SHORT-TERM FINANCIAL IMPACTS OF ENERGY-EFFICIENCY PROGRAMMES ON EUROPEAN ELECTRIC UTILITIES
Case Studies for Nine Utilities in Five Countries

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Abstract

In the long term, investments in end-use energy-efficiency can reduce the need for building costly new electric power plants. However, the threat of short-term net revenue losses due to under-collection of fixed costs can discourage utilities from promoting end-use efficiency. This paper assesses the impacts of conservation programmes under the accounting rules and cost structures that characterize selected utilities in Denmark, Germany, Italy, the Netherlands, and Sweden. For the utilities studied, net revenue losses resulting from reduced electricity demand range from 0% to 46% of total per-kWh revenues. Net revenue losses are minimized when variable costs represent a large portion of total revenues and when tariffs include fixed charges. Distributing companies are generally less-adversely effected than generating companies.

With certain caveats, the current practice in the five countries studied is to increase electricity prices in order to recover lost net revenues (and conservation programme costs). The same approach is taken in the often-noted Electric Revenue Adjustment Mechanism (ERAM) used in California, although an important distinction is that the procedures are less formalized in Europe. Decoupling utility revenues from electricity sales in this manner removes an important disincentive to promoting energy efficiency, although it falls short of providing a financial reward. European utilities have so far devoted very little effort towards improving energy efficiency. By applying new systems for cost accounting, utilities can receive a true incentive for investing in end-use efficiency rather than new supply.

In Europe, the practice of increasing prices to recover program-related costs, lost revenues, and possible extra incentive payments is often viewed as a potential source of public and political opposition to large-scale utility conservation spending, even if total consumer bills decline. The current practice of "expensing" conservation programme costs in a single year compounds this problem. Electricity price increases due to lighting programmes operated by eight utilities are trivial and lead to essentially unchanged or slightly decreased bills.

INTRODUCTION

Electric utilities are in many ways well-suited for providing energy-efficiency services to their customers. For example, utilities have pre-existing financial relationships and regular contact with their customers, detailed information on energy demand, access to financing, and the ability to procure and install energy-efficient technologies in large quantities (and thus low costs). Although there may be non-economic reasons why a utility could find it advantageous to offer energy-efficiency services, doing so may not be as *financially* attractive as building new power plants, and may even involve short-term revenue losses. This potential bias against demand-side investments is often overlooked in discussions of barriers to the increased efficiency of energy use.

This paper analyzes the short-term economic impacts of actual European programmes to promote energy-efficient compact fluorescent lamps (CFLs) from the perspective of electric utilities. More generalized examples are provided to show the prospective impacts from large-scale programmes achieving a range of savings.

Between late-1987 and mid-1991, electric utilities in 10 European countries (Austria, Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Sweden, Switzerland, and the U.K.) held over 50 programmes to promote energy-efficient lighting. During these programmes, utilities offered financial incentives to encourage the use of CFLs in the residential and/or non-residential sectors. These programmes represent the first efforts by European utilities to use financial incentives to stimulate increased energy efficiency among their customers. In the cases where data are available (33 programmes available to almost 6 million households), the programmes have been cost-effective from a *societal* economic perspective.[1] The average total societal programme cost per unit of electricity saved was 15 mECU/kWh (2.1 cents/kWh), including costs for energy-efficient lamps and indirect costs for administration, marketing, and evaluation. [1 mECU = 1/1000 European Currency Unit.] Total costs were significantly less than the cost of building and operating new electric power plants.

From the perspective of utilities, reduced electricity sales (due to efficiency improvements or other causes) lead to reductions in variable costs (e.g. fuel) in the *short term*, but sufficient revenues are not collected to amortize capital investments or provide required dividends to private shareholders or public authorities. If allowed under prevailing accounting practices, lost revenues and conservation programme costs can be recovered by increasing electricity prices. This solution can remove an important disincentive for utilities to promote the efficient use of electricity, but the lack of a clear financial benefit may still dissuade utilities from promoting large-scale programmes. Moreover, higher unit prices may not be welcome among consumers or politicians. In the *long-run*, a utility's generating capacity would more closely match demand and the question of revenue losses would cease to be a problem. In this event, only the recovery of programme costs would affect electricity prices and customer bills.

Surprisingly, we found that electric utilities generally had not systematically analyzed the short-term financial effects of their lighting programmes or those of prospective larger programmes. This was evident from our interviews and from the almost complete lack of attention to this question in various programme evaluations that the utilities have published. The greatest exception was found among the Danish utilities, which exhibited a relatively high degree of awareness and openness regarding these issues. The German and Swedish utilities, on the other hand, did not appear to have carefully considered these issues and were clearly reluctant to share information. In Germany, the relevant data are treated in a highly secretive fashion.

It should be noted that electric utilities obtain multiple benefits from their participation in energy conservation programmes. Some of these benefits are not economic. For example, utilities may view increased energy efficiency as a way to reduce airborne emissions and other environmental problems associated with the production and inefficient use of electricity. Utilities may also view energy efficiency as a way of improving relations with consumers and with the regulatory and/or other governmental agencies that affect the business and political environment in which utilities must operate. However, meeting this latter category of objectives generally requires only that programmes are *visible*, not necessarily that they are *effective*.

METHODOLOGY FOR ASSESSING LOST NET REVENUES

Net revenues are composed of fixed capital costs, other fixed costs not recovered through fixed charges, and an extra return-on-investment, if any, earned on capital assets. The basic task of this analysis is to determine the overall effect of conservation programmes on utility net revenues and the adjustments to electricity prices required to recover lost net revenues and programme costs. We analyze utilities in Denmark, Germany, Italy, The Netherlands, and Sweden. The exact effect of programmes on revenues depends on how program costs and (1) variable costs, (2) fixed costs, and (3) profits or dividends are handled in the design of electricity tariffs:

(1) If a utility sells electricity for, e.g., 100 mECU/kWh (14 cents/kWh) the utility does not simply "lose" 100 mECUs for each kilowatt hour conserved by its customers. Taxes, for example, are just a pass-through and are normally paid (by utilities to the state) only for electricity actually sold. Transmission and distribution losses also represent variable (demand-dependent) costs. Fuel and other variable operating costs are also proportional to electricity sales. As shown in Figure 1, the contribution of fuel costs to total electricity costs varies from 1% in certain hydro-rich regions of Canada to 60% in The Netherlands.

(2) Tariffs often contain a fixed-charge component (e.g. dollars/year rather than dollars/kWh). Since fixed charges are typically collected regardless of the consumer's actual demand, the associated revenues are retained by the utility even if consumers reduce their consumption of electricity. Fixed charges do not always equal fixed costs.

