European Commission
Directorate General Environment

Bridging the Valley of Death: public support for commercialisation of eco-innovation

Final Report

May 2009

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Executive summary

1 Context

All innovation tends to bring positive externalities - spill-overs - from progress in innovation. Eco-innovation brings a double benefit because the eco-innovations themselves then deliver a positive externality, for example, a reduction in external costs from environmental damage. This double benefit occurs where the cost of environmental harm is not factored into the market pricing of a product purchased or activity undertaken (Rennings, 1999) or where there are other production or consumption externalities – for instance where market prices of energy do not include energy security risks.

As these additional positive externalities from innovation are not included in the rewards for eco-innovators, the level of investment in eco-innovations is judged to be even further below the social-optimal level than the level of innovation activity generally, giving eco-innovation policy the potential to deliver greater benefits.

In addition, in certain areas, environment policy to internalize externalities is not put in place because the means of reducing environmental harm are not available or deemed affordable by decision makers. This prevents policy reaching the socially optimal level of environmental protection. In this case, eco-innovations can lower costs of achieving environmental goals and so enable political agreement of environmental policy. In these cases, eco-innovation policy is needed before or in parallel with environmental policy, to enable the solving of an environmental problem that would not otherwise be tackled. In a similar way, faster eco-innovation allows greater progress with environmental or energy-efficiency policy, for example greater progress in the setting of minimum standards for product efficiency.

Eco-innovation should not be seen only as innovation in manufacturing processes or products: it can include institutional or behavioural innovation. But great environmental, economic and energy efficiency benefits can be found from innovation in products being sold in very large numbers. This study looks particularly at these relatively high volume products.

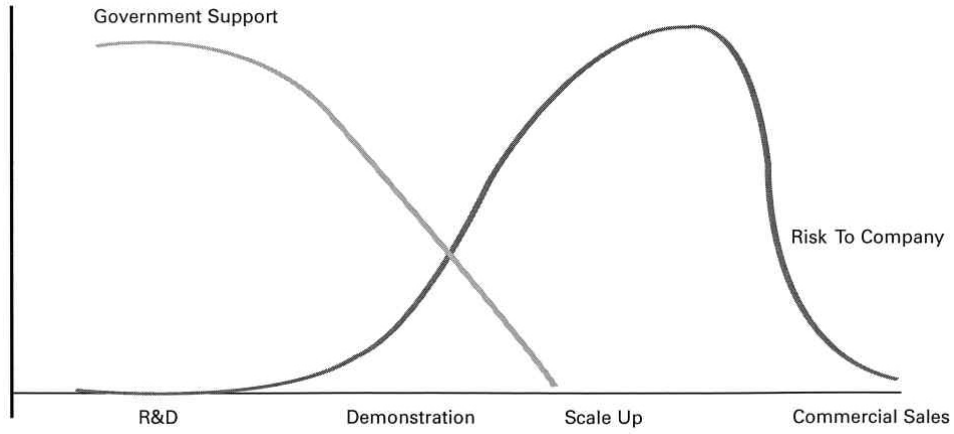
2 Constraints on eco-innovation: commercialisation of innovation and the 'Valley of Death'

We investigated where EU companies saw obstacles to greater eco-innovation. The companies we interviewed did not perceive risking funds on R&D expenditure as their main problem, viewing existing funding opportunities as adequate for them to develop innovations.

Our analysis identifies the most significant problem hindering eco-innovation as the 'chicken or egg' trap that prevents investment: manufacturers wait until there is a demonstrated demand before they develop and commercialise technologies, but buyers wait to see the product on the market before they demonstrate they will buy it (ten Cate et al, 1998). The eco-innovation may well have been developed as a prototype, but reaches a pinch-point at the decision to commercialise, which blocks its development.

This problem arises because companies usually decide to invest in innovation by making a comparison of their likely benefits against the risks of their investment. Particular problems occur at the stage where decision is taken on whether to commercialise an innovation as the risks are greater here than at other stages of innovation. Firstly, the move from a test-series of products to production of commercial volumes of a product requires significant investment. Secondly, this risk coincides with the stage in the innovation process when public support usually ends creating a risk profile (see figure below) that is sometimes known as 'The Valley of Death' for innovations.

Model of risk profile for companies of innovation processes



Source: DTI (2006:13).

It is difficult for firms to share this risk, which has proved to be a major barrier to the development and commercialisation of, for example, energy-efficient appliances. Gustavsberg, a large Swedish manufacturer of sanitary installations, had a product idea for development of an energy-efficient water mixer. Yet, the product development was not initiated before the Swedish National Energy Administration (STEM) investigated the potential market demand for energy-efficient water mixers and organised a technology procurement contest (see section 5.2.1).

These risks also lead to additional difficulties concerning late stage expansion funding. There is often a gap in the financing of small innovative companies in the pre-commercial stage, where they are no longer eligible for public start-up assistance, but the product development process is still too risky to receive sufficient private investments. Research by FUNDETEC indicates that there are too few public instruments operating to leverage private investment and share, or re-shape, risk in a way that makes these enterprises suitable for private investment (FUNDETEC, 2008: 66).

Many banks have desks and departments that are specialised in particular technologies (e.g. biotechnology and information technology). Recently some have developed knowledge on renewable energy technology, but often banks and traditional lenders do not have a desk set up for environmental technology which restricts their willingness to evaluate, and take, financing risks, restricting, or increasing further the cost, of funding (FUNDETEC, 2008).

3. Bridging the Valley: Demand-side innovation policy

In this situation of uncertain future markets, increased supply-side governmental support (e.g. for R&D) will not efficiently mitigate the risks to the company for further commercialisation of the product. Very large supply-side support would be needed to mitigate the significant investment risks of commercialisation directly. So the most efficient policy instruments are those which are able to reduce the market uncertainty, without second-guessing future market demand. These can harness the economic potential of the future market as the incentive to commercialise.

This is one of the roles of demand-side policy measures - defined as: *"all public measures to induce innovations and/or speed up diffusion of innovations through increasing the demand for innovations, defining new functional requirement for products and services or better articulating demand."* (Edler & Georghiou, 2007: 952).

Research conducted in the 1980s shows that public innovation procurement (a form of demand-side instrument) is a far more cost-efficient policy instrument than traditional R&D subsidies to promote innovations (Geroski, 1990). But whilst procurement for innovation was incorporated as an element of the European Commission's Research Investment Plan, and other instruments have been put in place, European action on demand-side instruments to promote innovation has been disproportionately small compared to the rewards. The innovation support polices most often put in place in the EU are supply-side policies (like provision of R&D funding) which mainly assist in the technological development of new products or processes.

Existing EU demand-side innovation policy

EU programmes to promote innovation, including eco-innovation, contain demand-side measures. Of particular note are:

- The Lead Market Initiative (LMI), launched in 2006 to give industries the opportunity to develop niche markets into export products or services in new high-growth markets.

- A '**pre-commercial procurement**' policy to encourage public procurers to share the risk (and reward) of developing and commercialising innovations which fit their needs.

- The Environmental Technologies Action Plan (ETAP) which recognises the importance of improving market conditions.

4. Experiences with past or existing innovation procurement policies

This study sets out to investigate how to best shape procurement policy to promote commercialisation of eco-innovations in the EU, researching past experience with innovation procurement programmes, including interviews with the firms and public bodies involved.

Different roles of procurement policy in innovation

Procurement designed to support innovation, can take many forms. It can: **initiate, escalate, or consolidate** markets (Edler et al; 2005:19). The majority of procurement policy in place – including green public procurement – focuses on purchase of commercially available products, which escalates (expands commercial niche markets) or consolidates markets, in addition to its direct public benefits.

This report focuses on exercises intended to procure innovations which are not yet commercialised – to initiate markets. Market initiation procurement can be divided into categories, depending on the final beneficiary of the commercialised product:

- Direct procurement where the public procurement body purchases the innovation for its own needs. Defence-related innovations or the acquisition of public transport technologies, e.g. high-speed trains, are examples of direct procurement (Edler et al, 2005: 16).

- Co-operative procurement involving joint buying with private purchasers to develop a new market for the technology they will both use (Edler et al, 2005: 16). An example is the procurement of energy-efficient lighting systems in Hamburg.

- Catalytic procurement is public sector action to catalyse the development of a technology, although the innovation will be exclusively used by private end-users.

- **Pre-commercial procurement**, as defined in European Commission policy, is direct procurement with the added characteristic that the public sector invests in the innovation process in return for a share of future revenues from its commercial success. It also involves bundling demand from several different procurers.

In this report, we use the term '**innovation procurement policy**' as a broad term which can cover all forms of market initiation procurement and also includes other public policy interventions to promote commercialisation of innovations through demand-side measures. Innovation procurement policy includes instruments that communicate likely future demand for innovation, even

though this may not involve public purchasing of products or services (the term 'procurement' is used in the wide sense of 'bringing about').

Innovation procurement policy

Our research gathered experiences with innovation procurement policy from within and outside the EU. The most comprehensive experiences come from NUTEK/STEM in Sweden, and from the US Department of Energy – this kind of innovation procurement policy is known as 'technology procurement'. This report has investigated cases covering:

- white appliances (energy-efficient refrigerators, ovens, washing machines and tumble driers), components (high-efficient motors).
- housing (energy-efficient water mixer).
- office blocks (control and monitoring systems, sun shading technology and lighting system).
- public transportation (hydrogen buses).

The most important features of these policies are described below:

- The central component of the policy is the creation of a way to solve the 'chicken and the egg' problem by exchanging information between innovators and potential buyers. A **'buyer group'** is created, gathering together purchasers with an interest in an innovation with environmental characteristics. These buyers set out what they desire from an innovation, in terms of its function, characteristics and price.
- Typically, the **public agent plays the role of a facilitator** of product innovation and product commercialisation. The public body initiating the technology procurement programme purchases neither the innovation process nor the final commercial product.
- The composition of the buyer group is crucial - it must constitute a considerable market share, so that its views on the desires for innovations convince manufacturers that there is a sufficiently large commercial market for their innovation. This **'bundling of future demand'** is a key aspect of the policy – individual buyers acting alone typically do not have the market strength to convince innovators to commercialise products. Bundling public and private sector demand can lead to 'critical mass' that gives technology developers a strong incentive to develop and commercialise new environmental friendly products.
- Usually, the buyer group draws up detailed **technical specifications** describing the innovation that they would want to be available. This goes beyond any solution already on the market, but must be technically possible. The process is informed by discussions with technical experts, manufacturers and innovators about what is feasible. In many cases, innovations which could meet the desired qualities are already known, but not commercialised. The buyer group is either set up as part of a specific project or a stable buyer group is used.

- To provide the incentive needed for innovators and manufacturers to engage in the information exchange, the gathering of information on the potential of innovations is usually set up as a **bidding contest**, in which the prize for the best bid is its selection for future market support. This is similar to procurement, although the 'prize' is not necessarily the purchasing of the innovations. Nor is it necessary for there to be only one 'winner' meeting the technical specification, although usually the best innovation against those criteria is selected. This approach has been used widely, particularly by NUTEK/STEM in Sweden.

- Various policy and market instruments may then be announced for future **support of the market uptake of the new products**. The choice of instrument depends on the problem faced by the innovator and the depth of support needed. For example, it may be enough that the performance of the developed products is documented. Gustavsberg participated for instance in a technology procurement programme with an energy-efficient water mixer and was awarded as winner of the bidding contest. The most important result for the company was the acknowledgement that the product they had developed was the most energy-efficient and of high quality. The fact that the public authorities facilitated the testing and evaluation of the product was of significant importance to the company, as this was an important way for the company to differentiate their product from their competitors' cheaper but less energy-efficient products.

- Even in cases where no innovation has been offered that would meet the specifications, the best product has been supported through public testing and a demonstration programme, allowing market success. In 2003, the Swedish National Energy Administration (STEM) initiated a technology procurement contest for development of a central control and monitoring system for heating, cooling and ventilation in office buildings. Several contributions were made to the bidding contest, but none of the solutions were able to meet all of the requirements. The result was that no winner of the contest was appointed. Instead, it was decided to invite the three best proposed solutions to an evaluation in existing office buildings. Larmia Control AB, a Swedish developer of systems for automation and monitoring of buildings, participated in on-site evaluation of their system, the energy programme Optimizer. The system developed by Larmia is evaluated as being able to bring down energy consumption of heat and electricity by approximately 10 to 20%, depending widely on the existing heating, cooling and/or ventilation system.

- Within some product groups the advance procurement of products that are not yet on a commercial market can mitigate the risks of the product developer. This policy instrument supports companies in the up-scaling of product volume (or product size). An example of **procurement of pre-commercial products** is the City of Copenhagen's purchase of a fleet of hydrogen fuel cell powered vehicles. The purchase of such pre-commercial products entails an excess risk to the procurer of the product. The case of City of Copenhagen shows that the reasons for public bodies to take the risk of purchasing a product with a performance (e.g. in terms of transport) potentially inferior to other products on the market include the support of

the development of the technology, environmental goals and improved public image.

Experiences from a range of technology procurement programmes show that many product manufactures are very interested in participating in innovation procurement programmes, even though the companies have to respond to detailed technical specifications.

Decisive for the companies' willingness to participate is the way in which their participation improves the market prospect of their products. The creation of a 'buyer group' of potential users or purchasers (both public and private buyers) is seen by the manufacturers as an assurance of a potential market. This effect is strong where the buyer group's composition reflects large potential buyers on the market.

In some cases, the process involving the buyer group by itself served to create sufficient market demand by showcasing a previously unknown innovation to buyers – and this led to commercialisation (exemplified by innovation in building sun shading systems described in Section 5.2.3.)

Complying with a bidding process is time consuming and costly. EU-wide bundling of potential demand could increase participation in such processes. The cooperation between public bodies can also reduce the costs for each entity of preparing and carrying out the tendering process.

By coordinating the buyers' needs with the suppliers' capabilities to develop new technologies the classic problem of the 'chicken and egg' can be resolved. The virtue of technology procurement is: "(…) to condense into a much shorter period the complicated exchange of market signals, intervening in a way that accelerates and strengthens - rather than displaces - long-term market relationships" (ten Cate et al, 1998).

Most of the capable potential manufacturers do not need a guaranteed delivery to the buyers of the product (Nilsson, 2003). If the product developers are convinced that the potential buyers will purchase the product and continue to do so, most product developers will be willing to bring the product to the market without sales guarantees. We also found that independent agency testing and evaluation of technologies that match the buyer group's need was a key driver for many companies to participate in the procurement programmes.

5. The value of expanding EU demand-side eco-innovation policy

In our analysis, the primary problem retarding commercialisation of eco-innovations is an information problem – the lack of information for innovators about whether the future market would want their innovation. Experience with existing programmes shows that an innovation procurement policy can have an important role in providing that information, particularly through the formation and support of buyer groups.

Yet we also found that each market is different, with market specific problems. Information measures can be effective at removing some of these problems, like financing constraints (by indicating a more certain market to financiers)

and overcoming market inertia (by demonstrating the success of an innovation to the wider market). A successful demand-side innovation policy should deal with each specific problem and this will require the use of a wider range of policy instruments both to support the operation of the information exchange in the buyer group and incentivise participation.

Current EU demand-side innovation policy appears limited in the way it tackles the 'chicken and egg' problem surrounding commercialisation decisions. Policy instruments which could be used to support commercialisation of innovation – particularly those relating to EcoDesign – do not appear to be structured to tackle this problem.

The implementation of ETAP is currently being evaluated (ECORYS/COWI, 2009). Progress with the Lead Markets Initiative is also being evaluated, to inform future measures and expansion of the initiative, with the review due to be published in the summer of 2009. These evaluations present opportunities to assess the extent to which current demand-side policy is successful in overcoming blocks to commercialisation, and to take on board experience in the EU and outside on the use of wider, deeper demand-side eco-innovation policy.

In a recent evaluation of the Swedish strategies and initiatives for promotion of environmental technology it is recommended to draw upon the Swedish experiences for technology and innovation procurement for setting up new procurement and innovation procurement schemes on an EU level. Clear ambitions and goals should be formulated and the needed resources should be allocated in order to increase the rate of development (Swentec 2008).

Action by the European Commission on innovation procurement policy could have significant added value, compared to similar actions by Member States. These advantages should come from the ability of EU policy to convey information to innovators about a much greater potential market (including export markets). EU action could then send stronger market signals, about the size of the market and about the international possibilities for innovations. There are other advantages:

- The pool of potential buyers to join a buyer group is much greater – allowing easier formation of large buyer groups with significant market power.

- Investments in innovation policy by each Member State are leveraged by the investments from the other participating Member States, with each Member State achieving its innovation goals more effectively, for a smaller investment.

- The European Commission has the ability to co-ordinate, or shape, the policy instruments to support market initiation across the EU, whether proposed by the EU (e.g. labelling) or requiring co-ordination in Member States (incentives) needed to support an innovation procurement programme.

The greater use of demand-side policy instruments, involving the use of buyer groups linked to targeted instruments could fit into the Commission framework for innovation, in particular the ETAP.

The added costs of co-ordinating potential buyers, innovators and supporting policies on an EU scale, rather than a national scale, needs to be considered, and may differ according to the market. Action at the EU level may produce greater information on this issue, particularly if it stimulates more Member State action on innovation procurement policy.

Products suitable for application of greater demand-side eco-innovation policy

The report analyses past experience of innovation procurement and assessed the potential of future policy with stakeholders in specific areas of innovation (chapter 5). To undertake innovation procurement at an international level, it is recommended to start at the component level and with small systems as such technologies are less dependent on existing infrastructure and variations in culture and climate conditions.

Experiences show that technology procurement has been most successful if the following conditions have been fulfilled:

- Products or features are attractive to a large number of motivated buyers.
- Products or features are not already widely available.
- Products are standardised and mass-produced and not custom-designed.
- More than one supplier can compete for the procurement.
- Desired changes in products or processes are not so fundamental that they require long lead times for R&D.
- The technology advances the manufacturers' own strategic goals e.g. reduced energy consumption.
- The manufacturers of the product perceive the potential market as a promising market.
- The product constitutes a considerable potential for environmental improvements.

In markets where the public sector's purchasing power does not constitute a significant part of a potential product markets, e.g. energy-efficient white appliances, the public sector can still potentially play an important role with respect to facilitating the development and market uptake of products with environmental characteristics.

In addition to the areas where innovation procurement has already been applied to achieve environmental goals (first 5 bullets below) we have identified potential application of innovation procurement for 5 further areas (the later bullets):

- White appliances (energy-efficient refrigerators, ovens, washing machines and tumble driers).
- Components (high-efficient motors).
- Housing (energy-efficient water mixer).
- Office buildings (control and monitoring systems, sun shading technology and lighting system).
- Public transportation (hydrogen buses).
- The transport sector (hydrogen powered fuel cell, electric car, electric motors, city buses).

- Wastewater treatment (environmental biotechnology).
- Chemical components (DEHP-free component).
- Healthcare products (e.g. ostormy or continence care products).
- Energy-efficient components (pumps).

Within each of these areas, it is possible to identify specific product functions that would be suitable for the application of technology procurement programmes. In a study made for the Swedish Procurement Group for Commercial Buildings (BELOK) future areas for technology procurement for energy efficiency in commercial buildings are recommended to cover:

- Energy-efficient food stores.
- Energy-efficient catering centre.
- Energy-efficient store lightening.
- Public application of light emitting diodes.
- Energy-efficient medical equipment.
- Energy-efficient climate cooling in offices.
- Energy-efficient office buildings with best indoor environment.
- Technology contest between ESCO on most energy-efficient buildings (Jagemar & Fahlén, 2007).

6. Practicalities of a wider EU innovation procurement policy

We are fortunate to be able to draw on practical experience of innovation procurement policies to understand how best to structure innovation policy to be most effective. The approaches to technology procurement used in Sweden, in the US, by the International Energy Agency DSM and in the Energy+ programme are very similar, and a range of general lessons can be learnt for application of the policy in the EU.

The basic methodology of an innovation procurement policy programme should be structured according to following steps:

1 Preparation of a feasibility study.

2 Creation of a buyer group.

3 Formulation of product requirements.

4 Tendering/discussion process with innovators.

5 Evaluation of innovations.

6 Announcement (and later application) of policy support measures, including spreading of information.

Our research shows that the best way to use innovation procurement policy is by identifying the risks associated with certain product and market characteristics and the application of targeted policy measures to mitigate these risks. It is

stressed that innovation procurement should not be understood as a fixed approach used the same way with respect to all types of innovations. On the contrary, innovation procurement should be seen as a flexible approach to innovation that is tailored to the specific type of product, size of product developer, product characteristics, technological complexity, and needed technological changes.

Instruments forming part of the policy programme

To tackle the market failures that hold back commercialisation of innovations, EU technology procurement policy should draw on an array of measures that combine in the right way on the specific market failures that exist for each area of innovation. The instruments that the policy should draw upon are outlined below.

1 Creation and use of buyer groups

The use of buyer groups to bring about information exchange is the core of the policy. The buyer group's work should be supported by a feasibility study setting out the technical requirements for the desired technology.

Policy instruments to provide incentives for participation in buyer groups may need to be offered in some cases, particularly if it is desired to bring risk-averse public procurers into the buyer group. If this incentive takes the form of a subsidy for purchase of a limited number of future products, the incentive also serves the primary purpose of demonstrating a stronger future market for innovation.

An indication from a buyer group that they would be likely to buy a certain number of products (even if not a promise to do so) is a very effective policy instrument.

2 Pre-announced market support instruments

The central role of the other policy instruments forming part of the innovation procurement policy is to provide advance reassurance to innovators that there will be market support for their innovation if they invest in its commercialisation. To be effective, these support instruments have to be:

- announced and guaranteed before the commercialisation.
- offered to products that meet the technical requirements, or which win the bidding contest.

Where there are several products which may meet those technical requirements, this future support can apply to the products actually sold – by way of a sales subsidy - allowing the market to determine the best product.

Instruments include:

- Testing and verification of the products (often found to be particularly important).
- Publicity campaigns for the best product(s), which could focus around the award of a prize, including promotion at trade fairs and establishment of product demonstration facilities.
- A financial 'prize' when the best product is put on the market.
- Sales support through subsidies for a certain number of products sold, either to the manufacturer or to purchasers (including those purchasers in the buyer group).
- The revision of product labelling classes (e.g. energy labels) to allow the innovative products to differentiate their performance from products already on the market.
- Matching future green public procurement criteria to the technical requirements set up for the product.
- Guaranteed markets – a pre-commitment to purchasing of a certain number of products meeting the technical specifications (including price). This can also take the form of a pre-commercial procurement process.

A new pan-European innovation procurement programme should be based on the experiences of the technology procurement programmes. This suggests that EU innovation procurement policy should draw on a broader range of policy instruments than past technology procurement programmes. This would then be able to target a wider range of areas of innovation.

Requirements for success

- The programme development process should be buyer-driven. The interests of the buyers, their preferences, market perspectives and willingness to buy are decisive for the success of the project.
- The programme developer should interact extensively with potential suppliers. The purpose is to learn about key technology and market issues from the supply side of the market.
- The setting up of a technology procurement programme is also about timing. It is necessary both to find interested buyers and interested manufacturers of the product.

The following factors are some of the other key elements in successful organisation of technology procurement:

- The selection of technology and markets that are suitable for technology procurement.
- A well-prepared preparatory phase.
- High credibility of the organiser of the programme.

- High commitment of the organiser and the buyer group through the whole procurement process.
- Long-term perspective.
- Continuity throughout the programme.
- Combination with other policy instruments and willingness to adjust the approach and involved policy instruments throughout the process.

Practicalities that should to be taken into consideration when forming a new buyer group should be:

- The purchasing power of the buyer group's potential members is important as the buyer group has to make up a promising market. An example of a buyer group that constitutes a significant share of the market is BELOK (the Swedish Procurement Group for Commercial Buildings). In 2007, BELOK's members together owned 17% of the heated area in commercial buildings and the BELOK member's investments made up 32% of the total investment in the commercial building segment (Bertelsen, 2008). However, buyer group members' commitment to the innovation procurement project is also decisive for a successful outcome of an innovation procurement programme.

- The forming of a buyer group should be seen as a continuous process, where new members may be added to the buyer group during the innovation procurement process, increasing purchasing power of the group. The selection of members to new buyer groups has in Sweden largely been based on knowledge of market players and personal networks. Potential members of buyer groups could be identified based on national and pan-European networks.

- STEM's experiences with creating buyer groups show that potential members of the buyer group should be involved very early in the innovation procurement process. In some cases the buyer group members have even made the initial suggestions for the technology procurement. The buyer group members' involvement in early discussions of performance requirements and potential demand for the desired product is very important to steer the process in the right direction.

- For success, the members of the buyer groups need to:
  - have a genuine interest in the development of the product.
  - take personal responsibility for the procurement project.
  - push the process forwards.
  - have a mandate from their employer to make decisions.
  - disseminate information on the project in the organisation where they work.
- As a step in the forming of EU wide buyer groups, it should be analysed to what extent national and regional differences in the EU influence on the potential buyer group members' demand for the desired technology. There are for instance significant differences with respect to the demand for cool-

ing and heating of building between North Europe and the Mediterranean region.

Long-term relationships are important for the sustainability of the project. Some of NUTEK's most successful technology procurement schemes have relied on long-term relationships with buyer groups. The long-term relationship has helped to overcome the initial criticism that the buyer group may have towards the technology procurement approach.

Assessment of Costs, Risks and Legal issues

A clear advantage of innovation procurement policy is the efficiency with which it can leverage the demand to incentivise commercialisation. This does not necessarily demand direct public financial intervention to support the market and should make any public expenditure of funds more effectively targeted at innovations which will have significant market uptake.

The costs to the public authority of the innovation procurement processes are connected with the preparation of the feasibility study, the facilitation of the development of technical specification of the buyer group and promotion of the winning technology. The costs vary significantly according to what kind of technology the procurement contest addresses. Estimated costs of a feasibility study are EUR 50,000 - 100,000. Based on the experience from Swedish technology procurement (in Chapter 5), full costs of implementation of a project to support commercialisation of an innovation are estimated to EUR 100,000 - 500,000. This can be compared with the costs of supply-side policy.

The procurement of pre-commercial products not only entails costs of preparing and carrying out the tendering process, the unit price of such innovative products is likely to be higher than the unit price of similar, traditional products. Only large cities normally have the resources to purchase pre-commercial products. A funding scheme for incentivising public procurement of pre-commercial products should be established as a branch of innovation/market transformation policy. This would allow small public entities (e.g. municipalities) to participate in programmes aiming at supporting commercialisation of pre-commercial products.

The very nature of supporting innovations is risky as no stakeholders involved in the innovation process can be sure that the innovation will succeed. Some of the projects already undertaken in the world have entailed a market transformation with a significant market uptake of the new product. In other cases, market penetration has been modest and in some cases sales have been very low. The risk must be accepted, it compares well to the risks of successful economic impact from R&D funding - one of the strengths of innovation procurement policy is that it provides market demand led support, rather than the support demanded by suppliers. This increases the likelihood that public innovation support is well targeted and moves innovation policy away from 'picking winners'.

A procuring agency involved in public procurement of innovation has to take risk evaluation into consideration, including evaluation of the likelihood of success of the procurement and the potential impact of the innovation. Based on Edler et al (2005) a model for risk evaluation of public procurement of eco-innovation has been set up, see Table 6.1.

