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From Green to Market:

An Eco-Integrated Wall-Pack Concept

The presented case study Eco Wall-Pack was worked out in close cooperation with industry as a real life project to be commercialised soon. The product concept integrates a range of aspects. To establish the environmental performance of the proposed product, the life-cycle energy consumption was evaluated and the toxic potential of product materials was determined. A product marketing concept was co-established from the very beginning of the conceptualising phase and industrial design studies were carried out: The aesthetic dimension of technology is viewed as an aspect of sustainability, a market opening and a means for channelling green design into the market. It is true that the price target is the most important factor in developing a green wall-pack. To reach the target, networking is essential.

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Setting the Scenery

The presented case study was conducted within the framework of the ongoing research project ELEKTRA. The project ELEKTRA aims at fostering ecological product innovation and improving the environmental performance of small and medium-sized enterprises (SMEs) of the electronics industry by application of easy-to-use management tools. ELEKTRA is funded by the German Ministry of Education and Science (BMBF) and co-funded by a range of industrial partners. Some aspects of the case study Eco Wall-Pack are part of the presentation of the project ELEKTRA at the EXPO 2000, Hannover.

Wall-packs do have an Impact

The black and clumsy wall-packs are well-known from consumer electronics equipment, as for example answering machines and cordless phones. These plugs house electronics for transforming AC to DC. Today, households and offices are flooded by those power supplies. Some manufacturers are producing an excess of 250 000 units daily. Estimates are that about 90% of all wall-packs feature the inefficient 50 Hz linear technology [1]. With this technology, efficiency is around 50%, in many cases as low as 30%. Switching mode power supplies showing efficiencies above 80%, but trading at about double price, account for only a small market share.

Most of the energy consumed by wall-packs (fig. 1) is wasted in the stand-by mode. Thus, wall-packs contribute substantially to the overall stand-by losses in office and household equipment. These losses were estimated for Germany at 20 TWh per annum (1995). About 11% of the electricity production for households and offices goes to waste [2]. For the European Union, stand-by losses in electric appliances and equipment are estimated at 100 TWh/a [3].

The contribution of AC/DC power supplies in general, or wall-packs in particular, to overall stand-by losses is hard to determine because some equipment uses built-in power supplies, some wall-packs, both in a range of different power ratings and efficiencies. Moreover, product innovation often makes former classification of appliances obsolete. In the fast-changing telecommunications market you often hardly know what you count.

To give a clear idea of the ecological potential related to energy consumption of wall-packs an example might serve to show the difference between the 50 Hz linear and the switching mode wall-packs. According to [2] an answering machine causes standby losses at an average of 4 W. Electric energy consumption is then about 35 kWh/a. With an efficient switching mode power supply (no-load consumption < 0,1 W) the answering machine's yearly energy consumption would be 1,2 kWh only. Substituting every inefficient answering machine (about 8 million units, 1995) by energy efficient technology would reduce standby losses in Germany by 273 GWh/a. Certainly, standby losses in the average answering machine is today less than the 4 W stated in [2], however, a lot more appliances have gone into operation since (total.number of answering machines in Germany 1998: about 13 million units, according to [4]).

Standby losses in consumer electronics have been identified as a major environmental problem. In Europe a group of national legal bodies, the Group for Efficient Appliances (GEA), has set up a scheme for labelling energy-efficient appliances. With regard to wall-packs the labelling criteria is set to no-load consumption of 0,5 W (homepage: www.energeavia.org). However, in Europe legal action on stand-by losses in wall-packs is not likely to ensue. For reducing stand-by losses in domestic appliances, the European Commission backs negotiated agreements rather than for-

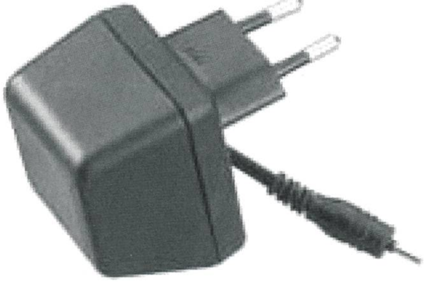

Fig. 1. Standard wall-pack.

