Life cycle assessment

SDAB
SVENSK DÄCKÅTERVINNING AB

LCA of the utilisation of used tyres

This study is the result of a project that has been performed by IVL Swedish Environmental Research Institute Ltd (IVL Svenska Miljöinstitutet AB), on behalf of Svensk Däckåtervinning AB (SDAB) and Ragn-Sells AB.

Lisa Hallberg at IVL has managed the project lifecycle assessment.

Erik Kärrman at Ecoloop has been a member of the reference group.

Goal & scope

The goal of this project is to compare the environmental impacts for six different scenarios for the utilisation of used tyres by using life cycle assessment (LCA).

The study is based on a functional unit of 1 ton of tyres collected from the tyre dealers. The life cycle starts with the input of used car tyres i.e. the production of tyres is not included. All raw materials, fuels and electricity are followed from the cradle except for some raw materials such as chemicals, additives etc. used in small amounts. The electricity production used in all processes in all scenarios is electricity according to Swedish average.

	Scenario	Replaced material & fuel	Short name
1	Incineration of tyres in a cement kiln	- Alternative fuels: coal and pet-coke - Alternative material: iron ore	Cement kiln (incineration)
2	Material recycling producing granulates used as filling material in artificial football fields	- Alternative material: EPDM (rubber)	Recycling in football fields
3	Reuse of the tyres as drainage material in final covering of landfills	Alternative material: coarse gravel	Reuse in landfill covering
4	Incineration of tyres in a district heating plant (1)	Alternative fuels: coal and renewable fuel	District heating plant (incineration)
5	Material recycling producing granulates used in asphalt	Alternative material: coarse gravel Extra bitumen needed	Recycling in asphalt
6	Reuse of the tyres as filling material in noise banks	Alternative material: Leca	Reuse in noise banks

(1) This scenario represents incineration of tyres in both a coal and a bio boiler. The relation between bio and coal boiler is 57/43 and corresponds to the situation in Sweden in 2004. In addition to this, two sensitivity scenarios have been studied (representing incineration in a coal boiler and in a bio boiler.

In all scenarios the systems have been expanded to include the materials (and in two cases also the fuels) that are replaced when tyres are used instead. The transportation and the production of these materials (fuels) are then subtracted from the system in order to reflect the environmental benefit caused by using tyres instead. The six scenarios are listed in the table below. For each scenario the replaced materials and/or fuels are presented.

For most scenarios, the environmental benefit associated with the replaced materials (fuels) showed to be larger than the environmental impact from the rest of the processes within each system.

This means that the scenario with the largest negative total results is the best scenario from an environmental point of view.

In scenario 2, 3 & 6, the potential water emissions caused by leaching of the tyre granulate in the different applications were included. The leaching of the alternative materials, coarse gravel (scenario 3 & 5) and Leca (scenario 6) was also considered.

Environmental parameters studied

A huge number of environmental parameters were included in the LCA calculations e.g. natural resources such as crude oil, natural gas, uranium, limestone, iron ore etc. and emissions such as carbon dioxide (CO_2), sulphur dioxide (SO_2), nitrogen oxides (NO_X), methane, hydrocarbons, heavy metals etc.

These parameters were evaluated by using the life cycle impact assessment methods Global warming, Acidification, Eutrophication and Photo chemical oxidant formation. In addition a number of water emissions caused by leaching in the different applications were analysed. These parameters were lead, nickel, chromium, cadmium, copper, zinc, iron, mercury and polyaromatic hydrocarbons (PAH). There are life cycle impact assessment methods for assessing the impacts from these emissions as well. These methods are based on human- and ecotoxicity, but since they are associated with quite large uncertainties, we have not applied them. Instead, the inventory results (mass flows) have been used for comparing these parameters.

Results

The comparison of the six scenarios is presented in the diagrams based on fossil energy use, emissions of CO_2 and emissions of NO_X.

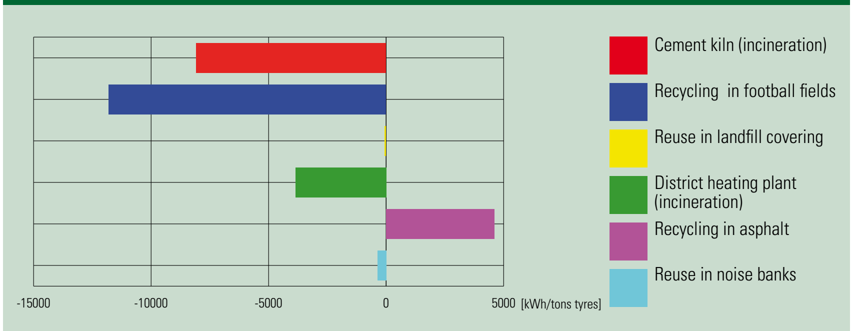
For lead, nickel, chromium and cadmium exactly the same result is obtained as for the fossil energy use. Unlike all other results, the "Material recycling in football fields" is however clearly the worst scenario when looking at copper, zinc, iron, mercury and PAH. These leaching emissions are much larger in the football field than in the landfill and the noise banks. The reason is that in the football field, the amount of water that drains through the tyre granulate layer is much larger per tons of tyre granulate than the amount of water per tons of tyre cuts in the landfill and the noise banks.

