USING FINANCIAL INCENTIVES TO PROMOTE COMPACT FLUORESCENT LAMPS IN EUROPE
Cost Effectiveness and Consumer Response in 10 Countries

Evan Mills
Department of Environmental and Energy Systems Studies
University of Lund
Sweden

Abstract

Between late-1987 and mid-1991, many electric utilities in Europe offered financial incentives to promote the use of energy-efficient compact fluorescent lamps (CFLs). At least 51 programmes have taken place in 10 countries: Austria, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Sweden, Switzerland, and the United Kingdom. These programmes represent the "state-of-the-art" in electric demand-side management in Europe. About 7.2 million households have been eligible for the programmes, acquiring about 2.2 million CFLs. For the seven countries (39 programmes) where data were available, the average societal cost of energy saved in the programmes was 2.1 cents/kWh (22 mECU/kWh), including 0.3 cents/kWh for programme administration and marketing. This is very cost-effective from a societal perspective, i.e. approximately one-third the cost of building and operating new electric power plants. Some of the programmes have been available to non-residential customers.

Post-program surveys contain a significant amount of useful information on programme impacts, consumer response, and broader market response. Key findings include: (1) the most societally cost-effective programmes resulted when utilities paid a high proportion (or all) of the cost of the efficient lamps, (2) consumer penetration rates correlate very weakly with the level of incentives, (3) information-only programmes achieved the lowest penetration rates (lamps/eligible household), (4) the form of the incentive is an important determinant of participation, (5) non-economic factors are at least as important as economic factors in determining participation, (6) women and men respond differently to lighting programmes, (7) pensioners and occupants of single-family homes are overrepresented as programme participants in relation to their representation in the total eligible populations, (8) consumer self-reported interest in buying CFLs is highly sensitive to lamp prices, with a strong increase in interest at a price of about $10 to $15 (7 to 10 ECU/lamp), and (9) the use of CFLs is highly coincident with periods of utility peak demand. Differences between the experiences in Europe and the United States are discussed.

ENERGY-EFFICIENT LIGHTING IN CONTEXT

The electric utility industry was born with the light bulb. By collecting payments for lamps instead of for electricity, Edison made increased energy efficiency a key to the competitiveness and profitability of his utility. Today, more than a century later, economic and environmental realities are leading electric utilities to renew their pursuit of energy-efficient lighting. As a result, electric utilities (along with other allies) have again become a major catalyzing force in the creation and development of markets for energy-efficient products.

Technologies and the market for energy-efficient lighting are developing rapidly. The overall efficacy of lighting (all sectors) tripled from approximately 25 lumen/Watt in 1960 to 50 lumen/Watt in 1990.[1] This is due to a combination of improvements in discharge lamps and to shifting among types of lamps (away from incandescent sources). Incandescent light sources fell from ~90% of all lamps sold in 1960 to ~75% in 1990. For efficiency improvements to continue, however, increased effort must be applied to promote more efficient lighting technologies. One example is the development of compact fluorescent lamps (CFLs) which yield ~60 lumen/Watt compared to ~15 lumen/Watt for the incandescent lamps that they replace. This paper offers an overview of recent experiences with promoting CFLs in 10 European countries. During a period of only three years (1987-1990), sales of CFLs rose six-fold in some of these countries (Figure 1).

A number of untraditional actors in the lighting market (utilities, governments, public interest groups, and others) are now actively helping to promote efficient lighting. Innovative marketing and implementation approaches have focused on the use of financial incentives targeted to help overcome the extra cost of CFLs compared to conventional technologies. The key actors have been local electric utilities. Some of the utilities are owned municipally, others are consumer co-operatives or private or semi-private companies. Both generating companies and distributing companies have run incentive programmes. Lighting retailers have also played an important role, in some cases sharing in the tasks of marketing and providing consumer information or offering in-store discounts (rebates) to compliment the incentives provided by utilities. .

DEFINING GOOD PRACTICE AND MEASURING SUCCESS

The existence of a large potential for improving the efficiency of lighting and all other major electricity end uses at a cost less than that of building new power plants is well established.[2] As a result, the question of *implementation* is now in the forefront. There are many proven methods for implementation and a combination of them should be used. In the case of electricity, a systematic approach to improving the efficiency of energy use (often called Demand-Side Management, DSM) can be pursued by local electric utilities and others. However, this requires a new planning and marketing paradigm that focuses on the provision of energy services rather than on the sale of energy *per se.*

Successful DSM programmes achieve high participation rates and cost-effective energy savings (a variety of definitions can be applied), while delivering the desired energy services and overall consumer satisfaction. For the purposes of this paper, the focus is on societal economics. Thus, the cost-effectiveness of the

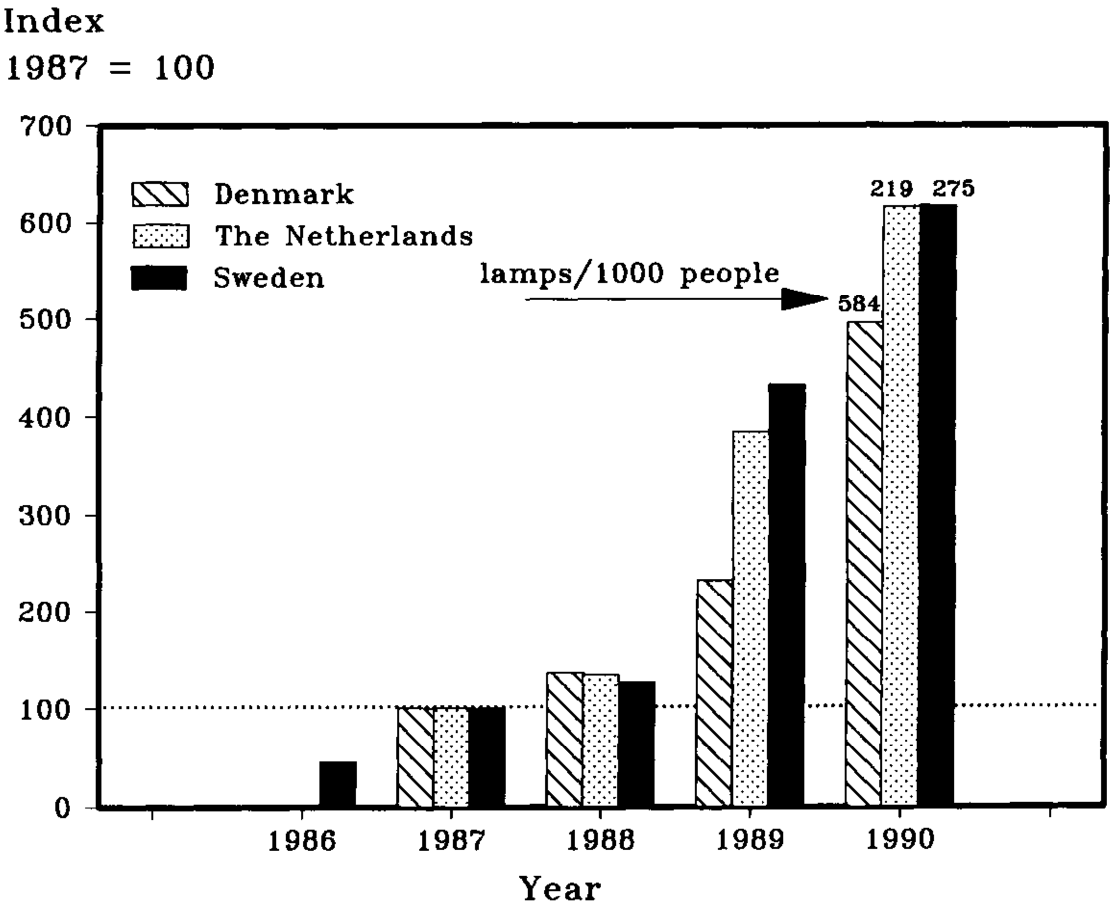


Figure 1. Annual lamp sales statistics were provided by the lighting industry trade associations and individual manufacturers and include both modular (separable lamp and ballast) and integral lamps. Penetration is shown in terms of lamps/capita (rather than lamps/household) because the sales to residential, commercial, and industrial consumers are included.

lighting programmes is computed in terms of a cost of conserved energy to all parties, i.e. the direct costs per unit of energy saved plus indirect costs such as those for administration, marketing, and evaluation/surveys, annualized using a 6% real discount rate and no taxes. In the following sections, information is presented to help construct an "impact evaluation" as well as a "process evaluation" of many European lighting programmes. Box 1 provides a generalized format for programme evaluations and information compiled in this paper.

The impact of programmes is measurable in terms of participation rates (e.g. percentage of eligible customers choosing to participate in a programme), numbers of efficient end-use devices adopted, resulting energy savings, the cost-effectiveness of achieved energy savings, and other benefits. In this paper, "eligibility" is defined as the group of households who had the possibility to participate in the programme, e.g. those receiving rebate coupons.

To measure success, post-programme process evaluations must also be done to assess the reason(s) for participation (*and* non-participation), and other qualitative factors responsible for the impacts that have occurred. The reactions of actors other than energy consumers (e.g. lighting retailers, manufacturers, and utilities) are also important. Thorough process evaluations also include an assessment of the effectiveness of pre-programme marketing efforts.

EUROPEAN LIGHTING PROGRAMMES

Between late-1987 and mid-1991, at least 51 financial-incentive programmes for CFLs were implemented in Austria, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Sweden, Switzerland, and the U.K. The 7.2 million households that were eligible for the programmes received 2.2 million CFLs. The average programme length was about six weeks.