(3) Some of the utilities we surveyed are not private profit-making companies but are owned by state or local governments. Many public utilities pay a dividend to their national or local governments. Revenue losses can occur whether or not a utility generates a dividend.

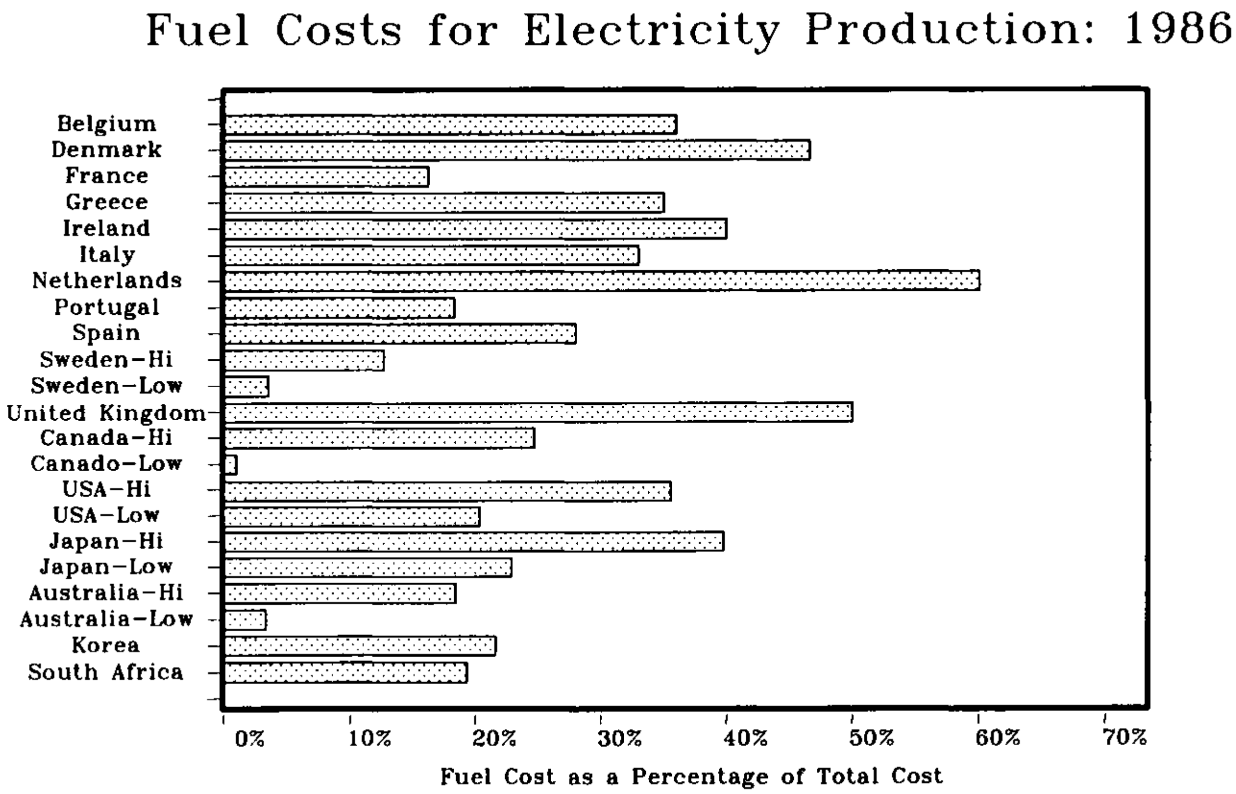

Figure 1. Fuel costs contribute in varying degrees to total electricity prices in different countries.[2] Sweden-Hi is Sydkraft, Sweden-Low is Vattenfall, Canada-Hi is Ontario Hydro; Canada-Low is B.C. Hydro; USA-Hi is Pacific Gas and Electric; USA-Low is Consolidated Edison; Japan-Hi is Chuba Electric; Japan-Low is Kansai Electric; Australia-Hi is Queensland; Australia-Low is Western Australia. Other variable costs (not shown) include taxes and operations and maintenance.

After accounting for the aforementioned factors, a *net* revenue reduction can be determined based on utility costs that are not directly a function of sales. Note that even if a utility does not help to pay for an efficient technology (or the administrative and marketing costs, which would reduce net revenues since they are an added cost), revenues decline as a result of reduced electricity sales. The one exception is when fixed costs equal the fixed charges.

In some cases, utilities may have the possibility to sell saved electricity to other utilities. This would of course eliminate the problem of lost net revenues.

In practice, energy conservation is only one of many factors that might lead to under-collection of revenues. Deviations from anticipated weather patterns or from the expected mix of fuels for producing electricity can have larger effects on revenues than conservation-related fluctuations in demand.

FINANCIAL IMPACTS ON ELECTRIC UTILITIES UNDER CURRENT ACCOUNTING PROCEDURES

The utilities examined in this paper represent power producers as well as distributors and provide 84% of the electricity delivered in Denmark, 2% in Germany, 90% in Italy, 100% in The Netherlands (all utilities follow a common rule), and 60% in Sweden. The marketing strategies applied in their lighting programmes ranged from lamp give-aways, in which the utilities paid for 100% of the lamp costs, to information campaigns or on-the-bill financing strategies in which no utility rebate was involved. We have also included the Swedish State Power Board (Vattenfall), which plans to operate large conservation programmes in the near future. The Appendix describes in more detail the situation for each country and utility.

Table 1 shows the electricity production and distribution cost structure for residential customers served by nine utilities and the net revenue losses resulting from reduced electricity demand. Two factors lead to significant variability in conservation-induced net revenue reductions among these utilities. Firstly, fixed costs represent between 11% and 58% of total revenues (Figure 2). Secondly, revenues from fixed charges insulate (to some degree) utilities from lost net revenues that would otherwise result from energy-efficiency programmes. Fixed charges (denoted as "Income, despite conservation" in Table 1) for the nine utilities range from 19% to 100% of actual fixed costs. Municipal utilities generally have far lower net revenue losses than generating companies.

In each country we examined, programme costs and net revenue reductions that may occur over the *short-run* as a result of conservation programmes may *in principle* be recovered via price increases in subsequent years. To help finance their conservation activities, utilities in Denmark and the Netherlands have explicitly included "efficiency" or "environmental" charges in electricity tariffs (0.6 to 3.9 mECU/kWh, or 0.1 cents/kWh to 0.5 cents/kWh). This internalizes at least part of the revenue correction before revenue losses occur. However, in some countries the system is only semi-formalized or there are practical factors that make it difficult or impossible to raise prices. Other European countries, e.g. Portugal and the United Kingdom, explicitly prohibit the inclusion of conservation programme costs and net revenue losses in the setting of electricity prices.