Rated Input Power	No-load Power	Consumption
	Phase 1 1.1.2002	***Phase 2 1.1.2005***
0,3 W and < 15 W	0.75 W	0.3 W
15 W and < 50 W	0.75 W	0.5 W
50 W and < 75 W	0.75 W	0.75 W

Table 1. EC External power-supply power consumption targets.

mal regulations [5]. Currently, a Code of Conduct on "Maximizing Energy Efficiency of External Power Supplies" [6] is being discussed. The draft paper provides power consumption targets. Taking into account the scope of possible innovation, these values for maximum no-load power consumption do not appear very ambitious.

Wall-Pack Development Aimed at Ecology and Market Success

It is a simple truth: Eco-products which are not in use cannot unfold their eco-potential. Therefore, a greened prototype electronic circuit board is but a starting point. If the eco-design as an engineering task certainly is a prerequisite for marketing the eco-product, we prefer a twofold approach: designing the eco-product and setting up the distribution and marketing network at the same time. Evidence gathered in the course of the project ELEKTRA proves the basic proposition that commercial enterprises are the most central figures in the process of product innovation. Eco-design and efficiency of household and consumer electronics equipment is thought by the authors to essentially have been triggered by the electronics industry (supply-push), not by legislation or consumer demand (demand-pull), although consumer demand might backup development of eco-products and legislation might instigate the process.
In the case of paving the way to an eco wall-pack, cooperation between power-supply manufacturers and appliance manufacturers has shown to be a crucial problem. Only within this cooperation can the development process result in a price competitive eco-product and hence in market success.
Considering the chances and possible ways of this cooperation, the globalized production chain has to be taken into account. Most of the 50 Hz linear wall-packs are made in the Far East. The same applies to many consumer electronics circuit boards and housings. Wall-packs are enclosed where the appliance itself is produced and both items are sent to the distributors as a set. Therefore, the eco wall-pack's production scheme had to be set into a global frame. When buying certain electronic appliances, customers are used to finding a wall-pack in the product package, not knowing that a multitude of different component and

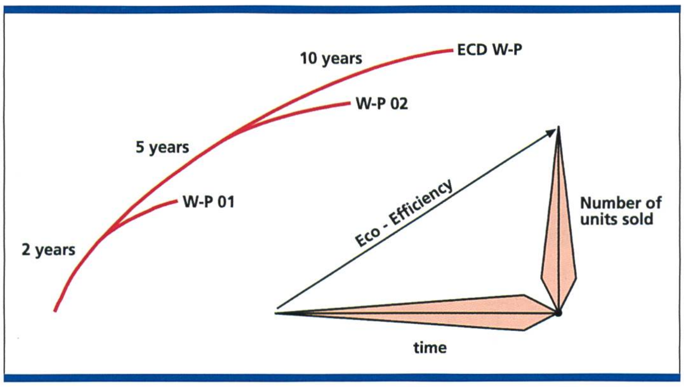

Fig. 2. Stepping towards an eco wall-pack.

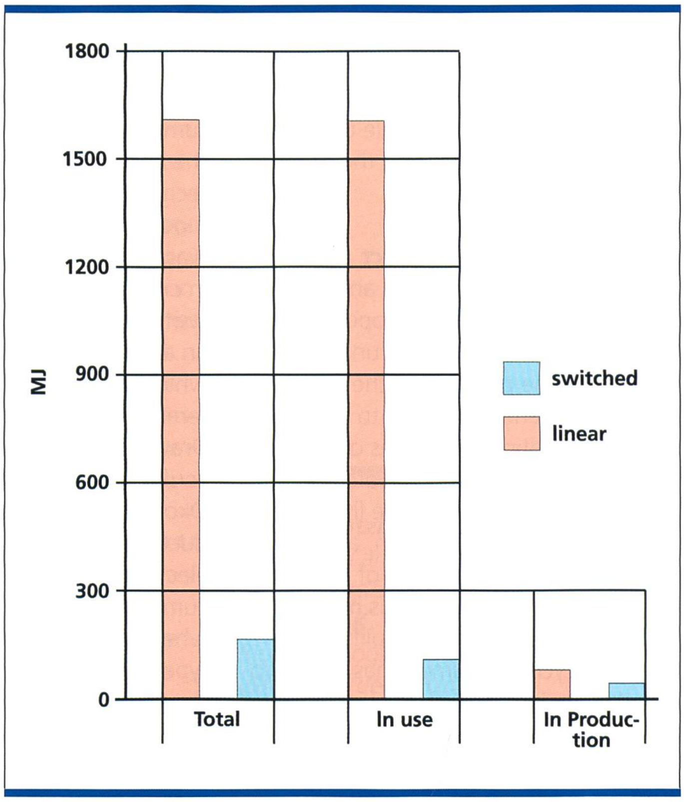

Fig. 3. Exemplary primary energy consumption of wall-pack in selected life phases.

product streams have had to flow together to form the package's content.

