Eco-Efficiency Analysis

Eco-Efficiency Study for Diesel Additives

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Summary

Eco-Efficiency Analysis

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- The study was made to compare additized diesel fuels and not additized diesel fuels.
- The most eco-efficient alternative in the base case is the additized fuel. The non additized fuel has the lowest eco-efficiency.
- It was shown that the application of additives is useful and eco-efficient.
- The efforts to produce the additives are much lower than the fuel energy that can be saved by using the additives.
- The alternatives in the differentiation calculation are very high. Possible uncertainties have low impact to that result due to the big positive impact of the additives in their useful life.
- The amount of additives that are needed are very low. Their function is very powerful and sustainable.

Objectives and Use of the Eco-Efficiency Study

Eco-Efficiency Analysis

- The study was made to compare different alternatives for fuels. The alternative in focus is the use of additives for fuels. It is not only the price and environmental impact of the alternative materials, which are important to the comparison. A life-cycle view should identify the strengths and weaknesses of the different alternatives.
- 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 chemical reactions and related materials which are required to achieve the desired product. It is one method between others that are able to assess environmental data over the whole life cycle.
- The ecological calculations of the single results in each category are following the ISO-rules 14040 ff in the main points. The quantitative weighting step to get the ecological fingerprint and the portfolio are not covered with the ISO-rules. The eco-efficiency analysis has more features than are mentioned in the ISO rules.
- The methodology has been approved by the German TUV. This methodology was used by the "Öko-Institut - Institute for applied ecology" in Freiburg Germany in different APME-studies. Öko-Institut uses a quite similar methodology with a different weighting system ("Ecograde"). . TNO in the Netherlands using the BASF standard method with a different weighting system. The Wuppertal Institute accepts the method: “Basically, the large number of indicators used in the eco-efficiency analysis of BASF make relatively reliable statements possible …“. The method was initially developed by BASF and Roland Berger Consulting, Munich.

www.tuv.com TÜV Berlin ID:5711150561

Validated Eco-Efficiency Analysis method

Objectives and Use of the Eco-Efficiency Study

- This study might be another step for the BASF to asses different opportunities in the fuel and lubricant business. The weaknesses and strength of using them in comparison to other cleaning systems might be an opportunity for benchmarking the BASF technology with others.
- Especially the growing market in Asia can be supported by assessing costs and environmental data over the whole life span and over the whole life cycle of products that are involved.
- Another objective might be to inform customers in a B2B-communication, to show them the relative advantages of using the most eco-efficient alternative. Therefore a different presentation of the results like a publication in a public available journal can be initiated.
- The presentation of the results to decision makers in the business will support the use of the most sustainable alternative in the future.
- The information coming out of this study might be also helpful for supporting R&D activities for the optimization of the product and for the market implementation of the new developed product.
- After finalization of the study, including a Critical Review, the labelling of the most eco-efficient product with the eco-efficiency label will be done by the TÜV Rhineland in Germany. A description of this critical review is introduced in the study, the important comments are also published directly. The whole CR-report can be send out after request.

Limits and Reglementation for the use of the Results

- Results are valid for materials in the defined applications. They are not valid for different applications, which have nothing to do with the original process defined in the study.
- The “cradle-to-grave” view focuses on all steps of the cleaning process. Steps before and after this process step are not considered.
- The protection and safety issues for workplaces are calculated in this study following the German Law and regulation, even if different country scenarios were worked out.

- Further information on the eco efficiency methodology: **http://www.oekoeffizienzanalyse.de**

Eco-Efficiency Analysis Label
Critical review from TÜV

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Eco-Efficiency Analysis

- After the eco-efficiency analysis was worked out and reviewed by a third party, the eco efficiency label can be awarded following the rules in ISO 14025. The attached label can be employed for fuels, which are using additives delivering a performance level similar to the one observed with the additive that was under investigation compared to a fuel without additives under the given conditions mentioned in this study.
- BASF SE is the owner of the label, all rights are reserved.

Questions around the sustainability of fuel additives

Eco-Efficiency Analysis

- Is there any benefit in using additized diesel fuel?
- How sustainable is additized diesel fuel?
- How can the end consumer perceive those benefits?

... an Eco-Efficiency Analysis of BASF can help to answer those questions!

Overview of Study

Compare environmental impacts and costs between

1. Diesel additized with Keropur® DP additive

2. Diesel non-additized

Diesel Additives

- Keep fuel injectors clean and free of deposits
- Improve cetane number of base fuel (if specific component present in the package)

Conclusions

Costs

Diesel with Keropur® DP additive has lower cost impact on the consumer due to better fuel economy