Table 1. Structure of utility electricity revenues for selected residential customer classes and net revenue losses due to conservation-induced sales reductions [a].

Utility	ELSAM	NESA	SEAS	SCHLESWAG	ENEL	GEB	Kalmar	Stockholm	Vattenfall	Vattenfall
		A/S	A/S	(b)			Energi AB	Energi AB		
Country	Denmark	Denmark	Denmark	Germany	Italy	Netherlands	Sweden	Sweden	Sweden	Sweden
Type of Utility (Producer, Distributor	[P,D]	[D]	[P,D]	[D]	[P,D]	[D]	[D]	[P,D]	[P,D]	[P,D]
Customer Class	N	N	N	A	A	N	N	N	N	N
	<---				(mECU/kWh)	-->				
PRODUCTION COSTS	34.5	0.0	38.7	0.0	42.5	0.0	0.0	26.7	29.9	27.3
Fixed:	21.1	0.0	17.0	0.0	20.4	0.0	0.0	21.5	23.4	20.8
Capital	11.9	0.0	7.0	0.0	--	0.0	0.0	--	--	--
Operations and maintenance	9.1	0.0	10.0	0.0	--	0.0	0.0	--	--	--
Variable:	13.5	0.0	21.7	0.0	22.1	0.0	0.0	5.2	6.5	6.5
Fuel	13.5	0.0	9.7	0.0	--	0.0	0.0	--	--	--
Operations and maintenance	--	0.0	12.0	0.0	--	0.0	0.0	--	--	--
TRANSMISSION & DISTRIBUTION COSTS	18.7	56.9	18.6	117.1	59.4	73.4	46.4	22.8	26.0	23.4
Fixed:	17.1	12.1	17.7	69.8	53.5	10.2	9.8	20.2	22.4	20.2
Capital	--	5.1	2.1	--	--	--	2.6	9.8	--	--
Marketing, administration, labour	--	7.0	15.6	--	--	--	7.2	10.4	--	--
Variable:	1.5	44.8	0.9	47.3	5.9	63.3	36.6	2.6	3.6	3.3
Electricity purchases	0.0	43.1	0.0	44.9	--	--	36.5	0.0	--	--
Trans. and dist. losses	1.5	1.8	0.9	2.4	5.9	--	0.1	2.6	3.6	3.3
OTHER "FIXED" COSTS	0.6	1.7	1.9	--	--	3.9	0.0	2.6	2.6	2.6
Dividend	0.0	0.4	0.0	--	--	0.0	0.0	2.6	--	--
Conservation programme fund	0.6	0.6	1.3	--	--	3.9	0.0	0.0	--	--
Other	0.0	0.6	0.6	--	--	0.0	0.0	0.0	--	--
SUBTOTAL (excluding taxes)	53.8	58.5	59.1	117.1	101.9	77.3	46.4	52.0	58.5	53.3
TAXES	63.4	63.9	63.5	26.4	33.3	14.3	23.3	24.7	26.0	24.7
TOTAL REVENUE (including taxes)	117	122	123	143	135.2	92	70	77	84.5	78.0
(US cents/kWh)	(16)	(17)	(17)	(20)	(19)	(13)	(10)	(11)	(12)	(11)
fixed portion	33%	11%	30%	49%	55%	15%	14%	58%	57%	56%
variable portion	67%	89%	70%	51%	45%	85%	86%	42%	43%	44%
Utility non-variable costs	38.9	13.7	36.5	69.8	73.9	14.0	9.8	44.2	48.4	43.6
Income, despite conservation [c]	15.9	13.7	10.4	35.4	23.6	12.5	8.9	9.6	9.4	15.0
Utility net loss per kWh saved [d]	23.0	0.0	26.1	34.4	50.2	1.5	0.9	34.6	39.0	28.5
Programme costs recovered in rates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lost net revenues recovered in rates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a]. The values shown are estimates of total average costs provided by each utility. A "--" indicates that the value for the row is included in the nearest subtotal. The following exchange rates as of January 23, 1991 are used throughout the paper: 1 Danish kronor = 0.127 ECU; 1 Dutch guilder = 0.433 ECU; 1 German mark = 0.488 ECU; 1000 Italian lire = 0.650 ECU; 1 Swedish kronor = 0.130 ECU; 1 US dollar = 0.724 ECU (1 mECU =

1/1000 ECU) The costs reflect common customer types: A = all residential customers, H = customers with electric heating tariffs; N = customers with non-electric heating tariffs. Time-of-day tariffs with fixed and variable charges that vary according to peak demand are now being introduced by many utilities. Modeling revenue impacts becomes more complicated when such tariffs are to be considered.

[b]. SCHLESWAG has both fixed ("take-or-pay") and variable costs in its power purchase contracts. All fixed costs are included under the "Transmission and Distribution" category. The values shown include a 7.4% duty that generates revenues used as a subsidy to the coal industry.

[c]. Income generated by sales-independent fixed charges.

[d]. Net revenue reductions due to reduced electricity sales (to be recovered via price increases).

