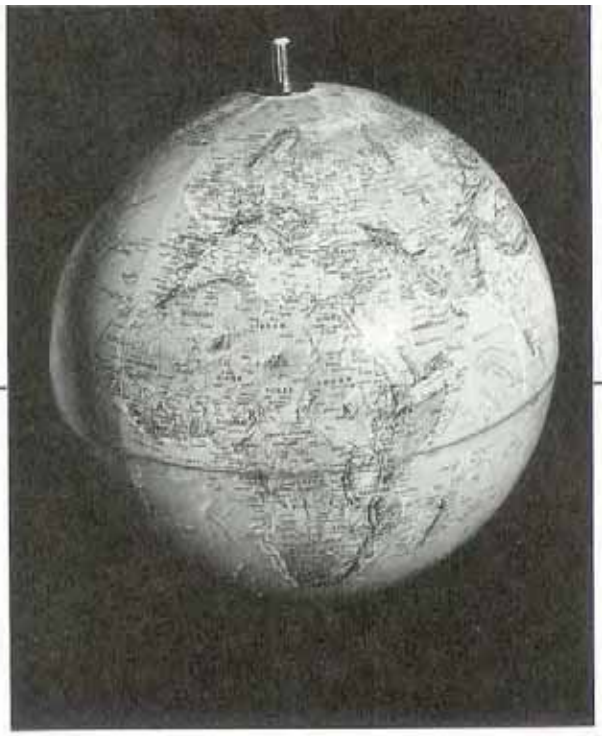
PURCHASERS´ REQUIREMENTS DICTATE DEVELOPMENT:

A STUDY OF TECHNOLOGY PROCUREMENT

EFFEKTIVARE ANVÄNDNING EL

NUTEK

PREFACE



If we look back to the decade of the 1980s, we see a period where the world began to set the global environmental agenda. It was in 1987 that the Brundtland Commission report on environment and development was first issued. Also in 1987, the world took its first actions to halt the production of chlorofluorocarbons that were destroying the ozone layer. In 1989, 123 countries met in London to call for further action on ozone depletion. And later that year, a high-level international meeting was called urging the world to begin to combat global climate change.

But if the 1980s saw the setting of the agenda, the 1990s can be viewed as the period in which we began to make the difficult decisions necessary to achieve its implementation. Beginning in 1990, the developed world began to focus on partnerships with developing countries. The first product of this partnership was the establishment of the Multilateral Fund to Protect the Ozone Layer. In 1992, at the Earth Summit, concrete actions were taken on biodiversity and global climate change, and the goal of environmentally sustainable development became the guiding principle for the future.

It is within this context of the goal of environmentally sustainable development that the very specific concepts of pollution prevention and energy efficiency must be viewed. Environmentally sensitive technologies must be developed that can meet our goals for the 21st century. But development alone is not sufficient; we must also direct our energies toward seeing that these products are purchased and used. And the role of government in this effort cannot be minimized. The Department of Energy Efficiency at NUTEK, the Swedish National Board for Industrial and Technical Development, is a leader in government efforts to play a catalytic role in bringing the best of new technologies to the market place. We are all grateful for your leadership.

Eileen Claussen

Special Assistant to President Bill Clinton
for Global Environmental Affairs

INTRODUCTION

Speed and reliability were the decisive factors at the spectacular Rainhill Trials in 1829, when all the famous designers of steam engines had gathered to find the best locomotive. Far more important than the order for five locomotives, which was the prize, was of course the fame that would be achieved by winning and being seen to be the best, fastest and greatest.

George Stephenson won with his Rocket, while his most serious competitor, John Ericsson, could only watch while his Novelty broke down.

No doubt, in due course, advances in engine design would have resulted in steam locomotives capable of 46 km/h, even without the spectacular Rainhill Trials. The question is merely when this would have happened. Obviously, the company that was to operate the newly-built line was not content simply to wait for development. Through the trials, they succeeded in pressing contemporary abilities to the uttermost, thus accelerating the rate of development not only of locomotives but also of steam technology in general.

ACCELERATED DEVELOPMENT

It would be more than another century before the concept of technology procurement was coined to describe the process of a purchaser attempting to accelerate development in a desired direction by pledging future purchases of something that did not exist at the time.

Traditionally, the public authorities in various countries have been very active technology purchasers. Orders to defence industries, for example, are often for equipment which, at the time of ordering, has not been produced. The space industry has largely followed the same long-term pattern and worked in close contact with demanding purchasers. Technology procurement in the defence and space industries has provided a major impetus in increasing the volume of data stored in small volumes and with minimum weight – something which, in turn, has had an enormous effect on civil applications of computer technology.

Sweden, too, has a long and rich tradition of technology procurement. The railway between Kiruna and Narvik, for example, required the most extensive and advanced electrification that had ever been used for railways up to the time that it was built.

The first commercial nuclear power stations, the DC cable to Gotland, the X 2000 high-speed train and, indeed, the public telephone system – based on requirements specified by the Swedish Telecommunications Administration – are further examples of negotiated projects in which extremely demanding performance specifications had been set by the purchasers. In turn, such projects have often been the start of extensive development work together with the suppliers.

The Rocket, George Stephenson's famous steam locomotive. In 1829, at a speed of 38 km/h at full load and 46 km/h unloaded, The Rocket won the Rainhill Trials to find the best locomotive for use on the recently-built Manchester to Liverpool railway.

SATISFYING DEMAND

Traditional technology procurement is concerned simply with satisfying a given defined requirement by a completely new product. (In this context, the term 'product' also includes systems or manufacturing processes). The associated technical development has essentially been regarded as a secondary effect, although a very desirable and valuable effect. However, in recent times, negotiations have been conducted in which it was instead the technical development, aimed at achieving more efficient designs, that was regarded as the prime aim. In such cases, it is the products that have been obtained almost as a byproduct.

NUTEK's Department of Energy Efficiency is the operating authority for the seven-year programme established by the Swedish Parliament, aimed at improving the efficiency of energy use, with particular application to electricity.

Technology procurement – often in its more modern form – has been found to be an extremely useful instrument, with the result that much of the Office's work is involved with it. Additional demand for products developed as a result of technology procurement is created by non-specific project grants, available also for competitive products as soon as they have met market requirements.

This study is intended to describe our experience to date in employing technology procurement and non-specific development project grants to influence technical development in the direction of more efficient use of energy.

Charles Edquist

Professor of Technology and
Social Change, University of Linköping

By tradition, and over a long period of time, technical development has been regarded as an essentially linear process, starting with basic research at one end and arriving at economic growth at the other end as the end product. Along the way there are admittedly various phases of, say, innovation and the spread of particular technologies, but on the whole the process can be regarded as linear.

