Revision of EU European Ecolabel and Development of EU Green Public Procurement Criteria for Indoor and Outdoor Paints and Varnishes

Preliminary Background Report

February 2012

Jiannis S. Kougoulis, Renata Kaps, Oliver Wolf

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Acknowledgements

The authors would like to thank all the stakeholders who contributed to drafting this document.

Glossary

Units Conventional SI units and prefixes used throughout: {k, kilo, 1000} {M, mega, 1,000,000} {G, giga, 10^9} {kg, kilogramme, unit mass} {t, metric tonne, 1,000 kg}

Contents

List of Tables

List of Figures

1 Introduction

1.1 Background

The EU Ecolabel and Green Public Procurement (GPP) initiatives are policy instruments designed to encourage the production and use of more environmentally friendly products and services through the certification and specification of products or services which have a reduced environmental footprint. They form part of the European Commission's action plan on Sustainable Consumption and Production and Sustainable Industrial Policy adopted on 16th July 2008.

The EU Ecolabel is a voluntary scheme regulated by the European Commission[1] which is used to distinguish environmentally beneficial products and services. The EU Ecolabel is awarded through an application process which demonstrates that the specified Ecolabel criteria for a particular product group are met. Successful applicants are then allowed to use the EU Ecolabel logo and advertise their product as having been awarded the EU Ecolabel.

GPP is a voluntary instrument which European public authorities can utilise in the procurement of goods, services and works: "…a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured"[2].

By using the extensive purchasing power of public authorities, GPP can make important contributions to sustainable consumption and production by motivating manufacturers to adopt more sustainable environmentally friendly practices.

The approach under GPP is to propose two types of criteria for each sector covered:

- **The core criteria**, which are those suitable for use by any contracting authority across the Member States and address the key environmental impacts. They are designed to be used with minimum additional verification effort or cost increases.
- **The comprehensive criteria,** which are for those who wish to purchase the best environmental products available on the market. These may require additional verification effort or a slight increase in cost compared to other products with the same functionality.

1.2 Purpose of this document

This document forms part of the first stages of redrafting the criteria for EU Ecolabel and developing them for GPP. The information contained in this document provides an overview of changes to the paints and varnishes market since the last revision in 2007, and a technical analysis to understand where the greatest environmental impacts arise in the lifecycle of paints. The purpose of this is to equip stakeholders involved in the revision process with a proposal for updated criteria, with evidence to support these changes. This report will form the basis of discussions of an Ad-hoc Working Group (AHWG) meeting to be held in February 2011.

This document focuses on the Ecolabel criteria. The GPP criteria will be developed by using modified EU Ecolabel on revision criteria.

The aim of this document is to provide an overview of the most significant environmental impacts of paints and varnishes over their lifecycle and to discuss and propose appropriate criteria as the basis for

[1] Regulation (EC) No 66/2010

[2] COM (2008) 400

the award of the EU Ecolabel or a GPP public specification in line with Ecolabel Regulation 66/2010 and Communication COM (2008) 400 “Public Procurement for a Better Environment” respectively.

The Regulation EC 1980/2000 concerning the Community Ecolabel award scheme was replaced by the Regulation EC 66/2010 to increase its effectiveness and streamline its operation. The revised EU Ecolabel regulation was adopted on 25th November2009 and entered into force on 19th February 2010. A number of key changes were incorporated:

1. That criteria would be determined on a scientific basis (Article 6.3)
2. The most significant environmental impacts over the product lifecycle should be addressed (article 6.3.a)
3. Substitution of hazardous with safer substances when this is technically feasible (Article 6.3.b)
    a. Any substances classified according to CLP as hazardous to the environment, toxic, carcinogenic, mutagenic or toxic for reproduction (CMR) and referred to in Article 57 of Regulation 1907/2006 (REACH) should be investigated to be restricted (Article 6.6)
    b. Derogations may be given in respect of the above, if substitution or use of alternative materials is not technically feasible. However no derogations are possible in respect of substances of very high concern (SVHC) identified in accordance with the procedure set out in Article 59. (Article 6.7).

In developing practical means to implement the regulation, DG ENV, together with the EU Ecolabelling Board (EUEB), has identified the hazard classifications for substances and preparations which should be used in order to determine which substances are subject to restrictions in all Ecolabel product groups following the implications of article 6.6 of Ecolabel Regulation 66/2010. These are presented in the report and form the basis for the discussion and proposal set out in the criteria proposal document.

Complementary to the Ecolabel Regulation, the communication “Public procurement for a better environment”, sets out the development of GPP criteria:

1. GPP criteria shall use a life-cycle approach and other European wide schemes where possible (Energy Star, Ecodesign implementing measures, Ecolabel etc) and national schemes where these are not possible.
2. The distinction between GPP "core" and "comprehensive" criteria will reflect differences in terms of ambition and availability of green products whilst at the same time pushing markets to evolve in the same direction.
3. GPP criteria shall be formulated in a way so as to facilitate their understanding by (public) purchasers and bidders and to ease their inclusion in public tender documents.

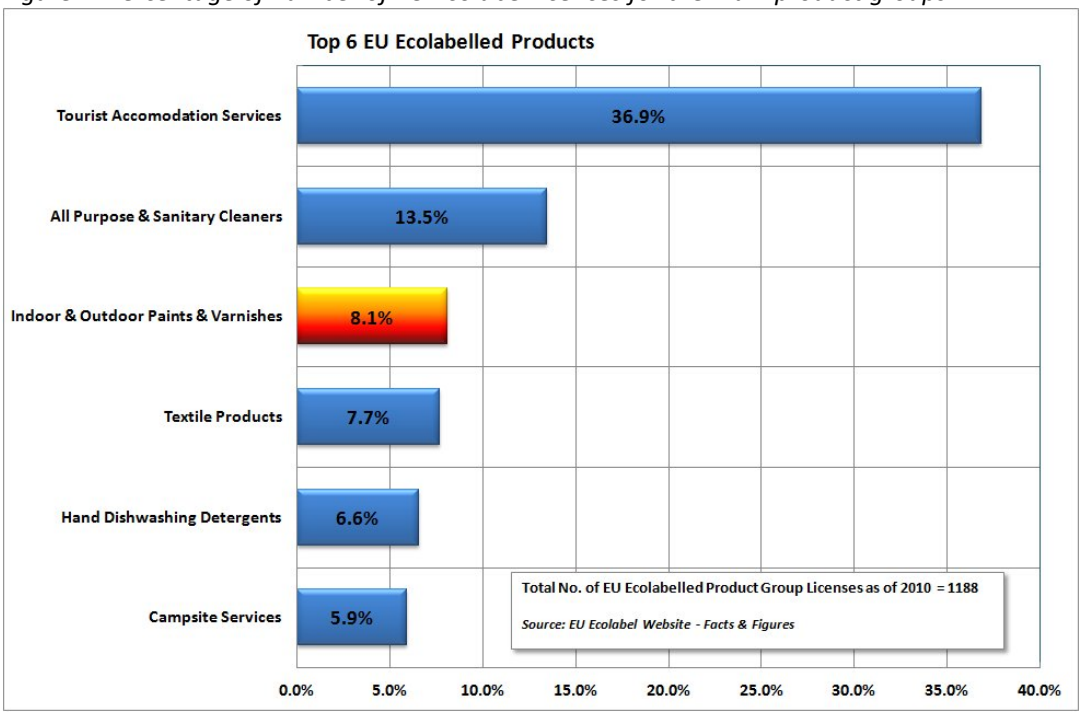
The product group of paints and varnishes is a new product group for the GPP scheme.

1.3 EU Ecolabel Indoor and Outdoor Paints & Varnishes

The EU Ecolabel criteria for ‘Outdoor Paints and Varnishes’ and ‘Indoor Paints and Varnishes’ were adopted in August 2008 [C(2008)4453] and the revision process commenced in September 2011.

As of the end of 2010, the EU Ecolabel had been awarded to 83 companies manufacturing 1157 distinct products. These figures indicate that paints and varnishes can be considered successful compared to other product groups within the Ecolabel scheme. Complementary to this the Nordic Swan scheme, one of the two best known Member States Ecolabels and uses the EU Ecolabel criteria requirements for this product group.

Figure 1: Percentage of number of EU Ecolabel licences for the main product groups



The following table estimates the number of companies who currently hold the Ecolabel across the EU. Note: this does not account for the amount of Ecolabel products within each company.

Table 1: Number of companies holding Ecolabel products, by EU country

Country	Number of companies with Ecolabel product(s)
Albania	1
Belgium	1
Denmark	3
Estonia	1
Finland	1
France	26
Germany	4
Greece	9
Italy	5
Norway	2
Portugal	3
Romania	1
Spain	10
Sweden	7
United Kingdom	2

Source: Adapted from eco-label.com

Further data on the market penetration of these Ecolabel products is not readily available for most EU countries. In the UK, however, an estimated 30% of trade sector paints have been awarded the Ecolabel, demonstrating a significant up-take figure.

The EU Ecolabel ensures a variety of standards are met by paint manufacturers, including factors such as the quantity of white pigment, release of solvents and ensuring the products contain no heavy metals, carcinogenic or toxic substances.

1.3.1 Ecolabels of member states and non-EU countries

As well as Ecolabel, which operates Europe-wide, there are a variety of national labels that can be applied to paints and coatings, including 'Nordic Swan' (Norway), 'The Blue Angel' (Germany) and 'Milieukeur' (the Netherlands). A number of labels are also used throughout the rest of the world, including 'Green Seal' (predominantly used in the US) and the 'Environmental Choice' labelling programme (New Zealand).

Germany, the largest market in terms of value of paint sales, also has a relatively large market for environmentally friendly paints ('*umweltschonender Lacke'*), supported by the 'Blue Angel'. Currently, an estimated two thirds of coatings produced in Germany fall into the category of low solvent or solvent-free. More than 1,000 individual products in the paint industry in Germany have been awarded the Blue Angel label.Within the DIY trade, there is also widespread use of water-based paints.[3]

The criteria for Nordic Swan labelled paints are identical to the Ecolabel criteria and are divided into indoor and outdoor paint categories.[4] Nine companies have products with this label. The Blue Angel label applies to 'wall paint' and is awarded to paints that demonstrate low content of certain critical materials, including VOC. This label is currently held by around 48 organisations each with varying numbers of qualifying products.[5]

In the USA, GreenSeal is a well recognised Ecolabelling standard that can certify paints. These paints meet strict volatile organic compound (VOC) limits to reduce indoor and outdoor air pollution. They do not contain 25 prohibited toxic chemicals including benzene, formaldehyde and heavy metals. They also stipulate requirements for paint cans and labels. At present 23 products are registered as certified through the GreenSeal programme.[6]

A lack of consistency between some of these labels may result in a lack of incentive for producers to acquire both a regional label and an ecolabel. The difference between various ecolabels is summarised in Appendix 3. For many small producers of coatings, it may be that the local market is more vital than the global or even European market, and so national labels may be more familiar and accepted. It does, however, seem that there is a high interest in Ecolabel in the paints market, judging by the high uptake across the EU.

1.4 Revision of EU Ecolabel Criteria

The existing criteria can be regarded as being 'fit for purpose' in that there is significant interest in the market. The revision of criteria, therefore, takes as its starting point the existing criteria and seeks to update these, to take into account technological and economic changes in the European market, relevant legislative change and improved scientific knowledge. Currently, separate sets of criteria exist for indoor and outdoor products. The revised Ecolabel criteria document is proposed to cover both product groups.

3 Available at: http://www.lackindustrie.de/default2.asp?rub=676&tma=728&cmd=shd&docnr=79732&nd=&ond=tv

4 Nordic Ecolabel, Companies 2011. Available at: http://www.svanen.se/en/Svanenmarka/Kriterier/Criteria/?productGroupID=129001

5 Blue Angel, Wall paints Vendors, 2011. Available at: http://www.blauer-engel.de/en/products_brands/search_products/produkttyp.php?id=224

6 http://www.greenseal.org/FindGreenSealProductsandServices.aspx?vid=ViewProductDetail&cid=0&sid=6

1.5 Legislative context - Key changes since 2008/2009:

1.5.1 Biocides

The Biocidal Products Directive (98/8/EC) regulates the placing of biocidal products on the market. The Directive applies only to products which have active agents that impart biocidal properties to the product into which they are incorporated.

According to the directive, active substances have to be assessed at the Communitylevel. Once an active substance has been assessed, it can be included in Annex I. Each Member State must then authorise products containing the biocide before they can be placed on the market in that individual Member State. Once authorised by a Member State, the product can be placed on the market in any other Member State.

The Commission is proposing some modifications to this Directive, so that although most biocidal products will continue to be authorised by Member States, the rules on the mutual recognition of existing authorisations will be simplified to speed-up decision-making, facilitate access to the market of other EU Member States, and to avoid duplicating work.

The proposal will turn the existing directive on biocides into a regulation from 2013. The new regulation will repeal and replace the current directive on biocides. From 2013, the mandate for the regulation of biocidal products will be transferred to the European Chemicals Agency (ECHA), which should result in convergence with the requirements for REACH and removal of the distinctions.

A standardised text is now included in all proposed EU Ecolabel criteria to ensure that only authorised and assessed biocidal substances are used.

1.5.2 Classification, Labelling and Packaging of Chemical Substances and mixtures (CLP)

The use of many, often incompatible, national systems for providing information on hazardous properties and control measures of chemicals require multiple labels and Safety Data Sheets for the same product. This causes confusion for customers of these chemicals and increases the burden on companies complying with many different regulations. To address this, the EU regulation on the Classification, Labelling and Packaging of Substances and Mixtures (CLP) was developed to harmonise the process, requiring only one set of labels for all products sold throughout the EU.

The regulation entered into force on 20th January 2009 and implemented the UN Globally Harmonised System (GHS) at EU level. The new system of classification, labelling and packaging had to be implemented by 1st December 2010 for substances, and by 1st January 2015 for mixtures. However substances and mixtures will still have to be classified and labelled according to the predecessor Dangerous Substances Directive (Directive 67/548/EEC) and Directive 1999/45/EC for preparations until 1st June 2015.

Hazard statements, as well as the equivalent R-phrases, are routinely used in all ecolabel criteria development work and have been in this document.

1.5.3 Indoor air quality

Studies in the 1980's in the USA[7] showed that the contamination of indoor air by 12 of the most commonly encountered organic pollutants (VOC's) was between 2 and 5 times that found in outside air, irrespective of whether it was in a rural or industrial environment. New legislation, in particular regulations in France, Germany and the soon to be introduced regulations for CE labelling based on the Construction Product (Regulation (EU) No 305/2011), is pushing paint companies to provide IAQ testing.

[7] EPA's Office of Research and Development's "Total Exposure Assessment Methodology (TEAM) Study" (Volumes I through IV, completed in 1985

The French regulations require mandatory testing and labelling of paints for Indoor Air Quality.[8] The scheme, called ANSES, requires testing to measure the emissions of paint in a sealed room 28 days after application. They have a classification system similar to that implemented for energy efficiency of white goods (C to A+). The German system AgBB: Health-related Evaluation of Emissions of Volatile Organic Compounds (VOC and SVOC) from Building Products, sets out restrictions on the level of emissions allowed for construction products (in particular flooring but can be applied to paints). An extensive list of chemicals are regulated, with limits described as "Lowest Concentrations of Interest" (LCI).

Development and implementation of a similar criterion within the Ecolabel would probably replace the current criteria: 3 (VOC content), 4 (VHA content), 6g (Formaldehyde) and 6h (halogenated organic solvents).

1.6 Paint Innovation

Innovation for sustainability is a concept that has recently gained significant ground within the coatings industry. The paints market is reliant on innovation to add value, in particular amongst SMEs where innovation provides a unique selling point. New products and innovative processes help to drive sales in the paints market and improve margins. In terms of sustainability, the impacts of paint can be varied. Unlike many other products, coatings can contribute to sustainability in terms of their abilities to extend the lifetime of products that are coated, avoiding the need for rebuild through decoration and reducing the need for lighting through its light refracting qualities.

1.6.1 Technological innovation

A primary area of new product development has been with regard to low VOC or VOC-free and water-based products which have few emissions. However, it may be that there is a limit to the possible reductions of VOC before functionality of paint is affected. As VOC paint content has decreased, due to legislation and consumer demand, ranges of VOC free paint have been developed. This type of paint is a very niche product, and in the UK at least, appears to be produced by small companies. Eco's Organic paints for example have developed a zero VOC paint which is 100% ecological and produced wholly from natural raw materials.[9]

The use of renewable resources in paint production is not surprising. Raw materials costs are estimated to constitute around 57% of the cost of sales[10]. With more than 300 inputs going into the manufacture of paints, 70% of which are based on petroleum, it is clear that the increasing price of these materials will have an impact on the market.[11] [12] [13] Natural materials can be used in place of these petroleum based products, and are especially utilized as materials for additives in the paint mix.

The rise of nanotechnology innovation is likely. The 2008 market for nanotechnology products was estimated to be over €100billion, with an expected increase to €1,000billion by 2015 demonstrating the projected growth in this technology. By 2015, an estimated 30% of paints and coatings sales are likely to be based on nanotechnology.[14] The use of nanotechnology can enhance product performance while simultaneously enhancing environmental protection, resulting in greater sustainability.[15] There is, however, a possibility that a somewhat fragmented market could be created due to the introduction of

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[8] http://www.eco-institut.de/fileadmin/contents/International_Labelling/VOC/Arrete_etiquetage_2011.pdf

[9] Ecos Organic Paints, 2011. Available at: http://www.ecospaints.com/

[10] The Economic Times, *Paints lose shine on soaring crude prices,* 2011. Available at: http://articles.economictimes.indiatimes.com/2011-01-19/news/28423595_1_crude-prices-crude-derivatives-titanium-dioxide

[11] Business Environment, *Paint sector,* 2008. Available at: http://www.docstoc.com/docs/15229858/paint

[12] Tikkurila, *How do changes in raw material prices affect Tikkurila? Available at:* http://www.tikkurilagroup.com/investors/faqs/

[13] Special Chem, *AkzoNobel earnings down on raw materials price, 2011.* Available at: http://www.specialchem4coatings.com/resources/editorials/editorial.aspx?id=17074

[14] Paints and Coatings Industry, *CEPE gives direction,* 2008. *Available at:* http://www.pcimag.com/Articles/Feature_Article/BNP_GUID_9-5-2006_A_10000000000000223958

[15] CEPE, 2010 Annual Report

varying national legislations with regards to nanotechnology. One example of the use of nanotechnology in coatings is the production of a new paint for hospitals that kills bacteria when placed under fluorescent light, especially useful in operating rooms.[16]

The introduction of the Dulux Paint Pod in 2008 (a powered paint roller system which incorporates its own self-cleaning facility) by ICI/AzkoNobel is another example of how innovative processes add value to the paints market. A downturn in consumer spending in 2008 had a noticeable effect on sales in the cost sensitive DIY sector. The introduction and subsequent success of the Paint Pod managed to offset ICI's decline in revenue.[17]

1.7 Investigation overview

In order to revise the existing EU Ecolabel criteria and develop GPP criteria, the following aspects have been undertaken:

1. Product definition and categorization of Indoor Paints and Varnishes, and Outdoor Paints and Varnishes product group
2. Economic and market analysis
3. Technical analysis including environmental performance investigation of this product group
4. Improvement potential (located within document Part 2)

[16] Details available at: http://www.sciencedaily.com/releases/2008/09/080909204542.htm

[17] Details available at: http://www.cambridge-design.co.uk/news/dulux-paintpod-sales-success/

2 Product definition

2.1 Paint: General concepts

Before discussing in detail the classification of paints and varnishes, it is important that certain key concepts are described on the composition of paint. Within the context of the Ecolabel and this report, the definition used is taken from Directive 2004/42/CE (limiting VOC in paint):

> *[a paint] provide[s] a film with decorative, protective or other functional effect on a surface; ... 'Film' means a continuous layer resulting from the application of one or more coats to a substrate;*

The current Ecolabel encompasses a range of paints that are based on both oil and water-based systems which both have a wide variety of end uses. As a result the overall composition of the paints will vary significantly and will affect the impact of the paint on the environment and human health.
Paint is made of four distinct components:

- Resin/polymer. This provides the chemical and physical properties of the dried film including its hardness, flexibility and resistance to water. Paints are categorised to the type of resin used (to some extent, the PRODCOM classifications also use this marker when determining the types of paint). Major resins include:
  - Alkyd
  - Vinyl
  - Bitumen
  - Polyurethane
- Pigment/extender. This provides the colour and opacity of the paint and also provides some of its physical properties. Common pigments include titanium dioxide (TiO_2) which is widely used as white, iron oxide which is used as red and ochre, and carbon black which is used as black.
- Solvent/thinner: In addition to water, organic solvents such as alcohols, esters and ketones are used to enable the pigment and resin to spread onto the surface and prevent curing of the paint.
- Additives: A minor component of paint, an additive is used to enhance its functionality. Additives perform a series of roles including improving mould resistance, improving spread rates, preventing foaming, improving the shelf life and physical properties of the paint. There are hundreds of different products and materials that fall into this category.

2.2 Classification of paints and varnishes types

For this market analysis seven separate PRODCOM data categories are available for paints and varnishes and included within the scope of this study. Table 3 lists these relevant data categories and provides a summary description for each. Each of the PRODCOM categories corresponds to one Combined Nomenclature (CN) code, which allows for further analysis of trade data within these paint and varnish categories. However it should be realised that the PRODCOM and corresponding COMEXT categorisations of paints and varnishes are based on paint composition, whereas the EU Ecolabel criteria define products based on their application. Table 2 highlights the differences between the PRODCOM data and that presented within the Ecolabel paints and varnishes.

Table 2: A comparison of the categorisation criteria for PRODCOM and Ecolabel paints and varnishes

PRODCOM categories (paint type)	Ecolabel product classification (application)
• Emulsion paints • Other paints and varnishes (synthetic polymers) • Gloss paints and high performance paints • Non-vinyl emulsion paints • Other paints and varnishes (acrylic / vinyl polymers) • Paints and varnishes: solutions n.e.c. • Gloss wood paints	• Coatings for exterior walls of mineral substance • Exterior trim and cladding paints for wood and metal including undercoats • Exterior trim varnishes and wood-stains, including opaque woodstains • Exterior minimum build woodstains • Primers • Binding primers • 1 Pack performance coatings • Two-pack reactive performance coatings for specific end use such as floors • Decorative effect coatings

There are therefore several factors that make it impossible to extrapolate from PRODCOM data to EU Ecolabel specifications. In particular, an Ecolabel criterion calls for the determination of volatile organic compound (VOC) content in order to classify products. VOC content is also an important indicator for consumers when purchasing paint products. Although the paint type can be extracted from the PRODCOM data, this is not broken down further and it is likely that each paint type within the coded category has a different VOC content. These data are therefore not very useful in analysing coatings that fall within the Ecolabel criteria.

The breakdown of the production (sold volume) of EU paints and varnishes production by PRODCOM code is given in Table 4, and totalled approximately 7 million tonnes in 2010. Emulsions account for over half of EU production in volume terms, at 3.7 million tonnes (52%). It is noted that the 'Other paints and varnishes (synthetic polymers)' category represents a total of 17% of paints and varnishes production. This is clearly a significant proportion of sales, and without a further breakdown of the paint types included in this category it is not possible to determine their fit with Ecolabel criteria.

