ANALYSIS OF PRICE AND NON-PRICE FACTORS INFLUENCING THE ADOPTION OF COMPACT FLUORESCENT LAMPS BY EUROPEAN HOUSEHOLDS

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ABSTRACT

It is often stated that the price of an energy-efficient compact fluorescent lamp (CFL) is the key determinant of consumer acceptance. Little systematic international research has been conducted, however, in this area. This paper presents results of price and non-price investigations into CFL purchasing behaviour in four European countries (France, Germany, Italy, and The Netherlands).

Some surveys designed to determine a "price elasticity" (e.g. percent of households willing to buy a CFL at a given price) are susceptible to bias.
More sophisticated price-perception research results show that there are certain "psychological price points" between which CFL prices are perceived as "normal". A normal price can be interpreted as a price that does not deter the consumer from purchasing the product. An "acceptable cheap" price, is perceived as a bargain price for the product. For prices higher than "normal", or lower than "bargain", consumer interest declines rapidly; lower prices can evoke doubts about product quality and higher prices are seen as too much money to consider buying. The relatively flat and wide "normal" price regions (typically range from ~$12 to ~$20) observed in each of the countries studied, suggest that CFL sales are adversely affected by non-price barriers and frictions in the marketplace. This finding is consistent with the nearly complete lack of correlation between CFL price and consumer response rates for a number of CFL programs held throughout Western Europe.

CFL promotion strategies must do more than focus on providing large financial incentives.

To achieve maximal penetration of CFLs, a multifaceted strategy for building the market should focus on minimizing non-price obstacles, increasing awareness of the benefits of CFLs (including environment), and increasing product availability. Successful efforts to address non-price factors will help reduce the flat price-responsiveness curves found in each country examined and thereby improve consumer price-responsiveness. Once this is achieved, reductions in prices will have more impact on consumer adoption of CFLs. Thus, for optimal results lighting manufacturers, utilities, and others interested in promoting greater use of energy-efficient lighting must address price and non-price factors at work in the market.

1 INTRODUCTION

Edison was more than a producer of lamps or of kilowatt-hours. Rather, he sold illumination. His competition was gas street lighting and the more energy-efficient his electric illumination, the less he had to spend on fuel for the power generation system. Non economic factors such as safety and convenience were also strong selling points for Edison, and remain so today.

Although many utilities today bear names that remind us of their roots as purveyors of lighting services: Oslo Lightworks, Seattle City Light, Long Island Lighting; it has been a century since they were true providers of (efficient) illumination. However, today there are signs of a re-integration of lighting companies and power companies. Electric utilities are investing hundreds of millions of dollars each year in lighting efficiency programs and lighting manufacturers are more actively promoting efficient lighting solutions. In the case of the United States, electric utilities are in fact spending more money each year on incentives to their customers than the lighting industry there spends on all advertising.

Given these profound developments, energy-efficient lighting has once again become an important goal for both industries. Utilities in many countries around the world have conducted various kinds of financial incentive programs for promoting compact fluorescent lamps (CFLs).[1]

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[1] Mills, E. 1992: "Efficient Lighting Programs in Europe: Cost-Effectiveness, Consumer Response, and Market Dynamics." Energy --The International Journal, vol.18, no.2, pp.131-144.

Indeed, these programs are the most widespread form of utility demand-side management (DSM) activity in most countries. Substantial success has been achieved in some of the programs--and world sales are in the vicinity of 150 million CFLs annually--but there remains much to learn about how to most effectively penetrate the market. Central to this goal is a better understanding of the factors that determine consumer acceptance.

There are three contrasting (yet complementary) paradigms concerning the promotion of CFLs (and other energy-efficient technologies).
First is the traditional energy-economic view that holds the price of energy as the driving force. This is expressed formally and quantitatively in a price-demand elasticity.
Second is the appreciation that the (incremental) cost of an energy-efficient technology is an important parameter: one could apply the term "cost elasticity". Thus, thirdly, non-price/cost factors are also seen to play a critical role.

The importance of non-price/cost factors is suggested by Figure 1. The figure shows a dramatic lack of correlation between the cost of CFLs received by consumers in about 40 recent European utility rebate programs and the rate of acceptance (measured in terms of CFLs per eligible household). One can observe from the figure that programs achieving very low consumer prices (e.g. $5/CFL) varied by a factor of ten in terms of the participation rate. Differences in the incomes[2] or prices of energy faced by the program participants do not explain the wide scatter. Rather, it is information and other non-price aspects that give rise to the unpredictable pattern of participation. These findings have two important implications for utility planners. Firstly, the task of achieving high participation rates is more complex than that of simply offering the lamps at a low (or even no) cost to the consumer. Secondly, if non-price factors lead to low participation rates, even very large subsidies and a "reasonable" level of spending on promotion (advertising, mailings, etc.) can ultimately appear as excessive in comparison to the final result: consumer participation.