Programme societal cost-effectiveness and participation rates have been analyzed previously and are updated here.[3] Based on a number of post-programme surveys and supplemental information collected from the programme sponsors and utilities, this paper presents new information on how participants reacted to the programmes, numbers and placement of lamps received during programmes, how the efficient lamps were used, and lessons learned for making future programs better. Some key differences between the European programmes and U.S. programmes are also noted.

Data on penetration rates and total programme costs, etc., for 39 of the European lighting programmes (5.7 million households in seven countries) are shown in Table 1. These data are based on information collected from the utilities, trade associations, manufacturers, and other parties involved in conducting the programmes. Standard definitions have been used to analyze and compare the data. In addition, a number of surveys of consumers' reactions to the programmes have been carried out and are reviewed here. The surveys differ substantially in scope and depth, but overlap in a number of important areas.

Programmes available to non-residential consumers have been held in Denmark, Germany, the Netherlands, and Sweden. Six of the residential programs were also available to commercial and/or industrial customers (see Table 1, note 5 and reference 3).

Cost Effectiveness and Participation Rates

For the 39 programmes, the average societal cost of conserved energy was 2.1 cents/kWh (22 mECU), of which 0.3 cents/kWh (2.3 mECU/kWh) is attributable to indirect costs. Non-participants also benefited, because increases in lamp sales due to the programmes prompted manufacturers to lower normal retail prices. In Denmark, for example, prices fell from 300 Dkr in 1987 to 125 Dkr in 1991, excluding the effects of inflation.[4]

Importantly, despite the cost of marketing CFLs under the programmes, the programmes achieved substantially *lower* overall societal costs of conserved energy than would have been the case if consumers had bought the lamps on their own. This is due to the low prices that utilities obtained when cooperating with lighting vendors or when buying lamps in large quantities. Utilities obtained prices that were about one-third to one-quarter of the prevailing retail prices.

On average, approximately 15% of eligible households chose to participate in the programmes, with a range of 1% to 100%. Participating households obtained an average of 2.3 CFLs. The number of lamps acquired because of the programmes varied from 0.04 to 6 lamps per eligible household, with an average of 0.36. When allowed to obtain more than one CFL, participants chose between 1.8 and 5.3 lamps (Figure 2). The average price paid by consumers was $10/CFL.

Participation rates can be further characterized as follows:

- o Lamp give-away programmes (no cost to household) resulted in the highest penetration rates (lamps/eligible household) and the lowest costs of conserved energy.
- o Aside from lamp give-away programmes, participation rates varied from ~1% to 30% of eligible households (12 programmes).

BOX 1. A Generalized Framework for Lighting Programme Evaluations

IMPACT EVALUATION

o **Direct Costs**
- Equipment (lamps, controls, luminaires, etc.)

o **Indirect Costs/Benefits**
- Marketing, salaries, evaluations, postage, labour savings, avoided lamp replacements, etc.

o **Participation/Penetration**
- Numbers of customers eligible for the program
- Percentage of eligible customers participating in the programme
- Numbers and kinds of energy-efficient lighting technologies installed
- Technologies per eligible customer (% actually used)
- Consumers' intentions to buy same kind of products in future
- Direct and indirect sales because of programme

o **Energy Use and Savings**
- Energy and peak demand; load-shape analysis
- Cost-effectiveness (public versus private perspectives)

o **Energy Services**
- Intensity (size of lamp replaced)
- Quantity (hours/day lamp operation)
- Quality (lighting quality)
- Takeback (longer/shorter lamp operation)

PROCESS EVALUATION

o **Participants**
- Demographics
- Reasons for participating
- Perceived advantages/disadvantages of lighting technologies
- Assessment of misconceptions about lighting
- Consumer willingness to purchase lamps as a function of lamp cost

o **Non-Participants**
- Demographics
- Reasons for not participating
- Perceived advantages/disadvantages of lighting technologies
- Assessment of misconceptions about lighting
- Consumer willingness to purchase lamps as a function of lamp cost

o **Comparative analysis of various incentive types/levels**

o **Marketplace Response**
- Manufacturer reactions
- Retailer, distributor, wholesaler reactions, etc.
- Reasons for product shortages, if applicable

o **Utility Impacts**
- Economic
- Customer relations
- Environmental
- Political

Table 1. Residential lighting programme descriptions and societal cost-effectiveness.

Country: Utility S = Sweden / DK = Denmark NL = The Netherlands D = Germany / A Austria IR = Ireland / FI = Finland	Duration (Days)	Type of Utility [1]	Program Description A-B-C [2]	Eligible Households (HHs)	Lamps Received Due to Program	Pene-tration (L/HH)	Lamps per Partic-ipating HH	Percent of Eligible HH	Cost to Utility (US$1000)	Cost Paid by Consumer [3] (US$/lamp)	<----Cost of Conserved Energy [4]----> Total Utility (c/kWh)	Indirect Costs (c/kWh)	Total Society (c/kWh)	Total Society (mECU/kWh)
S: Stockholm Energi AB				355000	151000	0.43			1328	8	2.6	1.3	4.4	45.5
Program 1 (1987)	5	G&D	Y-6-a,g	3000	18000	6.00	6.0	100%	164	0	2.7	0.0	1.2	12.1
Program 2 (1988)	32	G&D	N-1-c,h,k	355000	70000	0.20	2.3	8%	623	8	2.6	1.5	4.6	47.9
Program 3 (1989)	33	G&D	N-1-c,h,k	355000	46000	0.13	1.7	8%	454	8	2.9	1.5	4.6	47.9
Program 4 (1989)	15	G&D	N-U-h,k,m	355000	17000	0.05			88	16	1.5	1.5	4.6	47.9
S: Helsingborgs Energiverk (1988)	90	D	Y-1-a,g	53000	35000	0.66	1.0	66%	282	0	2.4	0.2	0.9	8.9
S: Malmo Energi AB (1989)	68	D	Y-U-a,c,g,k	136197	26562	0.20	2.3	8%	104	12	1.2	1.2	2.3	24.1
S: Kalmar Energi AB (1990)	16	D	Y-U-c,g,k	15000	4500	0.30			31	9	2.0	2.0	3.2	33.4
Sweden subtotal	52			559197	217062	0.39			1746	7	2.4	1.1	3.5	36.7
DK: EFFO				12000	30000	2.50			103	4	1.0	<--	1.2	12.9
Program 1 (1988) [5]	30	D&Co-Op	N-5-a,b,e,g	4000	15000	3.75	3.8	100%	63	0	1.2	<--	1.2	12.9
Program 2 (1989)	62	D&Co-Op	N-4-d,h	12000	10000	0.83			34	7	1.0	1.0	1.1	11.7
Program 3 (1990)	69	D&Co-Op	N-3-d,h	12000	5000	0.42			5	12	0.3	0.3	1.4	15.1
DK: BHHH (1989)		D&Co-Op	N-U-h,j,m	23492	12000	0.51			6	20	0.2	0.2	2.5	25.9
DK: ARKE A/S (1989)	62	D&Co-Op	Y-U-b,c,g,i	23860	8361	0.35			0	17	0.0	0.0	2.5	25.9
DK: SEAS A/S (1989)	30	G&D&Co-Op	Y-2-a,f,g	120000	240000	2.00	2.0	100%	2222	0	2.7	0.4	1.2	12.5
DK: KOH/KKF (1989)	90	D&Co-Op	Y-U-h,j,m	41997	1500	0.04			10	20	1.9	1.9	4.2	44.0
DK: KOGE (1989) [5]	30	D	Y-2-a,g	5990	11980	2.00	2.0	100%	111	0	2.7	<--	1.2	12.4
DK: ELFO, ELRO, & Randers (1990)	90	Co-Op	N-U-c,h,j,l	59500	10000	0.17			9	18	0.3	0.3	3.4	35.3
DK: NESA A/S (1990) [5]	48	G&D	N-5-h,i,j	407724	135000	0.33	4.8	5%	593	17	1.3	1.3	3.8	39.2
DK: KBV (1990) [5]	48	D	Y-2-c,h,l	294384	100000	0.34			129	17	0.4	0.4	2.9	29.8
DK: ELSAM [Odense and Dalum-Hjallese] (1990)	14	G	Y-5-c,g*	65000	9368	0.14	1.3	11%	19	13	0.6	1.0	2.0	20.8
Denmark subtotal	47			1069947	558209	0.52			3203	9	1.7	0.6	2.2	23.2
NL: 8 Provinces, 12 utilities [6]														
Program 1 [Friesland] (1988) [5]	53	G&D	N-2-c,e,h,i,k	250000	150000	0.60			54	13	0.1	0.1	1.9	20.0
Program 2 [EBA] (1989)	62	G&D	Y-2-c,h,i,k	375000	200000	0.53			64	10	0.1	<--	1.1	11.3
Program 3 [GEB] (1989) [5]	60	G&D	Y-2-c,h,i,k	191500	75000	0.39			52	10	0.2	0.2	1.4	14.8
Other programs (1989)	60	G&D	Y-2-c,h,i,k	2333500	748375	0.32			2718	10	1.1	<--	2.0	20.6
Netherlands subtotal	60			3150000	1173375	0.37	2.5	15%	2887	11	0.7	0.1	1.9	19.3
D: Energie-Versorgungsunternehmen Schwaben	90	G&D	N-1-c	800000	61000	0.08	1.0	8%	377	6	1.8	0.3	1.8	19.0
A: KELAG (Province of Carinthia) [5]	90	G&D	N-2-c,k	116000	14274	0.12			52	12	1.1	0.2	3.1	32.0
IR: Electricity Supply Board (ESB) (1990)		G&D	Y-4-d,i,k	25000	5000	0.20	4.0	5%	33	15	1.9	1.1	4.5	46.5
FI: (1990)	2	G&D	Y-1-a	17000	17000	1.00	1.0	100%	188	0	3.2	0.5	1.7	18.0
Total or Weighted-Average	49			5737144	2045920	0.36	2.3	15%	8486	10	1.2	0.3	2.1	22.3

Notes to Table 1.