Table 3: PRODCOM paints and varnishes categories, code and description

Database	Code(s)	Description
PRODCOM	20301150	Paints and varnishes, based on acrylic or vinyl polymers dispersed or dissolved in an aqueous medium (including enamels and lacquers)
CN	32091000	Paints and varnishes, incl. enamels and lacquers, based on acrylic or vinyl polymers, dispersed or dissolved in an aqueous medium
PRODCOM	20301170	Other paints, varnishes dispersed or dissolved in an aqueous medium
CN	32099000	Paints and varnishes, incl. enamels and lacquers, based on synthetic or chemically modified natural polymers, dispersed or dissolved in an aqueous medium (excl. those based on acrylic or vinyl polymers)
PRODCOM	20301225/ 20301229	Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium, weight of the solvent >50% of the weight of the solution including enamels and lacquers/ Paints and varnishes, based on polyesters dispersed/dissolved in a non-aqueous medium including enamels and lacquers excluding weight of the solvent >50% of the weight of the solution
CN	32081090	Paints and varnishes, incl. enamels and lacquers, based on polyesters, dispersed or dissolved in a non-aqueous medium
PRODCOM	20301230	Paints and varnishes, based on acrylic or vinyl polymers dispersed/dissolved in non-aqueous medium, weight of the solvent >50% of the solution weight including enamels and lacquers
CN	32082090	Paints and varnishes, incl. enamels and lacquers, based on acrylic or vinyl polymers, dispersed or dissolved in a non-aqueous medium
PRODCOM	20301250	Other paints and varnishes based on acrylic or vinyl polymers
CN	32100010	Oil paints and varnishes, incl. enamels and lacquers
PRODCOM	20301270	Paints and varnishes: solutions n.e.c.
CN	32089099	Paints and varnishes, incl. enamels and lacquers, based on chemically modified natural

		polymers, dispersed or dissolved in a non-aqueous medium
PRODCOM	20301290	Other paints and varnishes based on synthetic polymers n.e.c.
CN	32089091	Paints and varnishes, incl. enamels and lacquers, based on synthetic polymers, dispersed or dissolved in a non-aqueous medium (excl. those based on polyesters and acrylic or vinyl polymers)

Source: Eurostat, PRODCOM/COMEXT

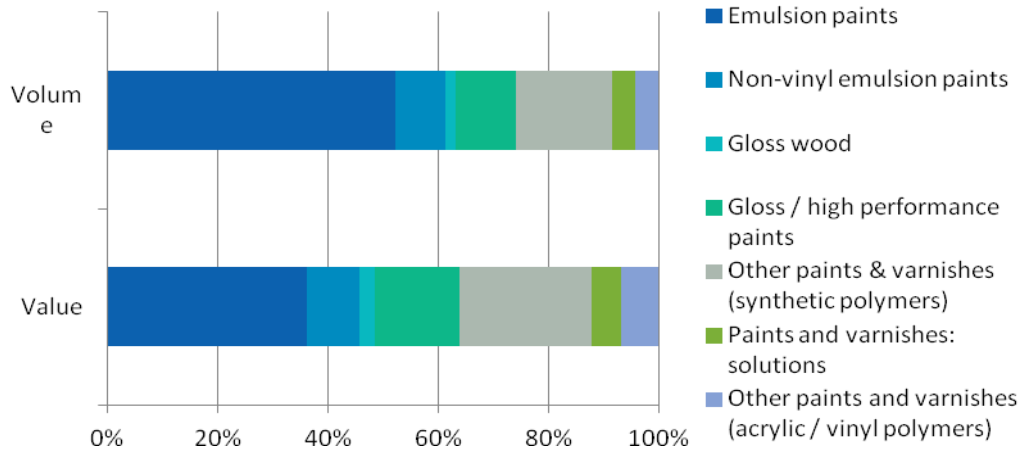
Table 4: Breakdown of EU27 paints and varnishes production (sold volume) by PRODCOM code (2010)

PRODCOM code	Description	Production (tonnes)	%
20101150	Emulsion paints	3,677,474	52%
20301290	Other paints and varnishes (synthetic polymers)	1,213,345	17%
20301225/ 20301229	Gloss paints and high performance paints	887,267	13%
20301170	Non-vinyl emulsion paints	619,243	9%
20301250	Other paints and varnishes (acrylic / vinyl polymers)	259,942	4%
20301270	Paints and varnishes: solutions n.e.c.	268,024	4%
20301230	Gloss wood paints	98,618	1%
EU27 TOTAL		**7,023,913**	**100%**

Source: Eurostat, PRODCOM (2010)

Figure 2 provides a graphical illustration of EU production of paints and varnishes by category for both volume and value. A number of variances in the production of paints and varnishes between volumes and values can be observed, notably for emulsion paints, which represent a much smaller proportion in terms of production value compared to production volume, indicating that this is more of a bulk product. In contrast 'Gloss / high performance paints' and 'Other paints and varnishes (synthetic polymers)' have relatively high production value compared to their production volume.

Figure 2: EU27 paints and varnishes production by type, value and volume (2010)



Source: Eurostat, PRODCOM (2010)

2.2.1 Summary

Analysis of PRODCOM data categories compared with the current EU Ecolabel criteria definition and scope indicates that the classifications are irreconcilable. The PRODCOM paint and varnish categories are not broken down in such a way that could be useful for current EU Ecolabel criteria analysis. Whilst the compositions of the products are outlined, it is necessary to break these down by application in order to provide data which are wholly applicable to the requirements of EU Ecolabel.

Therefore, throughout this analysis, cumulative data will be used to analyse the paint and varnishes market in Europe. This analysis will include all paint types outlined in Table 4 and so outputs are representative of the coatings industry as a whole. Although this will not allow for specific analysis of paint that fit within EU Ecolabel criteria, it will nevertheless allow for a comprehensive analysis of the European paints market.

3 Economic and market analysis

3.1 Introduction

In this section we identify significant changes in the market for paints and varnishes since the last revision of the EU Ecolabel criteria and investigate whether any such changes need to be reflected in the criteria, so that the 10-20% best environmentally performing products will be selected in accordance with Annex 1 of the EU Ecolabel regulation. This section also forms the basis for development of GPP criteria.

The research in this section consists of a desktop study using a variety of available literature and statistical databases. The market analysis is conducted for 2010 (the latest year for which data have been reported by at least half of the Member States) and the preceding two years. In analysing trends of production and trade (Sections 3.3 and 3.4), data are collated for the preceding five years. These data principally consist of PRODCOM for production, and COMEXT for trade data.

Data and information have also been collated on market structure, public procurement, innovation, supply of raw materials and environmental labelling.

3.2 Market Structure

3.2.1 Global market trends

Although the European paints market has seen a fall between 2005 and 2009, the global paints market has seen an increase in terms of volume of nearly 14%. This is explained by a large increase seen in the Asia-Pacific area which is predominantly led by China.

High growth markets, mainly China and Russia, are seeing higher investments from paint manufacturers. The construction industries in Brazil, Russia, India and China (BRIC countries) are expected to register robust growth and projected to register an overall CAGR of 10.7% to 2015.[18] However, it is in mature markets that medium and high quality paint is in demand. Paint consumption in these countries is linked to standard of living and lower quality paints see higher demand in areas with lower quality of life.

The paint and coatings industry in the United States, Western Europe and Japan, however, are considered mature. The paints market in these areas generally correlates with the health of the economy, in particular the housing, construction and transportation sectors. It is estimated that new construction represents approximately 20-25% of the overall demand in decorative paints.[19]

Currently, however, the construction and manufacturing sectors within the EU that provide the drivers for the paints market are not growing.[20] Drivers within the paints and coatings industry consist of a broad

[18] World construction network, *BRIC construction industry expected to register robust growth,* 2011. Available at: http://blog.worldconstructionnetwork.com/wcn_blog/2011/11/bric-constructi.html

[19] Tikkurila, *Annual Report,* 2010

[20] CEPE, *Annual Report,* 2010

range of factors: both economic drivers such as GDP and a change in Do-it-yourself (DIY) and decorating trends.

3.2.2 Major players

The paints market is dominated by several large companies. It was estimated in 2008 that the top ten coating producers accounted for one third of total global output[21], demonstrating their dominance over the markets.

These ten coatings producers are[22];

1. AkzoNobel (The Netherlands)
2. Henkel (Germany)
3. PPG (USA)
4. Sherwin-Williams (USA)
5. DuPont (USA)
6. BASF (Germany)
7. RPM (USA)
8. Valspar (USA)
9. 3M (USA)
10. Kansai Paint (Japan)

AkzoNobel, based in the Netherlands is a major supplier in the paint market, with total revenue of €14.6 billion in 2010, up from €13bn in 2009. Of this, the mature European market represented 39% and emerging Europe only 6%.[23] An increasing proportion of revenue is, however, driven by emerging markets, mainly China. AkzoNobel produces a variety of paint types. Performance coatings (including marine, car refinishes, industrial coatings, powder coating and wood finishes and adhesives) represent 45% of total revenue and decorative paint represents 35%. Of this decorative paint revenue, 52% is accrued within Europe, equating to €2.5 billion.

It is also noticeable that each of these global companies shows a degree of vertical integration within the structure of the organisation. Many of the chemicals produced within the organisations are used to produce a wide variety of paints. The European coatings market shows a similar structure to the global market; a few large companies dominate production. These are outlined in Table 5. The European paint market is well established, and even though there is a shift towards acquisitions and subsequent developments of large global companies, there are still an estimated 3,000 coatings manufacturers in the EU24.

Table 5: Top 5 largest companies in the European coatings market (2011)

Company name	Country	Sales (2011)	Global ranking
AkzoNobel	The Netherlands	$13 billion	1
Henkel	Germany	$9.7 billion	3
BASF	Germany	$3.42 billion	6
Sika	Switzerland	$2.3 billion	11
DAW	Germany	$1.4 billion	16

Source: Coatings World, 2011. Available at: http://www.coatingsworld.com/issues/2011-07/view_features/2011-top-companies-report/

[21] Coatings World, 2008. Available at: http://www.coatingsworld.com/contents/view_breaking-news/2008-04-03/china-s-paint-industry-becomes-world-s-second-larg/

[22] Coatings Worls, *Top Companies Report,* 2008. Available at: http://coatingsworld.com/contents/view_features/2008-07-14/2008-top-companies-report/

[23] AkzoNobel Report,2010. Available at: http://report.akzonobel.com/2010/ar/servicepages/downloads/files/akzonobel_report10_entire.pdf

[24] CEPE, 2007. Cited in CBI, *The paints and other coatings market in the EU,* 2007

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3.2.3 Small and medium sized enterprises

While the larger paint and varnish suppliers have a comprehensive product list, including decorative and speciality paints, small and medium-sized enterprises (SMEs) in the paints industry tend to focus on niche products and national consumer demands in the European market. In 2009, there were an estimated 1,000 SMEs in the coatings business in Europe[25]. There is a strong market for premium paint products often produced by small companies. Many of the SMEs represent the ecopaint market, specialising in products such as organic paints, wholly VOC free paints and paints from natural ingredients such as linseed oils.

The supply chain for paint materials is similarly composed of both large enterprises and SMEs. The solvents industry, for example, employs more than 10,000 people in Europe and more than 80% of companies are SMEs.[26] SMEs report that they are particularly suffering from the rising cost of raw materials, as well as the lack of access to credit due to the recession across Europe. Within Southern Europe, particularly in Italy and Spain where there are many SMEs who produce their own waterborne paints for decorative purposes, this threat is particularly severe[27]. The poorly performing construction market in these countries directly affects these micro-coatings businesses. In 2009, a number of acquisitions of paint producing SMEs took place across Europe, mainly in Germany, Europe's largest market.[28]

The larger, global coatings companies are currently seeing slower sales growth in Europe than in other parts of the world, most noticeably in Asia and Latin America. AkzoNobel, for example, now sees approximately 40% of its sales coming from these high growth markets. As such many European companies, including SMEs, have been extending their activities outside of Europe. For SMEs this means mainly extending business into Eastern Europe.

3.2.4 Market Segments

The coatings market is broken down into two top level categories: decorative coatings and performance coatings. Across the European coatings market, decorative coatings represent an estimated 58% of market volume and 50% of market value. The global market shows a similar split. It is estimated that within the global market for paints, decorative paints account for 51% of output but make up only 44% of the value. Within Europe this is reversed, with value outstripping volume in the European share of the worldwide paints market.[29]

The decorative coatings market in Europe comprises an estimated 35% of global revenues in this sector, making it the largest decorative coatings market in the world.[30] Among the larger paint producers, mainly operating on a global scale, performance coatings rather than decorative paints represent the largest sales area.

To give a further breakdown of the European decorative paints market, the Western European sector in 2007 comprised:[31]

- a professional paints market of 2.51 million tonnes

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[25] Coatings World, *SME's are fighting to hold on,* 2009. Available at: http://www.coatingsworld.com/contents/view_europe-reports/2009-02-02/smes-are-fighting-to-hold-on/

[26] European Solvents Industry Group, 2009. Available at: http://www.esig.org/uploads/ModuleXtender/Publications/104/Final%20position%20paper%20on%20paint%20directive%20(EN).pdf

[27] Coatings World, *SME's are fighting to hold on,* 2009. Available at: http://www.coatingsworld.com/contents/view_europe-reports/2009-02-02/smes-are-fighting-to-hold-on/

[28] Coatings World, SMEs are fighting to hold on, 2009. Available at: http://www.coatingsworld.com/contents/view_europe-reports/2009-02-02/smes-are-fighting-to-hold-on/

[29] IPPIC, 2009. Available at: http://www.ippic.org/site/assets/docs/GMA/GMA%20Executive%20summary%20and%20order%20form.pdf

[30] European coatings journal: The European coatings market, 2010

31 IRL: A Profile Of The Western European Paint Industry, 3rd Edition

- Home improvement/DIY (Do-it-yourself) paints market of 1.73 million tonnes
- 2.14 million tonnes in the factory-mixed paints market
- an in store-mixed-paint market of 2.10 million tonnes.

It should be noted that there is some overlap within these categories.

Within each of these categories, coatings can be further broken down by application. Decorative coatings, sometimes called architectural coatings, include paints, lacquers and varnishes that can be applied to indoor or outdoor surfaces. This includes both the DIY sector and the trade sector. In contrast, performance paints are used for more speciality purposes, such as car painting or glass, coating or packaging coatings.

The downturn in the economy across Europe has ramifications for both the decorative and performance coatings market. Decorative coatings have been affected by the dip in the housing market although growth has been experienced in Central and Eastern European Countries (CEECs). This essentially results in the decorative coatings market remaining flat over the past few years. A similar pattern can be seen within the performance coatings market.[32]

3.3 Production

EU production of paints and varnishes totalled €17 billion or 7 million tonnes in 2010. Table 6 presents an overview of the production of paints across the EU27 states, although it is important to note that data is not reported for some countries due to confidentiality issues.

In terms of production, the sold volume of production is used throughout this section of the report. The volume of total production is not reported across many products, including paint, since a production that is not sold cannot be valued.[33]

32 European coatings journal: The European coatings market, 2010

33 Use of PRODCOM data guidelines, http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/tables_excel

*Table 6: EU paints and varnishes production (sold volume), value and volume (2010)**

Country	Value (€000s)	Volume (tonnes)
Austria	238,340	80,895
Belgium	358,241	91,267
Bulgaria	42,200	48,874
Cyprus	0	0
Czech Republic	98,677	93,379
Denmark	157,315	57,650
Estonia	40,136	20,168
Finland	276,727	88,152
France	2,260,484	768,211
Germany	3,325,733	1,637,881
Greece	227,702	103,627
Hungary	79,881	67,150
Ireland	58,991	25,215
Italy	2,862,036	1,149,214
Latvia	0	0
Lithuania	4,708	5,527
Luxembourg	0	0
Malta	0	0
Netherlands	902,617	263,216
Poland	640,759	432,560
Portugal	364,989	159,757
Romania	132,487	133,431
Slovakia	27,615	27,185
Slovenia	5,589	5,969
Spain	1,443,849	745,564
Sweden	690,456	232,875
United Kingdom	1,795,951	634,230
Confidential data	966,761	155,090
EU27 TOTAL	**17,002,244**	**7,027,087**

Source: Eurostat, PRODCOM data (2010)
** Data for previous two years in appendix A*

3.3.1 Paint production by country

Table 7 breaks this down further by visually analysing the production share of each of the EU27 countries, in terms of both volume and value of produced goods:

- Germany is shown to be the largest producer of paints and varnishes in the EU, in terms of both volume and value; with total production of 1.6 million tonnes or €3.3 billion. This gives Germany a production share of over 20%.
- Italy is the second largest producer with 18% of the EU production volume and 17% of EU production value.

- France is the third largest producer with a production share at 14% EU production volume and 11% of EU production value.

Table 7: EU paints and varnishes production share by country, excluding confidential data (2010)

Country	% of Volume	% of Value
Austria	1.5%	1.2%
Belgium	2.2%	1.3%
Bulgaria	0.3%	0.7%
Cyprus	0.0%	0.0%
Czech Republic	0.6%	1.4%
Denmark	1.0%	0.8%
Estonia	0.3%	0.3%
Finland	1.7%	1.3%
France	14.1%	11.2%
Germany	20.7%	23.8%
Greece	1.4%	1.5%
Hungary	0.5%	1.0%
Ireland	0.4%	0.4%
Italy	17.8%	16.7%
Latvia	0.0%	0.0%
Lithuania	0.0%	0.1%
Luxembourg	0.0%	0.0%
Malta	0.0%	0.0%
Netherlands	5.6%	3.8%
Poland	4.0%	6.3%
Portugal	2.3%	2.3%
Romania	0.8%	1.9%
Slovakia	0.2%	0.4%
Slovenia	0.0%	0.1%
Spain	9.0%	10.8%
Sweden	4.3%	3.4%
United Kingdom	11.2%	9.2%

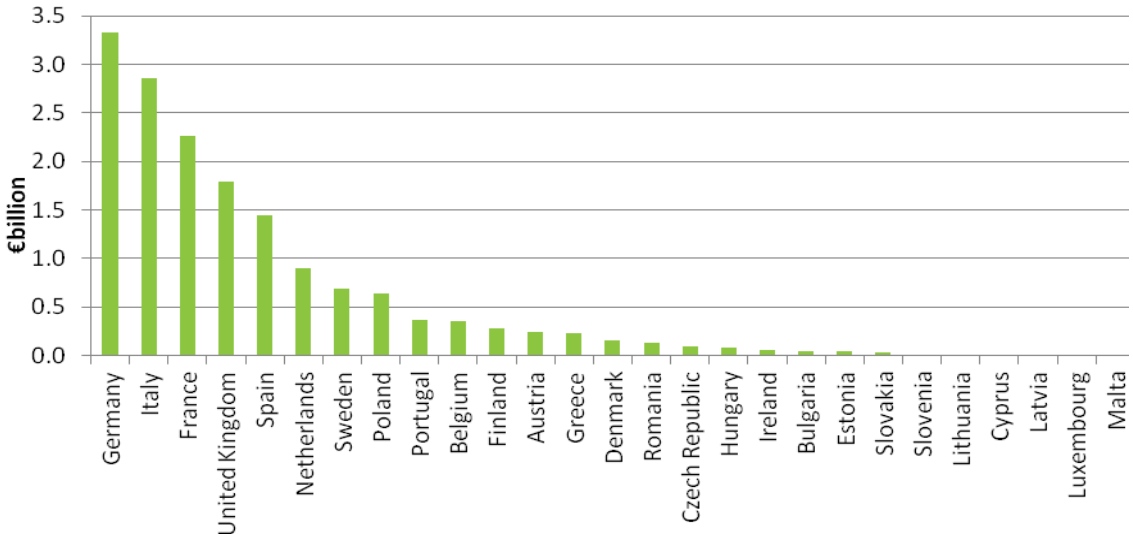
Source: Eurostat, PRODCOM data (2010)

Legend:	0%	2%	5%	10%	20%

Figure 3 graphically presents the value of EU paints and varnishes production by country for 2010. This illustrates that the top five producing countries account for 69% of the total value of production of manufactured goods. These five countries are:

- Germany (20%)
- Italy (17%)
- France, (13%)
- United Kingdom (11%)
- Spain (8%).

Figure 3: EU paints and varnishes production value by country (2010)



Source: Eurostat, PRODCOM data (2010)

It is clear from Table 7, that there are some differences between the volume and value of paint produced across the EU27 countries. Table 8 outlines the variation in unit value (i.e. the volume to value ratio) of sold production across each paint type, by country. Figure 4 presents the average unit value across all EU-27 countries. All average figures are weighted against actual production figures.

This analysis of the unit value highlights widespread differences across EU27 countries, with some states producing higher value products than others. The countries who are producing the highest value goods can be identified as Belgium (% above the EU average), followed by Finland and Sweden. It is also possible to identify those countries that are producing the lowest value products such as Lithuania (96% less than the EU average but a very low overall share to the EU-27 s. table 4), Ireland and Slovakia.

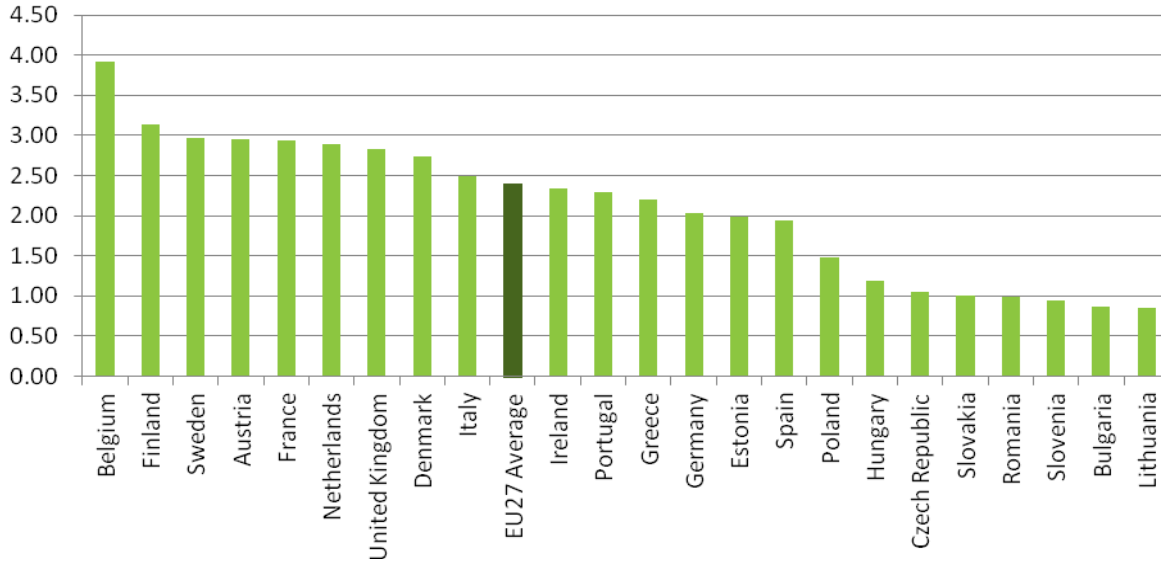
Table 8: Unit value across all paints and varnishes categories, €000s/tonne (2010)

Country	Emulsion paints	Non-vinyl emulsion paints	Gloss / high performance paints	Gloss wood paints	Other paints and varnishes (acrylic / vinyl polymers)	Paints and varnishes: solutions n.e.c.	Other paints and varnishes	Average*
Austria	2.30	2.93	4.09	:C	2.55	:C	4.62	2.95
Belgium	3.75	9.96	2.90	:C	:C	3.64	3.71	3.92
Bulgaria	0.70	0.61	1.14	:C	:C	1.69	1.86	0.86
Cyprus	-	-	-	-	-	-	-	0.00
Czech Republic	0.99	0.60	-	:C	2.06	:C	2.40	1.06
Denmark	2.20	4.29	4.79	5.07	3.30	-	4.91	2.73
Estonia	1.37	1.70	2.65	-	-	-	2.61	1.99
Finland	2.97	2.71	4.47	4.39	4.38	3.85	2.76	3.14
France	2.31	:C	4.00	:C	5.30	3.39	3.91	2.94
Germany	1.28	:C	4.12	3.26	4.03	4.31	3.82	2.03
Greece	1.70	4.22	2.91	3.50	2.97	4.07	3.09	2.20
Hungary	0.80	3.61	3.46	3.75	:C	4.99	4.83	1.19
Ireland	2.34	-	-	-	:C	:C	:C	2.34
Italy	1.83	2.47	2.49	3.71	4.37	2.57	3.05	2.49
Latvia	:C	:C	-	:C	:C	:C	:C	0.00
Lithuania	0.83	1.08	0.69	-	-	-	2.58	0.85
Luxembourg	-	-	-	-	-	-	-	0.00
Malta	-	-	-	-	-	-	-	0.00
Netherlands	1.75	5.05	4.83	4.80	:C	:C	3.83	2.89
Poland	1.02	1.71	2.83	4.89	2.40	2.95	3.00	1.48
Portugal	1.77	2.50	3.16	3.29	2.52	5.02	3.10	2.29
Romania	0.86	0.85	1.56	8.55	1.38	0.88	1.96	0.99
Slovakia	0.69	1.08	-	-	:C	:C	2.78	1.01
Slovenia	0.94	:C	-	:C	:C	:C	:C	0.94
Spain	1.36	1.26	3.45	3.72	2.08	3.04	2.36	1.94
Sweden	2.14	4.58	3.45	:C	5.35	3.00	3.33	2.97
United Kingdom	2.28	6.96	3.69	4.20	6.12	3.66	2.94	2.83
EU27 Average	**1.66**	**3.06**	**3.19**	**4.43**	**3.49**	**3.36**	**3.21**	**2.40**

Source: calculations based on Eurostat, PRODCOM (2010)

**Calculated as weighted averages, weighted by actual production*

Figure 4: Average unit value across all paints and varnishes categories, €000s/tonne (2010)



Source: calculations based on Eurostat, PRODCOM (2010)

3.4 Trade

3.4.1 Total trade

Section 3.3 showed that total EU production of paints and varnishes amounted to €16 billion and 7 million tonnes for 2010. In comparison the total value of imports across the EU27 amounted €5.3 billion (42% of total trade), with exports accounting for €7.4 million (58% of total trade) in 2010. In terms of volume, imports amount to 1.9 million tonnes (44% of total trade) and exports account for 2.5 million tonnes (56% of total trade).