[2] Along with price, incomes are also typically viewed as being a key determinant of energy-related behaviour. Yet here again, a very weak correlation is observed between total per-capita income for a number of countries versus annual per-capita sales of CFLs (integral plus modular). Although increasing wealth correlates approximately with higher penetration of CFLs, the variation within an income category can be over six-fold (from 50 CFLs/1000 people-year to 300 CFLs/1000 people-year). Hence, the two most important economic parameters (lamp price and income) fail to explain the market penetration of CFLs.

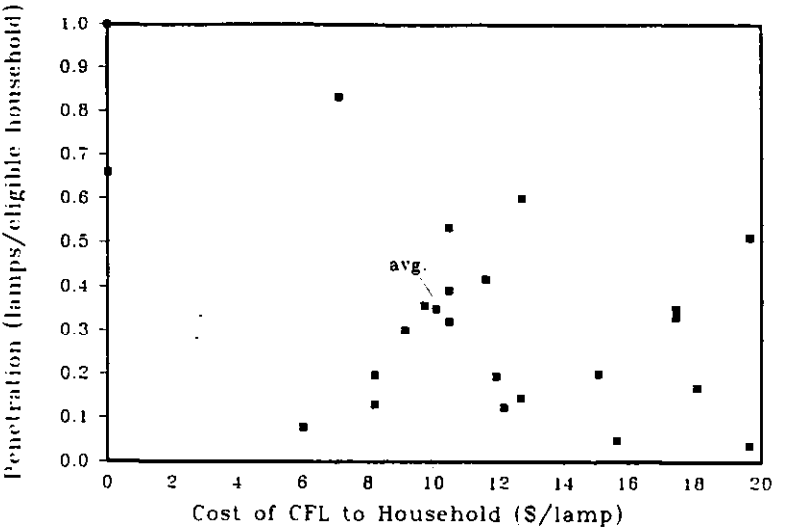


Figure 1 Customer cost (including taxes) versus program penetration rates. Five programs are off-scale: (18, 8.1), (0.6), (0, 3.75), and two with the coordinates (0,2).

The objective of this paper is to examine new survey results for several European countries on CFL price-responsiveness for the household sector. We present the results for France, Germany, Italy, and the Netherlands and identify that price is important in consumer's acceptance, but only to a certain extent. In-depth interviews are used to shed light on non-price factors: consumer's perceptions of the quality and function of light, size of luminaires, physical characteristics of CFLs, belief in benefits, product availability, potential applications with the home, and general awareness of CFLs.

We then suggest strategies and solutions for minimizing non-price factors that tend to work against consumer acceptance of CFLs and to maximize those that work in favour of CFLs. The goal is to better understand how to achieve maximum participation and the minimum cost per unit of energy saved by lighting programs.

Both of these goals are important to electric utilities interested in energy efficiency, and the first goal is of central importance for lighting manufacturers and others in the chain (e.g. distributors and retailers).

2 PRICE-PERCEPTION SURVEY METHODOLOGY

This section describes the research methods used for our analysis, illustrated first by an application of the method to the marketplace for men's shirts. By comparing the differences in buying behaviour for shirts and CFLs, it will become clear why additional research is necessary to identify market barriers (apart from price) concerning the adoption of CFLs by households. At the end of this section is a discussion of the difficulties encountered in the "real world" when trying to isolate price from other influences on consumer purchasing behaviour.

2.1 The Price Perception Technique

Several mistakes can be made, when conducting a price-responsiveness study: (1) When asking the question "what are you willing to pay for this (new) product?", one will end up with unrealistically low prices. (2) Especially in the case of relatively new products, telephone or mail surveys are not the best way to carry out price-sensitivity research, because it will be very difficult to explain the product to the respondents. (3) Lastly, phrasing the question "could you tell me how interested you are in buying this product for $x? and for $y (y<x), etc.?" assumes that consumer interest will necessarily increase at lower prices.
As demonstrated below, for some products this is not the case.

To cope with these price research problems, market researchers developed a technique to study consumer price perception: "The Price Perception Technique"[3]. Importantly, it yields a good description of "pricing areas" in terms of consumer perceptions.

