

DSM Carbon Footprint Study for Industrial Coatings Applied on a Metal Substrate

DSM Powder Coating Resins

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DSM presents Carbon Footprint Study for Industrial Coatings and takes next step towards a sustainable Coating Industry.

Climate change continues, and worldwide efforts to confront climate change continue as well. It is one of the biggest challenges facing industries, governments and society.

Policy makers and industry sectors across the world are working to understand their role and required actions. Individual chemical companies are already pulling their weight in the area of energy efficiency and innovation, recognizing environmental performance – alongside health, safety and security – as essential to business success.

To identify how we can improve the performance of the coating industry and what impact the choice of coating system has, we must first understand its current carbon footprint (based on raw materials consumed and energy spent during manufacture and application, and transferred to CO₂ emissions). DSM has taken the initiative to develop a common understanding of how this can be calculated. Along with related issues and challenges, individual companies will now be able to assess themselves in a way that is comparable across the industry. In the end this will empower the whole industry to make the right choices.

For many years users have enjoyed the economic and technical benefits of powder coatings. Very early, it was intuitively understood that powder coatings are the coating system with a relatively low carbon footprint. This was, however, never supported by a comprehensive analysis taking account of all elements involved in the coating process. DSM now has undertaken this step in order to underpin the prevailing view.

We proudly present our Carbon Footprint Study for industrial coatings on metal substrates. The outcomes of the carbon footprint calculations for the various coating systems have been validated by an independent third party. Outcomes which confirm that water borne coatings and powder coatings produce the lowest carbon footprint.

By far the most effective opportunity to further reduce the carbon footprint of powder coatings lies in the reduction of layer thickness, followed by epoxy/hybrid replacement and lowering of curing temperatures. DSM is investing substantially in all three areas of innovation and will continue to do so.

In our efforts to reduce the carbon footprint of our powder coating systems, we want to take the industry one step further. Our intention is to invest in new systems for new application areas including substrates that go beyond the traditional metal substrates, such as wood and plastics. Working in close partnership with our customers, we aim to help Shaping the Powder Coating Industry as a whole, by providing sustainable solutions for the future.

Climate change is not only a challenge, but an opportunity. A paradigm shift to a low-carbon economy can potentially drive forward a new era of technological innovation. It will require a third - this time green - industrial revolution. To realize that potential the new framework must harness the power of the market to deliver our environmental objectives. We trust this study is a first step of a long successful journey towards a strong, profitable, and sustainable Coating Industry.

Introducing DSM: DSM is everywhere

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- Located on five continents
- Approx. 22,700 employees
- Annual net sales of € 8 billion
- No 1 in Dow Jones Sustainability World Index
- Winner of 2009 Outstanding Corporate Innovator Award

Royal DSM N.V. creates innovative products and services in Life Sciences and Materials Sciences that contribute to the quality of life.

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About DSM

Royal DSM N.V. creates solutions that nourish, protect and improve performance. The company creates products and services in Life Sciences and Material Sciences.

Its end markets include human and animal nutrition and health, personal care, pharmaceuticals, automotive, coatings and paint, electrical and electronics, life protection and housing.

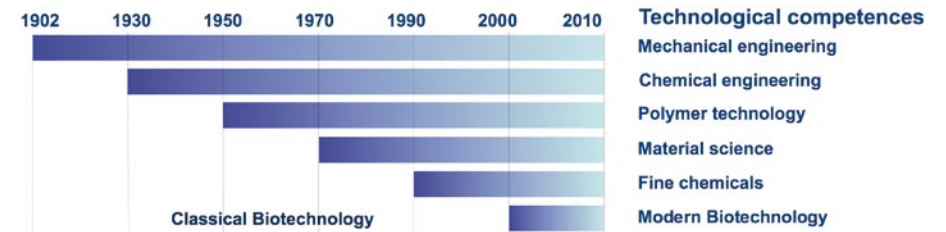
DSM manages its business with a focus on the triple bottom line of economic performance, environmental quality and social responsibility, which it pursues simultaneously and in parallel.

