With the contribution of the LIFE Programme of the European Union

BioPAINT

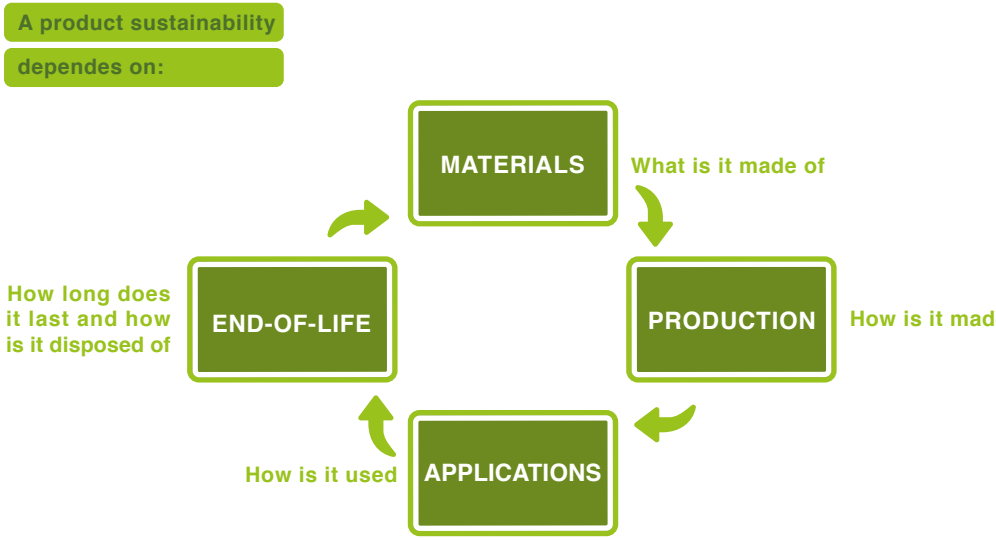
LAYMAN'S REPORT
CONTENT DRAFT

ivm Chemicals

coatings & polymers technologies

THE IDEA

Coatings, such as paints and varnishes, have clearly an esthetic function: they serve to make objects more beautiful. But coatings also have an utilitarian purpose: they **make the coated objects last longer and serve better their purpose**, one of the main aspects of the circular vision of a product sustainability (here marked as “End of Life”). Hence, overall, **coatings have a net environmental benefit**, especially wood coatings that greatly increase the useful life of objects made with the renewable resource wood.



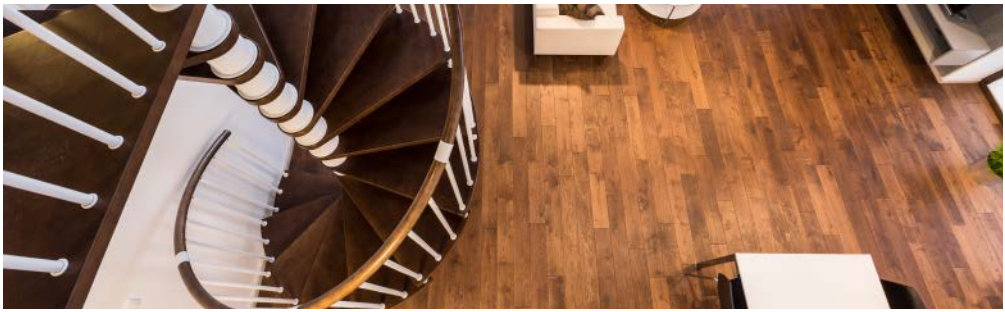
However, the sustainability of paints and varnishes can certainly still be improved: they are mostly made of non-renewable, energy intensive petrochemical materials, of which a good fraction is volatile and ends up in the air. To further improve on that, it is necessary to **use biorenewable sources in a low VOC formulation**, addressing another aspect of the holistic, circular vision of sustainability, the one here called “Materials”.

Unfortunately, biorenewable raw materials are still, currently, less reliable than their petrochemical equivalents. In order for innovative biorenewable paints and varnishes to be successful, new production processes must also be implemented to ensure a **low product** variability at least equivalent to that of the conventional coatings.

LIFE-BioPaint first aim was to do just that, designing and building a pilot production plant that would enable biorenewable coating products. As an added bonus, it was also possible to **decrease the energy draw and waste generation** of the “Production” step, with new technology applicable to any coating product.