[1]. Type of utility: **G** = generating company, **D** = distributing company, and **Co-Op** = cooperative.
[2]. **A-B-C**: **A**. program restricted to a particular lamp wattage (Yes or No); **B**. limits to number of lamps (Unlimited, or #); C. program delivery mechanism(s), according to the following key:
a. Give aways (to employees and/or customers)
b. Direct installation
c. Rebate coupon or other form of retail discount: cash
d. Rebate coupon or other form of retail discount: "buy-one, get-one-free" schemes
e. Government subsidy to lamp buyers or utility
f. Government waivers of lamp luxury taxes
g. Bulk lamp purchase (* = with savings split between utility and retailer)
h. Wholesaler lamp discounts to retail stores
i. Pay-on-your-bill approach
j. Retailer co-financing
k. Manufacturer co-financing (other than lamp discounts), e.g. promotion
l. "Kits" available containing a variety of CFLs for testing in the home.
m. Information, but no financial incentive
[3]. Lamp prices paid by consumers are net of rebates or other discounts, but include sales taxes.
[4]. The cost of conserved energy is the net annualized total cost (computed here with a 6% real discount rate) divided by annual electricity savings. The "societal cost of conserved energy" includes program costs (direct plus administrative costs), plus consumers' costs (less the value of avoided incandescent lamp purchases), plus any third-party financing (e.g. from government or retailers). Costs for program administration are included in the "Utility" CCE. Sales and value-added taxes on lamps are *not* included in the societal calculation (A 20%, D 14%, DK 22%, FI 20.48%, NL 18.5%, IR 12.5%, S 23.5%). Mid-1989 exchange rates are used throughout the article: 13.98 Austrian schillings/US$; 7.735 Danish kronor/US$; 2.24 Dutch guilders/US$; 4.4395 Finnish marks/US$; 1.9894 German deutschemarks/US$; 0.7060 Irish pounds/US$, 6.700 Swedish kronor/US; and 1.0408 ECU/US$.

Assumptions for electricity savings: Based on consumer surveys, the calculations assume a lamp operation time 4 hours/day and that 60-watt lamps are replaced (see text). Annual electricity savings are 75 kWh/year per lamp (including 9% annual average transmission & distribution losses). This assumes that a 60-Watt incandescent lamp (1000-hour service life, $0.75 retail price) is replaced with a 13-Watt compact fluorescent lamp (8000-hour service life). These lamp service lives are manufacturers' ratings for European conditions. Applying the assumptions normally used for North American conditions (10,000-hour CFL life and 750-hour incandescent lamp life) would lead to a cost of conserved energy of 1.0 cent/kWh. Due to the highly case-specific nature of the issue, no adjustments have been made for interactions between lighting savings and space-heating or cooling energy use.
[5]. CFLs also available to non-residential customers. Associated costs and lamp sales not included in the analysis, except for the Dutch programs where it was impossible to disaggregate the cost data by customer type.
[6]. Provincial generating companies: Groningen, North Holland, Gelderland, Friesland, Limburg, Zealand, Overigssel, and Utrecht. City generating companies: Groningen, Breda, Amsterdam (EBA), and Den Haag (GEB).

- o In addition to eligible participants' use of rebate checks, etc., a substantial number of "non-participants" bought CFLs who would not otherwise have done so[5] For example, the Swedish lamp manufacturers' trade organization estimates that the 75,000 rebate checks redeemed in the Stockholm Energi program "leveraged" 41,000 additional lamp sales. According to the Dutch utilities, the GEB program resulted in 25,000 direct sales versus 50,000 indirect sales. The corresponding numbers for the Freisland utility were 60,000 and 40,000 CFLs. In Switzerland, 7,000 CFLs were sold because of the programme and "normal" sales increased by 70,000.
- o Between 8% and 34% of eligible households (6 programmes) owned at least one CFL before the programme.
- o Between 17% and 100% of eligible households (6 programmes) owned CFLs after the programmes.
- o Between 7% and 38% of participating households (4 programmes) do *not* plan to buy additional CFLs in the future (at current lamp prices).
- o Three telephone/mail surveys investigated the question of whether or not CFLs obtained during the programmes had actually been installed. The finding was that 92% had done so in the Malmoe Energi programme [Sweden] (including 8% planning to install or give the lamp as a gift), 90% in the SEAS programme [Denmark], and 97% in the Friesland programme [the Netherlands].

- Single-family households represented a greater proportion of programme participants than they represented in the eligible populations (37% versus 12% for the Stockholm Energi programme, 63% versus 49% for the STEV programme, and 63% versus 33% for the Malmoe Energi programme). The degree to which this reflects differences in income, renter-vs-owner tenure, or other factors has not been determined.
- Pensioners (over 65 years old) also represented a greater proportion of programme participants than they represented in the eligible populations. In the 1989 Stockholm Energi programme, 44% of the participants were pensioners, versus 26% of eligible households. The corresponding values for the STEV programme were 38% and 27%. The possible greater value of convenience (long lifetimes) of CFLs and a relatively strong conservation ethic may provide a partial explanations.
- Programmes offering rebates for luminaires that can accommodate CFLs have been held in Sweden by the following Swedish utilities: Gothenburg Energiverk, Stockholm Energi, Stora Kraft, Karlstad Energiverk, Halmstads Energiverk, and Nykoeping Energi. Participation rates were rather low, probably due to limited choice (four choices) and product availability.
- The size of the eligible population does not appear to be an important influence on programme participation rates or cost effectiveness (Figure 3), i.e. programmes can be successful in small or large cities.

CONSUMER BEHAVIOUR AND PREFERENCES

In addition to cost-effectiveness and participation rates, it is important to assess how consumers used the lamps and how they responded to different marketing strategies. Various indicators of energy services can also be evaluated, e.g. sizes of lamps replaced, placement, perceived lighting quality, and use of the new lamps compared to the old lamps.

Lamp Choice

Two indicators of preferred lamp type have been described in post-programme surveys: the type of ballast and the size of incandescent lamp being replaced.

Lamps with electronic ballasts were used exclusively in programmes in the Netherlands and in the ELSAM programme in Denmark. They were used in 85% of the cases for STEV and NESA, 50% for SEAS, 35% for Malmoe Energi, and 12% for Stockholm Energi.

Based on four surveys, 60-watt incandescent lamps were effectively the most common size replaced. Participants in the Friesland programme/Stockholm Energi programme reported the following choices: 40 watts or less (31%/15%), 60 watts (45%/40%), 75 watts (13%/32%), 100 watts (10%/13%). The average lamp size replaced in the Pori programme (Finland) was 63 watts and 52 to 61 watts in the SEAS programme.

Lamp Placement

Seven surveys show where the CFLs were installed. Between 7% and 32% of the lamps were placed outdoors, 14% and 48% in kitchens, 1% and 2% in bathrooms, 21% and 84% in living rooms, and 2% and 10% in bedrooms.

When advised to do so, customers seem to reliably install CFLs in high-use sockets. In the SEAS programme in Denmark, two CFLs (240,000 total) were given to each household.[6] This is the largest programme so far in Europe. While only 7% of the lamps in homes were replaced, the old lamps represented 20% of household electricity use for lighting. Thus, the use of two lamps resulted in an approximately 15% reduction in *total* residential lighting electricity use. Even greater savings are possible, given that consumers reported that they could use, on average, 5.3 CFLs per home (single-family). About 17% reported that they could use 10 or more CFLs.

Lamp Utilization and Load-Shape Data

Various surveys have investigated the time-dependent utilization of CFLs (Figure 4). During winter months in Denmark and Sweden, average use is approximately 7 hours/day while during summer months use drops to approximately 3 hours/day, averaging about 4 to 5 hours/day on an annual basis.[7] The annual average in Finland is 4.4 hours/day and 5.3 hours/day in the winter months.[8] These usage levels are greater than those often assumed in estimates of savings potentials.