The success of the policy interventions in stimulating wide market uptake depends on matching the interventions to market conditions and the problems facing innovators. This requires detailed assessment, drawing on past experience.

From a legal point of view, there are no obvious barriers to carrying out innovation procurement programmes.

Recommendations

- To achieve the EU's objectives for increased eco-innovation in the EU, the European Commission and Member States should use innovation procurement policy to tackle the blocks retarding commercialisation.

- The European Commission should use upcoming evaluations of the ETAP and Lead Markets Initiative (LMI) to identify the current scope of EU demand-side innovation policy in tackling blocks to commercialisation and how aspects of existing instruments might be used as part of a wider innovation procurement policy.

- The European Commission services should expand their responsibility for the facilitation of EU innovation procurement programmes including the selection of products, the creation and support of buyer groups, and the assessment of products. The Commission services should establish expertise to prepare feasibility studies for potential innovation procurement projects. Particularly in the start-up phase, much effort must be devoted to the creation of a framework for the procurement programme and a multi-year commitment given.

- Buyer groups should be formed under the auspices of the programme drawing upon the public procurement networks set up under the Lead Market Initiative, existing green public procurement networks and other Commission groupings, including the Retail Forum. These groups should include private and public procurers representing a sufficiently large share of the potential future market for an innovation meeting a particular need (e.g. to improve energy efficiency of lighting).

- A European demand-side innovation policy should be based on an analysis of the potential market advantages and specific market failures retarding commercialisation of each area of future demand, carried out by the Commission. Analytical support for buyer groups should make use of the product market and technical analysis and expertise being made available by the Joint Research Centre to support EcoDesign, Eco-label and green public procurement policies.

- The success of an EU innovation procurement policy requires the belief by stakeholders that the policy measures to support the work of the commission services – e.g. incentives, information campaigns, dynamic labelling, and links to green public procurement – will be applied. This requires upfront commitments by the European Commission and Member States to make existing and future policy measures available. This can only take place in a context of greater understanding of the central role of eco-

innovation in meeting medium-term economic, energy and environmental objectives and co-operation between policy makers in these sectors.

- To overcome initial unfamiliarity with the potential benefits of innovation procurement policy that would be likely to reduce participation in buyer groups and from innovators, the Commission should allocate upfront funding to the policy programme to be used, as judged appropriate, to support commercialisation, e.g. for purchase subsidies for a limited number of products, incentivising participation of buyers and innovators. These funds should be leveraged with funding commitments from Member States.

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List of abbreviations

Abbreviation	Explanation
BELOK	Procurement Group for Commercial Buildings
BOA	Basic Ordering Agreement
CEE	Consortium for Energy Efficiency
Commission	European Commission
COP15	United Nations' fifteenth climate change conference
CFC	Chlorofluorocarbon
CUTE	Clean Urban Transport of Europe
DEHP	Di(2-ethylhexyl)phtalate
DOD	Department of Defence
DOE	Department of Energy
DSM	Demand-Side Management
EEI	Energy-efficient Index
ETAP	Environmental Technologies Action Plan
ESCO	Energy Service Company
EU	European Union
GDP	Gross Domestic Product
GPP	Green Public Procurement
ICE	Internal Combustion Engine
ICT	Information and Communication Technologies
IEA	International Energy Agency
IPR	Intellectual Property Rights
LMI	Lead Market Initiative
MOTIVA	Information Centre for Energy Efficiency
NOVEM	The Netherlands Agency for Energy and the Environment
NPPL	Pacific Northwest National laboratory
NUTEK	The Swedish Boarder for Industrial and Technical Development
NYPA	New York Power Authorities
PCP	Pre-commercial procurement
RE	Renewable energy
RFP	Request for Proposal
R&D	Research and Development
SBIR	Small Business Innovation Research Programme
SERP	Super-Efficient Refrigerator Program
SME	Small and Medium Sized Enterprise
STEM	The Swedish National Energy Administration
UK	United Kingdom
US	United States

1 Introduction

The Lisbon strategy was adopted in Lisbon, March 2000. The purpose of the strategy was to make Europe the world's most dynamic and competitive knowledge-based economy, capable of sustainable economic growth by 2010 (Kok et al, 2004).

In recent years, four expert groups were appointed to explore and enhance different policy instruments to achieve a 3% R&D target for R&D which the EU set for itself in 2002. Based on one of these expert group's work (Expert Group, 2003), procurement for innovation was incorporated as an element of the European Commission's Research Investment Plan to raise R&D to the 3% Barcelona target (Edler & Georgious, 2007).

All innovation tends to bring positive externalities - positive spill-overs from progress in innovation. Eco-innovation brings a double benefit: the additional benefit comes because eco-innovations themselves deliver a positive externality, for example, by reducing the external costs of environmental damage. This double benefit occurs whenever the environmental cost is not factored into the market pricing of a product purchased or activity undertaken (Rennings, 1999). But the externality need not only be the unpriced cost of the environment - where market prices of energy do not include pricing of energy security risks from the additional consumption of energy, eco-innovation that reduces energy consumption will also bring these additional benefits.

As these additional positive externalities from innovation are not included in the rewards for eco-innovators, the level of investment in eco-innovations is judged to be even further below the social-optimal level than the level of innovation activity generally, giving eco-innovation policy the potential to deliver greater social benefits from intervention in this area. In addition, in certain areas, environment policy to internalize externalities is not put in place because the means of reducing environmental harm are not available or affordable. In this case, the lack of eco-innovation prevents the creation of the market for those eco-innovations, and eco-innovation policy is needed before or in parallel with environmental policy, to enable establishment of the environment policy and the solving of the environmental problem.

Eco-innovation should not be seen as mainly innovation in manufacturing processes: it can include institutional, or behavioural innovation, and great environmental, economic and energy efficiency benefits can be found from innovation in products being sold in very large numbers, or for final consumption. This study looks particularly at these relatively high volume products.

The European share of the global market for eco innovation accounts for one-third and has been estimated to employ 2 million people. The environmental technologies are used in an array of sectors, including energy technologies and conservation, recycling, waste and emission control, construction, transport and agriculture (Aho et al, 2006).

An array of policy instruments can be applied to support the development of innovations. These policy instruments can be divided into supply and demand side policies. Supply side instruments focus on building up the framework conditions that support R&D and innovation. Supply side policy instruments include grants for industrial R&D, investment in infrastructure (e.g. through the educational system or government financed research laboratories), support for education and training, support for public sector research, corporation tax reduction, etc. (Geroski, 1990; Edler & Georghiou, 2007)

Demand side policy measures can be defined as: "*all public measures to induce innovations and/or speed up diffusion of innovations through increasing the demand for innovations, defining new functional requirement for products and services or better articulating demand.*" (Edler & Georghiou, 2007: 952). Demand side policy measures include the use of regulation and standard setting, support of private demand (e.g. through subsidies and tax incentives), systemic policies (e.g. cluster policies or supply chain policies) and public procurement (R&D procurement, public procurement of innovative goods) (Edler & Georghiou, 2007). The advantage of using demand-side policy instruments is that the public sector can steer the development and dissemination of innovations in a desired direction.

The purchasing power of the public authorities makes up 16% of the EU's GDP - in certain sectors the spending is higher, e.g. 40% of spending on construction and almost 100% on defence, civil security and emergency operations (http://ec.europa.eu/environment/gpp/; European Commission, 2007c). The public sectors' purchasing power thereby constitutes a significant potential for buying environmental-friendly products.

The EU and its Member States have made big efforts to investigate the potential for green public procurement (GPP). Green public procurement means that the public procurer takes environmental factors into account when buying products, services or labour (http://ec.europa.eu/environment/gpp). Green public procurement addresses existing products on the market and thereby supports the market uptake of environmental-friendly products.

Research conducted in the 1980s shows that public procurement is far more cost-efficient policy instruments than traditional R&D subsidies to promote innovations (Geroski, 1990). This has been a starting point for researchers to investigate the possibility of public procurement to drive innovation.

The basic differences between green public procurement and public technology procurement are that the products addressed by GPP are 'on the shelf' products, and hence these products are already commercial products. The products that are addressed by public technology procurement are products that are not yet

developed to a commercial level - and where product development and commercialisation constitute considerable risks to the technology developer.

The traditional idea of public technology procurement is to use the public purchasing power to drive product innovation. In the eco-industry, public technology procurement can be used to support the development of environmental-friendly products.

This report investigates the possible role of procurement-related demand-side policies can be used to stimulate commercialisation of innovation, and how policy in practice should be shaped. The study is based on interviews with industry as well as previous studies. The study draws on experiences with procurement policies and outlines the role that the public sector can play to facilitate and drive innovation of environmental technologies.

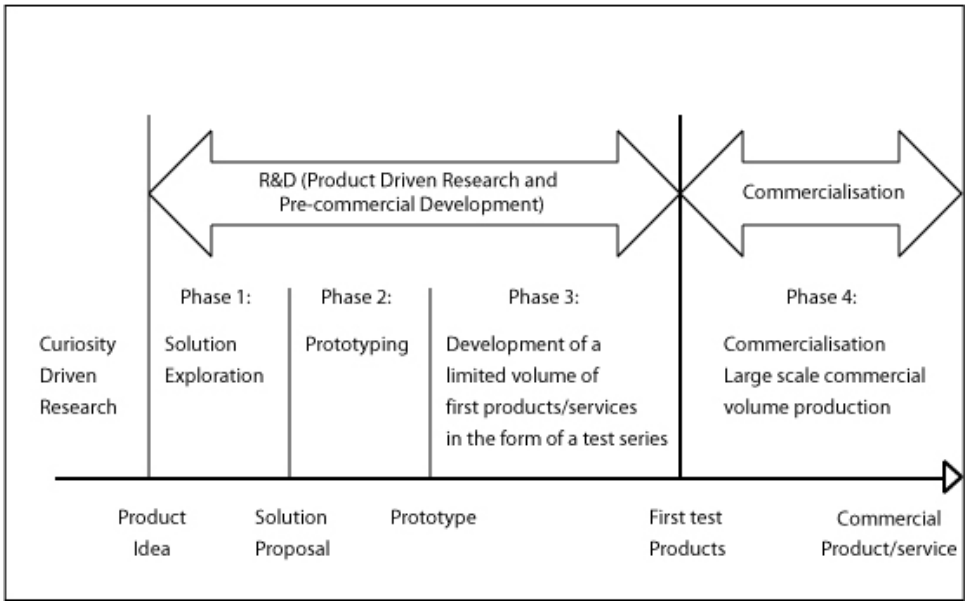
A range of companies have been interviewed in order to understand the nature of product characteristics and the markets for eco-innovation[1] that the companies have developed or could develop. Based on the sectors that make up the highest potential for green public procurement, the relevant product groups and market are identified. Some of the interviewed companies primarily produce products to the public sector, other produce primarily to the private sector.

[1] By 'eco-innovation' is understood the development of new environmental-friendly products.

2 The problem - the innovation process

The development of new eco-innovations goes through a range of steps from the basic product idea to the final commercial product.

Figure 2.1 Model of the development of innovations



Source: European Commission (2006a; 2007b).

Figure 2.1 shows a model for the development of eco-innovations. For each part of the development process certain risks are associated with the innovation process. The kinds of risks vary throughout the innovation cycle, and hence policies should be shaped in a way that best addresses these risks.

2.1 Market failures and gaps

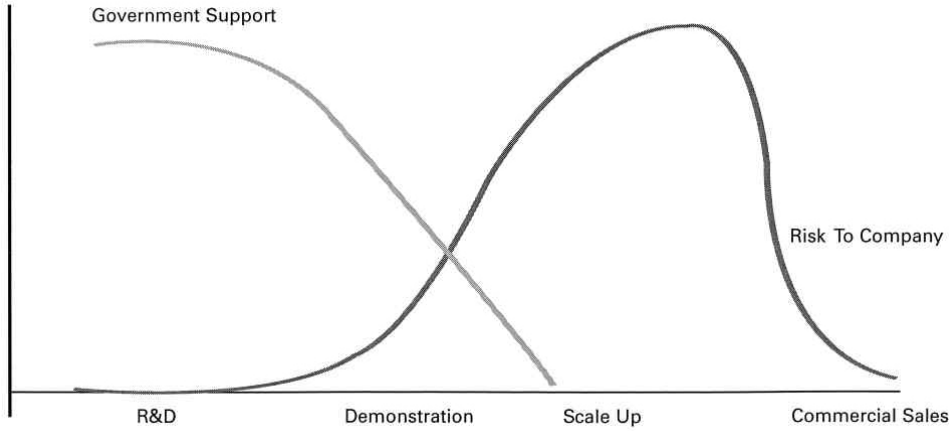
The most common market failure and gap is known by technology developers and financiers as 'The Valley of Death'. Risks associated with early-stage (un-proven and proven technologies) and middle-stage (pre-commercial) technologies are by private investors seen as too risky, and are therefore often not funded.

The problem for the developer is that the technologies at these stages are too advanced in their development to qualify for public research and development subsidies or other types of financial support - a further problem may be that the

capital required is larger than what the government finance programmes can provide. On the other hand, the company is too new and unproven to receive private financing (FUNDETEC, 2008: 66).

This leaves the company in a gap where it is no longer eligible for start-up assistance, neither mature enough to receive sufficient private investments. 'The Valley of Death' is a well-known problem that applies to all types of technologies and start-up growth enterprises - including eco-innovations. "There are very few financial instruments that will accommodate a higher risk profile without the prospect of high returns on investment. However, many technology development enterprises do not conform to that kind of risk-return profile, and will not receive sufficient funding. FUNDETEC research indicates that there are too few public instruments operating to leverage private investment and share, or re-shape, risk in a way that makes these enterprises suitable for private investment" (FUNDETEC, 2008: 66).

Figure 2.2 Model of risk profile for companies of innovation processes



Source: DTI (2006:13).

The model shows a risk profile for the innovation process where the risk for the company increases towards commercialisation of the product. The shape of the risk profile depends on the kind of technology that is innovated and the possibility for the company to get the innovation process funded. In the shown risk profile, the governmental support of R&D covers only the initial phases of the innovation, and the scaling up of the product therefore constitutes the largest risk to the company. In this case, increased governmental support for R&D will not efficiently mitigate the risks to the company for further commercialisation of the product, as bridging the risk gap calls for the application of other policy instruments.

The risks that companies have to deal with when developing products differ across sectors and product groups:

Scaling-up

Compared to the costs for the initial R&D phases (and other subsequent phases) the costs of commercialisation of products are often very high. The scaling up of a production from prototypes and demonstration facilities can be challenging. Among other things, there can be challenges with respect to designing the necessary infrastructure and finding components and staff. Moreover, the technology needs to be verified by independent experts to prove that the results presented by the technology developer are not biased (FUNDETEC, 2008: 69).

Examples among the investigated companies where scaling-up of the product series - or the product size of the production - constitutes a significant risk are companies in the transport sector, e.g. development of hydrogen fuel cell (H2 Logic), development of electric cars powered by Lithium-ion battery (Think), and development of electric motor systems in buses (e-Traction).

Uncertain demand

Uncertain demand for products constitutes a major risk for companies that restrain them from developing environmental technologies. Clear signals are needed from the market of demand for products with certain characteristics - including environmental performance - for the companies to take the risk of developing products.

There is a 'chicken or the egg' trap that prevents investment: manufacturers wait until there is a demonstrated market before they commercialise technologies, but buyers wait to see the product on the market before they demonstrate they will buy it. (ten Cate et al, 1998).

For some companies the positive indications from the market for a potential product is enough for the company to take the risks of developing a product. Examples among the investigated companies are development of low-energy water mixers (Gustavberg), development of energy-efficient white appliances (Electrolux), and development of sun shade technology (Sompfy).

Other companies need guaranteed markets for sale of a certain product volume in order to develop a product. Among the interviewed companies this is the case for bus manufactures developing city buses (Mercedes-Benz Buses, Volvo Buses and Scania Buses) and development of healthcare products (Coloplast).

Hazards

Certain sectors face sector or product group specific hazards. An example among the interviewed companies is the risk of storm-related damage of testing-site in connection with the development of wave energy converters (Wave Dragon). In some sectors large risks are associated with the approval processes of new products, e.g. approval of healthcare products (Coloplast) and development of new chemicals (Danisco's development of a product for the substitution of DEHP).

Late-stage and expansion

On late-stage and commercial expansion-stage technologies and ventures in general have fewer problems getting access to capital. At these stages the traditional debt instruments through banks are available. It is, moreover, often possible for the technology developer to apply for expansion-focused funds. Compared to other more established technologies, the environmental technologies here have a unique disadvantage. Many banks have desks and departments that are specialised in particular technologies (e.g. biotechnology and information

technology). Most banks and traditional lenders do not have a similar desk set up for environmental technology (FUNDETEC, 2008: 73).

3 Existing EU eco-innovation policy

3.1 Environmental Technologies Action Plan

In 2004, the European Commission launched the Environmental Technologies Action Plan (ETAP) to foster initiatives on environmental technologies and eco-innovations. The plan aims at promoting research, development and deployment, mobilize funds, drive demand and remove barriers to market developments. Important inputs to ETAP are the Sixth and Seventh RTD Research Framework Programme that allocate substantial resources for R&D. ETAP addresses the innovation cycle segregated into three areas 'Getting from research to market', 'Acting globally' and 'Improving market conditions'.

The ideas to improve market conditions include increasing the application green public procurement (GPP) and applying the market-based instruments that target economic incentives to promote the take-up of environmental technologies (European Commission, 2004b).

The purpose of ETAP is (re)focusing the efforts made both within the EU and within the Member States to improve the framework conditions for development and commercialisation of eco-innovations, including demand side instruments.

3.2 Lead Market Initiative

In 2006, following the EU's 2006 broad-based innovation strategy, the European Commission launched the Lead Market Initiative (LMI) for Europe. The LMI includes six lead markets:

- eHealth[2]
- Protective textiles[3]
- Sustainable construction

[2] The aim of eHealth is to deliver better care for less money within citizen-centred health (European Commission, 2007c).

[3] Protective textiles include clothing and other textile-based systems that aim at protecting the users from hazards and dangers in the conditions in which they operate (European Commission, 2007c).

- Recycling
- Bio-based products[4]
- Renewable energies[5]

The Lead Market Initiative aims at applying an array of demand-side policy instruments that work in synergy. The purpose is to break down barriers to innovative goods and services in the six lead market areas. The ultimate aim of the LMI is to give the industry the opportunity to develop the lead markets into world-wide leading products or services in new high-growth markets (http://ec.europa.eu/enterprise/leadmarket).

These six market segments provide solutions of broader strategic, societal, environmental and economic challenges. The lead market areas are highly innovative and respond to customers' needs. They have a strong technological and industrial base in Europe, and - compared to other markets - the growth in these markets depend on the creation of favourable framework conditions through public policy actions. A plan of actions for each of the six markets has been formulated for the next three to five years. The effect of strengthening these leading markets is expected to have positive impacts on growth and employment and an increased access to goods and services of high societal value (http://ec.europa.eu/enterprise/leadmarket).

The main policy instruments deployed by the LMI are:

Legislation	The LMI aims at developing legislation that avoids imposing burdens on innovative companies. By improving the coordination of regulations across different policy areas, the markets for innovative products and services can positively be affected.
Standardisation, labelling and certification	The setting up of more consistent technical, performance and product standards along the whole production chain, from raw materials to end products, can make standardisation more innovation-friendly.
Complementary instruments	In certain markets, other policy instruments are seen as necessary complements to help the development of lead markets. To facilitate the interaction of customers with the innovating companies financial support and incentives are sometime considered advantageous. This could include financial support such as Structural Funds and State aid schemes. (European Commission, 2007c)
Public procurement	Establishment of support networks for public procurement, to encourage greater procurement of innovation. This includes attempting to co-ordinate technical specifications to create greater consistent demand and technical dialogues with innovators and manufacturers about innovations.

[4] By bio-based products are understood products made from renewable, biological raw materials such as plants and trees (European Commission, 2007c).

[5] Renewable energy (RE) refers to energy derived from regenerative energy sources (wind, solar, biomass, biodegradable waste or feedstock, geothermal, wave, tidal and hydropower).

3.3 Pre-commercial procurement

To improve the application of public procurement as a policy instrument to drive R&D, the European Commission has presented the Member States with a innovative procurement concept called 'pre-commercial procurement' (PCP) (European Commission, 2006a; European Commission, 2007b). The kind of pre-commercial procurement discussed in the EU follows the US approach to public procurement known from the US multi-stage, multi-competitor R&D programmes. This involves forming groups of public procurers, to form a critical mass of demand and who share the risk (and reward) of developing and commercialising innovations which fit their needs. These programmes have not only been used in the defence sectors but also in other areas, such as energy, transport, health and in cross-sector Small Business Innovation Research Programmes (SBIR) (Edler & Georghious, 2007).

3.4 Technology Platforms

Under its Framework Programmes for Research, the European Commission has established more than 25 Technology Platforms. These bring together industry and stakeholders (notably research organisations and public authorities) to map out research leading to medium or long term needs. This includes dialogue to establish likely future markets for innovations, to target R&D. The platforms have been successful in discussing R&D allocation, and a primarily a supply-side instrument (IDEA Consult, 2008).

3.5 The match between actions under ETAP, LMI and the risks of commercialisation

The focus in the LMI is on strengthening the market uptake of innovations in the six lead markets through the use of demand-side policies. In the LMI, the applied policies are thought into a policy context also containing supply-side instruments, e.g. R&D funding, risk capital, fiscal measures, etc. The LMI is narrowly linked with ETAP, and draws on a range of the same policy instruments. The main difference is that LMI has a pronounced sector approach.

Both ETAP and the LMI address the risk reduction of the innovation processes. They support both the development of innovation and aim to support the markets for the innovation, in particular trying to bring about greater diffusion of innovations. The demand-side instruments have 3 strengths:

- Putting in place the economic conditions which create demand for innovation is essential for the success of innovation policy. If there is no demand, innovations will not be sold, and predictions of their failure will prevent development.

- Knowledge of existing market support is certainly a factor which encourages product developers to commercialise their innovations which match with that market support, as it is an indicator of a future market.

- The bringing together of public procurers into a dialogue with manufacturers may lead to greater exchange of information about potential markets and is likely to spread already commercialised innovations. The development of

greater knowledge of innovation procurement skills amongst public procurers is very important for increasing demand and uptake for innovations.

The existing EU innovation instruments may lack the ability to tackle the 'chicken and the egg' problem at the heart of blockages to commercialisation. In particular, the majority of instruments aim at the support of innovations which are already available on the market. There may be insufficient incentives in place for innovators to work with the public procurement networks – as their rewards for doing so, in terms of information about future markets or reward with support policies for commercialisation are not clear.

Support of development of environmental technologies must take in the best array of available instruments. The ETAP and LMI initiatives are contributing to the solving of various important aspects ranging from R&D subsidies to standardisation, green public procurement and the deployment of market incentives.

The supply-side orientated Technology Platforms have a wide mandate but have not achieved the link between innovators to potential buyers that would overcome hindrances to commercialisation. An August 2008 evaluation of the Technology Platforms noted that NGOs and end-users (i.e. consumers) have a small presence compared to the involvement of other stakeholders. Recommendation 9 of the evaluation indicates the supply-side focus, calling to strengthen the application of research results, by focusing not only on the development of the Single Research Area but also on the regulations and standards that affect the commercialisation of research (IDEA Consult, 2008).

As indicated in the next chapters, experience and organisations set up with the existing policy instruments would provide a good basis for a more effective, wider ranging demand-side innovation policy programme. This could easily fit into the existing Environmental Technologies Action Plan (ETAP).

3.6 Review of existing Demand-Side Innovation instruments

In 2009, the Commission is evaluating the implementation of ETAP (using a consortium consisting of ECORYS and COWI) (ECORYS/COWI, 2009), including a review of the demand-related challenges for innovation.

Progress with the Lead Markets Initiative is also being evaluated, to inform future measures and expansion of the initiative, with the review due to be published in the summer of 2009.

These evaluations present an opportunity for EU demand-side innovation to evolve to comprehensively tackle problems with commercialisation of eco-innovation.

4 Potential of innovation procurement policy to promote innovation

The economic rationale for interventionist policies are based on two main foundations: market and system failures (Edler & Georghiou, 2007: 952).

Development of new products is associated with risks - this also accounts for the development of environmental-friendly products. Product development risks become a social problem when products that potentially can lead to environmental and economic benefits are not developed due to market and system failures. Innovation policy should be designed to best mitigate such market and system failures.

Innovation procurement policy can be applied to mitigate these market and system failures – to bridge the 'Valley of Death' and overcome the 'chicken and the egg' problem of uncertain demand with the decision to commercialise. If the development of a new innovation is complex, time consuming and/or costly, and it is unsure whether the innovation process will succeed and/or there will be a commercial market for the innovation, the market might be unable to develop the innovation. The application of public policy related to procurement might be used in such cases to reduce the risks of the innovation process. The reduced risk may be the incentive private companies need in order to get engaged in innovation (Edler & Georghiou, 2007).

The nature of such market and system failures is quite sector and product specific. The Danish company H2 Logic is a manufacturer of hydrogen cell fuel motion power solutions. The costs related to the production of a series of vehicles powered with the hydrogen fuel cell technology are extremely high. The way to further develop the technology is to scale up the production volume. The next generations of fuel cells could be produced in larger series (up to around 500 examples). The testing and further development of the product in this phase is extremely risky. The manufacturing of such a number of products is very expensive, and the products might not work satisfactorily. The higher price is due to the lack of harvest economies of scale (see section 5.8.1).

The uncertainty of the market demand for environmental beneficial technologies has proved to be a major barrier to the development and commercialisation of energy-efficient appliances. Gustavsberg, a large Swedish manufacturer of sanitary installations, had a product idea for development of an energy-efficient water mixer. The development of the product was not initiated before the Swedish National Energy Administration (STEM) investigated in the potential

market demand for energy-efficient water mixers and organised a technology procurement contest (se section 5.2.1).

Innovation procurement policy for potential environmental-friendly innovations is to a wide extent tackling the same structural problems as general public technology procurement policy. The experiences of innovation procurement policies that do not have an environmental goal can be used to understand the framework conditions for procurement policy for eco-innovations. However, investments in eco-innovation do not only lead to environmental growth, eco-innovations are tackling environmental externalities as well, which contribute to greater societal benefits.

A way to understand in which sectors innovation procurement policy could be an appropriate policy instrument to drive commercialisation of innovation is to investigate the potential risk profile of potential innovations. The public procurement could then be designed to mitigate the area where the development to commercialisation of innovation is so risky to the company that it is unlikely that the innovation would take place without public support and/or the development and dissemination of technology would be considerably sped up.

This raises the question: what is the acceptable risk of failure? Whether in a specific case to apply this policy instrument should rely on cost-efficiency considerations, and the resources should be applied where the chance of success is high.

The discussion here focuses on products which are aimed at final users, or consumers, rather than technical goods for industrial processes.

4.1 Categorising procurement policy

There are many forms of public policy on procurement having an influence on innovation. To be clear on the differences between these, it is helpful to categorise them based on: the market availability of the innovation, and the degree of purchasing by public bodies.

4.1.1 State of the market

Edler et al (2005) distinguish between three different roles that procurement policy can play in relation to the market: initiation, escalation and consolidation.