The rest of the scenarios are about equally "good" concerning these emissions.

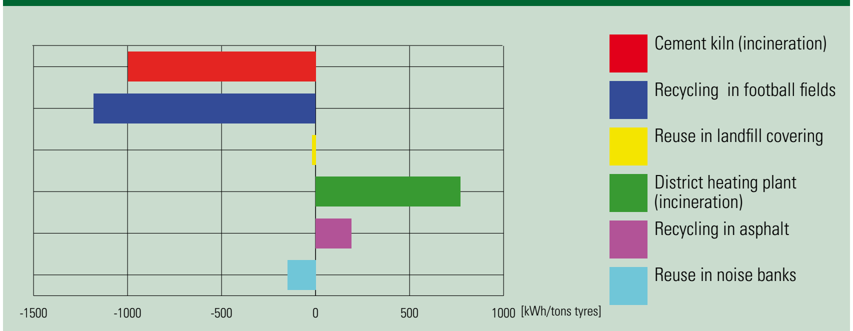
Conclusions

Most of the scenarios show negative results. This means that the utilisation of used tyres are environmentally beneficial compared to the use of "virgin" raw materials. The results also indicate that the largest benefits are associated with replac-

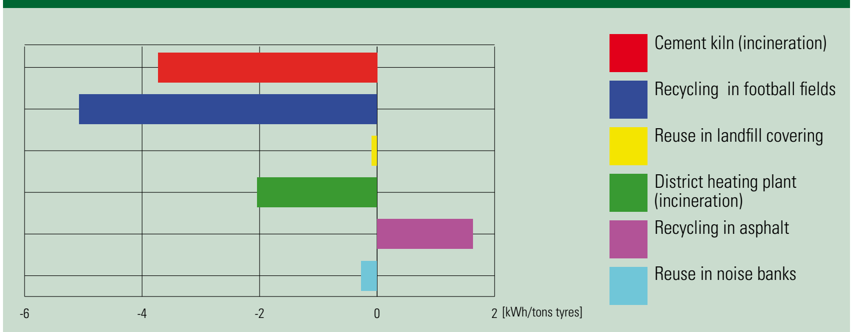
Fossil energy use



CO_2-emissions



NO_x emissions



ing EPDM with granulated used tyres (scenario 2), followed by replacing coal as a fuel in the cement kiln with used tyres (scenario 1).

It is always difficult to draw clear conclusions when the different studied result parameters do not show entirely the same results. The results however clearly show that the “Material recycling of tyre granulate in football fields (scenario 2)” is the best scenario, the ”Incineration of tyres in a cement kiln (scenario 1)” is the second best scenario and that the “Material recycling in asphalt (scenario 5)” is definitely the worst scenario.

The following order of preference sorts the three remaining scenarios between the second and the last scenario. It was however not possible to arrange them concerning their internal order of preference.

1	Recycling in football fields (scenario 2)
2	Cement kiln (incineration) (scenario 1)
3	Reuse in noise banks (scenario 6) Reuse in landfill covering (scenario 3) District heating plant (incineration) (scenario 4)
4	Recycling in asphalt (scenario 5)

The emissions of lead, nickel, chromium and cadmium associated with leaching of the tyre material show to be smaller than the emissions of these compounds from the production of the material that the tyre material replaces in the applications studied. This means that the use of tyre material in football fields, in final landfill covering as well as in the noise banks reduces the occurrence of these emissions compared to when using EPDM in football fields, coarse gravel in final landfill covering and Leca in noise banks. This is an unexpected and interesting result.

What is the benefit with recycling tyres?

If all six scenarios are applied in equal shares, the environmental benefit based on the total amount of discarded tyres per year (68 000 tons) will be 22 000 tons of CO_2-equivalents per year.

This is equal to the CO_2-contribution from the yearly driving of 8 000 cars (e.g. Volvo V70) in Sweden. This estimation is based on a petrol fuel consumption of 9,2 litres per 100 km and that a Swedish car owner drives about 12 000 km per year.

When looking at the use of fossil energy, the corresponding figure representing the environmental benefit is 200 million kWh per year.

This amount of energy corresponds to the heating of about 6 000 private houses using oil heating. This estimation is based on the assumption that one house consumes 3.5 m^3 of oil per year.

For a tyre dealer who delivers about 20 tons of tyres for recycling per year, the environmental benefits presented above will correspond to take 3/4 turn around the world by car and to the heating of 2 private houses per year.

The Swedish Tyre Recycling Association

In 1994, the Swedish tyre industry set up Svensk Däckåtervinning AB, SDAB (the Swedish Tyre Recycling Association). The first task of this new company was to participate in the process that led to the Ordinance (1994:1236) on Producers Responsibility for Tyres. This responsibility means that whichever company places goods on the market must also accept liability for how they are dealt with at the end of their service lives.

SDAB represents the tyre industry vis-à-vis the authorities and is responsible for organising the collection and recovery of all used tyres. The company is run as a non-profit organisation and is owned by DF (the Swedish Association of Tyre Suppliers) and DRF (The Swedish National Association of Tyre Specialists) which includes the retreading section, RS.

Consumers accept their environmental responsibility by paying a special recycling charge when they purchase new tyres.

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