DSM's Ability to change: 100 years of successful transformation

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Coal Fertilizers Petrochemicals Performance Materials Life Science Products Biomaterials / Biologics



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DSM and its History

DSM has a long history of transformation. From the beginning in 1902, when the Dutch government formed the state-owned coal company, to today's DSM: a Life Sciences and Materials Sciences company.

- At a very early stage, DSM realized the need for change. In the 1930s it converted a by-product from coal mining into a profitable commodity, ammonia, a key raw material for nitrogenous fertilizers.
- By 1970, chemicals and fertilizers comprised the company's main activity, accounting for two-thirds of its turnover. Petrochemicals then took centre stage.
- In 1989 DSM was privatized and its shares were floated on the stock exchange.
- Over the past 12 years major portfolio changes have taken place, such as the divestment of the petrochemicals business and the acquisition of the vitamins business. With the divestment of the base chemicals activities in recent years and the changes within the organization, DSM is now ready for the next growth phase.
- In this next phase DSM will deliver on its promise of creating brighter lives for people, driving focused growth, and becoming a truly global company.

DSM and the Dow Jones Sustainability Index: shaping powder

DSM is the No. 1 player in the chemicals market sector of the Dow Jones Sustainability Index

DSM takes responsibility for the Environment:

- As a company
- With the products it makes

DSM Sustainability Awards



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DSM's Mission and Sustainability

Our purpose is to create brighter lives for people today, and for generations to come. This mission is supported by our core value, which is that our activities should contribute to a more sustainable world.

By 'sustainable' we mean 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'. This is the widely accepted definition that the Brundtland Commission published in 1987. Like the Commission, we believe that achieving sustainability means simultaneously pursuing economic performance, environmental quality and social responsibility, in other words, creating

value on the three dimensions of People, Planet and Profit simultaneously. This is the 'Triple P' philosophy.

Our world is facing serious challenges. shaping powder

If current consumption continues, we will need 2 globes by 2040(*)



- Growing world population
- Resource constraints: scarcity of food, land, materials

- Carbon constraints
- Over exploitation of global eco-system

* Source: WWF, Living Planet Report October 2008

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DSM and Climate & Energy

We all know that climate change is a reality, and that energy is a central challenge for society both in terms of how to create it, and how to get the most out of it. Today the industry as a whole is seeking sustainable value chains with higher yields, reduced waste, lower energy use, and fewer GHG (Green House Gas) emissions.

Climate Change and Global Warming force society to think and act differently.

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* Source: WWF, Living Planet Report October 2008

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DSM's Focus on Planet

The Planet element of our sustainability strategy is essentially about caring for the environment. Here is how we work towards greater sustainability in the Planet field:

- by performing studies to understand the eco-footprint of our products
- by developing solutions that reduce eco-footprints throughout the value chains in which we operate.
- by continuously improving our own eco-footprint, for example, by using energy and raw materials efficiently and using renewable resources where possible;

Many companies have already integrated Sustainability into their strategy. So has DSM.

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- Sustainability embedded in the company
- The eco-footprint throughout the value chain
- Leader in White Biotechnology
- Diverse workforce
- Responsible partner in society

DSM's
sustainability is
an integral part
of its strategy



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DSM Makes Sustainability part of its Strategy

DSM believes that the implications of sustainability are so profound there is simply no future for a modern business which does not embrace a Triple P based approach to doing business. DSM believes sustainability will become the key business value driver and differentiator for companies worldwide and DSM has a unique opportunity to address and capitalize on this development.

The DSM in motion: *driving focused growth strategy* is based on addressing unmet needs in relation to Global Shifts, Climate and Energy and Health and Wellness, the major global trends.

To reach this next level DSM is building on its internal value and Triple P driven approach by making sustainability a primary business driver for all its activities. This means embedding Triple P more fully into its organization and activities, tapping the creativity of its increasingly global and diverse organization and pursuing its Triple P objectives in a simultaneous and balanced way.