Unfortunately, this very shortsighted view has created an equally shortsighted view of the role of the State: desirable development is accelerated mainly by increasing the resources provided for research and development. However, in reality, the process of spread of a particular technology is very much more complicated, often with interaction between the various parts of the system. If one accepts such a rather more accurate view, it is also clear that anyone attempting to influence development can intervene at many points in the system.

Conscious policy

The view of technology procurement can thereby be expanded so that it no longer represents only a way of making useful products available to public authorities: instead, it can consciously be applied as a means of accelerating and influencing technical development. This means that the State's technology policy suddenly becomes more complicated: no longer restricted only to subsidised research, it becomes a means of influencing the supply and demand side of the system.

With the stranglehold of the one-dimensional perspective broken, the feasibility of integrating social and environmental dimensions into technology policy is considerably enhanced. In addition – which ought to be a particularly important aspect as far as Swedish interests are concerned – technology procurement opens new ways of influencing technical development. Small countries have limited research resources and therefore limited possibilities of influencing research at the international level. On the other hand, their ability to influence the take-up and integration of new technology, both in geographical terms and in terms of new applications, is considerably greater.

A powerful instrument

Technology procurement goes back a long way, and there have been many occasions on the national plane to demonstrate that it is an extremely powerful instrument. The most obvious example is the defence industry. The State places orders for weapon systems that simply do not exist, for delivery at some time far in the future. Expressed in general terms, it can be said that the State is using its own future requirements as an instrument of technical policy.

It is perhaps less known that Vattenfall's and SJ's often very demanding purchasing requirements have been a spur to ASEA's development, while the Swedish Telecommunications Administration's demands have driven L.M. Ericsson forward. The fact is that public purchasing has played a very considerable part in the growth of these large companies.

Hans Westling

PhD and technology
procurement consultant

Within the field of innovation research, there is lively discussion as to which instruments have been the most effective in furthering development. Some research workers emphasise the importance of the product side, while others claim that the work should be concentrated on the demand side.

In recent years, the conclusion has been reached that work in both areas is important, but that the majority of innovations – some research workers say 75 % or more – have resulted from work on the demand side.

Many research workers also emphasise the importance of smoothly operating organisations and communications, while the importance of long-term relations between manufacturers and users has been shown by many investigations.

Technology procurement, which is a valuable tool on the demand side, is concerned with providing meeting-places for purchasers and manufacturers. The purchaser (or purchaser group) has the controlling role. A successful technology procurement project therefore almost always has its origin in a skilled purchaser group. It is important to put as much effort as possible into bringing together purchasers looking to the future, i.e. those who, from the start, are aware that problems may be encountered before the new product reaches the prototype or trials stage.

Importance of formulating requirements

However, the purchasers must also be thoroughly aware of their present problems, so that they can clearly identify their needs and express their requirements. It has been found that this particular aspect is not always so easy in practice. This is because skilled specification drafters do not grow on trees. It is all too easy to get caught up in the limitations implied by present-day technology and by conventional design solutions. However, the purpose of formulating requirements is to determine market needs and to express them in functional terms, without being led astray by what seems to be possible using a particular technology. Just this – demonstrating openness in terms of accepting that there can be new ways of fulfilling specified requirements – is the be-all and end-all of technology procurement.

When the results of a technology procurement project are being decided, the purchaser group must also have the necessary capacity to give sufficient time and thought to more general quality requirements, such as assessments of the suppliers' abilities to achieve sufficient manufacturing capacity for previously untried solutions.

From prototype to trial production

The initial stages of the work are followed by passing from prototype to trials series, in conjunction with the suppliers, at which stage all parties can benefit from regular and detailed exchange of experience. The members of the purchaser group must, in other words, be prepared to act as a kind of risk-taker, thus making it possible to accelerate installation of the trials

series. This does not mean, of course, that the suppliers should skimp on their development testing and hope that reality will serve as a test chamber. However, it is of great value if the first purchasers can quickly provide feedback of information, and it is also important for the suppliers to know where the first trials units have been installed so that they can apply improvements if appropriate.

Once more, therefore: technology procurement provides a meeting-place for purchasers and suppliers. A meeting-place at which the future user is able to influence the development process.

I am convinced that it is easier in Sweden than in other countries to operate technology procurement projects. We have a relatively homogeneous culture, so that users and purchasers find it comparatively easy to understand each other. This gives us a competitive edge, of which we should take good care.

Hans Nilsson

Manager, Department of Energy Efficiency, NUTEK

Technology procurement refined

Technology procurement is a method in process of refinement. The concept was originally employed by knowledgeable purchasers, turning to a limited number of suppliers. This method worked, and works, well for product development involving knowledgeable and clearly identified parties on the market.

Technology procurement with the objective of improving efficiency of energy use has also been successfully employed in Sweden and the USA for mass market products, and as an instrument for concentrating product development on features of products that are important for users. The next step will be technology procurement in joint international efforts aimed at encouraging greater competition and faster achievement of volumes for particular products, so that costs can be pressed and product launches brought forward.

Demand in markets such as these is created by bringing together important customers and formalising and expressing their requirements. This can be done with or without the support of central bodies. If the process is to operate quickly, there is often a need for support from some party that becomes involved in the work as a catalyst, with no commercial interest of its own. Various other observations of the feasibility of effectively influencing the markets are:

- *Support must not be aimed at individual producers, but at influencing the entire market. It is the companies' competitive abilities that are exploited to produce better products and more favourable prices. Support must be given, instead, to the purchaser, to enable him/her to influence the supplier. Purchasers' interest in better products must be gathered together in order to attract the interest of the suppliers.*
- *The market's best products to date are not sufficiently good. Generally, improvements in performance of the order of 10–20 % can be effected if demand is sufficient to ensure adequately large volumes to cover the costs. Encourage purchasers in order to create a demand for the best products (i.e. to create a market signal), but act in order to achieve even better products.*
- *Note that it is not the State that is buying the new products. This is being done by the purchasers (possibly with financial support from the State) if their demand can be organised into a coherent whole. The State does not need the products as such: instead, it is the ordinary market forces that are to be given a helping hand in the right direction. The State participates in helping to define requirements, dealing with administration of the project and ensuring that the resulting products obtain a foothold on the market.*
- *Don't pay for product development: utilise the companies' own development knowledge and facilities. Many manufacturers are willing to develop newer and better products, and have comprehensive knowledge of all aspects involved. They need only the challenge and motivation to concentrate their development resources.*