Environmental Impacts

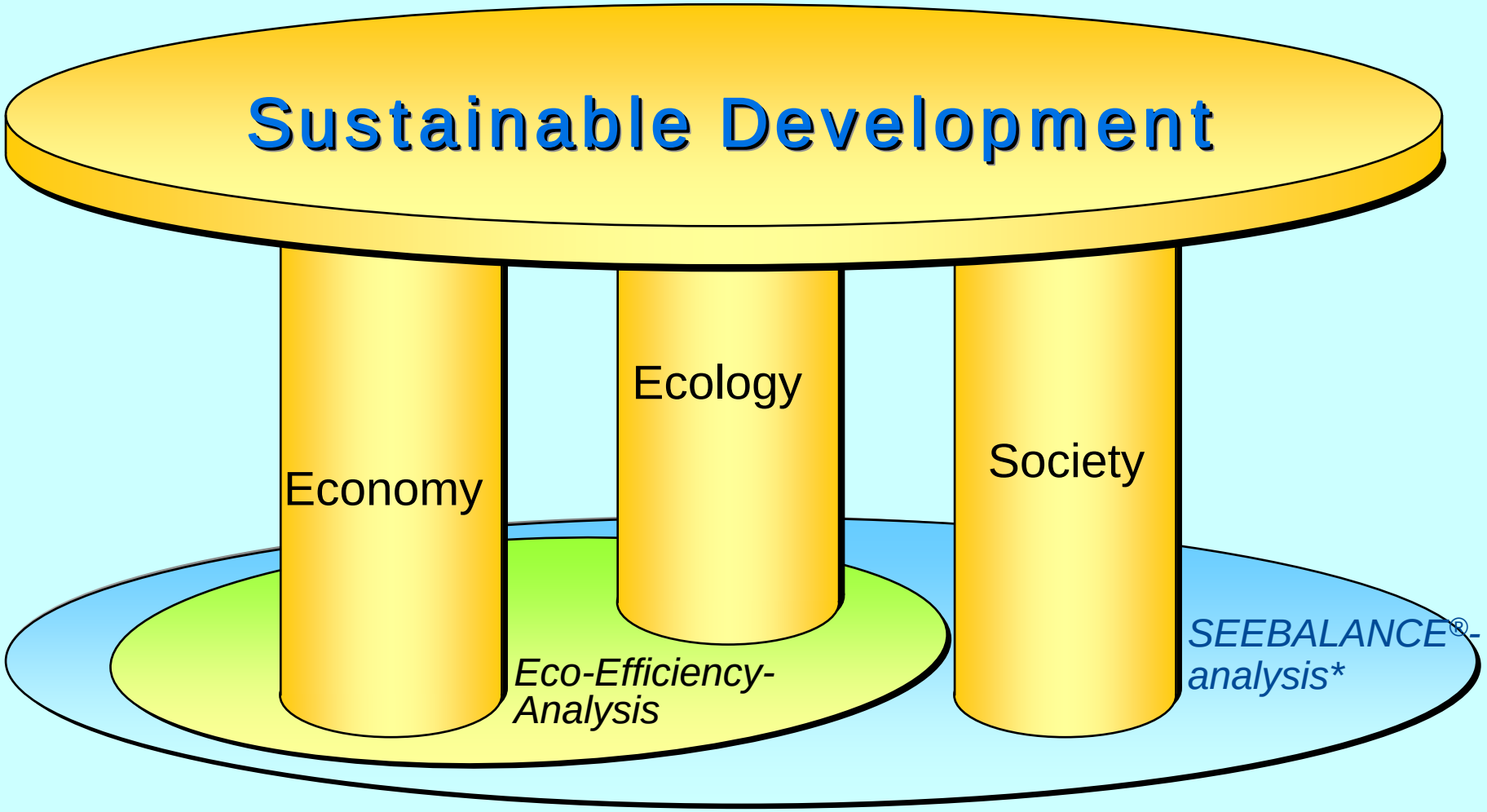
Diesel with Keropur® DP additive

- Produces less air emissions
- Conserves fuel and energy resources
- Lowers toxicity and risk potentials

Diesel with Keropur® DP additive has significant economical and ecological advantages over non-additized Diesel.

Sustainable Development is based on three Pillars

Eco-Efficiency Analysis



* Developed in 2005

Eco-Efficiency Analysis

What is it all about?

- Assessing economic and ecological impact of products and processes
- Analysis of the products from the angle of the end consumer (whole product life cycle)
- Simultaneously optimizes total cost and environmental impact*
- Standard tool in the BASF Group (more than 400 analyses have been carried out)

* Social aspects can be included as well.

Study overview

Eco-Efficiency Analysis

Compare environmental impacts and costs between

1. Diesel additized with Keropur® DP additive

2. Diesel non-additized

- **The BASF has an leading expertise in the world**
  - **BASF has a high level of competence in sustainability matters and professes itself to sustainable management**
  - **BASF has three competence centers around the world concentrating on this topic**
  - **the BASF-method is unique and has been validated by the TÜV**
  - **BASF cooperates trustfully with governmental departments, NGO´s, the UN, the GTZ etc.**