DSM conducts LCA* studies to maintain its high-level of commitment to Sustainability.



DSM LCA* methodology:

- SimaPro and EcolInvent database for environmental impact data
- Eco Indicator 99 for total Eco impact
- IPPC GWP 2007 for Carbon Footprint
- Own department for executing LCA
- Working with independent 3rd parties

* Life Cycle Assessment

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DSM and LCA Studies

Life Cycle Assessment may be used for various purposes. Traditional LCAs target relative scores for a range of options to be compared. The outcome of such a study, in principle, is that "A is better than B within the context of this Study". In order to ensure that such claims carry validity in a general sense, the ISO guidelines prescribe an expert review if the claim is to be made public.

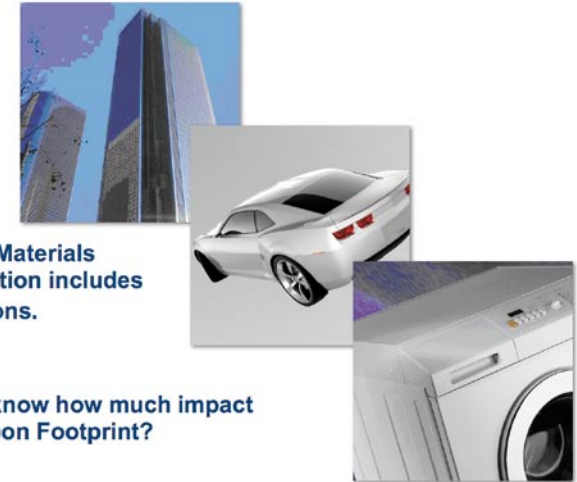
Today it is increasingly common to use so-called "footprint" information in B2B down the value chain negotiations. Footprints give an absolute score for a certain product within a standard methodology framework. One such framework is the British PAS2050, a commonly recognized

set of rules for carbon footprint of products, e.g. for use in B2C labelling.

DSM's Innovation Targets: sustainable coating solutions



Coatings are all around us.



Within DSM's Performance Materials cluster, the focus on innovation includes sustainable coatings solutions.

But how well, really, do we know how much impact any coating has on the Carbon Footprint?

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DSM aims at Innovative and Sustainable Coating Solutions

Among the many other areas in which DSM is involved, DSM is looking to develop sustainable solutions within the coating industry.

DSM has investigated the carbon footprint of the production and application of powder coating systems in comparison with typical liquid coating systems. This report presents the results of its investigations for selected powder, solvent and water borne coatings.

DSM has conducted an LCA study for Industrial Coating systems.

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This LCA determines the Carbon Footprint of the resin and coating manufacturing process and the application of the coating on metal, and defines the CO₂ emission of coating applied on 1 m² metal.



This study* includes:

- Resin production (both raw materials and energy)
- Coating production (both raw materials and energy)
- Coating application (solvent addition and energy)

*Note: The study was verified and its results validated by CE Delft, an independent and objective third party, in conformity with PAS2050 Carbon Footprinting standards.



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LCA Study for Industrial Coatings

This analysis aims to compare the carbon footprint of powder coatings with that of common liquid coatings.

The study includes impacts from cradle up to the application of the coatings onto a 1m², 1mm thick steel substrate.

All raw materials used in the production of the resin binders and final coating formulations have been taken into account.

The application phase analysis includes, where relevant, the energy required to heat the substrate, evaporate the solvents, and pre-heat

the air entering the curing oven to maintain the atmosphere below explosive limits.

Incineration of solvents is assumed with the associated release of CO₂ from the combustion of organic materials. This assessment is intended for B2B purposes and as such does not include the full life cycle of the studied products.

The coating formulations covered in this DSM study are:

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Powder Coatings (for interior and exterior use)



Water-borne industrial alkyd coatings



Solvent-borne polyester and acrylic-based high solids coatings



The coating formulations were analyzed on the basis of the amount of energy spent and impact on CO₂ emissions.