Table 9 shows the Eurostat statistics on imports and exports, presenting the sum of Intra and Extra EU trade data for 2010. The following sub-sections differentiate between Extra and Intra EU trade. Extra EU trade is the trade from EU27 to third countries, whereas Intra trade refers to trade within the common European EU27 market. Net export figures are also provided to determine those countries which are both significant importers and exporters. Overall, the EU27 is a net exporter of paints with a total of 571 thousand tonnes for 2010.

In terms of total import value the three largest importers are:

- Germany with a value of €0.7 billion (13% of total import value)
- France with a value of €0.6 billion (11% of total import value)
- Belgium with a value of €0.5 billion (9% of total import value).

In terms of total export value the three largest exporters are:

- Germany with a value of €2 billion (29% of total export value)
- Belgium and Italy, both with a value of €0.8 billion (11% of total export value each).

In terms of total volume across all trade, the largest importers are Germany (12% of total volume), France (11%) and Poland (8%). Germany and France also have the two highest import values, with Poland representing the fourth highest. This indicates that Poland imports a large volume of lower value paints. Germany (27%) and Italy (11%) are the countries that account for the greatest proportion of total export volume.

Table 9 also shows that some countries represent net exporters and some net importers. Germany represents the highest net exporter with a total of 449 thousand tonnes exported in 2010. Poland represents the highest net importer with a volume of 78 thousand tonnes.

*Table 9: EU total trade in paints and varnishes, imports and exports in value and volume (2010)**

Country	Value					Volume				
	Imports (€000s)	%	Exports (€000s)	%	Net Exports (€000s)	Imports (tonnes)	%	Exports (tonnes)	%	Net Exports (tonnes)
Austria	239,744	4.5	204,146	2.7	-35,598	89,518	4.6	63,339	2.5	-26,179
Belgium	491,013	9.2	801,666	10.8	310,652	146,450	7.5	191,771	7.6	45,321
Bulgaria	40,793	0.8	9,370	0.1	-31,422	14,977	0.8	5,208	0.2	-9,769
Cyprus	17,624	0.3	1,143	0.0	-16,481	7,879	0.4	337	0.0	-7,542
Czech Republic	266,159	5.0	45,478	0.6	-220,681	83,967	4.3	24,125	1.0	-59,842
Denmark	128,656	2.4	144,283	1.9	15,628	47,339	2.4	56,625	2.2	9,286
Estonia	37,270	0.7	47,761	0.6	10,491	15,297	0.8	22,824	0.9	7,527
Finland	78,282	1.5	130,161	1.8	51,879	24,338	1.2	50,440	2.0	26,102
France	589,181	11.1	652,016	8.8	62,835	216,069	11.1	232,261	9.2	16,192
Germany	686,351	12.9	2,124,387	28.6	1,438,036	237,614	12.2	687,450	27.2	449,836
Greece	82,872	1.6	49,749	0.7	-33,123	24,723	1.3	23,771	0.9	-952
Hungary	100,541	1.9	19,860	0.3	-80,681	36,844	1.9	10,484	0.4	-26,360
Ireland	51,214	1.0	8,281	0.1	-42,933	27,782	1.4	6,746	0.3	-21,036
Italy	282,197	5.3	800,846	10.8	518,649	86,544	4.4	270,214	10.7	183,671
Latvia	24,498	0.5	10,111	0.1	-14,387	11,053	0.6	4,273	0.2	-6,780
Lithuania	57,567	1.1	29,137	0.4	-28,429	21,855	1.1	9,483	0.4	-12,372
Luxembourg	25,968	0.5	6,802	0.1	-19,166	12,611	0.6	1,697	0.1	-10,914
Malta	6,580	0.1	1,725	0.0	-4,856	2,160	0.1	433	0.0	-1,727
Netherlands	301,649	5.7	552,606	7.4	250,958	146,976	7.5	183,444	7.3	36,468
Poland	417,953	7.9	164,375	2.2	-253,578	157,213	8.1	78,594	3.1	-78,619
Portugal	124,020	2.3	118,711	1.6	-5,309	31,030	1.6	39,263	1.6	8,234

Romania	143,274	2.7	8,312	0.1	-134,962	60,255	3.1	5,719	0.2	-54,536
Slovakia	129,032	2.4	9,375	0.1	-119,657	73,687	3.8	2,470	0.1	-71,217
Slovenia	44,875	0.8	86,700	1.2	41,825	13,164	0.7	33,710	1.3	20,546
Spain	367,668	6.9	379,517	5.1	11,850	146,640	7.5	161,115	6.4	14,475
Sweden	188,791	3.6	440,063	5.9	251,272	62,371	3.2	146,860	5.8	84,489
United Kingdom	390,816	7.4	581,012	7.8	190,195	154,152	7.9	211,331	8.4	57,179
EU27 TOTAL	**5,314,588**		**7,427,593**		**2,113,005**	**1,952,506**		**2,523,986**		**571,481**

Source: Eurostat, COMEXT (2010) database
** Figures for previous two years in appendix A*

3.4.2 Extra EU Trade

The previous sub-section presented statistics for total EU trade of paints and varnishes. The following analysis provides information regarding extra EU trade, which is summarised in Table 10.

Extra EU Imports
In terms of volume, extra EU imports represent 5% of all imports within the EU27 in 2010. The largest three importers of goods by volume were:

- Germany with 22% of extra EU import volume
- United Kingdom with 12% of extra EU import volume
- Sweden with 10% of extra EU import volume.

Germany's major source countries were Switzerland (72%) and Liechtenstein (8%). The UK's major source countries were United States (39%) and Norway (28%). Sweden's major source country was Norway (95%).

In terms of value, only 7% of total EU-27 imports were represented by extra imports in 2010. The largest importers of extra EU goods by value were Germany with 30%, the United Kingdom with 13% and France with 9% of total value.

Extra EU Exports
In terms of volume, extra EU exports represent 31% of all exports within the EU27 in 2010. The largest exporters of goods by volume were:

- Germany with 22% of extra EU export volume
- Italy with 16% of extra EU export volume
- Belgium with 10% of extra EU export volume.

Germany's major destination countries were Russia (24%) and Switzerland (21%). Italy's major destination countries were Turkey (14%) and Russia (12%). Belgium's major destination countries were Russia (20%) and the United States (11%).

In terms of value, 33% of total EU27 exports were represented by extra exports in 2010. The largest exporters of extra EU goods by value were Germany with 25%, Italy with 15% and Belgium with 11% of total value.

Table 10: Extra-EU trade in paints and varnishes, imports and exports in value and volume (2010)

Country	Extra EU Imports				Extra EU Exports			
	Value (€000s)	%	Volume (tonnes)	%	Value (€000s)	%	Volume (tonnes)	%
Austria	**17,611**	4.6	**3,934**	4.0	**41,595**	1.7	**11,451**	1.5
Belgium	**9,245**	2.4	**2,252**	2.3	**275,478**	11.4	**74,981**	9.7
Bulgaria	**3,318**	0.9	**1,739**	1.8	**2,348**	0.1	**1,248**	0.2
Cyprus	**1,417**	0.4	**1,535**	1.6	**428**	0.0	**136**	0.0
Czech Republic	**11,410**	3.0	**2,162**	2.2	**4,745**	0.2	**1,640**	0.2
Denmark	**14,729**	4.0	**4,497**	4.6	**27,013**	1.1	**9,108**	1.2
Estonia	**412**	0.1	**192**	0.2	**22,237**	0.9	**10,340**	1.3
Finland	**2,349**	0.6	**662**	0.7	**58,203**	2.4	**21,908**	2.8
France	**36,361**	9.4	**7,314**	7.5	**154,713**	6.4	**49,303**	6.4
Germany	**115,970**	30.0	**21,338**	21.7	**608,255**	25.1	**172,744**	22.4
Greece	**4,083**	1.0	**1,506**	1.5	**25,191**	1.0	**12,754**	1.7
Hungary	**6,767**	1.8	**2,588**	2.6	**7,971**	0.3	**2,194**	0.3
Ireland	**1,614**	0.2	**422**	0.4	**1,343**	0.1	**1,364**	0.2
Italy	**20,519**	5.3	**4,328**	4.4	**356,677**	14.7	**121,917**	15.8
Latvia	**564**	0.2	**245**	0.3	**2,772**	0.1	**1,096**	0.1
Lithuania	**3,377**	0.89	**2,018**	2.0	**25,101**	1.0	**7,569**	1.0
Luxembourg	**160**	0.0	**61**	0.1	**1,955**	0.1	**626**	0.1
Malta	**251**	0.1	**49**	0.1	**1,229**	0.1	**388**	0.1
Netherlands	**15,091**	3.9	**2,160**	2.2	**160,451**	6.6	**36,493**	4.7
Poland	**12,478**	3.2	**3,518**	3.6	**66,235**	2.7	**33,286**	4.3
Portugal	**1,262**	0.3	**331**	0.3	**30,718**	1.3	**11,102**	1.4
Romania	**12,775**	3.3	**8,499**	8.7	**2,213**	0.1	**1,451**	0.2
Slovakia	**1,733**	0.5	**538**	0.6	**578**	0.0	**623**	0.1
Slovenia	**2,583**	0.7	**1,069**	1.1	**62,177**	2.6	**22,527**	2.92
Spain	**9,394**	2.4	**3,624**	3.7	**108,878**	4.5	**46,136**	6.0
Sweden	**29,581**	7.7	**9,657**	9.8	**163,669**	6.8	**53,177**	7.0
United Kingdom	**51,854**	13.4	**11,924**	12.2	**207,995**	8.6	**65,933**	8.6
EU27 TOTAL	**386,908**		**98,161**		**2,420,169**		**771,496**	

Source: Eurostat, COMEXT (2010) database

3.4.3 Intra EU Trade

The previous sub-sections presented statistics for total EU trade and extra EU trade of paints and varnishes. The following analysis provides information regarding intra EU trade, which is summarised in Table 11.

Intra EU Imports
In terms of volume, intra EU imports represent 95% of all imports within the EU27 in 2010.
The three largest importers of goods by volume were:

- Germany representing 12% of intra EU import volume
- France with 11% of intra EU import volume
- Poland with 8% of intra EU import volume.

Germany's major intra EU source countries were France (21%) and the Netherlands (14%). France's major source countries were Germany (30%) and Belgium (17%). Poland's major source countries were Germany (40%) and Italy (14%).

In terms of value, the majority of total EU-27 imports were represented by Intra imports in 2010 (93%).
The largest importers of Intra EU goods by value were Germany with 12%, France with 11% and Belgium with 10% of total value.

Intra EU exports
In terms of volume, intra EU exports represent 69% of all exports within the EU27 in 2010. The largest exporters of goods by volume were:

- Germany with 29% of extra EU export volume
- France with 10% of extra EU export volume
- Italy with 9% of extra EU export volume.

Germany's major destination countries were the United Kingdom (13%) and Austria (12%). France's major destination countries were Germany (28%) and Spain (15%). Italy's major destination countries were Germany (16%) and Poland (15%).

In terms of value, 67% of total EU27 exports were represented by intra exports in 2010. The largest exporters of intra EU goods by value were Germany with 30%, Belgium with 11% and France with 10% of total value.

Table 11: Intra-EU trade in paints and varnishes, imports and exports in value and volume (2010)

Country	Intra EU Imports				Intra EU Exports			
	Value (€000s)	%	Volume (tonnes)	%	Value (€000s)	%	Volume (tonnes)	%
Austria	222,133	4.5	8,558	4.6	162,551	3.2	5,189	3.0
Belgium	481,768	9.8	14,420	7.8	526,187	10.5	11,679	6.7
Bulgaria	37,475	0.8	1,324	0.7	7,023	0.1	396	0.2
Cyprus	16,207	0.3	634	0.3	715	0.0	20	0.0
Czech Republic	254,749	5.2	8,180	4.4	40,733	0.8	2,249	1.3
Denmark	113,927	2.3	4,284	2.3	117,270	2.3	4,752	2.7
Estonia	36,858	0.7	1,510	0.8	25,524	0.5	1,248	0.7
Finland	75,933	1.5	2,368	1.3	71,958	1.4	2,853	1.6
France	552,820	11.2	20,875	11.3	497,303	9.9	18,296	10.4
Germany	570,381	11.6	21,628	11.7	1,516,132	30.3	51,471	29.4
Greece	78,789	1.6	2,322	1.3	24,558	0.5	1,102	0.6
Hungary	93,775	1.9	3,426	1.8	11,889	0.2	829	0.5
Ireland	49,600	1.0	2,736	1.5	6,938	0.1	538	0.3
Italy	261,678	5.3	8,222	4.4	444,169	8.9	14,830	8.5
Latvia	23,934	0.5	1,081	0.6	7,338	0.1	318	0.2
Lithuania	54,190	1.1	1,984	1.1	4,036	0.1	191	0.1
Luxembourg	25,808	0.5	1,255	0.7	4,847	0.1	107	0.1
Malta	6,329	0.1	211	0.1	496	0.0	4	0.0
Netherlands	286,558	5.8	14,482	7.8	392,156	7.8	14,695	8.4
Poland	405,474	8.2	15,370	8.3	98,140	2.0	4,531	2.6
Portugal	122,759	2.5	3,070	1.7	87,993	1.8	2,816	1.6
Romania	130,500	2.6	5,176	2.8	6,099	0.1	427	0.2
Slovakia	127,300	2.6	7,315	3.9	8,798	0.2	185	0.1
Slovenia	42,293	0.9	1,209	0.7	24,523	0.5	1,118	0.6
Spain	358,274	7.3	14,302	7.7	270,639	5.4	11,498	6.6
Sweden	159,210	3.2	5,271	2.8	276,393	5.5	9,368	5.3
United Kingdom	338,962	6.9	14,223	7.7	373,017	7.4	14,540	8.3
EU27 TOTAL	**4,927,680**		**185,434**		**5,007,425**		**175,249**	

Source: Eurostat, COMEXT (2010) database

3.5 Market trends

3.5.1 Production

The recent trend for the production of paints and varnishes in the EU27 shows a downward trend between 2005 and 2010 (Table 12).

For the five year period, production volume declined by 12%, with production value declining by 13%. These changes in paint sold equate to Compound Annual Growth Rates (CAGR) of -2.4% and -2.8% respectively.

The three year CAGRs also identify decreases in paint production of -3% year on year for paint volume and -2.1% per year for paint value.

Table 12: Trends in EU paint and varnishes production for 2005-2010

Production	2005	2006	2007	2008	2009	2010	%Δ 05-10	5yr CAGR	3 yr CAGR
Volume* (tonnes)	7,765,308	7,412,499	8,039,430	7,309,931	6,617,746	6,871,997	-12%	-2.4%	-3.0%
Value* (€000s)	18,447,315	17,340,364	19,057,825	16,740,513	15,576,184	16,035,482	-13%	-2.8%	-2.1%

Source: own calculations based on Eurostat PRODCOM database, (2010)
**Total's include confidential data*

Table 13 further outlines the changes in the paints market between 2008 and 2010 across each of the EU-27 members.

With the exception of Slovakia (whose large percentage increase in paint production has here been discounted due to the high presence confidential data in 2008), the largest value increase is seen in Denmark, with a 42% increase.

The largest value decrease is seen in Slovenia, with a -42% decrease. The largest volume decrease is, however, seen in Bulgaria, with a decrease of -35%.

The largest countries in the EU paints market show the following changes;

- Germany shows a decrease in value between 2005-2010 (-6%) but an increase in volume (7%)
- Italy shows a decrease in both value and volume (-7% and -18% respectively)
- France shows a large increase in value (44%) and in volume (22%)
- The United Kingdom shows a decrease in both value and volume (-14% and -17% respectively)

Table 13: Value and volume changes in the paints market 2008-2010

Country	2008		2009		2010		%Δ 08-10	%Δ 08-10
	Value (€000s)	Volume (tonnes)	Value (€000s)	Volume (tonnes)	Value (€000s)	Volume (tonnes)	Value (€000s)	Volume (tonnes)
Austria	270,306	88,701	210,881	74,484	238,340	80,895	-12%	-9%
Belgium	407,368	89,846	328,958	81,532	358,241	91,267	-12%	2%
Bulgaria	68,823	75,344	54,353	56,835	42,200	48,874	-39%	-35%
Cyprus	0	-	0	-	0		-	-
Czech Republic	119,415	103,542	98,140	66,452	98,677	93,379	-17%	-10%
Denmark	162,157	40,476	265,683	68,281	157,315	57,650	-3%	42%
Estonia	23,059	15,304	16,078	11,191	40,136	20,168	74%	32%
Finland	368,564	112,080	283,489	83,819	276,727	88,152	-25%	-21%
France	1,566,417	627,861	2,008,314	724,317	2,260,484	768,211	44%	22%
Germany	3,543,557	1,527,214	3,588,368	1,407,876	3,325,733	1,637,881	-6%	7%
Greece	273,749	120,998	239,190	110,244	227,702	103,627	-17%	-14%
Hungary	111,106	98,495	93,136	72,732	79,881	67,150	-28%	-32%
Ireland	74,606	36,402	51,489	-	58,991	25,215	-21%	-31%
Italy	3,066,936	1,397,158	2,716,593	1,242,598	2,862,036	1,149,214	-7%	-18%
Latvia	0	-	0	-	0		-	-
Lithuania	5,637	6,835	5,242	5,678	4,708	5,527	-16%	-19%
Luxembourg	0	-	0	-	0		-	-
Malta	0	-	0	-	0		-	-
Netherlands	952,439	334,647	863,708	272,619	902,617	263,216	-5%	-21%
Poland	642,119	440,097	511,251	406,615	640,759	432,560	0%	-2%
Portugal	378,666	177,487	282,562	125,956	364,989	159,757	-4%	-10%
Romania	175,044	130,626	150,470	152,684	132,487	133,431	-24%	2%
Slovakia	1,728	935	25,215	23,834	27,615	27,185	N/A	N/A
Slovenia	9,679	6,707	6,125	6,565	5,589	5,969	-42%	-11%
Spain	1,679,678	845,984	1,364,005	721,398	1,443,849	745,564	-14%	-12%
Sweden	755,367	269,773	627,695	229,875	690,456	232,875	-9%	-14%
United Kingdom	2,084,095	763,420	1,785,238	672,160	1,795,951	634,230	-14%	-17%
TOTAL EU27	16,740,515	7,309,932	15,576,183	6,617,745	16,035,483	6,871,997	-4%	-6%

N/A - % change figures for Slovakia not reported due to the high presence of confidential data for 2008
Source: calculations based on Eurostat, PRODCOM data (2008-2010)

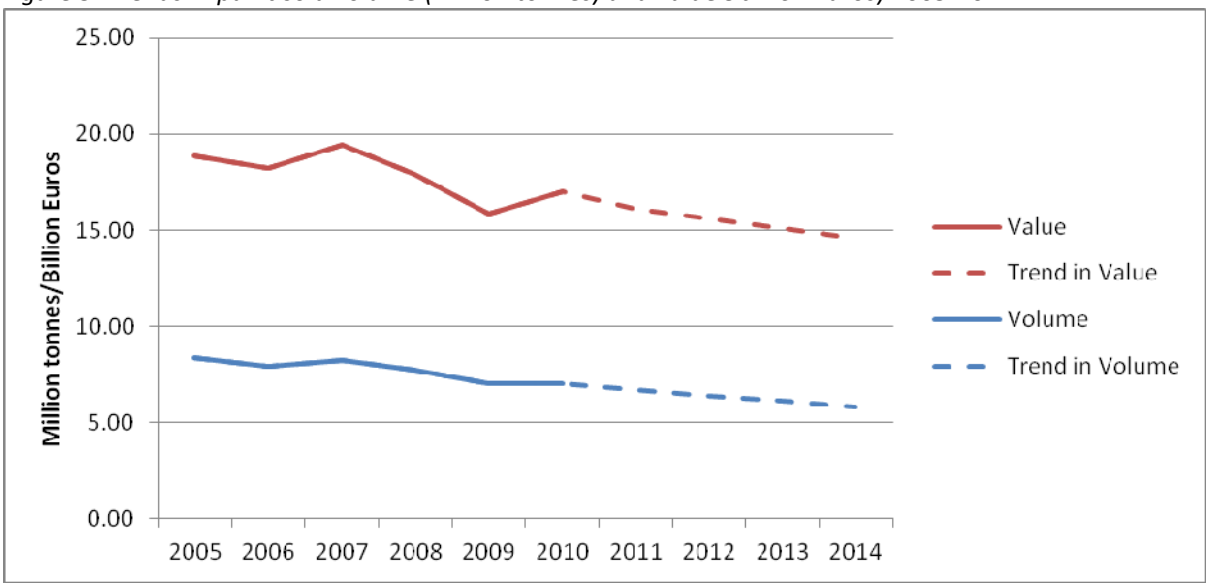
3.5.2 Trends in production

In terms of future trends, Figure 5 outlines the current trends and projections for paints and varnishes production for both volume and value to 2014. Continuing with the current trends in the paints market, both volumes sold and value produced are expected to fall, although value shows a steeper decline.

However forecasts for the European coatings market areas as a whole are somewhat positive and suggest short to mid term growth, although at a low rate. In terms of volumes, slow annual growth at a rate of less than 2% is predicted to 2014, which equates to a forecast consumption of 7.4 billion litres. Across

the same period, the value of the coatings market is forecast to grow to revenues of €23billion by 2014, a compound rate of over 3% annually.[34]

Figure 5: Trends in paint sold volume (million tonnes) and value 9billion Euros) 2005-2014



Source: calculations based on Eurostat, PRODCOM data (2008-2010) & European Coatings Journal

There is a clear difference between the two projections for trends in value to 2014. The downward projection, seen in Figure 5, is based on trends in production between 2005 and 2010, which have seen an almost continuous decrease. There are a variety of other factors which have an impact of the coatings market that are not included in this projection, including GDP, growth in the construction industry and trends in DIY. If the economy across Europe were to improve and these factors were to have a positive impact on the coatings industry, it is possible that the projection of €23billion, or at least an increase in value by 2014, would be seen.

This increase is estimated to continue, and forecasts for 2018 suggest revenues in Europe will reach €27.7billion by 2018. This value does, however, include industrial and decorative coatings. Demand for industrial varnishes is particularly expected to see growth in Eastern European countries. This market is the second largest field of coatings application behind the construction industry, and includes products such as powder coatings and acryl varnishes. In terms of value, the transport industry also plays a significant part within the market, with car and ship paints and coatings seeing above average growth. Although this sector only accounts for an estimated 8% of the paint and coatings industry, it represents nearly 15% in terms of value.[35]

3.5.3 Trends in trade

The trends in intra and extra EU trade between 2005 and 2014 are outlined in Figure 6 in terms of trade volume.

