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# USING LCA METHOD TO DESCRIBE LOGISTIC SYSTEM OF FUEL

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***Abstract***

*This paper presents the life cycle of the fuel with the use of LCA. This method is taken from the management theory allows to describe and predict the impact of production processes, transport and use of fuels on the environment. The aim of the study is to compare the energy consumption of the test fuels (diesel, a blend of rapeseed* *oil and butyl alcohol) in the process of their production. The results indicate that most energy is consumed during the processing of crude oil. This process produced a large quantity of sulphur oxides. Very energy intensive (53,859 GJ per 10 k litres of fuel produced) part of the production is rape culture. This is due to the long working hours of agricultural tractors and combines. In this process, are secreted large amounts of exhaust gas: CO (2.664 kg), NOx (23.31 kg).*

*Inter alia, environmental life cycle assessment, schematic structure of the LCA, the energy balance of the life cycle of diesel oil, the energy balance of the life cycle of rape oil mixed with butyl alcohol, the balance of raw material sourcing, the balance of the materials necessary to production of a mixture of rape oil and butanol alcohol are presented in the paper.*

***Keywords**: logistic system, LCA method, fuel efficiency, life cycle*

## 1. Introduction

LCA (Life-cycle Analysis) is a technique to assess environmental impacts associated with all the stages of a product's life from-cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, transportation, distribution, use, repair and maintenance, and disposal or recycling). LCAs can help avoid a narrow outlook on environmental concerns. The life cycle of the product in the environment has been divided into 4 parts: defining scope of the analysis, definition of a set of input and output data, environmental impact assessment, a description of the life cycle. LCA shows the components and results of production processes, evaluation of the impact of these processes on the environment, description of the product life cycle. In particular, there was demonstrated production of pollution, and the impact on the ecosystem. The purpose of the LCA is to provide guidance as to reduce the potential hazard of production, use and disposal of the product. An important element of this approach is a holistic look at the markets and economic aspects related to this product. The use of LCA is standardized. This is described in ISO 14000 Environmental management ISO 14040:2006 and 14044:2006. [5-9]