Market initiation

Market creation takes place when there is not yet a market for the innovation following its development. The development of the Internet is an example of market initiation. There was no direct market for the Internet when the US defence industry developed the Internet technology for internal purposes. The development of commercial application of the Internet technology took many years.

Market escalation

Market escalation occurs when a market exists for a new or alternative technology, but the technology has to be developed further in order to succeed com-

mercially. A range of examples of cooperative public procurement of energy-efficient office equipment falls into this category.

Market consolidation

Market consolidation takes place "where technical standards or performance criteria are standardised in order to coordinate and concentrate demand within the public sector, establishing 'critical' mass for the acceptance of new or alternative technologies and leading eventually to similar developments with respect to the patterning of private demand." (Edler et al; 2005: 19).

Procurement of innovation - market initiation - differs fundamentally from procurement of 'on the shelf'-products, e.g. pencils, paper, etc.; as such products do not need to be further developed to be used.

For example, in green public procurement a public purchaser can choose a more environmental-friendly product between various available products. If the policy aims at the market penetration of an environmental-friendly product that does not yet exist, it is far more complicated. To name a few of the potential problems: the desired output has to be defined, there may be various potential technological trajectories to be followed, the products have to be innovated, etc. All these processes involve different types of risks of failure.

4.1.2 Who will buy?

Innovation procurement policy supporting innovation can be divided into three categories, direct procurement, cooperative procurement and catalytic procurement, depending on who is going to buy the commercialised innovations.

Direct procurement

Direct procurement is the type of procurement, where the public procurement body purchases the innovation to meet internal needs. Defence-related innovations or the acquisition of public transport technologies, e.g. high-speed trains, are examples of direct procurement (Edler et al, 2005: 16).

Cooperative procurement

Cooperative procurement takes place when public authorities buy jointly with private purchasers. Cooperative procurement is often intended to develop a new market for the product (Edler et al, 2005: 16). An example of this kind of procurement is the procurement of energy-efficient lighting systems in Hamburg where the procured systems was used both by the public sector and private companies (see section 5.5.1).

Catalytic procurement

By catalytic procurement is understood procurement of innovations, where a state or public sector actor is involved or even initiates the development of a technology, but the innovation is in the end exclusively used by private end-users.

In direct procurement, public procurement is used as a policy strategy to fulfil the public purchaser's internal needs, whereas catalytic procurement aims at driving R&D to develop innovation exclusively for the private market sector. In cooperative procurement the innovation is developed to meet the needs of both the public and the private sectors.

4.2 Different forms of procurement of innovation policy already applied

4.2.1 Direct procurement

There is a wide range of examples of public technology procurement. According to Geroski (1990), electronic devices and systems, nuclear power, synthetic materials and new chemical products - and engines and transport equipment are sectors were public procurement policies have had a significance for technological innovation. Some of the most well-documented cases of successful procurement of innovations are known from the US, e.g. the development of the computer, civilian aircraft and the semi-conductor industries (Geroski, 1990; Edquist et al, 2000). In these cases, the defence-related governmental procurement is seen as the direct cause to development of technologies that later have reached successful commercialisation in the private sector.

At the stage where the innovations were initiated through public procurement, there was no private market demand for such technologies, and the risk of developing the innovations were primarily taken by the governmental purchaser. The purposes of the procurement of these technologies were to meet public needs, and it was first much later that private sector spin-off led to a successful commercial penetration into the private market (Geroski, 1990). However, it is far from always that defence-related public procurement of innovation lead to successful civil sector spin-off. On the contrary, the civil sector commercial spin-off from the defence sector has shown to be rather limited compared to the amount of money spend on R&D in the defence sector (Geroski, 1990, Alic et al, 1992).

The most frequently used arguments in favour of public technology procurement refer primarily to certain characteristics of demand: strategic importance, largeness of scale, high risks and high costs (Edquist et al, 2000: 14). Edler et al (2005) accentuate the following five characteristics of the State as a powerful purchaser:

Public demand

The State is often demanding innovative solutions to needs, and the State is often a lead user of technologies on the market. The lead user gets an advantage from using the new innovation before others, but also takes a risk with respect to adjusting to the new technology and encountering problems and errors of the innovation (Dalpé et al, 1992; Dalpé, 1994).

Bearing higher entry costs

The State is more frequently willing or able to pay a higher price in the beginning of the innovation life-cycle. Governmental procurers are often putting more emphasis on quality than on price. Insisting on high standards provide firms with the incentives and financial support they need (Geroski, 1990: 189).

Critical mass

The magnitude of the State's demand can reach a 'critical mass' buy bundling the needs of different governmental bodies. Critical mass can also be achieved by bundling the needs of public and private bodies. Critical mass can constitute an important market that significantly decreases the risks of private companies and therefore improves their incentive. In this way, the public procurer ensures a market when commercial possibilities at best are risky.

Visibility and signalling

The governmental demand for innovative products sends strong signals to private users. This often leads to a higher impulse of diffusion than private demand.

Linking innovation to production

Public procurement does not only support the development of new products and services but also develop the manufacturing expertise needed to produce the product efficiently. The development of innovations involves a learning period where mistakes are made. This period constitutes an 'externality' - a market failure - that all users benefit from, but all have an interest to free-ride on (Geroski, 1990: 189).

To sum up, the potential of public procurement for driving innovation is related to the special nature of public demand, where the state can mitigate some market failures and speed up innovative processes.

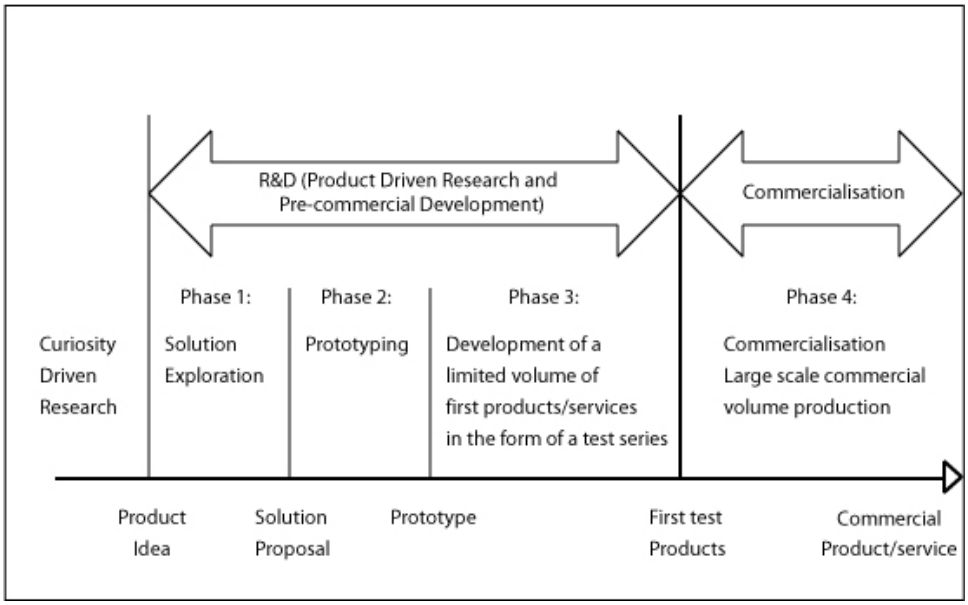
4.2.2 Pre-commercial procurement

Pre-commercial procurement (PCP) addresses the R&D phases of innovations that occur prior to commercialisation. It is usually a specific form of direct procurement for market initiations, with public bodies as the buyer. The concept of PCP is based on a linear understanding of the innovation process, shown in Figure 4.1 overleaf.

In the model, the pre-commercial development phases involving R&D are divided into three phases: solution exploration, prototyping and development of the first products/services in the form of test series. The fourth phase of innovation involves commercialisation of the product/service by large-scale commercial production of the innovation. PCP only covers R&D of the first three phases of the innovation. PCP targets innovation of products/services where further R&D has to be done in order to commercialize the innovation (Edler & Georghious, 2007). Hence, PCP does not involve commercial development activities such as establishing commercial viability of the innovation.

The purpose of PCP is simultaneously to drive innovative R&D and to ensure development of products and services for the public sector that outperform the available technologies on the market (European Commission, 2007b). PCP is designed in accordance with the new EU directives on public procurement. PCP is set up as joint development ventures between the public purchaser and supplying companies. It is a prerequisite that the public procurement of innovation does not take form as direct State aid.

Figure 4.1 Model for the development of innovations



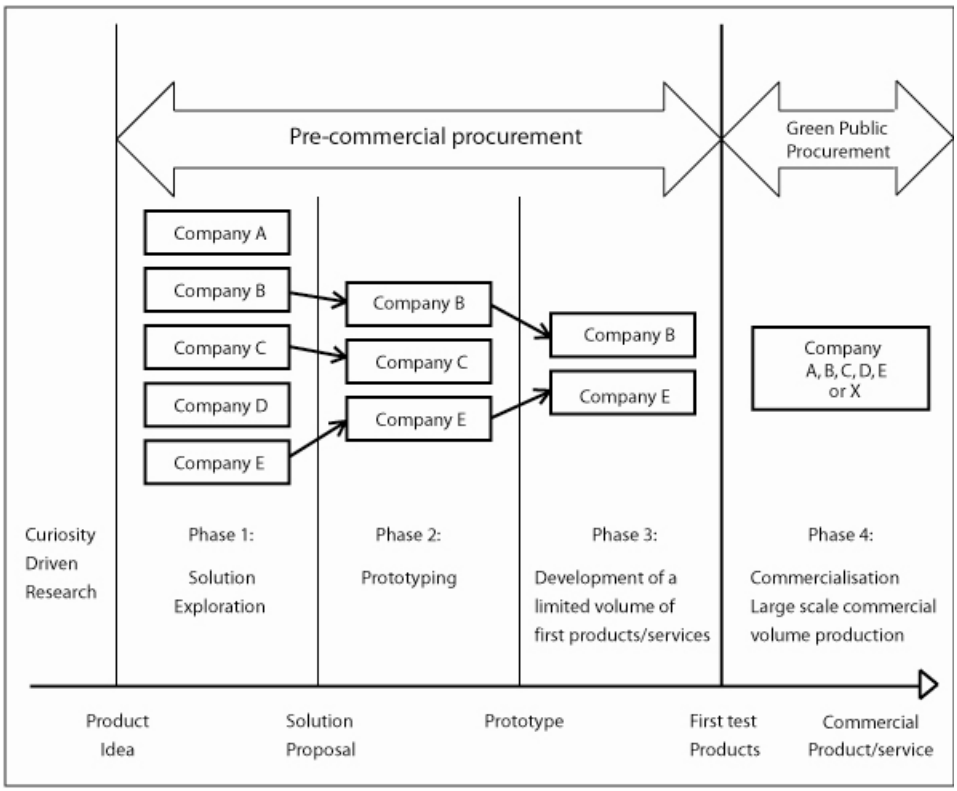
Source: European Commission (2006a; 2007b).

The risk sharing between the public procurer and the supplier must take place under market conditions and the procured product/service may not be acquired at higher costs than the market level. Moreover, the procurement process must be organised in a way "that ensures maximum competition, transparency, openness, fairness and pricing at market conditions [and] enables the public purchaser to identify the best possible solutions the market can offer." (European Commission, 2007b).

To ensure such a fair competitive process, PCP is designed to take in multiple tenders.

Figure 4.2 shows a model for the tendering process of PCP. In phase 1 of the innovation process, a range of tenders is invited in competition to develop the best solutions of a specified problem. Before continuing to the second phase an intermediate evaluation of the proposed solutions is made. The most promising solutions are developed further in phase 2. Phase 2 leads to development of prototypes of the innovation. A new intermediate evaluation takes place, where new contracts are set up with at least two companies to develop a limited volume of first products/series in the form of a test series. Based on the findings of the R&D process of the innovation, both the companies involved as well as those not involved in the innovation process may participate in the commercialisation of the innovation, and public procurement of the innovation may eventually take place. However, the commercialisation of the innovation is beyond the pre-commercial phase of the innovation development.

Figure 4.2 Model of R&D in pre-commercial procurement



Source: European Commission (2006a; 2007b).

PCP is based on the following principles:

- The idea of using multiple tenders aims at ensuring an open and competitive procurement process where several different innovative trajectories may be explored.

- The public purchaser and the involved companies can learn from exploring alternative solutions and comparing the pros and cons of the individual solutions.

- The procurement process is organised as a stepwise process, where the results of the R&D is evaluated after each phase. This allows the public purchaser to steer the development to best fit the public sector's needs.

- After each phase, the alternative solutions can be assessed in order to achieve interoperability and product inter-changeability. Based on the alternative solutions, standards may be developed relatively early in the innovation life-cycle. This decreases the supplying companies' risks of having to make the innovation compliant with standards defined afterwards.

- By retaining at least two companies until the last phase, the future competitiveness of the market can be ensured. The general idea is that a positive competitive pressure enables the public purchaser to choose "the best solution the market can offer while avoiding single supplier lock-in." (European Commission, 2007b: 9).

The economic rationale behind following several different innovative solutions is that companies innovating in a competitive environment are more likely to have success on a global market and that they are better prepared to attract external investments. Moreover, R&D of alternative solutions may in a short-term perspective entail higher investments, but in the long run, the quality/price ratio and the success rate of the development process is expected to be higher (European Commission, 2007b).

PCP is based on the sharing of risks and benefits between the public procurer and the supplier. In some cases, the public procurer may have special needs for reserving all rights and benefits of the procurement, including Intellectual Property Rights (IPR). This may be the case if the research concerns national security or if the public procurer is the only interested customer. However, in most cases the public procurer is believed to be better off, if the commercial exploitation of the research results is shared between the public procurer and the supplier (European Commission, 2007b). If the supplying company has to abstain from the rights to commercial exploitation of the R&D it conducts, the company has to be compensated financially. Thus, acquiring such property rights entails high costs. A solution can be that the suppliers get 100% ownership of IPR and that the governmental procurer has a license-free use of the innovation.

Contracts are set up with fixed prices for the activities covered by each of the three phases. If a company have more costs than is covered by the contract, the company must cover the excess costs. Further risks to the suppliers are that the public procurer after each phase can modify the R&D requirements for the next phase or even entirely stop the process. Moreover, the supplying companies take the risk of sharing their business plan for commercialising the innovated products and solutions. (European Commission, 2006a)

Other benefits for the involved companies can be to allow the suppliers to use the results from the R&D they have conducted to commercialise new products/services.

4.2.3 Pros and cons of pre-commercial procurement

The concept of PCP has some unambiguous advantages to grasp some of the potential limits of public technology procurement. Potential mismanagement of the industrial structure is avoided by ensuring an open and transparent tendering process with fair competition between multiple tenders. The contracts are based on functional specification, which opens up the possibilities for achieving multiple innovative solutions and potentially different application of the basic technical opportunities. On the other hand, the functional specification entails the need for the procurer to have in-depth knowledge of the market to evaluate and choose among the proposed solutions.

Dividing the tendering process into multiple phases ensures the possibility of steering the development of the innovation in a direction that meets the public purchaser's needs. This is a mechanism that helps secure good targeting of the innovation development. The multi-competitor model ensures that the innovation takes place in a sound, competitive environment. But by reducing the

number of tendering companies phase by phase, the companies that are excluded from the 'competition' may in the end lose potential gains from the innovation process. As all involved companies have to share the risks with the public procurer, the companies run a risk by taking part in the innovation process. The actual level of risk depends on how the contracts are formulated. And it should be settled which gains the firms may obtain if they are rolled out. However, no involved companies are guarantied the final contract for commercial production of the innovation. The PCP aims at a long-term commitment to the innovation programme, but the involved firms are not secured such a long-term commitment.

A built-in risk in the multi-tender approach is that there is a waste/excess of innovation. The abandoned solutions constitute an expense to the procurer. However, if the solutions are inferior, it may be contemplated as a necessary cost. The missing link between the pre-commercial and the commercial phase of the innovation-cycle constitutes another potential problem of the PCP model. If a significant part of the risk is combined with the commercialisation of the innovation, this may constitute a significant obstacle to the innovation process. Standardization - either formal or informal - testing and certification are areas where there is a considerable amount of risk. If these risk matters are not settled in the pre-commercial phase of the innovation, they may constitute a major risk to the procurement process. As there is a limit in the PCP to the risk that the governmental procurer can take, the potential gain from public procurement may be limited. Companies may be reluctant to take a significant part of the risk in the early phase of innovation processes, if there is not a promising market for the product.

4.2.4 Technology procurement

In Sweden, governmental agencies facilitate *catalytic procurement*. During the 1990s, the governmental agency NUTEK[6] (the Swedish Board for Industrial and Technical Development) initiated development of innovations in energy-efficient technologies (Neij, 1999). Similar procurement programmes for development of energy-efficient products have been launched in the US and by the International Energy Agency (IEA) (see section 5.1).

These technology procurement policy programmes aim at market transformation, the purpose is to bring new environmental-friendly products to the market *and* to ensure a market uptake of these products. The public sector's role as direct procurer is limited; on the other hand, the public sector plays a central role in facilitating the innovation process.

A public agency participates in the initiation of the product development by bringing together relevant stakeholders from the industry, research communities and potential buyers. Stakeholders cooperate on developing product performance requirements.

[6]The programme was taken over by STEM (The Swedish National Energy Administration) in 1998 (Edquist et al, 2000: 22).

Technology procurement programmes draw upon a broad range of instruments. The technology procurement is typically made as a bidding contest, where the winning bet gets a prize. The prize may contain a third party evaluation of product performance, public information and awareness campaigns accentuating the environmental virtues of the product, demonstration facilities, sales support for the product, etc. (see chapter 5).

4.3 Status of work on innovation procurement policy in EU

An array of studies has been conducted on the potential of applying public procurement to stimulate innovation in the EU. These efforts have, however, only to a limited degree resulted in practical projects of application of public procurement for innovation. This is especially the case within the environmental area. These reports have almost exclusively focussed on direct procurement, with much less consideration of catalytic procurement.

In 2004, a reviewing report was prepared to investigate the progress of the Lisbon strategy. The study was conducted by a High Level Group, chaired by Wim Kok, hence the report is known as the 'Kok Report'. The group recommended the European Commission to look into ways to use public procurement to provide markets for research and innovation intensive services and products (Kok et al, 2004: 21).

In 2004, new EU directives regarding public procurement (Directives 2004/17/EC and 2004/18/EC) were adopted. The directives opened the opportunities for technical and competitive dialogues between public procurers and potential suppliers of new technologies.

In 2005, the European Council made a mid-term review of the Lisbon strategy. The Council concluded that the results were mixed; alongside undeniable progress were shortcomings and delays. In order to re-launch the Lisbon strategy, Member States were called to refocus on public procurement as a mean to develop innovative products and services (European Council, 2005).

In September 2005, an expert group chaired by Rosa Wilkinson issued the European Commission with a report exploring options for good practice and policy in procurement for innovation. The expert group came up with a range of recommendations, including the recommendation that the European Commission and the Member States should set up systems to review the implementation of the new procurement directives and evaluate the effects of policies and practices for procurement of innovation. Moreover, public procurers should be issued with the necessary capabilities to ensure procurement that drives innovation (Wilkinson et al, 2005).

The European Commission had financed an additional research group to make a review of the experience on public procurement for innovation. Based on a literature review and investigation of nine case studies, in December 2005, the group provided recommendations for how to promote public procurement for innovation. The research group's conclusions concerned, among other things, experiences on tendering and negotiation processes, necessary structural condi-

tions (e.g. close cooperation between the end-users and the procurers of innovation) and needed capabilities of the procurers (e.g. intelligence gathering on the innovation market and knowledge on risk sharing) (Edler et al, 2005).

Ahead of the 2006 Spring European Council, the European Commission established an expert group, chaired by Esko Aho, to provide the Commission with advices and recommendations on how to accelerate the implementation of the revised Lisbon strategy. The expert group concluded in the so called 'Aho Report' that the lack of an innovation-friendly market for businesses was the main barrier to investments in research and innovation. According to this group, an innovation-friendly market could be provided through actions on harmonised regulation, ambitious use of standards, driving demand through public procurement, a competitive intellectual property right regime and by fostering a culture that celebrates innovations (Aho et al, 2006; Edler & Georgious, 2007). The expert group stressed the importance of utilising the new opportunities given in the procurement directives to drive innovation (Aho et al, 2006).

In spring 2006, the European Council widely endorsed the Aho Report's recommendations. The Council stated that a comprehensive approach to innovation policy could be achieved by supporting markets for innovative goods and services, hereunder through research in ICTs and eco-innovations (European Council, 2006: 6; Edler & Georgious, 2007).

A working group on public procurement in support of ICT research and innovation published a report on the subject in March 2006. Inspired by experiences of pre-commercial procurement from other parts of the world, primarily the US, the working group established a model for pre-commercial procurement taking into account innovation and market related conditions (European Commission, 2006a). The working group recommended the European Commission to provide a best practice on pre-commercial procurement for innovation.

In September 2006, the European Commission launched a strategic innovation paper encouraging Member States to stimulate innovation through public procurement. Pre-commercial procurement was referred to a as an untapped opportunity for authorities in the EU (European Commission, 2006b).

Based on the conclusions provided by the above-mentioned expert groups, in the spring of 2007, the European Commission released a guide on innovative solutions in public procurement - also known as the handbook on public procurement for innovation (Edler & Georgious, 2007). The guide describes 10 elements of good practice dealing with public procurement for innovation (European Commission, 2007a).

In December 2007, the European Commission addressed pre-commercial procurement in a Communication as a means to reinforce the innovation capabilities of EU. The Communication addressed the need for more innovation in the public sector, and pre-commercial procurement was suggested as a promising means. The Communication was based on the model for pre-commercial procurement proposed by the working group on public procurement in support of ICT research and innovation (European Commission, 2007b).

In spring 2008, a study on opportunities for public technology procurement in the ICT-related sectors was conducted by Rambøll Management. It was concluded that public technology procurement constitutes a potential in the ICT-related sectors, and that the application of the pre-commercial procurement methodology probable is suitable for the ICT-related sectors (Rambøll, 2008).

In a resent evaluation of the Swedish strategies and initiatives for promotion of environmental technology it is recommended to draw upon the Swedish experiences for technology and innovation procurement setting up new procurement and innovation procurement schemes on an EU level. Clear ambitions and goals should be formulated and the needed resources should be allocated in order to increase the rate of development (Swentec 2008).

4.4 Discussion of potential for innovation procurement policy for products

This report investigated the potential to apply wider innovation procurement policy that goes beyond (but expands upon) the direct and pre-commercial public procurement policy currently applied in the EU.

The characteristics of the investigated products and the markets on which the products can be sold differ significantly from sector to sector. The role that innovation procurement policy can play also differs. Table 4.1 provides an overview of companies, products and market characteristics of the investigated products and the main risks the companies face developing such products.

The companies are analysed according to size. The products are analysed with respect to technological complexity and the need for technological changes. The market is analysed with respect to potential size, potential for public procurement and extent of regulation. The characteristics of the risks faced by the product developer are also analysed.

4.4.1 Scaling up of the product

The technological complexity of the investigated products in the transport sector is on a multiple system level. Fuel cells, Lithium-ion batteries and electric motors have to fit into vehicles. Today, these products are at an advanced level where functional prototypes have been constructed. The major challenge to companies, such as H2 Logic, Think and e-Traction, is the testing and maturing of the products for commercialisation. The scaling-up of the technology constitutes a huge risk to the companies as the technologies have to be tested in larger series (100-500 products) under real life conditions. The scaling-up of products particularly constitutes a risk to SMEs as the scaling-up of product series is extremely costly and therefore requires large investments.

Table 4.1 Company, product and market characteristics for potential application of innovation policies

		Company characteristics		Product characteristics		Market characteristics			Need for mitigation of risks			
Sector	**Product type**	**Name**	**Size**	**Technological complexity**	**Needed techno-logical changes**	**Potential size**	**PP poten-tial**	**Regul ation**	**Scal-ing-up**	**Market uptake**	**R&D**	**Other**
Transport	Hydrogen pow-ered fuel cell	H2 Logic	SME	Multiple system	Testing, maturing	Large	High, indi-rect	Medium	X			
	Electric car	Think	SME	Multiple system	Testing, maturing	Large	Low, direct	Medium	X			
	Electric motors	e-Traction	SME	Multiple system	Testing, maturing	Large	High, indi-rect	Medium	X			
	City buses	More manufac-turers[a]	Large	Multiple system	Ranging from Incremental to testing, maturing	Large	High, di-rect/indirect	Medium		X		
	Cars	More manufac-turers[b]	Large	Multiple system	Ranging from Incremental to testing, maturing	Large	Low, direct	Medium		X		
WW	Environmental biotechnology	Paques	Large	Multiple system	Ranging from Incremental to testing, maturing	Large	High, direct	Medium	X	X		
WE	Wave energy converter	Wave Dragon	SME	Multiple system	Testing, maturing	Large	High, direct	Medium	X			Hazards
CS	Substitution of DEHP	Danisco	Large	Single compo-nent	Incremental	Large	High, indi-rect	Large		X		Approval
HC	Health care products	Coloplast	Large	Single compo-nent	Initial develop-ment	Large	High, direct	Large		X		Approval
EE	Energy-efficient circulator pumps	Grundfos	Large	Single compo-nent	None	Large	High, indi-rect	Low		X		

Note: CS: Chemical sector. CP: Component. HC: Health care. PP: Public procurement. SE: Sustainable energy. WW: Wastewater.

Note: a: Mercedes-Benz Buses, Volvo Buses and Scania Buses. b: SAAB, Toyota and Honda.

The purpose of such testing is to correct possible errors of the products. The products can in this phase of the development be sold on pre-commercial terms, i.e. the product is sold under special terms, where the buyer takes a part of the risk of having a new and not finally tested product. The buyer must be willing to pay a higher unit price for a clean car than for the price of a traditional vehicle, and the buyer must be willing to accept higher service needs and potential temporary product malfunctions.

In 2008, the City of Copenhagen signed a contract with H2 Logic on delivery of 15 hydrogen fuel cell powered vehicles (two utility vehicles and 13 cars). The total investment, including a 3 year warranty and service agreement amounts to DKK 11.5 million. (EUR 1.54 million). The vehicles are to be used in different departments of the City of Copenhagen for a wide range of purposes. The purchase of 15 hydrogen fuel cell powered vehicles and the establishment of a hydrogen filling station in central Copenhagen, as part of the project, will inevitably help facilitate the future establishment of a pan-Scandinavian hydrogen infrastructure. Moreover, purchasing hydrogen powered vehicles is part of the City of Copenhagen's Climate Abatement Action Plan. The cars and the filling station will be demonstrated and displayed during the COP15[7] in December 2009 to show that the City of Copenhagen is actively making efforts to reduce GHG emissions (Casper Harboe, 26 February 2009).

The case of the City of Copenhagen shows that when a public authority takes the risk of purchasing a product potentially performing (e.g. in terms of transport) lower than other products on the market it is to support the development of technology, to make environmental commitments and to get positive public attention.

The large car and bus manufactures face the same problems of scaling up products in the development of new vehicles. In contrast to the above-mentioned small companies, the large companies in the automotive industry have the financial means to make the investments. For the large manufacturers the highest risk is that of being able to sell the commercial product.

The scaling-up of products is also seen as a major risk to the companies, such as Wave Dragon and Paques. These two companies develop products involving extremely costly product testing. Consequently, the companies cannot afford failures on the way from the pilot phase to full-scale commercial projects.