Assuming current trends in trade continue:

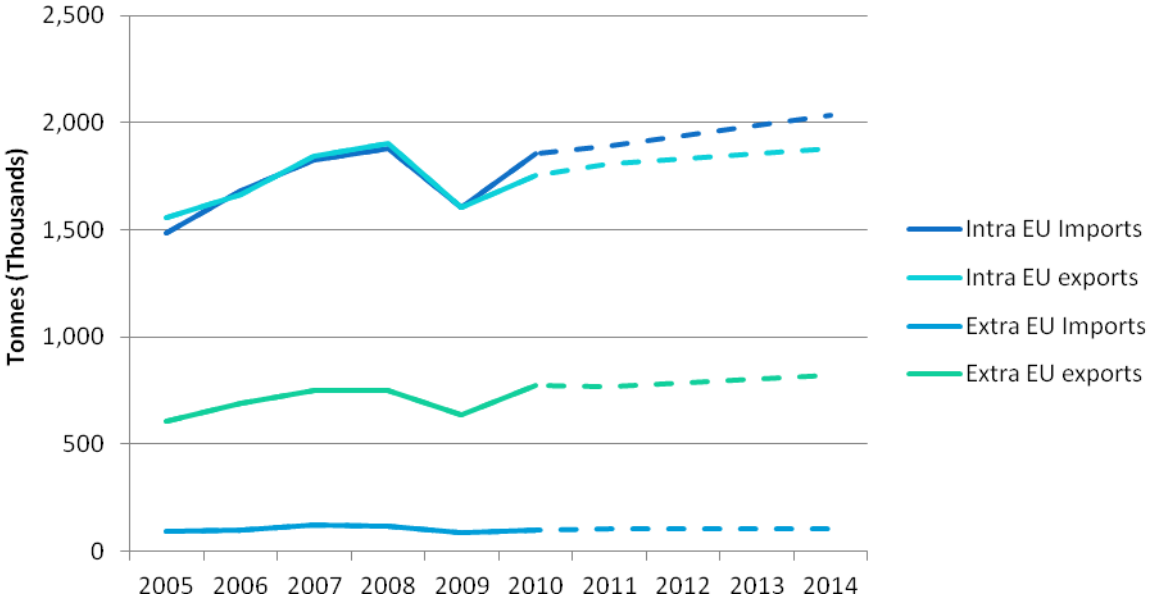
- Intra EU imports are expected to show a greater increase than other trade areas in terms of trade volume
- EU export will also see an increase in volume
- Extra EU imports show a slight decrease, although overall this is relatively steady
- Extra EU exports also show a slight increase in trade volumes

[34] European coatings journal: *The European coatings market*, 2011

[35] European Coatings Journal, *European paints market to grow*, *2011*

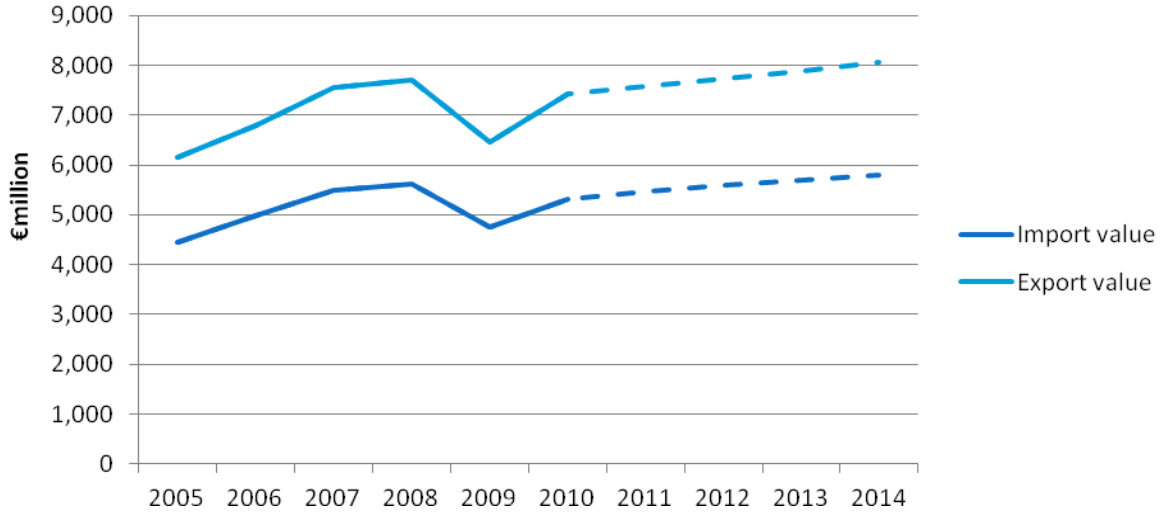
Figure 7 shows the trends in import and export value across the EU-27. Assuming current trends continue, both import and export values demonstrate a steady increase to 2014.

Figure 6: Trends in intra and extra trade (both imports and exports) 2005-2014



Source: calculated from Eurostat, COMEXT (2010) database

Figure 7: Trends in import and export value in the EU-27 across all paint types



Source: calculated from Eurostat, COMEXT (2010) database

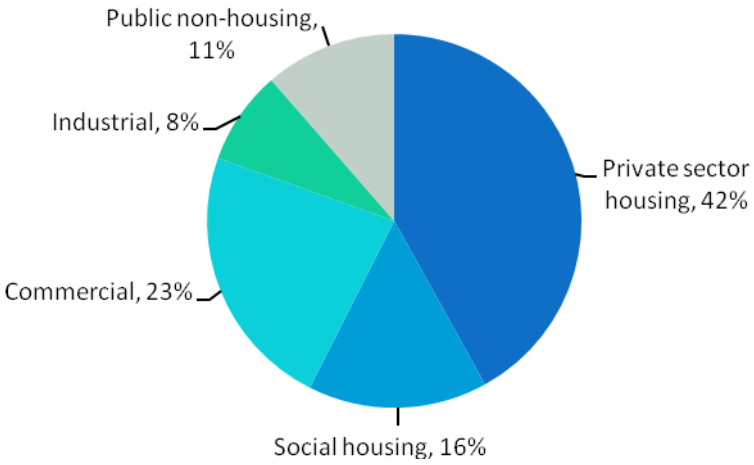
3.6 Public procurement

The trade paints market is analysed by sector in figure 4 for 2006. In terms of public procurement, 16% of the total is used for social housing and 11% for public non housing.[36] Figure 8 represents trade paint. In the UK, trade paint represents an estimated 43% share of the overall decorative paints market.[37]

[36] Palmer market research (2007), Trade paints market Report (GB)

[37] AMA Research (2009), *Paint, wall coverings and woodcare market, UK 2009-2013*

Figure 8: Trade paints market by sector 2006 (% share in sector)

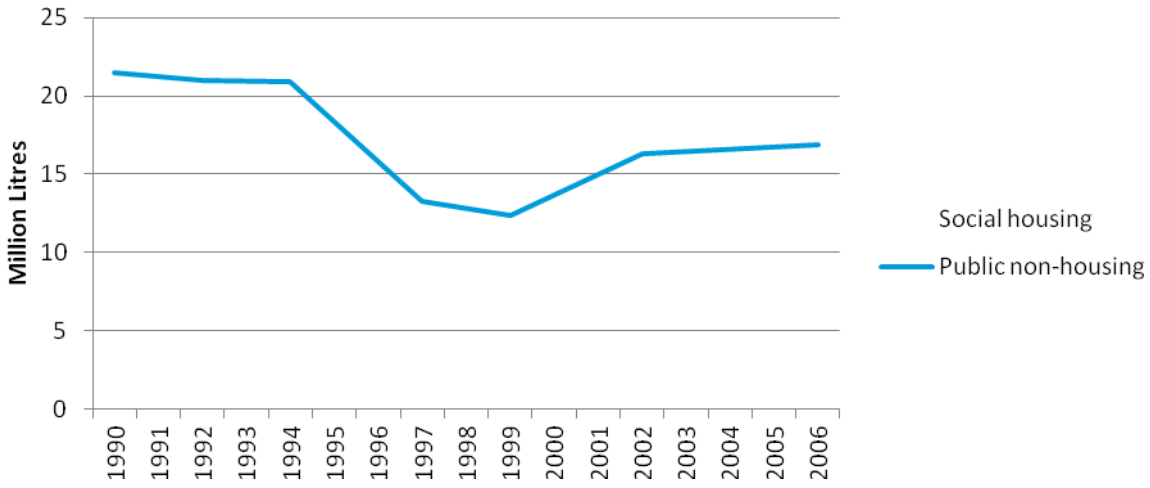


Source: Palmer market research (2007), Trade paints market Report (GB)

Within the trade paints market outlined in Figure 8 above, 86% of the litres of paint used are for existing buildings, mainly redecoration rather than on new buildings. Within each sector a high proportion of the paint used is, as expected, on this redecoration. Within the social housing sector in particular, 92% of paint used is for redecoration rather than use on new buildings.

The public sector across Europe does not usually procure paints and coatings directly from manufacturer, but uses professional contractors, painters and construction companies. In turn, these contractors purchase their paint from manufacturers or through wholesale or distributor channels. In 2006, only 14% of trade paint used in the social housing sector was applied by Local Authorities and Public Sector bodies, the remainder being applied by decorating firms and builders. Similarly, in the public non-housing sector most of the paint applied was done so by decorating firms, with Local Authorities and Public Sector bodies only accounting for 5%. This makes it difficult to trace the volume of that is used in the public sector[38]. Figure 9 displays the trends in the paint trade market sector for social housing and public non-housing in Great Britain. Data for 2007-2011 are forecasts only.

Figure 9: Trends in the trade paints market sector, public sector use in GB (2007-2011)



Data is available for 1990,1992,1994,1997,1999,2002,2006. All other data has been extrapolated from these data points.

[38] Palmer market research (2007), Trade paints market Report (GB)

Figure 9 shows that since 2000, there has been a steady increase in the volume of paint used for both social housing and in public non-housing. It should be noted, however, that the paints market is actually relatively steady and although the graph demonstrates volume changes, these are within a relatively small range. Between 1990 and 2006, public sector trade paint (in social housing and public non-housing) moved from a 26% share in the total trade paints market to a 27% share.

It is also not clear what is driving changes to paint use. A number of aspects could be having an impact on the amounts of trade paint used in the public sector, including economic, social and regulatory factors. For example, the UK Decent Homes Programme which set targets to improve all social sector homes by 2010, would have acted as a likely significant driver for increased paint use[39].

Currently, EU legislation broadly dictates the types of paint that can be used within Europe, ensuring paints containing heavy metals or high VOC contents are not used. Some EU Member States have themselves set more stringent measures, again relating to these factors. There is not, however, any contractual requirement between the public sector and professional contractor as to the type of paints used outside this criteria.[40]

Europe's Green Public Procurement (GPP) strategy may have an impact on the types of paints that are used. As demand for eco-friendly paints in the domestic paints market grows, it may be that more contractors offer customers the opportunity to choose from ranges of environmentally products.
An example of this can be found in the UK, where Low Carbon Products Ltd has developed a range of paints using between 90-95% recycled paint in each pot. Recycled paint is collected from commercial users and would otherwise have gone to landfill. The company will supply the paint to public sector organisations as well as trade customers. Additions to the paint, including anti-bacterial, anti graffiti and anti chewing gum properties, make the product especially ideal for health and public buildings[41].

Within the UK, public sector is estimated to account for 23% of total sales of decorative paints in 2008[42].
Across the EU there is, however, a lack of available data with regards to public procurement of paints and varnishes. The use of contractors for public sector painting, the number of uses of paint, and the irregularity of which redecoration/renovation of public sector buildings takes place, are all significant aspects that hinder the ability to make estimates in this sector.

3.6.1 Organisational innovation

Within Europe, many coatings companies are undergoing lots of restructuring and reorganizing of activities in order to run a more lean operation. The market has not returned to pre-recession levels and so organisations are attempting to improve infrastructure and distribution in order to reduce costs and strengthen margins.[43]

Innovative processes are also being developed within paint organisations in Europe. These processes operate both internally and externally. A change in internal processes, such as developing analysis within companies to ascertain the 'eco-efficiency' of products, is becoming more wide spread. AkzoNobel applies an 'eco-efficiency analysis' (EEA) to its paint production in order to reveal where one product, activity or process is more eco-efficient than another.[44] Similarly, Sherwin-Williams has developed the

[39] National Audit Office (2011) Decent Homes Programme. Available at: http://www.nao.org.uk/publications/0910/the_decent_homes_programme.aspx
[40] CBI, *European market information,* 2011. Available at:
http://www.cbi.eu/marketinfo/cbi/docs/sustainable_public_procurement_in_the_eu_paints_and_coatings
[41] Low carbon products Ltd, 2011. Available at: http://www.recycledpaint.co.uk/
[42] AMA Research (2009), *Paint, wall coverings and wood care market, UK 2009-2013*
[43] International Coatings Scene, *Paint firms look to emerging economies for growth opportunities,* 2010
[44] AkzoNobel Sustainablle Development, *Eco-efficiency analysis.* Available at:
http://www.akzonobel.com/sustainabledevelopment/approach/assessment/eco_efficiency/

EcoVision program which focuses all aspects of the company's business on developing ways to reduce impact on the environment.[45]

The development of take-back schemes for paints has also seen a recent increase. Crown paints, for example, are the UK's largest independent decorative paint manufacturers and have recently promoted a scheme which allows trade customers to return used Crown paint cans to store when they purchase new paint. A 'can-back' scheme has also been piloted where used paint containers are collected at Crown retailers and either reused or recycled back into the supply chain for the production of new paint containers. The process of granulating and recycling used plastic paint containers is also being introduced on a larger scale by Crown paints. The company also set a '*Zero waste to landfill by 2012*' target by recycling waste generated through manufacture.[46] A variety of other companies also run schemes by which unwanted paint can be returned to the supplier. For example, Paint +, who operate across the UK, take back unused paint free of charge to be sold or donated[47]. There are also a number of charitable organizations who collect unwanted paint and use it in community projects[48]. Further schemes operate internationally, for example CalRecycle operates a paint reuse facility in California[49].

3.7 Supply of raw materials

The paint industry is very raw material intensive[50]. In particular, it has a strong reliance on titanium dioxide ($Ti0_2$), which is a widely used white pigment in paints. Talcum, is also a widely used material in paint production. It has various functions as an extender mineral and is sold in a variety of particle sizes depending on use.

These imported materials have seen big prices rises in recent years[51], causing problems for paint suppliers - in particular for SMEs operating within an already difficult economic climate. The larger, international paint producers and suppliers have, however, also been affected by these price hikes. Price increases in 2009 were estimated to be around 10% per quarter, although since 2010 the expected price increase was exceeded by 30%. Within the paints and coatings industry, raw materials account for an average of 50% of production costs, highlighting the importance of raw material prices on profit margins.[52]

Surprisingly, however, a survey into research and development activities amongst coatings producers indicated that in fact little importance was attached to raw materials prices. Instead, market demand was cited as the main driver for R&D by 79% of respondents. This highlights the extent to which the paints and coatings market is consumer driven.[53]

[45] Sherwin-Williams, *Ecovision.* Available at: http://www.sherwin-williams.com/pro/green/ecovision/

[46] Crown Paints, ***Crown Paints Launches Carbon Revolution at Ecobuild,* 2011. A**vailable at: http://www.crowntrade.co.uk/LatestNews/LatestNewsStories/Pages/CrownPaintsLaunchesCarbonRevolutionatEcobuild.aspx

[47] Paint +, *Returned paint pur to good use.* Available at: http://www.paintplusuk.com/104/returned-paint-put-to-good-use/

[48] Community RePaint. Available at: http://www.communityrepaint.org.uk/Where_Get_Paint.php

[49] http://www.calrecycle.ca.gov/condemo/paint/

[50] The Economic Times, *Paints lose shine on soaring crude prices,* 2011. Available at: http://articles.economictimes.indiatimes.com/2011-01-19/news/28423595_1_crude-prices-crude-derivatives-titanium-dioxide

[51] Coatings World, *Price increases,* 2011. Available at: http://www.coatingsworld.com/contents/list_price-increases/

[52] Available at: http://www.lackindustrie.de/default2.asp?rub=676&tma=728&cmd=shd&docnr=79732&nd=&ond=tv

[53] European Coatings Show, 2011. Available at: http://www.european-coatings.com/fileserver/vincentzverlag/files/54500/54571/ECS_2011_Daily_01_online.pdf

4 Technical analysis

The updated regulation, EC No66/2010, which governs the production and use of the EU Ecolabel now requires that the most significant environmental impacts are considered (Article 6.3.a). Information of the environmental performance of paints and varnishes along their whole lifecycle is necessary to identify and address where the most significant impacts occur. This section details this information, identifies environmental concerns and where further investigation may be needed.

4.1 Life Cycle Assessments

Seven separate paint LCAs were identified. This section details their findings and comments on their suitability for determining the environmental hotspots of paint for the EU Ecolabel.

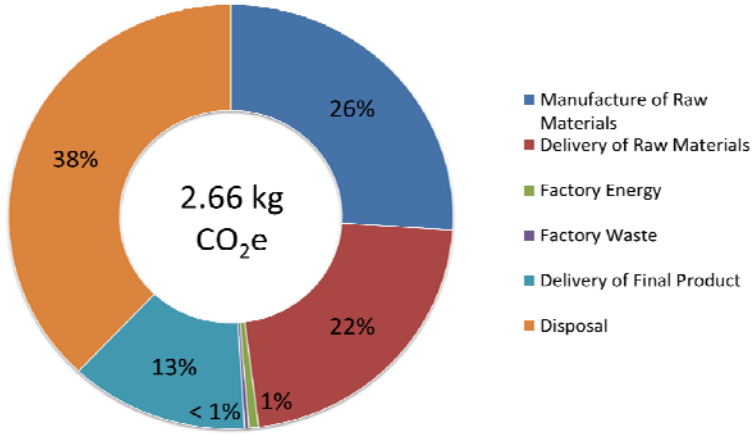
A study by the Swedish Paint & Printing Ink Makers' Association (Sveff)[54] examined three different paint formulations: a solvent-based varnish, a powder paint and a solvent-based alkyd. It examined the impact of paint production on greenhouse gas emissions, low-level ozone, acidification and eutrophication. They found that, for solvent based paints (which are of relevance to the EU Ecolabel), the main constituents (solvent, binder and pigment) equally shared the environmental impact. Any surface treatment that extended the life of a product contributed most to the environmental benefit of the paint and the impact of transportation was negligible.

In 2007, dcarbon8 performed a detailed carbon footprint for Jotun Paints for five of their products.[55] Two key findings emerged from the analysis. The first was that the carbon footprints of solvent-based paint systems were approximately three times greater than that for a corresponding water-based paint. This was due to the added environmental cost associated with the production of the solvent compared with the relatively low costs associated with water. The second important finding was that the impact of end of life was significant – for water based paints where the environmental impact was relatively low, the impact of disposal at end of life could reach 38% of the total environmental impact of the paint. However, some caution should be taken with this figure because end of life was ill-defined within the report and may include normal manufacturing processes. The following chart in Figure 10 shows the relative contribution of each life cycle stage to the carbon emission for one of the paint products that was investigated.

[54] Lifecycle assessment of paint: Summary of IVL Report B 1338-A, Sveff, 2004

[55] Jotun Paints – Product Life Cycle Assessment, dcarbon8, 2007

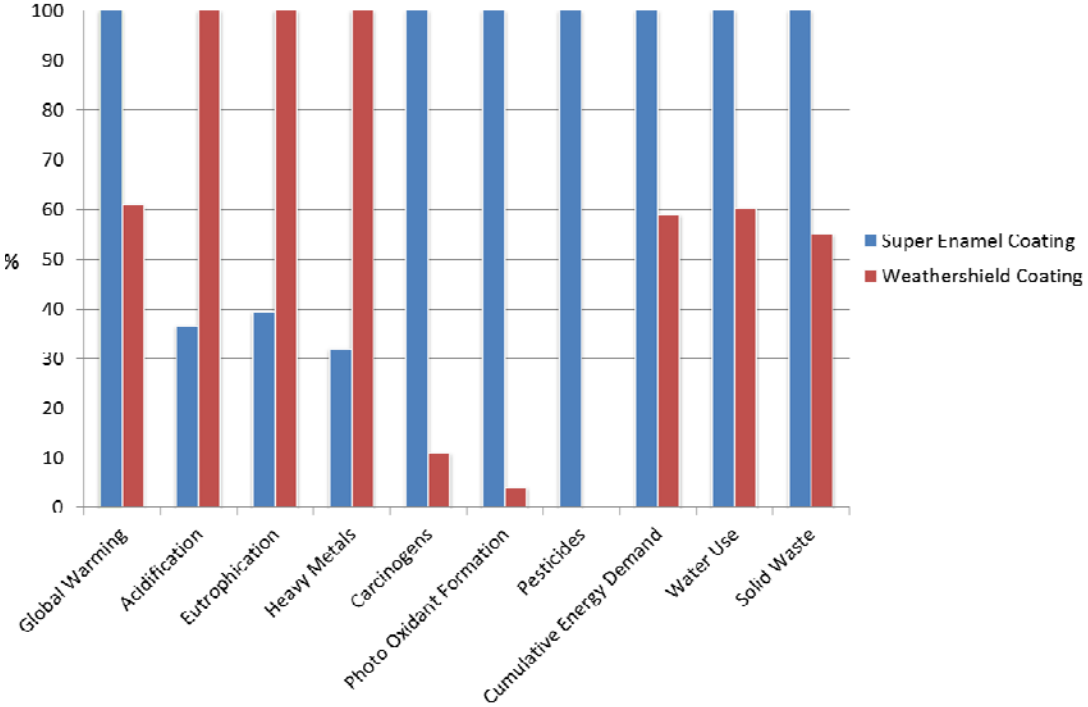
Figure 10: Relative contribution of each life cycle stage to the carbon emission for Jotashield Alkali Resistant Primer



Source: Adapted from the dcarbon8 report

The Centre for Design at RMIT University in Australia, in collaboration with Dulux, performed a comparative LCA on an oil-based alkyd (super enamel coating) and a water based (weathershield) paint. The energy demand and greenhouse gas emissions from the water-based paint were found to be approximately half that of the oil based paint. Conversely, the water-based paint led to higher environmental impacts, particularly for acidification, eutrophication and heavy metal release. There is no indication of the full methodology used and so the validity of their results is difficult to measure. The following figure (Figure 11) compares the two types of paint that were studied across all of the environmental impact categories; it should be noted that the values are expressed as a comparative percentage and that no conclusions about the magnitude or importance of each impact category can be made.

Figure 11: Comparison of the two types of paint across all impact categories.



Source: Adapted from the RMIT report

A comprehensive study[56] by VTT Building Technology examined the environmental impact of exterior coating systems. They examined coated wooden cladding over a period of one hundred years including:

- manufacture of raw materials for paint,
- manufacture of paints,
- transports,
- painting,
- care and renewal, and
- recycling and final disposal.

Thirteen model paints were analysed (Table 14). The study is comprehensive and is declared as complying with the now out-dated ISO 14041 standard for performing life cycle assessment. As part of data collection, major paint manufacturers were surveyed, and although based on relatively old data (the late 1990s), some of the model paints appear to be in use today.

Table 14 - Paint formulations examined by VTT (adapted from the report)

Formulations	Solvent (mineral spirit or water)	Binder	Pigment	Extenders ($CaCO_3$)	Additives
Alykyd (tall oil)					
1 SB priming oil	90%	10%			
2 SB undercoat	45%	25%	10% TiO_2	20%	
3 Factory primer	65% H_2O	10%	15% TiO_2	10%	
4 WB priming oil	90% H_2O	10%			
5 SB stain	77%	20%	3% iron oxide		
6 WB stain	77% H_2O	20%	3% iron oxide		
7 Opaque topcoat	20%	40%	20% TiO_2	20%	
Linseed oil					
8 Primer	20% (turpentine)	50%	30% ZnO		
9 Opaque topcoat		45%	15% ZnO 15% TiO_2	15% 10% talc	
10 Opaque topcoat		45%	30% yellow ochre 15% ZnO	10%	
Acrylic dispersion					
11 WB stain	77 – 82% H_2O	17.5%	3% iron oxide		
12 Opaque topcoat	50% H_2O	25%	15% TiO_2	10%	
Other					
13 Swedish red paint	66% H_2O	8% rye 6% linseed oil	16% Falu red pigment		4% iron sulphate

The study examined the whole life cycle of the painting system including in-use data such as cleaning, repainting and the impact of the wood itself.