The analysis does not include the CO₂ emissions occurring upon destruction of the paint at the end of the service life of the coated object.

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LCA Analysis of 11 Industrial Coatings

The study covers the analysis of 11 coating formulations applied to 1m² of steel substrate. Coatings included:

1. Powder coatings for interior and exterior use
2. Water borne industrial alkyd coatings and
3. Solvent borne polyester and acrylic based high solids coatings

While the focus of this report is primarily on the carbon footprint of each of the examined coating systems, other environmental impacts will be presented in the study to expose the overall eco-footprint.

Assumptions:

Industrial Metal	Surface: 1 m ² , flat Thickness: 1mm
Coating	TiO ₂ based white coating
Carbon Footprint Resin Technology	Assumed to be equal for all paints
Pigment / Resin Ratio Pigment	Dependent on product formulation
Curing Temperature	180°C Powder (Uralac® EasyCure™ at 155°C) 150°C others
Layer Thickness	40µ -60µ Powder 30µ others
Overspray	0% Powder 35 % for Solvent-borne and Water-borne
Drying Temperature	As defined per paint
Solvent Treatment	Incineration
Durability / Functionality	No differentiation

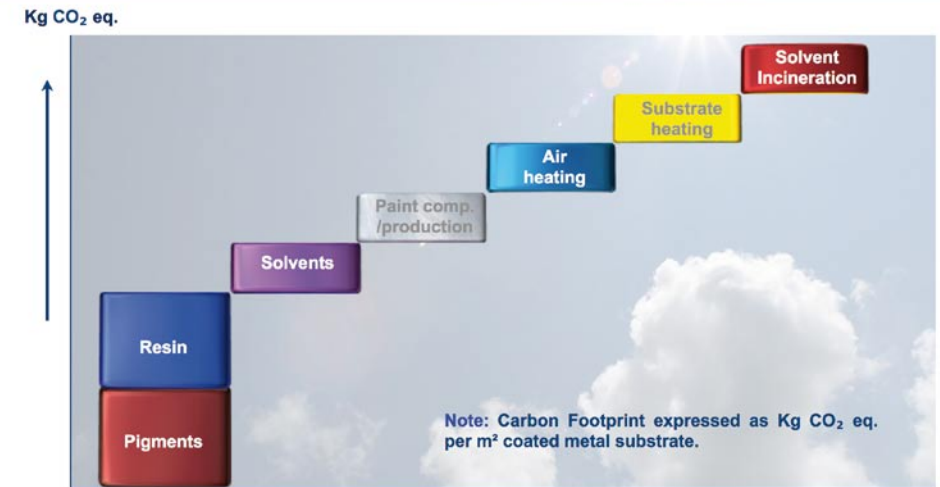
Assumptions and Methodology of the Study

Next to all of the above stated assumptions, the following methodology was applied: the carbon footprint was calculated using the IPCC 2007 GWP 100a assessment method and the results are expressed as kg CO₂ equivalents, using the associated characterization factors for the relevant greenhouse gases.

An assessment was made of each coating system using the Eco-indicator 99 method to check for unexpected environmental impacts in categories relating to human health, ecosystem quality and resource depletion.

The LCA software SimaPro 7.2.4 has been used for this study. This software contains the Eco-Invent v2.2 database which details the environmental profile of a large number of chemical processes and substances. We have used the data available from this database where possible, and defined our own where necessary.