Eco Wall-Pack Concept
Greening Wall-Pack Technology

Eco-design of the proposed wall-pack is not attempted in one single effort. Starting one step ahead of the available switching mode power supplies, the eco-performance of the proposed product will be increased over time by implementing step-by-step improvements. Two years from start a wall-pack will be available which shows a considerably lower no-load power consumption than the average switching mode power supply. The no-load energy consumption target is set to 0,1 W.
Striving for better eco-performance the next step will be – besides further lowering of the stand-by losses – to avoid hazardous substances in the material built-up, e.g. lead in the solder and halogenated flame retardants in components and casing. The second-step product will then be available in 5 years from start. In 10 years an "Eco" Wall-Pack should be ready for commercialisation which is worthy of its name due to highly improved energy consumption and very low toxic potential (fig. 2).
The proposed time frame mirrors the limited resources in time, capital and manpower of the small and medium sized industry and takes into account the uncertainty of eco-design principles caused by controversial ratings of processes and product materials. However, in the proposed time scheme eco-efficiency rises continuously, firstly through improving

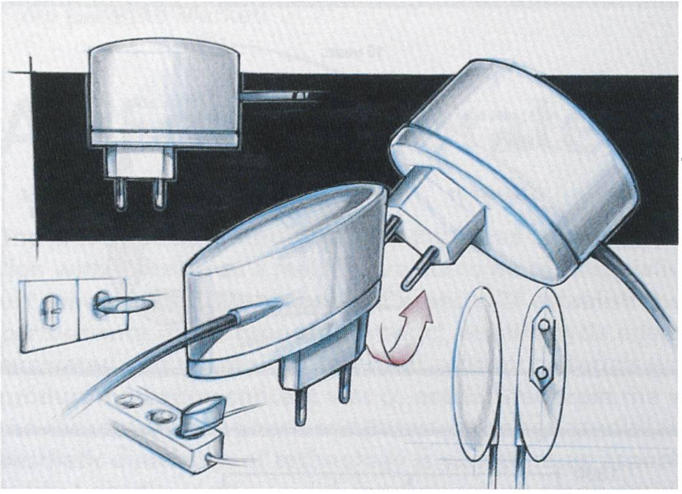

Fig. 4. *Artists view of a wall-pack (Design by: Th. Frackenpohl, D. Kels, B. Wachsmann, M. Wolf).*

the performance of the single unit, and secondly through increasing the number of units sold.

Eco-evaluating the Product

To answer the vital question about the ecological impacts of the proposed product no indepth analysis was undertaken. In line with the principle of the project ELEKTRA to seriously take into consideration the operating conditions of SMEs, simple screening methods were applied, laying emphasis firstly on the life-cycle primary energy consumption, and secondly on the toxic potential of those materials of witch the product is made.
A range of methods for simplifying detailed life-cycle assessment has been proposed by various authors so far and there seems to be growing consent that the general 80/20 rule, which says that 80% accuracy can be obtained with 20% of the effort and data, applies to eco-evaluation as well (see [7] or [8]). In certain cases, when single environmental effects related to product function or material are largely dominating the balance, it might be possible to even surpass the 80/20 rule.

Energy Consumption

In this case study, balancing the life-cycle consumption of primary energy was restricted to the two determining life-cycle phases: the production phase and the use phase. Product distribution, disposal, recycling etc. were thought to contribute only a negligible small fraction to overall primary energy consumption.
The screening showed that the use phase largely dominates the energy consumption. Again within the example of our answering machine, figure 3 gives the "life-cycle" primary energy consumption (production and use phase) for the appliance powered by 50 Hz linear technology and by an efficient switching mode power supply. Product life time was assumed at 5 years. The difference in energy consumption is significant. The switching mode power supply enables an answering machine performance which is better by factor 10 in energy terms.
Drawing on data published in [9] and verifying it with data provided by the Öko-Institut (Freiburg, Germany), production of the analysed switching mode electronics amounts to about 20 MJ accumulated primary energy (KEA), whereas production of an average 50 Hz type electronics of the same power rating accounts for about 30 MJ. This result is largely due to the employment of an equal amount of semiconductor devices in both electronics and might surprise considering a difference in weight of about a factor 10.

