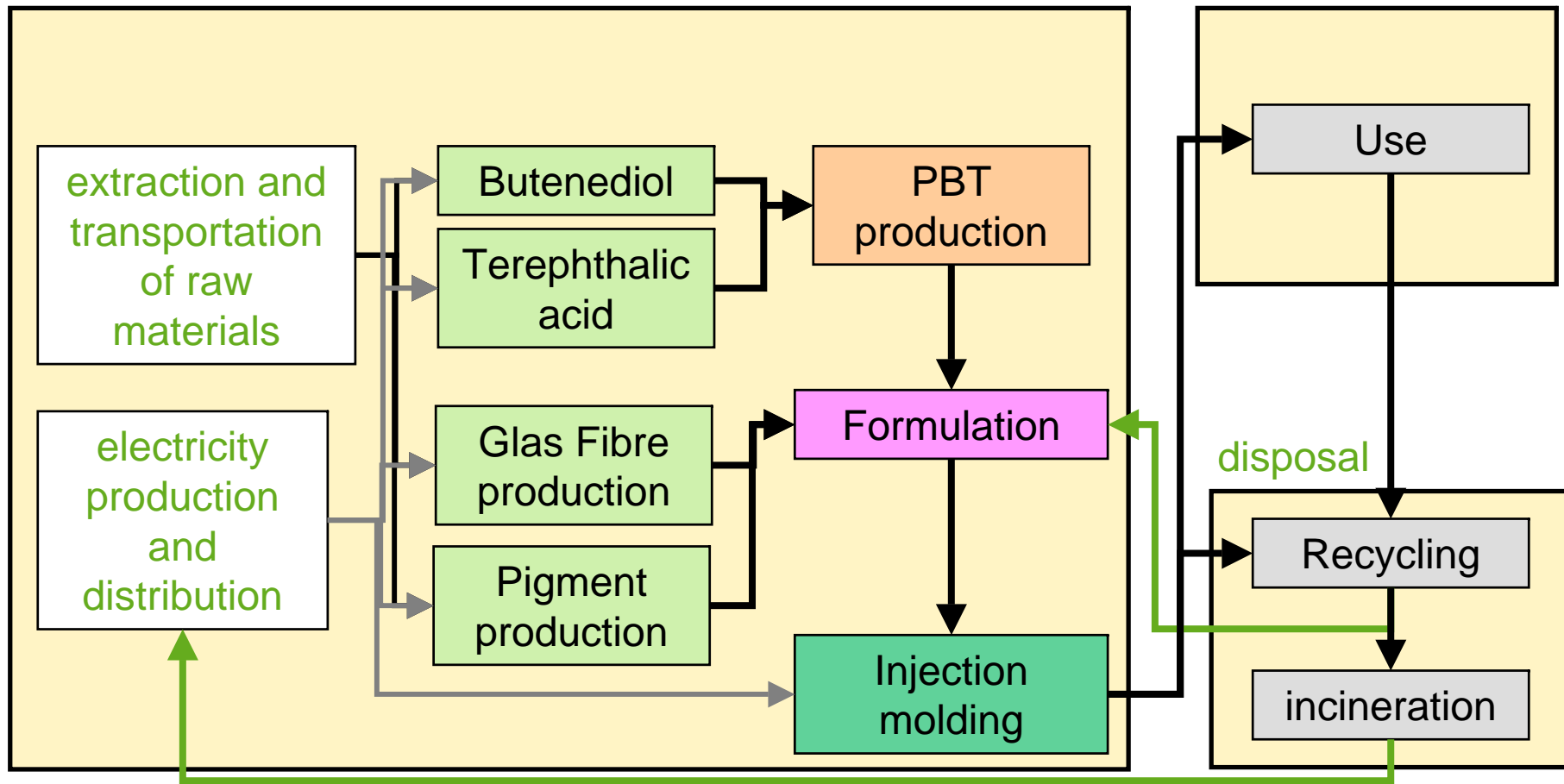


# System Boundaries:

Ultradur®

production

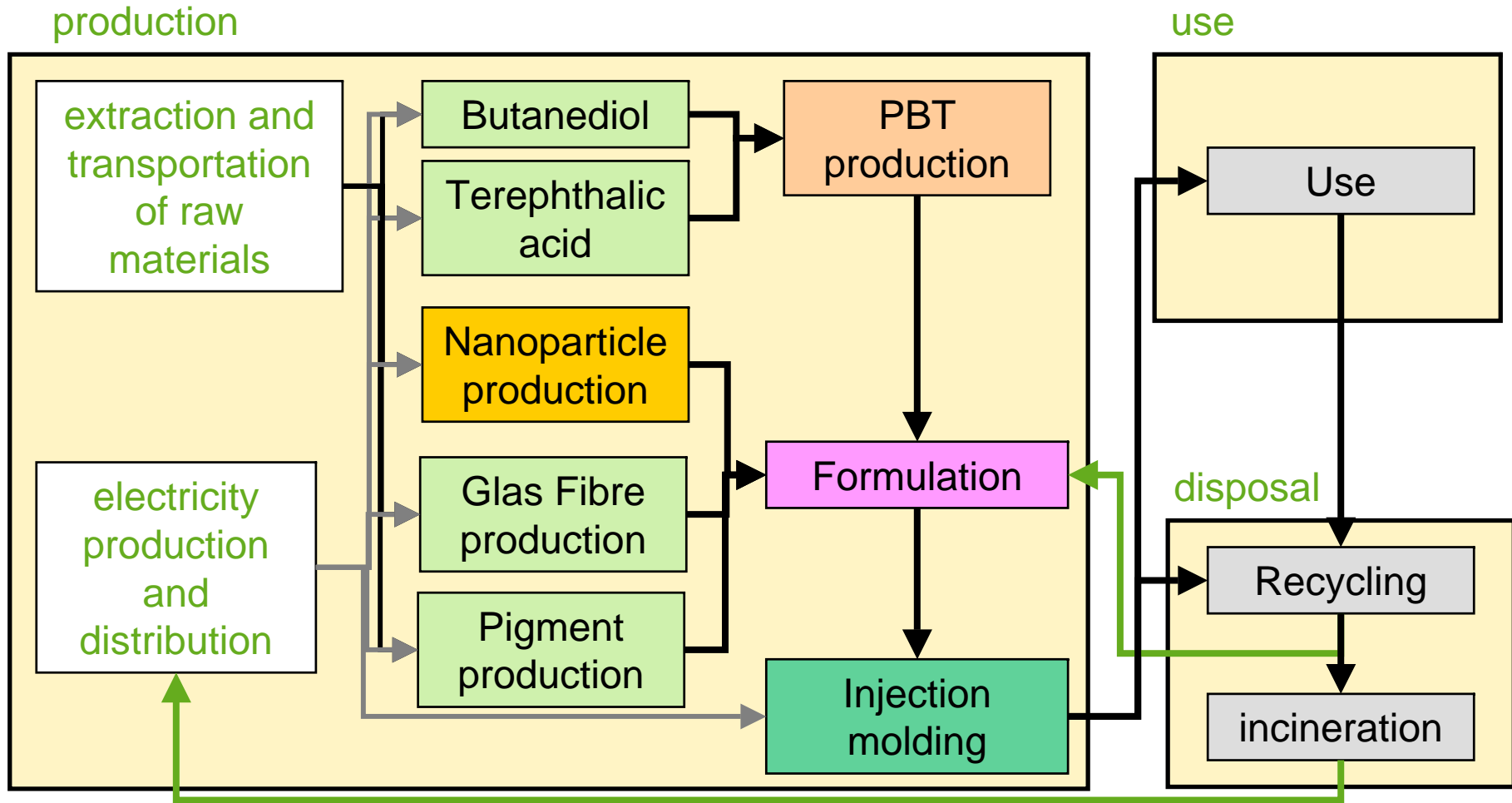
use



Grey fields are the same for all alternatives and are left out of the balance

# System Boundaries:

## Ultradur<sup>®</sup> High Speed

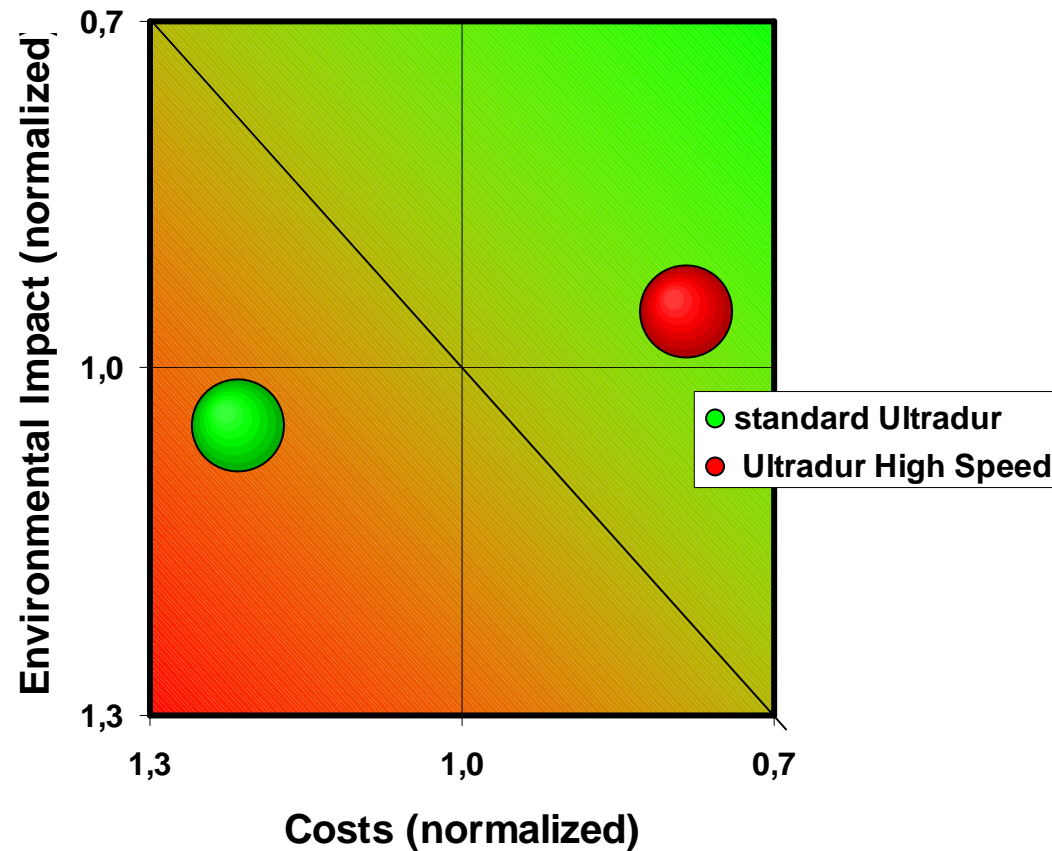