Several surveys attempted to determine how often CFLs were used compared to the incandescent lamps they replaced. In both the Stockholm Energi and SEAS programmes, almost 5% of the households reported using their CFLs for a shorter time than their old incandescent lamps. Households reported using their CFLs longer in 34% of the cases for the Stockholm Energi programme, 30% for Malmoe Energi, and 20% for SEAS. Only in

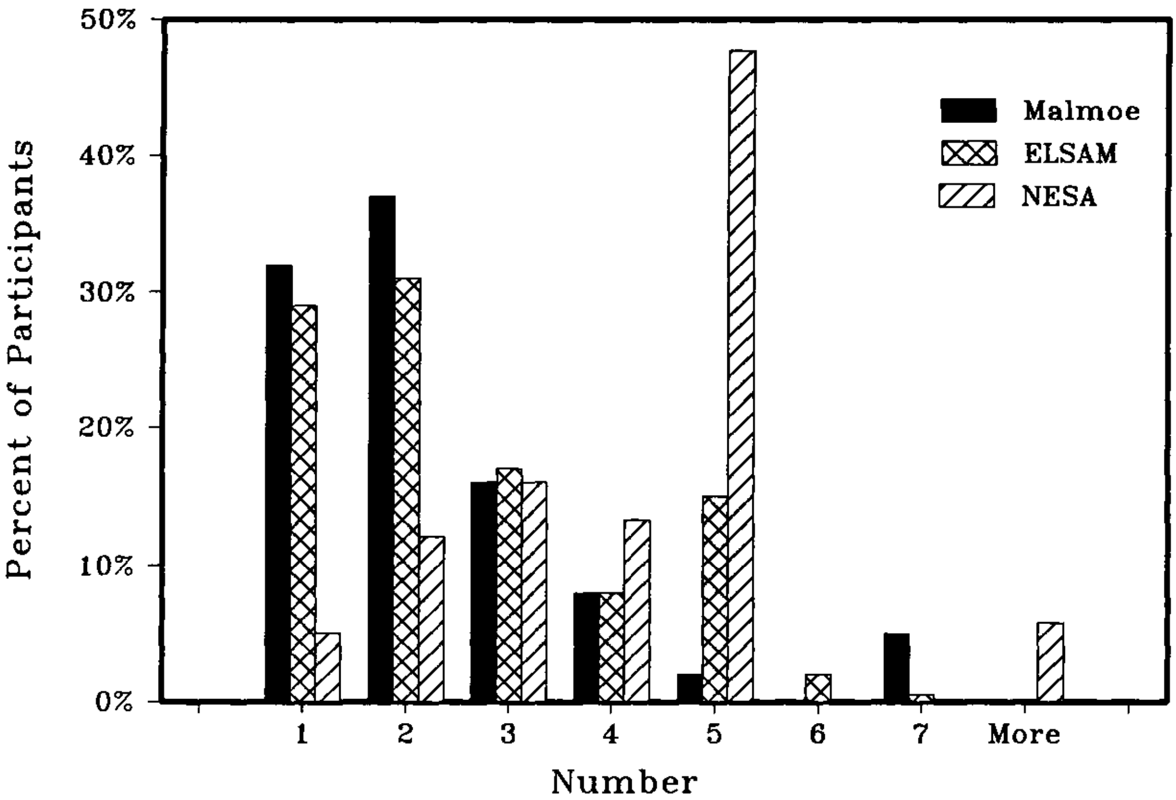


Figure 2. Number of lamps per participant. The NESA programme was limited to 5 lamps per customer. Some customers were given special permission to buy more lamps.

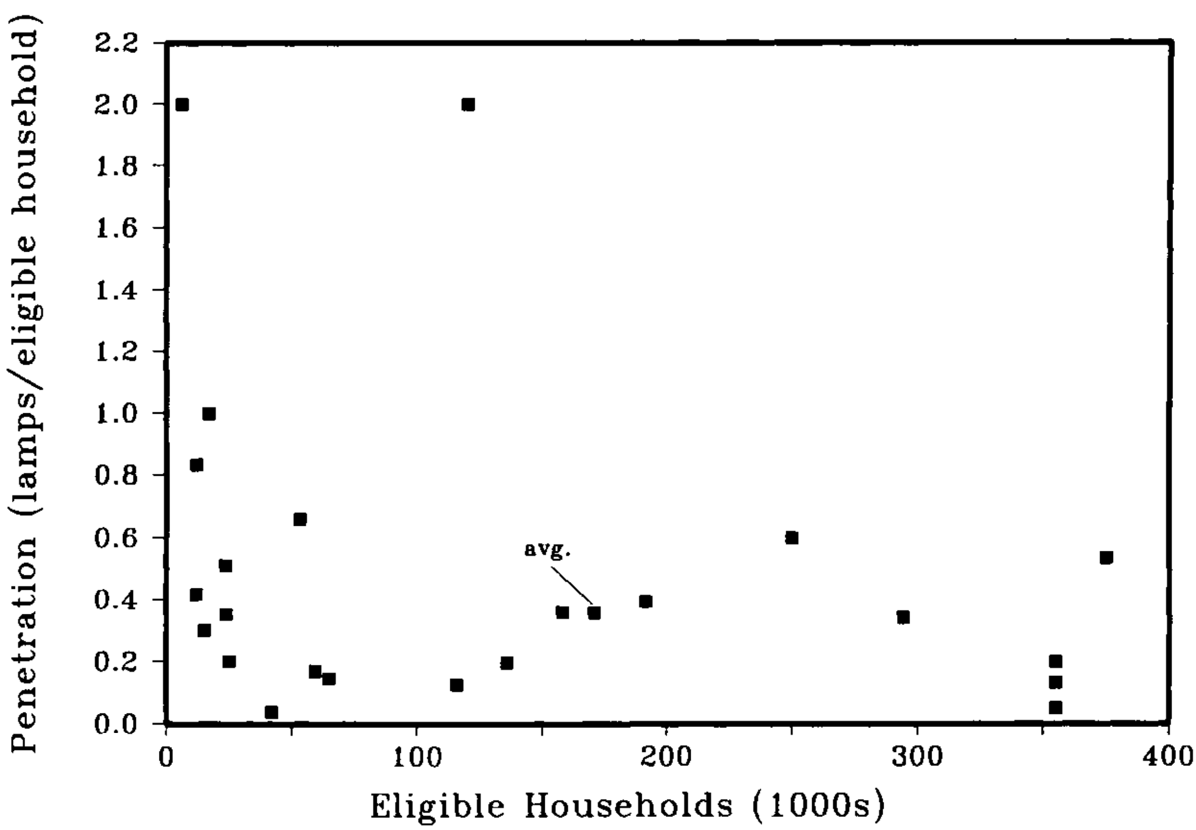


Figure 3. Size of eligible population versus penetration rates. Three programmes are off-scale: (3000, 6), (4000, 3.75), and (800000, 0.08).

Finland were consumers asked *how much* longer they used their CFLs; their answer was 0.7 hours/day on average. For the comparison of a 13-watt CFL with a 60-watt incandescent, if the incandescent was used 3.7 hours/day then the actual savings would be (5% lower than predicted (61 kWh/year rather than 64 kWh/year).

In Denmark, detailed load-shape data were developed using a survey in which 1200 households reported the number of CFLs burning during each hour of the day.[9] About 80% of the CFLs were in use during on-peak times. In a survey following an earlier programme in Denmark, the utility ELSAM found that 87% of the CFLs were operating during peak hours (17:00 to 18:30).[10] ELSAM also found that the total annual hours that CFLs were used were allocated as follows: 25% on peak, 39% during intermediate peak, and 36% on off-peak times.

Lamps obtained during the programme in Pori Finland, were operated during peak hours in 60% of cases.[11]

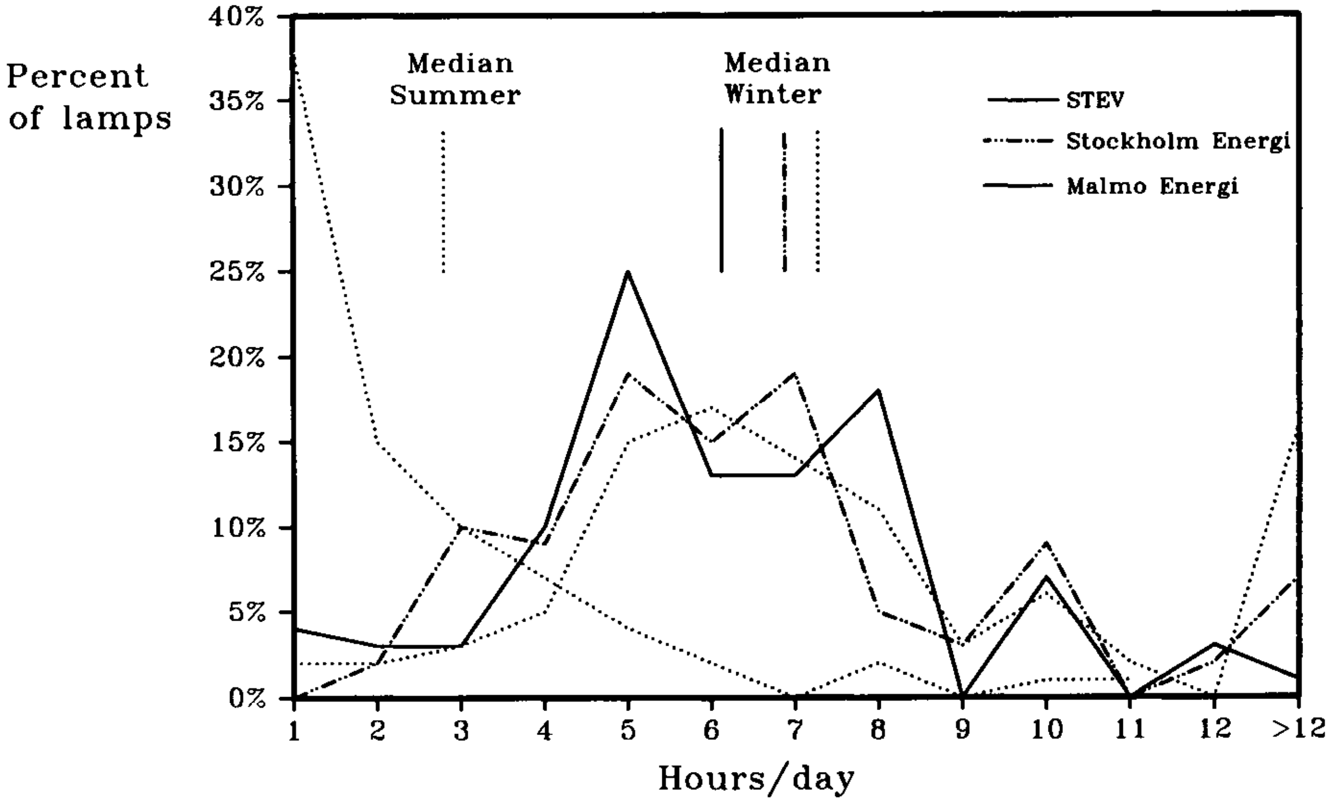


Figure 4. Distribution of daily operating times of CFLs for three programmes.