Among coating types, UV-cured products already satisfy most of the criteria for the “Application” sustainability requirements: they can be zero VOC, require little energy for curing, not necessitating of drying heat, and leave behind very little waste if applied by roller or curtain (no overspray), all while enabling fast, efficient industrial processes. It was also possible to introduce new biorenewable UV-curable binders at this time using itaconic acid as the radical-reactive component.

IVM Chemicals produces both resins and coatings, therefore it is uniquely placed to bring forth improvements on all these fronts. GreenDelta joined the proposal, bringing their ability to guide product and process design for best environmental benefit. The good people at the LIFE program agreed with us, financing this project.



MATERIALS | **PRODUCTION** | **APPLICATIONS** | **END-OF-LIFE**

A sustainable **coating** must:

Be made from:

- biorenewable sources
- with low VOC
- of low health risks
- and low environmental impact

Be produced with:

- low energy draw
- low emissions and waste
- high efficiency
- low variability

Be applied with:

- low energy draw
- low emissions and waste
- high efficiency and low variability
- on renewable substrate

Guarantee:

- long time in use
- low health risks
- low environmental impact

THE CHEMISTRY

As part of LIFE-BioPaint, new UV-curable resins with high biorenewable content were developed that made it possible to increase the biorenewable content and sustainability of the related coatings. Those coatings of course also contain other biorenewable materials that, fortunately, are constantly becoming more available and of better quality.

NEW RESINS AND COATINGS

NO VOCs

Highest biorenewable content

Minimal content of dangerous chemicals

(such as acrylates and styrene)

WITHOUT

- **bisphenols**
- **heavy metals**
- **benzophenones**
- **formaldehyde**
- **etc.**

Many different formulations were optimized, prototyped in the new plant and validated by industrial application. One example is a 94% biorenewable UV-cured oil mimicking the look and feel of linseed or wood oil traditional solvent-borne products, but with much greater mechanical and chemical resistance. Another one is a full cycle of floor coating with an overall renewable carbon ratio of 70% and performance wholly on par with the best state of the art.

These products also satisfy the other objectives of the project avoiding VOC, minimizing dangerous chemicals such as acrylates and avoiding many others as listed in the picture, thus reducing drastically the health and safety labeling required and providing peace of mind to both applicators and consumers.

THE PLANT AND PROCESS

LIFE-BioPaint also designed and built the pilot of a new generation of coating-production production units within the resin and paint production plant of IVM Chemicals in Parona, Italy. It includes optimized dispersion vessels for high and low viscosity systems operating within an integrated frame ensuring complete automation, control of temperature and atmosphere, precise and contamination-free dosing and reliably consistent dispersion via continuous rheological control, all features needed to enable successful production of coatings with a high biorenewable content.

PRODUCTION — **Designed for Perfection**

- wholly automated process with complete tracking
- closed circuit from components to packing and cleaning
- general and punctual temperature control
- controlled atmosphere (no emissions to or contamination from the outside)

- dedicated lines for more than 80 components
- automated dosing optimized by dual measure
- accuracy better than 10g per dosing
- line cleaning after each dosing

- dispersion optimized via rheological feedback control
- energy use optimization

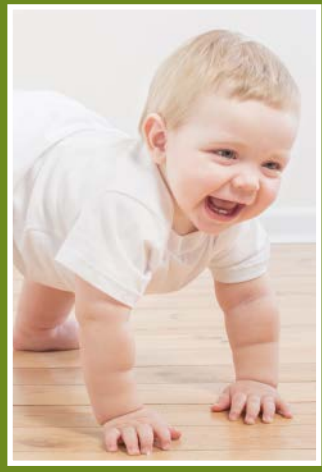
- advanced double closed circuit cleaning station
- solvent-recycling vat cleaning process

- identical batches from 100Kg to 2 tons

A number of innovative solutions are specifically meant to guarantee a lower use of energy and a lower generation of waste than in traditional processes, along with the complete avoidance of any VOC emission ensured by the closed circuit extending from raw materials to product packaging.