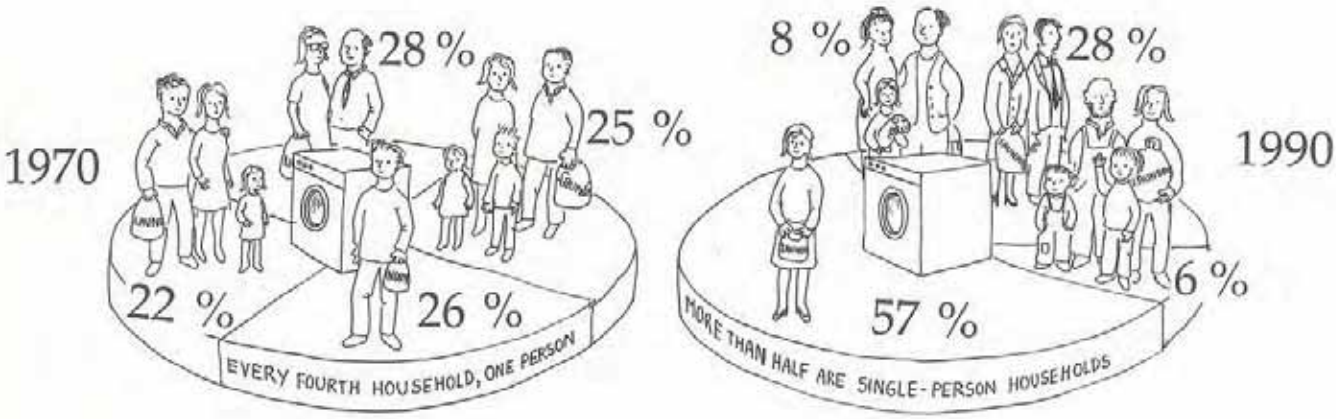
Suppliers perform market surveys in order to identify interested customers. In turn, interested customers are often looking for better products, but it is not always that the two parties meet. Technology procurement links up the more influential customers by bringing them together in a purchaser group. The group then prepares an enquiry specification and negotiates with the manufacturers, producing a coherent demand.

UTILITY ROOM – YES, BUT FOR WHOM?

It would be profitable to replace even quite new equipment with equipment having higher efficiency of electricity use.

At the end of the 1960s, a modern apartment with three rooms, kitchen and bathroom was the dream of many families with children. This dream included the well-equipped, modern, shared utility rooms in which the mothers of the families (often, at that time, full-time housewives) could stuff the big machines full and deal with a whole week's wash at one go.

At that time, almost half of all households consisted of families of three or more persons. Today, 85 % of households consist of two or fewer persons.



However, apartment block utility rooms are still being equipped in the way that they were 20 years ago: two 6 kg washing machines complemented with drying cupboards and tumble dryers are a common standard.

Our survey of washing habits, carried out in November 1991, shows that no less than two-thirds of the large apartment-dwelling households have their own washing machines and, in addition, often drying equipment. Among the small households, the corresponding figure is over one-third. It is, in other words, the very smallest households, often consisting of young or retired persons, who are wholly dependent on either the 6 kg machines in the building utility rooms or on hand washing. This represents about 1.2 million households, and the results of the investigation indicate, not unexpectedly, that many of them feel that it is difficult to produce a worthwhile load for the large machines.

However, the larger households too, need to sort their washing into different groups of temperatures and/or colours. The ability to run several loads in parallel, thus reducing the washing time, is a particularly common wish. Higher standards of cleanliness have resulted in such quantities that, despite all the new equipment, the time spent in washing clothes has not fallen since the 1930s.

40 % USED FOR CLOTHES CARE

In an apartment building, electricity for common purposes is that which is used for lifts, ventilation, stairwell lighting – and washing. Washing and drying account for up to 40 % of electricity for common purposes used in apartment buildings. Both tenants and landlords have every reason to be interested in reducing this amount.

However, market mechanisms have patently not operated: the range of equipment available does not match the demand. As long ago as 1969, the National Board for Consumer Policies indicated that there was a need for smaller washing machines for use in apartment buildings. During the subsequent years, this demand has hardly declined.

Another problem, which the product developers have not taken sufficiently seriously, is that of noise from the machines. The noise from utility rooms limits their use in the evenings and at weekends, i.e. at just the times when

modern families are most likely to want to deal with their washing.

It was therefore not particularly difficult to gather interested parties for a technology procurement project to provide the manufacturers with an appropriate incentive. In addition to the National Board for Consumer Policies, the purchaser group included representatives of AB Gavlegårdarna in Gävle, AB Familjebostäder in Stockholm, AB Förvaltaren in Sundbyberg, HSB, HBV (which is the joint purchasing organisation of the public housing companies), Skandia, Stockholm Energi and Huddinge Electricity Company.

TWO COMPETITIONS

The technology procurement project was operated in the form of a competition – or, more exactly, in the form of two competitions. This was because the purchaser group decided not only to encourage the development of smaller and more electricity-efficient washing machines and tumble dryers, but also to interest the manufacturers in the need for tumble dryers incorporating heat pumps.

Tumble dryers with heat pumps can be connected to the building's existing ventilation system, which can be an important advantage in somewhat older buildings, in which it is often difficult and expensive to convert the ventilation systems to provide sufficient capacity.

The electricity demand of such dryers is even less than that of tumble dryers without heat pumps, but it takes somewhat longer before the washing is dry. The drawbacks also include the fact that a tumble dryer incorporating a heat pump is more expensive to buy, and that (at least at present) its noise level is higher.

In the case of 'conventional' washing machines and tumble dryers, the basic performance requirement was expressed as a maximum electricity demand of 1.35 kWh of electricity per kg of dry, clean washing. This represents a reduction of 80 % in comparison with the average energy demand of machines installed today.

In the case of washing machines and tumble dryers fitted with heat pumps, the basic performance criterion was set at a maximum demand of 0.95 kWh electricity per kg of clean and dry washing. Both competitions also specified a number of other requirements, e.g. in terms of water consumption and noise level. Quiet machines can be used for a greater part of the day, thus increasing the availability of the utility rooms.

Eight tenders were received. Two companies, Miele and Electrolux-Wascator, met all the basic performance requirements. However, it was Electrolux-Wascator which succeeded in winning both classes. With a 3.3 kg washing machine (manufactured by Asko Cylinda but marketed by Electrolux-Wascator, who had also been involved in its development), in combination with a 'traditional' low-energy tumble dryer, the total electricity demand per kg of clean and dry washing was brought down to 1.23 kWh/kg: in other words, well below the competition's target of 1.35 kWh/kg.

For the tumble dryer with heat pump, Electrolux-Wascator put forward a 4 kg machine having an electricity demand of 0.78 kWh/kg of clean and dry washing, i.e. well below the competition's requirement.

In comparison with a ten-year-old utility room with large machines, these new small low-energy machines would pay for themselves in less than six months.

The first machines are due for delivery during the autumn of 1993. We are providing financial support for the hundred first utility rooms as demonstration installations.

FACTS

Sweden's 30 000 apartment building utility rooms annually consume over 1 TWh of electricity, costing SEK 600 million at an electricity price of 0.60 SEK/kWh.