Participant Motivations and Market Segmentation

Programme participants are motivated by a spectrum of factors. The range of reasons for participating and not participating is shown in Figure 5. Interestingly, non-economic motivations can be as important than economic factors in shaping consumer attitudes. Environmental protection through energy efficiency is often the most important non-economic motivation.

Several surveys indicate that the *form* of the incentive (as opposed to the size of the incentive) is also important. In Denmark and the Netherlands consumers were given the option to pay cash for CFLs or pay for them gradually via their electricity bills. In each case, approximately three-quarters of the participants preferred to purchase their lamps by making periodic payments on their utility bills. Furthermore, consumers in Denmark paying over three bills bought 5 CFLs (the maximum number allowed) in 60% of the cases, whereas consumers paying in cash bought 5 CFLs in only about 15% of the cases (Figure 6). It is not clear to what extent the different numbers of lamps purchased is a result of the types of incentives versus different consumer groups choosing different incentive options. Pay-on-the-bill programmes were also held in Ireland (ESB, 1-year payment period), Germany (Schleswig-Holstein, 7 years), and Sweden (2 years).

Three surveys addressed the issue consumer responsiveness to lamp costs. As shown in Figure 7, willingness to purchase CFLs increases rapidly when the price falls to approximately $10 to $15/lamp (7 to 10 ECU/lamp). The similarity between the Swedish and Danish curves in notable, given that residential electricity prices are twice as high in Denmark. Swedish households choosing not to participate in one of the programmes exhibited a noticeably larger reluctance to pay for CFLs than exhibited among participants. Half of the non-participants could not articulate an acceptable price.

Only one survey looked in detail at differences between womens' and mens' reactions to the programmes. Among the findings, women had a more positive reaction to the programmes and were more willing to invest in energy efficiency (Figure 8).

The surveys have rarely been used to identify consumers' misconceptions about CFLs. However, the STEV programme survey assessed consumers' awareness of the differences between CFLs with magnetic versus electronic ballasts. Very few respondents could correctly identify the important differences and many misconceptions existed.

Lessons for Marketing

A common finding in all countries is that the lighting programmes have opened up and accelerated the market for CFLs in the household sector, where before manufacturers saw little or no market. In Sweden, Denmark and the Netherlands, programmes have increased national residential CFL sales by four- to fivefold.

However, much remains to be understood about how to effectively market lighting programmes.

The striking lack of correlation between the level of program costs--both to utilities and to consumers--and participation rates suggests that it is not enough to just "throw money at the problem" (Figures 9 and 10). Successful programmes must offer an adequate financial incentive *and* employ effective marketing strategies. As an example of variations in the efficacy of marketing efforts, between 45% and 87% of the households receiving promotional literature reported being aware of the programmes.

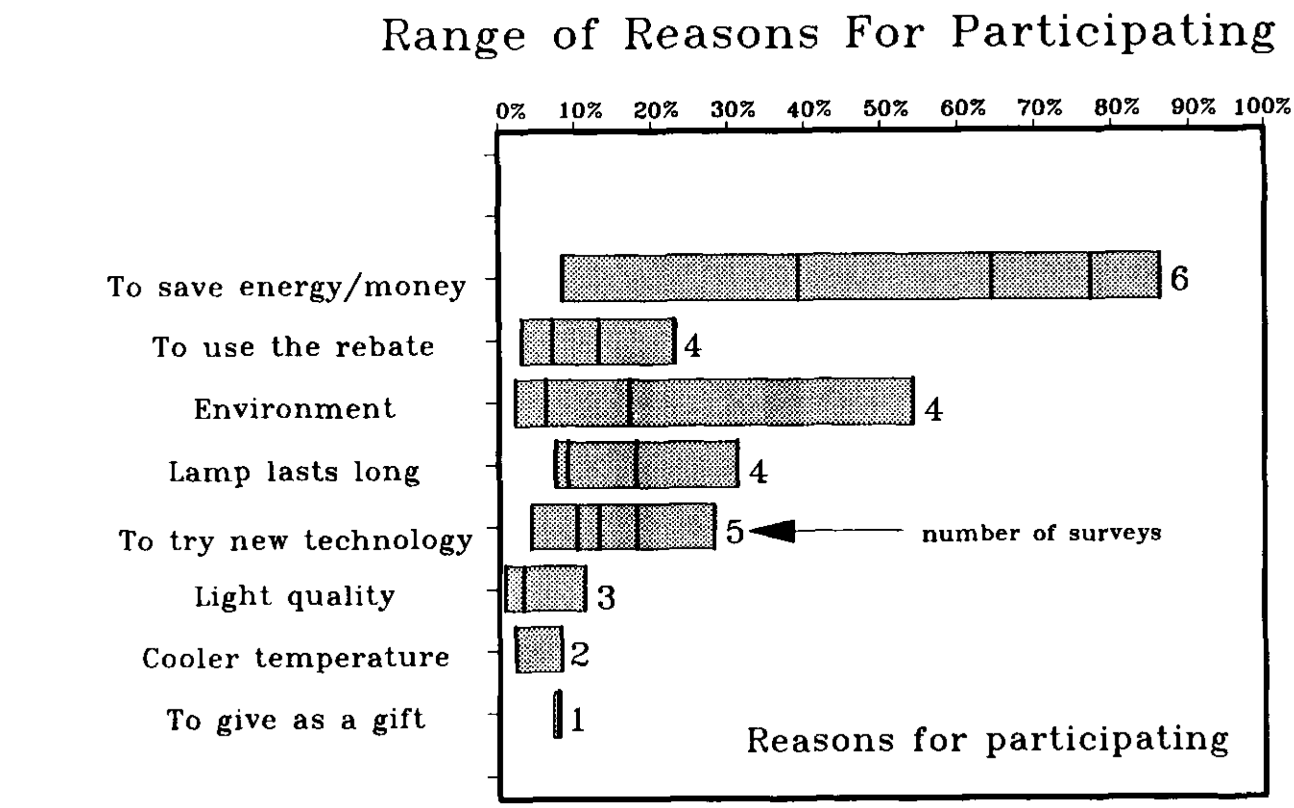
Almkvist has offered constructive criticisms of the promotional methods and materials used by European utilities in their CFL programmes.[12] He identified as a widespread problem the tendency of utilities to take a very naive approach, treating all customers as essentially the same. He argues that it is much better to segment the market according to consumer motivations. The existing programmes have appealed mostly to the already-convinced and utilities have focused on moral appeals (the environment) and rational appeals (save money), but few focused on emotional appeals (e.g. lighting quality). (Based on 4 surveys, between 68% and 94% of the participants were satisfied with the quality of light from the CFLs they obtained during the programmes.) It may also be helpful to introduce an actor other than the utility as the communicator. This has indeed been the case in the U.S., where programmes with non-utility sponsors attained much higher participation rates than those with utility sponsors.[13]

Information alone is a weak tool for promoting energy efficiency. According to Almkvist and field data from the programmes, informational materials don't necessarily motivate consumers to act. Participation rates tend to be significantly lower and overall lamp costs higher when utility efforts are focused only on marketing and information efforts (Figure 11). In a recent German programme in Schleswig-Holstein, an intensive informational effort was conducted (focusing on environmental benefits of using CFLs, but offering no financial incentives).[14] The impact of this programme (CFLs/eligible household) was one-tenth that of the financial-incentive programmes shown earlier in Table 1. The information programme held in 1990 by Stockholm Energi achieved only 25% of the participation of its 1988 programme and 35% that of their 1989 programme, even though retailers offered discounted prices.

IDENTIFYING AND OVERCOMING MARKET BARRIERS

Many actors (consumers, utilities, governments, manufacturers of lighting equipment, distributors, and retailers) have been involved in and affected by the lighting programmes. There are potential conflicts (real and perceived) among these groups, as well as potential synergies, and their interests should be taken into consideration during the design, implementation, and evaluation stages. Since these groups can all benefit from increased use of energy-efficient technologies, greater success can be achieved if they co-operate to maximize program effectiveness.

Lamp manufacturers report that utilities are often unaccustomed to marketing products other than electricity and have difficulties helping consumers find exactly the right efficient product to meet their needs. Programmes with joint utility-manufacturer cooperation seem to attain greater success than programmes in which utilities do not cooperate with the lighting industry.



