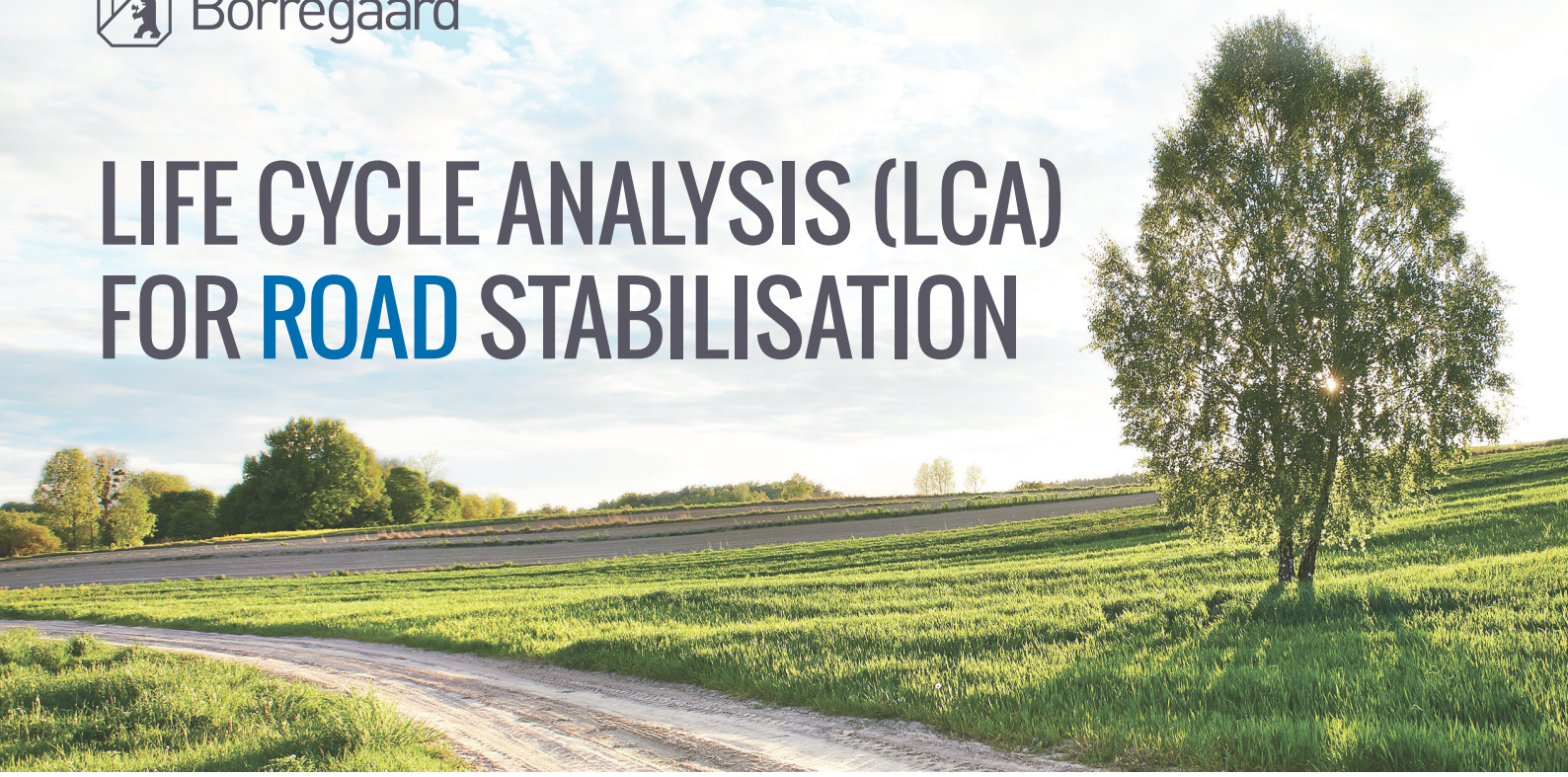
Borregaard

LIFE CYCLE ANALYSIS (LCA) FOR ROAD STABILISATION



A Life Cycle Analysis (LCA) was conducted on cement, bitumen and Dustex® (lignin) when used for road stabilisation. When comparing the seven impact categories, Dustex surfaced as the overall most sustainable choice.