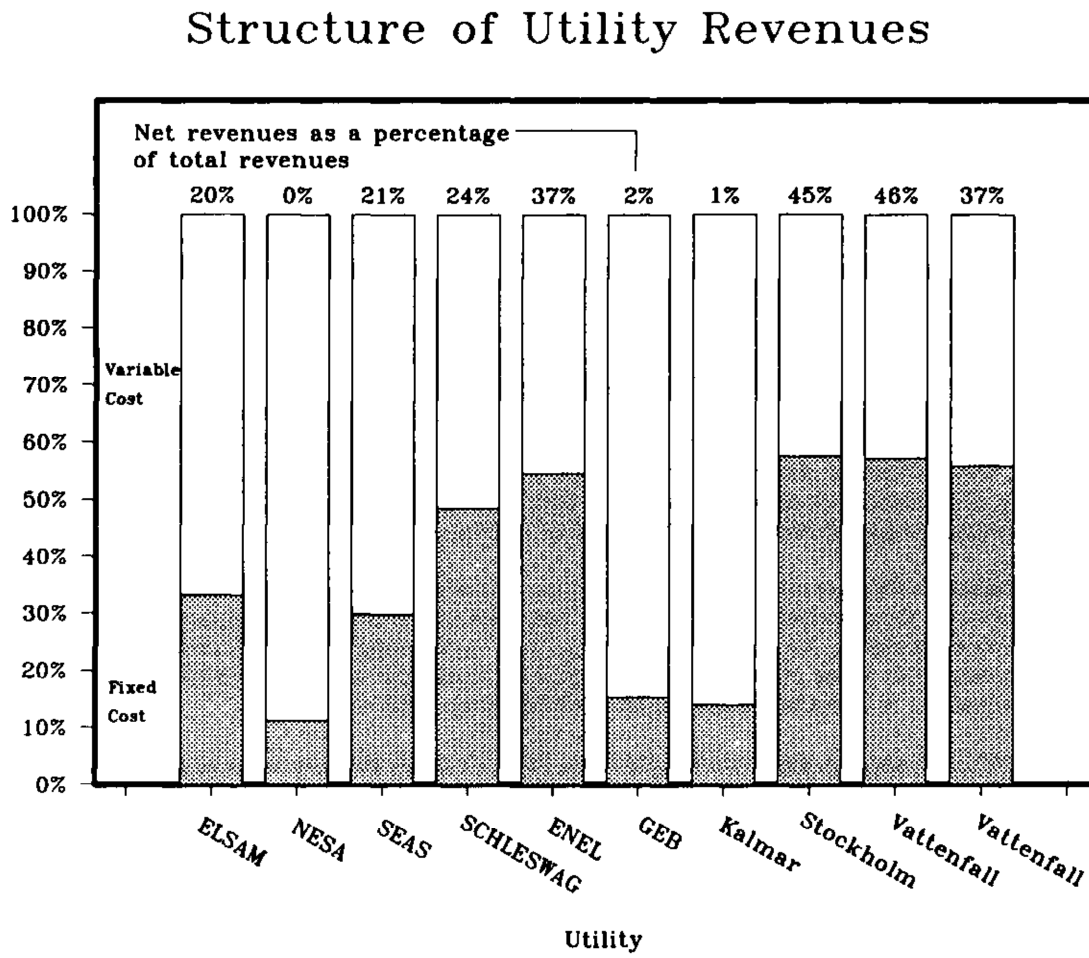

Figure 2. The structure of utility revenues has important implications for the size of lost net revenues due to conservation programmes. Values above the bars show the net revenue losses that occur per kWh of demand reduction. See Table 1 for more details.

Programme costs may be recovered via rates, but they are "expensed", i.e. recovered in a single year. This is done despite the fact that conservation investments result in long-lived assets.

The values shown in Table 1 reflect average costs for providing electricity to certain residential customer classes for the various utilities. A more precise evaluation of revenue reductions would be based on the structure of marginal costs during the exact periods when conservation takes place. To quantify this depends on the time of day or year and the depth of the demand reduction, and hence which supply resources are avoided. With this question in mind, the Danish utility ELSAM has analyzed the use of CFLs delivered to residential consumers via their incentive programme.[3] They found that the average value of energy saved by the CFLs was within 10% of the average overall cost of producing electricity in their utility. The CFLs were used 36% of the time off peak, 39% during times of intermediate peak, and 25% during the main peak. Thus, while our results are illustrative of net revenue losses and reflect average costs and revenues, they provide an accurate representation for the energy-efficient lighting programmes, at least in the case of Denmark.

It should be noted that reduced electricity sales normally result in lost tax revenues to e.g. local or national governments. As shown in Table 1, taxes can represent more than half of the total tariff.

POLICY ISSUES

European utilities are still far from achieving an approach to energy investments that minimizes total overall costs. Achieving a least-cost electricity system in Europe requires substantial increases in end-use energy efficiency.

Although there are differences among countries, the various European cost-recovery mechanisms have essentially the same effect on the utilities as that of the much-noted ERAM (Electric Revenue Adjustment Mechanism) system implemented in California in 1982.[4] It was expected that by decoupling utility profits from sales volumes that ERAM would lead to greatly increased interest and investment in conservation by California utilities, because they were not previously allowed to recover lost net revenues. In both the Californian and European systems, if sales *exceed* demand estimates upon which tariffs are based, e.g. because conservation programmes are unsuccessful, the windfall revenues are in principal returned to the consumers via a corresponding electricity price reduction in the following year. However, the procedures used in European utilities are not as formalized as is the case for ERAM. This is especially important in the cases of Germany and Italy where utilities are often under pressure not to raise prices.

Effects of Conservation Programme Costs on Electricity Prices and Bills

The utilities with which we spoke generally agreed that it was logical to allow for the recovery of programme costs and net revenue losses through tariffs. However, most utilities expressed the practical concern that their consumers (and politicians) would eventually disapprove of the required price increases. This concern exists in part because consumers have been conditioned to focus on unit prices (cost/kWh) rather than total costs.

In practice, very substantial conservation programmes would have to be initiated before prices would increase significantly. If consumers are responsive to prices, then price increases can lead to additional demand reductions. The degree of price responsiveness is, however, highly uncertain.[5]

Based on actual data for eight utilities, we calculated the net revenue losses (and the corresponding price increases required to recover those revenue losses) resulting from their previous lighting programmes (Table 2). The cost of the lighting programmes has had a very small impact, representing up to 1.3% of the prevailing electricity prices. The maximum value corresponds to the SEAS programme in which two CFLs were given to each residential consumer at a cost of 2.2 million ECU (S3 million) to the utility.

To test the effect of substantially larger programmes, Figure 3 shows changes in prices and bills that would arise from the actual structure of revenues and tariffs (fixed versus variable costs) for each utility described earlier in Table 1. Each bar reflects different levels of electricity demand reductions over the entire utility. The greatest bill reductions correspond to the greatest price increases. However, for a 30% demand reduction, bills decline by ~10% to ~25% depending on utility cost structure.

A more generalized illustration is provided by Figure 4, which shows changes in electricity bills over a range of hypothetical electricity prices, conservation programme costs, and the relative proportions of fixed and variable costs associated with a utility's production of electricity. Bill increases only occur when electricity prices are low, and fixed and programme costs are high.

Where price increases are viewed as unacceptable, non-utility financing of energy-efficiency improvements can be sought. However, even when all efficiency-related costs are paid by non-utility parties, net-revenue losses will still lead to price increases. The extent of the problem varies widely among utilities. If fixed charges are lower than fixed costs, utilities with very capital-intensive supply systems will have to implement relatively large price increases to recover lost net revenues.

The role that fixed charges play in limiting net revenue losses means that energy savings among different customer/tariff groups will lead to varying impacts on prices. For example, saving energy in Swedish electrically-heated homes, which pay relatively high fixed charges, will lead to smaller final price increases than savings in other homes. Each kilowatt-hour saved in Vattenfall's non-electrically heated homes results in 39 mECU (5.4 cents/kWh) of lost revenues versus 29 mECU/kWh (4.0 cents/kWh) for homes heated with electricity. However, it should be kept in mind that fixed charges have the undesirable effect of shielding the consumer from awareness of the long-run cost of energy.

Offering Financial Incentives to Utilities That Promote Energy Efficiency

Ensuring the recovery of lost net revenues and programme costs may not be enough to make energy-efficiency investments financially attractive to utilities.