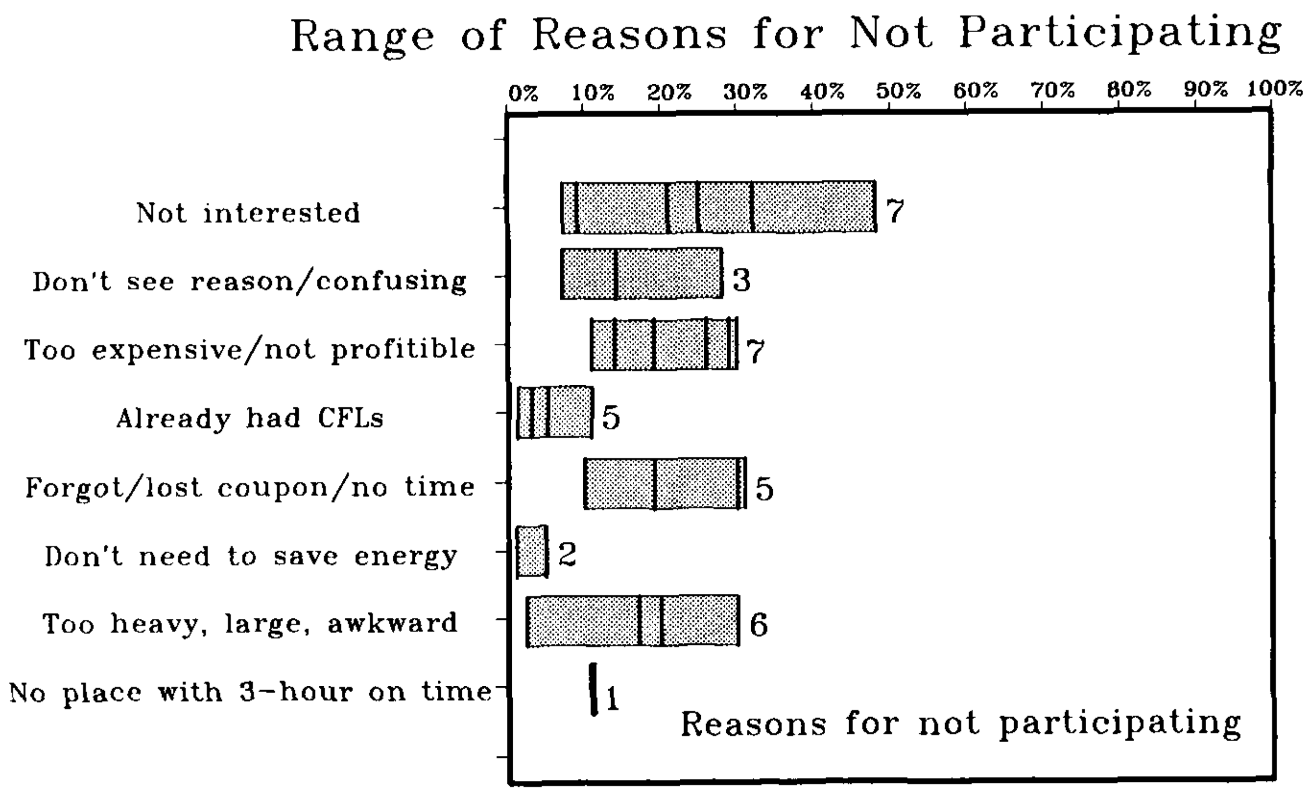


Figure 5. Ranges of reasons for participating and not participating in the programmes. Individual values are indicated by vertical lines and the number of surveys is indicated by a label to the right of each bar.

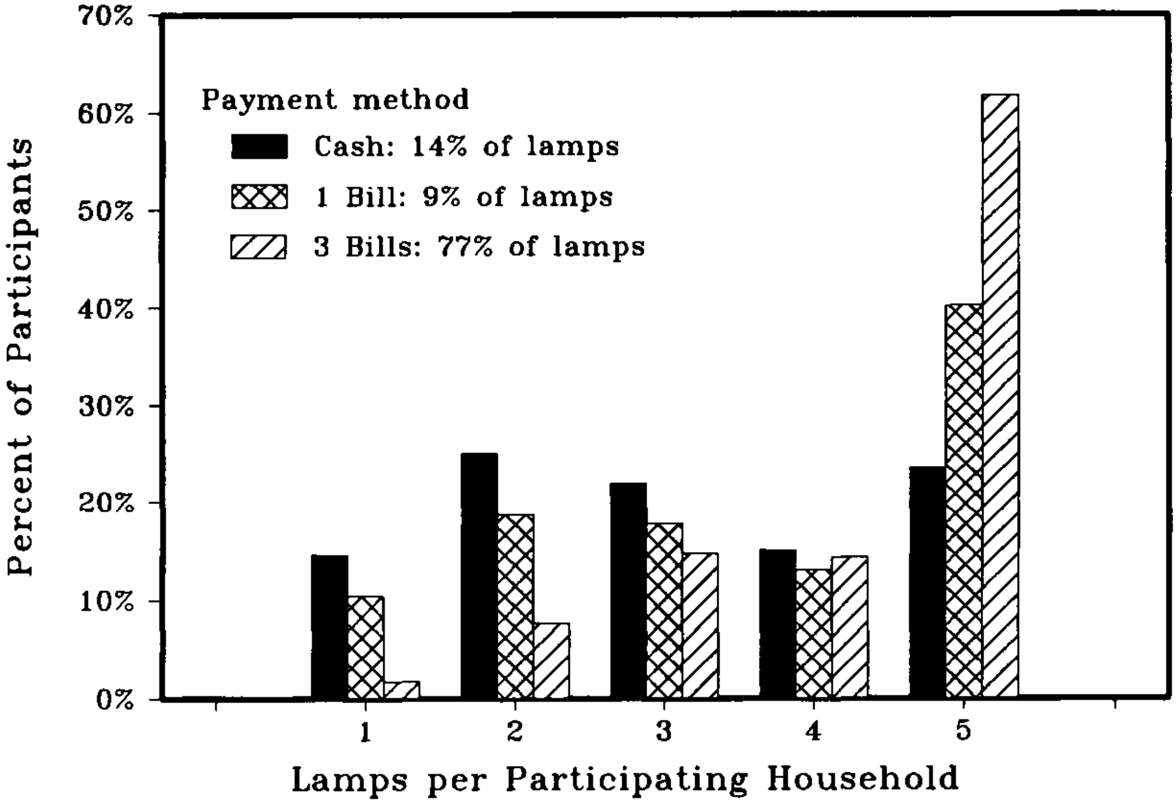


Figure 6. Participation rates versus incentive type for the NESA programme (single-family homes) [Denmark]. Participants preferred to pay for CFLs via the bill and bought more lamps than participants choosing to pay cash.

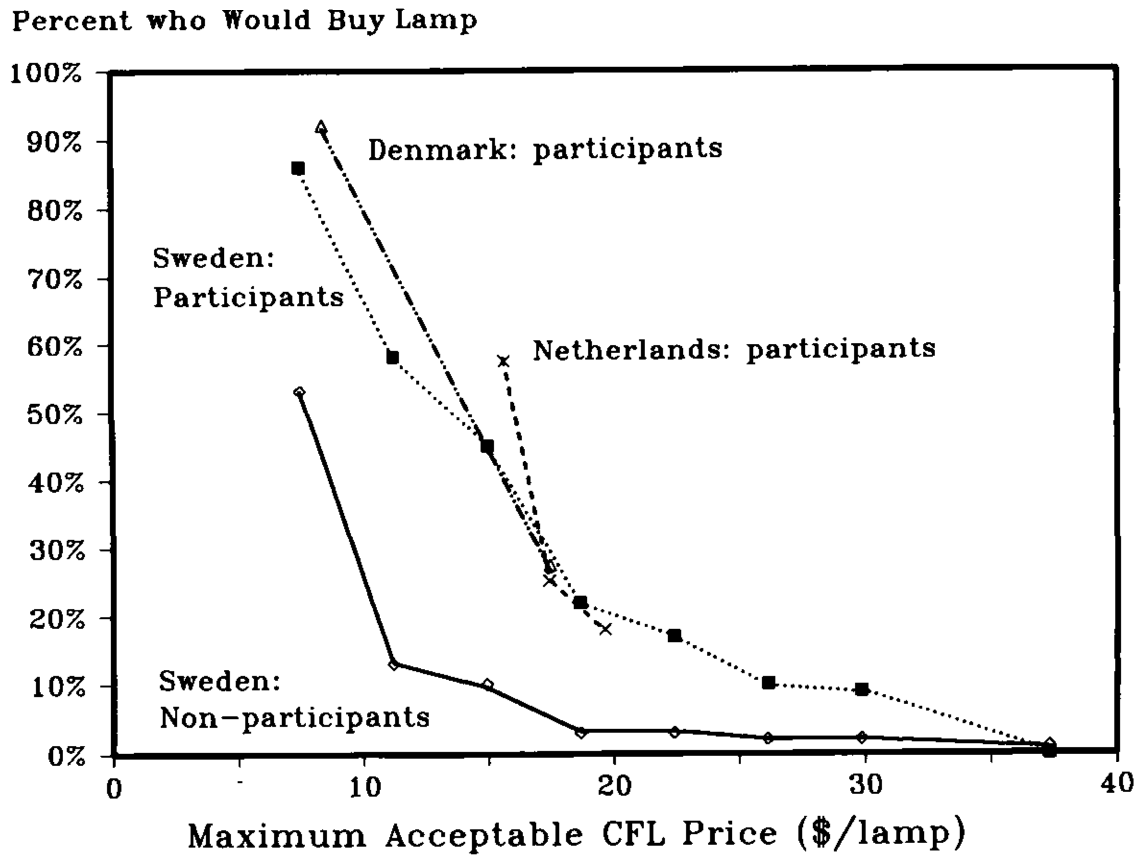


Figure 7. Consumer cost-response curves show the price that consumers report a willingness to pay for CFLs. The Danish example is the ELSAM programme, the Dutch example is the Friesland programme, and the Swedish example is the STEV programme. Exchange rates are the same as those shown in the notes to Table 1.