SUMMARY

The study was performed in 2019 by NORSUS, Norway's leading independent research institute for LCA and other environmental impact analyses. The LCA includes seven impact categories and Dustex has a lower impact in five of these impact categories[1].

Overall, Dustex is the most sustainable choice of the three products - with clearly lower CO_2 emissions and consumption of fossil fuels.

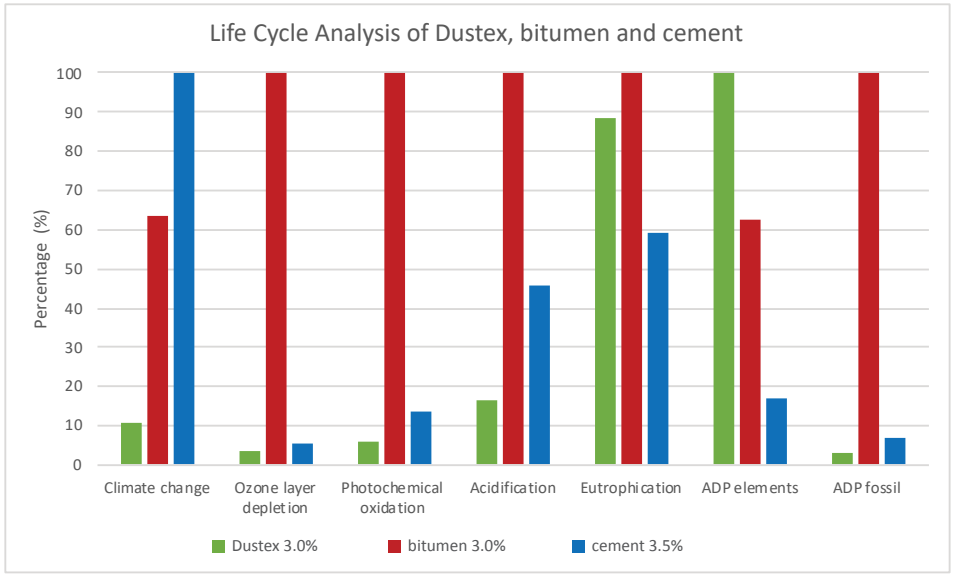


Chart1: These data are presented on the graph to show the relative environmental performance for all three products in the seven categories tested. The results have been adjusted to account for the dosage rate used for stabilisation for each product (% binder as is by weight og road material).

ABOUT DUSTEX

> Based on Lignin – a natural biopolymer produced by trees

> Lignin is the earth's 2nd most abundant biopolymer

> 1.5 kg CO_2 is removed from the atmosphere to produce 1 kg of lignin

> 100% certified as BioPreferred by the USDA

> Sustainable, Renewable, Non-Corrosive, Non-Toxic

> REACH exempt

DUSTEX®
The bio-based road binder

ABOUT THE TESTING

The seven environmental impact categories evaluated are listed in Table 1, along with the assessment method, unit and a description of the potential value lost for each category. The results from the LCA, which also constitute the basis for Chart 1, are listed in Table 2.

Table 1: Environmental impact categories included in the analysis.