Table 2. Impact of eight actual energy-efficient lighting programmes on electricity prices and bills.

Utility	ELSAM	NESA A/S	SEAS A/S	SCHLESWAG	ENEL	GEB	Kalmar Energi AB	Stockholm Energi AB
Country	Denmark	Denmark	Denmark	Germany	Italy	Netherlands	Sweden	Sweden
Type of Utility (Producer, Distributor	[P,D]	[D]	[P,D]	[D]	[P,D]	[D]	[D]	[P,D]
Customer Class	N	N	N	A	A	N	H	H
Year of Lighting Programme	1990	1990	1989	1990	1990	1989	1990	1989
Type of lighting incentive	Rebate	Rebate	Free	Information	Rebate	Rebate	Rebate	Rebate
Percent of cost paid by utility	~30%	0%	100%	0%	30%	~30%	~30%	~30%
Number of compact fluorescent lamps	9368	135000	240000	20000	15000	75000	4500	70000
Lamps per eligible customer	0.12	0.36	2.0	0.04	0.05	0.39	0.30	0.43
Electricity sales to eligible customer	0.170	5.680	0.616	1.807	44.7	0.687	0.067	1.349
A. Cost of lighting program (1000 ECU)	19	583	2183	0	54	50	27	543
(1000 US$)	26	804	3014	0	75	69	37	749
B. Net Revenue reduction (1000 ECU)	16	0	470	52	56	9	0.3	182
(1000 US$)	22	0	649	71	78	12	0.4	251
Total cost (A + B) (mECU/kWh)	0.119	0.022	1.541	0.029	0.002	0.029	0.093	0.223
(US cents/kWh)	0.016	0.003	0.213	0.004	0.000	0.004	0.013	0.031
Change in electricity prices [a]	0.10%	0.02%	1.26%	0.02%	0.00%	0.03%	0.13%	0.29%
Change in bills [a]	-0.12%	-0.60%	-1.36%	-0.06%	-0.18%	-1.45%	-0.01%	0.15%

[a]. The costs of the lighting programmes are allocated only to the electricity sold to the consumer group(s) eligible for the programmes. To transform the cost of the lighting programmes into a per-kWh cost, they are annualized over a representative estimate of the service life of a compact fluorescent lamp (based on 4 hours/day operation) using a 6% real discount rate.[6] See notes to Table 1 for the exchange rates used. The German programme was not funded by the utility.

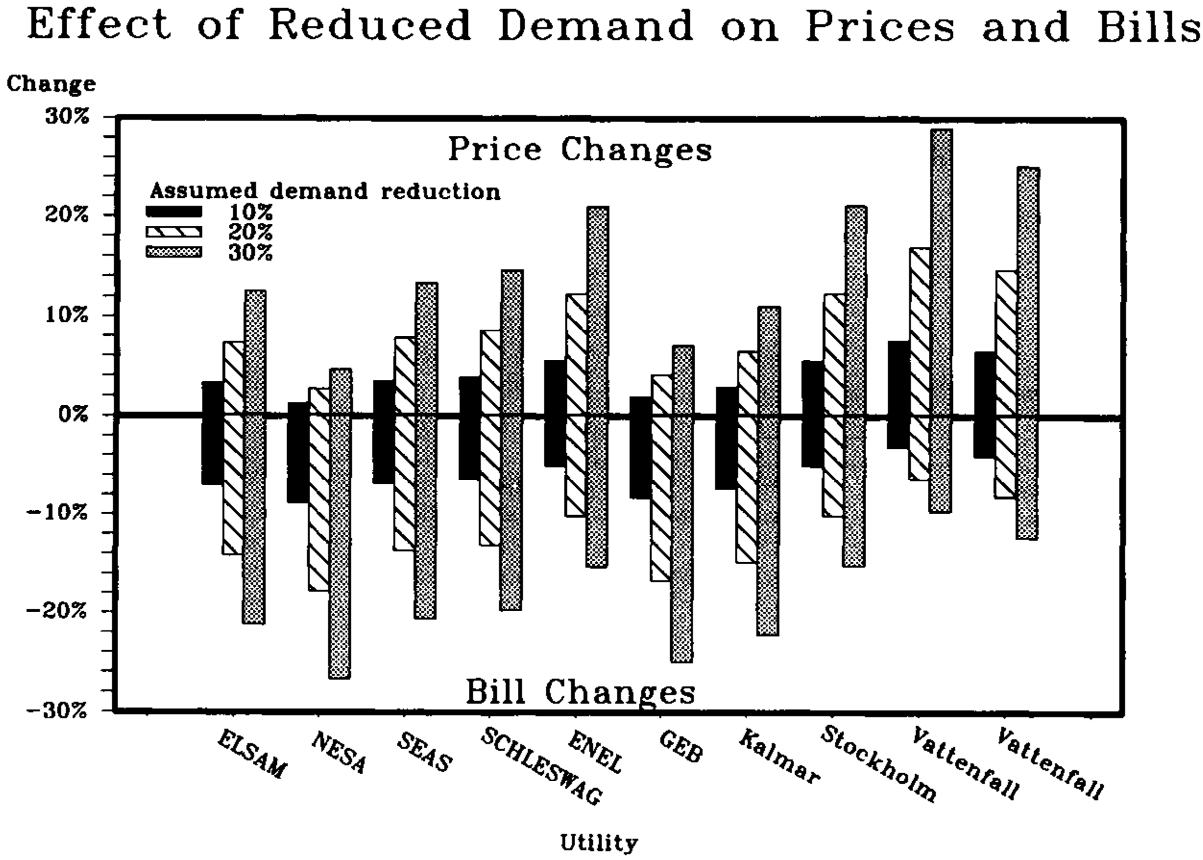

Figure 3. The bars show price and bill impacts for a range of savings levels, based on the actual composition of revenues and tariff structures for each utility described in Table 1. The hypothetical percentage savings are applied to *total* consumer demand (not only to lighting). An annualized cost of conserved energy of 14 mECU/kWh (2 cents/kWh) is assumed.

