AGREED PERFORMANCE CRITERIA FACILITATES MORE EFFICIENT HOUSING SOLUTIONS

HANS WESTLING
Promandat AB, P.O. Box 24205, SE-104 51 Stockholm, Sweden

ABSTRACT

Introduction
A number of cases have been executed and analysed. Lessons learned from the International Energy Agency six-year project “Co-operative Procurement”, which has just ended, and a number of innovation projects in Sweden financed by the Swedish Council for Building Research and the Swedish National Energy Administration are presented. An analysis lately about a technology procurement project for more cost-efficient production of multi-family houses is compared with the other cases.

Purpose
The overall objectives of all the different projects, which are both in the energy and building area, were to inspire the innovation of more efficient solutions. The immediate goal was to reduce the use of energy, the environmental impact (use of water, noise), the time used for the installation work or to reduce the total cost for both production/construction and operation.

Approach
Within all the analysed cases the procedure used was technology procurement including the creation of a group of clients/buyers in which the requirements for the work were formulated as performance criteria. These criteria were to be fulfilled by the contractors and/or suppliers in submitted proposals, prototypes and full-scale pilot projects. Different mechanisms for rewards have been used such as guaranteed deliveries of first series, large information and labelling efforts in collaboration with the influential customers and receipt of highly esteemed awards like the “International Energy Agency Award of Excellence” for very advanced energy efficient solutions.

Results
In general, theoretical research about innovation instruments on the demand side, better communication, building up of networks in fragmented areas and the creation of powerful buyer groups have been stressed as important and essential components for successful technology procurement projects. It is however very time-consuming to build up new buyer groups in areas with a large degree of fragmentation as in the building sector. In many of the cases presented in this paper, it has been found that formulation of the requirements as performance criteria can inspire innovation, especially if important clients/buyers are involved and the efforts are combined with different recognition mechanisms such as Awards with high prestige. These efforts seem to have a large influence on the contractors’ and suppliers’ decisions to concentrate development efforts in the actual area.

Concrete results in the cases are components with 50% energy reduction, industrial motors with 20-40% reduction of losses and ventilation systems with better performance, more satisfied users/occupants and lower operational costs. In some cases, the total costs have been reduced almost by half. The involved project managers and experts have identified a large number of lessons learned which will be presented in the paper.
KEYWORDS:
Performance criteria; procurement; networks; awards; innovation.

INTRODUCTION

More than 150 countries and international organisations have jointly declared that it is urgent to follow up with concrete actions the international climate agreements made in Rio, Kyoto and Buenos Aires. The countries have agreed to contribute, in various ways, to reducing the risks of climate changes, among other things by facilitating the development and diffusion of more efficient energy solutions, which will lead to less emission of greenhouse gases. A proper market transformation will also be accelerated where more efficient solutions will have an increasing market share.

Use of mandatory regulations, as well as large rebate programmes, are expected to encounter increasing difficulties and opposition and, in many cases, lack of funding. The present trends are towards a desire for more individual choices, deregulation and privatisation, which will diminish the possibilities for government interventions using regulations and other traditional methods. Joint procurement activities with expressed innovative purposes can offer good alternatives for governments, buyers and users, but also for manufacturers, to bring about reliable solutions that are quicker accepted on the market.

A number of procurement and competition projects have been executed and analysed. Lessons learned have been formulated in the International Energy Agency (IEA) six-year project “Co-operative Procurement”, and in a number of innovation projects in Sweden financed by the Swedish Council for Building Research and the Swedish National Energy Administration. An analysis lately about a technology procurement project for more cost-efficient production of multi-family houses is compared with the other cases.

The overall objectives of all the different projects, which are both in the energy and building area, were to inspire the innovation of more efficient solutions. The immediate goal was to reduce the use of energy, the time for the installation work or the total cost for both production/construction and operation.

DEFINITIONS AND THEORETICAL FRAMEWORK

The whole innovation process is normally divided into the separate phases: invention, first use in the market outside laboratories and the following diffusion on the whole market and acceptance – the market transformation (Figure 1).