Environmental impact category	Impact assessment method	Unit	Value lost	Comment
Climate change	IPPC 2013 GWP 100a, V1.03	kg CO_2-eqv.	Increased average global temperature could lead to severe impacts on human health, material resources and ecosystems.	Assuming steady state in biogenic systems (not considering uptake of CO_2 in biological systems, nor counting biogenic CO_2 when burning biological matter).
Ozone layer depletion	CML-IA baseline v3.04 (April 2013, v4.2).	kg CFC-11-eqv.	The ozone layer in the stratosphere protects humans, animals and plants from possibly damaging UV rays from the sun.	
Photochemical ozone creation	CML-IA baseline v3.04 (April 2013, v4.2).	kg C_2H_4-eqv (ethene/ ethylene-eqv.)	The creation of ozone near ground level can lead to respiratory diseases and inhibited growth for plants and other members of the ecosystem.	
Acidification	CML-IA baseline v3.04April 2013, v4.2).	kg SO_2-eqv.	Acid depositions lower pH in soil and water bodies and affect plants and animals, as well as buildings and other infrastructure.	'Sulfur oxides' has been included manually by Ostfold Research.
Eutrophication	CML-IA baseline v3.04 (April 2013, v4.2).	kg PO_4^{-3}-eqv.	Eutrophication occurs when too many nutrients are released into the environment. This leads to some species growing fast, depleting oxygen in lakes and rivers, for example, and causing loss of biodiversity.	'Monoethanolamine' (to air/water/soil, factor 0,132 for all) were added manually by Ostfold Research. This factor was calculated in the report OR 15.09 ('LCA of Electricity, including CCS - A study of a Gas Power Plant Case with Post-Combustion CO_2 Capture at Tjeldbegodden') for Statoil.
Use of resources: ADP elements	CML-IA baseline v3.04 (April 2013, v4.2).	kg Sb-eqv.	Non-renewable resources consumed (minerals).	
Use of resources: ADP fossil fuels	CML-IA baseline v3.04 (April 2013, v4.2).	MJ LHV	Non-renewable resources consumed (fossil fuels).	Extended with additional fossil fuel substances and values to make the list of fossil fuels complete.

Table 2: Potential environmental impacts from production of the chemicals included in the competitor analysis: Dustex, bitumen and cement.
The potential environmental impacts are calculated based on the dosage of the chemical.

Impact category	Climate change	Ozone layer depletion	Photochemical oxidation	Acidification	Eutrophication	Use of resources: ADP elements	Use of resources: ADP fossil
Unit	kg CO_2 eq	kg CFC-11 eq	kg C_2H_4 eq	kg SO_2 eq	kg PO_4^{3-} eq	kg Sb eq	MJ LHV
Dustex (3,0%)	3,18E-03	5,68E-10	8,65E-07	2,02E-05	2,44E-05	8,15E-09	4,03E-02
Bitumen (3,0%)	1,88E-02	1,52E-08	1,41E-05	1,22E-04	2,76E-05	4,65E-09	1,39E+00
Cement (3,5%)	2,97E-02	8,55E-10	1,95E-06	5,59E-05	1,64E-05	1,37E-09	9,91E-02

[1]The ADP elements impact category shows that Dustex has a higher impact than bitumen and cement. This is due to the infrastructure of the Norwegian distribution line of electricity, that contains copper. The ADP elements category is calculated by the amount of the element that is consumed every year and the prospected amount remaining to be extracted. For the Eutrophication impact category all three products score similarly with regards to eutrophication. Borregaard complies with strict regulations regarding emissions of organic matter, and has several planned actions for further reduction.

ADDITIONAL RESOURCES:

Environmental Product Declarations (EPD) for powder lignosulfonate and liquid lignosulfonate:

https://www.epd-norge.no/getfile.php/138643-1550843291/EPDer/Kjemikalier/NEPD-1517-517_Lignosulfonate-powder.pdf

https://www.epd-norge.no/getfile.php/139993-1550841157/EPDer/Kjemikalier/NEPD-1714-516_Liquid-lignosulfonate-Dustex.pdf

Life cycle analysis of products from the wood-based biorefinery in Sarpsborg, Norway:

https://norsus.no/publikasjon/the-2015-lca-of-products-from-the-wood-based-biorefinery-at-borregaard-sarpsborg/