Grey fields are the same for all alternatives and are left out of the balance

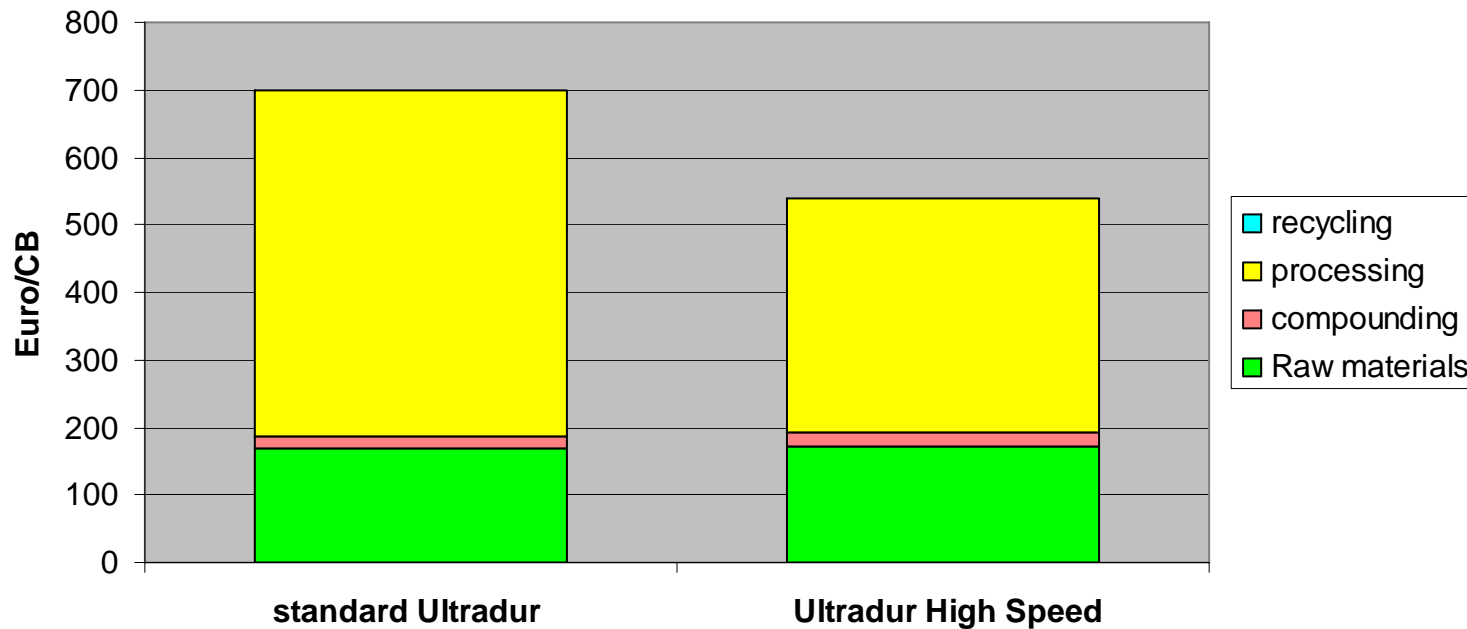
# Base Case: Eco-Efficiency Portfolio

**customer benefit:**

Production of 1000 injection molding components