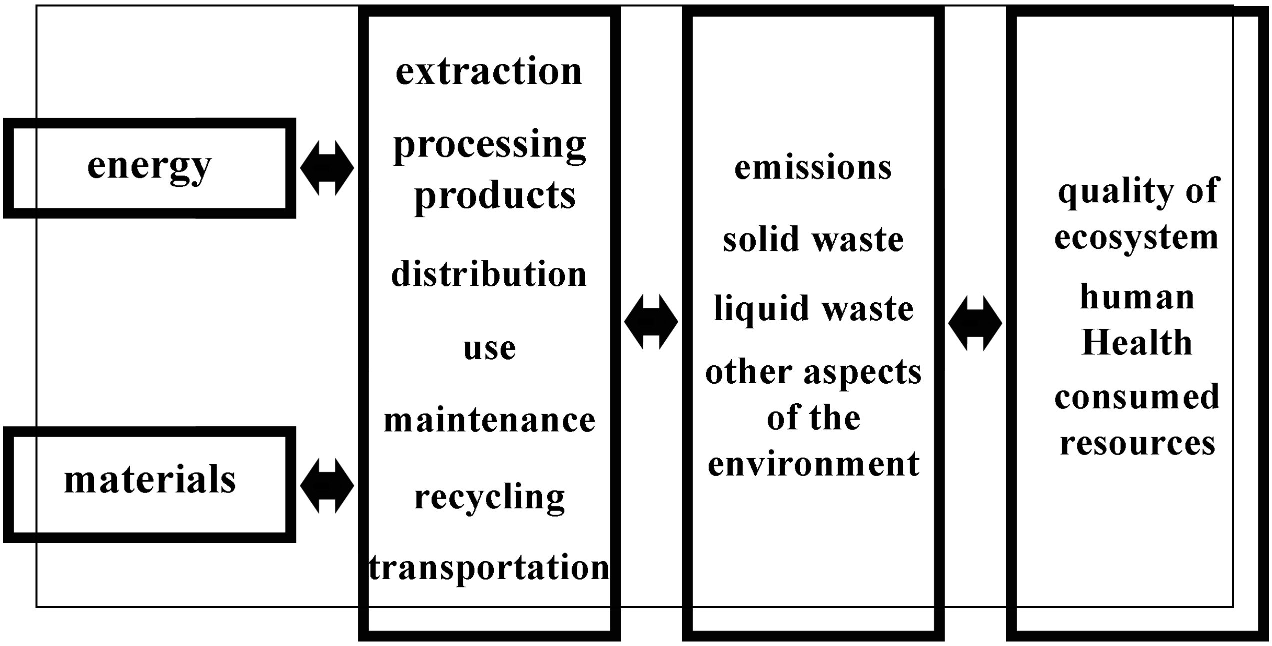


*Fig. 1. Environmental life cycle assessment*

Important stage of LCA is determine borders and restrictions of the system. The method is establishing process unit as combination of materials and energy, which should be precisely specified for the analysis. Functional units are determining quantities effects in life cycle analysis. Input and output of product systems should be measurable and be precisely defined for comparing different products.

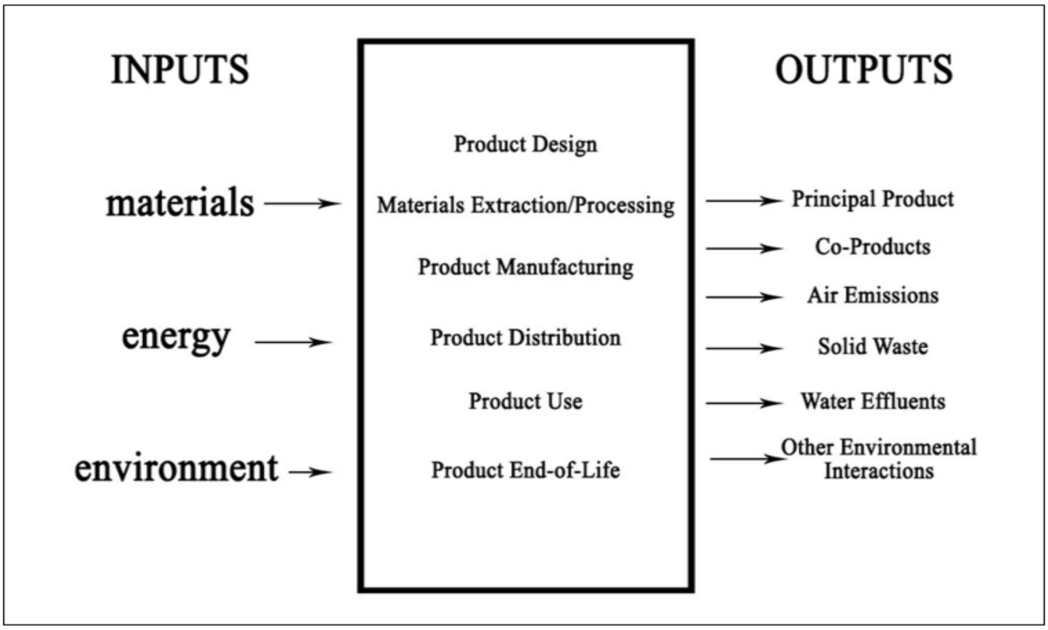


*Fig. 2. Schematic structure of the LCA*

## 2. Production of engine fuels using LCA method

LCA analysis is divided on production, processing and distribution of fuel. Typically, the method is used to evaluate the energetically performance of the cycle and to estimate the total energy consumption during that cycle. The method is also used for the assessment of pollutant emissions from motor vehicles. The theme of this work is the description of the above figures for the production of 10 000 litres of fuel following:

- rapeseed oil and butyl alcohol mixture (2:3 ratio),
- diesel oil.