Toxic Potential

Screening the toxic potential of materials the analysed electronics sample is composed of was carried out by the Fraunhofer Institute for Reliability and Microintegration IZM (Berlin).
The IZM screening was based on an evaluation model which is not life-cycle oriented but gives an ecological material rating. Table 2 shows the evaluation result.
The Toxic Potential Indicator TPI is a worst-case indicator of the environmental performance of a material. The rating method is based on regulations of the German environmental legal framework, namely the Hazardous Substances Declaration, the Allowable Workplace Concentration and the Water Pollution Clas-

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sification. For more information on the IZM-TPI please see [10].
On the product material level, the switching mode technology has shown to be significantly "greener" as compared to the conventional 50 Hz linear technology. However, the state-of-the-art switching mode technology as represented by the analysed electronics sample shows potential for further improving the ecological performance.

Table 2. Screening results of toxic potential.

Sample electronics	Weight	TPI	TPI/mg
50 Hz type	140 g	211 000	1.5
Switching-mode type	20 g	23 500	1.15

Tuning the Price Target

What is the appropriate price for an environmentally friendly wall-pack with a power rating of, for example, 5 W? Will consumers pay more for saving on energy costs and owning a product with reduced content of potentially hazardous substances? Skipping the lengthy discussion related to this subject, our market analysis gave a simple answer to the question: the interviewed Original Equipment Manufacturers (OEM), who are the customers of the power-supply manufacturers, say no. "No, they are not going to pay more." This means – as it is in many other eco-design cases – the eco wall-pack will be successful only if its price is competitive in a strict sense. And unfortunately, the reference for setting the target is not taken from the state-of-the-art switching mode power supplies, but from the 50 Hz linear technology. Thus, 2 US-$ is the price target.
One way out of this very narrow developmental corridor lies in the systems approach. The wall-pack might carry additional functions which to realise in the appliance itself would only make it more costly.
Another way to avoid the price trap lies in aesthetics. It is not difficult to notice how ugly wall-packs are nowadays. With most domestic and office equipment, the design discrepancy between the appliance itself and its power supply is obvious and from an aesthetic point of view almost inexplicable. Our case study comprises studies in industrial design, exploring the possible looks of wall-packs. Good design, our analysis shows, is a real plus for which customers are willing to pay. Shaping the wall-pack's outer appearance must then be made part of the OEM appliance concept (fig 4).

Networking for Market Success

A range of interviews with central figures has provided evidence that market success of the proposed eco-product will be based not only on realising both high technology and low-cost production, but on networking.
Networks, which are still to be extended, and sustain different tasks were founded on different levels.
Firstly, in the SME power supply company knowledge on product design, processes and market situation was brought together and completed by knowledge from applied science. A somewhat time-consuming detour from the business-as-usual procedure had to be taken by the working group.
Secondly, the need for an intercompany network stretching internationally was identified. Development and production of made-to-order AC/DC power supplies in small quantities (< 100 000 units/a) might successfully be handled within a one-nation-only setting. When it comes to large quantities, a globalization-sensitive scheme must be developed. In the case of the eco wall-pack this means that a production and/or marketing network is to be established covering Asian key countries.
By forming and tightening an outer network as sketched above, the medium-sized company realises a gain in safety of planning otherwise not attainable. 8

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Zusammenfassung

Das Eco-Integrated Wall-Pack-Konzept

Die Fallstudie «Eco Wall-Pack», wurde in enger Zusammenarbeit mit der Industrie durchgeführt. Das Produkt, dem sie galt, soll demnächst vermarktet werden. Das Produktkonzept berücksichtigt eine Vielzahl von Aspekten. Zur Feststellung seiner Umweltleistung wurden der lebenslange Energieverbrauch und das toxische Potential seiner stofflichen Zusammensetzung ermittelt. Von Beginn der Entwicklungsarbeit an wurde ein Marketingkonzept auf die Beine gestellt und die Frage des industriellen Designs in mehreren Arbeiten erörtert. Hierbei wurde die ästhetische Dimension der Technik als Element der Nachhaltigkeit, als Marktöffner und als Mittel betrachtet, umweltfreundliches Design am Markt zu etablieren. Dessen ungeachtet bleibt der Preis die wichtigste Grösse bei der Entwicklung eines umweltverträglichen Wall-pack. Hierzu ist eines unerlässlich: Networking.