The components of the Life Cycle Analysis of Coatings:



Components of this LCA Analysis

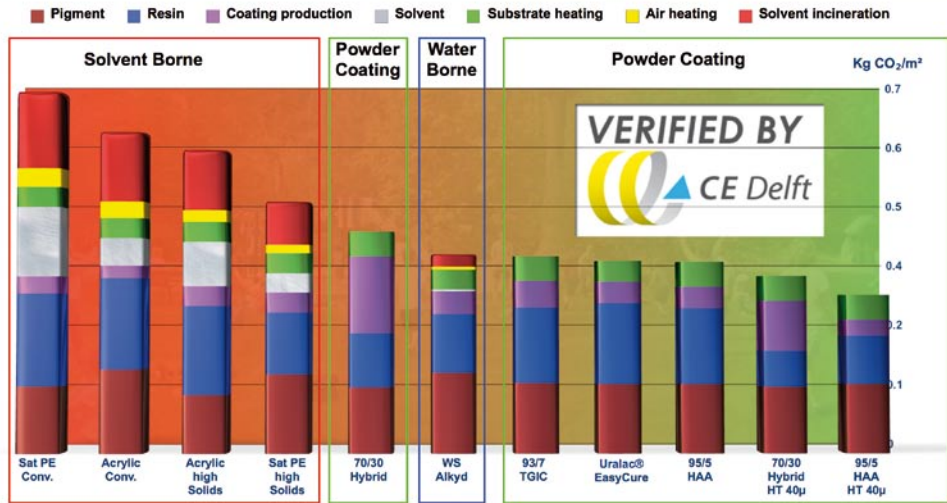
1. The substrate is 1m² of 1mm thick steel.¹
2. The impacts of the energy required to evaporate solvents and water
3. The impacts of the energy required for substrate heating
4. The impacts of the energy required to heat the process air *
5. The CO₂ emissions from solvent incineration**
6. To calculate the quantity of each coating required*** the following parameters were taken into account:
 - a) Solids content
 - b) Pigment / binder ratio
 - c) Application thickness of cured, dried coating
 - d) Transfer efficiency

¹ Specific weight of steel 7800kg/m³, specific heat capacity of steel 438J/kg.°C.

* - *** for more details please refer to a full report that is available upon request

The results of the DSM study:

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Note: Carbon Footprint expressed as Kg CO₂ eq. per m² coated metal substrate.

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The Results

For many years users have enjoyed the economic and technical benefits of powder coatings. Early on it was already intuitively understood that among all coating solutions, powder coatings have a relatively low carbon footprint.

This study confirms that water borne and powder coatings have the lowest carbon footprint when industrially applied on a metal substrate.

DSM requested CE Delft to assess the conformity of this study with PAS2050 guidelines.

CE Delft confirmed that the Carbon Footprint Study had been performed with care and with

comprehensive coverage of inputs and outputs of DSM processes. Completeness is estimated at 97% and is PAS2050 compliant.

More than one sustainable coating solution:

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There are different coating solutions for different applications. For a 1 mm thick industrially coated flat metal substrate we proved that:



Water-borne paints and Powder Coatings produce the lowest Carbon Footprint.

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Solvent based coatings typically produce the highest Carbon Footprint.

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More than One Sustainable Solution

There are massive opportunities to reduce CO₂ emissions by replacing solvent borne coatings with powder coatings and or water borne paints.

Powder Coatings can help reduce CO₂ emissions.

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THE STUDY - CO₂ emissions:

On a flat metal surface Powder Coatings produce the lowest Carbon Footprint compared to other industrial coating systems.

Powder coatings at thinner layers generate less than 0,33 kg CO₂ eq per m².

Powder coatings at thicker layers and Water-borne paints generate 0,35 - 0,41 kg CO₂ eq per m².

Solvent-borne and High Solids (@30 μ) coatings generate 0,47 - 0,67 kg CO₂ per m².

Powder Coatings reduce CO₂ emissions by 25 – 60% against conventional solvent-borne coating systems.

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Powder Coatings Can Help Reduce CO₂ Emissions

Solvent borne coatings have a higher carbon footprint than powder coatings as they typically require more paint to obtain equivalent coverage, and more energy for solvent evaporation and air heating.

Powder Coating reduces GHG emission.

