

# **Procurement and demonstration of lighting technologies for the efficient use of electricity**

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## **1. SYNOPSIS**

By introducing new criteria for energy efficiency in agreements with important producers, NUTEK stimulates the Swedish market for energy-efficient products and systems.

## **2. INTRODUCTION**

One important objective of the Swedish energy efficiency procurement and demonstration program is to encourage the development and commercialization of new technologies. NUTEK has therefore introduced some innovative technology procurement processes.

For more than two years several important real estate owners have been stimulated by NUTEK to ask for more efficient products and systems in new and retrofit and constructions. The result is that today they have regular procedures to specify efficiency and performance demands when purchasing new lighting and ventilation installations. These procedures have now spread to other purchasers.

## **3. METHOD**

In order to fulfill the intentions of the program, NUTEK had to activate the most important purchasers with a strong influence on the market. Agreements have thus far been signed with 15 real estate management companies and owners of public, commercial and industrial buildings. The agreements define new efficiency standards and monetary incentives, but each single actor can establish his or her own priorities and specifications. That gives them the incentives to procure somewhat more efficient products and systems than is motivated by their normal design specifications and economic criteria. The main objective is to increase the demand for more energy efficient systems and products by establishing new design criteria. In several completed office projects they have met with efficiency standards 10W/sq.m. for lighting and 1,5 W/cu.m./ sec. of fan power for ventilation. These criteria are also used by others, in some cases even without monetary support.

### **3.1 New efficiency and performance criteria for lighting**

In Sweden there has not therefore, been any wide spread combined efficiency and performance standard for lighting. In our first approach we aimed at efficiency of 10 W/sq.m. for lighting of offices. This chosen level was based on the results from early projects with well designed lighting installations, including efficient luminaires furnished with HF electronic ballasts.

It has been shown that this efficiency criterion is appropriate. In the next step, we launched a special office lighting demonstration project in cooperation with some of the most customer-oriented distributors of electricity in the country. We then had to give them guidance on how to design efficient lighting installations with good performance. As a result, we have also developed a list of stipulated lighting quality factors within a group of lighting specialists (NUTEK 1993a). This list contained, among other, demands on illuminances, luminances, glare, contrast rendering, color rendering, room surface reflectances, electrical and magnetic fields and energy-efficiency. To limit flicker it was compulsory to use electronic ballasts.

Within the office lighting project, manufacturers of luminaires have been offered the possibility of having their system approach to office lighting examined and measured in relation to how they meet the specifica-

tions asked for. So far, some 40 systems from more than 10 manufacturers have been tested. About 50% of the systems tested have complied with the stipulated performance demands. This means that performance demands are adequate.

Similarly, for the lighting of hospitals and schools we have asked some of the best lighting scientists and designers to study lighting installations and, based on their findings, suggest new efficiency and performance criteria also for these kinds of premises (NUTEK 1993b, NUTEK 1993c). The objective is to initiate campaigns for better lighting in cooperation with the owners.

### 3.2 Technology procurement

To support the group of purchasers, certain components have been procured (Stillesjö 1991) based on collective specification in central contracts, e.g. HF electronic ballasts. In the fall of 1991 an invitation for tenders (NUTEK 1991) was sent to the major manufacturers of HF electronic ballasts. The technical specifications were based on the latest experience from the installation and operation of a number of new lighting systems with electronic ballasts and control systems in demonstration projects. The aim of this was the new development of control systems and low installation costs for the complete system including control devices.

From the successful bidder we have, in cooperation with a group of purchasers, promised to order at least 26,000 dimmable as well as non-dimmable ballasts intended for linear 36 W and 58 W fluorescent tubes respectively. For some large building projects planned for completion in 1992-93, the purchasers order ballasts directly from the successful bidder who delivers them to the manufacturers of luminaire fixtures identified by the purchasers for each specific building project. The purchasers request that these electronic ballasts be installed by the luminaire manufacturers who supply the fixtures. Thus, they can provide complete fixtures with ballasts to the individual building contractors working on the projects. The contractors install the complete fixtures, following the installation instructions from the fixture manufacturer.

So far, more than 30,000 ballasts have been delivered according to the contract which expires this summer. Thus, the total order might be much larger than the minimum promised to the winning contractor.