By way of example, the change of technological trajectory towards circulator pumps based on permanent magnet motors did constitute a considerable risk for Grundfos as the new pumping technology was not mature, and technological development did not only have to take place in Grundfos but also with Grundfos' suppliers.

The risk of the scaling-up of products applies to products where the unit production costs for production of the first series of units are high. Larger companies can easier handle such kind of risks than smaller companies. For smaller companies the pre-commercial sale of limited series of their products under

[7] The COP15 conference is the fifteenth Conference of the Parties under the United Nations' Climate Change Convention. The conference will take place in December 2009.

special terms would help mitigate some of the largest risks that these companies are facing. Though, the scaling-up might also constitute a major risk for larger companies as the cases of Paques reflect.

4.4.2 Uncertain markets

Uncertainties about the market uptake of new environmental friendly products are stated as the main risk by most of the large companies interviewed. The development of new cars and buses are extremely costly. The innovation among large bus manufacturers is highly influenced by customer demand, and in order to commercialise buses powered by alternative energy sources, the companies have to be sure that there is a market for the products. The same accounts for buses with lower NO_x emissions. The large car manufacturers are all involved in the development of alternatively powered vehicles. To speed up eco-innovation in the industry, guaranteed markets for a large volume of vehicles would be needed.

In order for Coloplast to develop environmental-friendlier products, they need a customer for the product. Guaranteed sales would also here play an important role. Initial sales on the market also play an important role for Danisco. The new environmental friendly product Soft-N-Safe that the company has developed has a slightly different functionality than the traditional DEHP contained products. The initial sales of the product can help to ensure the rest of the market of the qualities of the products. Thus, the demonstration to the market that the product is a quality product is crucial for the later market uptake of the product as the market is held back by the other buyer's inertia/risk aversion. When the product is accepted by the market as a quality product competitive with traditional products, the demand for the product will increase. The initial buy of a volume of products may be of huge importance to the future market uptake of the product.

Grundfos states that a cash rebate scheme for energy-efficient circulator pumps could have helped achieve an earlier market penetration of the energy-efficient pump.

4.4.3 R&D

The interviewed companies have all been involved in development of eco-innovations. The companies have all been able to develop prototypes of their products. Considerable costs are associated with the R&D and construction of prototypes. However, the companies do not express a need for better support in these innovation phases. A range of R&D subsidies are available, and combined with internal and external funding, the companies have been able to bring the products to the prototype phase. Many of the smaller companies have primarily relied upon national funding as it can be hard for small companies to overcome the bureaucratic requirements associated with getting access to EU funding.

As the interviewed companies have been selected because they *have* manufactured prototypes of their products, there is a bias in the investigation. Other

companies might have experienced a lack of opportunity for getting R&D subsidies.

4.4.4 Other Risks

Danisco and Coloplast are manufacturing products to highly regulated sectors. Replacement of one component with a less hazardous one is not easily done in the development of health care products. Such substitution entails comprehensive studies and testing that is time-consuming and very costly. It is therefore not realistic to substitute components in existing products. New products brought to the market could principally include less hazardous components. New products developed by Dansico have to be approved by the EU. This is also a time-consuming and costly process. The long lead time on the product development, the costs connected with the approval and the risks of not being approved constitute considerable risks to the company.

Wave Dragon is confronted with a high risk on installation of their plants. The risk of wreckage of the plant due to storms and hurricanes constitutes a considerable risk to the company.

4.4.5 Potential of innovation procurement policy

The areas where the public procurement plays a direct role, bundling of public agents demand can be used to drive innovation. With respect to the city bus sector public authorities have already used the procuring power to set up performance requirements for new buses, which have been driving bus innovation towards lower emissions and higher fuel efficiency. In areas where the public procurement indirectly plays an important role, e.g. where the public transportation is outsourced to private or semi-private bus operators, the public sector can put up performance requirements to their suppliers for the products it procurers. These requirements can be formulated in such a way that a certain degree of innovation is needed to bring new products to the market. Risks associated with lack of guaranteed sales can be addressed in this way.

Attention should be directed towards areas where special risks are connected with the development of new products, e.g. due to comprehensive regulation or hazards of force majeure. Here, the public sector might help the companies by taking a part of the risk. However, the public authorities should carefully consider the potential social gains of bringing the products to the market versus the extended risks to the public sector.

In the conducted study, no companies have pointed against the need of further mitigation of risks in the R&D and prototyping phases.

Sharing intellectual property rights

The companies develop products to sell them on large markets. The intellectual property rights of the developed products are the basis for the companies to commercially exploit the innovation. There is therefore no interest among the interviewed companies in sharing the intellectual property rights (IPR) on the developed products.

The share of IPR is a crucial part of the pre-commercial procurement methodology suggested by the European Commission (see section 4.2.2). In cases were the public sector desires the development of a product for which there is a limited or very uncertain market, the sharing of IPR might be a useful way to share costs and potential benefits. However, the interviewed companies all point against the potential market - either a large market or a promising niche market - as the main driver to participate in innovation procurement projects. The companies will only participate in such projects if they are convinced that there is a potentially lucrative market for the product. In order to exploit these potential markets, the companies must have the exclusive IPR of their products. Without the IPR they are not interested in participating in the projects.

4.5 Areas where application of innovation procurement policy is likely to lead to benefits

Various approaches can be applied to spur innovation through innovation procurement policy. 'Innovation procurement' is in this connection understood as procurement of products currently in pre-commercial phases. Innovation procurement thereby differs fundamentally from commercial procurement, where products exist on the market. Innovation procurement policy constitutes a basket of potential policy instruments where an actual innovation procurement project is organised towards a specific goal taking in the necessary means.

Importance of public market compared to private market

When identifying where to apply innovation procurement, the first important question to rise is the importance of the public and private markets. In some sectors, e.g. the city bus sector, the demand for public procurement makes up an important share of the market. With respect to other products as white appliances public procurement constitutes a very limited share of the market.

Market potential through buyer groups

Experiences from a range of technology procurement programmes show that many product manufactures are very interested in participating in innovation procurement programmes where the companies have to cope with technical specification for environmental-friendly products. Decisive for the companies' willingness to participate is the market prospect of the products. The federation of potential users or buyers through the establishment of buyer groups consisting of both public and private buyers is seen by the manufacturers as a kind of assurance of a potential market, and the buyer group is involved in the formulation of the technical specification of the products. The buyer group's composition should reflect the large potential buyers on the market.

The purpose of using innovation procurement could exclusively be to meet public sector needs. Examples of this kind of procurement are well known from the defence sector, but it is also used to development of high-speed trains and computer programmes. Potential application of innovation procurement to fulfil environmental goals exists within product groups and markets with both public and private buyers. The focus of the procurement should therefore be how to get products on a commercial market. The following analysis therefore takes as its starting point the social desire for bringing new environmental-friendly products to the market *and* to ensure a market uptake of these products.

Mitigation of risk

Policy instruments can be applied to bring a new environmental-friendly product to the market but if the product has a low market penetration, there will be almost no social gains from the product. To ensure both the introduction of the product on the market and the market uptake of the product, the manufactures of the products have to have proper incentives to carry out the development and commercialisation of the product. To understand how such incentive structures in companies work, the study focus has been on understanding and identifying risks associated with development and commercialisation of products within the manufacturing companies. By identifying the risks the companies face, the appropriate policy measures can be used in order to help these companies mitigate such risks.

For some companies (e.g. H2 Locic and Think Global) the highest risks are associated with scaling up product series. For other companies (e.g. Danisco, Coloplast, Electrolux, Gustavsberg , Scania, Volvo and Mercedes Buses) the risks associated with developing new environmental friendly products are related to uncertainties of market demand. Some companies (e.g. Danisco and Coloplast), moreover face risks associated with product approval.

It is concluded that the best way to use innovation procurement policy is by identifying the risks associated with certain product and market characteristics and the application of proper policy measures to mitigate these risks. Innovation procurement policy is likely to be successful if it is possible to mitigate the risks that restrain companies from producing environmental-friendly products or by speeding up the market introduction of these products. It can not be too clearly stressed that innovation procurement policy should not be understood as a fixed approach used the same way with respect to all types of products. On the contrary, innovation procurement policy should be seen as a flexible approach to innovation that is tailored to the specific type of product.

In Table 4.2 and Table 4.3 the products investigated in this report are analysed with respect to company size of product developer, product characteristics, technological complexity, needed technological changes and applied/suggested policy instruments.

- Technological complexity varies from single component (e.g. an electric motor) to multiple systems (e.g. control and monitoring systems). Where the technological complexity is high, there is more comprehensive demand for integration of single components.

- The needed technological changes address the technological development required in order to develop the product. The needed technological changes vary from initial development (e.g. healthcare products) to incremental changes (e.g. most energy-efficient applications).

- The market characteristics are analysed with respect to the potential for public procurement. In some markets the public sector constitutes an important share of the market. The public procurement potential is here high and direct. In other product markets the public sector does not constitute a large market share, but still may play an important role in pushing the product development. This is stated as an 'indirect' market potential.

- For the products that have been developed the policy instruments that were used to support the development and market uptake of the product are analysed. For products that could be developed the policy instrument that would support the development and market uptake of the product are analysed.

Sectors

The cases included in this report, where approaches to innovation procurement policy *have* been applied in order to achieve environmental goals are: white appliances (energy-efficient refrigerators, ovens, washing machines and tumble driers), components (high-efficient motors), housing (energy-efficient water mixer), office blocks (control and monitoring systems, sun shading technology and lighting system) and public transportation (hydrogen buses). Some of the projects have entailed a market transformation with a market uptake of the new product. In other cases, market penetration has been modest and in some cases sales have been very low. Compared to the anticipated sales, not all projects have been successful. There are many risks of failure associated with these kinds of programmes and projects that have led to inadequate sales can not easily be judged as failure projects. Lack of support of bringing the product to the market or bad timing has an important impact of the product's sales rates.

The product markets that have been investigated for *potential* application of innovation procurement policy are the transport sector (hydrogen powered fuel cell, electric car, electric motors, city buses and cars), wastewater treatment (environmental biotechnology), sustainable energy (wave energy converter), chemical components (DEHP-free component), healthcare products (e.g. ostomy or continence care products) and energy-efficient components (pumps). Except from wave power, there is a high potential in the investigated cases for application of innovation procurement.

Innovation procurement policy could constitute a considerable potential in all these product markets. For large car manufacturers innovation procurement policy will, however, not sufficiently mitigate high risks in the form of constituting a significant assistance in bringing new environmental-friendly products to the market and ensuring a market uptake of these products. With respect to the pumping technology, innovation procurement policy does not presently constitute a potential for driving further development of circulator pump technology. Grundfos' circulator pump technology is now a mature technology. On the other hand, Grundfos perceives that innovation procurement constitutes a potential for application of circulator pumps in larger systems, e.g. heat and air condition installations.

With respect to wave energy, the technology is not near commercialisation and a procurement contest project is not relevant. The public sector does in general not own power utilities and therefore cannot handle direct procurement of power.

Where innovation procurement policy does not constitute a potential for achieving environmental goals on a component level, it is important to investigate if innovation procurement could constitute a potential at the systems level where the product has to fit in with other technologies.

		Company charac.		Product characteristics		Market charac.	Applied policy instruments for technology procurement					
Sector	**Product type**	**Name**	**Size**	**Technological complexity**	**Needed tech. changes**	**PP potential**	**Techni-cal specs**	**Award of best product**	**Information spreading**	**Demonstra-tion project**	**Guaranteed markets**	**Sales rebate**
White Appliances	Refrigerator (SERP)	Whirlpool	Large	Single systems	Incremental	Low, direct	X	X	(X)			X
	Clothes washer	Sides Supply/ Frigidaire	Large	Single systems	None	Low, direct	X	X	X			
	Oven	Electrolux	Large	Single system	Incremental	Low, direct	X	X	(X)			
	Refrigerator (NUTEK)	Electrolux	Large	Single systems	Incremental	Low, direct	X	X	X		X	X
	Refrigerator (E+)	Electrolux	Large	Single systems	Incremental	Low, direct	X	X	X			
	Tumble drier	AEG	Large	Single systems	Incremental	Low, direct	X	X	X			X
CP	Motor	ABB	Large	Single compo-nent	Incremental	Low, direct	X	X	X			
BU	Water mixer	Gustavsberg	Large	Single compo-nent	Incremental	High, indirect	X	X	X			X
Office Blocks	Control and moni-toring systems	Larmia	SME	Multiple systems	Incremental	High, indirect	X	X	X	X		
	Sun shade technol-ogy	Sompfy	Large	Single system	Incremental	High, indirect	X	X	X	X		
	Lighting system	More suppli-ers	SME	Multiple systems	Incremental	High, direct	X				X	X
TP	Hydrogen powered buses	EvoBus	Large	Multiple systems	None	High, direct/ indirect	X		X			

Table 4.2 Applied instruments for technology procurement BU: Buildings, CP: Component, PP Public procurement TP: Transportation

		Company charac.		Product characteristics		Market charac.	Suggested policy instruments for innovation procurement					
Sector	**Product type**	**Name**	**Size**	**Technological complexity**	**Needed technological changes**	**PP potential**	**Technical specs**	**Award of best product**	**Inform. spreading**	**Purchasing of limited series**	**Guaranteed markets**	**Sales rebates**
Transport	Hydrogen powered fuel cell	H2 Logic	SME	Multiple system	Testing, maturing	High, indirect	X	X	X	X		
	Electric car	Think	SME	Multiple system	Testing, maturing	Low, direct	X	X	X	X		
	Electric motors	e-Traction	SME	Multiple system	Testing, maturing	High, indirect	X	X	X	X		
	City buses	Several manufacturers[a]	Large	Multiple system	Ranging from Incremental to testing, maturing	High, direct/indirect	X	X	X		X	
	Cars	Several manufacturers[b]	Large	Multiple system	Ranging from Incremental to testing, maturing	Low, direct	X	X	X		X	
WW	Environmental biotechnology	Paques	Large	Multiple system	Ranging from Incremental to testing, maturing	High, direct	X	X	X	X		
SE	Wave energy converter	Wave Dragon	SME	Multiple system	Testing, maturing	High, direct						
CS	Substitution of DEHP	Danisco	Large	Single component	Incremental	High, indirect	X	X	X		X	
HC	Health care products	Coloplast	Large	Single component	Initial development	High, direct	X	X	X		X	
CP	Energy-efficient circulator pumps	Grundfos	Large	Single component	None	High, indirect	(X)	(X)	(X)	(X)		(X)

Table 4.3 Suggested policy instruments applied to support innovation procurement of products

Note: CP: Component, CS: Chemical substances, HC: Health care, PP: Public procurement, SE: Sustainable energy, WW: Wastewater.

Table 4.2 and Table 4.3 above reflect the array of policy instruments used in past technology procurement projects and the instruments suggested to be used respectively. In cases where it has not been possible to choose a winner, the best product - or products - has been tested and evaluated in a demonstration programme. What matters is getting environmentally beneficial products on the market. None of the investigated cases has had a demand for support in the R&D phases of the innovation.

The interviewed companies do not perceive the R&D as the main risk as the existing opportunities of funding are adequate for the companies to develop their products. For some of the interviewed companies, particularly the SMEs, the scaling-up constitutes a significant risk to the company. Public purchase of a limited series of products can be a major support of the commercialisation of these products.

The bundling of demand in the public sector constitutes a high potential for development of certain products. The demand for new products may either be directed towards products purchased directly by the public sector, e.g. wastewater treatment plants, or products purchased indirectly, e.g. DEHP-free components in hospital equipment. The development of more environmental-friendly buses, wastewater treatment facilities and healthcare products requires a long lead time, and the investments are high. By guaranteeing a certain extent of sales, new environmental-friendly products can be brought to the market.

5 Practical Examples

5.1 Experiences with technology procurement

The purpose of this section is to describe practical experiences with technology procurement of eco-innovation. ('Technology procurement' can be taken as a synonym for innovation procurement policy: 'procurement' being used is the broad sense of 'bringing about' even if there is no purchasing by those running the policy). The main focus of such programmes has been the innovation and market uptake of energy-efficient technologies. The most comprehensive experiences are held by NUTEK/STEM in Sweden, by the US Department of Energy (US DOE) and in the Super-Efficient Refrigerator Program (SERP) in the US and under the auspices of the International Energy Agency (IEA). Cases of technology procurement from these technology procurement programmes and a few other examples of public procurement of environmental-friendly innovations are examined. Focus is on understanding how the technology procurement has been organised, what incentives companies have had to participate in such projects and the product and market characteristics where innovative procurement projects have been applied. The empirical input is based on interviews combined with intensive desk research.

5.2 Experience with technological procurement of energy-efficient products in Sweden

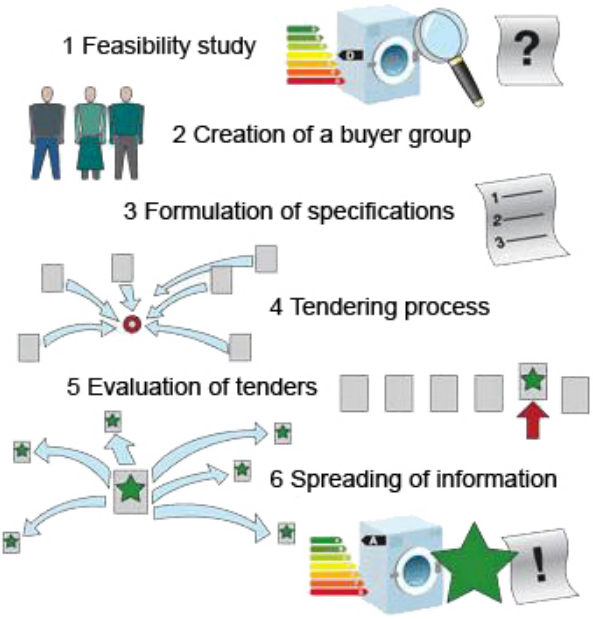
In 1988, the Swedish Government launched a technology procurement programme for energy efficiency. Until 1998 the programme was managed by the Swedish Board for Industrial and Technical Development (NUTEK), and since 1998 by the Swedish National Energy Administration (STEM). The programmes included the technology procurement of a range of energy-efficient technologies, e.g. combined refrigerator-freezers, HF lighting systems, energy-efficient windows, monitors, washing machines and dryers, heat pumps, radiator control systems, air-handling units, ventilation filters, water heaters, home lighting, mine ventilation fanes, energy-efficient factory doors, traffic lights, sun shading systems and electric cars (Neij, 1999; Persson, 2004).

The purpose of technology procurement is to bring energy-efficient products to the market *and* to get a market uptake of these products. The public agent plays the role of a facilitator of product innovation and product commercialisation. The public body initiating the technology procurement programme purchases neither the innovation process nor the final commercial product. Spending on

development of prototypes and test series is paid by the companies participating in the technology procurement programme.

Figure 5.1 reflects the process of technology procurement used in the Swedish technology procurement programmes. The basic idea is the organisation of a bidding contest for energy-efficient technologies, where the market uptake of the winning product is supported.

Figure 5.1 Phases of technology procurement used by STEM



Source: STEM's website, http://www.energimyndigheten.se.

Feasibility study

The purpose of the feasibility study is to identify what relevance the suggested product, system or process has on the energy consumption and what potential the process constitutes for improvements. The feasibility study also includes an analysis of the stakeholders involved in the development and manufacturing of the product. Moreover, the study investigates the market for the product and to what extent the market is local or global. Another important purpose of the feasibility study is to identify the potential buyers of the product, and whether the buyers' area consists of small or large entities and how they are organised (Persson, 2004).

The feasibility study should also evaluate if technology procurement would be a suitable approach. In the feasibility study the criteria that the technology should be evaluated against should be established. It is also important to find out whether it is necessary to evaluate the performance of existing products on the market, and how prototypes developed as a result of the technology procurement project are tested. A possible feature of a feasibility study is the setting up of scenarios for the outcome of the technology procurement and a simple risk analysis may be made of the project (Persson, 2004: 11-13).

The establishment of a 'buyer group'

A 'buyer group' is made up by potential buyers of the technology. The composition and involvement of the buyer group is crucial for the success of project. It is important that the buyer group constitutes a considerable market share so it is likely that there will be a market for the product. It is also important that the members of the buyer group have a personal interest in the development of the product and that they assume responsibility for the technology procurement project. If there is not a buyer of the product, there is a risk that the project only ends up in demonstration of technological capacities. The buyer group should push the process forward. Moreover, it is important that the members of the buyer group has a mandate from their employer to make decisions regarding the issues that the technology procurement concerns, and that the members disseminate information on the technology procurement in the organisation they work in. (Nilsson, 2003; Persson, 2004; Hans Nilsson, 7 July 2008).

The buyer group is either set up as part of a specific project or a stable buyer group is used. The participants from such stable buyer groups change from project to project. BELOK (the Swedish Procurement Group for Commercial Buildings) is such a stable buyer group. In 2007, BELOK was made up by 13 commercial real estate owners. Five companies are private companies, two are region-owned companies, and six are governmental owned companies. Eight of the 13 companies have been members of BELOK since it was established in 2001 (Bertelsen, 2008).

Technical specifications

The technical specifications of the project include all the requirements that the buyer group have to the product. The requirements should be established as the total function of the buyer group's needs, where energy efficiency is just one of the characteristics required. Other important technical specifications regard requirements for price, installation, service, security, design, etc. The product should deliver the desired services and do it with an efficient use of energy (Nilsson, 2003; Persson, 2004; Thomas Berggren, 25 June 2008). The appearance of the product is important and a product with an unattractive design will not be likely to have success on the market. All technical specifications should be set up as performance requirements. The technical specifications are divided into requirements that *must* be fulfilled and requirements that *should* be fulfilled. Only proposals that fulfil the *must*-requirements can win a given contest, whereas the fulfilment of *should*-requirements is highly appreciated (Persson, 2004).

The purpose of the technology procurement is to stimulate the development of more energy-efficient technologies, and the technical specifications should therefore be ambitious but also technically possible to meet. Before the final technical specifications are set up, it is often value adding to discuss the proposed requirements with potential manufacturers at a workshop. At such workshops, it is possible to get feedback on whether the technical specifications are too easy to achieve or the desired product maybe already exists. The performance requirements might be too tough or the desired product might be impossible to develop at reasonable costs. From the technical specifications it should be unambiguous how the bids are evaluated (Persson, 2004).

Issue of competitive solicitation

Ensuring competitive solicitation is of major importance for the technological development. It is important to try to involve not only domestic but also inter-

national manufacturers in the bidding contest. The requirements for service and accessibility can, however, be a problem for non-Swedish manufacturers.

Early in the process, the buyer group should take contact to suppliers and manufacturers. This can help ensure that the suppliers and manufacturers become engaged in the technology procurement. Through an early contact with industry, the manufacturers can better use the time available for providing bids. This dialogue also helps the buyer group to get an impression of the industry's technological capacities, and whether the manufacturers already are on the way to develop concepts that are pointing towards the desired product, or whether the development of the product is new to the industry. The needed length of the time period to bid for the programme depends much on these factors (Persson, 2004).

Evaluation of bids

The incoming bids are evaluated according to whether all *must*-requirements are met and how many of the *should*-requirements that are met. In some cases, it is even evaluated to what extent the incoming bids are going beyond the performance requirements. The methodologies used to evaluate the bids are calculations, laboratory testing and field testing. The evaluation of the technology can further include pilot studies to investigate how the product performs under real-life conditions. This may even include evaluation of end users' perception of the product (Persson, 2004).

Early in the technology procurement process, it is also important to decide how precise the evaluation of the product should be made, as this is decisive for time consumption and the costs associated with the testing and evaluation of the product.

Promotion and dissemination

Various policy and market instruments may be used to promote the market uptake of the new products. Information on the winning technology may be disseminated through campaigns, news letters, newspaper articles, participation in fairs, workshops etc. It is preferable already from the beginning of the technology procurement process to market the project.

Support to a limited series of products is used in some cases. The purpose is to ensure an initial market uptake of the technology. The application of this instrument can be seen as a mitigation of the risk for lead buyers. The new technology may entail risks that were not possible to identify in the evaluation process; the product might for instance break down. The establishment of demonstration installations can also be a way of showing the virtues of the product that can inspire a wider market penetration of the product (Persson, 2004).

Further development

An important question connected with successful technology procurement is how to ensure a continuous further development of the technology. How such further development should be approached depends widely upon which stakeholders have the largest interest in the further development of the product. Also non-successful technology procurement where the developed product is not satisfactory to the buyer group constitutes a potential for further development (Persson, 2004). It is important to include considerations about the need for further development of the desired product when designing the procurement programme.

Financial support

STEM plays the role of a facilitator of the technology development. The preparation of the feasibility study, the costs associated with facilitating the buyer group's involvement in the project, evaluation of the technology and the support to promotion of the technology is financed by STEM. Companies participating in the bidding contest pay the expenses associated with the development of the product in question.

The costs to the public authority of the technology procurement processes are connected with the preparation of the feasibility study, the facilitation of the development of technical specification of the buyer group and promotion of the winning technology. The costs vary significantly according to what kind of technology the procurement contest addresses. More complex technologies demand more sophisticated and resource-demanding testing. Products involving a single component level, e.g. a motor, are much easier to test and evaluate than technologies that are at a multiple system level, e.g. control systems for ventilation and cooling. The testing of a single system can be carried out in laboratory tests, whereas the testing and evaluation of more complex systems may require expensive field testing (Thomas Berggren, 25 June 2008).

The costs associated with the preparation of a feasibility study are in the range of SEK 250,000 - 300,000 whereas facilitation of the development of technical specification and testing and evaluation of the submitted products may constitute costs in the range of SEK 2-3 million. Additional costs can be associated with cash rebates for market uptake of the winning product (Tomas Berggren, 25 June 2008). There is a requirement of a 50% co-financing from the participants of the costs connected with the preparation of feasibility study, development of technical specifications, testing and evaluation of submitted products and technical specifications (SFS, 2003: 564).

5.2.1 Technology procurement of energy-efficient water mixers

In 2001 STEM - in cooperation with Stockholm's local investment programme (Lokala investeringsprogrammets kansli) - set up a technology procurement contest for energy-efficient water mixers.

Goal of the programme

The potential energy savings by such water mixers was estimated to 600-750 kWh per household. As a part of the prize, the winner of the competition would get financial support in the form of cash rebates of the product (STEM & LIP-kansliet, 2001). Giving a cash rebate offers greater security of demand and has a demonstration effect for diffusion of technology into markets. The combined use of different policy instruments i.e. the testing of the product, the public attention connected with appointing a winner of the bidding contest and making a cash rebate aimed at ensuring a high market uptake of the product.

Buyer group

The buyer group consisted of representatives from the housing sector and stakeholders from the sector, including inhabitants in houses and flats. Moreover, the buyer group included experts in energy consumption. The technical specifications were made by the buyer group (STEM & LIP-kansliet, 2001). The buyer group was very engaged in the technology procurement programme which contributed to the success of the project (Persson, 2004).

Evaluation of bid

Only one manufacturer managed to submit a prototype to the procurement contest. The product was made by Gustavsberg, a large Swedish manufacturer of sanitary installations. The product met all requirements of the technology. In order to test and evaluate the product the proposed prototype was compared with the best available technology on the market. The testing of the product was made both in a laboratory and in the field. The tests found that Gustavberg's prototype was in average 40% (from 5 to 55%) more energy-efficient than most other water mixers on the Swedish market (STEM, 2006).