THE BENEFITS

The pilot plant is already designed so as to be expandable to a total production capacity of 11.000 tons of paint production per year. We have been able to measure its performance at startup, and can estimate with sufficient confidence what its environmental footprint will be at full production scale relative to the same volume of coatings made in a traditional production line.

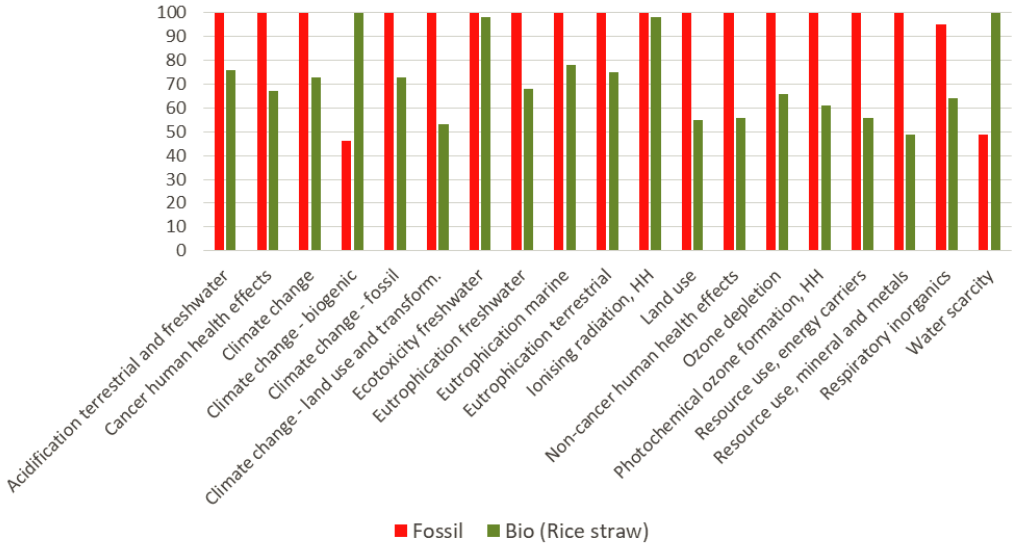


At that stage, plant and process innovation will ensure that:

- waste generation will become ¼ of what it would be under baseline scenario, dropping by 330 tons/year
- cleaning solvent (acetone) use will be at least halved by 110 tons/year;
- 2,2 tons/year of VOC will no longer be emitted;
- energy use will decrease to ¼ of baseline values, decreasing by a significant 548 MWh/yr
- in consequence, CO2 emission to produce that energy will also drop to ¼, for 170 tons of CO2/year: that is **equivalent to 1,1 million fewer km** driven by the average car*.

* 2019 WLTP data =148,1 g CO2/km, from the European Environment Agency dashboard for CO2 emissions from new passenger cars.

It is instead much more difficult to fully estimate the environmental impact of the product innovation, given the much more complex interaction of factors interested by the full supply chain from the initial oil or vegetal sources to the paint mixing vessel. However, GreenDelta carried out a very detailed LCA calculation that yielded some good indications.



BIO and fossil varnish impact comparison (relative results)

It could be proved that formulations with a large biobased content would be better than their conventional counterparts under almost all points of view, as shown by the ratio between the red and green bars in the attached graph. This kind of analysis also tells us where potential issues might be, making it possible to address them.

Notably, overall climate change impact is in both cases almost identical to the fossil component since the biogenic contribution, deriving from land use, agriculture and transformation of the biobased feedstocks is only a small fraction of the impact of the petrochemical industry. Moreover, it can be also estimated that, with the expected replacement of acrylate resins with safer biobased UV-curable binders developed within LIFE-BioPaint, 3300 tons/year of acrylics and acrylates will no longer be produced and used, and the carbon footprint of their production, transport and use will similarly be cut.

THE WAY FORWARD

LIFE-BioPaint is only a beginning. The partners will build on the technology developed and piloted and on the know-how acquired to

- increase deployment of sustainable UV-cured coating products in all the markets, wood but not only wood, served by IVM Chemicals
- exploit and enlarge the innovative process and plant to reduce environmental impact of all UV-cured products at IVM Chemicals
- continuously improve on product and process sustainability thanks to the guidance provided by the LCA, EIA and Socio-Economic Assessment methods and calculations developed by Green Delta

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