---

Figure 1. Innovation and diffusion of new technologies and applications
Innovation instruments

Over the years, researchers have consistently debated which *instruments* are most effective in producing *innovations*. Some researchers have emphasised the supply side (technology push), others the demand side (market pull). The conclusion drawn in recent times is that initiatives are important on both sides, but that most innovations – some researchers say 75% or more – have probably materialised as the result of steps taken on the demand side. Several researchers are agreed that apart from demand-side initiatives (Marquis, 1969), efficient organisation and communication are also important (Mowery & Rosenberg, 1978; Lundvall, 1985). A comprehensive OECD report found that technology procurement is the only sure way of speeding up innovation (OECD, 1978).

*Technology procurement* is an entire acquisition process on the demand side (Edquist, 1990) with the expressed purpose of stimulating innovation. The creation of new networks, across time and trade borders, has proven to be of particular importance for innovations (Håkansson, 1987 and Teubal, 1991). The importance of long-term work in *interactions* between buyer and manufacturer has also been pointed out (Lundvall, 1988). It is particularly essential to bring about collaboration between future-oriented, influential buyers and users, so-called *lead users* (Hippel, 1986), or, as sometimes expressed in the United States, *anchor buyers*. Generally, requirements are made up in the form of *performance requirements*. The requirements are often expressed on two levels, *mandatory* requirements, which must be met, and *desired* requirements, which are evaluated as positive in procurements and competitions. A complete performance specification, with requirements in various areas – e.g. in addition to energy when working with more energy-efficient products, also other requirements, such as reduction of noise and water consumption, etc. – will facilitate the diffusion of new solutions.

*Co-operative procurement* includes also, in addition to technology procurement, a joint procurement, which aims at increasing the use of the existing best products. Internationally, the terms *volume* or *bulk purchasing* are also used.

**SOME HISTORIC EXAMPLES**

Technology procurement is not a new process introduced in connection with energy efficiency. The method of technology procurement has been used earlier, above all in order to develop new national systems, e.g. in the transportation, power supply and telecommunications areas. Contests have often inspired significant innovations. There are some well-known historical contests and challenges in which clear goals were established. The development of a new clock for ship navigation is one example. By the discovery of new continents and the efforts to improve the sea routes, many nations, e.g. Spain, France and Britain, had offered, since the end of the 16th century, large sums of money to the inventor of a practicable solution of the longitudinal problem - to determine the exact degree of longitude at sea. A ruling committee, The Board of Longitude, was established in Britain in the beginning of the 18th century. The functional requirements stipulated an accuracy of determination of position between 1 degree and 30 minutes, which had to be tested on a voyage to the West Indies during six weeks. The prize amount set up was ,10-20,000. It was not until in the 1760s, after 30 years and 4 prototypes, that John Harrison managed to meet the requirements. He had to prove the function of his prototype chronometer, H4, during two voyages from England to the West Indies and back, and the error after the voyages was only 6 seconds. In the 1770s, during his second expedition to the Pacific, Captain James Cook had a copy of Harrison’s chronometer onboard his ship.

Another well-known historic example is the competition at Rainhill in England in 1829, which was something of a breakthrough for the new technology with steam-operated locomotives in the railway area. The company who wanted to build a railway between Manchester and Liverpool announced a competition. A number of performance requirements were laid down as regards pulling capacity, speed, various safety demands and also an economic target of £500. The arranging company promised then to buy at least five “locomotives” from the winner. So far, individual railways had
used steam engines on railway carriages, above all for transports of material, but there had been no breakthrough for railways with transportation of both goods and people in regular traffic. Several interesting solutions entered the competition. The winner was Robert Stephenson with his locomotive “The Rocket” (Figure 2), who was given the guaranteed orders and many successive ones.

Figure 2. The winning locomotive “The Rocket” (photo from the Science Museum, London)

**APPROACH**

**Process used**
The process used in the projects described below has been gradually developed using experience from different areas. The preparatory steps are summarised in Figure 3 and some examples presented below.