From this study, it was concluded that:

- fillers (e.g. calcium carbonate or talc), pigments (e.g. ferric oxides, red or yellow ochres) and additives (e.g. ferric sulphate) provide only a minor contribution to the environmental burden of the paints. The relative significance of transportation (modelled at 100 km) was considered minor.

[56] Environmental Impact of Coated Exterior Wooden Cladding, VTT Building Technology, 1999

- the organic solvent is responsible for the majority of impacts in paints, where there is a high content of white spirit (particularly in priming oils and stains). The environmental burdens (emissions and use of resources) are typically one third less in the corresponding water-borne products having alkyd as the binder.
- the environmental burdens of acrylate stains are roughly double compared with water-borne alkyd stains.
- solvent based paints lead to a ten-fold increase in VOC release in use compared to water borne alternatives.
- the impact of titanium dioxide dominates for paints with a titanium dioxide concentration of 10% or greater
- Rather than measuring the manufacturing process it was estimated at 10% of the total environmental burden.

An investigation of the lifetime of the product showed that the frequency of repainting had a proportional effect on the overall impact – an increase of three years in periods between repainting resulted in a 15% decrease in energy consumption.

A relatively old study by Ecobilan, which was the basis for the development of the initial EU Ecolabel paints and varnishes study, assessed the environmental impact of 11 different paint formulations (Table 15).[57] The data is based on production from 1991 using information provided by paint manufacturers. To remove performance variation and provide a fair comparison between paints, the study defined the functional unit as the amount of paint that is needed to cover a 20m^2 area to a 98% opacity.

Table 15 - Paint formulations for the Ecobilan study (adapted from the report).

	Paint type	Solvent medium	Binder	Solvent type	Quantity of paint required for functional unit (litres)
A	Matt	Water	Styrene-acrylate		2.47
B	Glossy	Water	Styrene-acrylate		2.08
C	Semi-glossy	Solvent	Alkyd	White spirit >5%	1.90
D	Glossy	Solvent	Alkyd	Isoparaffin	1.96
E	Matt	Solvent	Styrene-acrylate	Isoparaffin	2.99
F	Glossy	Solvent	Alkyd	Isoparaffin	1.77
G	Glossy	Solvent	Alkyd	White spirit >1%	1.77
H	Matt	Solvent	Linseed oil	Isoparaffin	3.13
I	Matt	Water	Linseed oil emulsion		2.94
J	Glossy	Solvent	Alkyd (high content of solid matter	White spirit >1%	1.163
K	Matt	Water	Styrene-acrylate (micro-voids)		2.17

It was concluded that:

- the TiO_2, binder and solvent contributed most to the environmental impact of the paint
- transport has a very low impact on the environmental impact of paints
- water-based paints' environmental impact was less than those with organic solvents.

The comprehensive LCA database, Ecoinvent, contains three LCA datasets (covering the lifecycle from cradle-to-gate) referring to paints:

[57] European Ecolabel project for application to Paints and Varnishes, Volume 5, results of the extension phase, The Life Cycle, Analysis of eleven indoors decorative paints, ECOBILANCOMPANY, 1993

- acrylic varnish, 87.5% in H_2O
- alkyd paint, white, 60% in H_2O
- alkyd paint, white, 60% in solvent.

The processes cover the transport of raw materials to the plant and the subsequent manufacture of the product. The authors of the datasets do state that this data shall not serve for comparisons between different paints but rather should be used as a good estimation of the environmental impact of generic products. The data on product composition was taken from a report referring to European manufacturers.[58] The data for each of the individual components within the product process, such as electricity and chemicals, are more up-to-date. The main issue with this analysis is that the paint formulations are relatively old and considered not representative of the current market.
Results from the Ecoinvent LCAs broadly follow the results detailed in the other studies in this review. The binder and TiO_2 were the largest contributors to the environmental impact. Solvent also played an important role within the LCA of alkyd paint in solvent. Interestingly, the environmental burden of growing and producing soya oil for the alkyd paints produced different, but not necessarily less, environmental impact than corresponding synthetically produced binders. This meant that the impact of producing biologically derived binders were important within the LCA.

Internal carbon footprint calculations of one stakeholder were made available to the team and show that environmental impacts related to packaging are high and can reach up to 70% of the overall green house gas emissions. This differs significantly with other findings presented here.

4.1.1 Summary

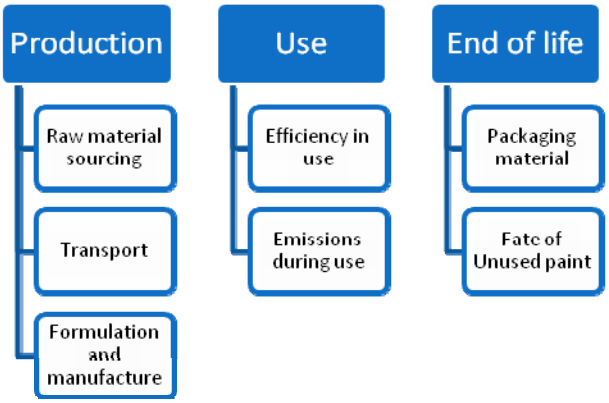
Based on the review of the identified LCAs described above, the following conclusions can be made:

- Solvent-based paints have a higher environmental impact than corresponding water-based paints
- Extending the life of a product contributed most to the environmental benefit of the paint
- The impact of transportation is negligible.
- The lack of inventory data on paint fillers, pigments and additives meant that the assessment of the environmental impact of these components is largely incomplete. Solvent-based paints can lead to a 10 fold increase in the release of VOCs compared to water based paints
- Where greater than 10% titanium dioxide is used, it is the most significant contributor to the environmental impact.
- Manufacturing impacts where vague within all examined studies

4.2 Major life cycle consideration of paint

Typically, when considering the lifecycle of a product (in this case a paint), the production (incorporating material extraction, production and manufacturing), use and final disposal of the product must be taken into account. With regards to paint, the production stage can be well defined and, when analysed in isolation, is termed a cradle-to-gate analysis. This includes all of the impacts associated with the extraction and processing of the materials, formulation of the paint, packaging and shipping prior to use.

[58] The referenced report was: Vergeichende okologische Brewertung von Anstrichstoffen im Baubereich, von Danken A and Chudacoff M., 1995



Within a paints use-phase, its performance during application and in use is critical. It affects the amount of paint needed to cover a surface and also the number of repaints necessary with a set time frame. These two effects have an impact on the amount of paint required and therefore the production phase of the LCA. Also within the use-phase is the direct release of emissions to the environment during painting and whilst in-use.

At the end of life, following aspects need to be addressed:

- Where paint is unused. This is important because it can have an impact on the overall performance of the paint and needs to be accounted within the performance characteristics. It also has its own environmental impact because it enters the waste stream for recovery or disposal.
- The fate of packaging material
- The fate of At the end of life of the building (or the substrate that the paint is attached to) the paint will enter the waste stream with that substrate or bulding material. In general the fate of the building material is the focus of most environmental analysis rather than the paint itself.

4.3 Assessment of the impact of Paint in Production

In addition to the currently available information from the references, a cradle-to gate LCA was performed using the Ecoinvent database to identify environmental 'hotspots', particularly for paint ingredients. The initial goal is to perform a simplified LCA first which could provide sufficient data to identify where environmental impacts of paint manufacture are. The detail level of the analysis can be extended later, based on the significance of the expected outputs e.g. focus on relevant differences between alternative paints or on areas which are explicitly addressed in the current Ecolabel criteria etc. This section focuses on determining the environmental impact of the production phases of paint.

The Ecoinvent database contains three LCAs of paints and varnishes (water based paint, solvent-based paint and varnish). However, the studies are based on data from the early 1990s and the paint formulas are considered no longer widely used and are unsuitable for analysis of the modern paint industry. They do, however, provide a framework for the environmental impact of production of paint. A combination of the LCA model developed for the EcoInvent database and updated bills of material will provide sufficient depth to enable identification of key environmental hotspots.

4.3.1 Choice of paint

A key problem in defining the environmental impact of a paint is that there is no 'standard' paint formulation. An online paint product directory contains 10,000 different resin/polymer formulations,

9,000 additives and 4,500 pigments and fillers.[59] This large number of different ingredients can be used in a variety of combinations giving rise to tens to hundreds of thousands of different paint formulations. Clearly, assessing the environmental impact of all varieties of paints will be impractical and a representative sample of products is needed.

Information provided within the PROCOM database identified two paint types with the largest market share:

- **Water-based vinyl emulsions** which can be used for a diverse range of paint applications from wall paints and trim paints
- **Water-based Alkyd emulsions** that are largely used in varnishes.

Based on the analysis provided in section 2.1, these two paints represent approximately 50 % of the entire European market share of paints. These are water based paints largely targeted at the home and professional market and therefore represent a large portion of paints relevant to the EU Ecolabel. The formulation and exact composition can vary significantly depending on the required properties for the paint and therefore some assumptions over the Bill of Materials are needed (discussed below). This has an effect, for example, on the amount of VOC within the paint, its hardness and the type of substrate that it can be applied to. Stakeholders are asked to provide feedback regarding further determination of representative paint case studies considered relevant for Ecolabel.

4.3.2 Functional unit and reference flow

The functional unit is used to define what the LCA is measuring, and provides a reference to which the inputs and outputs can be related. Ideally, the functional unit of the paint should be similar to that described in a previous LCA[60] by VTT Building Technology which modelled the use of paint covering a defined surface for a defined time frame with intermittent repaints.

However, this would need a more comprehensive model and more detailed information regarding the representative paint's average performance levels within the EU27 market. Therefore, at the current phase, a more simplified model was used. Further consultation with stakeholders regarding this issue may become necessary.

As described in section 4.1, the use-phase plays an important role in determining the overall environmental impact of the paint: a better performing paint requires fewer repaints reducing the environmental impact in production in addition to well in other lifecycle phases An indication regarding the significance of the paint's performance in the use-phase and its environmental consequences are separately investigated in section 4.4. This analysis aims at emphasising the importance of the paint performance and provides an indication related to the environmental implications but is not intended to present precise quantification of these impacts.

This project intends to define 'baseline' environmental impacts rather than comparative analysis. The outcome of a comparative analysis would be too specific for this report and provide only a limited overview of the issues. The use phase is separately addressed within the document as is the end of life considerations Hence, an LCA on the production phase, a so-called cradle to gate analysis, was performed. One practical way is to use a reference flow based on the amount of paint that a consumer buys. Following this reasoning, the development of cradle-to-gate LCAs for two model paints was conducted using 1 kg of paint as reference flow.

4.3.3 System boundaries, bill of materials and cut-off level

[59] http://www.specialchem4coatings.com/

[60] B. Weidema, H. Wenzel, C. Petersen, K. Hansen, "The Product, Functional Unit and Reference Flows in LCA", Environmental News No. 70 2004, http://www.norlca.org/resources/777.pdf

A system boundary within an LCA defines the processes and products that are measured when determining the LCA of the product. To determine the manufacturing impacts of paints, the following impacts are assessed:

- Extraction raw materials
- Manufacturer raw materials
- Transport of raw materials prior to formulation
- Processing impacts associated with production of the final paint
- Normal losses/wastes from the manufacturing process

The LCA does not include:

- The manufacture or disposal of the paint pot
- Any packaging associated with the manufacture and distribution of components or the final product
- The use phase including transport or impacts associated with the building
- Disposal of the final product
- Disposal of any unused paint

Identification of the bill of materials for these paints was achieved from several sources. Primarily, formulations were developed based on manufacturers recommended sample formulations using promotional material. Academic literature was also used to estimate bills of material for proprietary blends (particularly in respect to binders). An industry consultation was held in parallel to ensure that our findings were accurate. The bill of material for the two sample paints are presented in Table 16 and Table 17.

A cut-off limit of 5% w/w of the paint was applied. Biocides, surfactants, defoamers and other chemicals that are used to improve the performance of the paints are not assessed within this analysis. The lower the cut-off limit, the more detailed and comprehensive the analysis becomes, requiring more specific information. As discussed before, a wide variety of different paint additives are in use and modelling the effect of each individual component is difficult. Moreover ensuring representative additives are used that reflect the paint market of EU27 becomes even more challenging. However, an investigation on impacts on specific compounds that raised awareness in the previous Ecolabel criteria development, and which are directly or indirectly related to the use of these substances, is presented under the section 4.5.

Table 16: Bill of materials for vinyl emulsion wall paint bill of materials

Material	Amount
Water	326
Binder: butyl acrylate	144.1
Binder: Methyl methacrylate	117.9
Titanium Dioxide	120
Filler (calcium carbonate)	272
Other additives (biocides, surfactants and defoamers)*	20

** These additional ingredients vary significantly on the type of paint used. Defining a paint formulation that is representative is not possible for these minor ingredients.*

Table 17: Bill of materials for alkyd emulsion paint

Material	Amount
Titanium Dioxide	250
Alkyd Emulsion: propylene glycol	90
Alkyd Emulsion: Phthalic anhydride	90

Alkyd Emulsion: Linoleic Acid	120
Metal drier 8% Colbalt solution	4.5
Thickener (organo-clay)	32
Additives (Defoamer, biocide, dispersant)*	12.5
Water	401.5

** These additional ingredients vary significantly on the type of paint used. Defining a paint formulation that is representative is not possible for these minor ingredients.*

4.3.4 Manufacturing processes and Transport

Without specific access to information on energy inputs and outputs from manufacturers, a standard unspecified chemical plant energy input and the environmental impact to build the paint plant was used as part of the manufacturing process. The average EcoInvent European energy mix was used to determine environmental impact of energy used during the processing of the paint and the process was determined by a previous study developed for the Ecoinvent database. Consideration for transport was incorporated through the use of data supplied from the Ecoinvent database. Standard transport distances of 100km are assumed for a plant based in Western Europe.

4.3.5 Analysis and comparison

The impact assessment was performed using the IMPACT 2002+ method. IMPACT 2002+ is a combination of four methods: IMPACT 2002 (Pennington et al. 2005), Eco-indicator 99 (Goedkoop and Spriensma, 2000, 2nd version, Egalitarian Factors), CML (Guinée et al. 2002) and IPCC. The data refers to the production of 1 kg of the respective paints.

Table 18 details various environmental impacts of the two model paints. This view provides an overview of total paint impacts. The overall environmental impact (single score) of producing both paint types are within 10% of each other. Due to any inaccuracies associated with the modelling, these differences are within the bounds of error and suggest that the overall manufacturing processes for these two paints are equivalent. Damage to the ecosystem caused by the alkyd emulsion paint is significantly higher than the corresponding vinyl paint. This represents the only noticeable difference between the two products and is due to the sourcing, harvesting and processing of soya oil for linoleic acid. This can be balanced against the higher impacts on human health and energy for the completely synthetic paint (vinyl emulsion).

Table 18: Results from a simplified impact assessment for two model paint systems.

Human Health / DALY		
	Vinyl emulsion wall paint	Alkyd emulsion paints
Carcinogens	1.07E-07	8.20E-08
Non-carcinogens	5.03E-08	8.60E-08
Respiratory inorganics	1.13E-06	1.33E-06
Ionizing radiation	5.81E-09	1.08E-08
Ozone layer depletion	2.09E-10	3.20E-10
Respiratory organics	3.47E-09	2.37E-09
Total	**1.30E-06**	**1.51E-06**

Ecosystems / PDF.m2.yr		
	Vinyl emulsion wall paint	Alkyd emulsion paints
Aquatic ecotoxicity	6.20E-03	6.92E-03
Terrestrial ecotoxicity	1.83E-01	3.31E-01
Terrestrial acid/nutri	3.71E-02	4.85E-02
Land occupation	9.19E-03	5.44E-01
Total	**2.36E-01**	**9.30E-01**

Resources / MJ Primary		
	Vinyl emulsion wall paint	Alkyd emulsion paints
Non-renewable energy	5.16E+01	4.92E+01
Mineral extraction	3.22E-02	4.2E-02
Total	**5.16E+01**	**4.93E+01**

Single Score / Pt		
	Vinyl emulsion wall paint	Alkyd emulsion paints
Human Health	1.83E-04	2.13E-04
Ecosystem quality	1.72E-05	6.79E-05
Climate change	2.45E-04	2.34E-04
Resources	3.39E-04	3.24E-04
Total	**7.84E-04**	**8.39E-04**

The carbon footprint of these two paints was 2.42 and 2.32 kg CO_{2e} /kg of paint for the vinyl emulsion and alkyd emulsion respectively. This compares favourably to the results presented by dcarbon8[61] for their carbon footprint of a Jontun Paints' product that had a carbon footprint of 2.66 kgCO_{2e}/kg

A more in-depth analysis of the environmental impacts from production of the individual components enables the identification of 'hotspots' in the production of the paints and ensures that the developed Ecolabel criteria appropriately addresses these issues. Table 19 provides a breakdown of the environmental impact of manufacturing the major constituents of the paint.

Table 19: The major environmental impacts of the components of a model vinyl and alkyd emulsion

	Single Score (Pt x10^{-5})	**Human Health** (Daly x10^{-7})	**Ecosystem** (PDF x10^{-2})	**Global warming** (CO2e, Kg)
Vinyl emulsion				
Butyl acylate	20.7	2.98	5.37	0.584
Methyl methacrylate	21.6	3.45	1.32	0.696
TiO2 (Cl process)	8.3	1.45	3.15	0.239
TiO2 (SO_4 process)	9.7	2.38	2.74	0.278
Plant energy	15.6	2.21	9.18	0.571
Alkyd emulsion				
TiO2 (SO_4 process)	20.1	4.95	5.71	0.578
TiO2 (Cl process)	17.4	3.01	6.56	0.498
Penta erythritol	9.95	1.29	TRACE	0.260
Phthalic anhydride	8.87	1.37	TRACE	0.206
Soya oil (linoleic acid)	9.96	1.83	63	0.158
Plant energy	15.6	2.21	9.18	0.571

[61] Jotun Paints – Product Life Cycle Assessment, dcarbon8, 2007

(Key: red = high, orange = medium, green = low)

Based on the data provided above, the three biggest contributors to the environmental impact of paint are binders, TiO_2 pigment and paint plant energy in production/formulation. This mirrors the evidence provided by the LCAs review in section 4.1. Interestingly, about one quarter of the overall environmental impact of the paint is from the paint manufacturer (operating formulation plant). Conversely, 75% of all carbon footprint of the paint is within the supply chain of the paint manufacturer.

A reduction in the amount of TiO_2 used could produce a significant reduction in the environmental impact of the paint. The environmental impact of TiO_2 production was modelled based on a 50:50 mix of material produced via the sulphate process and chloride process. As can be seen from the breakdown of the emissions from these two manufacturing routes, the environmental impacts are similar, with the sulphate route being slightly more environmentally damaging than the corresponding chloride route. Based on this analysis there is an argument that the EU Ecolabel could encourage more use of chloride-derived TiO_2. The formulation of the vinyl paint uses a calcium carbonate filler in place of some of the TiO_2. This has reduced the impact of this paint meaning the contribution to the overall impact from TiO_2 is roughly half that of the corresponding alkyd paint.

As a major constituent of paint, it is unsurprising that binders have a significant contribution to the overall impact. The most noticeable difference between the binders modelled here is that linoleic acid production has at least a 10 fold increase in the environmental damage to the ecosystem than any of the binders, which is a consequence of the crop growth and agricultural activities. This is important to note if further discussions occur on the use of naturally derived materials for the use in paints. The whole lifecycle of paint should be examined to determine if bio-derived products give the intended environmental saving.

It is difficult to synthesise appropriate recommendations to limit the use of binders within EU Ecolabel criteria because they have a key role in determining the final product's surface covering properties. This steps outside the remit of the EU Ecolabel.

Little additional information can be derived about the environmental impact of the processing and transport. Although a significant impact within both models, the data is based upon information from a generic chemical manufacturing plant. Based on this data, further investigation is warranted because it could be an impact factor in the environmental impact of paint manufacture.

Examining the unit processes for the four main environmental impacts does not reveal further insight beyond the ‘top level’ data provided within Table 19. The complete flow diagrams are included in Appendix 2.

4.4 Assessment of the impact of Paint in use

4.4.1 Paint application and performance

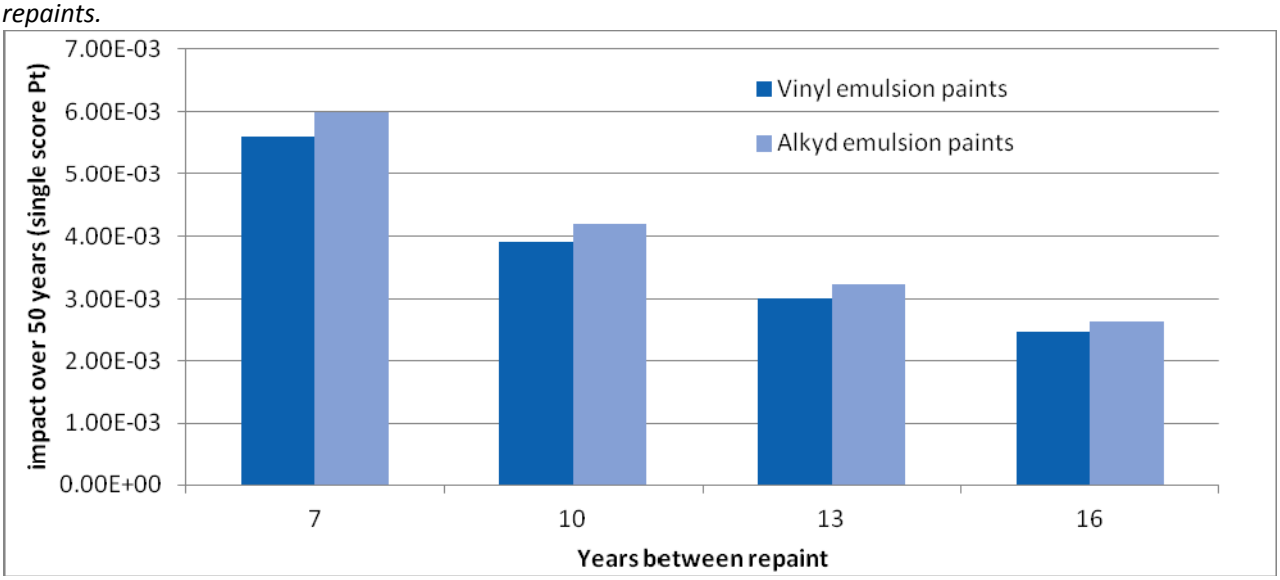
Conclusions from the LCAs reviewed in section 4.1.1 denote that the amount of paint used and the lifetime of the paint are important when considering their environmental impact. Within the confines of this project, information on the relative performance of a range of paints was not sufficient enough to allow integration with the LCA described in section 4.3, therefore the usage and lifetime of the paints was assumed to be equivalent. However, this approximation delivers uncertainty into the assessment of the overall lifecycle environmental impacts of the paint. In order to overcome this limitation and to get an indication regarding the environmental significance of this aspect a preliminary investigation was undertaken.

A performance of paint can be investigated based on the following:

1. The overall amount that is necessary to use for painting a certain surface (and reach a predefined painting quality) and
2. The time that is needed until the next repaint.

A paint with good performance characteristics will use a small amount of paint and require less frequent repaints. As a consequence, using a smaller amount of paint results in a lower environmental impact related to the paint production, along with the release of air pollutants during application and the treatment of waste. Both factors are important but to simplify, periods between repaints are discussed in depth below although the argument is equally valid for amount of paint used at application.
The effect of the lifetime of the use phase of the paints can be illustrated by examining period needed between repaints. Figure 12 depicts the environmental benefits from increasing the performance of the paint resulting in increased periods between repaints.