Artur Horowitz

National Board for Consumer Policies

No doubt, even without the competition, we would eventually have seen the results of this product development, but there are strong reasons for wondering when this would have been.

The fact that the make-up of households in apartment buildings has changed radically in size has been well known for a long time. The Board has very clearly and constantly pointed out the changed requirements for utility rooms for almost twenty years.

Market forces have patently not worked: laziness and conservatism of both purchasers and manufacturers have triumphed.

So all right – the arguments for a technology procurement project were very strong. NUTEK gathered a powerful purchaser group, representing a large proportion of the total Swedish market.

The Board's role was to contribute with advice and experience. The work of a purchaser group when drawing up its requirements is very much a balancing act. On the one hand, there is the interest in arriving at the best possible results, while on the other hand, if the requirements are too severe, it will result in stress and failure to attract entries.

In this particular case, the short time scale was somewhat special. The new machines had to be presented in such a short time that their designs had to be based on existing technology.

Now, when the competition has been concluded and the products are starting to enter the factories, negotiation has entered its second stage. This consists of very close liaison between the manufacturers and purchasers, with rapid feedback of results, which must be a major benefit.

Sten-Håkan Almström

Responsible for process development at Electrolux-Wascator

From the point of view of the State, this type of technology competition is a particularly effective way of achieving good value for money.

When we decided to enter the competition, it was to win, and nothing less. There was sufficient prestige – and naturally a corresponding risk of loss of prestige – in the competition. Consider important customer groups such as HBV and HSB, who together represent a very large proportion of the market: who would want to fail publicly in front of them?

We have therefore done our utmost in development. We weren't satisfied merely with fulfilling the specified requirements, but set our sights on a still higher target. Development cost us considerably more than what was directly available in the form of the various prize premiums, and the work was carried out with a quite different intensity than would have been the case if we had, for example, simply been given a public development project.

When the competition was announced, we were in the process of developing a smaller machine that would be better suited to present-day requirements in apartment building utility rooms. Our strategy in respect of the competition was to develop an even more energy-efficient variant of this machine.

The work on improving energy efficiency was carried out in parallel with the rest of the design work on the machine. The result was a considerable reduction in electricity demand, although the greatest difference is, in fact, in terms of the noise level.

It is very valuable to have trials series of machines installed by the purchasers, who know what is involved and will not hesitate a second in giving us rapid feedback. However, this does not mean that we can skimp on our own test programme: if anything, the contrary applies. The most difficult requirement to fulfil was not, as said above, that of energy efficiency, but that of low noise level. It has been invaluable to be able to discuss ideas with the purchaser during the test stage.

ELECTRICALLY-EFFICIENT WORKING CONDITIONS FOR MORE EFFICIENT OFFICE WORKERS

Flickering lighting and flickering computer screens can both cause eye strain and headaches in many people.

High-frequency lighting fittings operate at such a high frequency that the human eye cannot see any flicker. In addition, the lights come on immediately the switch is pressed, without any initial flickering. Several investigations have shown that this, together with the freedom from flicker during operation, is very comfortable to the eyes. A British investigation showed that many of the office workers covered by the investigation felt that they worked better, and that the usual afternoon headache failed to materialise.

High-frequency operation also results in significantly improved efficiency, of the order of 25 % or more. The tubes simply provide more light for less energy.

More efficient lighting means less wasted heat. Less wasted heat means less cooling requirement. And reduced cooling requirements mean less energy use by ventilation fans and for possible comfort cooling.

As the lack of flicker, together with the reduced heat load, gave such clear improvements in working conditions, NUTEK decided to go all the way. The desired development of electrically-efficient office lighting would also assist development of lighting fittings with improved visual ergonomic performance and better knowledge of how ergonomically correct lighting should be arranged.

DEVELOPMENT IN TWO STAGES

This was to be arranged in the form of a two-stage competition. Problem One was that of the expensive high-frequency lights themselves – the market was small and split, and no manufacturer was ready to start volume production in order to bring down prices.

A first technology procurement project was therefore run in 1991, with the aim of influencing the current market structure for high-frequency lights as quickly as possible. The incentive was a firm order for 26 000 lights – a volume far greater than any manufacturer had previously even dared dream of.

In the final stage, three companies were competing against each other. The winner, Helvar AB, was chosen primarily because its entry was designed with continued development towards 'intelligent lighting' in mind. The lights are prepared for future connection to electronic control systems for such applications as control by room occupation sensors or automatic lighting/extinguishing control.

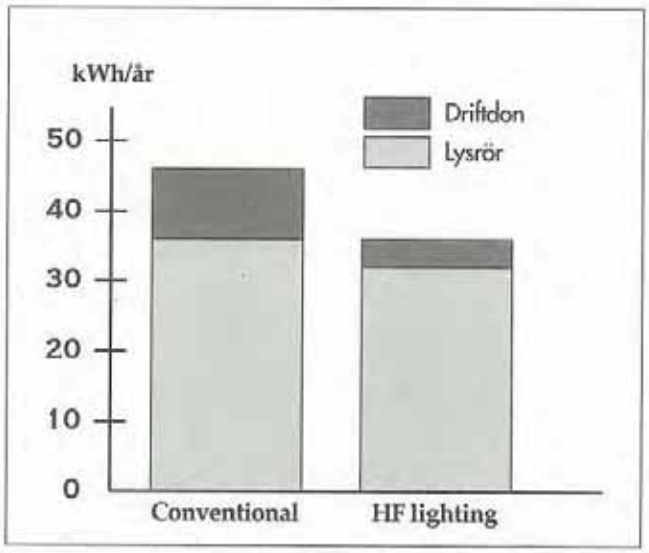
Demand, manufacture and sales of high-frequency lights have now increased dramatically: about 65 000 were sold in 1991 and about 140 000 in 1992. The price has been reduced almost to half.

The second stage of the project, known as the 'corridor lighting' stage, was used as a way of enhancing awareness of visual ergonomics. A test room, representing the commonest form of office room in Sweden, and consisting of 2.5 modules, was constructed.

It was now the turn of the manufacturers of lighting fittings. They were invited to submit proposals for lighting the room, which were then tested in reality. Objective performance parameters such as light intensity, contrast and freedom from dazzle were measured.

Those lighting arrangements that met the specified requirements, together with a maximum installed power of 10–12 W/m², were approved as solutions eligible for entry to the corridor lighting project.

This will mean that the particular lighting arrangement can be installed in existing office rooms of an existing



Power losses in conventional and HF lighting units, 36 W.

FACTS

Electricity use in Sweden for lighting amounts to 14 TWh/year, which is 10 % of all electricity. The proportion of this demand accounted for by fluorescent lighting is about 8 TWh/year. If all conventional 50 Hz fluorescent tubes were replaced by high-frequency lamps, about 1.6 TWh/year of energy would be saved.

corridor somewhere in the country. This will be arranged in conjunction with local energy utilities: the systems may be installed in the energy utilities' own properties or in those of their customers. The important element is that the corridor can be made available as a show installation.