Figure 3. Some important preparatory steps in technology procurement (Westling, 2000)
Swedish examples in the 1980s
In the building and construction sector, the technology procurement method has been used in some refurbishing projects. Different criteria have formed the main goal. In a project for lifts for existing multi-family buildings in the 1980s in Sweden, the main goal was to cut the total cost by half, which was nearly achieved, down to 52% of the original cost (Sundin & Westling, 1989). At the same time, it was possible to reduce the disruption to residents, installation taking a few days instead of several weeks or months as before (Figure 4). The project also resulted in one of the main suppliers, KONE, receiving very large international orders through its subsidiaries, e.g. 250 lifts in one project in The Netherlands and advantages when further developing more efficient lift solutions such as the “lift without a machinery room”.

![Figure 4. Rapid lift installation – Completely prefabricated lift shaft.](image)

Another project involved the burdensome process of refurbishing bathrooms, which, in itself, is very difficult to fulfil, especially with people living in the apartments. In this case, a very challenging goal was set up: to have only 2 days for the work. The result was that three groups of companies showed in demonstration projects how they could reduce the total installation time to 30-40 hours (Westling & Dranger Isfält, 1990). These examples included a high degree of prefabricated components and the establishment of working groups or teams, which in these cases reduced the number of trades involved and the waiting time between the work to be carried out by these trades.

In the energy field, a whole range of projects in Sweden showed energy reduction by 30-50%. From the Swedish projects mentioned here, characteristics of projects suited for technology procurement were formulated (Westling, 1991).

International examples
Similar methods have been used internationally, e.g. by the French organisation HLM, the Association of Municipal Housing Companies, in developing control systems for apartment buildings, “Domotique”, a form of intelligent buildings (HLM et al, 1990) and in a ventilation and cooling project in Germany (RWTUV, 1991) where it was possible to reduce energy consumption by more than half, down to 40% of the earlier consumption. An important factor in this project was that there
was one strong customer, Deutsche Telekom, the German Telecommunications Administration, pointing at a large market of several thousand units.

In the United States, the method has been applied, e.g. in the space and defence field. The U.S. Energy Policy Act (1992) and Climate Change Action Plan (Clinton & Gore, 1993) contain initiatives, which have been followed by concrete actions in many areas with Federal and State Agencies as important buyers. The “Golden Carrot” programme was first used for energy efficient refrigerators with 30-35% energy reduction, and is now being followed by the Consortium for Energy Efficiency, CEE, in a number of fields, such as ventilation and cooling systems.

The International Energy Agency co-operative procurement
Annex III “Co-operative Procurement” was a Task - with 8 participating countries and supported by the European Commission - within the International Energy Agency (IEA) Demand-Side Management (DSM) Agreement (Westling, 2000). The objectives of Annex III were to establish a process for activities in international co-operation, based on the demands of the market, and to execute pilot projects to gain experience. The Annex III experts and project managers developed a preliminary process (Westling, 1996).

Various alternatives were identified to give recognition to new, successful solutions, not necessarily by guaranteed large-volume purchasing only. An Award, “the IEA DSM Award of Excellence”, was introduced, which has been given to four projects. The first Award was granted to a drier for household laundry where the energy consumption was reduced down to 50%. This drier is now being introduced on the European market as the first heat pump “Class A drier” (Figure 5).

![Figure 5. The winning AEG heat-pump drier - the first “Class A drier” in Europe](image)

Further Awards have been granted: to ABB within the area of Hi-Efficiency Motors (Figure 6) with losses reduced between 20-40% and very short payback periods, between 1-3 years, and in the “Copyier of the Future” to RICOH and Canon with solutions reducing energy down to 25%. This is close to meeting the factor 4 goal introduced in an international context (i.e. only one fourth of the original consumption).

![Figure 6. Longer lifetime through reduced losses - M2BA280, a winning ABB motor](image)
In a new project for “traffic lights with LED” (light emitting diodes), including control systems and transformers, it was indicated at a seminar in Amsterdam in April 2000 that it would be within reach to reduce the use of energy to one tenth, i.e. to reach factor 10. Even if the area does not represent a very large use of energy, this could inspire efforts in more areas (Traffic Lights with LED, 1999-2000).