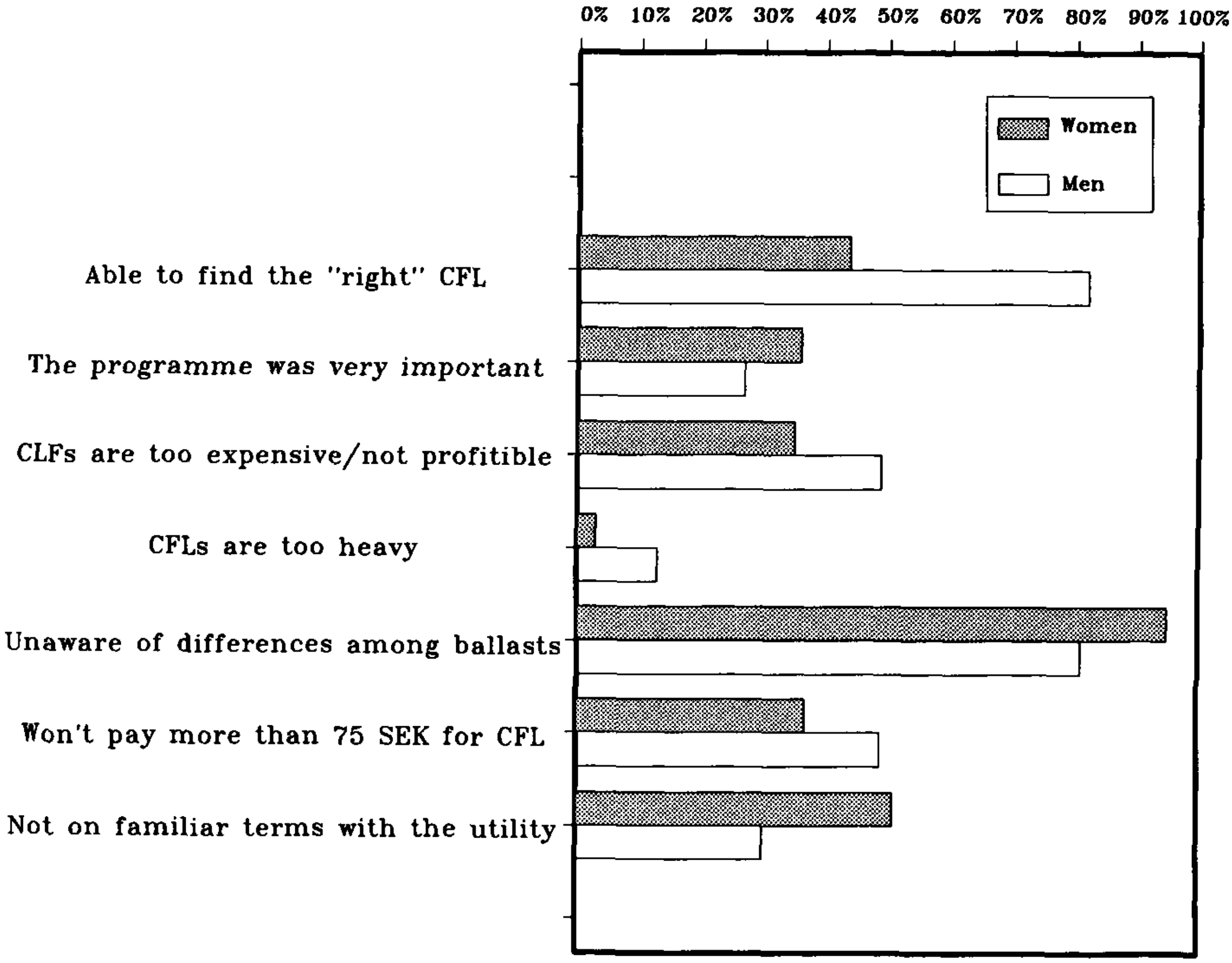


Figure 8. Differences between women's and mens' responses to the STEV programme [Sweden].

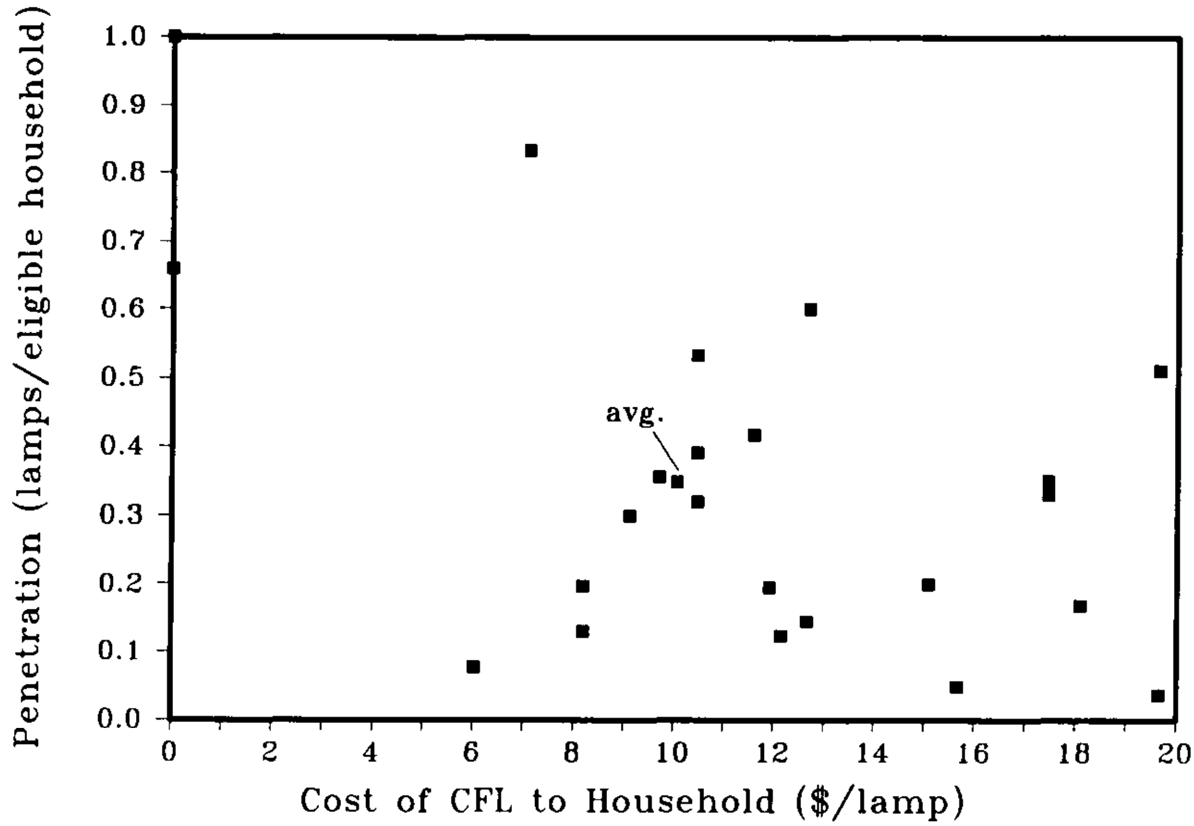


Figure 9. Customer cost (including taxes) versus programme penetration rates. Four give-away programmes are off-scale: (0, 6), (0, 3.75), and two with the coordinates (0, 2).