Production of diesel oil comprises the steps of production of crude oil, transportation to refineries, refining of crude oil. In contrast, the production of rapeseed oil is composed of cultivation of rape, rape transportation, getting oil, the production of butyl alcohol, transportation of the mixture. Tab. 1 and 2 are containing energy demand production of fuels.

*Tab. 1. The energy required to produce 10,000 litres of diesel fuel*

| Process | Energy consumption(MJ) |
|---|---|
| Extraction of crude oil | 1113 |
| Transportation of crude oil to refineries | 201 |
| Raffination of crude oil to the diesel oil | 41400 |
| Transportation of diesel fuel to the recipient | 2954 |
| Sum | 45668 |

*Tab. 2. Energy consumption during production and transportation of the mixture of rape oil and butanol alcohol*

| Process | Energy consumption(MJ) |
|---|---|
| Production of rape | 53856.1 |
| Transportation rape to company which press them | 2713.2 |
| Extrusion of rapeseed oil | 1684.8 |
| Transport of the mixture of rape oil and butyl alcohol to the recipient fuel | 114.43 |
| Sum | 58368.53 |

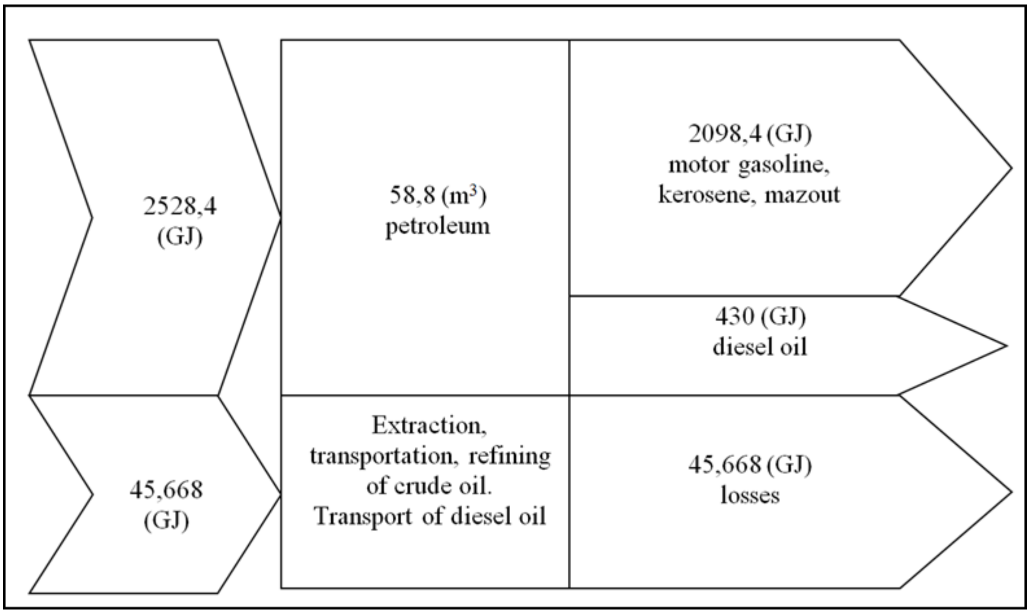


*Fig. 3. The energy balance of the life cycle of diesel oil*

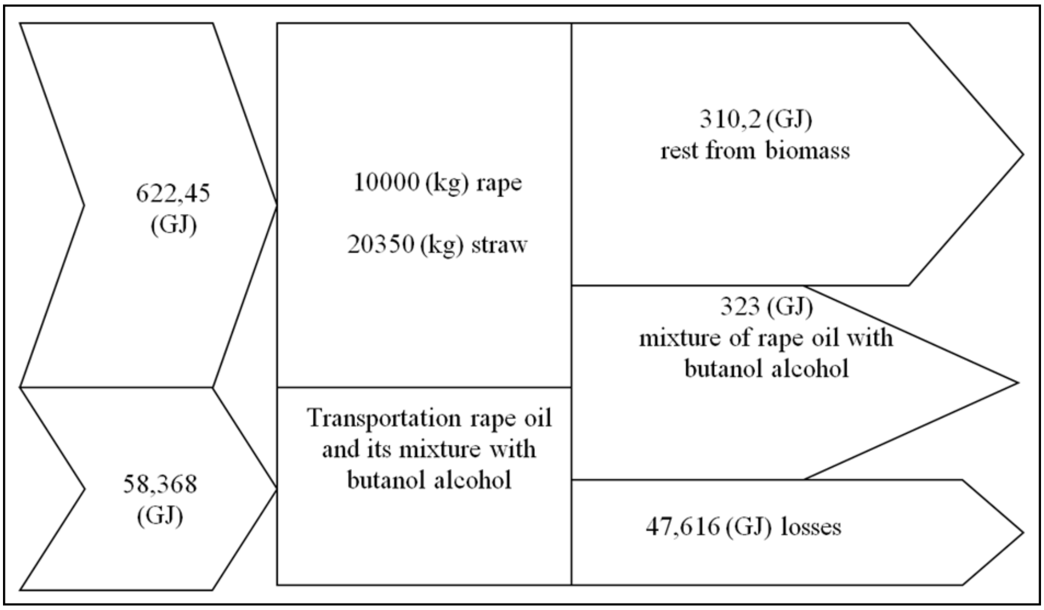


*Fig. 4. The energy balance of the life cycle of rape oil mixed with butyl alcohol (ratio 2:3)*