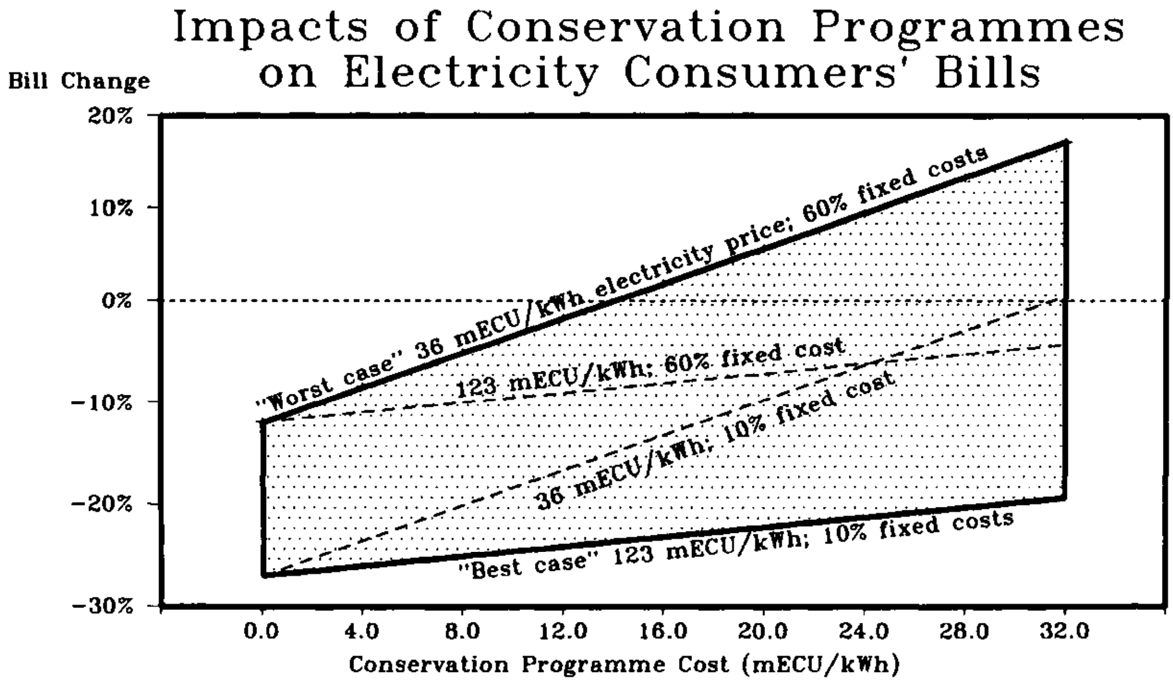

Figure 4. The shaded area represents a wide range of utility and conservation cost conditions, which together determine the net effect of programmes on consumer bills. In the "worst" case (greatest bill increase), the prevailing cost of electricity is only 36 mECU/kWh (5 cents/kWh), the utility has high fixed costs (60% of revenues), and the cost of savings is high (32 mECU/kWh) (4.4 cents/kWh). In the "best" case (greatest bill reduction), the electricity price is 123 mECU/kWh (17 cents/kWh), fixed costs are low (10% of revenues), and there is no direct programme cost to the utility. Two intermediate cases are also shown. A 30% total electricity demand reduction is assumed in all cases.

Even environmental taxes (e.g. CO_2 taxes) do not provide an incentive. Although they increase the price of electricity, such taxes do not directly contribute to or detract from utility profits.

If a goal of energy policy is to foster societally cost-effective utility investment in energy-efficiency, it may be necessary to provide larger financial incentives for efficiency investments. This has been the experience in California where, after a decade of strong political demand for utilities to promote energy efficiency, plus the introduction of revenue-recovery mechanisms like those in Europe, it came to pass that:

> "[M]andating conservation program funding levels, rather than measuring and rewarding the achievement of energy savings from utility conservation programs, has contributed to a decline in both program scope and program effectiveness."[7]

Without a true incentive linked to performance, utilities may not be sufficiently motivated to pursue energy efficiency. The level of spending on conservation is not necessarily a measure of how much energy is saved. The results of previous European lighting programmes exhibit virtually no correlation between utility spending and programme participation rates or cost effectiveness.[8] Furthermore, the fact that European conservation programmes have thus far been limited almost exclusively to one technology (compact fluorescent lamps) in one sector (residential), suggests that current incentives--or lack of disincentives--has not been sufficient to stimulate a significant broad-based effort.

Following are descriptions of four mechanisms that have been implemented or proposed to make investing in energy efficiency financially attractive to electric utilities. Some of the possible systems discussed (utilities owning or leasing energy-efficient equipment) have the additional benefit of separating efficiency costs from electricity prices.

1. Sale or leasing of energy-efficient equipment

Utilities can purchase energy-efficient equipment and sell or lease the equipment in such a way that the income generated compensates for revenues lost due to reduced electricity sales. The buying-power of utilities enables them to procure equipment at a much lower cost than is possible for individual consumers. For example, utilities have been able to purchase compact fluorescent lamps for ~75% less than prevailing retail prices. By sharing the savings with the consumer, both parties can benefit. In the lighting programme operated by ELSAM the utility bought CFLs at a discounted price and set the consumer price at a level that generated enough income to offset part of the programme costs. Another Danish utility, ARKE, sold CFLs for S2.70 above cost and used the proceeds to finance the programme costs. Utilities in Denmark, Germany, the Netherlands, and Sweden have offered on-the-bill payment programmes for CFLs. In some countries, however, utilities are not allowed to sell energy-using equipment.

2. Sale of energy services

As a variant on the previous approach, in Denmark, Norway, and Sweden (and probably elsewhere) utilities typically own the street lighting equipment and sell lighting services "by the lux" to cities or others desiring the service.[9] Thus, the annual subscription fee covers utility costs for providing the lighting equipment and the electricity. If utilities increase the efficiency of the equipment the costs of providing services can go down. Direct costs plus net revenue losses can be reflected in the lighting services fee. This system could be extended to other end uses, such as water pumping for municipal or agricultural purposes, electric boilers, or industrial furnaces.

3. Utility profits for conservation programmes

An efficiency incentive can also be created by allowing utilities to earn a rate of return on the capital they invest in efficient end-use technologies. This has been done recently for the Orange & Rockland utility in the United States, which now earns an 11.45% "DSM [demand-side management] incentive" on their energy-efficiency investments.[10] The incentive is a product of the energy savings and the difference between avoided supply costs and conservation programme costs. Included in the avoided costs is a 10.1 mECU/kWh (1.4 cent/kWh) "environmental externalities benefit" to reflect additional (non-economic) environmental benefits that result from energy savings. Under this system, the utility maximizes its benefits by finding the most economical ways to save energy. Benefits are reduced if the actual savings do not meet the projections. Moreover, if treated as a fixed cost, conservation programme expenses are spread out over time and thus affect prices much more gradually.

Another way to generate an incentive for utilities is to formally divide the total benefits of conservation programmes between utilities and electricity consumers. The benefits can be defined as the value of total lifetime energy savings minus programme costs. Prices can then be adjusted to achieve the desired allocation of benefits. Such "shared savings" systems have recently been implemented at North American utilities.[11] Pacific Gas and

Electric Company, for example, is allowed to retain 15% of the net present value of programmes and 85% is returned to the customers through lowered electricity prices. An added incentive is that utilities are essentially allowed to recover their share of the benefits over an accelerated three-year period. Minimum-performance standards have been set and utilities failing to meet the standards are subject to penalties on earnings.

