



Executive Summary

Life Cycle Assessment of PVC and of principal competing materials

Commissioned by



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Commissioned by the European Commission, July 2004

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Executive Summary

The overall goal of the study was to compile an overview of the publicly available information on Life Cycle Assessments (LCA) on PVC and competing materials, for a variety of applications, in order to assess existing information and to identify information gaps.

LCA comparisons should be undertaken at application level rather than at material level. Depending on the kind of product, the environmental impact during use or after end-of-life can be even more important than the environmental impact of material production (e.g. fuel saving light-weight parts in automotive applications or use phase effects of the cleaning of flooring materials). Approximately 100 LCAs related to PVC have been identified, with only 30 making comparisons at the application level.

Many of the reviewed LCAs do not fulfil all requirements outlined by ISO 14040 ff.

LCAs are strongly goal and scope dependant. Therefore, two studies on the same product system may give different conclusions. LCAs do not aim to evaluate the effects of exposure and hazard related data in the way Risk Assessments do. LCAs identify the important environmental aspects and stages over the life cycle and Risk Assessments analyse exposure and hazard related information. However, they can both be used within one tool-box.

The following general conclusions on PVC and its life cycle can be drawn:

- **Within the PVC life cycle chain, the production of intermediates**, particularly the processes from the extraction of crude oil and rock salt up to VCM production, **plays a major role** for the environmental impacts.
- From a PVC life cycle perspective, the production of stabilisers and plasticizers plays a significant role, whereas the production of pigments offers a comparatively low optimisation potential, because of the small volumes used.
- Some **new technologies** exist, e.g. mechanical recycling based on selective dissolution, **for recycling PVC** in an **economically feasible** way. However, currently only a small amount of PVC post consumer waste is being recycled. Incineration, in conjunction with municipal waste disposal, is a simple option that allows for the partial recovery of energy and substances, if state-of-the-art technology is applied.
- Regarding the **positive effects of increasing recycling rates, mechanical recycling** (or material recycling), which loops the material back directly into new life cycles, substitutes, to a certain extent, the processes of resource extraction, intermediate production and granulation/polymerisation during the production of virgin material. **Chemical recycling** (feedstock recycling) is another option of recycling PVC into another life cycle.
- In contrast to some metals, the recycling market of plastics, and therefore the demand in secondary material, is not yet established in an adequate way. Nevertheless, today and in the near future we see a mix of mechanical and chemical recycling pathways and state-of-the-art disposal routes as the most favourable way to optimise the environmental impacts of PVC and competing materials.
- The **user will not accept recycled products with lower optical or aesthetic quality** (colour, surface quality), even if the technical quality (mechanical properties, dura-

bility) is the same. This is especially true for building, electronic and automotive products.

The most important applications of PVC are in the building and construction sector (windows/shutters, sheets, flooring and pipes), the electric and electronic equipment sector (predominantly cables), the transport sector (plastic, artificial leather, dashboards, structural parts) and the packaging sector (non-beverage packaging). A remarkable amount of LCA information is available for building materials and products, but a strong dependence on the specific results and the goal and scope of the studies case-by-case remains.

The main findings concerning sector- and application-specific LCAs of PVC and its competitors are:

- For **windows**, one of the most important PVC applications, the **available studies** conclude that there is no “winner” in terms of a preferable material since most of the studies conclude that none of the materials has an overall advantage for the standard impact categories. The **most promising potential** for lowering environmental impacts **of windows** is expected through the **optimisation of the design**. Therefore the choice of material is of rather minor importance, as long as the material can provide the required system quality of the window.
- Most **flooring application** studies conclude that linoleum has comparable or slightly fewer environmental impacts compared to PVC flooring of equivalent quality in the production phase. One study (IPU 0013) states that wooden flooring tends to have lower impacts than PVC and linoleum, but is more demanding in the use and maintenance phase. There is little LCA information about carpeting, a main competitor for flooring applications.
- For **roofing applications** the available study concludes that a higher quality of the systems (thermal conductivity per thickness of roofing sheet layers) as well as the accuracy of the laying and maintenance processes has a large influence on the reduction of environmental impacts. The study reports that some polymer solutions tend to have lower environmental impacts than competitive systems.
- The **results on pipes are very heterogeneous**. Some studies see clear advantages for concrete and fibre cement pipes, some report clear advantages for polymer pipes such as PVC and PE, some conclude that the material plays no role as long as no cast iron is chosen.
- The only **toy applications** requiring significant amounts of PVC are applications such as inflatable toys, paddling pools and rubber boats/rafts. The potential risks associated with the misuse of toys (e.g. ingestion, sucking or chewing) are of particular concern. However, an LCA cannot analyse these risks properly, therefore, these concerns should be addressed using other tools, such as risk assessment.
- **Few comparative LCA studies** pertaining to **consumer goods** are available. No useful general conclusions on material comparisons could be drawn.
- The **relevance of PVC in packaging is decreasing**. PVC bottles tend to have comparable impacts to those of PET bottles; however, the market share of PVC bottles in Europe is now minor.

- In the **transport sector** (incl. automotive) many comparative LCA studies including PVC alternatives have been performed. However, these studies are confidential and were not available for analysis in this study.
- **PVC cable** does not seem to have significant competitors in many cable applications, therefore few PVC cable LCA studies exist. Recycling processes have been in place for some time, due to the high economic value of the recovered copper and aluminium. Economically feasible options exist for the recycling of recovered PVC.

No comparative LCA studies exist for materials used **in medical applications**, and little environmental optimisation in medical products has taken place thus far. Taking this into consideration, together with the large amount of waste produced by hospitals as a result of waste medical products, the potential of comparative LCA studies identifying methods for environmental improvement is expected to be high.