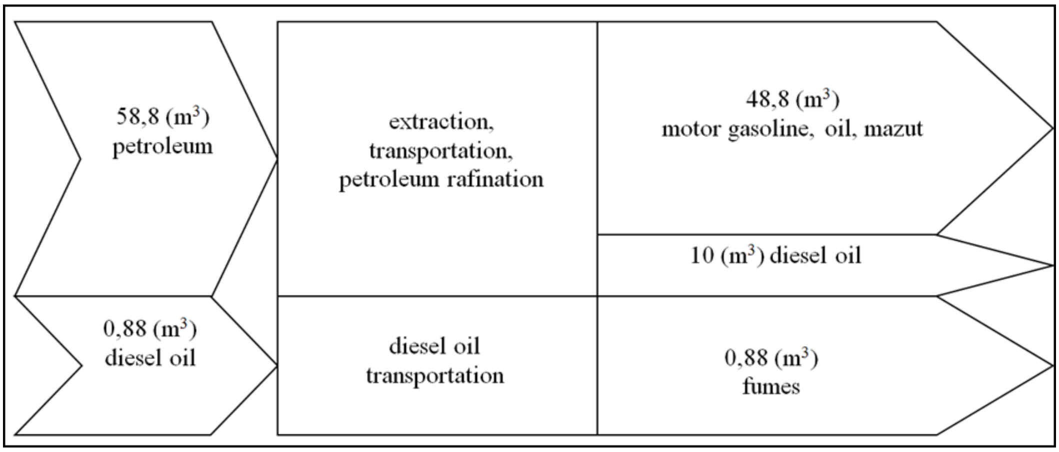


*Fig. 5. The balance of raw material sourcing 10,000 litres of diesel oil*

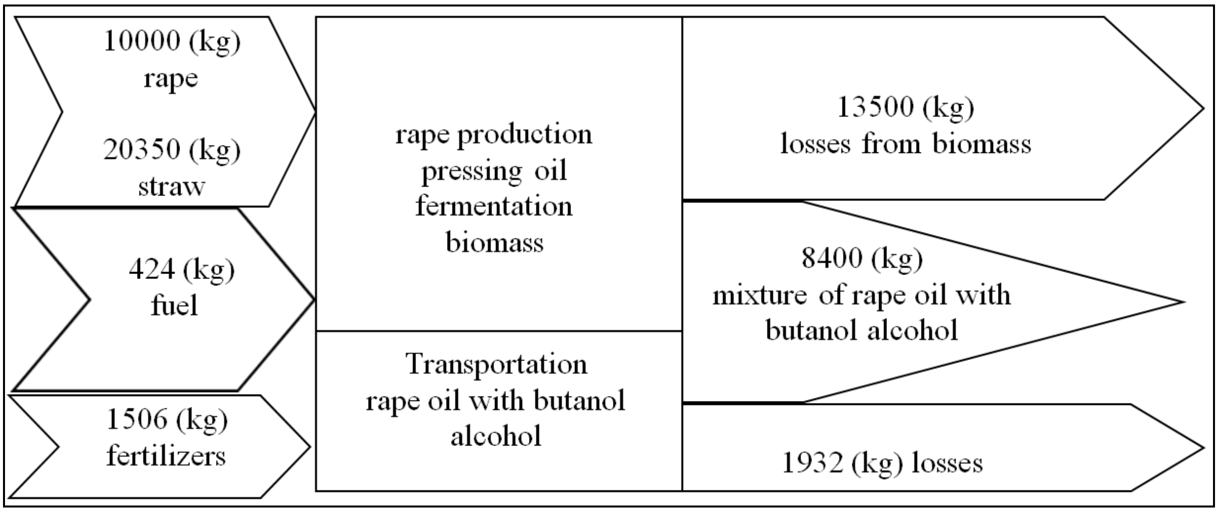


*Fig. 6. The balance of the materials necessary to production 10000 litres of a mixture of rape oil and butanol alcohol (2:3 ratio)*

*Tab. 3. Air emissions during the life cycle of oil*

| Process | Emission (g/10000 litres diesel oil) | | |
|---|---|---|---|
| | CO | $NO_x$ | $SO_x$ |
| Production Crude oil | 6.8 | 16.4 | 89 |
| Transportation of crude oil to refineries | 0.2 | 1.3 | 7 |
| Refining crude oil into diesel oil | 51500 | 2060 | 50000 |
| Transportation of diesel fuel to the recipient | 25168 | 1069 | 363 |
| Using diesel oil in transport company | 227703 | 91368 | 3282 |
| Sum | 235376 | 944921 | 83287 |

*Tab. 4. Air emissions during the life cycle of 10000 litres of a mixture of rape oil and butanol alcohol (2:3 ratio)*

| Process | Emission (g/10000 litres mixture) | | |
|---|---|---|---|
| | CO | $NO_x$ | $SO_x$ |
| Production of rape | 2664 | 2331 | 0 |
| Transportation rape to company which press them | 336 | 2940 | 0 |
| Extrusion of rapeseed oil | 6.72 | 42.24 | 162.2 |
| Fermentation of biomass and obtain butyl alcohol | 0 | 0 | 0 |
| Transport of the mixture of rapeseed oil butanol (2:3 ratio) to the fuel recipient | 33.6 | 294 | 0 |
| The use of mixtures of rapeseed oil with butanol (2:3 ratio) as a fuel in transport company | 102108 | 893445 | 0 |
| Sum | 105148.32 | 920031.24 | 162.24 |

## 3. Conclusions

The resources needed to obtain 10 k litres of diesel oil are:

- 58.8 $m^3$ of crude oil,
- 475.668 GJ of energy total (in whole life cycle).

Production and usage of diesel oil is followed by emissions of:
- 235.376 kg of CO,
- 944.921 kg of $NO_x$,
- 83.287 kg of $SO_x$.

The most important part of life cycle, in the sense of minimizing energy consumption and polluting, is the process of refining crude oil into diesel. Analysing another fuel: to obtain 10 k litres mixture of rape oil and butanol alcohol there is need following resources:
- 10 k kg of rape,
- 20.35 k kg rape straw,
- 370.616 GJ of energy total (in whole life cycle).