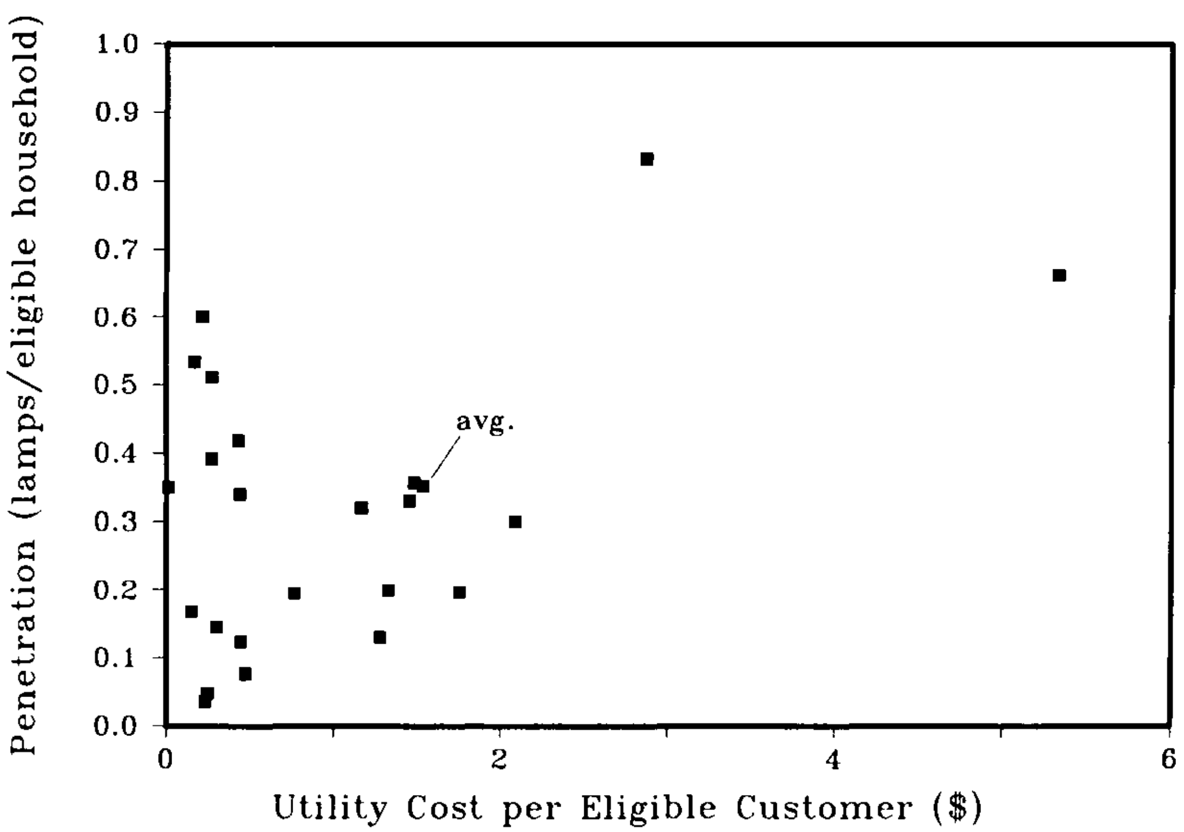


Figure 10. Utility spending per eligible customer versus programme penetration rates. Four programmes are off-scale: (55, 6), (15.8, 3.75), and two with the coordinates (18.5, 2).

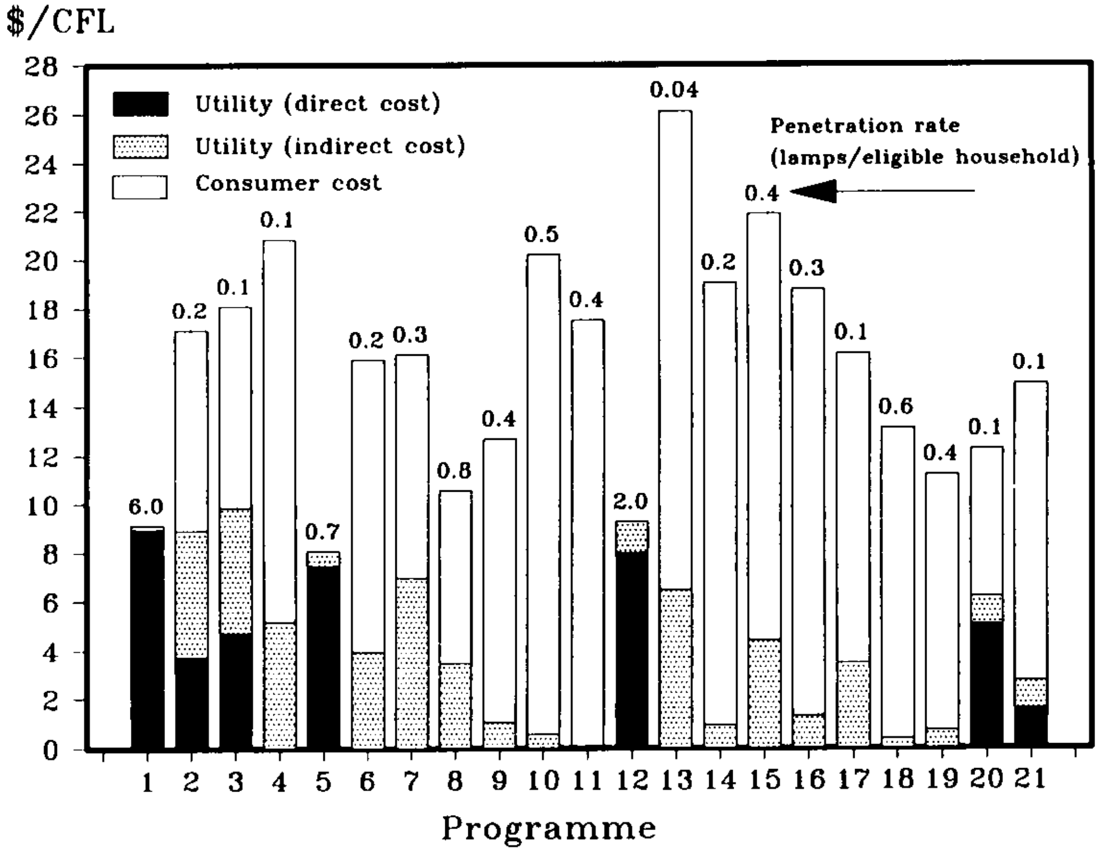


Figure 11. Components of total programme costs for 21 programmes.

In some cases, the concern has been raised that traditional actors (e.g. wholesalers, distributors, or retailers) lose sales or profits as a result of lighting programmes conducted by non-traditional actors. Give-away programmes are an obvious case in point. However, the following four factors should be taken into consideration:

1. Most programme participants would not have bought a CFL without the programme, and hence do not represent a lost sales opportunity to the traditional actors.
2. Even in cases where profits are reduced or certain actors (e.g. retailers) are excluded during programmes, lamp sales through normal channels will ultimately be enhanced as participants replace their CFLs. In the extreme case, lamp give-away programmes (as in SEAS or Helsingborg) can increase the percentage of households having CFLs by ten-fold or more. Only a small portion of participating households need to (re)buy CFLs in the future to compensate retailers for the effects of earlier discounts or lamp give-aways.
3. As noted above, indirect sales due to the programmes are often comparable to the sales associated with, for example, returned rebate checks. These indirect sales provide the full profits to traditional actors.
4. Retailers often focus on the numbers of units (lamps) sold rather than the value of sales. Selling one $15 CFL, however, no doubt generates more profit that the sale of eight $1 incandescent lamps.

Solving the problem of lamp shortages is also important. According to manufacturers, there is today a *global* shortage of CFLs. As suggested earlier by Figure 1, the five- to sixfold increase in CFL sales between 1987 and 1990 has put a tremendous strain on lamp supply. In a number of cases, programmes achieved very low success rates (one-tenth of similar programmes without shortages) at least in part because inventories of lamps were exhausted during the opening days of the programme and could not be replenished. Utilities and manufactures should work together to ensure an adequate supply of CFLs and appropriate programme timing. It is in the interest of both parties that the demand for CFLs does not dramatically (and embarrassingly) exceed the supply. Currently, it is unfortunate that there is no coordinated feedback between the European utilities and other non-traditional actors are the lighting manufacturers. Such coordination has recently been initiated in the United States.[15]

Governments can play a direct role in addressing barriers. For example, national governments (Denmark) eliminated luxury taxes on CFLs. In Canada and the United States, national governments are also in the process of developing mandatory lighting-efficiency standards. Examples of such programmes include the US EPA's Green Lights programme and the Federal Energy Management Programme (FEMP).

Finally, while utilities in at least five of the countries where lighting programmes have taken place are in principal allowed to increase tariffs to recover programme costs and lost net revenues, they have no clear positive incentive to invest in energy efficiency.[16] However, within a short period of time it is possible to institute reforms to utility regulation and other mechanisms to ensure that investing in energy efficiency is profitable to energy suppliers and to society as a whole.

DIFFERENCES BETWEEN EUROPEAN AND U.S. PROGRAMMES

There are some distinct differences between experiences with energy-efficient lighting programmes in Europe and the United States.[17] No doubt with some exceptions, there has been more direct and active manufacturer involvement in the European programmes, higher consumer participation rates, and lower costs of conserved energy. The post-programme surveys also tend to be more detailed in Europe. Government involvement has been greater in Europe.

On the other hand, the whole approach to marketing has been more naive in Europe and the technological focus has been much narrower. Financial-incentive programmes in Europe have focused exclusively on compact fluorescent lamps and almost exclusively on the residential sector. In the United States, on the other hand, a broader spectrum of lighting technologies has been promoted, with least effort spent in the residential sector. National lighting efficiency standards are being developed in the United States and are already in place at the local level, but have not yet been seriously considered in Europe.[18]

CONCLUSIONS: Towards Expanded Use of Energy-Efficient Lighting

Given the experience to-date, it is possible (and justifiable) to widely implement financial-incentive programmes for efficient lighting. Many implementation strategies and technologies can be used without further technical development or institutional changes. In the longer term, technology improvements could increase the number of potential applications for efficient lighting. For example, the development of dimmable CFLs would have a big effect. An increased range of lamp shapes and sizes, lighting color/quality, and variety of fixtures that can accommodate CFLs are also needed.

The following ten conclusions and recommendations can be made:

- Previous lighting programmes have been highly cost-effective, and administrative costs have been low.
- Energy-efficiency programmes can build new markets.
- Success is not simply proportional to utility spending.
- Information is many-times less effective than financial incentives.
- No single incentive is right for all groups.
- Lowering the cost of efficient products can be more effective in stimulating the use of CFLs than increasing the price of energy.
- The risk of product shortages can jeopardize programme success.
- Cooperation among utilities, trade allies, and governments is essential.
- More work must be done to better understand consumer motivations (market segmentation).
- The development of formal evaluation protocols can help to improve understanding of how to promote energy efficiency.

Finally, it is important to broaden the spectrum of business approaches for delivering demand-side management programs and energy services. Currently electric utilities are often the only large player. To make the playing field more competitive, means should be pursued to create market opportunities for independent energy service companies. Energy-efficiency programmes should now be targeted at a broader range of technologies and end-uses.

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