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Validated

Eco-Efficiency Analysis

The life cycle view: System boundaries

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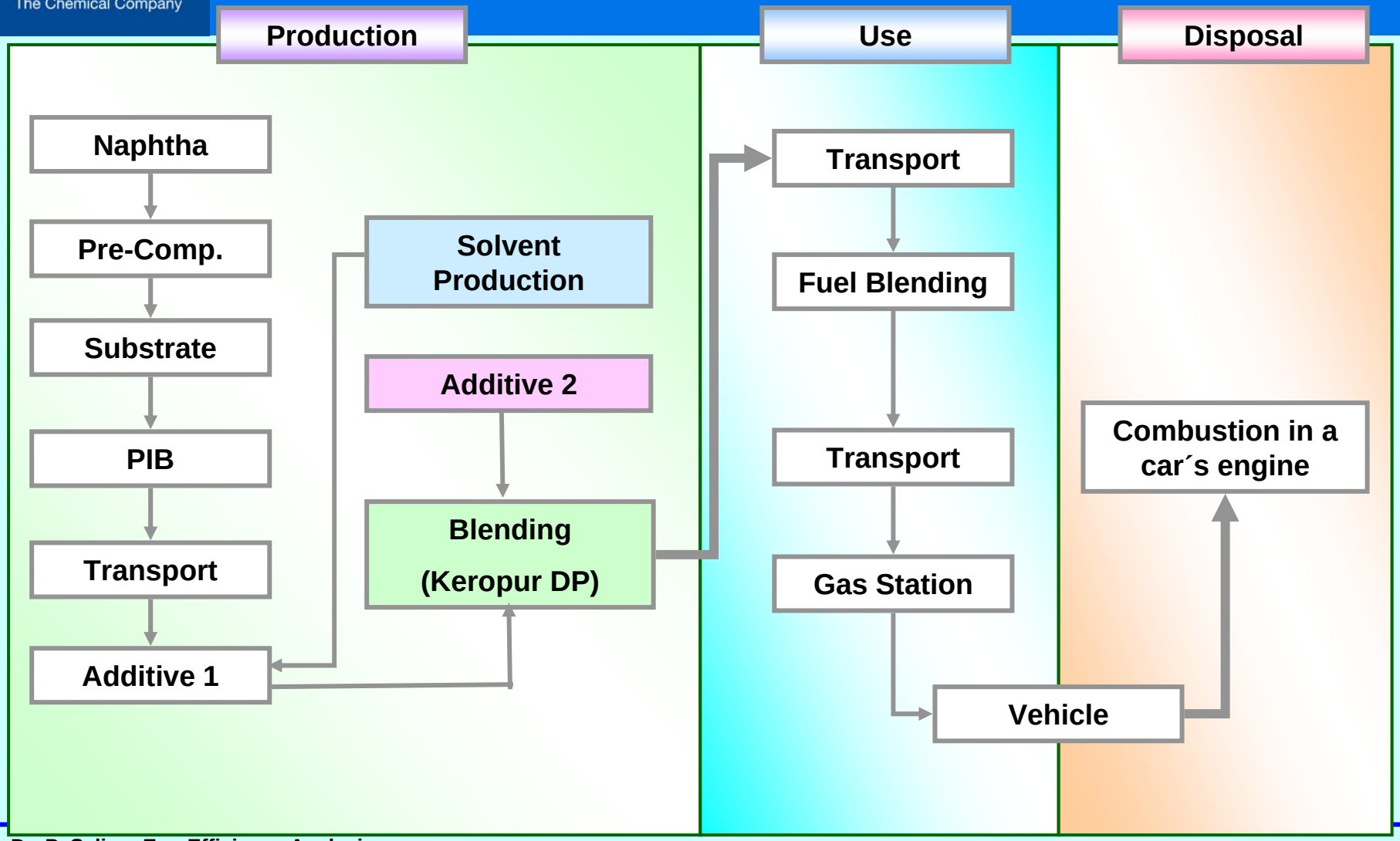
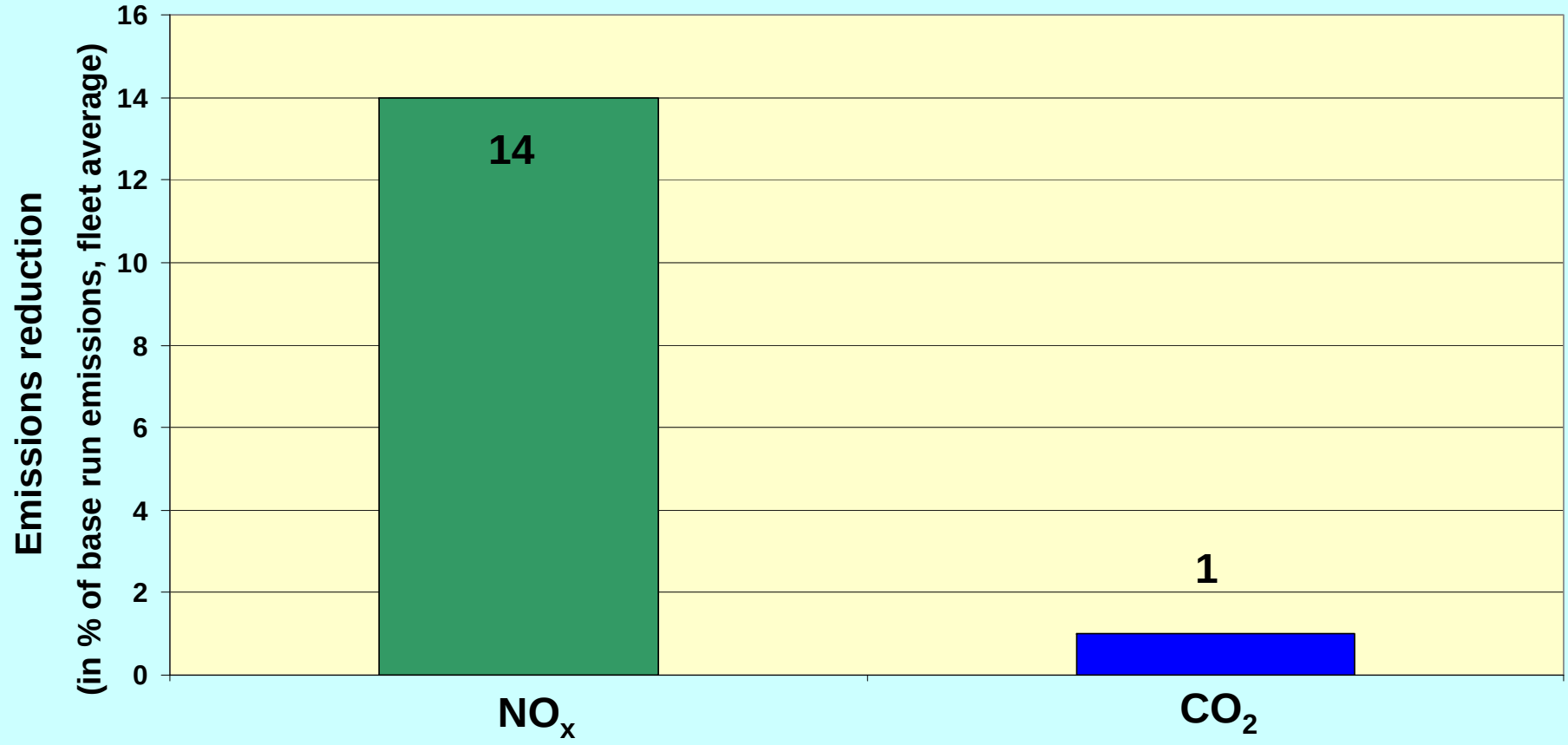