2.2 Applying The Price Perception Technique in Surveys

The basis of the Price Perception Technique is the observation that buyers, when confronted with a continuous list of prices for competing products (e.g. in shops), perceive them in different ways.

[3] Westendorp, P.H. van, N.S.S. Price Perception Technique, Esomar, Montreux, 1974

Our survey included the following four questions:

1 At which price in this list you begin to feel that <the product> is cheap?

2 At which price in this list you begin to feel that <the product> is expensive?

3 At which price in this list you begin to feel that <the product> is so cheap that you doubt you can get good quality at such a price?

4 At which price in this list you begin to feel that <the product> is so expensive that you would never buy such a brand at such a price?

Most consumers (80-90%) will be able to answer these questions. It is important, to include both the lowest possible and highest possible perceived prices in the range. This means that it should range from a "ridiculously low price" to a "ridiculously high price".

2.3 Illustration of Survey Results of The Price Perception Technique: The Case of Shirts

The survey results of the Price Perception Technique will be shown in two ways; by (a) the "potential market" and (b) price ranges.

Ad a) The "potential market" is the fraction of consumers who are still "in the market" at a certain price.

Consumers who are "out of the market" find the product for this price either too cheap (because they distrust the quality, see question #3 in the preceding list) or too expensive to consider buying (question #4).

The potential market, at a certain price, consists of 3 parts: (1) price perception is "acceptable cheap". This is the percentage of respondents who perceive the price as cheap, minus the percentage who perceive it as too cheap. (2) price perception is "acceptable expensive". This is the fraction of respondents who find the price expensive, minus the fraction who find it too expensive. (3) the remaining part of the potential market experience the price as "normal", which is defined as not cheap, and not expensive. For men's shirts, the potential market is plotted in Figure 2.

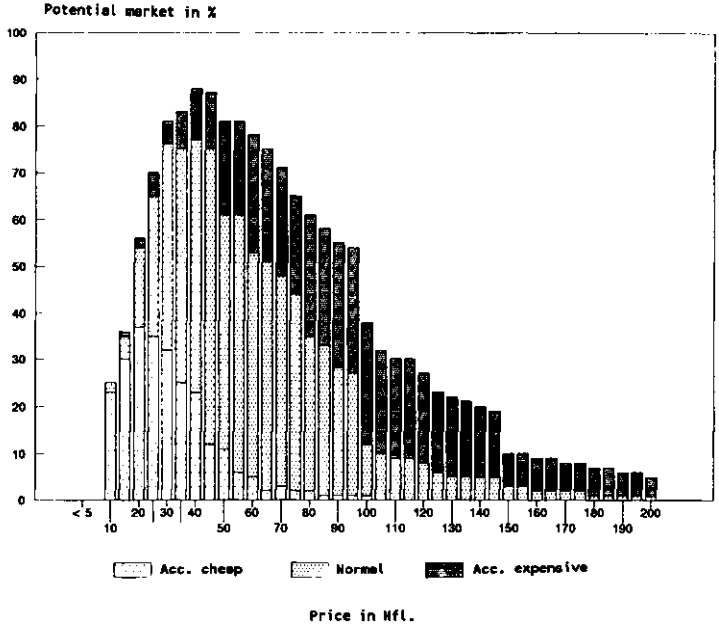


Figure 2 Price sensitivity (market potential) in the purchase of men's shirts (Courtesy of NSS Marktonderzoek B.V., 1993).

Notice the clear "peak" in the graph (highest potential market Hfl. 45) and the areas left and right of this peak, which show a clearly declining potential market, implying a price-sensitive consumer base. Also notice that thresholds in pricing can be detected in the graph.

Ad b) Price ranges. Thresholds in pricing can be better illustrated by determining price ranges. As shown in figure 3, the "normal range" for men's shirts is between Hfl. 27 and Hfl. 77.