Figure 12: The effect on the environmental impact of improving performance and increasing time between repaints.



The figure above calculates the impact of covering $5m^2$ of wall with 1 kg of paint over a 50 year timeframe. The model is relatively simple and does not include any impact associated with application of the paint onto the wall or preparing the wall between coatings, however, if these factors are assumed to be constant throughout the study lifetime, they can be removed from the calculation. It should be also highlighted that it is assumed that the same type of paint is used for the repaints and new developments and improvements in the paint sector are not taken into account.

The base-case assumes here 7 years between repaints. It should be noted that this model does not account for consumer behaviour and based on the investigation on the Ecolabel for buildings it is estimated that every 15 years a major renovation takes place. In this case, even if a repaint is not necessary it can be assumed that this will probably take place for indoor paints. Conversely for outdoor paints, having 15 years as the upper limit may be not applicable and longer lifespan could be possible.

Decreasing the frequency between repaints has a significant effect on reducing the environmental impact of the paint. The relationship between the impact and the frequency between repaints is proportional and a relatively minor increase in performance can lead to a significant reduction in the overall impact of the paint (over the modelled 50 year lifetime). In the example above, although there is a 7% difference in the environmental burden of the vinyl and alkyd emulsion paint, this is dwarfed by the savings made through the reduction in environmental burden by increasing the period between repaints. Even based on this simple approximation the importance of including performance criteria of paints seems to be evident.

Stakeholders are invited to provide supportive information on this thematic of "paint performance-period of repaint/amount of paint needed" as well information on the frontrunners.

4.4.2 Hazardous Emissions

In the LCA performed in section 4.3 gives a cut-off limit of 5% w/w of the final paint, this largely included the “additives” portion of the bill of materials. It is difficult to determine a representative assessment of the additives due to the large number of different chemicals that could be considered in this category and the diversity of their environmental impact. In order to overcome this limitation an investigation on some of these chemicals which are of concern to the environment and human health are discussed here. Of particular concern is the emission of hazardous and ecotoxic chemicals both during production as well during the application and use of the paint.

This section tries to highlight a limited number of chemicals which are considered to be of particular concern within the paints industry and the Ecolabel scheme. A large number of traditional paint ingredients are toxic or harmful. It is not the intention of this section to identify every chemical which may be of concern but to investigate further and assess the environmental importance of taking an action within the EU Ecolabel policy for the chemicals that have been highlighted through regulatory control and are of special importance for the stakeholder group. These chemicals were highlighted through stakeholder engagement at previous revisions of this criteria. Further investigation on other chemicals may be needed later based on the input given by the Ecolabel technical ad-hoc working group. These chemicals are currently within the latest revision of the EU Ecolabel paints and varnishes criteria.

The concern for these chemicals is centred on their emission and associated impacts in the paint’s use-phase rather than their production. Inventory data on the rate of emission of these chemicals from paints is not available and would require further fundamental experiments into their release, which is beyond the scope of this project. Also, it is not possible to quantify the amount of each chemical within the paint because their amounts vary between paints. Stakeholders are asked to provide relevant information on this aspect.

One way to assess the risk of these chemicals is to determine their impact based on the release of a standard amount into the environment. Based on this analysis, Table 20 models the environmental impact of a release of 50 g these chemicals into the environment. This is equivalent to the maximum amount of chemical used in approximately 2 litres of paint over 16m^2 of wall. The data for the impact of these chemicals is based on the Ecoinvent database

Table 20: The effect of releasing 50 g of chemicals highlighted as causing significant environmental impact

		Human Health (DALY)		Ecosystems (PDF m2 yr)	
	Proxy	**Air**	**Water**	**Air**	**Water**
Alkylphenolethoxylates (APEOs)	Alkyl phenols	Not defined in IMPACT			
Perfluorinated alkyl sulfonates (PFAS)	None	Not defined in IMPACT			
Formaldehyde	Formaldehyde	6.40E-07	2.90E-09	1.01E-03	1.64E-03
Halogenated Organic Solvents	Hydrocarbons, halogenated	1.75E-08	N/A	0.00E+00	N/A
Phthalates	Phthalate, dioctyl-	8.90E-07	4.63E-08	1.14E-04	2.85E-02
Heavy Metals	Mercury	5.35E-05	1.12E-04	1.52E+03	3.97E+01
Volatile Aromatic Hydrocarbons	Aromatic hydrocarbons	4.96E-04	2.18E-05	7.20E-03	4.29E-01
Volatile Organic solvents	Volatile Organic Compounds	3.23E-08	0.00E+00	0.00E+00	0.00E+00
	non-methane volatile organic compounds	6.40E-08	0.00E+00	0.00E+00	0.00E+00
	VOC as C	6.45E-08	0.00E+00	0.00E+00	0.00E+00
Isothiazolinone compounds	2-n-Octyl-4-isothiazolin-3-one	0.00E+00	0.00E+00	3.36E-01	1.18E+00
	1,2-Benzisothiazolin-3-one	0.00E+00	0.00E+00	3.43E-01	4.24E-02

As can be seen each of the identified chemicals all have a significant impact on the environment or human health. The values associated with APEOs and PFAS are not available through this analysis and further stakeholder engagement may be needed. The text below qualitatively describes the impact of these chemicals.

Alkylphenolethoxylates (APEOs)

APEOs are non-ionic surfactants, which have an emulsifying and dispersing effect when processing paints, and in binders, dispersion aids, thickeners, driers, anti foam agents and pigment pastes.[62] APEOs are produced in large volumes, with uses that lead to widespread release to the aquatic environment. They are highly toxic to aquatic organisms, and in the environment degrade to more environmentally persistent compounds. These chemicals have been detected in human breast milk, blood, and urine and are associated with reproductive and developmental effects in rodents.[63]

Perfluorinated alkyl sulfonates (PFAS)

Perfluoroalkylated sulfonates (PFAS) is the collective name for a group of fluorinated surfactants. Similar to APEOs, these are used in dispersants, thickeners, driers and pigment pastes. Of particular concern is perfluorooctane sulfonate (PFOS), which has been analysed in a limited number of European environmental and food samples and has been shown to bioaccumulate in fish. This bioaccumulation seems to be an important source of human exposure to PFOS.[64]

[62] Paints and how they affect the environment, Tommi Nurmi and Konsta Kanniainen, 2008

[63] http://www.epa.gov/oppt/existingchemicals/pubs/actionplans/RIN2070-ZA09_NP-NPEs%20Action%20Plan_Final_2010-08-09.pdf

[64] Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts, Scientific Opinion of the Panel on Contaminants in the Food chain, European Food Safety Authority, 2008.

Following absorption, PFOS is slowly eliminated and therefore accumulates in the body. PFOS shows moderate acute toxicity. In sub acute and chronic studies the liver was the major target organ and developmental toxicity was also seen. Other sensitive effects were changes in thyroid hormones.[65]

Formaldehyde

Formaldehyde is used as a biocide in water-based paints (particularly protecting the head-space within the paint pot). Formaldehyde can cause irritation of the skin, eyes, nose, and throat. High levels of exposure may cause some types of cancers, for example, some studies of people exposed to formaldehyde in the workplace found more cases of cancer of the nose and throat than expected. In animal studies, rats exposed to high levels of formaldehyde in air developed nose cancer.[66] Formaldehyde is often used as proxy, a reference indicator for other similar chemical structure substances which are not covered in the LCIA models (no characterisation factor determined).

Halogenated Organic Solvents

A halogenated solvent is an organic solvent, molecules of which contain halogenic atoms: chlorine (Cl), fluorine (F) , bromine (Br) or iodine (I)[67]. They can be found in the paint industry in paint thinners, strippers and solvents. They are used as they are largely non-flammable, though if they do combust, they can produce toxic gases. Risk to health from using halogenated organic solvents in paint includes dermatitis and eye irritation. More serious exposure via vapours or high levels of the solvents can lead to kidney and liver damage, heart irregularities and are potentially carcinogenic[68].

Phthalates

Phthalates are commonly found in PVC, used as plasticisers, giving the plastic desired physical properties. They can be also used in paints to alter the overall finish of the paint. Several phthalates have been shown to be endocrine inhibitors this can cause cancerous tumours, birth defects, and other developmental disorders. There is some guidance provided by the EU that certain phthalates, in particular di-isononyl phthalate (DINP) and diisodecyl phthalate (DIDP) have no associated health risks.[69]

Heavy Metals

In large quantities, heavy metals are considered carcinogenic and hazardous to human health[70]. Although present in the environment, and necessary for human health in small amounts, any large concentration can cause acute or chronic toxicity[71]. As they are elements, they cannot be broken down and therefore will persist in the environment[72]. When absorbed by humans, they have been shown to have detrimental effects on kidney function, reproductive organs and the nervous system, particularly in unborn infants and young children. The use of some of these metals is now subject to regulation from REACH (**R**egistration, **E**valuation, **A**uthorisation and Restriction of **CH**emicals) which came into effect on 1 June 2007[73]

- Cadmium
  Cadmium is used as a colourant in paint pigment[74] and levels are controlled by EU regulations except in the use of certain items coloured for safety reasons.[75] Paint that contains a level of cadmium (as a pigment) higher than 0.01% by mass is prohibited. If the paint contains a high

[65] Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and their salts, Scientific Opinion of the Panel on Contaminants in the Food chain, European Food Safety Authority, 2008.

[66] http://www.atsdr.cdc.gov/tfacts111.pdf

[67] Dr. Dmitri Kopeliovich, Classification of Solvents, http://www.substech.com/dokuwiki/doku.php?id=classification_of_solvents

[68] http://www.psfc.mit.edu/esh/halosolv.html

[69] OJ C90/5 13.4.2006 (http://www.didp-facts.com/upload/documents/document8.pdf)

[70] http://www.apis.ac.uk/overview/pollutants/overview_HM.htm

[71] http://www.lef.org/protocols/prtcl-156.shtml

[72] http://www.apis.ac.uk/overview/pollutants/overview_HM.htm

[73] http://www.hse.gov.uk/foi/internalops/fod/oc/200-299/253-11.htm

[74] HSE, web leaflet INDG391(rev1), revised 03/10

[75] http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_136/l_13620070529en00030280.pdf

level of zinc, the residual concentration of cadmium must be as low as possible, in any case not higher than 0.1% by mass[76].

- Lead
  Lead-based paints were banned for sale for use by the general public in the EU in 1992[77], although some specialist uses for industry and the military are still permitted. Lead had originally been used in paint as a pigment and drying agent. White lead was predominantly used as the white pigment in primer type paints. The lead-based pigments (lead tetroxide/calcium plumbate, or "red lead") were used as an anti-corrosive primer agent in paint used on metal[78]. Nowadays the exposure to, or removal of, old leaded paint can still present a hazard to human health.
- Chromium VI
  This is a group of compounds which has a low or neutral PH. Zinc, lead and calcium chromates form the most important compounds in the group. Calcium chromates are rarely used in paints nowadays. Zinc chromates are often used in primer paints as they have high anti-corrosive properties[79]. Lead chromates are used in topcoat paints and occasionally in primer paints[80]. CRII is an unstable compound and therefore little used in paint. CRIII is used in paints as a green pigment or as a protective coatings on metals (anti-corrosive). It may cause some respiratory difficulties or skin reactions but is not considered highly harmful.
- Mercury
  In the past, phenyl mercuric acetate was commonly used as a fungicide in water-based latex paints, to prevent the growth of bacteria[81]. Its use in paint was banned in the USA in 1991[82]. In the UK, paint companies have voluntarily removed mercury from paints, though its use is still legal.
- Arsenic
  Arsenic is popularly known for its poisonous properties. For this reason, it is not used in paint production today, although traces may rarely still be found in green paint pigment, particularly on artists' frescoes or canvases.
- Barium
  Synthetic barium sulphate is used as a filler in the paint and varnish industry and can also be an element in white pigment. Its inertness and high density qualities make it useful to improve the consistency and handling properties of paint[83].
- Selenium
  Selenium is normally extracted as a by-product of copper production[84]. One of the main applications for selenium is for pigmentation in glass manufacture to colour and decolourise glass, and also in paint, which comprises approximately 40% of the selenium demand. It is used in the photovoltaic industry and demand is therefore predicted to rise in the future[85].
- Antimony
  This metal is found in paint pigments, as well as in batteries, ceramics and glass[86]. It was initially used by make-up artists for black face paint, known as 'kohl'. Nowadays it is valued in paint for its flame-retardant properties[87].

Volatile Aromatic Hydrocarbons

[76] www.cbi.eu/?pag=85&doc=416&typ=mid_document

[77] Marketing and Use Directive (89/677/EEC) through the Environmental Protection (Controls on Injurious Substances) Regulations 1992 (Statutory Instrument 1992/31)

[78] http://www.rsc.org/chemistryworld/News/2007/August/21080701.asp

[79] HSE Information Sheets: Chromate Primer Paints, engineering sheet number 32

[80] HSE Information Sheets: Chromate Primer Paints, engineering sheet number 32

[81] UNECE, *www.unece.org/.../TFHMs_3.ProductsReviewChapter.draft.05.04.06*

[82] http://www.epa.gov/hg/consumer.htm#pai

[83] http://www.nanopartikel.info/cms/Wissensbasis/Bariumsulfat

[84] http://www.mmta.co.uk/metals/Se/

[85] Minor Metals Trade Association, Selenium

[86] http://www.lenntech.com/processes/heavy/heavy-metals/heavy-metals.htm

[87] Minor Metals Trade Association, Antimony

Volatile Aromatic Hydrocarbons include compounds such as benzene, toluene and benzaldehyde. VAH are used as solvents in paints. They can have severe effects on the human body and the environment including having a effect on the reproductive system and carcinogenic.

Volatile Organic solvents

Volatile organic Solvents (VOCs) are used as solvents within paints to help keep it stable prior to use and aid in spreading and delivery of the paint to the substrate. VOCs encompass a wide variety of compounds and are generally classed as organic substances with a boiling point less than 250 °C.[88] VOCs generally evaporate or sublimate from the paint during and after application. The release of these emissions can cause eye, nose, and throat irritation along with headaches and loss of coordination. Due to the wide diversity of compounds encompassed by this classification, more extreme reactions can also present, in particular: damage to liver, kidney, and central nervous system and some are suspected or known to cause cancer in humans.[89]

Isothiazolinone compounds

Isothiazolinone compounds are found in wood coatings[90] and in some paint formulations. They are a broad spectrum fungicide, algicide and bacteriostat used in solvent based coatings, surface protection products and other xylene compatible products.[91] For people susceptible to their effects, the compounds can cause irritation to the skin and mucous membranes.[92] The extent to which they do this depends greatly on the level of concentration in the product used and the method of exposure – long-term oral exposure being particularly hazardous.[93]

Nanomaterials

The term nanomaterial has only recently been defined by the EU. There are concerns raised over the impact of these very small particles on human health. The current rules dictated through REACH and CPL are not sufficient to appropriately test the environmental and human health implications of these materials. Depending on the interpretation of the definition, many different nanomaterials are used within paints. The use of these materials in paints means that a universal ban is unlikely to be suitable, but further research is needed in this area.

4.5 Assessment of the Impact of Paint at End of Life

Unwanted or unused paint results in a similar increase in environmental impact experienced with increase frequency of repaints (described in section 4.4.1). The combined environmental impact of left over paint (including the impact of production) must be accounted for when assessing the environmental impact of painting. Figure 13 indicates the effect of wasting paint based on painting 1m^2 of wall (assumes that 1 litre of paint will cover 8m^2 of wall based on a density of 1g per cm^3). In simple terms, the relationship between the amount of paint used and the environmental impact of the paint can be considered to be inversely proportional, therefore the more paint unused the higher the environmental impact of painting a set area.

88 Directive 2004/42/CE

89 http://www.epa.gov/iaq/voc.html

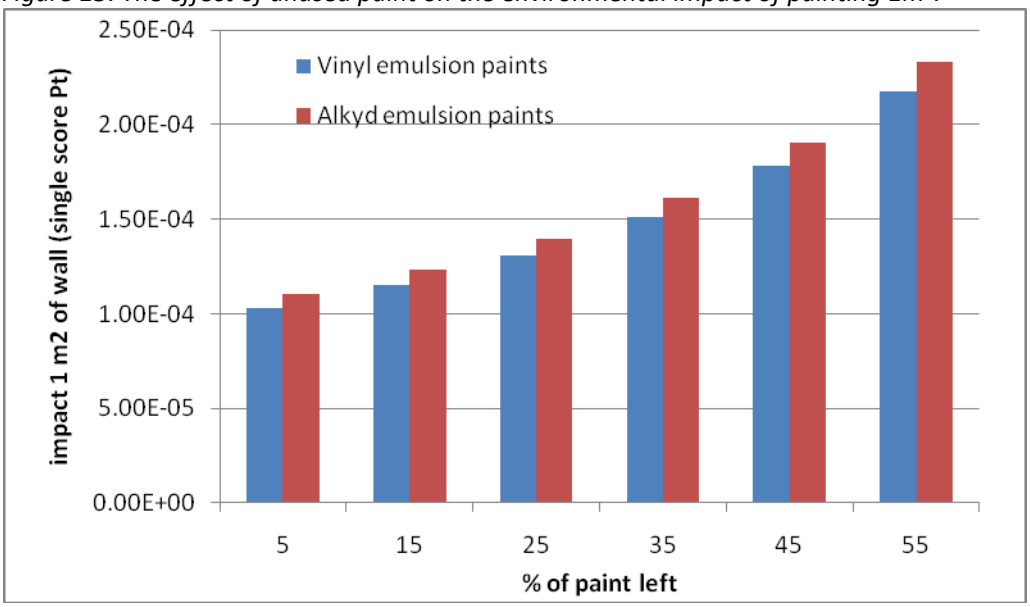
90 Revision of European Ecolabel and Development of Green Public Procurement Criteria for Indoor and Outdoor Paints and Varnishes, October 2011

91 Akcros Chemicals, http://www.akcros.com/products/europeproductrange/productsbycategory/microbiocides.aspx

92 Consumer exposure to biocides - identification of relevant sources and evaluation of possible health effects, Stefan Hahn, February 2010

93 Consumer exposure to biocides - identification of relevant sources and evaluation of possible health effects, Stefan Hahn, February 2010

Figure 13: The effect of unused paint on the environmental impact of painting 1m^2.



A recent study[94], based on relatively old data, highlights the problem of unused paint in the UK. In the do it yourself market, an estimated 25% of all paint goes unused, whereas wastage in trade use drops to 1.5%. Scaling up to Europe, this equates to approximately 900,000 te of unused paint wasted every year, suggesting that approximately 12% of the environmental burden of paint is from wasted paint. Any reduction in the amount of unused paint would have a significant reduction on the environmental impact of the paint and paint industry. This could include the sale of appropriate quantities of paint using different sized tins or bespoke dosing systems or correctly conveying the amount of paint required by the user to prevent over-ordering. Where paint is not needed, the appropriate reuse (where possible) will also reduce the environmental impact. Take-back schemes are available (usually run by the charitable sector) that could limit wasted paint. This is also discussed in section 3.6.1.

An additional problem is that waste paint can be considered a hazardous material and therefore disposal should be appropriately controlled.

Used paint pots present a recycling challenge as they invariably contain leftover paint inside. It appears that the inherent composition of paint pots (both steel and plastic) enables them to be readily recycled. However, containers are very unlikely to be in a sufficiently clean condition for this to be achieved. In general in the UK spent paint pots are sent to landfill[95] with efforts directed towards the reuse of left over paint rather than the recycling of the pots.[96]

Recycling of paint pots does appear to be possible in the trade sector but requires specialist equipment and is not suitable for the do it yourself market.[97] The recovery of energy appears to be a favoured route to dispose of paint pots, for example using them as cement kiln furnaces for fuel.[98] This has the advantage of eliminating any hazardous substances.

[94] Paint and woodcare products - distribution and delivery, WRAP, 2011

[95] http://www.thisisgloucestershire.co.uk/ways-recycling-paint-tins-users-urge/story-11893909-detail/story.html

[96] http://www.recyclenow.com/what_can_i_do_today/can_it_be_recycled/liquids_and_chemicals/paint.html

[97] http://www.hankinson.co.uk/news/hankinson-recycling-centre/

[98] http://www.leics.gov.uk/index/environment/waste/recycling_sites_and_permits/recycling_household_waste_sites/recycling_information.htm

4.6 Summary of the key environmental considerations of paint

Based on the information from sections 4.1, 4.3, 4.4 and 4.5, the following conclusions can be made on the environmental impact of paints and varnishes:

Conclusion	Significance	Addressable in the ecolabel?
In-use durability plays a key role in determining the environmental impact of paints as do periods between repaints.	Very High	Yes, through performance criteria
Unwanted paint has a significant environmental impact	High	Possibly, though the requirement of take-back schemes
Solvent based paints have a higher environmental impact than water based paints	High	Yes, by controlling the amount of VOC present in the paint
The impacts of transportation are very low	Low	No, would require specification for local sourcing
Binder manufacture is an important environmental impact of paint production	Medium	No, dictating the conditions for binder use may stifle innovation
TiO2 manufacture is an important environmental impact of paint production	Medium	Yes, reducing TiO_2 use can be achieved
Only ¼ of the carbon footprint is due to energy in production at the paint manufacturer, meaning that the majority of greenhouse gas emissions are emitted from the supply chain	Medium	No, paint manufacturers cannot easily control their supply chain emissions making any criterion impractical.
Additives have a wide range of health and environmental implications. No studies have quantified this effect but they are of concern.	Medium	Yes, encouraging manufacturers to use alternatives is possible.

The conclusions from the study performed within this document broadly reflect those identified through the literature survey.

4.7 Environmental hotspots and mitigations

The EU Ecolabel criteria should reflect and address the impacts identified in the previous parts of this section. A mapping exercise was performed to translate the current EU Ecolabel criteria for paints and varnishes for both indoor and outdoor paints onto the impacts identified in the paints and varnishes lifecycle, Table 21. Where gaps in the current criteria were identified, additional criteria are suggested for discussion in the following sections and are highlighted in red in the table below. Issues which have appeared since the last revision, such as the use of nanomaterials, which should be considered for inclusion within the revision, are also highlighted in red.

Table 21:A map of the current (blue) and proposed possible new (red) criteria against the lifecycle of paint.

Life cycle stage	Impact	Criteria
Production	Raw material sourcing	1. White pigments 2. Titanium Dioxide 6. Dangerous substances
	Formulation and manufacture processes	*Green house gas emissions* *Water use*
Use	Efficiency in use	7. Fitness for use
	Emissions during use	3. Volatile organic compounds 4. Volatile aromatic hydrocarbons 5. Heavy metals 6. Dangerous substances 8. Consumer information Biocides Nanoparticles Indoor air quality
End of life	Packaging material	Packaging material
	Unused paint disposal	Unused paint disposal

Note: Criteria areas mentioned in the accompanied note from the current Ecolabel decisions of indoor and outdoor paints for consideration in the revision process are in italics.