Diesel Performance Packages

Fleet test with a customized Keropur® DP package: Basic conditions

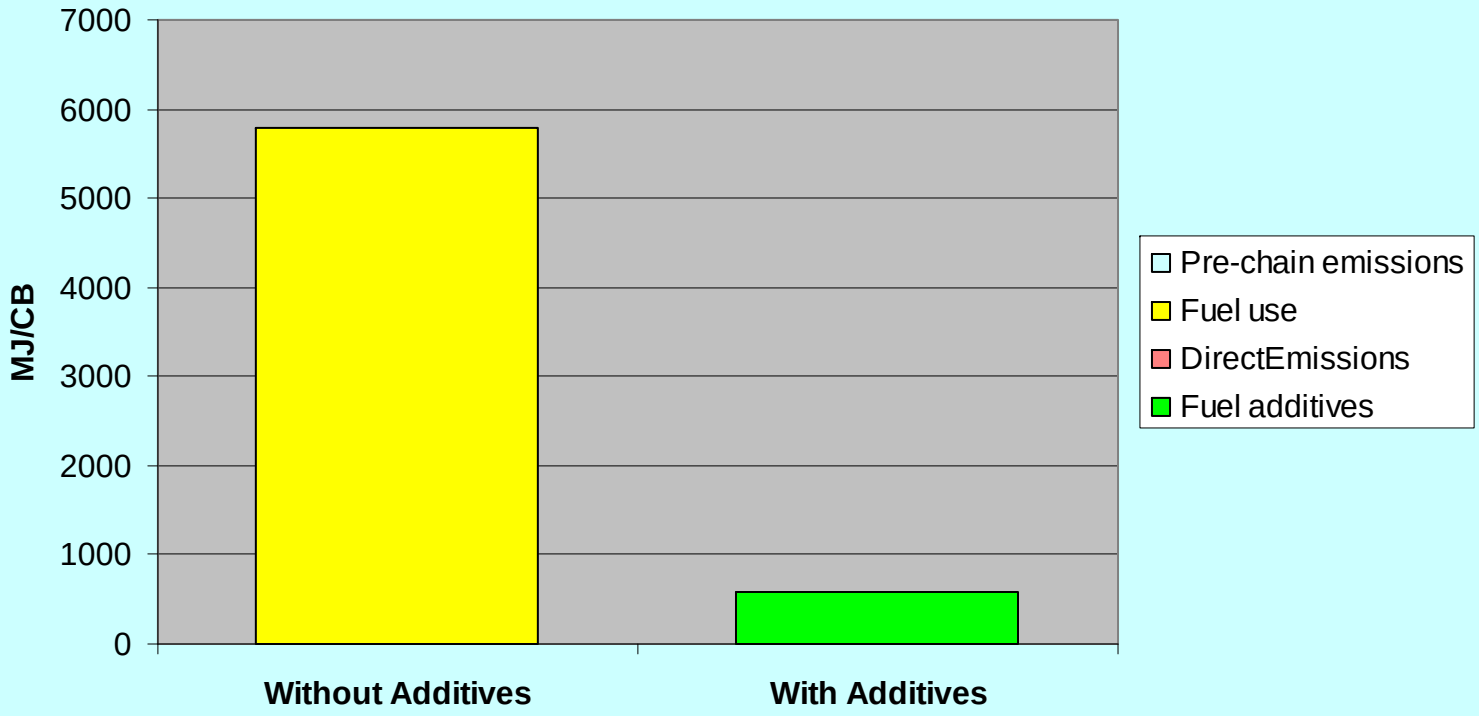
Eco-Efficiency Analysis



Environmental results

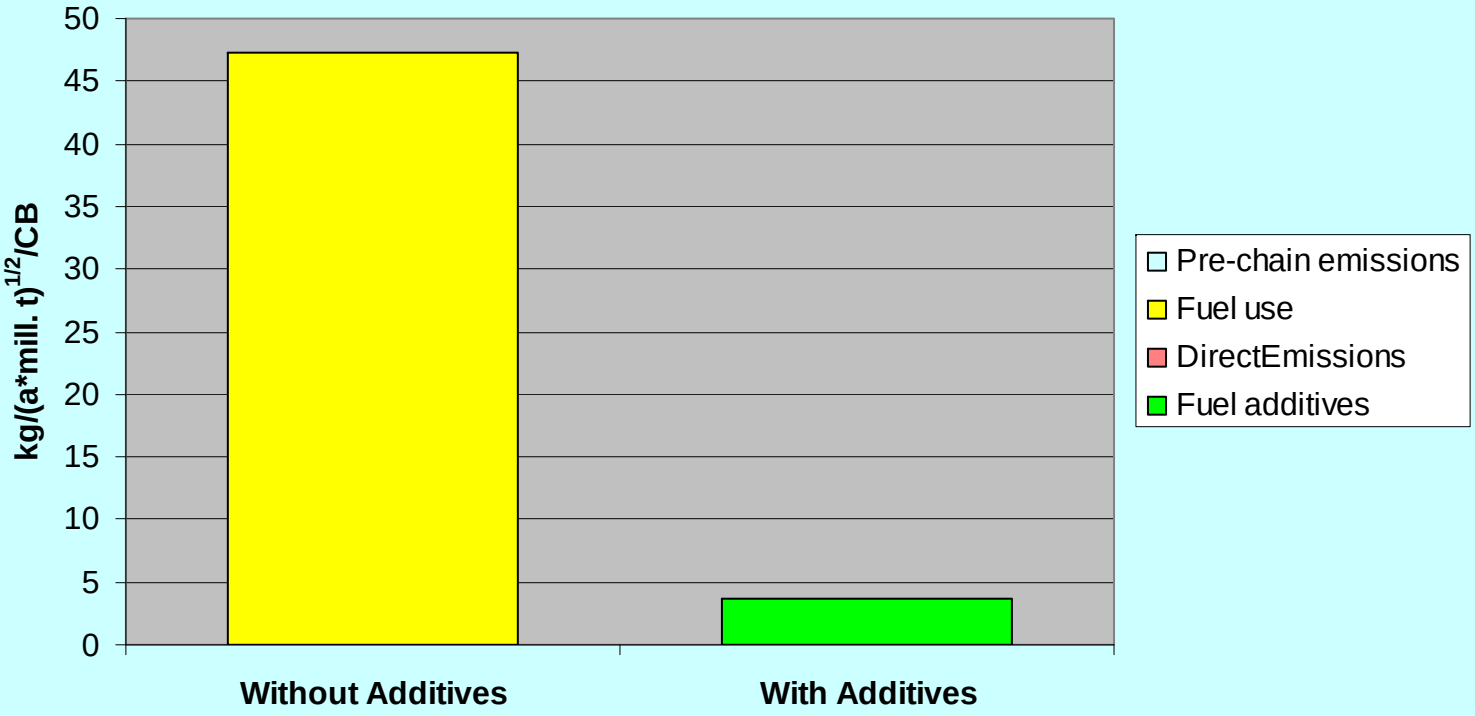
Energy consumption