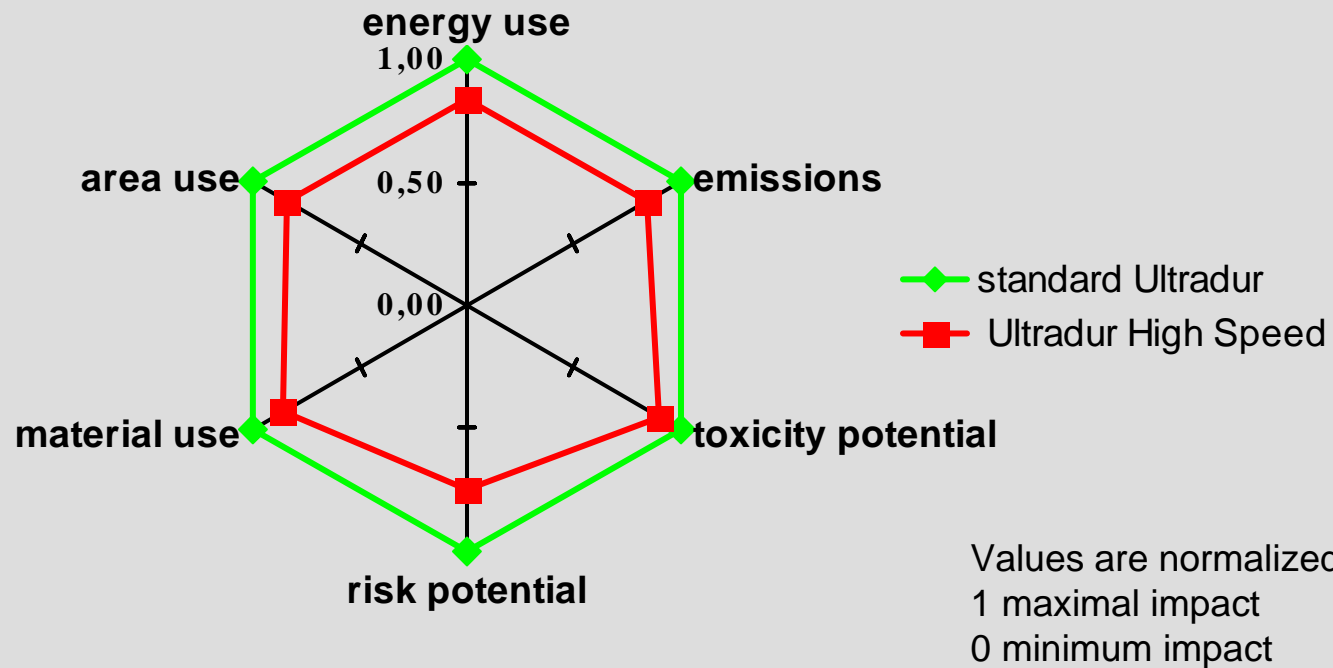
# Costs for the Customer: Base Case



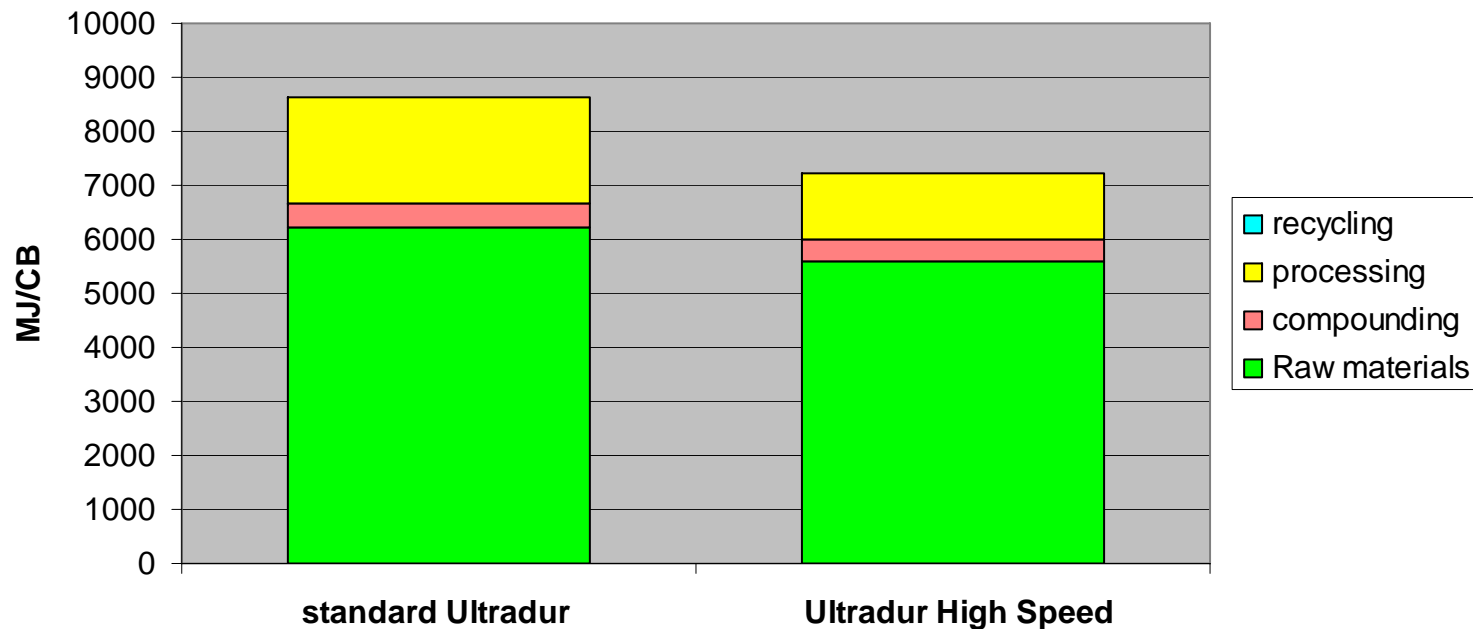
Savings 160 € per 1.000 pieces

CB- customer benefit

# Base Case: Ecological Fingerprint



# Primary Energy Consumption: Base Case



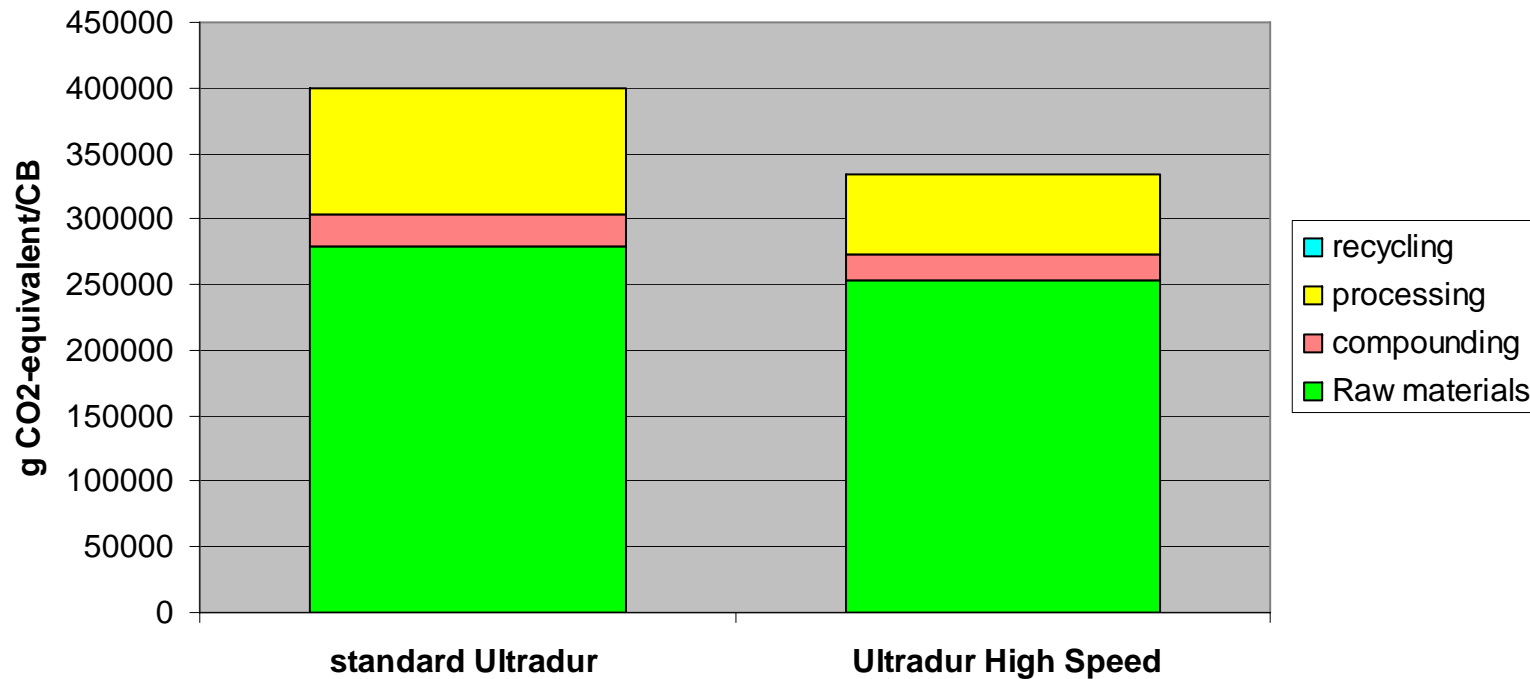
Savings 1400 MJ per 1.000 pieces

Equivalent to the average consumption of an utility car\* in 475 km

CB- customer benefit

\* Calculated with a gasoline VW Golf 75 HP (emissions: Euro 4)

# Air Emissions: Base Case Global Warming Potential



Savings 66 kg CO<sub>2</sub> -eq. per 1.000 pieces

Equivalent to the average CO<sub>2</sub> exhaust of an utility car\* in 300 km

\*Calculated with a gasoline VW Golf 75HP (emissions: Euro 4)

CB- customer benefit

# Scenarios

The following scenarios are shown in subsequent pages:

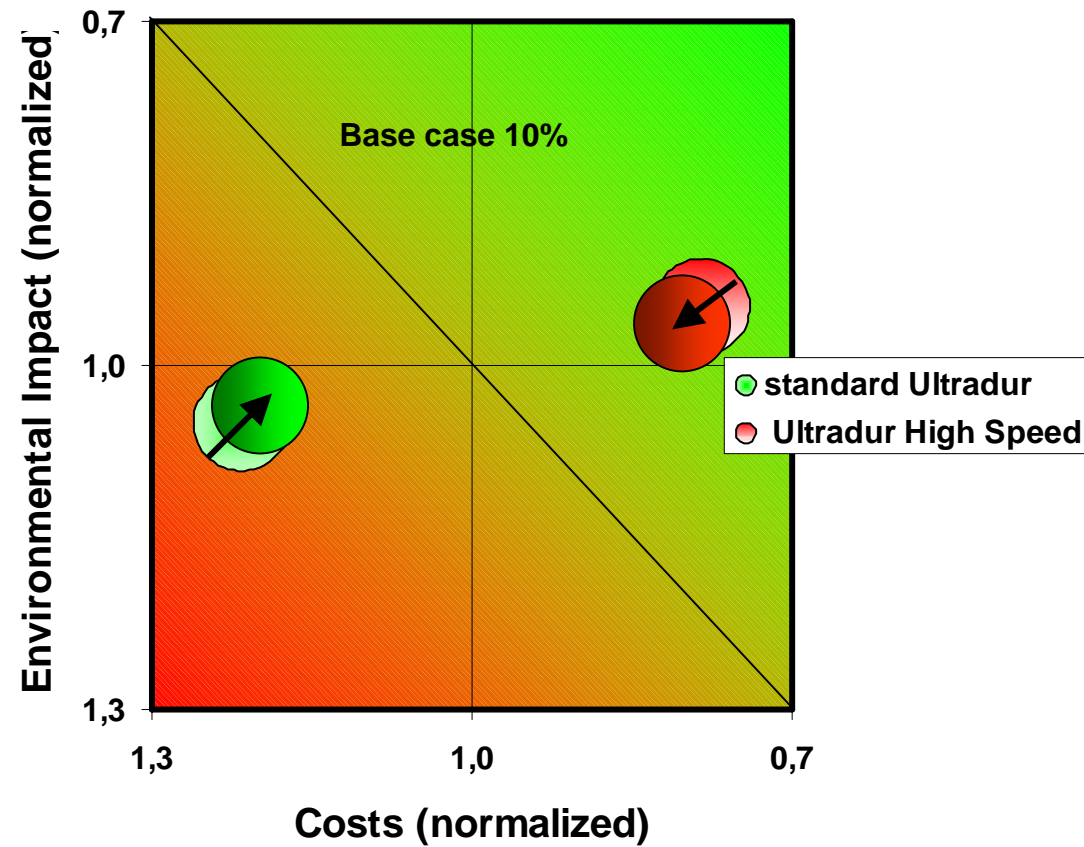
<b>name</b>	<b>scenario</b>
<b>Scenario 1</b>	<b>5% material savings</b>
<b>Scenario 2</b>	<b>20% material savings</b>
<b>Scenario 3</b>	<b>No material savings</b>
<b>Scenario 4</b>	<b>Investment in new process equipment with 25% mold cost savings</b>
<b>Scenario 5</b>	<b>Application for automotive components</b>