Appendix 1: Additional Production and trade data

EU production (sold volume) 2008-2009

EU paints and varnishes production (sold volume), value and volume (2009)

Country	Value (€000s)	Volume (tonnes)
Austria	210,881	74,484
Belgium	328,958	81,532
Bulgaria	54,353	56,835
Cyprus	-	-
Czech Republic	98,140	66,452
Denmark	265,683	68,281
Estonia	16,078	11,191
Finland	283,489	83,819
France	2,008,314	724,317
Germany	3,588,368	1,407,876
Greece	239,190	110,244
Hungary	93,136	72,732
Ireland	51,489	-
Italy	2,716,593	1,242,598
Latvia	-	-
Lithuania	5,242	5,678
Luxembourg	-	-
Malta	-	-
Netherlands	863,708	272,619
Poland	511,251	406,615
Portugal	282,562	125,956
Romania	150,470	152,684
Slovakia	25,215	23,834
Slovenia	6,125	6,565
Spain	1,364,005	721,398
Sweden	627,695	229,875
United Kingdom	1,785,238	672,160
Confidential data	302,577	381,539
EU27 TOTAL	**15,878,761**	**6,999,284**

EU paints and varnishes production (sold volume), value and volume (2008)

Country	Value (€000s)	Volume (tonnes)
Austria	270,306	88,701
Belgium	407,368	89,846
Bulgaria	68,823	75,344
Cyprus	-	-
Czech Republic	119,415	103,542
Denmark	162,157	40,476
Estonia	23,059	15,304
Finland	368,564	112,080
France	1,566,417	627,861
Germany	3,543,557	1,527,214
Greece	273,749	120,998
Hungary	111,106	98,495
Ireland	74,606	36,402
Italy	3,066,936	1,397,158
Latvia	-	-
Lithuania	5,637	6,835
Luxembourg	-	-
Malta	-	-
Netherlands	952,439	334,647
Poland	642,119	440,097
Portugal	378,666	177,487
Romania	175,044	130,626
Slovakia	1,728	935
Slovenia	9,679	6,707
Spain	1,679,678	845,984
Sweden	755,367	269,773
United Kingdom	2,084,095	763,420
Confidential data	1,177,099	416,438
EU27 TOTAL	**17,917,613**	**7,726,369**

EU total trade, imports and exports 2008-2009

EU total trade in paints and varnishes, imports and exports in value and volume (2009)

	Value			Volume		
Country	**Imports (€000s)**	**Exports (€000s)**	**Net Exports (€000s)**	**Imports (tonnes)**	**Exports (tonnes)**	**Net Exports (tonnes)**
Austria	196,936	162,510	-34,426	81,981	73,700	-8,281
Belgium	440,284	611,673	171,390	139,215	140,505	1,290
Bulgaria	37,630	10,200	-27,430	14,664	15,239	576
Cyprus	14,388	821	-13,567	6,803	6133.6	-669
Czech Republic	224,308	31,870	-192,438	76,515	70,143	-6,372
Denmark	120,628	153,955	33,327	193,263	228,040	34,776
Estonia	27,060	42,729	15,669	46,888	50,134	3,246
Finland	60,582	115,673	55,091	11,505	16,803	5,298
France	482,551	612,005	129,453	99,102	103,240	4,138
Germany	568,975	1,799,986	1,231,011	17,831	20,371	2,540
Greece	92,895	43,037	-49,858	183,406	193,525	10,118
Hungary	88,439	16,498	-71,941	122,341	120,451	-1,890
Ireland	51,167	6,965	-44,201	26,660	27,042	381
Italy	246,469	669,663	423,193	35,768	34,375	-1,393
Latvia	20,511	9,265	-11,247	30,610	28,390	-2,221
Lithuania	43,731	18,335	-25,396	78,039	106,444	28,404
Luxembourg	23,301	5,463	-17,838	17,880	16,171	-1,709
Malta	7,024	2,659	-4,365	6,476	6020.9	-455
Netherlands	262,272	492,689	230,417	9,429	8,700	-729
Poland	356,219	117,108	-239,111	1,758	1,905	146
Portugal	104,427	96,859	-7,568	105,306	113,148	7,842
Romania	134,701	7,367	-127,334	125,523	124,416	-1,107
Slovakia	101,434	7,920	-93,514	29,368	40,569	11,201
Slovenia	42,957	73,093	30,136	55,576	50,306	-5,270
Spain	346,587	316,857	-29,730	54,012	71,763	17,751
Sweden	153,608	376,827	223,219	12,909	19,348	6,439
United Kingdom	327,516	469,978	142,462	57,915	54,637	-3,278
EU27 TOTAL	**4,576,600**	**6,272,004**	**1,695,403**	**1,640,743**	**1,741,515**	100,773

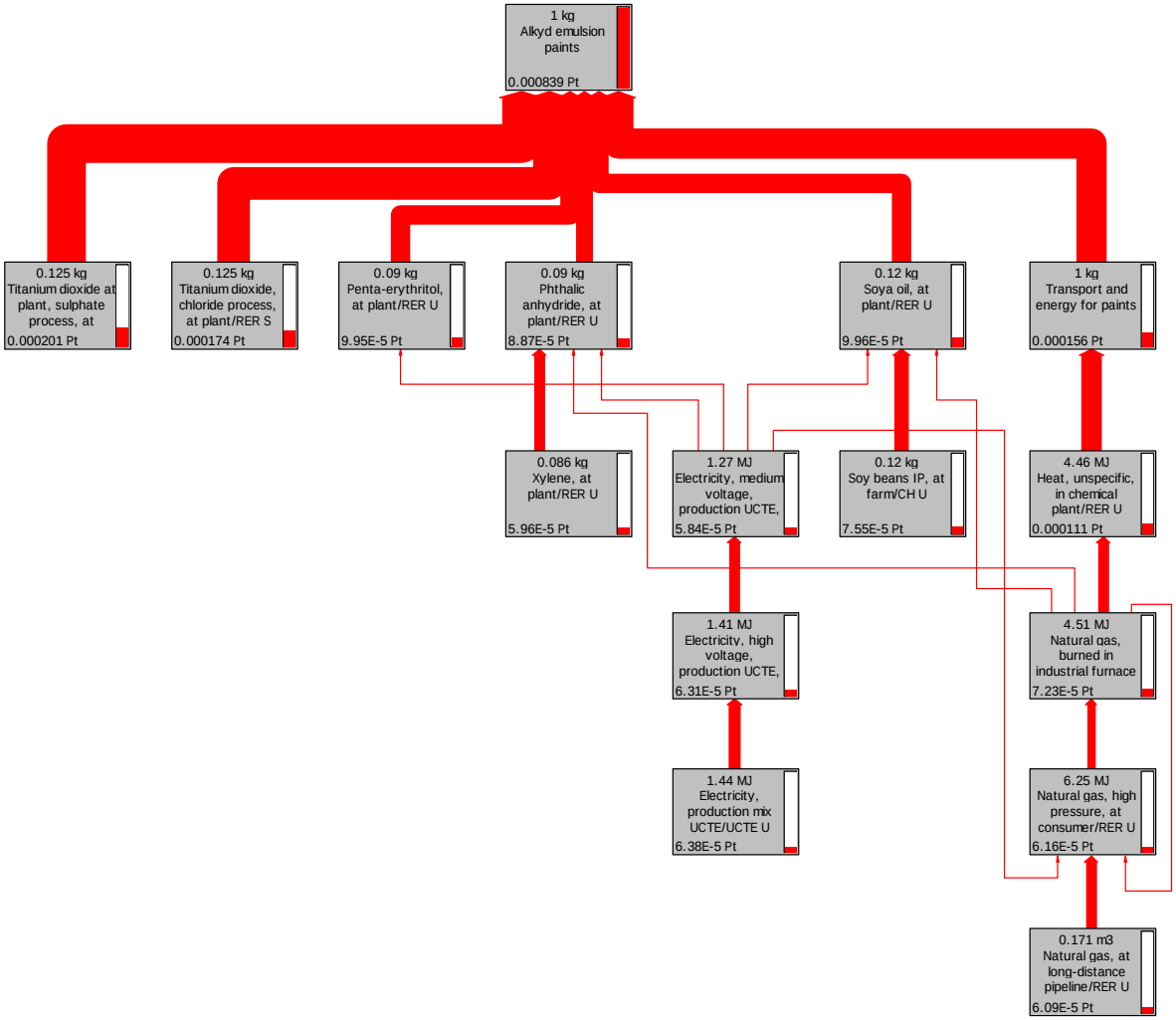
EU total trade in paints and varnishes, imports and exports in value and volume (2008)

Country	Value			Volume		
	Imports (€000s)	Exports (€000s)	Net Exports (€000s)	Imports (tonnes)	Exports (tonnes)	Net Exports (tonnes)
Austria	228,487	206,403	-22,083	89,428	80,395	-9,034
Belgium	463,913	739,144	275,231	146,523	140,522	-6,001
Bulgaria	43,005	13,660	-29,345	15,075	19,320	4,244
Cyprus	17,700	863	-16,837	8,487	8025.8	-461
Czech Republic	262,218	44,913	-217,306	88,508	79,768	-8,740
Denmark	146,874	174,648	27,774	52,278	54,950	2,673
Estonia	39,779	52,590	12,811	16,599	23,578	6,979
Finland	77,112	166,246	89,134	23,292	30,181	6,889
France	544,105	769,035	224,930	196,853	219,063	22,210
Germany	692,701	2,074,507	1,381,806	229,406	265,943	36,537
Greece	117,027	52,071	-64,956	34,971	33,520	-1,451
Hungary	121,941	22,096	-99,846	47,486	45,870	-1,616
Ireland	71,067	3,806	-67,261	39,167	35,335	-3,832
Italy	285,303	799,662	514,359	84,398	116,513	32,115
Latvia	29,651	13,452	-16,200	14,578	13,579	-999
Lithuania	55,445	18,045	-37,400	22,452	19,905	-2,547
Luxembourg	24,418	5,669	-18,748	7,251	6,889	-362
Malta	8,716	2,457	-6,259	2,471	2411.7	-60
Netherlands	325,527	563,671	238,144	111,448	115,337	3,889
Poland	442,074	150,350	-291,725	151,133	151,104	-30
Portugal	123,013	115,030	-7,983	31,108	46,509	15,402
Romania	151,400	5,831	-145,569	64,339	56,226	-8,113
Slovakia	131,064	7,355	-123,709	78,747	74,816	-3,932
Slovenia	49,705	110,005	60,300	15,206	23,442	8,236
Spain	366,835	352,179	-14,656	144,274	149,257	4,983
Sweden	211,121	434,761	223,640	71,866	89,049	17,183
United Kingdom	380,773	603,951	223,178	145,827	144,862	-965
EU27 TOTAL	**5,410,974**	**7,502,400**	**2,091,426**	**1,933,171**	**2,046,369**	**113,199**