NUTEK will provide a modest subsidy for the installations, and the users of the rooms along the trials corridors will be interviewed for their views on their working conditions before and after installation. This interview investigation is a very important part of follow-up of the project.

It is naturally not only poor lighting that increases the need for ventilation and comfort cooling in workplaces. Office machinery of all types accounts for much of the heat input, and the same rule of thumb applies for all of it: that a unit reduction in energy input results in a corresponding unit reduction in energy for cooling requirements.

If allowance is made for this system effect, conditions become more favourable for hoping that investments in improvement in the efficiency of energy use will be taken into account when determining the financial requirements for return on investment. Unfortunately, the individual office machine manufacturers do not take account of this system effect. The proper market signals fail to be made.

AUTO POWER-DOWN MONITORS

The auto power-down computer monitors that resulted from NUTEK's technology procurement project result in running cost reductions of up to SEK 1 600 each year. Indoor humidity is improved, which improves comfort. As opposed to screen-saver programs with ghostly aquaria or night skies, the genuine auto power-down monitor actually turns off the display as soon as nothing has happened for a predetermined period of time. Touching any key on the keyboard immediately brings it back to life.

After NUTEK's competition, there are now six companies that supply auto power-down monitors: ICL, Salora, Cominvest System AB, Facit, Eizo and Secus Data. Together, these companies account for over 25 % of annual sales on the Swedish market, and several of them are of the opinion that auto power-down control will be standard in monitors sold during 1993.

In addition, auto power-down monitors reduce users' exposure to electromagnetic fields – a clear essential in the light of the present intensive debate. For although research has not been able to establish the facts of any cause/effect relationships, it has not either been able to prove that radiation is beneficial. It should, in other words, be minimised as soon as possible by simple means.

Bo Everborn

Managing Director of Fagerhult AB

The considerable interest in HF lighting systems depends on the ability to improve working conditions, in terms of visual ergonomics, coupled with the ability to regulate the light. Light quality is important, and the associated conservation of energy means that the new technology is financially very attractive.

NUTEK's participation has helped us to bring this technology to Sweden earlier than would otherwise have been the case. Without it, development would have been much slower, particularly bearing in mind the effects of the current recession.

A massive project such as this, with equally massive emphasis on information, is considerably more plausible than if one small manufacturer alone takes the initiative. It sends out clear signals to all parties on the market, both buyers and sellers, to the effect that this is something important and right, as well as being financially interesting.

NUTEK's awards have been confined solely to purchase of the HF lighting units that won the technology procurement competition. However, from the point of view of responsibility for the complete luminaires, we would probably have preferred a 'more normal' purchasing procedure.

FACTS

In certain sectors, Sweden has a well-justified reputation for being a fastidious technology purchaser – something that, correctly applied, can assist in furthering development on the international plane as well.

In the USA, the Federal Environmental Protection Agency (EPA) has been inspired to follow Swedish efforts in respect of auto power-down monitors. Computers which want to receive the EPA Energy Star must incorporate auto power-down features.

IBM, too, is careful to point out on the diskette on which the company is internationally advertising its new 'green' computers that they fulfil NUTEK's requirements for auto power-down control and other features.

James W. Davis

President, IBM Corporation,
Boca Raton, Florida

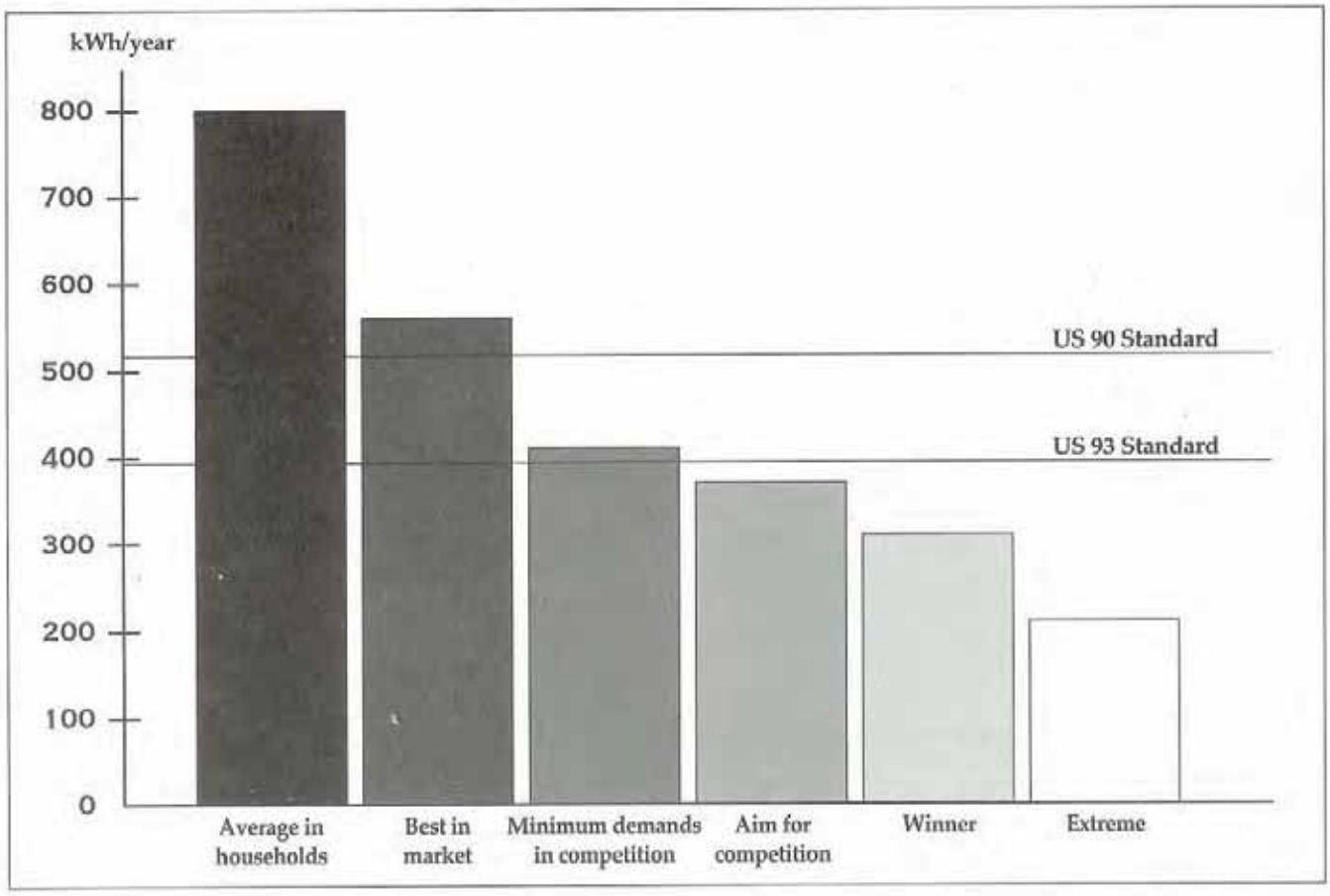
As I became involved with the U.S. Environmental Protection Agency, developing the EPA Energy Star Computers program, I discovered Sweden, through NUTEK, was already leading the way for energy efficient Personal Computer monitors. NUTEK has lead the world in developing a specification for energy efficient personal computer monitors. This specification has set the worldwide standard for excellence, and has established the defacto goal that personal computer monitor developers and manufacturers around the world are striving to reach. It's clear that NUTEK will play a key role in emerging worldwide energy programs.