Eco-Efficiency Analysis



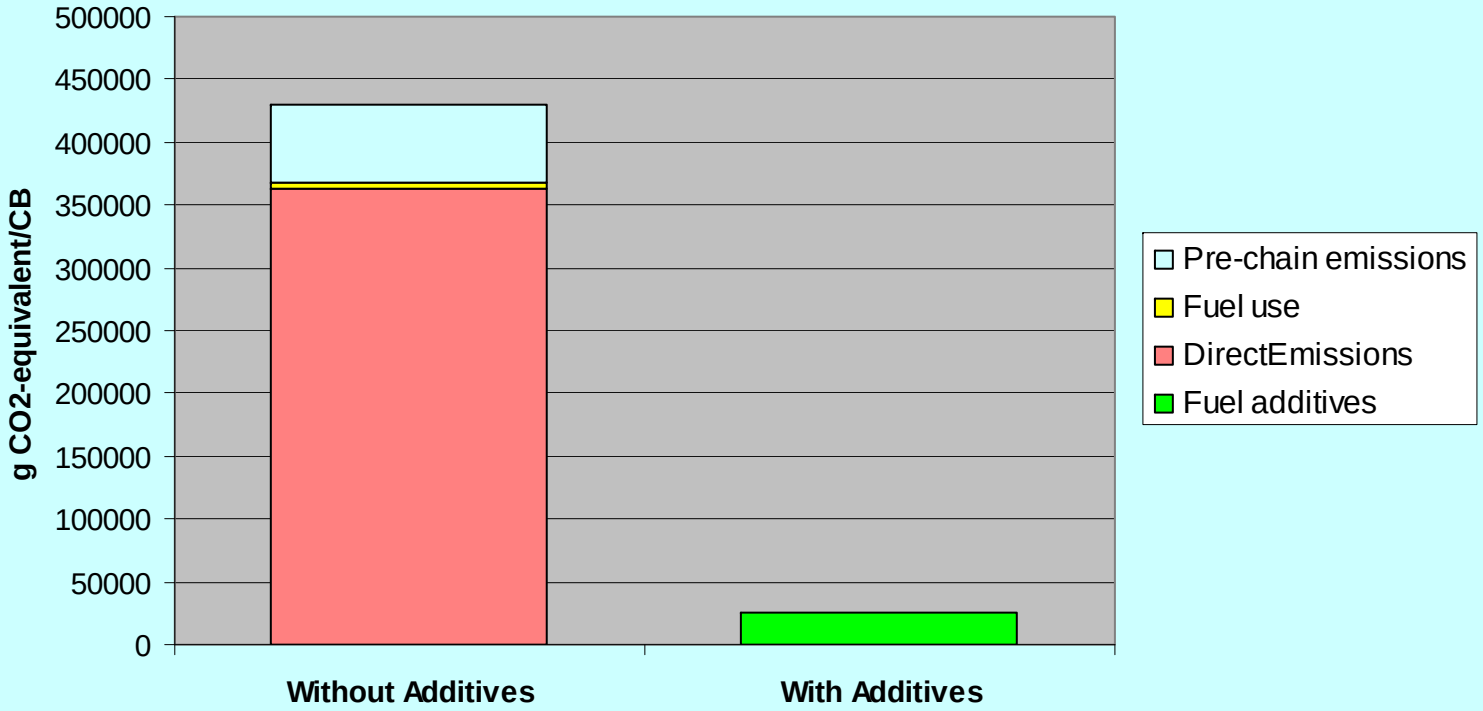
Resource consumption

Eco-Efficiency Analysis



Air Emissions: Carbon Dioxide

Eco-Efficiency Analysis



Basis = fuel consumption 8.7 litre per 100km; range 200,000km

Ecological Fingerprint:

Assessing 6 ecological criteria

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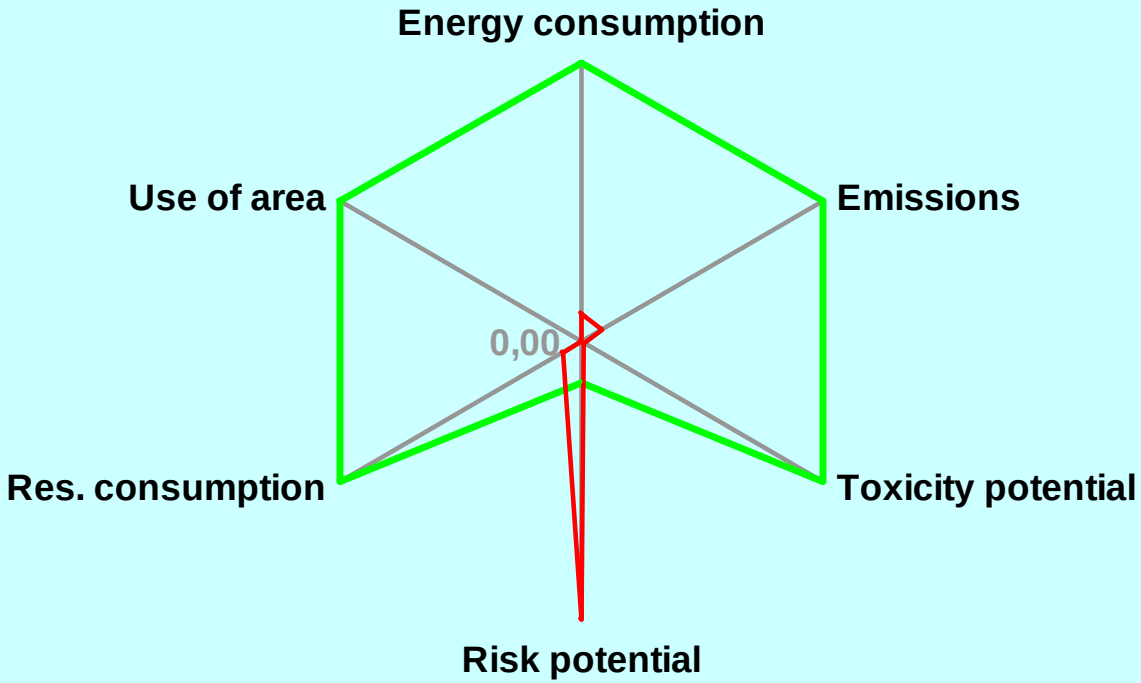
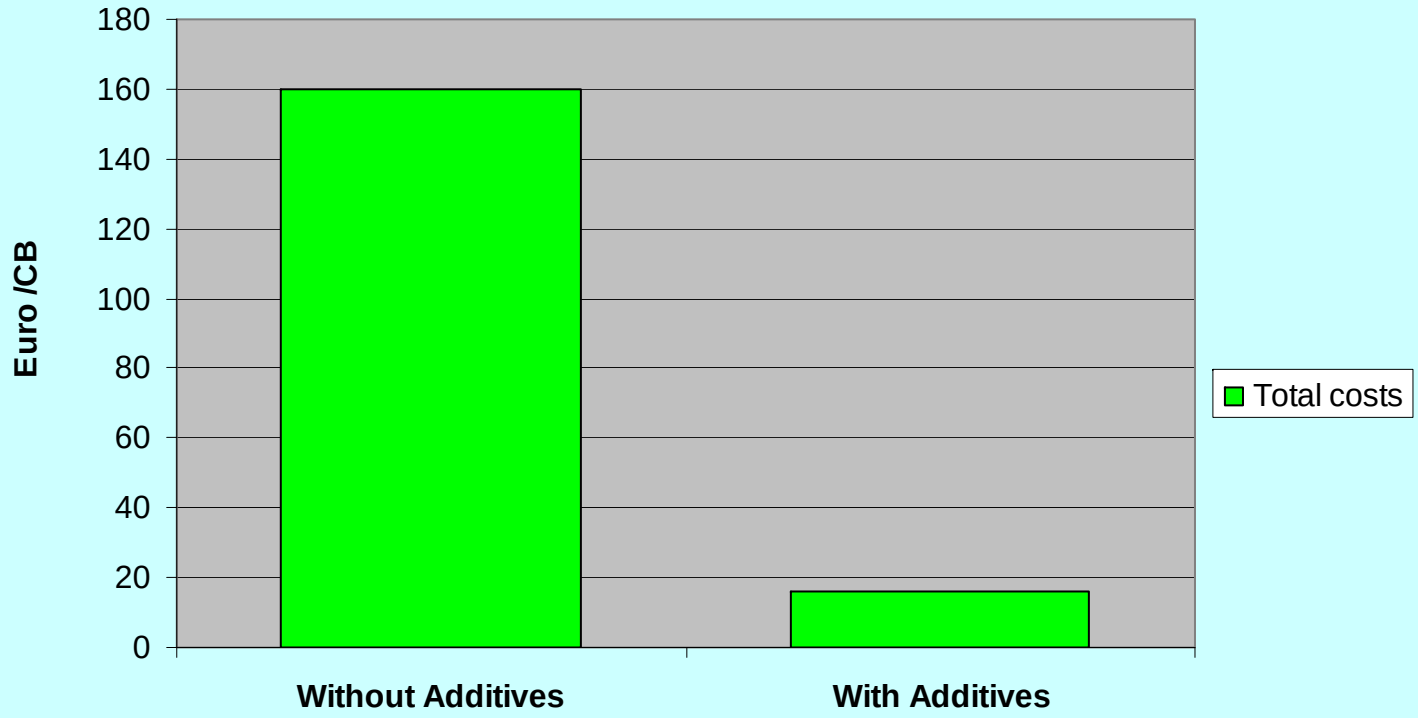
1,0 = worst position, relatively better position <1