Development of the technology

When the technology procurement contest was initially launched, Gustavsberg had already thought about how to develop an energy-efficient water mixer. The company treated the development process as a normal R&D project where an internal project group was set up to investigate possible solutions. The technology that Gustavsberg came up with saved energy by reducing unnecessary consumption of hot water. If the user leaves the mixer, the water temperature decreases. The advantage of this solution is that the user can get the water as hot as needed, but the risk of unnecessary consumption of hot water is reduced (Matti Weineland, 5 June 2008).

Incentives for participation

Gustavsberg operates on a market with fierce price competition. However, Gustavsberg does not compete on price but on quality and special features. An energy-efficient water mixer would therefore fit well into the company's product portfolio. The launching of the procurement contest initiated the product development, as the company had not been convinced about the market demand for this kind of product. (Matti Weineland, 5 June 2008)

Result

The largest advantage to the company by participating in the procurement programme was the acknowledgement that the product they had developed was energy-efficient and of high quality. The fact that the public authorities facilitated the testing and evaluation of the product was of significant importance to the company, as this was an important way for the company to differentiate their product from their competitors' cheaper but less energy-efficient products. The prize was financial support for market uptake of their product on the Swedish market. STEM subsidised the product so it could be sold at a lower price. The total amount of the financial support was approximately SEK 4 million (EUR 0.35 million). The market demand for the product has been high, and it has been popular also after the subsidy expired. The financial support for the market uptake was an advantage to Gustavsberg, but it has not been as important as the testing and evaluation of the product and the positive impact on the company's reputation (Matti Weineland, 5 June 2008).

The technology has been implemented as a standard in a range of Gustavsberg's water mixers.

5.2.2 Technology procurement of control and monitoring systems for office buildings

In 2003, STEM and BELOK launched a technology procurement contest for development of a central control and monitoring system for heating, cooling and ventilation in office buildings. The background was that many of the existing heating, cooling and ventilation systems were too energy consuming. The

potential for energy savings was estimated to 5-15% by improved operation, and with a low need for investments (BELOK & STEM, 2003).

Technical specifications

The buyer group that participated in the technology procurement project was BELOK (Procurement Group for Commercial Buildings). The system requirements for the procurement contest were established by the members of BELOK and experts from the Swedish Royal Institute of Technology. The requirements were very detailed with respect to a broad array of criteria. There was focus on simplicity in operation of the system and well-designed feedback mechanisms presenting the energy consumption of the heating, cooling and/or ventilation system (Abel et al, 2006; Hans Bolöv, 1 July 2008).

Evaluation of bids

Several contributions were made to the bidding contest, but none of the solutions were able to meet all requirements. The result was that no winner of the contest was appointed. Instead, it was decided to invite the three best contributions to a test side evaluation of the proposed solutions in existing office buildings. Larmia Control AB, a Swedish developer of systems for automation and monitoring of buildings, participated in on-site evaluation of their system, the energy programme Optimizer. Larmia's system was installed in one of Bergkällan HB's buildings on a commercial basis, i.e. other offers were also taken into consideration. The costs of testing and evaluating the system were financed by STEM (Hans Bolöv, 1 July 2008; Tomas Berggren, 25 June, 2008). Their system was evaluated as being superior to the other tested systems, and Larmia ended up winning the design contest in 2006. The system developed by Larmia is evaluated as being able of bringing down energy consumption of heat and electricity by approximately 10 to 20%, depending widely on the existing heating, cooling and/or ventilation system. An example of problems encountered in Larmia's system is leaking valves. Such leakages are energy consuming and can be very difficult to identify (Hans Bolöv, 1 July 2008).

Incentives for participation

When the technology procurement contest was first launched, Larmia was already involved in the development of a similar system. The interest in the development of the product was Larmia's main reason to participate in the contest. There was no economic incentive to the winner of the project, and there was no guarantee of a market share, but there would be a lot of publicity connected with being chosen as the winner.

Result

The members of BELOK had contributed to the bidding contest with the specific requirements they needed. This resulted in Larmia getting access to a market where their system was the only one able to meet the buyer group's requirements. Since then, competitors have gradually developed systems that match the performance of Larmia's system. The technical specifications of the technology procurement contest had a significant impact on the way the system was developed.

The gain to Larmia was the development of a commercially successful system that was developed fast and with a clear target. The testing and evaluation of the system has been very important to Larmia as it enhanced their marketing of the system - the same goes for the publicity following winning the contest resulted in. The system would probably have been developed in any case, but through a direct dialogue with the potential end user of the technology it was

possible to develop the technology that matched the costumers' needs, which led to a commercial success. (Hans Bolöv, 1 July 2008).

5.2.3 Technology procurement of sun shading systems

In December 2003, STEM and BELOK launched a technology procurement project on development of sun shading systems.

Goal

The purpose of the contest was to develop a shading system that would reduce energy consumption for heating, cooling and lighting. Moreover, the contest aimed at accumulating knowledge on automatic sun shading systems. The shading systems should be designed for office blocks built between 1970 and 1990 (WSP, 2003). The basic idea was to develop blinds that allowed for higher passage of sunlight without dazzling people working in the office. To develop this system there was a need for a control system with a light sensor inside the office and to develop a blind system that allowed higher passage of sunlight into the building (Bülow-Hübe, 2007).

Evaluation of bids

The sun shading industry showed a huge interest in the technology procurement contest. The industry, however, had difficulties meeting the demands of the procurement contest. Four companies submitted products for the contest, but none of the companies could meet all requirements. As a result, no winner of the contest was appointed (Bylund, 2004). The industry had not been able to meet the demands specified in the tendering document as the industry did not have experiences of making the type of measurements required. The industry saw a big potential for developing such technologies, and there was a further dialogue between the industry and BELOK about the possibility of continuing the development of the product. BELOK and the sun shading industry decided to make a demonstration project to test the product. One of the participating companies was Sompfy, a Swedish manufacturer of sun shading technologies. When the bidding contest was launched, Sompfy had submitted a project involving a control system and an electric motor. At this point of time Sompfy had already thought about the development of such a technology. This had led to the development of an intelligent control system. Based on censor measurements of the luminosity at working places, the blinds were automatically adjusted. In the demonstration project, Sompfy's technology was tested in combination with blinds that already existed on the market. The demonstration project was completed in the autumn of 2007, and the technology was subsequently evaluated. The evaluation found that the technology was an efficient solution (Bülow-Hübe, 2007; Anders Hall, 18 June 2008).

Results

The bidding contest and the demonstration project did not lead to the development of new technologies, as Sompfy had recently developed a suitable control system. If the control system had not been developed, Sompfy would still have developed the technology as the potential market was estimated as being very promising (Anders Hall, 18 June 2008).

Right from the beginning there was no guarantee of a market for the technology. The purchasing power of the members of BELOK is, however, very high and the BELOK members' interest in buying the product was a strong driver for Sompfy to participate in the bidding contest and subsequently in the demonstra-

tion programme. There was no prize awarded to the winner, but the winning company would get the opportunity of a product evaluation. This external evaluation was a key driver for the company to enter the contest and subsequently the demonstration programme. Moreover, the project initiated a high dialogue between the industry and BELOK-members. It is crucial for the industry to know customer demands, and what they think about the product. The evaluation of the demonstration programme was made at Lund University, and the evaluation of the product has stimulated the demand for Sompfy's energy-efficient shading systems significantly (Bülow-Hübe, 2007; Anders Hall, 18 June 2008).

The cooperation between BELOK and the sun shading industry has pushed the dissemination of the system enormously. The main gains to the industry are the increased interest in the product. Previously, energy-efficient shading systems received very little attention from building owners (Anders Hall, 18 June 2008).

5.2.4 Technology procurement of energy-efficient ovens and refrigerators and freezers

Electrolux has won three technology procurement competitions. In 1990, the company won a refrigerator-freezer procurement project set up by NUTEK. In 2001 the company won a pan-European Energy+ procurement and promotion programme and the same year the company won an integrated cooker procurement project (Dahlman et al, *not dated*). Dahlman et al (*not dated*) have evaluated the procurement process from Elextrolux's point of view.

NUTEK refrigerator-freezer project

In 1990, NUTEK launched its first technology procurement project. The purpose of the programme was to stimulate manufacturers to commercialise a super efficient refrigerator-freezer that would fit into normal Swedish apartments. The specification of the technology procurement was a technology that was 25% more efficient than the best-performing products on the market, and the winning unit should furthermore be CFC-free. At the time the competition requirements were published, none of the refrigerators that Electrolux were developing met the requirements. The development of the winning product did, however, not entail basic research, as all solutions used in the product were known to the company. The challenge was to combine the known solutions, which turned out to be tricky. The winning technology was subsequently further developed with input from the Swedish Consumer Agency. NUTEK gave a cash rebate to the first 500 units sold on the market. The cash rebate constituted approximately EUR 100 per unit (Dahlman et al, *not dated*; STEM, 2006).

The buyer group was very committed to the procurement process which contributed to the success of the project (Persson, 2004). The commitment of the buyer groups was, however, somewhat a disappointment to Electrolux. Electrolux had expected to sell a higher volume to the buyer group.

The Integrated Cooker

In 2000, STEM launched a technology procurement of an energy-efficient cooker with an oven and a built-in microwave oven. Most of the specifications were based on ideas from the Swedish Consumer Agency. The energy efficiency of the cooker should be 25% to 40% higher than existing products (Dahlman et al, *not dated*; STEM, 2006). The time period for developing a pro-

totype was short (half a year). Due to lack of time Electrolux did not succeed in finding the solutions they had hoped for and the winning product was not chosen by the company as a part of the design line that it originally was intended to. The original intention of STEM and the consumer agency was to support the market uptake of the winning technology by giving a rebate to the first 1,000 units and through various promotion activities. By the time Electrolux's cooker was announced as the winner, STEM had lost its interest in the cooker and failed to deliver the promised promotion (Dahlman et al, *not dated*).

Energy+

In the autumn of 1999, a pan-European procurement programme for cold appliances was launched. The European Commission and energy agencies in the majority of the Member States supported the project and participated in establishing the specifications. No buyer group was established. The winners of the programme were found through a bidding contest. The competition included a one-door class and a two-door class. Electrolux was awarded the prize for the two-door class. The specifications were to meet the threshold level of an Energy-efficient Index (EEI) that was 0.42 or lower. This equalled a 25% to 40% more energy-efficient product compared to the basic Class A of the EU's energy labelling scheme. The EEI of the product Electrolux submitted to the contest was 0.36 which was below the minimum requirements. The technical specifications were not so demanding; the challenge was rather to find out what solutions to combine and at what price (Dahlman et al, *not dated*).

The winning Energy+ product turned out not to sell very well. Still, Electrolux was satisfied with the participation in the project, as the Energy+ project led to increased prestige and was an advantage for the corporate image. The product paved the way for similar products with almost identical performance that were successful on several markets. A clear advantage of the Energy+ project was that it ran over a long time with repeated competitions (Dahlman et al, *not dated*).

Preparatory phase

In these three cases the initiative came from an energy agency. In the case of the Energy+ project, the project was initiated by an international group of energy agencies and the European Commission. The initial phase of the procurement programmes was characterised by an informal initial contact between the suppliers and the organisers. In this phase the state-of-the-art of technology was assessed and the relevance of the product choice discussed. The informal contact with the organiser is stressed by Electrolux as being very important for the process. The energy agency project group has been responsive to the suggestions from the manufacturer, but still keeping a clear demarcation between supplier and public interests. In a small domestic market such as the Swedish one there is an ongoing dialogue between suppliers, retailers, professional buyers and government agencies. With the international focus, in the Energy+ project the contact was more formalised. It was harder for this group of energy agencies to know whom to contact in the appliance business. The backing of the project by the European Commission gave the project additional prestige to the Elextrolux managers involved (Dahlman et al, *not dated*).

Response to the technical specifications

In the Swedish procurement programmes, the specifications to the technology procurement were clear, and the final technical specification did not come as a surprise to the company. In the Energy+ project Electrolux has the impression that their recommendations have been more 'diluted' and that the final require-

ment could have been more technically demanding. An important issue is the price-performance ratio in the technical specifications. The price factor was not weighted much in the technical specifications in the Energy+ project. This entailed that there was little guidance to the company on optimising the product submitted (Dahlman et al, *not dated*).

Decision of participation

The participation in the technology procurement projects was seen by Electrolux as a natural consequence of having been involved in the preparatory phases. The involvement of both the marketing and production function in the preparatory phase entailed that they were prepared for what was coming. The structure of Electrolux included several different departments and area of responsibility. A number of decision-makers have to agree on a project before it is implemented. In order for the decision-makers to agree on the participation in a technology procurement project, the organiser of the project has to be perceived as credible. The company must trust that the rules of the procurement process are fair and that the buyer group and the energy agencies must reaffirm their commitment when the winner has been chosen (Dahlman et al, *not dated*).

It is a corporate goal for Electrolux always to win technology procurement contests. A precondition for participation is, however, that there is a potential market for the product (Tomas Dahlman, 4 July 2008).

The advantage for Electrolux

Significant costs are related to developing new products and bringing them into production. The technical specifications given in the Request for Proposal (RFP) help the company to determine which solutions that should be combined to form a final product. However, if the technical requirements turn out not to represent what the market actually demands, sales will decline once the public support has been withdrawn. There are, however, incentives for Electrolux to participate in technology procurement programmes.

Technology procurement can assist in cutting life-cycle costs of energy-efficient products. The prestige of Energy+ products makes it possible to sell products where the life-cycle costs are higher to the customer than less energy-efficient appliances. When the product is brought to the market, the product development people start to improve the products on a continuous basis. This will eventually lead to falling prices on the product, so the product can be sold at prices where the life-cycle costs of the product is indeed lower than the life-cycle costs of less energy-efficient products (Dahlman et al, *not dated*).

Other drivers for participation are:

- Market visibility and publicity. Market communication is expensive and the support from energy agencies is very valuable.
- Electrolux corporate image. The participation in technology procurement programmes helps Electrolux to strengthen its corporate image as an innovative, leading company.
- Future product development. The participation in technology procurement programmes helps Electrolux to work to develop future products. A prerequest ensures that the specifications are professionally developed with input from test laboratories and other relevant stakeholders and that the technical specifications represent future trends.

- Customer care. Participation in technology procurement competitions where large institutional buyers are involved entails an opportunity for Electrolux to improve customer relations.
- Sales support. The winning of a technology procurement competition has an important impact on the marketing of the product. The product is a winning product - not just a good product.
- Corporate environmental policy. The participation in technology procurement projects is in line with Electrolux's corporate environmental policy.
- Prestige. The cost involved in the development of the technology can partly be seen as an investment needed to gain prestige (Dahlman et al, *not dated*).

Need for improvements

In order to make technology procurement a success the winning product has to be placed on the market. Even where the buyer group is purchasing a volume of the product, it is important to ensure that the products are sold through normal channels in large volumes. In order for this to take place the organisers of the technology procurement has to help the winning company to promote the new technology on the market. Electrolux has experienced that the organisers of the technology procurement have not provided the support and commitment that was promised or indicated before the competition (Dahlman et al, *not dated*).

It is important that commitment from the public authorities is long-term and sustainable. The appliance market is a global market. Electrolux therefore welcomes pan-European technology procurement initiatives, as the potential buyer groups can be much wider compared to the buyer groups in the domestic, Swedish technology procurement schemes (Dahlman et al, *not dated*; Tomas Dahlman, 4 July 2008).

Cash rebates are preferred to other kinds of financial subsidies. Cash rebates from governments or utilities for the most advanced energy-efficient products are efficient ways of increasing sales. Electrolux, however, finds that cash rebates are not always a feasible tool. Electrolux recommends the usage of the public sector's purchasing power to create markets for the most energy-efficient products.

Lessons learnt by Electrolux

- It is almost impossible for the manufacturer to identify all the needs of their buyers. This is particularly the case when it comes to energy efficiency and environment.
- The procurement process helps reduce the risk for progressive manufacturers that want to improve the performance of their products.
- The market introduction and expansion phase of the winning product is as important as the appointment of winning the procurement contest.
- The positive market recognition is good but it has to be backed up by communication through an independent agency. The largest improvement can be made with respect to the support from the buyer group and the governmental agency (Dahlman et al, *not dated*).

5.3 Experience with technology procurement from the IEA DSM Annex III programme

From 1994 to 1999 eight countries and the European Commission participated in a technology procurement programme known as IEA DSM Annex III 'Co-operative Procurement' (International Energy Agency, Implementing Agreement on Demand Side Management, Annex III). The objective of the programme was to "establish a co-operative demand-pull procedure to bring more energy-efficient and environmentally-adapted demand-side management technologies to the marketplace, to rank innovative candidate technologies for competitive procurement activities, and to procure DSM technology options that have not yet reached the marketplace in order to demonstrate and test the procedure developed" (Westling, 2000: 1). In a number of pilot projects more energy-efficient technologies were developed and tested. The programme resulted, among other things, in the development and market introduction of a clothes dryer, electric motors and a copier.

The technology procurement approach used in the IEA programme is basically the same as the one used by NUTEK/STEM in Sweden, where a feasibility study is made, a buyer group is established, performance criteria are formulated, the participating prototypes are tested, a winner is found and policy instruments are applied to ensure the market uptake of the product. As in the NUTEK/STEM model, there has not been economic support to R&D for development of the technologies. The prize for the winning technologies was awarded with an 'IEA DSM Award of Excellence' certificate, documenting the energy efficiency of the product (Westling, 2000). The main difference from the NUTEK technology procurement was that a range of European countries, the US and the European Commission participated. In this way, the potential market was much larger.

5.3.1 Technology procurement of electric motors

In 1997-98, MOTIVA, the Information Centre for Energy Efficiency (Finland), organised a technology procurement of high-efficient induction motors on behalf of IEA DSM Annex III. The purpose of the technology procurement was to develop a high-efficient induction motor with an energy loss about 25-50% lower than the average motors, at price level and a performance level that would guaranty a lasting significant market share (IEA, 1998). The buyer group consisted of 30 major companies in Finland.

Only two motors developed by ABB Motors AB met the technical specifications. Both motors were chosen as winners of the procurement contest.

ABB Motors financed the development of the technology. The procurement contest led to considerable technological innovation. The prize awarded to ABB Motors was a certificate for the technology, the 'IEA Award of Excellence'. The company gained a lot of internal capacities from the development of the technology, but there was little gain attached to the commercialisation of the technology. The participation in the technology procurement programme did not lead to substantial mitigation of risks. The requirements for participating in the contest were set at a very high level, which in the future might be an advantage for the companies should there be a demand for high-efficient energy

saving products, as the company has the capacity of manufacturing such a product (Christer Holgersson, 12 June 2008). The lack of market uptake of the energy-efficient motors was probably due to high unit prices compared to normal products on the market.

5.3.2 Technology procurement of high-efficient clothes dryers

Another IEA DSM Annex III project was the technology procurement of a high-efficient clothes dryer. The governmental organisation in charge of the technology procurement was NOVEM (The Netherlands Agency for Energy and the Environment). NOVEM organised the set up of a buyer group. The buyer groups were composed by leading buyers from the participating countries Finland, the Netherlands, Sweden, UK and Switzerland (Rambøll, 2008, 6.9.10).

Technical specifications

A range of stakeholders with knowledge of clothes dryers were involved in setting up technical specifications for the clothes dryer. Most of the specifications concerned standard requirements for clothes dryers and the only challenging specification was connected to energy consumption. The requirement of the technology was a 50% reduction of the energy consumption (Rambøll, 2008, 6.9.10).

Support

It was known that the technical solution needed to bring down the energy consumption would entail an approximately 20% higher price than the highest price of traditional dryers (Rambøll, 2008, 6.9.10). In order to secure the market uptake of the technology, the unit price of the new product should not exceed EUR 1,500. EUR 200,000 was granted in support to the winning product and a unit cash rebate of approximately EUR250 was given to the first buyers of the winning product (Tomas Dahlman, 4 July 2008).

Evaluation of bids

Despite the efforts of the organisers to include more companies in the procurement contest, only one company managed to meet the technical requirements - the German company AEG (later merged with Electrolux). Other suppliers did not have a product that met the specifications, and one supplier (Whirlpool) did not manage to have their bid ready in time (Rambøll, 2008, 6.9.10).

Technological solution

The technological solution that the AEG presented was the application of heat pump technology in the clothes dryer. Since the 1970s, the technical solution had been known to AEG, however, due to high development costs and high product unit prices the company had refrained from developing and commercialising the invention. In order to be energy-efficient many components had to be specially constructed (Rambøll, 2008, 6.9.10; Onur Dumos, 26 June 2008).

Result

The winning product managed to be the first product receiving the EU Energy Class A Label, whereas the most energy-efficient clothes dryers on the market only were able to meet the Energy Label Class C (Onur Dumos, 26 June 2008). Although a cash rebate was granted, the clothes dryer did not sell very well. After a couple of years, the clothes dryer was withdrawn from the market. In 2006, the clothes dryer was re-launched on the market at a lower price, and sales have since increased (Onur Dumos, 26 June 2008).

Although considerable costs were connected with the commercialisation of the clothes dryer, the AEG had the technological capacities already, and the technology procurement did not lead to substantial innovation in the company. According to Dr. Professor Reiner Stammenger, former head of AEG R&D, a guaranteed purchase would have been more beneficial to the company than the cash rebate scheme (Rambøll, 2008, 6.9.10). The reason for this was properly that the biggest problem faced by the AEG was to obtain market uptake of the product, as the original unit price of the product was significantly higher than that of normal clothes dryers on the market.

5.4 Experience with procurement programmes from the US

The US DOE (Department of Energy) and the Pacific Northwest National Laboratory (PNNL) have used technology procurement to speed the market introduction of new, energy-efficient products. Examples of such products are: energy-efficient refrigerators, washing machines and subcompact fluorescent lamps, residential recessed downlights and rooftop air conditioners (Ledbetter et al, 1999; US DOE, 2003).

The approach to technology procurement used by the US DOE is basically similar to the NUTEK/STEM model. Potential large volume buyers of the technology are identified, interaction with the buyers takes place in order to understand their business and technology needs in detail, technical specifications are developed in consultation with both buyers and manufacturers, a competitive solicitation is issued to potential manufacturers and suppliers that is requesting bids to make new products that meet the performance requirements and one or more winners are selected from the bids. Policy instruments are then applied to maximise the purchase of the new product. The fundamental idea is to reduce the risk to manufacturers by organising large volume buyers for the product and by allowing the manufacturers to introduce the new products at more competitive prices (US DOE, 2003).

Technology procurement has also been used by other organisations in the US e.g. the New York Power Authorities (NYPA), and the Consortium for Energy Efficiency (CEE) and DOE have cooperated on an Apartment Size Refrigerator Program. Moreover, electric utilities and CEE have cooperated on the Super-Efficient Refrigerator Program (SERP) (US DOE, 2003).

5.4.1 DOE High-Efficiency Clothes Washer Volume Purchase

The High-Efficient Clothes Washer Volume Purchase was a technology procurement programme that was initiated by the US DOE in 1997.

The goal of the programme

The goal of the programme was to stimulate the market for resource-efficient, high performance clothes washers. This should be done by facilitating the sale of such cloth washers to volume buyers. Buy building an early sales volume for the product, the manufacturers would more quickly recover their investments in the new washers (Ledbetter et al, 1999).

Market research	The market research of the programme included extensive communication with water utilities and volume buyers in order to identify their interest in the programme and what key features these stakeholders whished to see in high-efficiency clothes washers. The clothes washer manufacturers were also consulted to explore their opinion on programme design, technical issues and market issues. Based on the dialogue with the stakeholders a Request for Proposal (RFP) was formulated.
Performance requirements	The specification included requirement to environmental performance (energy and water consumption), functional requirements and requirements to warranty. The requirements were set up in order to allow the qualification of minimum three known producers of clothes washers (Ledbetter et al, 1999).
Evaluation of bids	The bids were evaluated according to a scoring system. 80% of points were assigned to life-cycle costs of the technology, which included the initial price of the machine and energy, water and wastewater costs of operating the machine. Three bids were submitted. Sides Supply, a distributor of washing machines, had participated in the bidding contest with a clothes washer developed by Frigidaire. Sides Supply was chosen as the winner of the bidding contest. The clothes washer was able to meet the requirements, and the machine was offered at a highly discounted price. A Basic Ordering Agreement (BOA) was set up with Sides Supply. For a period of one year the City of Austin and other local partners could purchase the clothes washers at the bid prices. Two one-year optional time extensions were included in the BOA. DOE had hoped to be able to offer BOA to more than just one bidder, but the other two bids did not score high enough (Ledbetter et al, 1999).
Promotion	The policy instruments applied to promote the market uptake of the technology was financial support to the customer. The City of Austin gave a general rebate on all clothes washers that were able to meet the Energy Star® specifications. A relatively small additional rebate (USD 30) was given to customers buying the winning Frigidaire machine in the programme period.
Result	Although a lot of potential local partners wished to participate in the programme, only City of Austin was able to organise the procurement before the programme terminated in December 1998. Austin did not purchase and resell the clothes washers to the customers, but instead asked local retailers to participate in the programme. Austin was thereby the only participant in the 'buyer group', but without constituting a significant purchasing power (Ledbetter et al, 1999). In 1998, Sides Supply and Frigidaire were not interested in extending the Basic Ordering Agreement (BOA). The reason was that Frigidaire was selling 100% of their product through other channels, and there was no point for the company in continuing to sell heavily discounted machines through the programme. At the end of the programme in December 1998, 579 washers had been sold through the programme. All except 42 washers were sold to customers in Austin. This was considerably fewer machines than the 10,000 target set up for the programme. Where the programme had not been successful in meeting its sales target for sale of machines, the aggressive bidding contest had resulted in considerable discounts on the high-efficiency clothes washers sold in Austin, where sales had been robust.

The primarily goal of the programme was not to push the performance of existing technologies. The technical requirements were established in such a way that it allowed the qualification of existing technology. The bids were evaluated according to a score system where 80% of the possible points were assigned to the costs of purchasing and operating the machine. A machine sold at a lower price could therefore principally outperform a more water and energy-efficient technology, as the initial costs of buying the machine could be weighted higher than lower operating costs throughout the product life-cycle. Hence, not only the set-up, but also the methodology to evaluate the bids is decisive for the degree of innovation that takes place.

5.4.2 The Super-Efficient Refrigerator Program

In 1991 a consortium, the Super-Efficient Refrigerator Programme (SERP) was formed by a group of US utilities. The purpose of the consortium was to advance the technology of refrigerators and bring energy-efficient and environmental-friendly refrigerators to the market at a competitive price. The refrigerators should be made available to the customer years before they would have been available under normal market conditions. In July 1992, SERP made a RFP stating that manufacturers able to make the most energy-efficient refrigerator with the lowest energy costs in kilowatt-hour would win a prize of up to USD 30 million of incentive money. 14 companies submitted bids. Whirlpool Corporation's bid was chosen as the winner and qualified for the full amount of incentive money (Ledbetter et al, 1999; Holloman et al, 2002).

Goal

The primary goal of the technology procurement was to develop a CFC-free refrigerator that was at least 25% more energy-efficient than the 1993 federal standard at a price that was comparable to non-SERP products. The level of energy efficiency improvement was chosen, as it was believed to be a realistic balance between increased energy efficiency and price. The secondary goal of the project was to show that it was possible to develop such a high efficiency technology without using CFCs. A third goal was to convince the refrigerator manufacturers that the development of cost-efficient and more efficient units - that could cope with higher standards - would be technically and economically feasible.