When every family in China owns a refrigerator...

The responsibility of the industrialised countries to pursue technical development towards low-resource and low-pollution targets is naturally beyond question. One of the major areas to which this applies is that of the energy consumption of the most commonly used white goods.

There is also very strong international interest in finding new and electrically-efficient designs. The refrigerator/freezer market is a very clear example of this, in that it presents not only an objective of improved electrical efficiency but also an urgent environmental reason for reducing the use of CFCs.

Even in terms of financial savings at the individual level, it is relatively easy to find further reasons for pursuing such policies in respect of their effects on future generations. Food storage in refrigerators and freezers, for example, accounts for more than 30 % of the electricity use of an average Swedish household. However, by tradition and force of habit, refrigerators and freezers have not been accompanied by any information on their energy requirements. Operating costs have not been given the attention they deserve, and the non-coherent domestic market has not exerted sufficient pressure on the manufacturers to persuade them to improve their designs in respect of electrical efficiency. However, public, cooperative and housing association purchasers represent an important share of the market. Annual sales of combined refrigerator/freezer units to apartment buildings in Sweden amount to no less than 170 000, which is a significant fraction of the entire market for refrigerators and freezers of about 525 000/year.



A REAL CHALLENGE

In April 1990, NUTEK, the National Council for Consumer Policies and representatives of no less than 25 % of apartment building housing associations announced a technology procurement project for electrically-efficient and environmentally friendly refrigerators/freezers. The purchaser group specified hard requirements: only those units that use less than 1.00 kWh/l and year would qualify even for consideration in the competition. Additional premiums were promised to all manufacturers who succeeded in reducing electricity use to less than 0.90 kWh/l and year.

In addition, environmental requirements specified performance 'from cradle to grave', primarily in respect of the use of CFCs in the thermal insulation and as refrigerant. A third condition was that the low-energy units should be accompanied by details of their energy use in such a clear and unambiguous manner that potential purchasers could compare one with another in the shop before purchase.

The winning manufacturer was guaranteed an order for at least 500 units. Purchasers of these units were also encouraged by a promised subsidy of SEK 1 000 per unit.

The competition was won by Electrolux with a unit having an electricity demand that was 30 % less than the previously most electrically-efficient unit on the market. At the same time, it also contained considerably less CFC, and the company announced plans to produce an entirely CFC-free product.

That was in the autumn of 1991. Today, the CFC-free refrigerator is available on the market, together with several other electrically-efficient variants. Over a period of just one year, average electricity use by the market's ten best refrigerators/freezers fell by 20 %. Prices have dropped considerably, and NUTEK is no longer paying any market subsidies.

THE BATTLE FOR EUROPE

Whirlpool is not only one of Electrolux' strongest competitors in the USA. Since the company bought 53 % of the Philips domestic appliances sector in 1988, it has entered the battle for Europe in the white goods market. As opposed to the USA, where the market is depressed, and to Asia, where the Japanese companies still dominate, there is no clear leading European white goods manufacturer. However, there are many pretenders, including Electrolux and the newcomer, Whirlpool. Energy efficiency will be an important means of competition.

FACTS

'The USA's Golden Carrot', worth SEK 200 million

In the summer of 1992, the successful result of the Swedish technology procurement project inspired 25 of the USA's leading electrical utilities to announce a similar competition with a very much larger prize.

US$ 30 million, equivalent to about SEK 200 million, was the prize for the manufacturer producing a refrigerator that would use 30–50 % less energy than the average American refrigerator, and without employing CFCs. Other requirements were specified in terms of production capacity and that the price should be about the same as for present-day models.

Fourteen companies entered this prestigious competition. Twelve – including General Electric, with the largest share of the American market at 35 % – where eliminated in the preliminary rounds. This left the final to be contested by Electrolux' subsidiary company, Frigidaire, and the American company, Whirlpool.

On the 29th of June, the prize was awarded to Whirlpool. Actual payment will not be in the form of a lump sum, but as US$ 100 for each refrigerator sold. There was no technical difference between the two designs: the balance was tipped in Whirlpool's favour mainly by the delivery arrangements that the company could offer.

Whirlpool's refrigerator is expected to be available on the American market at the beginning of 1994, at a price of about US$ 1300–1400.

Frigidaire receives no prize or award apart from the prestige of having been selected for the final out of such an initially large field, and the value arising from the development work.

Leif Johansson

Managing Director of Electrolux AB

A lot of the environmental effect of white goods occurs during their use, as opposed to during their manufacture. Much of Electrolux' work on environmental aspects is therefore concentrated on reducing levels of use of energy, water and chemicals.

Perhaps the most important of these is to reduce energy use. This is an area in which major advances have been made. Today, Electrolux' refrigerators and freezes use only half as much electricity as ten-year-old models, but we have not stopped here.

NUTEK's competition for the development of even more energy-efficient refrigerators provided further incentive for improvement. Competitions such as this involve many sectors of the company.

USA finalist

A similar competition to that arranged by NUTEK in 1990 was recently concluded in the USA. Electrolux' American subsidiary, Frigidaire, came second out of 14 entrants.

We succeeded in winning NUTEK's competition by tackling the project seriously and optimising our refrigerators and freezers in terms of their energy consumption. The winning unit is probably the world's most energy-efficient, with an electricity demand of only 0.79 kWh/l and year. Using the same technology, we have now continued development of the winning unit and developed an entire range of extremely low energy consumption refrigerators, freezers and refrigerators/freezers. All are based on the winning principle.

NO COLD DOWN-DRAUGHTS FROM THE 21ST CENTURY WINDOW

Well-insulated windows, often triple-glazed, were one of the most important ways of dealing with the energy crises of the 1970s. Heat losses from apartment buildings and single-family houses have also been greatly reduced over the last 20 years. However, there are many benefits from using a window with a considerably higher performance, of which one of the most important is perhaps the elimination of cold downdraughts.