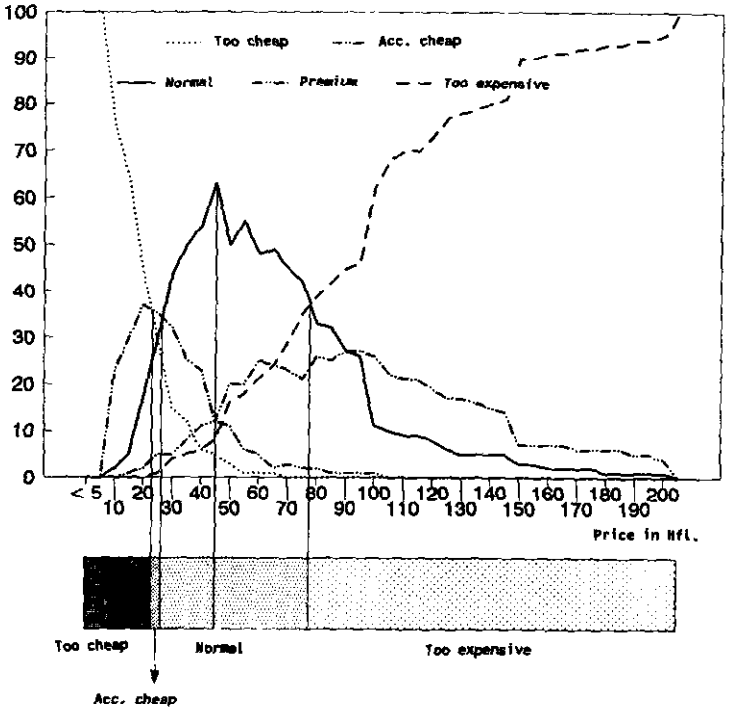


Figure 3 Price ranges in the purchase of men's shirts

The reason for showing these results for shirts is to illustrate that within the "normal range", for some products, consumers are price sensitive. That consumers are price sensitive, even within one price range (the normal range), is a reflection of the great variety of shirts and prices, consumer awareness of price differences, and consumer perception that choice of shirt is a means of differentiating themselves from other people.

2.4 The Price Perception Technique and CFLs

In 1992, Philips Lighting B.V. carried out price-perception studies in France, Germany, Italy and the Netherlands. Total number of interviews was 1910.

Respondents were residential households, both users and non-users of CFLs, evenly divided between 25 and 65 years of age. Of all respondents, 50% was male and 50% female. The sample was representative for all social classes (A, B, C and D).

When comparing CFLs with shirts, there are quite a few differences, including a smaller perceived variety of products to choose among, lower variation in quality (at least in the eyes of consumers), lamps are a low-interest product; and consumers do not distinguish themselves by buying an expensive lamp.

This means that a simple "lower-price strategy" only, would be insufficient to maximize penetration of CFLs in homes. Because of this, we needed to do, apart from price research, qualitative research into consumer perception, and buying behaviour. The investigation included in-depth interviews with 80 consumers, both users and non-users in the Netherlands and Italy. The investigation was partly carried out in 1992, and partly in 1993.

2.5 Price Perception Technique and "the real world"

The price-perception curve can be usefully viewed as a relative scale rather than as an absolute one. For example, very low income households (or those in developing countries) would experience a curve shifted considerably to the left from those shown in this paper for relatively wealthy countries. Furthermore, utility rebates or other forms of financial assistance will have the effect of shifting the curve to the right. In any case, a price-perception curve reflects consumer attitudes and awareness at the time of the survey; thus, the curve can change over time as the consumer's decision-making environment changes.

3 PRICE-PERCEPTION SURVEY RESULTS

This section focuses on the potential market, price ranges, and why there is little difference between users/non-users and among different types of lamps.

3.1 Price ranges

Figure 4 compares the price ranges for PL*Electronic (PL*E) lamps, in France, Germany, Italy and The Netherlands. The results were made comparable, by converting all currencies into Dutch guilders (Hfl), based on December 1992 exchange rates.
For reference sake, the local currencies are between brackets.

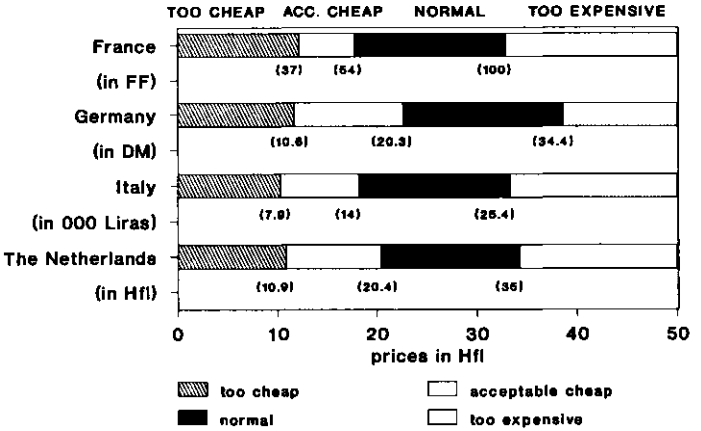


Figure 4 Price ranges for PL*E lamps

As can be seen from this figure, the differences between the countries are not very large. The "normal" price range is typically between Hfl 20 and 35 (~US$ 12 and ~20) in all surveyed countries. In each country, the variation from the price points Hfl 20 and Hfl 35, is no more than 10%. Prices above the normal range are perceived as "too expensive" and there is no "premium", or "acceptable expensive" range. The "bargain" ("acceptable cheap") range is between Hfl 10 and 20, but prices below this level are perceived as too cheap (i.e. questionable product quality).