The electric utilities included in SERP served 21% of US households. These utilities provided the USD 30 million of incentive money and contributed financially to the development of the programme. The project was also financially supported by the US Environmental Protection Agency (Ledbetter et al, 1999).

Technical specifications

The RFP included specifications on the energy consumption of the refrigerator, it should be CFC-free, and there were requirements for the size of the item. It was believed that by setting up a broader size range, the company would get higher freedom in developing the refrigerator to match the customers' size needs. Moreover, it was expected that the technology in the winning refrigerator eventually would be used in all refrigerator models. There where no requirements for style. The RFP included a requirement for the number of refrigerator that the manufacturer would sell during the life span of the programme. The bidders were thereby not only asked to design a refrigerator but also to

commit to a volume of sales of the product. The higher the number of sales, the higher the potential energy savings and the higher the technology score. The RFP gave credit for the proposals that could show the ability of early assemble and delivery of units, and hence realisation of energy savings early in the programme. A tracking system was also included in the RFP so the utilities could see where the SERP refrigerators were installed (Ledbetter et al, 1999).

Participation decision

The main incentive that the manufacturers stated for participation in the programme was not the USD 30 million of incentive money. The manufacturers perceived that the potential publicity and media attention connected with being chosen as the winner was very attractive (Sandahl et al, 1996; ten Cate et al, 1998).

Evaluation of bids

The bids were evaluated according to a system where the maximum score was 100 points. 75 points of the possible points were given to total energy savings of the proposed technology. The score system that SERP had developed gave credit for the number of kilowatt-hours and not the percentage of kWh saved. This gave the bidders an incentive to develop large refrigerators.

Performance of technology

Whirlpool Corporation was chosen as the winner of the bidding contest. Their refrigerator exceeded the 1993 federal standard for energy efficiency by 29.7% to 41%. The first SERP model was brought to the market in 1994, and in 1995 the SERP refrigerator was improved so it exceeded the energy standards by 38% to 41%.

Result

The SERP programme received extensive media coverage in the beginning, but afterwards it had to rely on limited dealer promotion. Media advertising, SERP unit floor models in-store promotional material and utility promotion were important parts of promotion of sales of the SERP refrigerator. The declining use of these promotion instruments contributed to diminishing sales (Lee & Coger, 1996).

Despite the USD 30 million of incentive money that was used as subsidy for bringing the SERP refrigerator to the market, Whirlpool did not succeed in selling all the 250,000 SERP units it had proposed to sell during the programme. Whirlpool stopped manufacturing the refrigerators in 1998. It is uncertain how many units Whirlpool succeeded in selling, but it was substantially fewer than the 250,000 units (Ledbetter et al, 1999).

The scoring system had encouraged Whirlpool to develop a large deluxe refrigerator. Compared to most refrigerators on the market the SERP refrigerator was expensive, and the refrigerator may have been too expensive. Another possible explanation to the low sales was an insufficient dealer and salesperson awareness and understanding of the rebate structure for SERP units (Lee & Coger, 1996; Ledbetter et al, 1999).

The development of the technology had an impact on the energy efficiency performance of the technologies developed by Whirlpool in the following years as there was an overall increase in the energy efficiency of the company's refrigerators (Holloman et al, 2002).

5.5 Environmental-related public technology procurement projects

Two European public technology procurement projects are described in the following. One project is about procurement of an energy-efficient lightning system in Hamburg, and the other is a procurement of fuel cell buses in European cities.

5.5.1 New lighting systems of energy efficiency in Hamburg

The State and municipality of Hamburg has procured an energy efficiency lighting system to the 1,500 public buildings under its responsibility.

Goal of the project

The purpose was to save energy, improve lighting quality and lower life-time costs of lighting. The aim was a 60% reduction of energy in office workspaces. The policy background for the programme was that the State government wanted to contribute to the city's energy efficiency objectives and save resources. The new lighting system was a modification of the existing system and therefore called for the suppliers and service providers to invest in innovative solutions. However, the procurement aimed at disseminating new energy-efficient technologies and not at generating new products (Edler et al, 2005).

Preparatory phase

10 years before the energy efficiency programme was launched, the State of Hamburg had conducted a pilot project. Based on the pilot project the responsible agency understood the potential energy savings. Six months before the tendering process started, informal preliminary talks took place in order to ensure that an affordable and innovative solution could be found, and possible systems and reductions in purchasing costs were discussed. Based on the desired requirements a Europe-wide tendering process was initiated. The suppliers of lighting-systems came from outside of the State of Hamburg whereas installation and maintenance was taken care of by local service providers. The programme therefore both had an effect on the local economy and the economy outside the State of Hamburg. The contracts consisted of a range of small contracts that had to be managed, the contracts included milestones that the companies should achieve and contract penalties, and the suppliers work was controlled though random sampling (Edler et al, 2005).

Subsidies

The programme included a spill-over to the private sector. Companies that started using the lighting system were subsidised. The subsidies covered investment assistance of between EUR 1,000 and EUR 50,000, and the companies could obtain significant price reduction by buying energy-saving lighting systems similar to the one procured by the city. The participating companies where also entitled to participate in the EU-initiative 'green light' programme, through which their efforts would receive public attention (Edler et al, 2005).

Reason for the success

The advantage of the programme was that "technological solutions are optimised, external knowledge and investment in advanced technologies is affordable (critical mass), economies of scale in the whole procurement and implementation process as well as in maintenance, and enhanced environmental effects through the broad application of solutions" (Edler et al, 2005: 55). Through the magnitude of the public procurement it was possible to gain critical mass. The procurement process was centralised in the hands of a large

agency, and there were very strict investment plans. The lighting system procured was only slightly innovative and therefore only posed a relatively low risk. In addition, the programme involved close cooperation with the local electricity suppliers.

5.5.2 Public procurement of fuel cell buses

The CUTE project (Clean Urban Transport of Europe) and its successor, the HyFLEET:CUTE project, are public technology procurement projects, where a technology that is not yet commercially viable is procured for testing purposes and for facilitating further development of the technology.

In 2001, the CUTE project was initiated. The purpose of the project was to introduce zero-emission buses in nine large European cities. The demonstration phase of the project started in 2003 and ended in 2005. In each of the nine cities three EvoBus fuel cell buses were tested (Rambøll, 2008: 6.9.2).

HyFLEET project

The CUTE project was followed by the HyFLEET:CUTE project. The aim of the HyFLEET:CUTE project is in the period January 2006 to September 2009 to operate 47 hydrogen powered buses in 10 large cities spread over three continents. Two kinds of hydrogen-based technologies are included: fuel cell and hydrogen powered internal combustion engines (ICE). The costs of the project are estimated to EUR 43.16 million. The European Commission co-funds EUR 19 million. 31 partners are involved in the project including governments, automotive companies, transport companies, energy companies, infrastructure suppliers, academic organisations and consultancies. Hydrogen technology was chosen because the technology is highly efficient and emission-free (http://www.global-hydrogen-bus-platform.com).

In October 2006, representatives from the cities of Amsterdam, Barcelona, Berlin, Hamburg, London and a representative from the Canadian province of British Columbia agreed on a 'Memorandum of Understanding', where a purchasing alliance of procurement of hydrogen buses was made. The purpose of establishing this network was to guarantee a reliable demand for hydrogen fuel cell buses, in order that the vehicle industry develops hydrogen fuel cell buses that are technically and economically ready for series production (Rambøll, 2008: 6.9.2).

The City of Hamburg was so satisfied with the result of the CUTE project that it decided also to participate in the HyFLEET:CUTE project. In addition to the original three fuel cell buses the six fuel cell buses tested in Stockholm and Stuttgart as part of the CUTE project were also purchased. To this end, Hamburg has presently the world's largest fleet of fuel cell buses. Hamburg decided to purchase the buses even though they were five times as expensive as traditional buses. The advantage of operating the buses in Hamburg is that the buses can be tested in a major city with large passenger numbers and short distances between stops. In Hamburg, the company Hochbahn operates the buses. The Swedish energy company Vattenfall and BP have built a hydrogen plant producing the hydrogen needed to supply the vehicles (http://www.hysolutions-hamburg.de; Rambøll, 2008: 6.9.2).

5.6 Lessons learnt from technology procurement programmes

The approaches to technology procurement used in the Swedish, US, IEA DSM and the Energy+ programmes are very similar, and a range of general lessons can be learnt.

5.6.1 Organisation of technology procurement

By coordinating the buyer's needs with the suppliers capabilities to develop new technologies the classic problem of the 'chicken and egg' can be resolved. Manufacturers normally wait until there is a demonstrated market, before they develop energy-efficient technologies, and the buyers want to see the product on the market before they buy it. (ten Cate et al, 1998). The potential virtue of technology procurement is: "(…) to condense into a much shorter period the complicated exchange of market signals, intervening in a way that accelerated and strengthens - rather than displaces - long-term market relationships." (ten Cate et al, 1998).

Risk minimisation

In a normal R&D project possible failure is normally an accepted outcome of the process as the project still can bring experience and knowledge. In a technology procurement programme, each participant may take considerable risks - risks that might be difficult to accept for many organisations. It is therefore of huge importance that the technology procurement is organised in a way that risks are minimised (Suvilehto & Öfverholm, 1998).

Choosing right approach

Depending on the specific product or system for which development and commercialization is considered, it is important already in the feasibility study to conclude whether technology procurement is the right approach. This depends widely on the product and market characteristics.

Early involvement

It is important to agree on the goals early in the process, and sufficient time and resources should be devoted to undertaking the feasibility study. Early in the process all important stakeholders should be involved, and a systematic identification of existing market barriers should be identified (Westling, 2000).

Buyer driven process

The programme development process should be buyer-driven. The interests of the buyers, their preferences, market perspectives and willingness to buy are decisive for the success of the project (Holloman et al, 2002).

The programme developer should interact extensively with potential suppliers and distributors. The purpose is to learn about key technology and market issues from the supply side of the market (Holloman et al, 2002).

Whether fixed or changing buyer groups should be used depend among other things on the kind of product, system or process that the technology procurement is going to address (Persson, 2004).

Qualification of personnel

Of key importance to successful innovative procurement processes is the involvement of motivated and competent staff. A way to motivate the staff is to set up and communicate clear visions for the use of technology procurement. Except of Sweden, procurers and personnel in other relevant public organisa-

tions in the Nordic countries have limited knowledge of technology procurement. A training programme of the personnel is therefore seen as a precondition for expanding the use of technology procurement in the Nordic countries (Bauer et al, 2008).

Long-term relationship

Long-term relationships are important for the sustainability of the project. Some of NUTEK's most successful technology procurement schemes have relied on long-term relationships with buyer groups. The long-term relationship has helped to overcome the initial criticism that the buyer group may have towards the technology procurement approach. The cooperation with the buyer group is time consuming as the performance requirements have to be coordinated and the commitment has to be secured. In addition, it must be verified whether a real market exists. By way of example, it took NUTEK more than 25 projects to establish solid credibility with buyers and suppliers of assuming the role of broker of technology procurement (ten Cate et al, 1998).

Time consuming process

The implementation of a technology procurement project is time consuming and may take several years. Innovation is not a linear but a circular or spiral process, and it is important to maintain continuity throughout the programme. The involved experts have to have sufficient time and resources to contribute to the process (Westling, 2000). The technology procurement projects that depend on sales to large volume buyers, especially governmental agencies, should be designed in a way that gives the buyers a long time period to buy the products (at least two years) (Holloman et al, 2002).

The setting up of a technology procurement programme is also about timing. It is necessary both to find interested buyers and interested manufacturers of the product. Sometimes it takes time for buyers and manufacturers to become mature enough for participation in the project. In this respect it is important to be patient and await the emerging interest from the potential participants (Hans Nilsson, 7 July 2008).

Involvement of trusted organisations

It is important to involve trustworthy institutions recognised for objectivity, technical expertise or consumer interests in the implementation of the programme. Credible and independent testing and evaluation can, however, be costly (Holloman et al, 2002).

Needed investment

Alison ten Cate et al (1998*)* conclude that there are no easy answer to how many buyers or unit purchases that are required to launch a technology procurement that is sustainable on the market. "A successful procurement is not necessarily defined by the size of the initial buy (in dollars, units, or market-share), or by the numbers of buyers, but by these factors among many others, some of them largely symbolic." (ten Cate et al,1998). Some buyers may constitute a large market potential that is not captured by competitors and thereby constitute a large potential for the suppliers. The characteristics of the product also play an important role. Is the product likely to appeal to a broad market segment or will the product fit in to a small but very lucrative market?

Combination with other policies

The process of successful market transformation includes a range of separate but coordinated activities, where the procurement is the start - but not the end to the process (Suvilehto & Öfverholm, 1998). Technology procurement has shown to be most successful if the technology procurement is combined with

other policy instruments, e.g. coordinated rebates, promotional campaigns, volume purchasing by large buyers and voluntary or mandatory efficiency standards (ten Cate et al, 1998; Westling, 2000). It is important that there is a high degree of flexibility to change application of policy instruments during the process. It is not always predictable what outcome the policy instrument will have (Nils Borg, 7 July 2008). An example is the case of the STEM-BELOK sun shading programme where no winner of the procurement contest was chosen. In order to continue the work, it was decided to transform the project to a demonstration project of the best solution.

Right conditions

Technology procurement projects are not only about developing new technology, they are also about ensuring that the right conditions are in place for a market uptake of the product. In 1994, NUTEK set up a technology procurement project for introduction of electric and hybrid cars in Sweden. NUTEK was in dialogue with Citroën, Renault and Peugeot, but the car manufacturers hesitated to bring their products to the Swedish market. One of the reasons was that the car manufactured did not have the necessary infrastructure in place to guarantee service of the vehicles all over Sweden (Hans Nilsson, 7 July 2008).

Strong commitment to market support

The commitment of the organisers of the procurement programme to support the market introduction of the new product is very important. The NUTEK-STEM programme has been very well organised from preparation of feasibility studies to the choice of the winner of the product. The problem has been related to insufficient support of the market uptake of the product (Persson, 2004; Tomas Dahlman, 4 July 2008).

Dissemination of product

It is important that all stakeholders from organisers of the procurement, the buyer group, manufacturers and suppliers of the technology and trade associations are involved in the spread of the technology. It is important that the members of the buyer group communicate information and knowledge about the new technology within their organisations throughout the technology procurement process (Persson, 2004).

Lack of aggressive bids

In the SERP project and the high-efficient clothes washer programme, the bidding structure was organised in order for manufacturers, suppliers and distributors to submit the most aggressive bidding on low item product prices. But even though technology procurement programmes relied upon guaranteed sales or exclusive access to comprehensive financial rewards, the projects were not always successful in attracting aggressive bids. In the US this has especially been the case, where the technological development has entailed incremental technological improvements and not large leaps forward (Holloman et al, 2002). The reasons for the incremental improvements were due to the product requirements not being very challenging for the product developers.

Multiple award winners

In several technology procurement programmes, there have been few - and in some cases only one - submitted bid that were able to meet the technical specifications. In an evaluation of the US programmes it is concluded that it is preferable to make more than one award in the bidding contest. If the programme relies on one manufacturer it becomes vulnerable as it becomes dependent on one company (Holloman et al, 2002). Experiences from the Sweden, however, show that technology procurement programmes can be successful in developing

a desired product and getting market uptake in cases where only one winner is chosen from the bidding contest.

Potential role of SMEs

Procurement projects where the new products entail relatively low capital requirements, small companies can be important agents. The requirements in the High-Efficiency Clothes Washer project were established in a way that was heavily weighted towards of working with large manufacturers (Holloman et al, 2002).

Factors of importance for success

The following factors are some of the key elements in successful organisation of technology procurement:

- The selection of technology and markets that are suitable for technology procurement
- A well-prepared preparatory phase
- High credibility of the organiser of the programme
- High commitment of the organiser and the buyer group through the whole procurement process
- Long-term perspective
- Continuity throughout the programme
- Combination with other policy instruments and willingness to adjust the approach and involved policy instruments throughout the process.

International recommendations

To undertake technology procurement at an international level, it is recommended to start at the component level and with small systems as such technologies are less dependent on existing infrastructure and variations in culture and climate conditions. "For more complicated systems it is necessary to have very firmly pronounced high-level support and long-term commitment in order to be successful" (Westling, 2000: 16).

Programmes with need for more R&D

Holloman et al (2002) suggest the alteration of the technology procurement model in cases where the technology needs one to two years of further development before commercialisation. The model would include a two-stage model, where companies that are interested in receiving technical and financial support in late-stage technology development could participate in a competitive solicitation process. The winning company should be selected based on the highest willingness of cost-sharing, evidence on appropriate technical knowledge and product concepts or prototypes. In the second stage, the winning bidders from the first stage would be invited to compete on providing high-volume quantities of their products to an organised buyer group. The winners should be selected according to the performance of their products, price and ability to fulfil the anticipated purchase orders. The purpose of the second stage would be to support companies with the commercialisation of the products (Holloman et al, 2002).

Economy

The costs of setting up the IEA DSM Annex III programme in the period 1994-1999 were USD 900,000. An additional USD 100,000 was used on making workshops. A rough estimate of the total costs including costs for man hours is amounts to nearly USD 3 million (Westling, 2000: 16). In the period 1991-

1998, the economic framework for technology procurement in Sweden was approximately SEK 710 million (Lund et al, 1996).

Co-financing

The requirement of 50% private co-financing of Swedish technology procurement programme entails a risk for project budget to get artificially expanded. There is also the risk that the requirement for co-financing entails difficulties in carrying out the technology procurement as members of the buyer group might have difficulties in financing the preparation of feasibility study and development of technical specifications (Persson, 2004).

5.6.2 Characteristics of products and markets

The characteristics of the products that have been investigated are shown in Table 5.1. The technological complexity of the products ranges from single component to multiple systems. Technology procurement programmes are based on the setting up of technical specifications that the industry with a certain effort is capable of meeting. The technological changes needed to fulfil the technical specifications for energy efficiency have therefore been incremental. In the HyFLEET case, the hydrogen-powered buses were already available, the price and performance of the buses render them non-commercial products.

The potential markets have been large for all products. Some products have, however, turned out only to be sold in a niche market for high energy-efficient products. Typical characteristics of the markets where technology procurement has been used are large markets. The markets for white appliances are fragmented with many potential buyers. Other markets, e.g. the renting out of commercial buildings, are characterised by a few actors making up a large percentage of the market.

The purposes of all programmes except of the HyFLEET project have been to obtain a market uptake of more energy-efficient products. Energy efficiency is an add-on feature to the products that does not fundamentally change the functionality of the product. There are therefore limited regulatory issues to be considered when bringing these types of products on the market.

Table 5.1 Product and market characteristics of procured technology

		Product characteristics		Market characteristics		
Agent	**Product type**	**Technological complexity**	**Needed technological changes**	**Potential size**	**PP potential**	**Regulation**
NUTEK-STEM	Water mixer	Single component	Incremental	Large, MB	Small	Low
	Control and monitoring systems	Multiple systems	Incremental	Large, FB	Large	Low
	Sun shade technology	Single system	Incremental	Large, FB	Large	Low
	Oven	Single system	Incremental	Large, MB	Limited	Low
	Refrigerator	Single systems	Incremental	Large, MB	Limited	Low
E+	Refrigerator	Single systems	Incremental	Large, MB	Limited	Low
IEA	Motor	Single component	Incremental	Large, FB	Limited	Low
	Clothes dryer	Single systems	Incremental	Large, MB	Limited	Low
US	Refrigerator	Single systems	Incremental	Large, MB	Limited	Low
	Clothes washer	Single systems	None	Large, MB	Limited	Low
HH	Lighting system	Multiple systems	Incremental	Large, FB	Large	Low
HyFLEET	Hydrogen powered buses	Multiple systems	None	Large, FB	Large	Medium

Note: FB: Few buyers, HH: Hamburg, PP: Public procurement, MB: Many buyers.

Based on the evaluation of US approaches to technology procurement Holloman et al (2002) single out the following features as product characteristics suitable for technology procurement. The recommendations seem to be valid for technology procurement in general:

- Products or features are attractive to a large number of motivated buyers
- Products or features are not already widely available
- Products are standardised and mass-produced and not custom-designed
- More than one supplier can compete for the procurement
- Desired changes in products or processes are not so fundamental that they require long lead times for R&D
- The technology advances the manufacturers' strategic goals, e.g. reduced energy consumption (Holloman et al, 2002)

5.7 Drivers for companies to participate in technology procurement

Risk minimisation

The main reason for the companies to participate in technology procurement programmes has been to reduce risks connected with the market introduction of the technology. Different approaches have been chosen to minimise such risks. The US approach to technology procurement has emphasised the combination of technology procurement through competitive solicitation and the application of guaranteed sales or access to large financial rewards. Financial rewards have also been used in the European approaches where, in the IEA DSM Annex III project of procurement of a high-efficient clothes dryer, support was given to the initial purchase of units on the market. Similarly, a cash rebate of procurement of water mixers was given in the STEM project.

Cost of R&D

The companies involved in the technology procurement programmes have not received subsidies for the development of their technologies. All costs connected with R&D and the development of prototypes has been covered by the companies or through existing R&D funding. In some instances, the development of the winning technology has entailed considerable costs, in other cases the technological specifications have matched the present technological capacity of the company, and the development costs have then been limited.

Importance of buyer group

The buyer groups play a very important role in setting up the performance requirements. If the buyer group is constituted by reliable and large buyers, the input from the buyer group is of huge importance to the companies. The buyer group can help the companies to develop products that match their needs.

It is important that the specifications for the product also include non-energy related features as the products have to fulfil a range of requirements to be attractive to the buyers and end-users. The most important motivator for prospective buyers may be related to non-energy features of the technology. An example of this is procurement of energy-efficient clothes washers in Swedish apartment buildings, where the machines were quieter than earlier models (ten Cate et al, 1998). In an evaluation of US approaches to technology procurement it is concluded that non-energy related features of the technology often are more compelling reasons for the buyers to purchase the energy-efficient product than the actual energy savings are. Emphasis should therefore be put on highlighting such features in programme development and product promotion (Holloman et al, 2002).

Emerging markets

Manufacturers may be interested in gaining a foothold on new markets in order to capture new customers (ten Cate et al, 1998). A new product may entail a potential for development of solutions for an emerging market. This was the case in the technology procurement for controlling and monitoring systems, where the winning company Larmia got access to a new market.

Guaranteed sales

Most of the capable, potential manufacturers do not need a guaranteed delivery to the buyers of the product (Nilsson, 2003). If the product developers are convinced that the potential buyers will purchase the product and continue to do so, most product developers are willing to bring the product to the market without sales guarantees.

Key drivers to participate

The testing and evaluation of the technology by an independent agency was a key driver for many companies to participate in the procurement programmes. Being awarded a prize for the manufacturing of a superior product plays an important role for the companies' image and is therefore highly valued. The promotion of the product through newspaper articles, demonstration installations, participation in fairs, etc. are also very important drivers for the companies to participate.

The perspective of receiving financial support to secure market uptake of the product through cash rebates on the first items on the market is an effective instrument, but is often perceived as a less important driver than the dialogue with the buyer group, the testing and evaluation and being chosen as the winner of the contest.

In the SERP programme, the main driver for companies to participate was the positive public publicity received by the winner and not the prospect of getting access to USD 30 million of incentive money. Similarly, Gustavsberg perceived the positive impact on the company's image and the independent testing and evaluation of their product as the main advantage of winning the procurement contest and not the award of SEK 4 million of incentive money for cash rebates on their energy-efficient water mixer. In the case of the IEA DSM Annex III high efficient clothes dryer, the winning company AEG would, on the other hand, have preferred a guaranteed sale instead of the cash rebate on the market for the first volume of products.

There are some examples of technology procurement that have been unsuccessful as there has been a lack of incentive money to support the market uptake of the product. In other examples the need for market promotion of the technology has been rather limited. The experiences point to an absolute minimum requirement for market promotion, i.e. the establishment of demonstration installations or other pilot projects (Persson, 2004).

The US Department of Defence (DOD) committed USD 20 million over a three-year period to buy 6 million light bulbs that would use 25-30% less energy than conventional light bulbs. Each light bulb should not cost more than USD 3. The initial procurement was not successful in attracting bids that could meet the cost and performance specifications. A major reason for this was that even a purchase of this size by *one* customer did not demonstrate to lighting manufacturers a sufficiently robust long-term market that would justify the construction of an entirely new assemble line (ten Cate et al, 1998).

An important learning point is that technology procurement and other kinds of innovation procurement with respect to certain markets and product characteristics can be used to drive product innovation without direct investments in R&D and commitment to guaranteed sales.

In larger companies there are often different views on innovation of new technology internal in companies. The product development division might eagerly support development of a new product whereas other departments may be opposed to such projects due to lack of confidence in the market perspective of the product. In such cases, the external input on the company of the setting up of a technology procurement contest can be decisive for the company's decision

of taking the risk of developing the product (Tomas Dahlman, 4 July 2008; Hans Nilsson, 7 July 2008).

5.8 Potential application of innovation procurement policy

The purpose of this section is to investigate the potential application of innovation procurement policy within a range of product groups. The product groups are chosen as they constitute a potential for green public procurement. A range of companies was contacted in order to investigate what part of the development and commercialisation process of new, environmental-friendly products that constitutes the highest risk, and which role the public sector with respect to innovation procurement could play to mitigate such risks.

The investigated product groups include the transport sector, wastewater treatment, energy production, chemical substances, health care products and electric appliances. The interviewed companies from the transport sector include car and bus manufacturers, and manufacturers of alternative solutions to powering the vehicles.

5.8.1 Development of hydrogen fuel cell technology - H2 Logic

H2 Logic is a small Danish company that develop hydrogen fuel cell motion power solutions. The company's fuel cell technology is implemented in a range of demonstration projects.

The company has developed the product with research subsidies from public research programmes. The extent of support given in these R&D programmes covers the development of the technology up to - and including - the construction of prototypes and demonstration models. The production of a series of vehicles powered with the hydrogen fuel cell technology constitutes a large risk for the company, as there are not adequate instruments for financial support of this phase of the development.

The way to further develop of the technology is to scale up the production volume. The volume of the company's first generation hydrogen fuel cells is rather limited (around 10 examples). The next generations of fuel cells could be produced in larger series (up to around 500 examples). The testing and further development of the product in this phase is extremely risky. The construction of such a number of products is very expensive, and the products might not work satisfactory. Such errors therefore have to be detected and fixed. The product is sold under special conditions where the purchaser accepts a certain degree of temporary malfunctioning. After several generations of further development, the product can eventually be sold on a commercial basis. Even then, the company does not expect the product to be able to compete without subvention with other engine technologies. It will properly take several years before the product will be sustainable on the market without financial support. The prices of fuel cell powered vehicles in the scaling-up phase are considerably higher than the prices of vehicles powered by traditional engine technology. The higher price is due to the lack of harvest economies of scale.