In the case of a 'normal' window, even modern triple-glazed ones, the indoor air in contact with the inner pane is cooled so that it sinks towards the floor. This cold current of falling air is experienced as a draught. Cold downdraughts are countered by the rising flow of hot air from radiators, which means that their given place is beneath a window.

If a window has sufficiently good thermal insulation performance so that it does not cause any cold downdraughts, a whole new range of possibilities to meet the building's heat supply is opened up. The additional cost of the more expensive window can be offset by a cheaper heating system. In Västerås, for example, the Anund housing association had no difficulty in justifying the additional costs of its new windows: heating energy requirements were calculated as being reduced from 5 900 MWh/year to 3 300 MWh/year, while the radiators were replaced by a convector heater in the hall and one in the bathroom of each apartment.

60 % GREATER ENERGY SAVINGS WITH NEW WINDOWS

This could not have been done without the windows that resulted from NUTEK's technology procurement project, and which save 60 % more energy than ordinary triple-glazed windows.

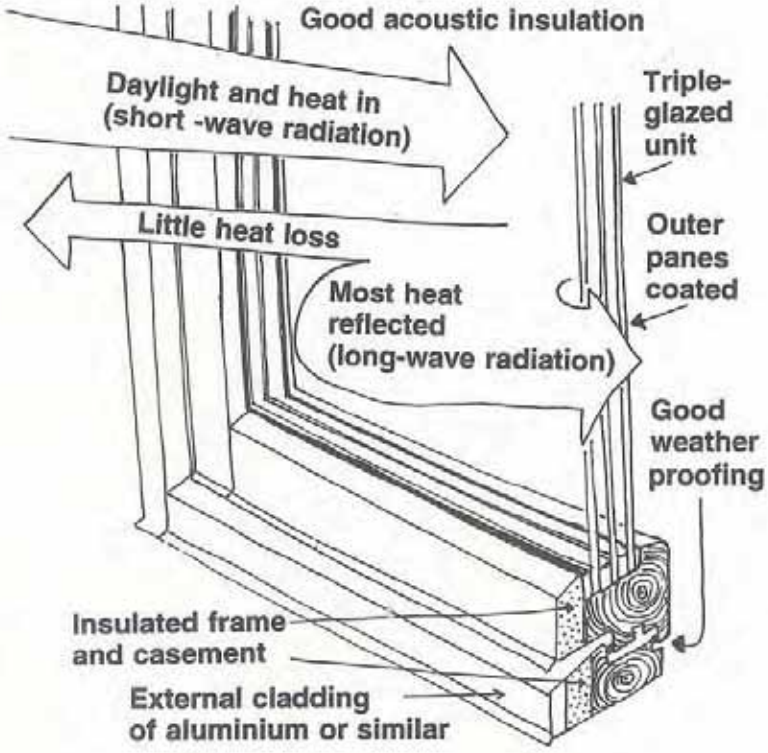
The competition was announced in May 1991, specifying that the energy losses should be not more than half those through a conventional triple-glazed window. In addition, other performance requirements related to noise reduction, low weight and maximum admission of daylight.

There were, admittedly, already high-performance windows available on the market, but they were too expensive, too cumbersome and too poorly designed to admit sufficient light. NUTEK's role was therefore to gather requirements from the large purchasers of windows, and effectively to articulate the market for the manufacturers.

The purchasers' viewpoints showed that it was not only energy conservation that was of interest. Simple maintenance, long life, good noise reduction performance, ease of installation and good daylight transmittance were the most important requirements.

The competition was concluded in January 1992, with the first prize being shared between AB Överrums Fönster and Johs Rasmussen AS from Norway. In addition to the prize premiums, market stimulation was provided by a subsidy of SEK 500/m^2 for the first 2 500 m^2 of windows, paid to the purchasers of the windows.

A further seven manufacturers had submitted prototypes for the competition, and the work of the purchaser group has helped to create a more aware market, thus improving the conditions for rapid spread of the technology.



Diana Avaroo

Glass Consultant with
Pilkington Floatglas AB

I am not at all sure that this development would have occurred without NUTEK's action. The unfortunate truth is that certain sectors have only a very short-sighted view, and those who live from hand to mouth are seldom particularly receptive to signals from the world around them.

To take an opposite example, the motor industry did not rest on its laurels with the T-Ford. Modern vehicles are marketed with arguments such as high passenger safety, reduction of emissions and 90 % recyclability. The fact that they also provide transportation is regarded as obvious and not as a sales argument.

A conservative branch

The window manufacturing industry, on the other hand, shows many signs of still being at the T-Ford stage. Windows are merely for seeing through, and nothing else. No one enquires about their noise reduction performance, whether they are safe, whether they can save energy or simplify complicated and expensive installation work.

The window manufacturers, in their turn, have employed little in their marketing arguments other than to point out new fittings and colours or to emphasise a low price.

Today, glasses are available that save energy, reduce cooling requirements, prevent break-ins, delay the spread of fire, reduce noise and so on. As glass makes up about 70 % of the area of a window, it is important to make the best use of these potentials.

Even the other 30 % could be greatly improved, which was clearly shown by the results of NUTEK's competition. Only two competitors met all the specified requirements, which should be seen against the fact that there are several hundred manufacturers of windows in the Nordic countries, of whom about 30 are large.

An excellent result

Against this background, I think it can be said that NUTEK's competition gave an excellent result. It succeeded in persuading a conservative branch to invest time and money in developing a high-performance window. Sixteen manufacturers indicated their interest, and nine got to the stage of presenting prototypes. All of these met the low-energy requirements, although seven of them failed some of the other requirements, e.g. in terms of daylight transmittance or low weight.

This competition not only succeeded in making the window manufacturers look again at their products. Architects and property-owners have started to think about the new potentials opened up by the use of high-performance windows: simplified building work, improved daylight transmission, reduced noise etc.

At present, the Swedish Building Regulations for new buildings are being revised in order to harmonise them with the EC Building Products Directive. We can expect more stringent requirements in respect of noise reduction in dwellings, schools and hospitals, as well as higher performance requirements for energy conservation, air quality and daylight admission. To meet these requirements, we are going to need the high-performance windows.

Finally, I would like to point out the impressive fact that it took only one year from the time of announcing the competition until high-performance windows were in mass production. After only a further year, they were already installed – and evaluated.

ENERGY CONSERVATION – A LOT OF HOT AIR?

Ventilation uses considerable quantities of energy. Electricity is needed for fans and other equipment for moving the air, while considerable quantities of heat are lost in the air that is exhausted.

Money, comfort, health and kilowatt-hours can be saved through the use of improved ventilation systems. However, such systems require not only better fans, better duct design and construction, better motors and better control, but also improved performance from those who design, install, operate and/or maintain them.