The beginnings of similar incentive systems can be seen in Europe. In the State of Schleswig-Holstein, the Ministry of Social Affairs, Health and Energy may soon grant one utility a slightly increased rate of return as an incentive for pursuing energy efficiency. In Sweden, a new subsidiary has been created within Vattenfall (the Swedish State Power Board) with the sole purpose of financing energy efficiency. This subsidiary will earn the same 12% level of profit (then paid to the State) as does the rest of Vattenfall. In the increasingly competitive electricity market, offering energy-efficiency services to its customers is seen as one way of holding on to customers that might otherwise choose another utility.

4. Making new markets for the sale of conserved energy

The creation of a new "energy-efficiency" market among electric utilities has been proposed by the Swedish National Energy Administration[12] Under the proposed system, if a utility generates a surplus of power by implementing successful conservation programmes, they would have the option of selling this excess to another party at a negotiated price.[13]

The prospects for such an approach depend on the availability of open-access to the electricity grid which would allow any two utilities to negotiate power transfers, even if separated geographically by one or more utilities. A similar system is newly in effect in Norway, and the approach is referred to as the "balance principal" because it strives for an optimal mix of demand- and supply-side resources.[14] This concept could be extended to international power transfers. The European Community's Directorate General for Energy has expressed interest in opening up the European grid. Open access allows for, but does not ensure, utility investment in energy efficiency.

It is important that incentive systems reward utilities only if programmes are effective. Penalties for under-performance may also be appropriate. The appropriate type of incentive strategy is partly a function of the types of programmes or technologies that the utility pursues. Acceptable measurement and verification methods must be developed.

CONCLUSIONS AND RECOMMENDATIONS

We found that utilities had not closely analyzed the short-term financial impacts of existing or proposed energy conservation programmes. Utilities often focused on the long-term benefits of avoiding the construction of power plants rather than the short-term implications of reduced revenues. Our analysis of current utility accounting and price-setting methods showed that mechanisms are in place in Denmark, Germany, Italy, the Netherlands, and Sweden to allow utilities to recover lost revenues and programme costs. Due to the relatively small role of fixed costs, distributing companies suffer much smaller net revenue losses than do generating companies.

Mechanisms for recovery of lost revenues are not, however, universally in use throughout Europe. Even among countries that in principal allow for cost recovery, a number of obstacles exist that are likely to discourage utility investment in energy efficiency:

- Lack of a formalized cost-recovery mechanism may lead utilities to avoid conservation programmes because cost-recovery is not explicitly assured.
- There may be negative reactions to price increases necessary for the recovery of lost net revenues and programme costs.
- Programme costs are typically expensed rather than annualized. Annualizing such costs would allow for more gradual rate impacts.
- The loss of tax revenues resulting from reduced electricity sales may lead local and national governments to have mixed feelings about energy efficiency.
- Because conservation programmes have been very small, European utilities have not yet developed systems for explicitly allocating the recovery of programme costs and lost net revenues to the tariffs of groups eligible for the programmes. The current practice of raising prices will eventually be opposed by non-participants on the basis of equity reasons.

Although energy-efficiency programme costs and net revenue losses may be recovered by raising electricity prices, total bills can decline under most conditions. We haven't explicitly analyzed the overall household perspective, but the payback times of energy-efficiency investments will be little effected by the kinds of price increases called for. Unless programmes are very large and the average cost of saving electricity approaches the cost of purchasing electricity, price increases are not likely to become a source of concern. Acceptance will also depend on efforts to inform consumers of the prospects for lower energy bills despite higher unit prices.

Despite the existence of price-adjustment mechanisms in the countries we examined, limited utility activity on energy efficiency suggests that stronger incentives may be necessary. Furthermore, current rules do not encourage or reward *effective* conservation programmes. Introducing new performance-based incentive/penalty systems could provide substantial encouragement to utilities.

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APPENDIX: Background on the Utilities in Five Countries

Denmark

Lighting-efficiency programmes are prevalent in Denmark. Generating as well as distributing companies have operated programmes offering a wide variety of financing mechanisms. The Danish utilities described here deliver 84% of the electricity in Denmark.

Although current price-setting protocols do not formally allow utilities to adjust prices to reflect conservation-induced differences between forecasted and actual sales, this is the generally-accepted practice and will be formalized (on a national basis) in a revision of the Danish Electricity Act expected in 1991. Danish utilities are often organized as cooperatives, and thus have a clear interest in investing in energy efficiency. Danish utilities do not produce a dividend.

Danish utilities are under strong pressure from the government to pursue energy efficiency. Since most of Denmark's electricity is generated with coal, electric utilities will play an important role in attaining the national 20% CO_2 reduction goal from 1988 levels by the year 2005.

ELSAM. During 1990 ELSAM conducted lighting rebate programmes within two of its distributing companies. The utility purchased a large number of CFLs at a discount, which were later sold through retail shops at a slightly higher price. The "profit" was shared between the shops and the utility. ELSAM represents a large group of Danish power production and distribution utilities, which together provide 56% of Denmark's electricity. Fixed costs represent 33% of revenues. On a per-kWh basis, conservation-induced net revenue losses equal 20% of total revenues.

NESA A/S. In 1990, NESA operated the only European programme available simultaneously to residential, industrial, and commercial customers. The incentive mechanism was a retail lamp discount (no cost to the utility) plus the option to pay for the lamp(s) gradually via the utility bill. NESA sells 18% of the electricity used in Denmark. As a distributing company, most of NESA's revenues (89%) reflect variable costs. Because the fixed-charge component of the total tariff equals the company's actual fixed costs, there are no net revenue losses from reduced sales and hence no need for revenue-related price increases. Programme costs must nonetheless be recovered through prices.

SEAS A/S. In 1989, SEAS operated the largest European programme to-date, delivering two free CFLs to each of its 120,000 residential customers. SEAS, a power producer and distributor, sells almost 10% of the electricity in Denmark. Fixed costs represent 30% of revenues. On a per-kWh basis, conservation-induced net revenue losses equal 21% of total revenues.

Germany

Electricity prices in Germany are regulated at the state level. German utilities are allowed to earn a return on investment of up to 6.5% to 8.5% for their shareholders. In principal, large utilities are permitted to recover conservation programme costs and lost net revenues through price increases, although this is not clearly stated in the Federal Electricity Act. Small utilities don't need approval for tariff increases but are required to keep prices in parity with those of neighboring utilities and thus don't have full freedom to make ERAM-type price adjustments.

As in the other countries we have examined, political and environmental pressures are currently a key motivation for utilities to pursue energy efficiency. The government has set targets for reducing CO_2 missions by 25% from 1987 levels by 2005 in former Western Germany and by 30% in former Eastern Germany. Various utilities have held lighting programmes.