Presently, there is a lack of public funding of the innovation in the phases between the development of the prototypes and until the product reaches the commercial market. Public procurement could here play a central role. A municipality might desire to acquire 100 fuel cell powered buses for public transportation. A consortium of companies including the fuel cell supplier and an automobile manufacturer could develop the technology. The costs of the limited series of hydrogen powered buses would, however, constitute such high costs that the buses would be extremely expensive. In order to promote the development of the technology, the municipality might be willing to pay costs that are a little higher than the market prices for other available technologies. In order to make the development of the product feasible, the hydrogen fuel cell manufacturer suggests that the excess costs primarily are covered by public development funding.

The existing Danish rules for tendering do not allow the municipality to engage in the above-mentioned kind of consortium. According to the existing rules, all potential tenders in EU must have the same opportunities to bid for the project. There are various problems associated with this. First, the municipality might not want to have the trouble of organising up a competitive tender process. Second, such bidding contests are very time consuming, and the need for awaiting the result of the bidding contest, and not knowing whether the company is awarded the contract in the end is an obstacle to H2 Logic because it could be waste of time and resources. Third, the Danish policy programme for developing hydrogen fuel cell technology aims at supporting Danish companies, and companies from other Member States are not likely to become funded within the programme (Mikael Sloth, 17 April 2008).

Potential for public procurement for innovation

H2 Logic is a small company that develops a technology which is very expensive to bring to the market. The existing possibility for obtaining support has made it possible for the company to develop the technology to the prototype and demonstration phases. The largest risk for the company is to proceed from the production of prototypes and demonstration models and to scale up the technology. The scaling-up is an important part of the development process as the technology has to be tested by the end-users to identify and amend possible errors. It is extremely expensive to produce such test series, and at this point the public authorities can support the technological development by purchasing a limited number of vehicles. The public procurer needs to be willing to take the risks of buying a product that firstly needs more service than the commercially available vehicles on the market and secondly where occasional malfunctioning might occur.

5.8.2 Development of electric vehicles - Think

Think is a small Norwegian manufacturer of electric cars. The company has recently commercialised a new electric car model. The development of the technology has been undertaken by private investors. There are large risks associated with the development of prototypes and demonstration models, but the largest risk is connected to the process of scaling-up production. The company is working on development of a car powered by Lithium-ion battery technol-

ogy.[8] In the spring of 2008, the company tested prototypes with Lithium-ion batteries. The problem of Lithium-ion batteries is to develop a proper power control unit that can control the charging of the battery and manage the distribution of power from the battery.

Before the Lithium-ion battery powered car can be commercialised, the technology must be tested under real-life conditions in approximately 350 vehicles, preferably with a geographical spread across different countries. Public innovation procurement of the Lithium-ion battery powered cars in the testing phase would assist the company in bringing a car with a better battery technology to the market (Richard Waitz, 23 April 2008).

Potential for public procurement for innovation

The largest risk assumed by Think in developing electric cars with Lithium-ion battery technology is connected to the scaling-up of the technology. The way that the public sector can help to mitigate this risk is by purchasing vehicles that are not yet commercialised. The public procurer will thereby take a part of the risk by purchasing vehicles that need more service than similar vehicles on the commercial market.

5.8.3 Development of motor technology for the transport sector - e-Traction

A small Dutch company, e-Traction, has developed a technology called TheWheel. The concept of TheWheel is electric motors placed directly in the wheels of a vehicle. The advantage is - according to the manufacturer - a significantly more energy-efficient propelling of the vehicle. With the current fuel prices[9], the consumption reduction would be approximately EUR 25,000 per city bus per year. The construction of such buses will reduce greenhouse gas emissions by 70 tonne CO_2 per bus per year[10] (Arjan Heinen, 4 August 2008). TheWheel technology has been developed without a market demand for the technology. On the contrary, the company has experienced a lack of interest from one of the potential markets, the bus sector.

The development of the technology was financed through own investments, external financing and through R&D subsidies and other types of funding. The existing opportunities of obtaining economic support have been adequate to develop the product to the prototype phase. The company has twice applied for funding from EU-projects, but the procedures have been too complicated. The company is too small and cannot spend the time and resources needed for applying for EU-funding.

The major problem for the company is to proceed from the innovation to the commercial phase where the scaling-up of the product constitutes the highest risk. Due to the relatively low amount of components bought by the company

[8] Since the interview with Think was conducted, the company has brought a Lithium-ion propelled electric car to the market.

[9] By August 2008.

[10] Payback time of the extra investment is three years while the lifetime of the bus is 12 years. At the end of its lifetime a new bus can be acquired for money saved by using the e-Traction system (Arjan Heinen, 4 August 2008).

for construction of products in the scaling-up phase, the unit prices are 25-30% higher than the prices paid by large manufacturers. Support to new innovative technologies in the commercialisation phase would be a great help to the company.

In the summer 2008, the company was manufacturing two buses that were to be operated in Rotterdam and five buses for Apeldorn. The buses are sold on a commercial basis, but e-Traction has had to invest money in the buses by themselves. The contracts contain a special agreement on service and problem-solving.

Potential for public procurement for innovation

The existing R&D subsidies have been adequate for e-Traction to develop the technology to prototype and demonstration phases. The highest risk of the company is the scaling-up of the product. The costs of developing the first volume of the product are very high as there is no economy of scale (Arjan Heinen, 14 May 2008).

5.8.4 Innovation procurement of buses - Mercedes-Benz Buses, Volvo Buses and Scania Buses

The city bus segment constitutes a very large share of the bus market. The bus operation is in many cities outsourced to bus operators. The bus operators have to comply with mandatory requirements set up in the tendering documents. As a part of the concession the local government set up requirements for the environmental performance of the vehicles. Due to a politically-based desire for a clean local air environment, the requirement for NO_x emissions of the vehicles often exceeds the present Euro standard of air emission levels.[11]

All bus manufacturers have invested in development of alternative technologies as hybrid technology, fuel cell technology and the development of engines powered by alternative fuels. The development of hybrid technology and the fuel cell technologies is extremely costly. The bus manufacturers use R&D subsidies, but such support only makes up a very little part of the resources spent on R&D.

Mercedes-Benz Buses and Scania have been involved in the testing of their vehicles, in cases where the vehicles have been sold on pre-commercial basis. The results from procurement of Scania's hybrid buses have not led to an increase in orders for buses (Urban Wastljung, 5 June 2008).

The bus manufacturers agree that the best way to support the development of more environmental-friendly buses is to include performance requirements in the tendering documents. The lead time of developing new technology is long in the industry, and the manufacturers therefore stress the importance of formulating technical specifications for new buses a long time in advance. For buses that are to be procured in 2020, the requirement that the public sector is going to apply should be set up now. If the procurers adhere to these requirements, it will be possible for the bus manufacturers to provide the technology. The requirements should be formulated as functional requirements, e.g. as maximum

[11] From September 2008, the industry has to comply with the Euro V standard.

emission of g CO_2/km, and not as requirements to the application of a specific technology. If the targets are clear, the bus manufacturers will know what they have to cope with, and the companies will be willing to make the needed investments to develop the technologies (Urban Wastjlung, 5 June 2008; Michael Goepfart, 29 May 2008; Ulf Gustavsson, 16 May 2008).

Potential for public procurement for innovation

The bus sector is an area, where there is a huge potential for driving innovation of the environmental technology by establishing performance-based requirements. Such requirements are already included in the tendering requirements for procurement of city buses. If CO_2 emissions were included as a requirement in the tendering documents, the bus manufacturers will have to develop technologies that meet these requirements. According to the industry, the bus manufacturers have the financial means to invest in the development of new innovative products. Clear targets for the emission standards to be met by vehicles are needed.

5.8.5 Car industry - SAAB, Honda and Toyota

Development of radical eco-innovations in the car industry is extremely costly and has a long lead time. Large car manufacturers, such as Honda and Toyota, have developed hybrid technologies, and Honda has recently commercialised a fuel cell powered car. The investments in the development of such technologies are primarily covered by the car manufacturers although a minor share of the costs is funded through R&D subsidies. SAAB has made incremental changes to their existing internal combustion engines that have made it possible to use 85% bio-ethanol fuel to power the vehicles.

The public procurement of cars does not constitute a high share of the total volume of cars sold. The public sector's purchasing power is therefore limited. The large car manufacturers are sceptical of the effectiveness of using public procurement to drive the innovation of technological development. If the public sector sets requirements to development of new car technology, the costs incurred will be substantial. Therefore, the car manufacturers do not perceive procurement as an interesting way to improve the environmental performance of their vehicles (Anna Petre, 3 June 2008; Stephen Stacey, 19 June 2008; Chris Roger, 17 June 2008).

Potential for public procurement for innovation

The car manufacturers do not see innovation procurement policies as realistic tools to develop new vehicles as the development of new technology is extremely costly and the public sector's procurement of cars does not constitute a sufficiently large share of the market making it economically feasible to develop special environmental-friendly cars. Procurement of products that are not on the commercial market may, however, constitute a potential for developing the technology further towards commercialisation.

5.8.6 Wastewater treatment sector - Paques B.V.

Paques B.V. is a Dutch company that is market leader in the development and application of innovative environmental biotechnology. Among other things, the company develops technologies for anaerobic effluent treatment and an-

aerobic purification installations for production of biogas. The company has a total of 320 employees in Holland and Shanghai.

One of the risks that the company is facing is long lead time involved in the development of their technologies. Another risk is finding new clients that are willing to invest in their technologies. Paques cannot afford failures on the way from pilot projects to full-scale projects, and their customers are not willing to take the risk. The companies refrain from developing environmental beneficial technology because of too high entry costs, long lead time of the products and lack of maturity on the market.

The company uses R&D subsidies, but it does not guide the company's target on development. The technological development is driven by the market expectations.

The public sector constitutes around 5-10% of the company's turnover, but it is becoming more important. The public sector is reluctant to invest in new technologies due to the public sector's strict control of their public position. New technologies will bring risks to the public authorities for which they cannot assume responsibility.

The maximum contracts that the company is capable of managing are in the range of EUR 10 million (Peter van Leeningen, 1 July 2008).

Potential for public procurement for innovation

Public procurement for innovation constitutes a potential in the wastewater treatment sector. The case of Paques shows that there are innovative environmental-friendly technologies that can be developed in the sector. The risks that innovation procurement policies can eliminate are risks associated with developing new technologies and risks associated with the scaling-up of such technologies. There is, however, a major barrier to the application of new environmental-friendly technologies with the public authorities as the public authorities are presently not willing to take the responsibilities for the risk associated with purchasing such technologies.

5.8.7 Wave energy - Wave Dragon

Wave Dragon is a small company that has developed a floating, slack-moored energy converter that produces power from wave energy. The technology is being tested for hydraulic behaviour and turbine strategy in a site installed offshore at Nissum Bredning, Denmark, where power is produced to the grid.

However, from a financial point of view, the technology is not easily scaled up from demonstration sites as the plant has to be developed so it matches the actual wave length and the significant wave height of real wave conditions. Nissum Bredning is chosen as the waves correspond to the waves in the North Sea with a factor 4.5. Consequently, it is possible to develop a 20 kW facility that is 1:4.5 of the size of a potential facility in the North Sea. In the summer of 2008, final testing of the prototype was conducted at the same site.

50% of the development costs of the basic R&D have been covered through R&D subsidies. Approximately 50% of the costs of developing and testing the

prototype at Nissum Bredning are covered by public funding, and the remaining costs are privately financed

A 7 MW demonstration unit in Wales is expected to receive maximum 35% grant (EU and local regional funds). The development of this 1:1 demonstration facility is very expensive, and the costs will be in the magnitude of EUR 25 million.

The European electricity market has been privatised during the last 10-15 years. The market is characterised by a few large electricity utility companies. The electricity utilities are not willing to take part in the risks of developing wave power. Some of the large power producers have indicated an interest in the technology, but they are not willing to invest in the technology before it has proven to work in the real environment, i.e. in the North Sea. In this respect, a major problem is that the technology has to be able to withstand severe whether conditions such as storms or hurricanes. If the technology is wrecked through force majeure, the question of who is going to cover the losses remains. According to Hans Christian Sørensen, Wave Dragon, the public sector could help solving this problem by assuming a part of the risk, e.g. by setting up a fund that would cover damage to the demonstration site in case of force majeure.

Although the public sector is a large consumer of energy, the purchasing of a demonstration facility or a commercial wave power site is not an obvious solution as the power supply has been privatized. This, however, depends on the specific power sector regulation in the Member States (Hans Christian Sørensen, 16 June 2008).

Potential for public procurement for innovation

The development for functional solutions to production of wave power constitutes a high potential for production of sustainable energy. The development of the wave power technology has been supported by existing R&D subsidy programmes. The risks that the company face are not easily solved by application of innovation procurement policies. In order to commercialise the technology, there is a need for use of policy instruments to help the developers share the risk. Innovation procurement policies are, however, not a suitable policy instrument for this.

5.8.8 Chemical substances - Danisco

Danisco, a Danish manufacturer of ingredients for e.g. the food and the plastics industry, has developed a product that can replace DEHP (Di(2-ethylhexyl)-phthalate). DEHP is assumed to cause hormonal disturbances. Dansico's product, Grindsted Soft-N-Safe is made of vegetable oil. The product is presently being in the approval process in the EU. The approval process is very expensive and time-consuming. Approval of the product costs approximately EUR 3.3 million, and the approval process may take several years. The approval of such products constitutes a high risk especially to small companies (Knud Alleman, 2 June 2008). Soft-N-Safe can be used in a range of hospital equipment, e.g. tubes and other plastic material that are in direct connection with the patients' body.

Public procurement of innovation could play a large role for bringing a product such as Danisco's to the market. The relevant market is characterised by strong price competition, and it is therefore difficult to introduce a new and more expensive product to the market. This problem is particularly felt when the functionality of the new product differs from the functionality of the traditional products, thus making comparison of products difficult. Although Soft-N-Safe is a product that is developed to a commercial level, there will still be a need for feedback from the users of the chemical in order to improve the product. If the public sector buys products containing Soft-N-Safe, this will send signals to the rest of the market about the quality of the product, which might lead to a greater market uptake (Bjarne Nielsen, 11 June 2008).

Potential for public procurement for innovation

The public sector constitutes a significant market for a range of products containing chemicals. The chemical market is characterised by fierce price competition. The public sector may play an important role in demanding products based on environmental-friendly substances. If, for instance, the public sector set requirements for DEHP free plastic tubes, it could trigger the development of such products. If the public sector sends clear signals about what kind of substances products should contain, and they are willing to pay for it, then there will be an incentive for the industry to develop the products. The chemical sector is subjected to the REACH regulation which implies that large investments have to be made in order to obtain product approval. Public procurement for innovation of environmental-friendly substances is possible, but an important issue to settle is who will pay for the approval of the products and on what terms.

5.8.9 Healthcare products - Coloplast Group

Coloplast Group is a worldwide provider of quality and innovative healthcare products, e.g. in areas such as ostomy, continence, wound and skin care products. The market for health care products is a highly regulated market with strict criteria for the chemical compounds used in the products. The development of new technologies is driven partly by market demand but also by feasibility of technologies.

The main focus for development of new products is quality and convenience for the customer using the product. Environmental requirements are always included in the product development, sometimes the company goes beyond the legal requirements - other times the company simply meet the requirements. Very early in the product development process, the product designers take into account which substances that they should use and which they should avoid.

The development of new products is very time-consuming and risky. New products have to go through a range of clinical tests as well as user tests in order to be approved. The testing of new substances in the product development is very resource demanding. Possible impacts by the substances should be identified through literature review, laboratory testing and field testing. It is not easy to replace substances in existing products as the new products have to go trough the testing and approval process. Products with environmental-friendly substances may have a negative impact on the product's quality and consumer convenience.

The public sector is a very important buyer of healthcare products. In many countries, the market for these products is characterised by being heavily subsidised by the public sector, in order to make the products affordable to the users. If the public sector is willing to pay the costs of development of more environmental-friendly products, the company will develop the products. Presently, the public procurers do not focus on the environment when procuring healthcare products. There is, however, a trend towards environmental issues gaining increasing significance (Birgitte Holm Christensen, 9 June 2008).

Potential for public procurement for innovation

The development of healthcare products is a highly regulated area. The development of new health care products focuses primarily on quality and consumer convenience. Environmental benefit is no easy add-on to the products, as there may be a contradiction between developing more environmental-friendly products and products that are convenient to use for the customer and of a high quality. It is very expensive to develop a product similar to one already existing on the market where certain substances are replaced. If innovation procurement policies should be used to develop new products, it should be included from the beginning of the design of new products.

5.8.10 Energy savings in electric appliances - Grundfos

Grundfos is a large Danish manufacturer of pump solutions. In the last 15 years, Grundfos has developed the circulator pump technology to a stage where it is significantly more energy-efficient. From 2001-2005 a shift in technological trajectory took place. Grundfos changed from a circulator pump technology based on induction motors to permanent magnet motors. The new, high-efficient pumping technology is less energy consuming.

The technological problem by this shift of technological trajectory was that the technology was 'immature'. Before the product could become a commercial product, technological development had to take place both in Grundfos and with its suppliers. One of the major challenges was to develop a built-in motor control that was much smaller than the ones previously used. Grundfos' suppliers had to develop the needed technological solutions. The 'maturing' of the permanent magnet motor circulator pump technology took long time during which Grundfos could not influence the speed of technological development of its suppliers. Concurrently with the 'maturing' of the circulator pump technology, due to economy of scale, the prices of the suppliers' components went down, and, hence, the price of the new circulator pump decreased.

Circulator pumps are one of Grundfos' core activities, and the development of a permanent magnet motor circulator pump technology was a necessary investment in future market share. Support of the technology through a cash rebate scheme could have increased early market penetration of permanent magnet motor circulator pumps as lower prices would have been a strong incentive for costumers to purchase the pump earlier. The speed of the technological development could, on the other hand, not have been improved.

With respect to the present circulator pump technology, there is, on the component level, not a high potential for more energy-efficient circulator pumps, but on system level, e.g. heating and air condition installations, circulator pumps

could be applied in more energy-efficient equipment. Participation in innovation procurement schemes constitutes a potential as the development of such facilities for public sector buildings could have a positive impact on market penetration of the product (Niels Bidstrup, 3 June 2008).

Potential for public procurement for innovation

A cash rebate support of permanent magnet circulator pumps could have helped bring the product to the market earlier. Presently, in Grundfos there is not a potential for innovation procurement of more energy-efficient circulator pumps. On the other hand, application of circulator pumps in more complex systems, e.g. heat and air condition installations, constitutes a potential for public procurement for innovation.

6 Policy practicalities

In markets were the public sector makes up a significant part of the market, the public purchasing power constitutes an important potential as a driver of development and commercialisation of environmental technologies. Bundling public and private sector demand can lead to 'critical mass' that gives technology developers a strong incentive to develop and commercialise new, environmental friendly products.

In markets where the public sectors purchasing power does not constitute a significant part of a potential product markets, e.g. energy-efficient white appliances, the public sector can potentially play an important role with respect to facilitating the development and market uptake of products with environmental characteristics. Experiences from technology procurement programmes applied in Sweden, US and under the auspices of IEA DSM Annex III show that there is a high potential for public involvement in facilitating the development and commercialisation of environmental benign products.

6.1 Innovation procurement policy

The kind of market failures that product developers face differs between sectors and product groups. An innovation procurement policy should be designed to tackle the market failures that hold back development and commercialisation of environmental technologies. Such a product innovation policy should draw on an array of measures that combined in the right way addresses the specific market failures in question.

The instruments that the policy should draw upon are outlined below:

Procurement of innovation

In product groups where the public sector constitutes the majority of the market for a product; public procurement can be used to purchase the innovation of products. The procurement can include the whole innovation process or be limited to certain phases, e.g. R&D, development of prototypes or demonstration facilities, limited series of products, etc.

In many environmentally related product markets the product developer is, however, willing to take the necessary risk of developing a product - e.g. an energy-efficient appliance - if the developer is confident that there will be a market for the product. The product developer is interested in having the intellectual property rights to the product. If the public sector purchases the innovation process, this leaves a potential conflict between the public body and the

private developer on the sharing of the intellectual property rights of the innovation.

Procurement of pre-commercial products

Within some product groups the procurement of products that are not yet on a commercial market can mitigate the risks of the product developer. This policy instrument supports companies in the up-scaling of product volume (or product size), and contributes to managing 'The Valley of Death' phenomenon (se section 2.1). Though the procuring body will have to take into consideration to what extent such products covers its needs.

The purchase of a fleet of hydrogen fuel cell powered vehicles entails an excess risk to the procurer of the product. The case of the City of Copenhagen show that reasons for public bodies to take the risk of purchasing a product - with a performance (e.g. in terms of transport) that potentially is inferior to other products on the market - are to support the development of the technology, to make environmental commitments and to get positive public attention.

The procurement of such products can entail higher unit costs and higher risks of inferior performance compared to traditional products on the market. The purchase of such products will require an EU-wide tendering process (see Appendix D). To comply with such a tendering process is time consuming and costly. The EU-wide bundling of various public bodies' demand can be a lever for carrying out such procurements. The cooperation between various public bodies will allow them to purchase larger series of products. This may entail some economies of scale. The cooperation between public bodies can also reduce the costs for each entity of preparing and carrying out the tendering process.

Product performance requirement

The basic element in the suggested product innovation policy is the public role with respect to defining product performance requirements. The environmental performance of the product is one among a range of important product characteristic, e.g. price and design.

The establishment of proper performance requirements reflects the potential market demand for the product.

Using buyer groups

Manufacturers normally wait until there is a demonstrated market before they develop and commercialise products, and the buyers want to see the product on the market before they buy it. The involvement of potential buyers in the development of the product through specifying their needs and how the desired product may contribute to cover these needs is convincing evidence for the product developer to take the necessary risks to develop and commercialise the product.

Bidding contest

The use of performance requirements can with advantage be combined with bidding contests. Bidding contests can be set op for product with certain desired characteristics.

Award of winner

The winner(s) of the bidding contest is awarded a prize. The prize may include one or more of the following instruments:

3rd part product evaluation	The use of independent evaluation of product performance is a very important innovation policy tool. This gives the company an independent non-biased evaluation of the product performance. For the product developer this is essential with respect to convincing potential costumer about the product's qualities. Third party product evaluation thereby contributes to ensuring market uptake of the product. In the case of development of energy-efficient water mixers, the public authorities facilitating the testing and evaluation of the product was of significant importance to Gustavsberg as this was an important way for the company to differentiate their product from their competitors' cheaper but less energy-efficient products.
Sales support	Sales support e.g. in the form of product cash rebates is a policy measure that in some cases can initiate market take-off of new products. Sales support schemes should be made in a way where the sales rebates structure is transparent both to the sales persons and the customers. Subsidies offer both greater security of demand and a demonstration effect for diffusion of technology into markets.
Dynamic Labelling	The revision of product labelling classes (e.g. energy labels) to allow the innovative products to differentiate their performance from products already on the market.
Guaranteed markets	Guaranteed markets - either trough sales guarantees or the setting up of minimum product requirements may be necessary for product manufacturers to develop and commercialise new products. This is for instance the case within healthcare products and the city bus sector where a precondition for the manufacturers to develop and commercialise environmental friendly products is some magnitude of guaranteed sales or customer-defined product performance requirements. Experiences from public procurement of city buses show that the performance requirements that the set-up of public procurement authorities for city buses in large European cities has been a main driver for the development of environmental performance of city buses. These public procurement authorities have formulated performance criteria with respect to e.g. NO_x and solid particle emissions that are more demanding than the requirements of the Euro norm standard. The bus manufacturers have had to make the needed technological adjustments to their buses in order to qualify for sale of city buses on these markets.
Green public procurement potential	The prize of the bidding contest could also include that public procurement authorities have to match the product performance criteria for future public procurement with the performance of the winning product.
Information, awareness raising and demonstration	A range of further instruments can be applied in order to support market uptake of products. Such measures include information an awareness raising campaigns (e.g. newsletters, newspaper articles, participation in fairs, workshops, etc) and the establishment of product demonstration facilities.
Combination of instruments	Technology procurement has shown to be most successful if combined with other policy instruments, e.g. coordinated rebates, promotional campaigns, vol-

ume purchasing by large buyers and voluntary or mandatory efficiency standards (ten Cate et al, 1998; Westling, 2000).

The right combination of instruments is therefore decisive for making successful product innovation projects. If there is more than one market failure in the innovation process, it may be necessary to use a combination of policy instrument to mitigate these market failures.

It is important that there is a high degree of flexibility to change the application of policy instruments during the process, as the outcome of the policy instrument is not always predictable. An example is the case of the STEM-BELOK sun shading programme where the procurement did not find a winner. In order to continue the work, it was decided to transform the project to a demonstration project of the best solution.

Experience from the technology procurement programmes shows that cash rebate is an efficient instrument to bring products to the market. However, the dialogue with the buyer group, the product testing and evaluation and being appointed as winner of the bidding contest are often more important drivers for companies to develop and commercialise products, as the combined use of these instruments may more effectively mitigate the risk related to market uncertainties.

External input's impact on enterprises' decision making

In large companies there are often different in-house views on innovation of new technology. The product development division might eagerly support development of a new product whereas other departments may be opposed to such projects due to lack of confidence in the market perspective of the product. In such cases the external input on the company of the setting up of an innovation procurement programme can be decisive for the company's decision to take the risk of developing the product.

Framework conditions

Innovation procurement projects are not only about developing new technology, it is also about ensuring that the right conditions are in place for a market uptake of the product. The necessary infrastructure has to be in place to ensure the market uptake of the product. The public procurement of, for instance, hydrogen fuel cell powered vehicles only makes sense if the needed fuel infrastructure is included in the project.

Limits of product innovation policy

An innovation procurement policy is not always an efficient way to support development and commercialisation of products. The price of the developed product is crucial for the potential success of an innovation procurement programme. Energy-efficient applications offer long-term energy savings. If the potential energy savings throughout the product's life span lead to economic savings that exceeds the additional costs of the product the consumer gets an incentive to purchase the product.

Where an environmentally benign product does not lead to economic savings, and the product's performance does not exceed the performance of other products (in terms of non-environmental product performance), the consumer does not have an economic incentive to purchase the product. The benefits in terms of environmental commitment, environmental branding and/or support of eco-innovation are the drivers of potential buyers to purchase the product. The en-

ergy-efficient motors developed by ABB are an example of products that did not reach market uptake - probably due to too high unit costs.

If it is not easy to establish buyer groups that reflect an important market share, it can be very difficult to use innovation procurement policies. An example is the car industry, where private consumers make up the majority of the market. Fuel efficiency is only one among a range of parameters that the consumer takes into account when buying a car. It can therefore be difficult to establish a buyer group that will convince the large car manufacturers to take the risk of developing and commercialising environmental-friendly vehicles (the case of Think, on the other hand, shows that the public sector's limited purchasing power in this sector still can have an important impact on the development and commercialisation of e.g. electric cars).

The development of wave power technology is another example where the risks faced by the product developer are no easily solved by the use of innovation procurement policies. The risks that the product developer faces are related to large-scale investments, hazards of extreme weather events and problems associated with the infrastructure of the energy sector. Risks that are not easily mitigated by the use of innovation procurement policies.

Coordinating efforts between governmental bodies

Cooperation between governmental agencies is crucial to ensure the success of innovation procurement projects. The bundling of demand is necessary to ensure a strong public purchasing power and to establish environmental product performance requirements. In the CUTE programme local representatives from the cities of Amsterdam, Barcelona, Berlin, Hamburg, London and a representative from the Canadian province of British Columbia agreed on a 'Memorandum of Understanding' in October 2006, establishing a purchasing alliance of procurement of hydrogen buses. The purpose of establishing this network was to guarantee a reliable demand for hydrogen fuel cell buses, encouraging the vehicle industry to develop hydrogen fuel cell buses that are technically and economically ready for series production (Rambøll, 2008: 6.9.2).