The situation is not improved by the fact that ventilation is a difficult area, in which the common rule of thumb is "If in doubt, make it a bit larger", which is understandable, as it is often extremely difficult to make any substantial changes to an installation once it has been completed.

It is important to effect improvements both in the design and the construction of new systems and in many existing systems. It is also important that improvements are applied across the board.

ELECTRICITY BILL HALVED

HSB in Lysekil needed to replace 59 fans in a residential area, at an estimated cost of SEK 20 000 per fan. Instead, with NUTEK's help, the company announced a competition. Three different contractors were asked to renovate each fan, and at the same time to reduce electricity consumption.

One of the competitors, Fläkt AB, succeeded beyond all expectations. The electricity requirement for ventilation was halved from 750 kWh to 380 kWh per apartment and year. Individually, the improvements were unspectacular, but considerable attention was paid to the combination of various measures: changing from belt drive to direct drive, better matching of fans and motors, steps to avoid unnecessary pressure drop in the ducts. And all this at a cost of SEK 10 000 per fan.

It is estimated that there are about 50 000 similar units in the country, resulting in potential savings of over SEK 100 million for the country's entire stock of apartment buildings.

The next step to get the fan manufacturers moving is now being taken. A thousand fans, of which half are in HSB properties and half in the properties of other housing associations, are to be renovated during 1993.

Per Cedergren

Managing Director, Fläkt

Ever since the energy crises of the 1970s, we have often and comprehensively discussed energy conservation – in terms of heating. The electricity used by ventilation systems has been ignored.

This competition was an excellent way of concentrating attention on the importance of electricity use in determining the overall costs.

In short, an excellent way of using tax payers' money. NUTEK has quickly and specifically demonstrated the hidden savings available to the purchaser group.

FACTS

Outline agreements

are one of the means employed by NUTEK's Department of Energy Efficiency for such objectives as encouraging the spread of energy-efficient technologies that have been developed through technology procurement.

Outline agreements are entered into primarily with energy utilities and larger property-owners. The party undertakes actively to promote energy efficiency in connection with new building, extension and conversion work.

In the case of low-energy installations in property, NUTEK applies performance key indicators of approximately the same type as that employed for lighting in the Corridor Lighting project (10–12 W/m²). For ventilation, the performance indicator permits a maximum approved installed fan power rating of 1.5 kW per m³/s. However, the financial incentive is not linked to the installed drive power capacity, but to the actual energy saving. SEK 1:50 is the premium for each annual kWh of electricity saved, in comparison with the performance of a conventional ventilation system.

Outline agreements also specify performance requirements for lighting, control systems, heating systems, refrigeration/freezing, washing, drying, windows etc., as well as for other apparatus and for activities intended to enhance system and performance knowledge.

Mårten Fackler

Energy/Environment Manager
for Östergötland County Council

We decided to accept the challenge, and saw the difference from a normal building project immediately. In the case of conventional tendering for a project, we presumably would not have specified any requirements in terms of electrical efficiency of the ventilation system at all, but would have waited for the consultant's design proposals for the ventilation system. Now, however, as a result of the outline agreement, we had a guideline of 1.5 kW per m³/s of air. Normally, ventilation systems require twice this.

NUTEK's contribution was, admittedly, marginal, but sufficiently large to tip the balance so that the special investments could be guaranteed viable.

Electricity accounts for a large part of the total energy use for building services. Of this electricity, lighting accounts for about 10 % and ventilation about 25 %. If we can succeed in reducing the electricity requirement for ventilation to a half, total electricity use is reduced by 12.5 % In other words, there is financial justification for quite considerable investments.

In old ventilation systems, 70 % of energy costs can be traced to the fan rooms, with 30 % in the duct designs and their air resistance. Fortunately, fan rooms are the easiest to modify.

We have still not decided exactly how the fan rooms in new properties are to be designed. We have, though, decided on the details of the duct system, one of the features of which will be the incorporation of guide vanes at bends to reduce turbulence and friction losses.

New thinking

As far as the heating and ventilating sector is concerned, it has obviously not been effective to compete on the grounds of electricity efficiency. And I must admit that, five years ago, I myself was not even aware that fans used so much energy.

We need strong measures to break down these old habits, which applies just as much to those of us on the ordering side of the desk. There are so many things to think about in a project, so many items to follow up. I can understand that many would be unwilling to give themselves extra work, and particularly if they feared that it might result in extra problems.

It is therefore of the greatest importance that there is time and opportunity to consider everything right from the start. We were actually surprised by the fact that the differences from a 'normal' building project were so easy to deal with.

The same thought lay behind the world's first locomotive; 'The Rocket', from 1829, the world's most energy-efficient refrigerator/freezer and the auto power-down monitors: technology procurement. Technology procurement is either a prerequisite for a product reaching the market at all, or reduces the time needed for, or before, market introduction.

An underlying reason for this inertia is that the market is out of balance. There are many purchasers (property-owners, for exampel), but they are not united. They may well have valuable ideas on what products are needed, or how they could be improved. The sellers (e.g. of equipment for utility rooms), on the other hand, are few and technically skilled. They wonder what their customers really want, and if there are sufficient of them. But the necessary dialogue for each side to reach the other fails to materialise. Technology procurement brings together a number of important purchasers, draws up performance requirements, makes clear to the manufacturers that the purchasers are ready to buy if the requirements are met and sets the manufacturers competing with new designs and with price.

Small countries such as Sweden have little chance of swaying multinational manufacturers through their own production or research and development. They can achieve greater effect by marshalling purchasers' demands in respect of performance often jointly with other countries.

TOMORROW'S COMMONPLACE NEEDS TO BE STARTED TODAY

Technology procurement projects are often concerned with applications such as more efficient use of energy, reduced environmental impact or improved working conditions. They also provide a competitive edge for the companies participating in them. Not enough is known about how technology procurement, acting as an incentive on behalf of purchasers and users, encourages market development.

For four years now, NUTEK's Department of Energy Efficiency has been operating a program of which technology procurement is a vital element. This is in accordance with Swedish Government policy on restructuring of the country's energy system. Several technology procurement projects have been run with great success: efficient refrigerators/freezers, low-energy apartment building utility rooms, high-frequency lighting, auto power-down monitors and energy-efficient windows.

After four years' work, we know that it is possible significantly to improve the efficiency of energy use. Bringing about such improvement is often considerably cheaper than building or developing new energy sources.

EFFEKTIVARE EL ANVÄNDNING

NUTEK

Swedish National Board for Industrial and Technical Development

DEPARTMENT OF ENERGY EFFICIENCY
THE NATIONAL BOARD FOR INDUSTRIAL AND TECHNICAL DEVELOPMENT, NUTEK
ADDRESS: NUTEK-ENERGI, S-117 86 STOCKHOLM, SWEDEN
TELEPHONE +46 8 681 91 00. TELEFAX +46 8 681 95 85

info 120-1993