# Scenario 1: 5% material savings

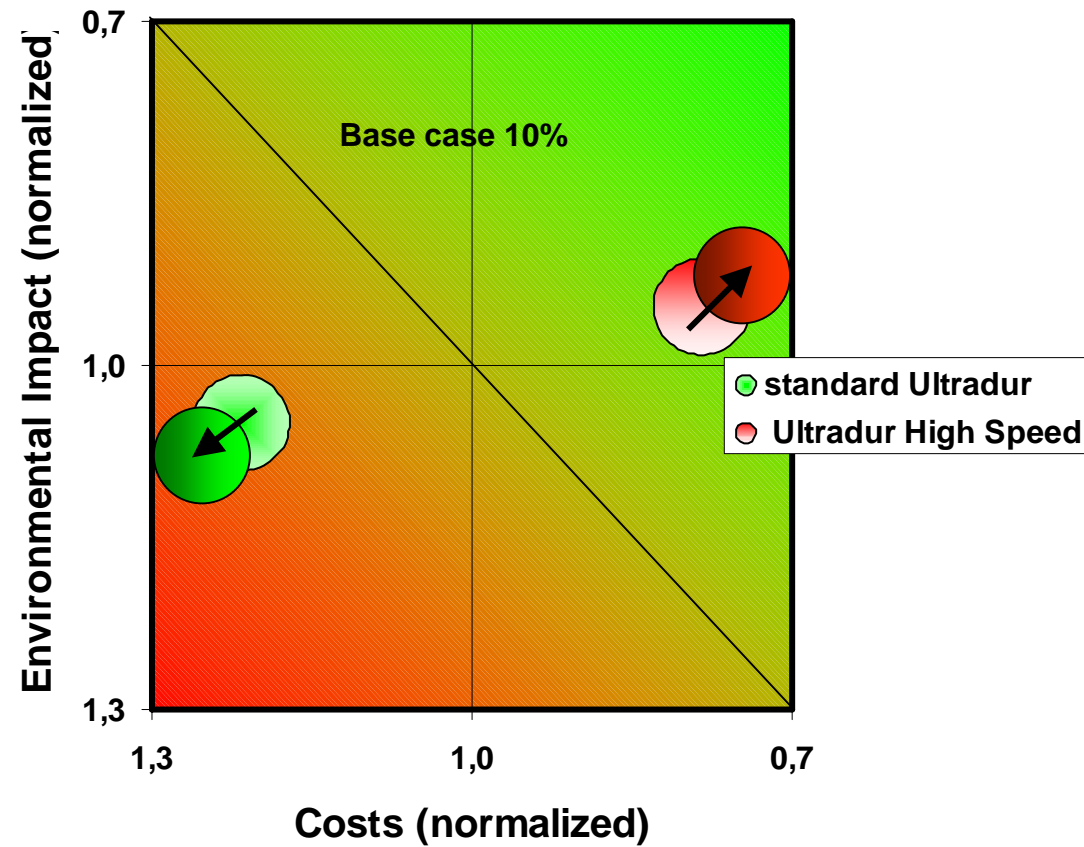
**customer benefit:**

Production of 1000 injection molding components



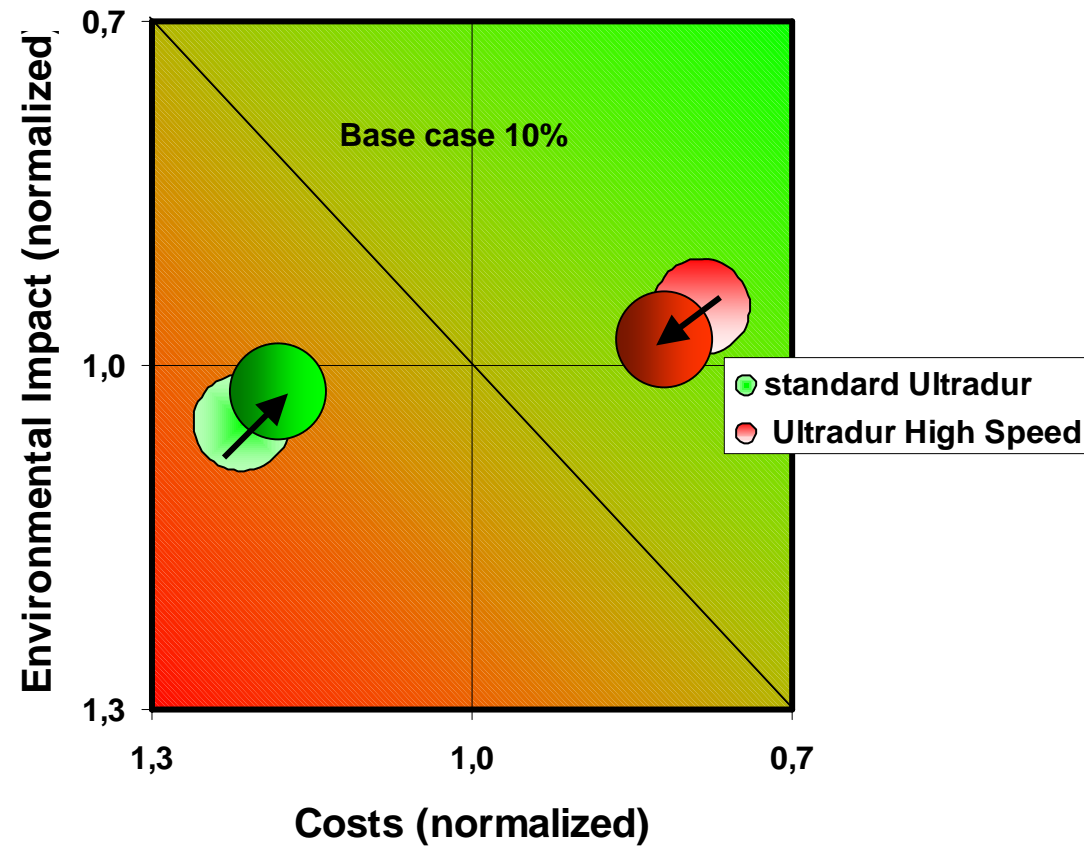
# Scenario 2: 20% material savings

**customer benefit:**  
Production of 1000 injection molding components



# Scenario 3: no material savings

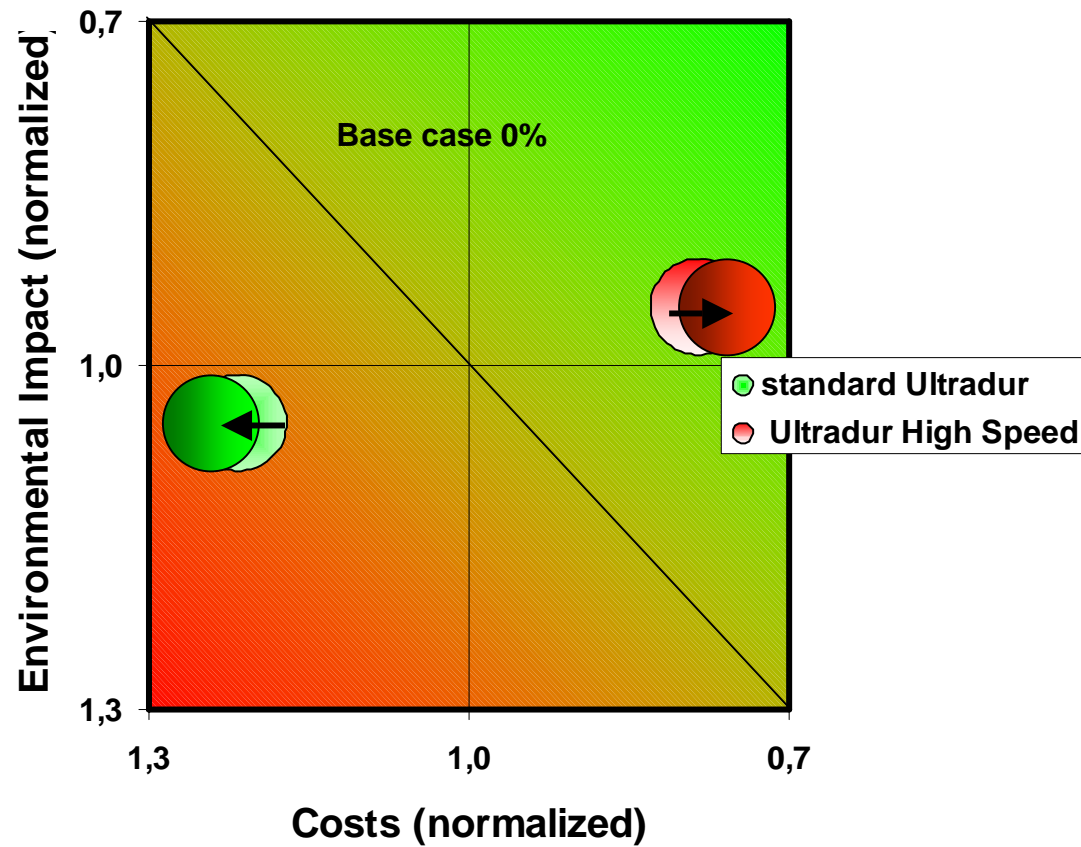
**customer benefit:**  
Production of 1000 injection molding components



# Scenario 4:

Investment in new process equipment with 25% mold cost savings