Schleswig-Holstein. Since 1990, utilities in Schleswig-Holstein have offered compact fluorescent lamps to all public-sector buildings, with the option of financing the lamps (at 6% interest) over a seven-year period. In a separate non-utility programme, a large information campaign has been targeted towards the household sector. In Table 1 the utility SCHLESWAG is analyzed. SCHLESWAG distributes 70% of the electricity in the state. Some of this power is redistributed by smaller municipal utilities, such as that serving the city of Kiel. SCHLESWAG sells 68% of the electricity in Schleswig-Holstein and 2% of all electricity in Germany. Fixed costs represent 49% of revenues. On a per-kWh basis, conservation-induced net revenue losses equal 24% of total revenues.

In Schleswig-Holstein, many municipal governments are dissatisfied with the ambition level of the regional utilities. In some cases, they have explored the possibilities of forming new municipal utilities to promote energy efficiency at the local level. In such situations, the state authorities give their support to the utility (local versus regional) that makes the greatest effort to promote energy efficiency.

Italy

Various political and technical factors provide a strong impetus to pursue energy efficiency in Italy. A non-binding resolution of the Chamber of Deputies calls for stabilization of CO_2 levels at 1990 levels by 2000 and a 20% reduction by 2005. A public referendum has resulted in a halt of the nuclear power programme. Three existing reactors (1160-MW total) have been taken out of service and construction has been stopped on three new reactors. Italy imports substantial amounts of electricity from France and Switzerland, but there is little or no excess capacity on the transmission system. Moreover, there is a desire to minimize energy-import dependence. In a recent accord with the government, ENEL (the state-owned utility) has agreed to use energy efficiency to slow demand growth by 0.6%/year between 1990 and 2000.

ENEL. One lighting programme has been operated by ENEL. In 1990 rebate checks were sent to 300,000 of ENEL's residential customers. ENEL produces 82% of all electricity in Italy and distributes 90% of all electricity. The utility pays no dividend to the state. Because of concern about public reactions, ENEL has at times operated at a deficit. Fixed costs represent 55% of total revenues. On a per-kWh basis, conservation-induced net revenue losses equal 37% of total revenues.

The Netherlands

Lighting programmes have been pursued more aggressively in The Netherlands than anywhere else in Europe. During the period 1988-1990, 8 of the country's 12 provinces held rebate programmes, which were available to approximately 60% of the country's households. A national rebate programme is now underway.

There are private and public utilities in the Netherlands. All electric distribution utilities are municipally owned and have identical price-setting rules and overall financial structure. The municipal utilities pay variable (fuel-related) charges to the supply companies and have very low fixed costs. As of January 1991, an environmental surcharge has been included in the electricity tariffs (0.5% to 2.0% of the existing tariff) to finance energy-efficiency investments. The Dutch government helps to finance conservation programme costs as part of their overall policy aimed at achieving reduced CO_2 and other emissions. There is a goal to achieve 3% to 5% CO_2 reductions from 1989/1990 levels by the year 2000.

GEB. The case of GEB is representative of that in other Dutch distributing utilities. As in almost all the Dutch programmes, rebate coupons for CFLs were combined with a "pay-on-the-bill" approach. Fixed costs represent 15% of revenues. On a per-kWh basis, conservation-induced net revenue losses equal only 2% of total revenues.

Sweden

The utilities examined in this paper produce or deliver approximately 60% of Sweden's electricity. Half of the electricity production capacity in Sweden is state-owned. The State Power Board (Vattenfall) sells half of its electricity to direct customers and half to distributing companies. The balance of electricity in Sweden is generated and distributed primarily by municipally-owned utilities. (On December 30, 1991, Vattenfall will become a shareholder company, "Vattenfall AB".)

The National Board for Industrial and Technical Development (NUTEK), Department for Energy Transmission and Distribution (*Enheten foer Ledningsbunden Energi*) plays an important policy-making role in the electricity sector. Although Sweden's Electricity Act does not explicitly allow for the recovery of conservation programme costs through prices, this is today an accepted practice, and NUTEK views this as a logical way for such costs to be treated. The Price Regulatory Office (*Prisregleringsnaemnden*) and the Department work closely together at NUTEK on electricity policy questions. According to the Price Regulatory Office, price increases resulting from energy-efficiency costs are acceptable as long as the utilities help their customers to lower their overall costs (bills).

As part of the NUTEK's plans for encouraging utilities to pursue energy-efficiency more vigorously, franchises will now be reviewed periodically. Utilities showing progress with energy-efficiency will enjoy a faster review process. NUTEK is also endorsing the conversion of municipal utilities into shareholder companies, because they believe that this will facilitate government oversight and monitoring of fiscal responsibility.

The first European lighting programmes were held in Sweden. The government's goals for a nuclear phase-out, holding CO_2 emissions constant, and protecting the four remaining large wild rivers could be expected to provide a stronger impetus for demand-side management than in any of the other countries we have examined. The development of demand-side management has, however, progressed more slowly than elsewhere in Europe.

Stockholm Energi. Stockholm Energi operated the first European lighting-efficiency programme. The utility gave 18,000 CFLs to its employees as a "Christmas present" in 1987 and rebate checks for CFLs were sent to each of its 355,000 residential customers in 1988, 1989, and 1990. Stockholm Energi produces and distributes almost 10% of the electricity sold in Sweden. Fixed costs represent a significant share of revenues (58%). On a per-kWh basis, conservation-induced net revenue losses equal 45% of total revenues. Stockholm Energi pays a 12% annual dividend to the local municipality. The utility has substantial excess capacity at the moment. However, there are areas in the city of Stockholm where the distribution grid has little or no excess capacity. The costs of increasing the capacity of the grid can be as high as 52 mECU/kWh (7.2 cents/kWh).

Kalmar Energi AB. In 1990, Kalmar held a simple lighting rebate programme, available to all residential customers. Since Kalmar Energi is a distributing company, fixed costs represent only 14% of revenues. On a per-kWh basis, conservation-induced net revenue losses equal only 1% of total revenues.

Vattenfall. Although Vattenfall has not yet held lighting programmes, we have analyzed the potential financial impacts because Vattenfall is the largest single actor in the Swedish electricity market and because they are now planning large-scale programmes targeted to a variety of consumer groups and end uses. In addition, energy-efficiency activities undertaken by utilities that buy electricity from Vattenfall will ultimately impact Vattenfall's revenues. Fixed costs represent ~55% of revenues. On a per-kWh basis, conservation-induced net revenue losses equal 46% of total revenues for customers without electric heating and 37% of total revenues for customers with electric heating.

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