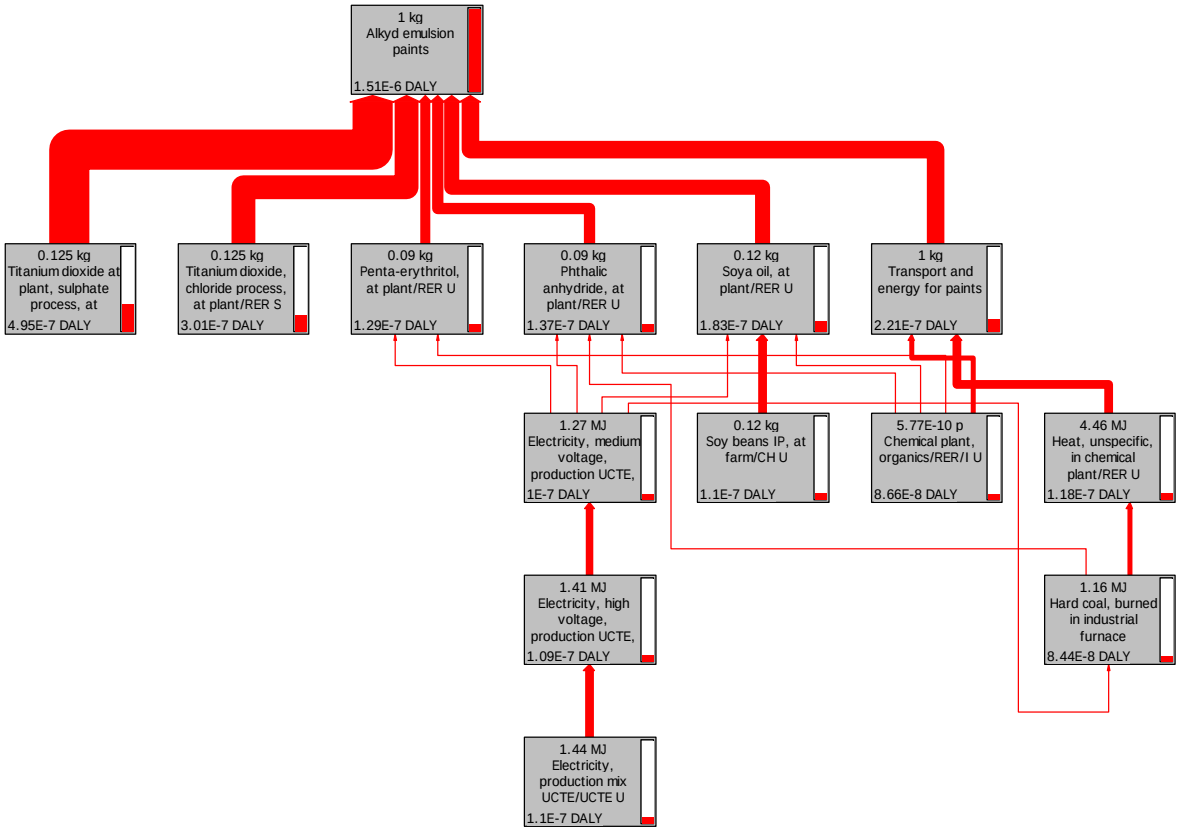
Appendix 2: Unit flow processes for LCA

Alkyd emulsion paint

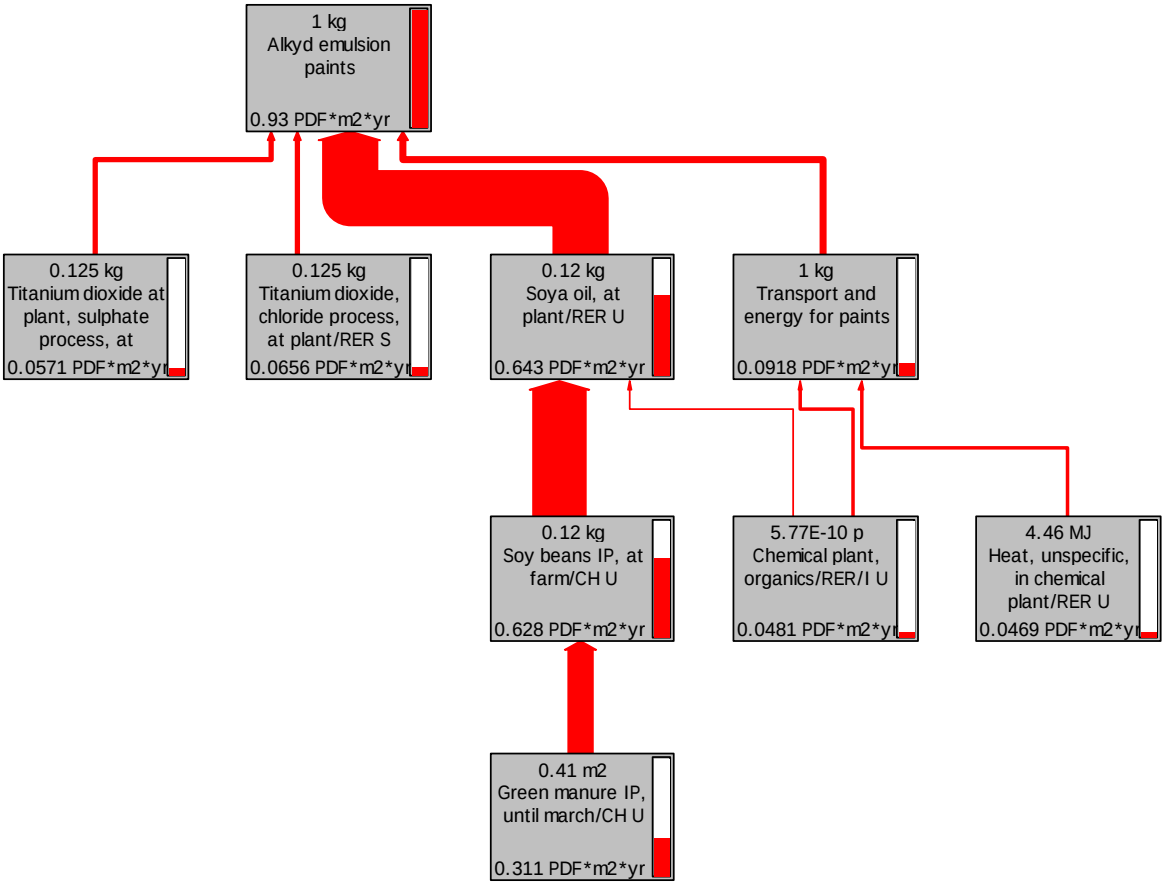
Single score



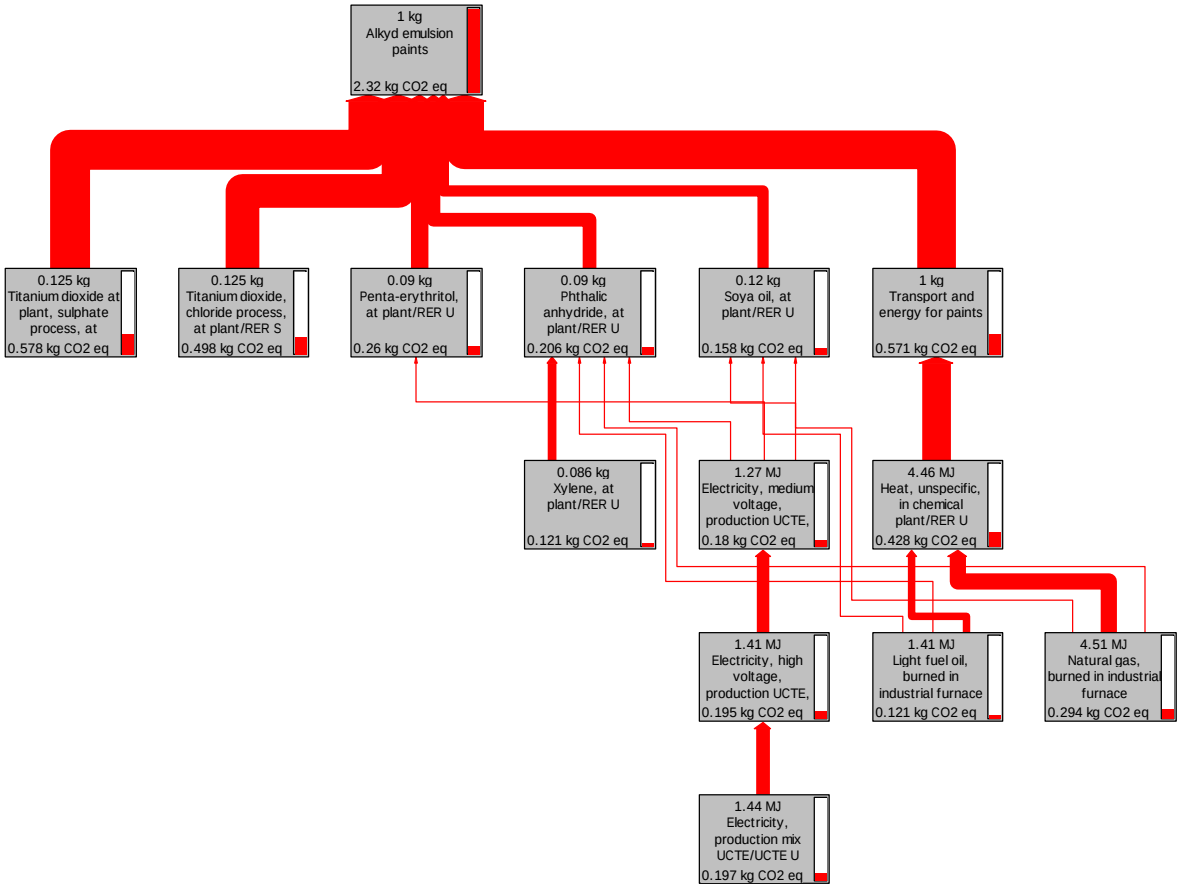
Human Health



Ecosystem quality



Climate Change

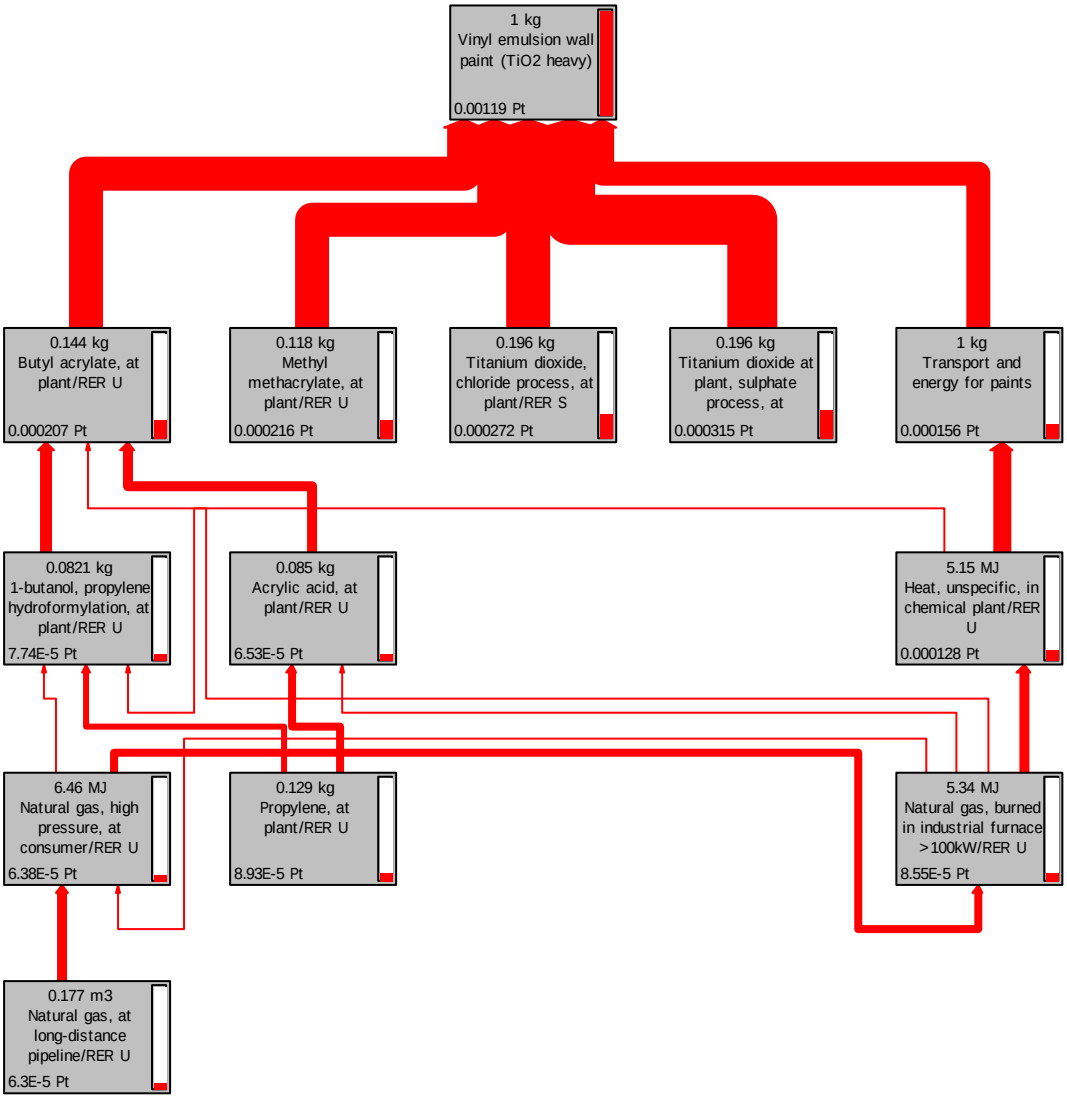


Resources

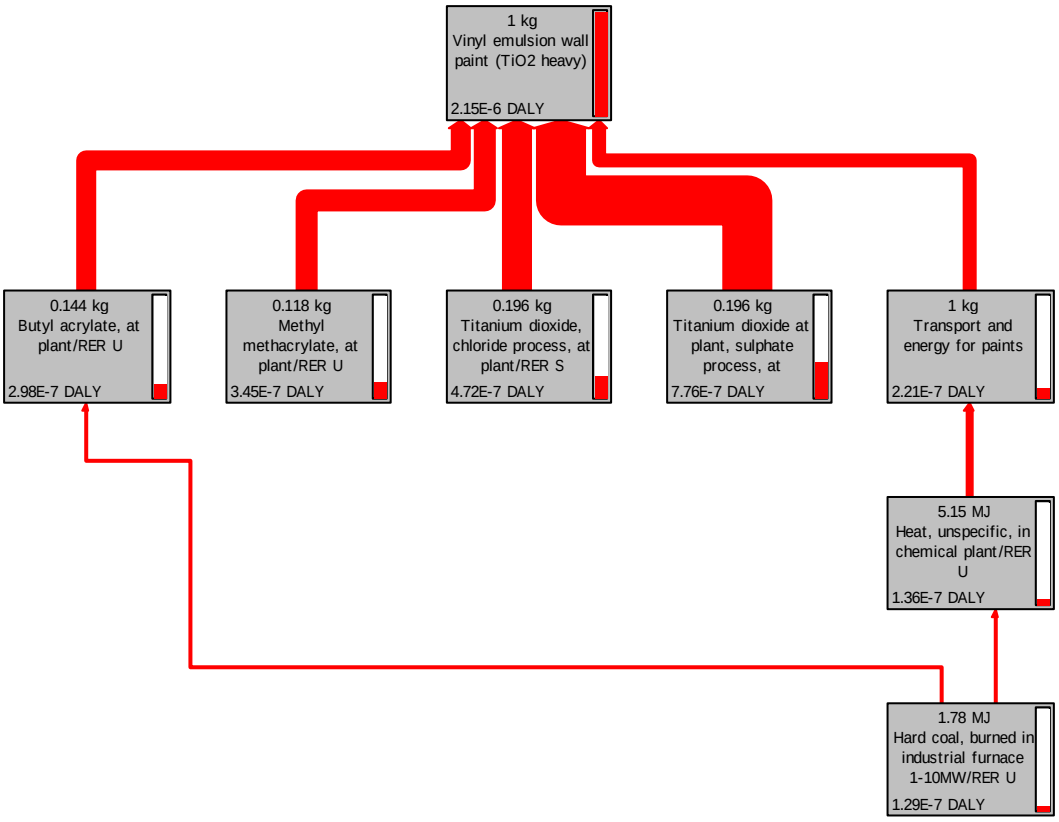

1 kg
Alkyd emulsion paints
49.3 MJ primary
0.125 kg
Titanium dioxide at plant, sulphate process, at
10.4 MJ primary
0.125 kg
Titanium dioxide, chloride process, at plant/RER S
11.5 MJ primary
0.09 kg
Penta-erythritol, at plant/RER U
8.01 MJ primary
0.09 kg
Phthalic anhydride, at plant/RER U
7.15 MJ primary
1 kg
Transport and energy for paints
9.26 MJ primary
0.0847 kg
Formaldehyde, production mix, at plant/RER U
4.01 MJ primary
0.086 kg
Xylene, at plant/RER U
5.76 MJ primary
1.27 MJ
Electricity, medium voltage, production UCTE,
3.76 MJ primary
4.46 MJ
Heat, unspecific, in chemical plant/RER U
7.18 MJ primary
0.0967 kg
Methanol, at plant/GLO U
3.8 MJ primary
1.41 MJ
Electricity, high voltage, production UCTE,
4.1 MJ primary
4.51 MJ
Natural gas, burned in industrial furnace
5.65 MJ primary
6.25 MJ
Natural gas, high pressure, at consumer/RER U
7.73 MJ primary
0.0758 m3
Natural gas, at production onshore/DZ U
3.14 MJ primary
1.44 MJ
Electricity, production mix UCTE/UCTE U
4.15 MJ primary
0.171 m3
Natural gas, at long-distance pipeline/RER U
7.72 MJ primary
0.0627 m3
Natural gas, production RU, at long-distance
3.08 MJ primary
0.0734 m3
Natural gas, at production onshore/RU U
3.07 MJ primary

Vinyl emulsion wall paint (TiO_2 as filler and talc) (5% cut-off)

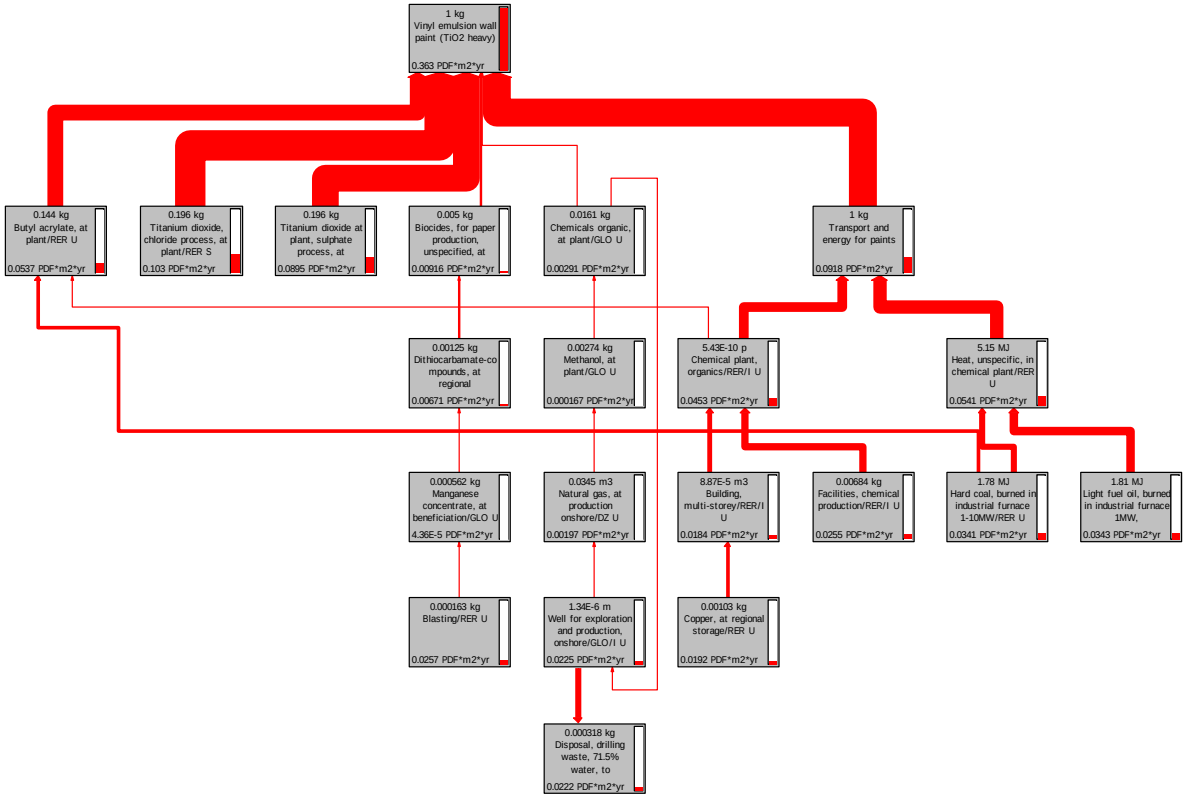
Single score



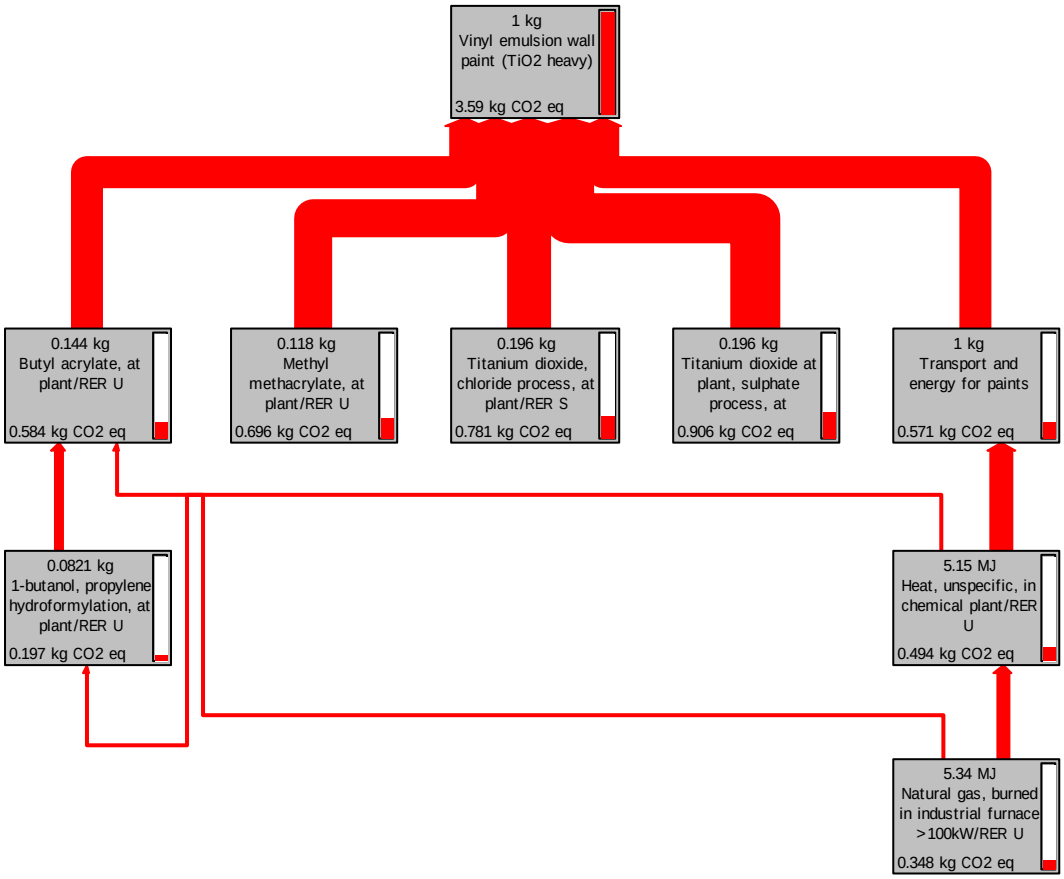
Human Health



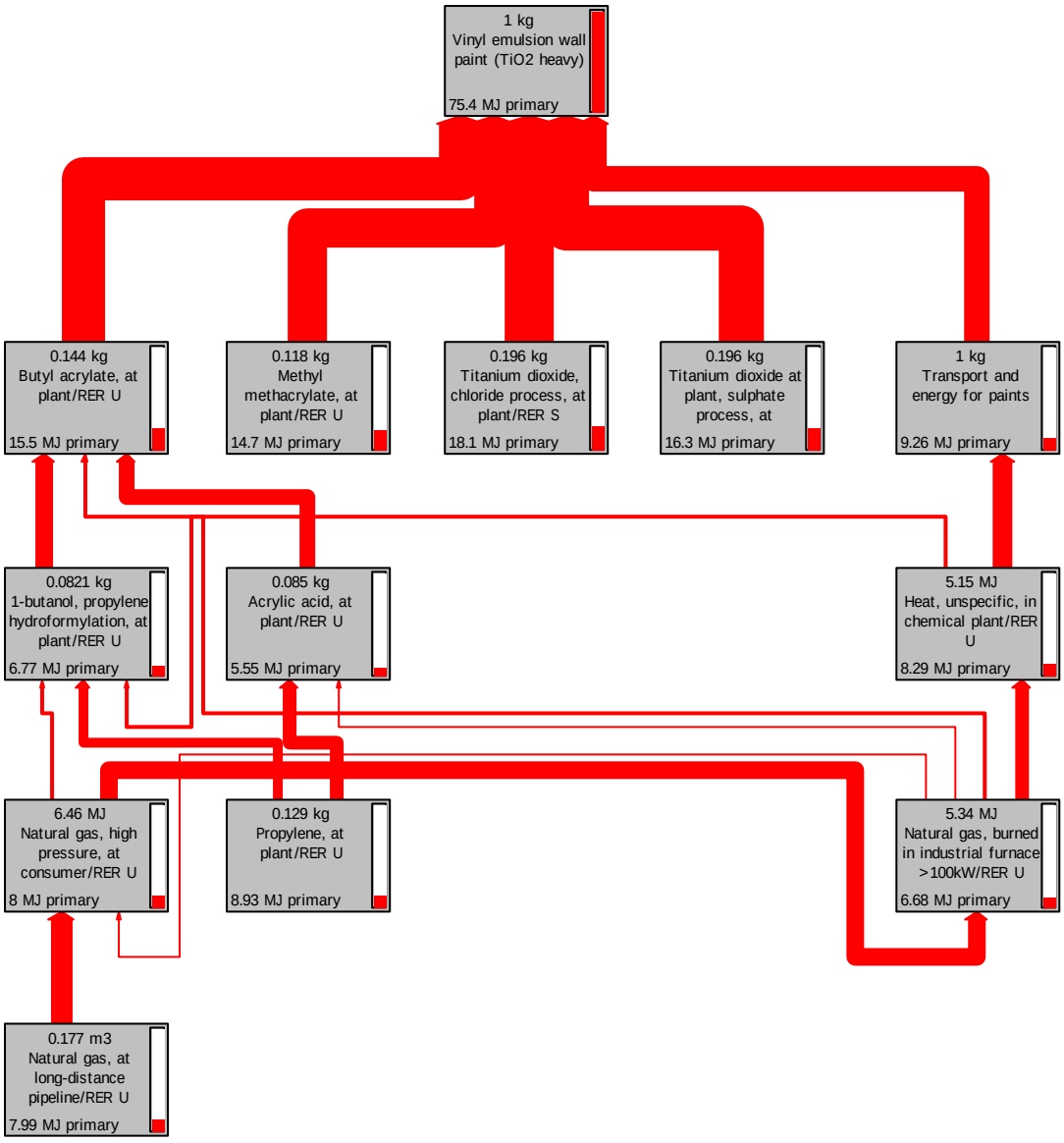
Ecosystem quality



Climate change



Resources


1 kg
Vinyl emulsion wall paint (TiO2 heavy)
75.4 MJ primary
0.144 kg
Butyl acrylate, at plant/RER U
15.5 MJ primary
0.118 kg
Methyl methacrylate, at plant/RER U
14.7 MJ primary
0.196 kg
Titanium dioxide, chloride process, at plant/RER S
18.1 MJ primary
0.196 kg
Titanium dioxide at plant, sulphate process, at
16.3 MJ primary
1 kg
Transport and energy for paints
9.26 MJ primary
0.0821 kg
1-butanol, propylene hydroformylation, at plant/RER U
6.77 MJ primary
0.085 kg
Acrylic acid, at plant/RER U
5.55 MJ primary
5.15 MJ
Heat, unspecific, in chemical plant/RER U
8.29 MJ primary
6.46 MJ
Natural gas, high pressure, at consumer/RER U
8 MJ primary
0.129 kg
Propylene, at plant/RER U
8.93 MJ primary
5.34 MJ
Natural gas, burned in industrial furnace >100kW/RER U
6.68 MJ primary
0.177 m3
Natural gas, at long-distance pipeline/RER U
7.99 MJ primary

Appendix 3: A comparison of Ecolabels

NOTE Nordic Swan have an indoor paints and varnishes that are equiv to EU Ecolabel	Austrian Ecolabel - Paints, Varnishes and wood sealant lacquers UZ01 (2010)	Austrian Ecolabel - Wall paints UZ17 (2010)	German Blue Angel – Low emission paints RAL UZ12a (July 2010) – Varnishes & Glazes	German Blue Angel – Low emission paints for interior walls RAL UZ102 (2010)	Japanese Ecomark 126 – Paint Version 2.3 (2011)	US Green seal – Paint & Coatings (2010) (GS-11)	US Green seal – Stains & Finishes (2009) (GS-47)
VOC limits	8% to 5% (white opaque coatings) and a maximum limit of 3% SVOC (inclusive of impurities)	Wall paints: max of 500ppm and no more than 200 ppm SVOCs	Paints allocated to a group according to % solid mass. Each group Group I < 20 % - 2 mass percent Group II > 20 % to < 30 % - 8 mass percent Group III > 30 % - 10 mass percent. Further restrictions within each group: for compounds with a higher boiling Point. In addition, the individual compounds are toxicologically evaluated by means of a LCI value and this is also restricted	Max 700ppm	No VOC components added in excess of: Solvent based paints – 200g/l Water based paints: Indoor – 1g/l Outdoor – 10g/l	Grams per litre of product excluding colourants & water . Flat Topcoat 50 Non-Flat Topcoat 100 Primer or Undercoat 100 Floor Paint 100 Anti Corrosive Coating 250 Reflective Wall Coating 50 Reflective Roof Coating 100 Grams per liter of product with colourants added at the point-of-sale: Flat Topcoat 100 Non-Flat Topcoat 150 Primer or Undercoat 150 Floor Paint 150 Anti Corrosive Coating 300 Reflective Wall Coating 100 Reflective Roof Coating 150	Grams per litre of product. Varnishes 350, Conjugated Oil Varnish 450, Lacquer 550, Clear Brushing Lacquer 680, Shellacs/Pigmented 550, Finishes Shellacs/Clear 730, Stains 250, Sealer 200, Waterproof Sealers 250, Low Solids Coating 120.
Heavy metal compounds (cobalt, cadmium, chromium IV, lead, arsenic, mercury and other toxic heavy metal compounds)	None except max of 50ppm and 10 ppm for arsenic & cadmium. Mercury can exceed 2ppm if justified. Cobalt max of 0.1% and Manganese at 0.5%.	None except max of 50ppm and 10 ppm for arsenic & cadmium. Mercury can exceed 2ppm if justified.	Lead, chromium and cadmium IV cannot be added – impurities allowed up to 100 ppm (200 ppm for lead	Lead, chromium and cadmium IV cannot be added – impurities allowed up to 100 ppm (200 ppm for lead)	Cannot add: Cadmium 4, Mercury, Hexavalent chromium, Lead, Arsenic	No heavy metal compounds – max 0.01%. Carbon black excepted. Cobalt and manganese may be allowed no more than 0.06% as active metal.	No heavy metal compounds – max 0.01%. Carbon black excepted. Cobalt and manganese may be allowed no more than 0.06% as active metal.
Titanium Dioxide	Allowed - but must be produced in accordance	Allowed - but must be produced in	Allowed - but must be produced in accordance with	Allowed - but must be produced in		Allowed	Allowed

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	with EC-Directive 92/112	accordance with EC-Directive 92/112	EC-Directive 92/112	accordance with EC-Directive 92/112			
White Pigment							
Reactive solvents	No 2 butoxyethyl acetate, diethylene glycol methyl ether, ethylene glycol, triethylene glycol	No diethylene glycol methyl ether, ethylene glycol, triethylene glycol					No halogenated solvents
Plasticizers	No phthalic acid derived plasticisers allowed	No phthalic acid derived plasticisers allowed	No phthalate derivatives or organophosphates	The total softener content must not exceed 1g per litre.	Not allowed: Butyl benzyl phthalate, Diethyl phthalate Di-n-butyl phthalate, Di-2-ethylhexyl phthalate	No phthalates	No phthalates
APEOs	No alkylphenol ethoxylates	No alkylphenol ethoxylates	None allowed	None allowed	No Alkylphenol, Nonyl phenol, 4-octylphenol	None allowed	None allowed
Aromatic hydrocarbons	Up to 100 ppm impurities are allowed	Up to 100 ppm impurities are allowed			Solvent based paints: up to 10 g/l Water based – up to 1g/l (except non emulsions – up to 10g/l)	No more than 0.5% by weight	No more than 0.5% by weight
Hazardous Chemical substances	None classified as carcinogenic, mutagenic, toxic to reproduction or hazardous to the environment	None classified as carcinogenic, mutagenic, toxic to reproduction or hazardous to the environment	No substances classified as teratogenic, carcinogenic, mutagenic, toxic to reproduction or hazardous to the environment	No substances classified as teratogenic, carcinogenic, mutagenic, toxic to reproduction or hazardous to the environment		No Carcinogens, Mutagens, Reproductive Toxins, Hazardous Air Pollutants or Ozone-depleting Chemicals	No Carcinogens, Mutagens, Reproductive Toxins Hazardous Air Pollutants or Ozone-depleting Chemicals
Formaldehyde	10 ppm in the product. Except can be up to 100ppm if the air emission in a test chamber is a max of 0.25 ppm during processing & drying and a max of 0.05ppm after 24 hours after application.	10 ppm in the product. Except can be up to 100ppm if the air emission in a test chamber is a max of 0.25 ppm during processing & drying and a max of 0.05ppm after 24 hours after	10 ppm in the product. Except can be up to 100ppm if the air emission in a test chamber is a max of 0.25 ppm during processing & drying and a max of 0.05ppm after 24 hours after application	10 ppm in the product. Except can be up to 100ppm if the air emission in a test chamber is a max of 0.25 ppm during processing & drying and a max of 0.05ppm after 24 hours after application	No added formaldehyde. Emissions to air less than 5µg/hr/m2 except for Coating Powder, or paints authorized by the Govt.	No Formaldehyde donors	No Formaldehyde donors

NOTE Nordic Swan have an indoor paints and varnishes that are equiv to EU Ecolabel	Austrian Ecolabel - Paints, Varnishes and wood sealant lacquers UZ01 (2010)	Austrian Ecolabel - Wall paints UZ17 (2010)	German Blue Angel – Low emission paints RAL UZ12a (July 2010) – Varnishes & Glazes	German Blue Angel – Low emission paints for interior walls RAL UZ102 (2010)	Japanese Ecomark 126 – Paint Version 2.3 (2011)	US Green seal – Paint & Coatings (2010) (GS-11)	US Green seal – Stains & Finishes (2009) (GS-47)
		application					
Preservatives	Used only for in-can preservation and only Government certified substances with specific limit values between 15 and 200 ppm.	Used only for in-can preservation and only Government certified substances with specific limit values between 15 and 200 ppm.	No micro biocides unless on German approved list and only for in-can preservation	No micro biocides unless on German approved list and only for in-can preservation	Up to 0.5% of product weight		
Water endangering classification				No higher than category 1 of the water-endangering classification scheme (Water Endangering Category 1, slightly water endangering)			
Packaging	No use of halogenated organic based plastics, re-sealable. No sprays.	No use of halogenated organic based plastics, re-sealable. No sprays.			Containers shall be returnable. Containers shall be lead-free metal cans of recyclable design. Containers are collected and recycled. Doesn't apply to certain categories No aerosols	A minimum of 20% recovered material content, except if manufacturer take-back program for recycling in place Heavy metals and phthalates can't be used unless part of recovered material. No aerosols.	A minimum of 25% recovered material content, except if manufacturer take-back program for recycling in place Heavy metals, phthalates, Bisphenol A, and chlorinated compounds can't be used unless part of recovered material. No aerosols.
Disposal	Take back and recovery/recycling system	Take back and recovery/recycling system				Encourage recycling	Encourage recycling
Fitness for use	All claims are tested according to instructions. Standard tests for adhesion, ductility, coverage and dry film thickness etc.	All claims are tested according to instructions. Standard tests for adhesion, ductility, coverage and dry film thickness etc.	All claims are tested according to instructions. Standard tests used.	All claims are tested according to instructions. Standard tests used.	Various tests according to standards specified dependent on prospective use	Various tests according to use, in accordance with specified standards:	Various tests according to use, in accordance with specified standards:
Nano materials	Special attention using	Special attention					

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	Swiss categorisation of risks	using Swiss categorisation of risks					
Production	Waste management systems required in production facility	Waste management systems required in production facility					
End User Information	Expiry date and %age solvents	Expiry date and %age solvents			Instructions on use etc.	Instructions on dosage and use online and in print format	Instructions on dosage and use online and in print format
Residual Monomers			Limited to max 5% of binder				
Anti-fouling ingredients					Triphenyl tins and tributyl tins not allowed	Triphenyl tins and tributyl tins not allowed	Triphenyl tins and tributyl tins not allowed
Irritant components			No components labelled Xi and C				
Other					No Tetradecane, Acetaldehyde No chlorofluorocarbon (CFC5s), specified halogenated hydrocarbons, other CFCs, carbon tetrachloride, trichloroethane and alternatives for chlorofluorocarbon.	No 1,2-dichlorobenzene	No 1,2-dichlorobenzene