Costs results

Total costs evaluation

Eco-Efficiency Analysis



The Eco-Efficiency portfolio

Eco-Efficiency Portfolio: Base case

Eco-Efficiency Analysis

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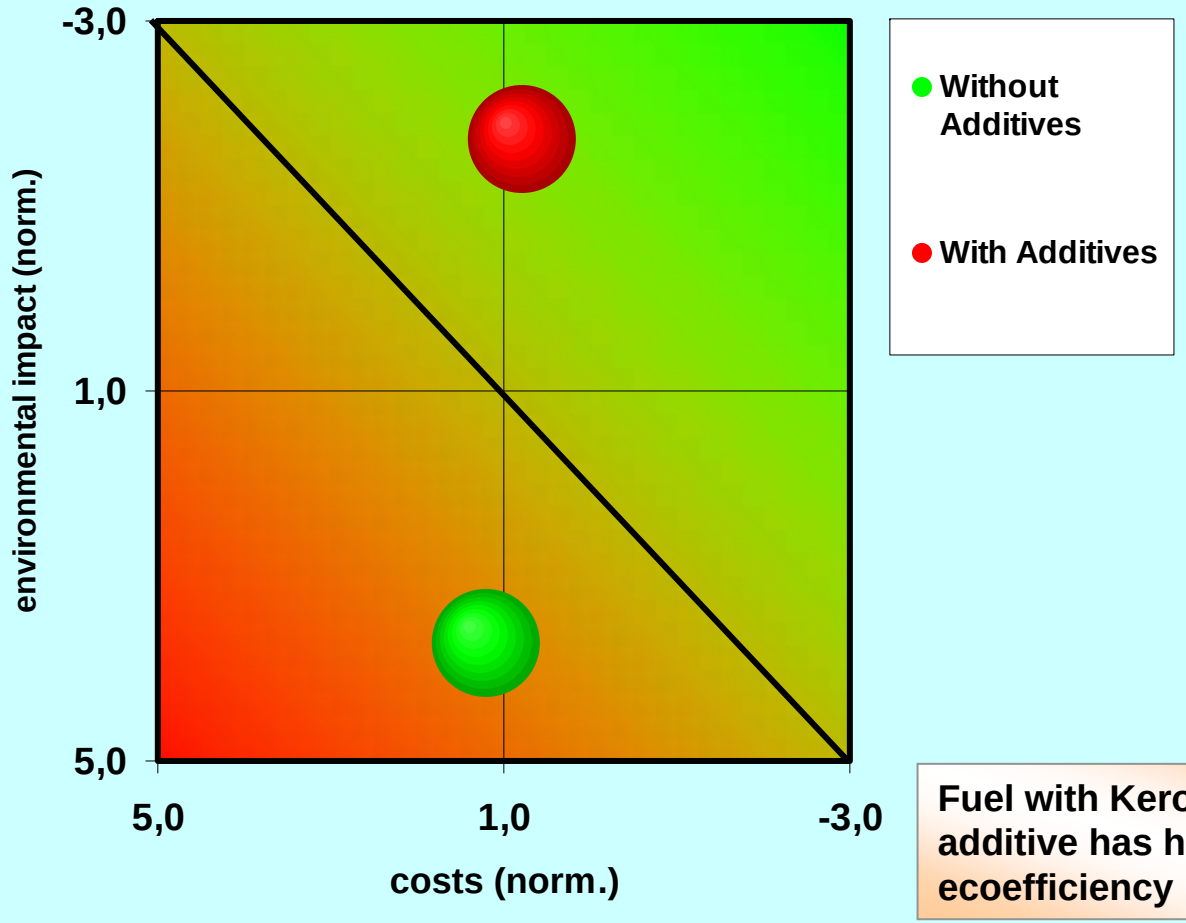
Base case: Based on improvement in fuel economy for driving 200,000km Estimated fuel price: 1Euro/litre



Fuel with Keropur® DP additive has higher ecoefficiency

Eco-Efficiency Portfolio: Base case

Eco-Efficiency Analysis

- Distance evaluated: 200,000 km (125,000 miles)
- Fuel consumption (unadditized): 8.0 l / 100 km
- 1 % fuel economy gain due to additization
- Fuel price 1 € / l ($ 6 / gal)
- Difference calculating

Relevance Factors

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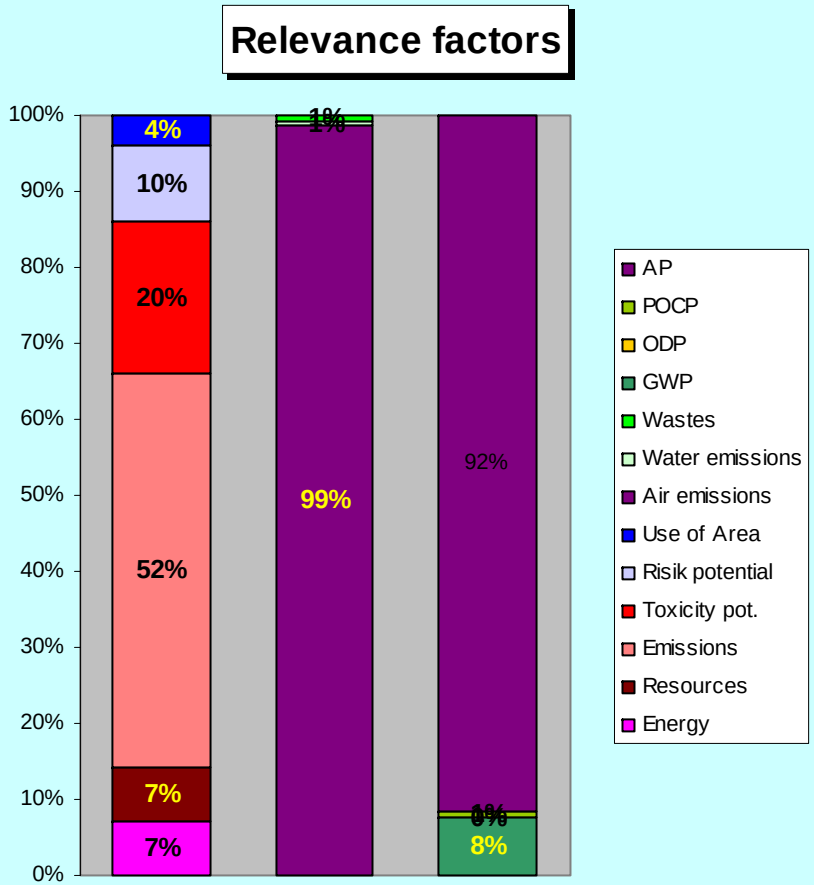
Eco-Efficiency Analysis

Air emissions carries a high weighting compared to other emissions



Calculated Factors

Air emissions carries a high weighting compared to other emissions