3.2 Potential market

The potential market consists of the fraction of consumers who are still "in the market" at a certain price, because the price is perceived as "acceptable cheap", "normal" or "acceptable expensive". Figures 5a-d show the market potential for France, Germany, Italy, and the Netherlands.

figure 5a

GERMANY
(users)

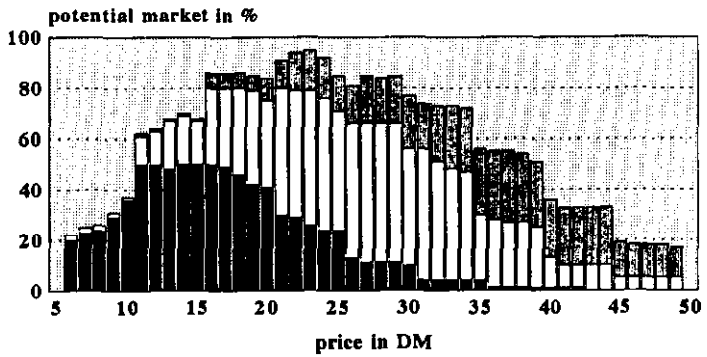
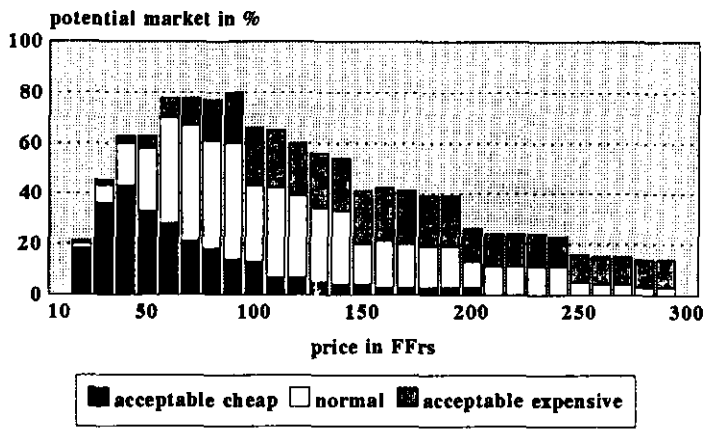


figure 5b

FRANCE
(users + non-users)



Figures 5a-5b Price-sensitivity (potential market) curves for PL*E lamps in France and Germany.

figure 5c

ITALY

(users + non-users)

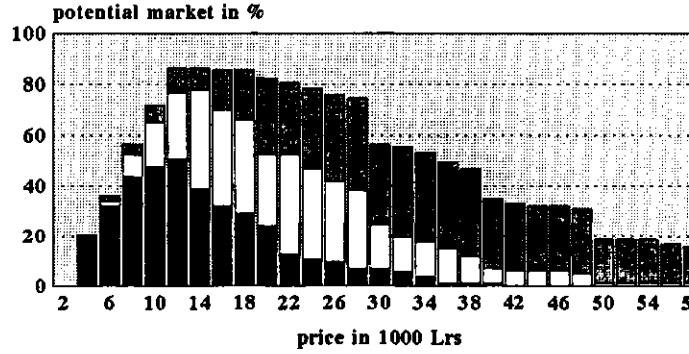
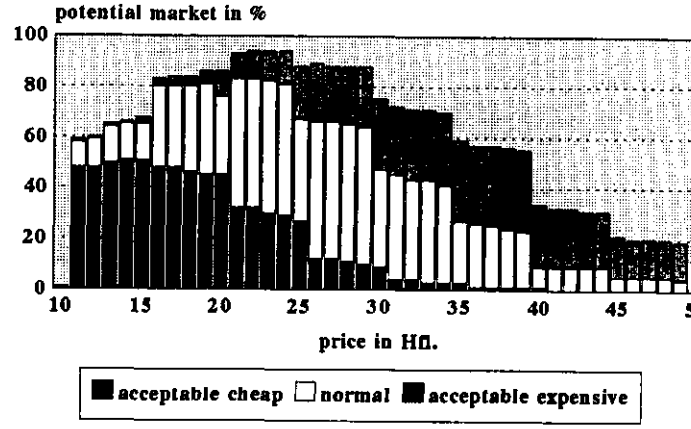


figure 5d

NETHERLANDS

(users)



Figures 5c-5d Price-sensitivity (potential market) curves for PL*E lamps in Italy and The Netherlands.