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If all solvent-borne coatings on metal applications in which currently powder coatings can be applied would be replaced by powder coatings, then the Green House Gas (GHG) emissions avoided would be equivalent to:

the annual emissions of approximately 9.5 million cars

or

to approximately 2.9 million trips around the world in a car,

or

the average annual carbon footprint of 1,5 million people in Western Europe



Conversion to car kilometers

To convert savings to car kilometers a well-to-wheel emission factor of 140 g CO₂-eq/km was used as reported in a MIT study (Europe's Evolving Passenger Vehicle Fleet: Fuel Use and GHG Emissions Scenarios through 2035, Kristian Bodek & John Heywood, March 2008, Publication No. LFEE 2008-03 RP). For round the world trips a conversion factor of 40.000 km/trip was used.

Conversion to people's footprint

To convert to people's footprint the value for Dutch people for 2006 (10.500 kg CO₂-eq/capita) was used as a representative sample from the United Nations Framework Convention on Climate Change (UNFCCC) data set on the Millennium Development Goals Indicators site of the United Nations (mdgs.un.org)

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Reducing Green House Gas Emissions by Switching Coating Systems

We can protect the environment by lessening our CO₂ emissions by up to the equivalent of 9.5 million cars or average annual carbon footprint of 1.5 million people.

DSM innovates to make Powder Coatings even more sustainable.

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THE STUDY - CO₂ emissions:

The Innovation efforts of DSM in Powder Coating Resins are mainly based on:

Reducing Layer Thickness



Epoxy and Hybrid Replacement



Lowering Curing Temperatures



DSM in Powder Coating Resins works to develop resins that possess the properties that will help us reduce the Carbon Footprint of Powder Coatings even further.

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DSM's Innovation efforts in Powder Coatings

By far the most effective opportunity to reduce the carbon footprint of powder coatings is the reduction of layer thickness, followed by epoxy/hybrid replacement and lowering of curing temperatures. DSM is investing substantially in all three areas of innovation and will continue to do so.

DSM has confirmed the long-held hypothesis that Powder Coatings are among the most sustainable coating solutions.

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Next to the economic and technical benefits of Powder Coatings, the hypothesis has long been that Powder Coating Systems very likely produce the lowest Carbon Footprint.

This is the first quantitative analysis to confirm that statement.

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Powder Coatings have Great Environmental Benefits

For many years users have enjoyed the economic and technical benefits of powder coatings. Very early it was intuitively understood that powder coatings are the coating system with a relatively low carbon footprint. Until now, this was never supported by a comprehensive analysis, taking into account all elements involved in the coating process. With this study DSM has demonstrated that powder coatings are among the most sustainable coating solutions.

Together with DSM, you can help reduce the Carbon Footprint through sustainable coating solutions.

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CO₂

CO₂

By using sustainable coatings throughout the value chain, together we can all help reduce the Carbon Footprint.

By delivering the right raw materials, DSM supports development and growth of sustainable coating solutions.

DSM is the only Global, Committed and Innovative Powder Coating Resins supplier.

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In our efforts to reduce the eco footprint of our powder coating systems, we strive to take the industry one step further. Our intention is to invest in new systems for new application areas and substrates that go beyond the traditional metal substrates, such as wood and plastic. Working in close partnership with our customers, our mission is to help Shaping the Powder Coating Industry as a whole, by creating sustainable solutions for the future.

Want to know more about this study?

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If you would like to know more about this study, or how much impact the coating formulation you use has on the Carbon Footprint, contact:

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Enabling you
to make the
right choices.



You can now assess your coating formulations in a way that is comparable across the industry.

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Together We Can Reduce the Carbon Footprint!

The philosophy behind this initiative has been to take the powder coating value chain up to a higher level, and to underpin the sustainable character of this technology.

To identify ways in which we can improve the performance of the coating industry and the impact of the choice of coating system, we must first learn to understand the current carbon footprint. Along with related issues and challenges, other companies will from now on be able to assess themselves in a way that is comparable across the industry and that will help them make the right choices.

A copy of the study is available (at no charge) for all interested parties who wish to join us in Shaping the Powder Coating Industry.

For more information and a full report please go to www.dsm powdercoatingresins.com and select Sustainability page.