Production and usage of diesel oil is followed by emissions of:
- 105.148 kg of CO,
- 920.031 kg of $NO_x$,
- 0.162 kg of $SO_x$.

The data is showing significantly lower emission level in LCA of rape oil and butyl alcohol mixture then in LCA of diesel oil. It should be pointed out that most of polluting substances are emitted due to work of agricultural machinery. Using rape oil and butanol alcohol mixture instead of diesel oil can significantly lower emission of $CO_2$.

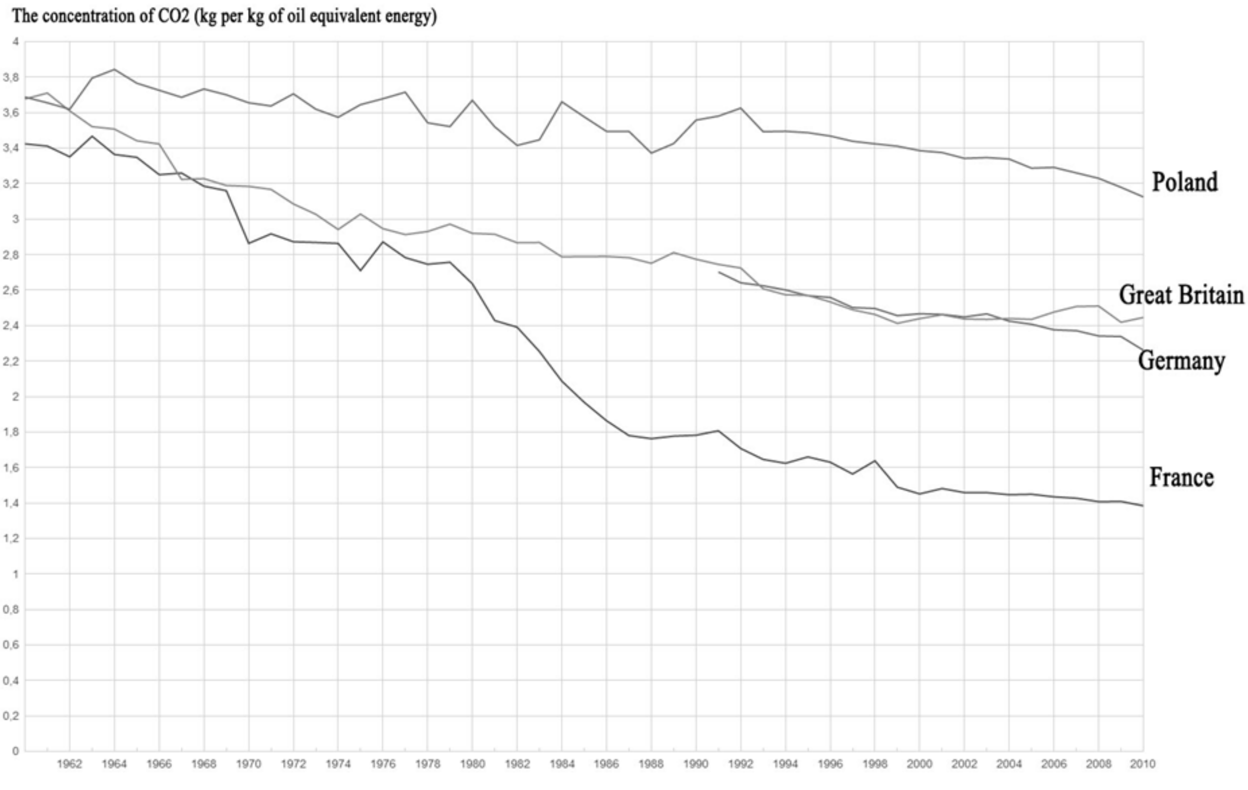


*Fig. 7. The concentration of $CO_2$ in selected European countries over last decades*

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