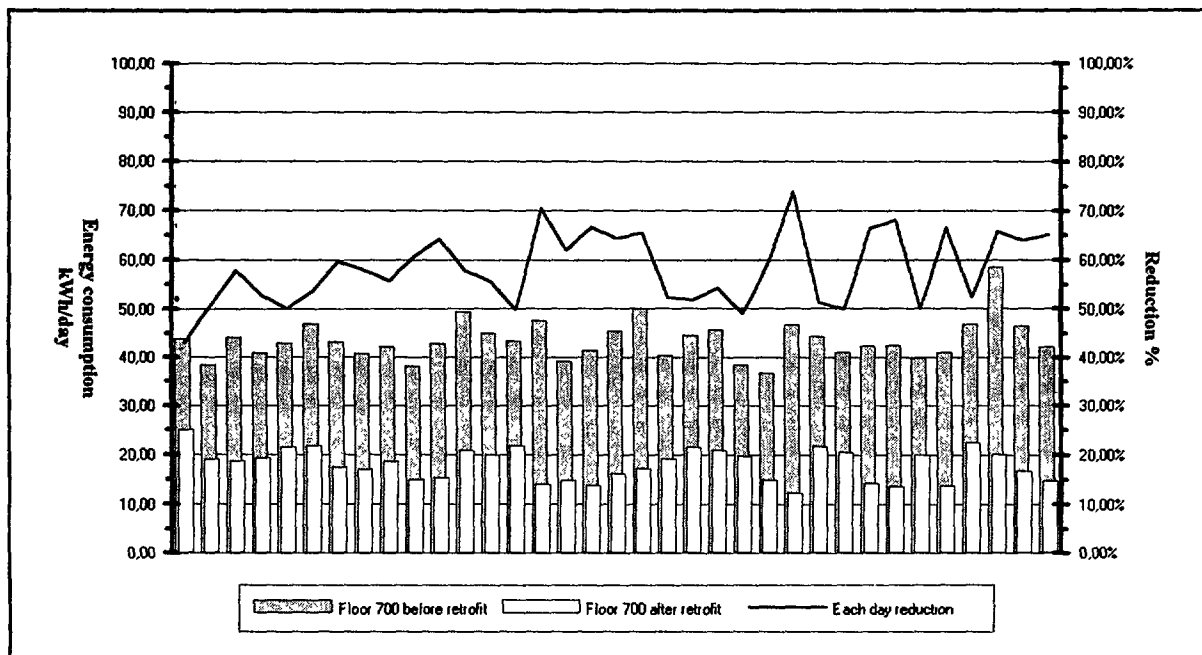


Figure 1. Energy consumption at the Frosö hospital for various days before and after the retrofit

The winning contractor in this technology procurement also offered, as part of the tender, development of a

new programmable lighting control system based on an intelligent microchip integrated in the ballast electronic. This control system will be installed, tested and evaluated in a number of lighting installations. This system will make it possible to address, individually every luminaire in a lighting installation. Control signals can be sent from each node--sensors etc.--in the system.

#### 4. RESULTS

More than 50 lighting and ventilation projects have been completed under agreements signed with large real estate owners. It has been shown that when the new efficiency criteria of the agreements have been applied to the procurement process, energy reductions on lighting of 50 to 70 percent have been achieved in retrofit and 20 to 30 percent in new construction. New energy efficiency criteria have thus been tested and are now in widespread use. One example of a 60 percent reduction is shown in figure 1.

For different kinds of premises, both energy efficiency and performance criteria have been set. These program criteria are the first of their kind in Sweden, and they will be used in future projects and campaigns. The criteria are listed in figure 2.

In a technology procurement process, several important real estate owners, based on central contract with

Type of premises	Illuminance (lux)	Luminance (cd/m <sup>2</sup> )	Contrast reduction (percent)	Colour Rendering Index (Ra)	Color temperature (K)	Medium reflectance factor (percent)	HF electronic ballasts	EMF (nT and V/m RMS)	Installed power demand W/m <sup>2</sup>
<b>Offices</b>									
Work space	Reading >500 On desk >300 Elsewhere >100 Vertically >100 Vertically on monitor <200	Normal visual field <1000-500 Rel. <10:3:1 Above field <2000-1000 Rel. <20:1	<15%	>80	2 700-4 000	Roof >80 Wall with window >70 Walls >60 Floor 20-40 Desk 30-60	Yes	5Hz-2kHz <250 nT <25 V/m 2kHz-400kHz <25 nT <2.5 V/m	Small rooms <12 W/m <sup>2</sup> Large rooms <10 W/m <sup>2</sup>
Corridors	>100	Rel. <40:1		>80	2 700-4 000	Roof >80 Walls >60 Floor 20-40	Yes		<8 W/m <sup>2</sup>
<b>Hospitals</b>									
Patients room	>600 for examination and treatment else variable	<800 in luminaires as seen from bed Rel. <20:1		>80 >95 for correct colors	2 700-3 000 4 000-5 000	Roof 75-90 Walls 55-70 Floor 25-30	Yes		<12 W/m <sup>2</sup> at examination and treatment else 2-5 W/m <sup>2</sup>
Corridors	>70	Rel. <40:1		>80	2 700-3 000	Roof 80-90 Walls >75 Floor >25			<3 W/m <sup>2</sup>
Intensive care	>100	Rel. <40:1 <20:1 along c			3 000-4 000	Roof 80-90 Walls 60-75 Floor 25-30	Yes		<6 W/m <sup>2</sup>
Reception	>150				2 700-3 000				<8 W/m <sup>2</sup>
Administr	>150				2 700-3 000				<8 W/m <sup>2</sup>

Figure 2. Performance criteria

the successful bidder have purchased some 30 000 HF electronic ballasts now used in a large number of lighting installations. According to this contract the producer fulfills very stringent technical specification including a 5 year warranty combined with a favorable price. Under the contract, the manufacturer has developed a new intelligent lighting control system. Two pilot installations have been completed and will be evaluated.

## 5. DISCUSSION

It has been shown that it is possible to establish new design criteria and stimulate large real estate owners to ask for even more energy efficient product and systems. In new and retrofit construction the payback period is reasonably short even with the low Swedish price of electricity. The end-users also see other advantages, e.g. flicker-free light, less waste heat etc. In many projects it is surprising how small monetary incentives are needed to get the process going.

In the next step, the new design criteria will be demonstrated and evaluated on a broader scale, and information in the results will be spread to those involved in the design and construction of lighting installations.

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