Two of the Annex III projects have been specially pointed out as successful examples of IEA projects in connection with the IEA 25th anniversary in May 1999 (International Energy Agency, 1999).

At the Annex III international workshop on “Lessons Learned” which was held in London in 1999, the project managers and experts presented experience from the pilot projects. About 60 different “lessons learned” have been identified in the field. An evaluation report by an external evaluator was also presented (Annex III London Proceedings, 1999).

The most important lessons from the IEA Co-operative Procurement six-year project were:
- Early agreement among many important buyers about the goals.
- Market contacts early and repeatedly.
- Innovation projects take time.
- Availability of sufficient funding over a long time.
- Many very knowledgeable specialists needed also for information.
- Rewarding mechanisms adapted to the different areas should be elaborated.

**Energy-efficient ventilation**

In a recent ventilation project in Sweden (Lindgren & Blomberg, 1999), there was a technology competition and procurement, followed by testing and evaluation of five pilot installations. The installations comprised improvement of exhaust air systems with better functioning fans and cooker hoods. Energy and indoor climate measurements and surveys directed to a sample group of people were carried out in 1998-99. To get a balance between energy efficiency and air comfort, a group of representatives of major housing companies had drawn up a performance specification with a number of mandatory and desired requirements. These requirements comprised air change, filtering of smells of frying, sound levels, air exchange efficiency, thermal indoor climate, air quality, energy efficiency as well as operation and maintenance.

Five pilot objects were tested. The installation that was appointed winner in the competition met all the mandatory requirements and most of the desired requirements. The fan energy consumption was reduced by two thirds. The residents were pleased according to surveys. The total energy consumption was low in comparison with what it had been before. At the same time, the air quality and thermal comfort were improved or unchanged.

The experience derived from the whole project that comprised reconditioning of the ventilation installations in 128 apartments can be summarised:
- That the process itself with competition and technology procurement requires sufficient time.
- That the experience of making calculations as LCC analyses is limited so far and needs to be improved.
- That large information efforts have to be made early in a competition and technology procurement project in order to make the whole construction sector conscious of the need for and possibilities of a coming market.
- That the different performance criteria have stimulated to development efforts in sub-stages even though a large break-through has not been shown.
- That, on the whole, the requirements have been realistic and have encouraged to development such as they have been drawn up by a buyer group of housing companies who has also actively taken part in the project.
- That ventilation solutions are now available which are tested and ready to be spread onto the market.
The Swedish Governmental Commission for building costs, BKD

A technology procurement for apartment houses was carried out in 1996-1998 by the Commission for building costs, BKD, set up by the Swedish Government (SOU 2000:4, 2000). The purpose of this procurement was to inspire the development of decidedly more cost-effective solutions for dwellings in apartment houses, which was needed in the new situation in Sweden with clearly reduced government housing subsidies. Some 70 sub-requirements were set up by an experienced group of experts. The requirements comprised the areas of housing quality, indoor environment, resource management and eco-cycle adaptation. The tenders submitted were evaluated in respect of economy 40%, housing quality 20%, indoor environment 20% and resource management and eco-cycle adaptation, each 10%.

About 250 companies received the competition documents and about 70 of them submitted applications to be pre-qualified for participation. 10 of these companies were chosen to submit tenders. Finally, 4 companies were selected to build full-scale pilot houses, comprising 12-15 apartments. Many interesting sub-proposals came up at the competition, but there were no pioneer solutions clearly pointing at the implementation of the goal – decidedly reduced housing costs through lower building and operational costs. In the BKD report, an account is given of some useful experience, which was obtained from the technology procurement, see Table 1. There are also a number of suggestions for improvements to get more efficient competition in the whole building sector and to improve the building process.