Notice from the diagrams that there is no clear "peak", which means that there is not one specific price, for which we can expect the largest market; and the price range with a high potential market (80% of people surveyed or more) is very wide. Both observations indicate that the consumer market for CFLs is not price sensitive. But this statement is only valid within the "normal price range" and part of the "acceptable cheap" range. For prices above the normal range ("too expensive"), the potential market drops drastically (e.g. from Hfl 34 to 40, potential market is reduced by 50%).

As shown by comparisons between Figure 5a (German users) and Figure 6 (German non users), the price-sensitivity does not differ significantly among users and non-users.

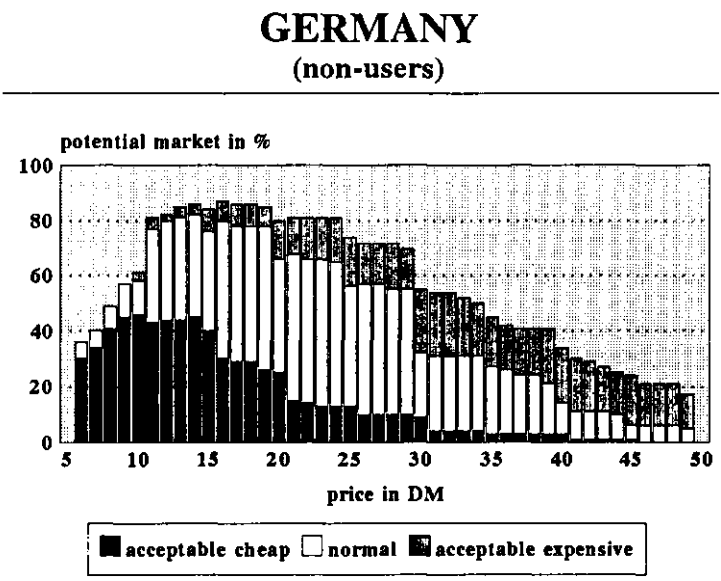


Figure 6 Price-sensitivity curve PL*E, for German non-users

A discount of approximately 5DM would roughly align the German non-users with users.

By comparing Figure 5c (Italy, PL*E) and Figure 7 (Italy, SL), we can conclude that the price perception does not differ much between different kinds of CFLs either (electronic versus magnetic).

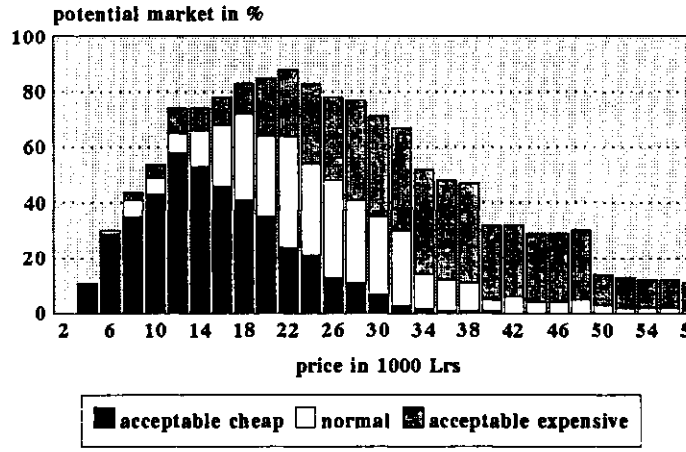


Figure 7 Price-sensitivity curve SL lamp, Italy

This relates to the earlier observation about low consumer awareness of differences among products.

The overall conclusion from this section is that, unlike the case of shirts, we see that the marketplace for CFLs is rather un-responsive to price. This conclusion is valid for different countries, target groups (e.g. users and non-users) and different CFLs. The following section presents some possible explanations.