**customer benefit:**  
Production of 1000 injection molding components

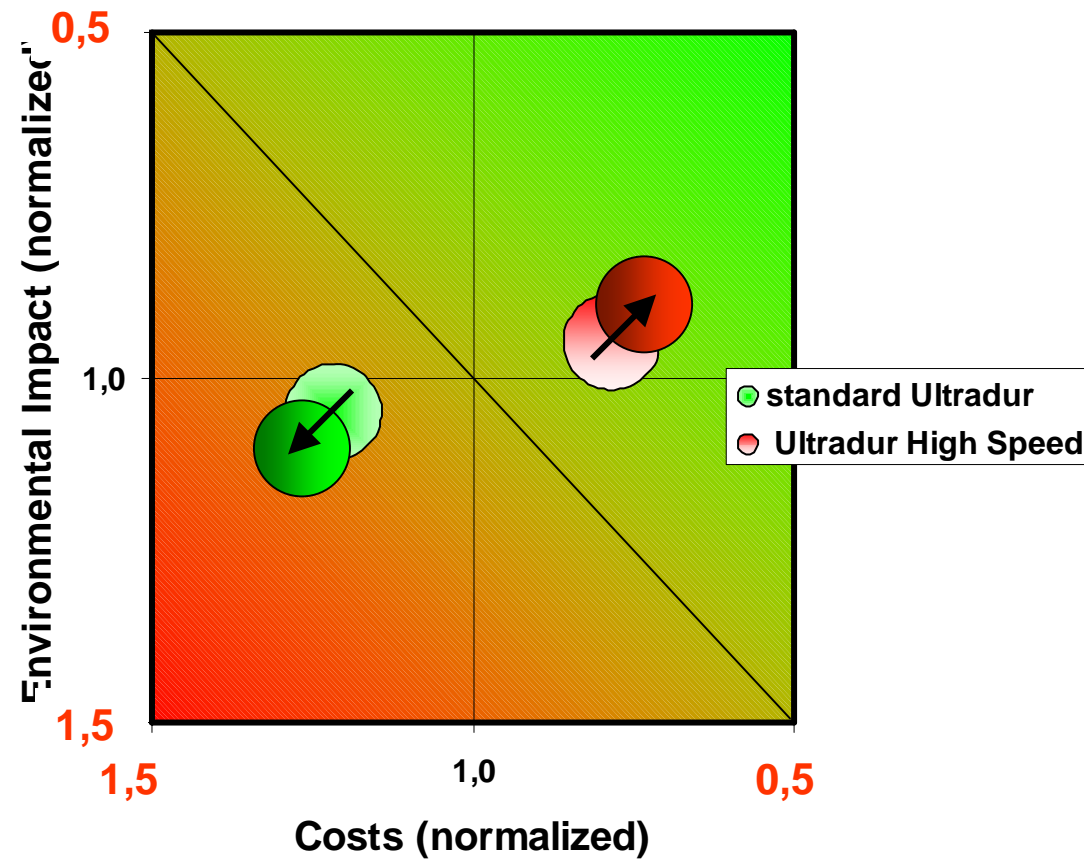


# Scenario 5:

## Application for automotive components

**customer benefit:**

Production of 1000 injection molding components



**Change in scale!**



**Summary**

**The most eco-efficient alternative for the production of 1000 injection molding components is *Ultradur<sup>®</sup> High Speed*. The advantages are due to primarily to less material use and lower electricity consumption.**