<table>
<thead>
<tr>
<th>Positive – to aim at in the future</th>
<th>Negative – to avoid in the future</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Always set aside sufficient time in relation to the task</td>
<td>The time set aside was far too short</td>
</tr>
<tr>
<td>2 Concentrate gradually on different parts problems</td>
<td>The task set was very comprehensive</td>
</tr>
<tr>
<td>3 Identify a large coming market</td>
<td>A large coming market could not be promised</td>
</tr>
<tr>
<td>4 Clear, long-term – and for the investors positive – financial rules</td>
<td>Some uncertainty as regards future financing conditions</td>
</tr>
<tr>
<td>5 The technology procurement method should preferably be used when there is powerful long-term support from society and large buyers</td>
<td>Future buyers were not sufficiently involved</td>
</tr>
<tr>
<td>6 Aim at clarity when expressing the over-reaching goals and most important requirements</td>
<td>Too many detailed requirements were stated in the tender documents</td>
</tr>
<tr>
<td>7 State a specific place for the erection of prototypes and the first series</td>
<td>Not correct to aim at building houses immediately in the whole of Sweden</td>
</tr>
<tr>
<td>8 Increase the awareness of life-cycle and total costs</td>
<td>The construction sector has not yet sufficient experience of LCC calculations and tenders in the form of annual rents</td>
</tr>
</tbody>
</table>

Table 1. Experience gained from a recent Swedish technology procurement project for reduced housing costs
To sum up it can be stated:

- That the BKD technology procurement tried to solve too many problems in a very limited time.
- That major buyers and users were not sufficiently involved in the process from the beginning, which made it more difficult to point at coming orders. This contributed to reducing the interest on the part of contractors and suppliers in investing large resources for preparatory work for the project.

Generally, it can be stated that the requirements, which were set up in functional terms, were well balanced and well suited for the area, but that they were perhaps too comprehensive. It would have been an advantage if strong buyers early had been behind the requirements, feeling that they shared the responsibility for them.

**Performance Contracting – New IEA work**

Within the IEA DSM Implementing Agreement a new Task X “Performance Contracting” has started in December 2000 (International Energy Agency, 2000). The objective of this work is to facilitate the use of performance contracts and other energy service company (ESCO) contracts. Performance contracting is in some countries a well-established mechanism for promoting the installation of energy efficient building equipment and systems. For example, facility owners and energy service contractors use this method to retrofit equipment to save money on building operations. The savings in energy bills due to the installation of this more energy efficient equipment is then shared between the facility owner and the ESCO under the terms of the agreement they entered. In this scenario, the ESCO has taken on the project’s performance risk by guaranteeing a specified level of energy savings. Its compensation for this risk is directly tied to achieving savings. The financing for such a project could come from the ESCO, the equipment supplier or a third-party company.

The Task experts from 8-10 countries will collect and evaluate experience of countries familiar with performance contracting, such as Canada, the United States and some European countries, and listen to the needs of countries that are developing such systems and perform some demonstration projects. Within this two-year project, the participating experts will provide a better general understanding of how performance contracts can be used, outline the benefits of performance contracting and the potential to promote energy efficiency and mitigate global climate change. Finally, the experts will analyse the legal context, identify market potential and barriers when implementing these contracts and suggest solutions in order to improve the tendering process.

**CONCLUSION**

Increased interest has been shown lately for using procurement initiatives for innovation and market transformation. A number of EU initiatives and IEA studies are examples in this area. Furthermore, experience from several large procurement projects in various countries has been analysed in a comprehensive study (Edquist et al, 2000).

With the increased interest in procurement initiatives for acceleration of innovation, it is important to continuously analyse earlier projects and consider earlier experience when planning for new procurement projects.

Some of the most important lessons learned about the use of the technology procurement process are:

- To establish high-level and long-term support.
- To stress the importance of understanding the market as a whole and the underlying conditions and to consider a product with all different performance criteria.
- To stress the importance of creating influential buyer groups and preparing performance specifications in functional terms.
- To set aside sufficient time for preparation and realisation of innovation projects.
- To combine competitions and procurements with different support mechanisms, such as labelling, bulk purchasing, minimum standards, information and rebate programmes.
- To secure large agreement on clear goals.
- To spread more experience among all stakeholders of using LCC evaluations.
- To change the role of governments from being only a big buyer to also playing an intermediary role as stressed in a couple of EU studies (EC DG XII, 1998).
- To stimulate innovations and more efficient solutions by using different processes which have similarities with technology procurement (performance specifications in functional terms and competitions or purchasing).

REFERENCES