4 NON-PRICE FACTORS INFLUENCING CONSUMER ADOPTION OF CFLs

This section discusses non-price factors, influencing the adoption of CFLs in homes. We choose Italy and the Netherlands because Italy represents lighting in South Europe and the Netherlands represents North Europe. The following discussion is based on in-depth interviews. Given the small sample sizes, the results are qualitatively indicative rather than quantitatively precise.

Lighting in homes. In the purchasing process for lighting, the features of the luminaire (especially design) are the determining factor, not the lamp. This is especially the case in the living room, where "image" is more important than in functional rooms like the kitchen or bathroom.

Consumers' knowledge about lighting is limited. One of the reasons for this is the fact that when buying a luminaire it is difficult for the consumer to imagine the lighting optical performance at home.

Most respondents distinguished between functional and atmospheric lighting. Functional lighting is lighting for reading, working or orientation (e.g. hallways, outdoor). For functional lighting one requires much (white) light in order to see well. "Atmosphere" or "cosyness" is not important. Atmospheric lighting is usually wanted in the living room. There is a difference between consumer preferences for atmospheric lighting in the Netherlands and Italy. The general preference in the Netherlands is soft, warm light and a low lighting level. In Italy, consumers prefer white light and a higher level. This partly explains why halogen is so popular in Italian homes (the other reason is, of course, the availability of well-designed luminaires designed for halogen lamps). Linear fluorescent ("TL") light for atmosphere lighting is unpopular, both in Italy and the Netherlands.

Perception of CFLs. Although CFLs have improved substantially in the last 5 years (size, weight, light distribution), they still have the image of big, bulky TL-light-like lamps, which are restricted to functional areas (outdoor, kitchen, hallways, ...). As a result, especially non-users have doubts about CFLs in the living room; they do not associate CFL with atmosphere lighting.
We assume that an important part of this association is because of image, not real experience. Evidence for this assumption is the fact that most users discover that the lamps can also be used indoor: 40-45% of the residential CFL sockets in Germany and the Netherlands are in the living or dining room. In the Netherlands, these users do not have negative reactions about CFLs. In Italy, they even have positive reactions: light that is "strong", "luminous", "bright", "diffused", and "free of shady patches".

Size of luminaires, sockets and burning hours. For this section, we use data from so called "Light in House" studies, which include data on sockets and type of lamps in homes. Many consumers complained that CFLs would not fit in their luminaires. This is especially a problem in Italy, where more than 50% of the sockets are E14 (small socket) for candle or lustre lamps.

The size of these luminaires, and the shape (decorative) of the candle/lustre lamps, hardly permit replacement by CFLs.

In the Netherlands (1989) and Germany (1991) surveys found approximately 30 incandescent lamp sockets per household. When analyzing the possibilities for a higher penetration of CFLs in homes it is very important to have an idea about burning hours. In the Netherlands, respondents were asked for each socket, if it was used for basic lighting ("does the lamp always burn at darkness, when someone is at home?"). Of these so called "basic lighting sockets" 51% were in the living room, while only 28% of total sockets were in the living room. Second was the kitchen: 13% of basic light sockets and 9% of total sockets, followed by bathrooms plus hallways (13% and 21%) and by outdoor lighting (8% and 10%).

Consumer awareness of CFLs. In most countries in Europe, the awareness in terms of "have you heard of energy-saving lamps?" is high (>80%). But the qualitative research in Italy and the Netherlands showed that the level of information about the features of these lamps is low (energy savings, lifetime). Another problem is the lack of awareness about different types of CFLs, especially about the recent models. This was a problem in the Netherlands and a bigger problem in Italy.

(Perceived) availability. For consumers, CFLs are available in traditional lighting shops, and in most non-traditional outlets like Do-It-Yourself, Department Stores, Cash & Carries and Hypermarkets. This is the state of the art in both Italy and the Netherlands. Still, the perceived availability is low. Respondents complain, that it is difficult to find CFLs in the shop. The reason for this is the fact that people are nowadays used to buying their incandescent lamps in supermarkets. CFLs in the Netherlands are not available in supermarkets, and in Italy only in the very large supermarkets.

Conviction in benefits. Consumers are convinced that CFLs save energy, but they are not convinced that it will save them money. The reasons quoted in the market researcher were: (1) consumers have no idea about the influence of lighting on their energy bill; too difficult to estimate. (2) if they consider trying to lower the bill, they think about lowering the wintertime thermostat setting, closing the curtains at night, using electrical appliances less frequently, etc. but not about CFLs, and (3) consumers cannot verify the savings on their energy bill.
Utilities have greatly increased their promotion of efficient lighting via their residential CFL campaigns. The reason for this is the fact that consumers believe the utilities' message, because they are regarded as objective institutes.
Although consumers cannot prove that CFLs save money, the most quoted reasons for buying CFLs are to save energy, obtain longer-lived lamp, to save money, and to help the environment. Environment is an especially important reason to buy CFLs in the Netherlands, because it is emphasized by utility campaigns.

5 DISCUSSION AND RECOMMENDATIONS FOR PROGRAMS AND POLICIES

The non-price factors discussed above contribute to the flatness of the price-response curves. This situation reflects that lamps, in general, are a low involvement product (not much interest to consumers). Moreover, consumers often have a negative perception of the product (big, bulky, TL-like light), especially among non-users, and because it does not fit the lighting needs (or the luminaires) in the living room (wrong light quality/atmosphere). Lastly, low awareness, little conviction of the benefits and low (perceived) availability also hamper consumer receptiveness to CFLs.

To address these factors, emphasizing the practical application of CFLs may have more appeal to certain consumers than would stressing their applicability for "atmospheric" lighting. In addition, utility campaigns can play a larger role in increasing consumer awareness of the modern CFL technology (and how it has changed in recent years), and can even offer "return-for-full-refund-if-not- satisfied" offers to allow sceptical consumers to become familiar with the technology before making a financial commitment to it. Lastly, placing more emphasis on environmental benefits--especially if done by non-manufacturer groups, such as governments--can stimulate new interest in CFLs.

For lighting manufacturers, energy planners, and others interested in building markets for energy-efficient lighting, the price-perception curves shown above may be looked upon as something that can be managed and re-shaped. Efforts to reduce non-price barriers (and to increase awareness of non-price benefits such as CFLs' long life, their "high-tech" appeal, cooler operating temperature, and their emissions reducing effect) can play a central role in this process.

Tools that can be employed towards this end include:

* Improved information
* Financial incentives to consumers
* Financial incentives to retailers
* Changing the form of the price (e.g. pay-on-the-bill over time)
* Increasing product availability
* Product development
* Legislation

Prospective parties in this process include:

* Lighting manufacturers
* Electric utilities
* Government agencies
* Third-party retailers or entrepreneurs
* Non-governmental organizations
* International lending agencies

Two particular program case studies illustrate the most and least successful utility-sponsored CFL programs to-date, and serve as a useful demonstration of the role that can be played by the tools listed above.

The French utility EDF's program on the Caribbean island of Guadeloupe illustrates the successful integration of many of the items listed above. The program was announced to the public on television jointly by the French Agency for Environmental and Energy Management (Ademe) and EDF; financial incentives (rebates) were given to consumers (~$25/lamp) and retailers (~$1/lamp); consumers were allowed to pay for the lamps in instalments through six sequential electricity bills; and the lamps were made widely available throughout the island (over 80 stores carried them during the campaign). The result was 358 000 lamps sold to 44 000 households (37% of all households).
This is the most successful CFL campaign yet held in the world.

In contrast, one of the most unsuccessful programs was held in Sweden in 1990.

In this case, consumers received inadequate information about the lamps, availability was severely limited, the financial incentive was much lower than on Guadeloupe, and government cooperation with the utility was not visible. The result was less than 1% participation.

6 CONCLUSIONS

The flat price-response curves found for compact fluorescent lamps are evidence of market barriers/failures. As a result, consumer price-sensitivity is diluted by non-price factors.
Importantly, certain commonly-used survey methods fail to reveal this phenomena.

The great variation of success among previous utility-sponsored financial-incentive programs for CFLs was shown in Figure 1. One explanation for this is evidence of inadequate attention to non-price factors in some of the less successful programs. To achieve optimal results, non-price implementation methods must be used hand-in-hand with price management. There can even be a productive feedback between gradually reducing non-price barriers (and thereby boosting demand) and subsequent price reductions as a result of improved scale economies.

CFL promotion strategies must do more than focus on providing large financial incentives. To achieve maximal penetration of CFLs, a multifaceted strategy for building the market should focus on minimizing non-price obstacles, increasing awareness of the benefits of CFLs (including environment), and increasing product availability. Successful efforts to address non-price factors will help eliminate the flat price-responsiveness curves found in each country examined and thereby improve consumer price-responsiveness. Once this is achieved, reductions in prices will have more impact on consumer adoption of CFLs. Thus, for optimal results lighting manufacturers, utilities, and others interested in promoting greater use of energy-efficient lighting must address price and non-price factors at work in the market.