6.2 Risk analysis

The very nature of innovations is risky as the stakeholders involved in the innovation process do not know whether the innovation will succeed. A procuring agency involved in public procurement of innovation therefore has to take risk evaluation into consideration, including evaluation of the likelihood of success of the procurement and the potential impact of the innovation has to be considered.

Based on Edler et al (2005) a model for risk evaluation of public procurement of eco-innovation has been set up, see Table 6.1

The likelihood of success depends on the risk level of the innovation. The higher the risk, the less likely the innovation is to succeed.

High uncertain procurement is the procurement of radically new probably service-based products. The innovation has a high risk of failing, if it fails the only advantage to the company involved and to the economy will be the ad-

vancement of knowledge and training of the persons involved in the procurement.

Table 6.1 Risk evaluation of public procurement of eco-innovation

	Low potential impact on the environment	**Medium potential impact on the environment**	**High potential impact on the environment**
Highly likelihood of success of the innovative elements of the procurement	*Case 1*: Highly probable success with limited impact: It is worth trying	*Case 2*: Highly probable with medium impact, even more worth trying than Case 1.	*Case 3*: The typical innovation procurement. It would be a mistake not to try.
Medium likelihood of success		*Case 4*: It may be worth trying, depending on overall budget constraints and the potential of risk sharing	*Case 5*: Worth trying as much as case 2.
Low likelihood of success			*Case 6*: It may be worth trying only if sufficient information is available, risk is shared and industrial policy budget is available.

Note: The table is inspired by Edler et al (2005: 34).

High risk procurement also refers to the procurement of radical new innovation. However, the probability of success is roughly known and the cost-benefit is the same as above.

Medium risk occurs where the procurement deals with the diffusion and transfer of technical solution that exist elsewhere.

Low risk occurs where there only is the need for minor adaption of existing innovation, or where the technical solution calls for new standards (Edler et al, 2005: 32-33).

6.2.1 Risk minimisation

Risk minimisation is essential in application of innovation procurement policy. The risks should be minimised and distributed to those actors best suited for handling the risks. This section focuses on the public procurer and the facilitator of procurement based product innovation.

In regular R&D projects failures are normally an accepted outcome of the project, and R&D efforts can still contribute with experience and knowledge.

Defining success

The experiences from technology procurement projects show that some of the developed products are successful in terms of achieving market uptake - others not. The products that do not get a large market uptake may still entail important technological achievements that can be used in other products. It is crucial

that the involved stakeholders agree on the criteria for success of an innovation procurement project. For some product groups, e.g. energy-efficient applications, the aim of a project is to bring a product to the market *and* to ensure the market uptake.

Where the public sector purchases pre-commercial products, e.g. hydrogen-powered vehicles; the purpose of the procurement may be limited to support the development of environmental-friendly products - and not to aim at a market uptake of the product. From the public procurement authority's point of view the product has to meet the agreed performance requirements in order for the procurement to be successful.

There is no easy answer to the question of what is the acceptable risk of failure. The risk of failure should be proportional to the potential benefits gained through the procurement project.

Risk for facilitator

A failure of an innovation procurement project can be either due to an unsuccessful procurement process or an unsatisfactory product output.

The process of a project may turn out to be unsuccessful due to a broad range of reasons, e.g. the organising body of the procurement project does not have the needed capabilities, the allocated resources are to scarce, there is a lack of interest for or long-term commitment to the project among the participants, the timing is bad, etc. In section 6.4 the necessary framework for carrying out innovation procurement projects is outlined. The recommendations aim at ensuring a high success rate - and hence reducing the risks of failure.

The Swedish National Energy Administration (STEM) has comprehensive experiences in facilitating technology procurements. A project that has not achieved its initial objectives, e.g. in terms of a bidding contest leading to the award of a winner, does not entail that the project is perceived as a failure project. As none of the submitted products could comply with the product requirements in the Swedish technology procurement project for development of sun shading technologies, no winner was selected. Instead it was decided to transform the programme into a demonstration project for testing of the products submitted in the bidding contest. The testing of the product showed that the product submitted by Sompfy indeed entailed large energy savings. The flexibility of refocusing the aim of an innovation procurement project can help ensure a successful outcome of the project.

Risk for procurer

If a public body decides to purchase a product that is still in a pre-commercial phase, e.g. hydrogen fuel cell or electric-powered cars, the public body will have to minimise the risk of ending up with a product that does not work satisfactorily. The risks should be minimised by making as thorough market and product investigations as possible identifying the project entailing the most acceptable risks. The basis for public authorities' involvement in product innovation projects should therefore be trough development of a feasibility study identifying risks to the involved stakeholders.

The public body has to compare the risk of purchasing a product that potentially has a lower performance (e.g. in terms of transportation) than a traditional product on the market to the benefits of the procurement. The potential benefits

include support to the development the technology, environmental commitment and positive public attention.

6.3 Capabilities required of the procurement organisation

Taking care of procurement of innovation is demanding for the procurement organisation. There is a range of internal conditions and market conditions that are decisive to the success of the procurement process.

To deal with procurement for innovation, the procurer has to have a good understanding of the market, awareness of the different technological alternatives and an understanding of what the market can deliver today and in the future (Bodewes & Boekholt, 2006; Edler et al, 2005). To cope with procurement for innovation the procurer has to have insight into the existing technologies on the market and an understanding of the market areas' importance for the economy and how mature the market areas are for innovation (Edler & Georghiou, 2007). The procurer has to be able to make an evaluation of the risk of entering the procurement, and the setting up of the tendering process is a demanding task. "Key aspects in drawing up tendering specifications include specification of needs, tender structure, defining the ability of possible suppliers, and management of risk" (Edler et al, 2005). The tenders have to be assessed and contracts must be awarded. The success of this phase of the procurement process depends on the quality of previous phases, i.e. the gathering of market intelligence and the setting up of tender specifications. Moreover, mechanisms have to be set up for managing contract delivery, where the progress of the innovation process has to be monitored and evaluated (Edler et al, 2005).

The procurer in charge of the procurement is often not the end-users that are going to use the innovation. This calls for coordination in the procuring organisation, where technical experts contribute with specifications of the innovation and the requirements, the desires of all users have to be known and contacts should be established to the end-user throughout the process (Edler et al, 2005). To carry through the procurement for innovations, the procurement organisation must be skilled in contract and project management, have procurement skills and have access to legal advice.

Use of contractors

The requirements of a public body that is interested in participating in public procurement for innovation is therefore very demanding. Many public organisations will probably refrain from initiating such public procurement programmes due to lack of the needed capabilities. A way to overcome this barrier is to organise product innovation programmes in a way that reduces the role of the public body to facilitation of the process. This can be done by the use of external experts.

6.4 Practicalities in application of innovation procurement policy

Public agent as facilitators of the process

A public agent should be responsible for forming the structure of innovation procurement projects and facilitating the tasks undertaken. In this capacity, the public agent plays a key role in the process and should therefore have the

proper qualifications to carry out the project. In case of lack of experience the public agent will need proper training. It is of utmost importance that the public agent has a high credibility and is deeply involved in the project.

The design of procurement contracts governs the way it stimulates innovation. Many procurement contracts have focused narrowly on highly specific uses, and there has been little focus on the wider application of the innovation. This has particularly been the case in defence-related procurement.

An innovation procurement project should be organised as an open and fair bidding contest where all companies meeting certain requirements can participate. The methodology of an innovation procurement policy programme is structured according to following seven steps:

1 Preparation of a feasibility study

2 Creation of a buyer group

3 Formulation of technical specifications

4 Tendering process

5 Evaluation of tenders

6 Promotion and spreading of information

7 Further development.

The first task is to set up a feasibility study. Sufficient time and resources should be used to make a well-prepared feasibility study.

Feasibility study

The feasibility study should answer the following questions:

- What relevance has the suggested product to the environment?
- Who are the important stakeholders to involve?
- Who are the potential buyers of the product and how are they organised?
- What are the market trends for similar products?
- What share of the market constitutes public procurement?
- How do the technological capacities of the industry match the desired product?
- What incentives would companies have to participate in the project?
- What are the existing barriers in the market?
- What risks does the project entail for the involved companies and how are these risks best mitigated?

The feasibility study should also identify:

- The criteria against which the technology should be evaluated.
- The need for evaluation of existing products on the market.
- How to test the developed products.

- The setting up of scenarios for the outcome of the project.
- A simple risk analysis of the project.

Based on the feasibility study an array of policy instruments should be combined in order to ensure the success of the project. The project should be organised in a way that secures the lowest costs for the public sector. In technology procurement programmes the public sector does not invest money in R&D and the public sector does not purchase a limited series of pre-commercial products. Still, the manufacturers have participated in the programmes and developed prototypes without getting financial support in the programme. The main reasons for the companies to participate are to get access to a (new) market. And the main incentives are the link to the potential buyers, the testing and evaluation of their product by an impartial agent and the support of bringing the product to the market through dissemination of information. Guaranteed sales and cash rebates have been important instrument but is perceived as less important than the above-mentioned drivers for participation.

If the market perspectives for the product are very uncertain, it should be strongly considered whether it is worth going for the development. By bundling the public sector's demand, a strong demand for particular product can be made. The public sector is, however, in general averse to risk and there are therefore limits to the price the public sector is willing to pay for an environmental feature of a product or service. Guaranteed product markets can be a way to bring new products to the market. An example is the development of more environmental-friendly city buses, where the public sector is an important procurer, and the guaranteed product markets will drive innovation among the bus manufacturers. Similarly, the guaranteed markets for hospital equipment without DEHP can bring such products on the market, and when the products have first proved to the market that they are functional quality products, a wider market uptake of the products is likely. In cases where the unit price of the product is very high and a limited series product has to be tested, the purchase of these not-yet-commercial products can play a significant role in bringing such products to the market.

Based on the feasibility study it should be possible to make this kind of considerations.

Creation of a buyer group

The buyer group should be made up by potential buyers of the product. The composition and involvement of the buyer group in the project is essential for a successful outcome. The buyer group should be able to meet the following criteria:

- The buyer group constitutes a considerable market share, so there will be a market for the product.
- The interests of the buyers, their preferences, market perspectives and willingness to buy are decisive for the success of the project.
- The members have a personal interest in the development of the product.
- The members take personal responsibility for the procurement project.
- The members push the process forwards.

- The members have a mandate from their employer to make decisions.
- The members disseminate information on the project in the organisation where they work.

If the feasibility study points against the need for guaranteed sales of a product in order to bring it to the market, potential buyers interested in making such orders should be included in the buyer group.

These buyers can both be private and public bodies. It should also be considered if there is a need for third party funding of the product. Hydrogen fuel cell powered buses may for instance be so expensive that the buyer cannot pay the full costs of the product. Public development funding could be used to assist the financing of such products. Though, it should be settled under the conditions where such funding may take place.

There are some practicalities that should to be taken into consideration when creating a new buyer group. The purchasing power of the buyer group's potential members is important as the buyer group has to make up a promising market. An example of a buyer group that constitutes a significant share of the market is BELOK (the Swedish Procurement Group for Commercial Buildings). In 2007, BELOK's members together owned 17% of the heated area in commercial buildings and the BELOK member's investments made up 32% of the total investment in the commercial building segment (Bertelsen, 2008). However, buyer group members' commitment to the innovation procurement project is also decisive for a successful outcome of an innovation procurement programme.

The forming of a buyer group should be seen as a continuous process, where new members may be added to the buyer group during the innovation procurement process. STEM's experiences with creating buyer groups show that potential members of the buyer group should be involved very early in the innovation procurement process. In some cases the buyer group members have even made the initial suggestions for the technology procurement. The buyer group members' involvement in early discussions of performance requirements and potential demand for the desired product is very important to steer the process in the right direction. During an innovation procurement process, the initial buyer group can be expanded with more members adding to the total purchasing power of the buyer group. The selection of members to new buyer groups has in Sweden largely been based on personal networks (Tomas Berggren, 7 May 2009).

As a step in the forming of EU wide buyer groups, it should be analysed to what extent national and regional differences in the EU influence on the potential buyer group members' demand for the desired technology. There are for instance significant differences with respect to the demand for cooling and heating of building between North Europe and the Mediterranean region. Potential members of buyer groups could be identified based on national and pan-European networks. Examples of such networks are established in relation to the Lead Market Initiative, existing green public procurement networks and other Commission groupings, including the Retail Forum.

It is either possible to use the same buyer group in more projects or to change the buyer group from project to project. Whether permanent or changing buyer groups should be used depend among other things on the kind of product or system to be developed.

Where public entities form buyer groups in order to purchase pre-commercial products (e.g. hydrogen fuel cell powered buses), the purpose of the procurement is to support the commercialisation of the product - but not the market uptake of the product. The unit size of the initial buy will be limited and the buyer group does not have to constitute a considerable share of the market. The size of units should be designed in accordance with the product developer's need of testing the product.

Early in the process, the programme developer should interact extensively with potential suppliers of the product. Through the early contact with the industry, the manufacturers optimise the time available for providing bids. Moreover, the early contact helps the manufacturers to engage early in the project, and the buyer groups get the opportunity to find out how far the industry is from being capable of meeting the technical specifications.

Formulation of technical specifications

A carefully prepared formulation of a Request for Proposal (RFP) is crucial to the success of the innovation procurement project. The technical specifications should be established by the buyer group in cooperation with external experts. The experts should have knowledge of the environmental potential of the specific product.

The technical specification should be formulated in a way so that:

- Environmental aspect is just one feature of the product.
- Other features regard installation, service, price, security, design, etc.
- All technical specifications are performance requirements.
- The specifications are ambitious but possible to meet.
- The criteria against which the products will be evaluated are stated.

Before the final technical specifications are formulated, it is value adding to discuss the proposed requirements with potential manufacturers at a workshop. Feedback on the proposed requirements can then be included in the final RFP.

An important issue is the price-performance ratio in the technical specifications. The price factor was given very little weight in the technical specifications in the Energy+ project. This meant that there was little guidance for Electrolux to optimize the product submitted. The case of technology procurement of an energy-efficient clothes dryer did not lead to a market uptake of the product as the original unit price was too high.

If the feasibility study concludes that a precondition for the commercialisation of the product is financial support to R&D, there are two options. A separate R&D project can be initiated where subsidies are only given to projects that meet certain technical specifications, or R&D subsidies can be included in the innovation procurement project. The winner could be chosen according to the

tender that has the highest willingness of cost-sharing, has evidence on appropriate technical knowledge and product concepts or prototypes.

Evaluation of bids

The bids submitted are evaluated with respect to what extent the technical requirements are met. The way each criterion of the requirements is weighted is decisive for further product development. In the case of technology procurement of SERP refrigerators, the manufacturers had incentives to construct large instead of small refrigerators - although large refrigerators consume more energy than smaller units.

The setting up of requirements that *must* be met and requirements that *should* be met has proved to work well in Sweden.

The costs associated with the testing and evaluation of products are highly dependent on the complexity of the product. It is much more expensive to test and evaluate the energy efficiency of multiple systems than of single components. The approach to testing and evaluating a product differs from product group to product group. For healthcare products the testing of products is a prerequisite for the manufacturer to obtain product approval.

The testing and evaluation of products by an impartial entity is very important to companies and is perceived as one of the best ways of mitigating risks. The impartial testing and evaluation of their product plays a significant role for the companies, as it supports the credibility of the product and thereby assists the market penetration of the product.

Promotion and dissemination

To be awarded the winner of an innovation procurement contest is highly valued by many companies. The company gains prestige and there is a lot of positive publicity associated with winning such prizes. The promotion of the product should, however, be systematically carried out on a long-term basis subsequent to the choice of the winner. The Swedish approach to technology procurement has shown in various cases to be insufficient in its long-term commitment towards the promotion of the new product. Promotion and spread of information can include campaigns, newsletters, newspaper articles, participation in fairs, workshops, etc.

An example were the commitment did not endure was the development of an energy-efficient cooker. By the time, that Electrolux's cooker was announced as the winner, STEM had lost its interest in the cooker and failed to deliver the promised promotion.

Further development

An important aspect of an innovation procurement project is to secure further development of the product. Both successful projects as well as projects where the developed product is not satisfactory to the buyer group have to be further developed. How such further development should be approached largely depends on which stakeholders have the largest interest in the further development.

By applying this methodology with respect to innovation procurement, successful innovation procurement of environmental-friendly products can be achieved. However, it is important to ensure that the involved actors have a long-term involvement in the project. Results do not come easily, and some-

times it is necessary to await the right timing - both suppliers and buyers have to be mature with regard to developing the product and being willing to buy it respectively.

Methodologies for pre-commercial procurement from other sectors

As described in section 4.4.2, a methodology for pre-commercial procurement has been suggested, by which a public entity procures innovation from private companies. The procurement can take place in a solution phase, a prototyping phase and/or a scaling-up phase. In these phases, solutions, prototypes, and a limited series of product can be purchased. In a recent report the potential for application of this model in ICT-related sectors was investigated. It is concluded that there is limited experience with the application of such procurement schemes in Europe. In small business research programmes the model has been applied, but it is too early to evaluate the result (Rambøll, 2008).

The cases investigated in this report do support the notion that a phase divided approach can mitigate risks in the scaling-up phase, where the procurement of a limited series of product can support the commercialisation of the product - this especially applies to SMEs. The findings of this study do, however, not indicate that the application of a phase divided approach in the solution and prototype phases is needed to develop environmental-friendly products.

In sectors where public procurement constitutes a significant market, it is the end-market that the companies are interested in. Rather than selling the development of the innovation, the companies are interested in getting access to the product market. The market potential is therefore a much stronger driver than the perspective of only participating in one phase of the procurement programme. Instead of mitigating risks, the proposed approach could create risks to the companies. The companies participate in the programmes in order to develop a product for which they want the intellectual property rights. If the companies cannot keep the intellectual property rights to the innovation they develop, they will have to be compensated financially. If the companies are ruled out of the competition, the time and resources invested might be in vain.

To ensure competition between companies more than one product may be chosen as the winner of the innovation procurement contest.

6.4.1 Structural requirements

Innovation procurement policies can with advantage be applied on an EU level. Experiences from the Swedish technology procurement programme point to the potential of a large European market will be a main driver for technology developers to participate in product innovation projects. The potential of a European market will mitigate end market uncertainties.

The Commission services role

The setting up of an innovation procurement programme could therefore with advantage be organised under the auspices of the European Commission. The Commission services should be responsible for the facilitation of the product innovation programme, the selection of potential products, the creation of buyer groups, award of winners, etc. It is important that the cooperation with the stakeholders takes place on a continuous and long-term basis. Particularly in

the start-up phase much effort must be devoted to the creation of a framework for the procurement programme. This will be time-consuming and costly.

The Commission services have to build up a network of experts. Each product type included in the programme requires a team of experts. Experts with insight into the present product market should be used to prepare the feasibility study.

The Commission services should initiate procurement programmes of pre-commercial products and the relevant public bodies should be encouraged to participate in buyer groups for procurement of such products. The Commission services should also provide the relevant public bodies with information on available pre-commercial products that will be viable to purchase.

Funding scheme

The procurement of pre-commercial products not only entail costs of preparing and carrying out the tendering process, the unit price of such products is likely to be higher than the unit price of similar, traditional products. Only large cities normally have the resources to purchase pre-commercial products. A funding scheme for public procurement of pre-commercial products should be established. This would allow small public entities (e.g. municipalities) to participate in programmes aiming at procurement of pre-commercial products.

Selection of products

The selection of potential products is a key issue, which there is elaborated on below (see section 6.5). The identification of potential products should draw upon a network of potential users and product buyers.

Buyer groups

The establishment of buyer groups is essential to the success of the programme. The buyer group could include both public and private stakeholders. To best illuminate the market needs and potential market demand the buyer groups should include representatives from several Member States.

Public attention

Calls for tenders and the selection of winning products should be given sufficient public attention. The public attention makes the programme more attractive for the technology developers to participate in the programme.

Further development

The Commission services should keep an ongoing dialogue with the buyer group and product developer on needs for further development of the product, and the Commission services should work for a proper and lasting public attention and interest in the product.

6.4.2 Estimate of needed investments

An important lesson learnt from the technology procurement programmes is that it is possible to get far with product innovation procurement without investing directly in the product development and without guaranteeing sales and promising sales rebates.

The investment of money in the product development process should be regarded as 'a last resort'. If it turns out that the instruments available in the technology procurement approach are inadequate to get potential tenders to submit contribution to the product innovation programme, then it should be considered to invest in the development process.

Experiences from technology procurement programmes show that there is no easy answer to the amount of money that has to be invested in innovation procurement projects. The success of the procurement depends on the size of the initial buy (in terms of Euro, units or market share) as well as a range of other factors - many mainly symbolic.

With respect to the costs of organising a specific innovation procurement project, the associated costs depend widely on the desired product. The estimated costs of a feasibility study are EUR 50,000 - 100,000. The costs of testing and evaluating products depend on the characteristics of the product, e.g. the technological complexity. The costs of facilitation of a project, evaluation and testing and information spreading are estimated to EUR 100,000 - 500,000 (based on the experience from the Swedish technology procurement case study as described in chapter 5).

6.4.3 Legal aspects

From a legal point of view, there are no obvious barriers to carrying out innovation procurement programmes. A contracting authority may find it sensible to initiate an innovation procurement procedure by extensive contact to the market. By assuring that this 'technical dialogue' does not distort the possible later competition, the contracting authority may decide whether to start a R&D procedure or a regular public procurement procedure, such as a competitive dialogue or negotiated procedure. Depending on the complexity of the contract, the contracting authority may start a procurement procedure based on the findings of the technical dialogue.

On the other hand, the contracting authority may decide that the technologies and specifications of the product are still so unclear that a R&D procedure exempted from the public procurement procedures may be needed. This R&D procedure may eventually lead to a separate public procurement procedure in order for the contracting authority to achieve the products or technologies formed by the R&D (see appendix D).

6.5 Identifying product categories for innovation procurement policy programmes

Attractive product markets are either large markets or niche markets. Innovation procurement policies can be applied in the event where the public sector's procurement constitutes a significant market and in case the public sector's procurement is less important.

A range of considerations is needed to decide on product group to go for in a product innovation project.

6.5.1 The need that the public procurement fulfils

The way public procurement should be used depends on the needs that the procurement aims at fulfilling. Where the public sector makes up the majority of a potential product market, e.g. high speed trains, the procurement only has to cover the public sector's needs. If the market primarily is made up of the private

sector, e.g. white appliances, the procurement will have to be shaped in a way that covers private sector needs.

6.5.2 The role of the procurement with respect to the existing technological trajectory and the market

The innovation can constitute anything from a radical shift from existing technological trajectories to incremental adjustment of the existing technology. The more radical the innovation, the more subjected to risk the innovation process will be. Exploration of new technological trajectories constitutes a big risk. If there is a risk that a technology never becomes commercially feasible, the development is costly and time consuming.

The public procurement can play different roles towards the market. The procurement can develop new markets that do not exist, it can escalate existing markets and it can consolidate markets.

Market initiation

Market creation can be used to develop new markets. However, for most environmental-related technologies, there will already be a market for the products.

Market escalation

Market escalation is typically relevant for environmental technologies. There is a potential market for the product, e.g. water mixers, but the market acceptance to an energy-efficient water mixer is uncertain.

Market consolidation

Market consolidation takes place, where a product exists on a market, but where the market has not decided on standards and where the performance criteria of the product is not is not finally settled. Procurement can be used to establish 'critical mass' for the acceptance of new or alternative technologies.

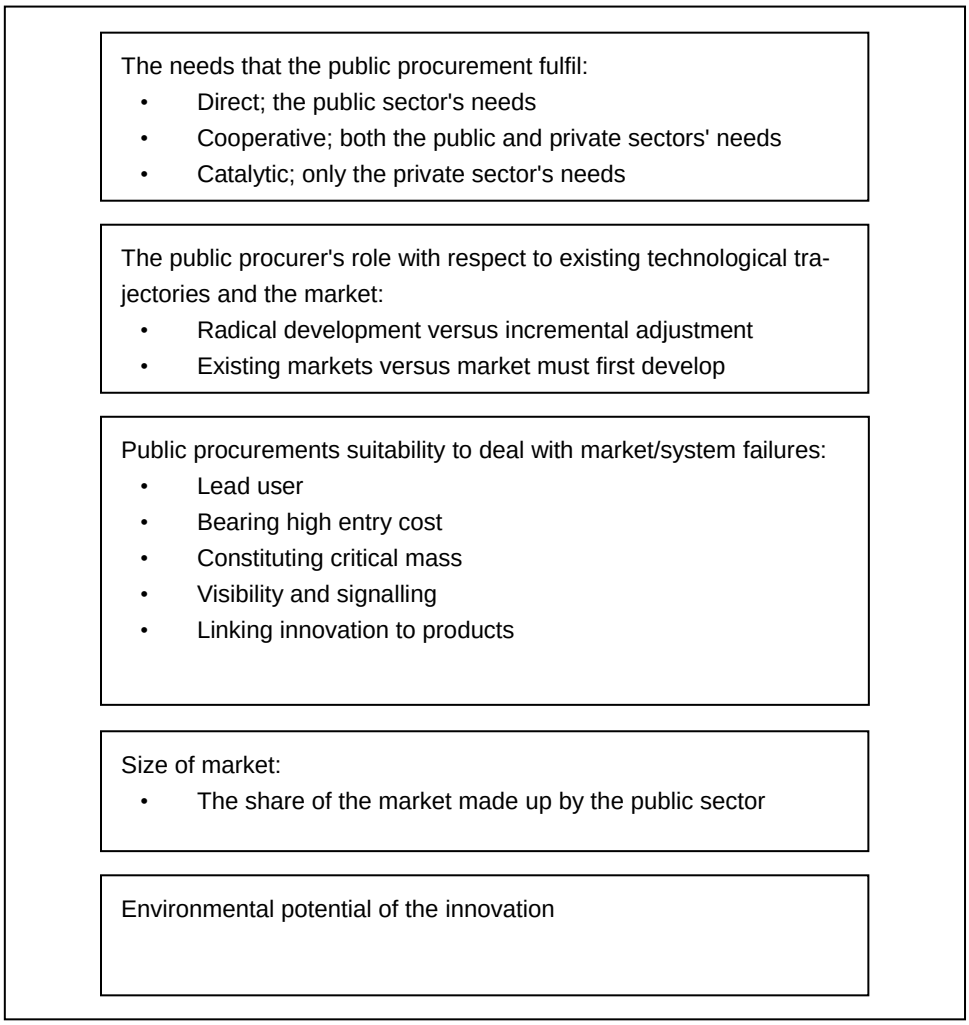
6.5.3 Public procurement suitability to cope with market/system failures

The nature of public procurement can cope with some of the market failures that hold back the development of technologies. The potential of the public procurement is that the public sector can act as a lead user of the technology, it can bear higher entry costs, by bundling its demand public procurement can constitute a critical mass, by acquiring new green technologies the public sector can support the technologies by sending specific signals, and, finally, through public procurement the technological capacities of the private sector can be supported.

Some product types constitute a larger environmental potential than others.

The parameters that can be used to find potential product groups for public procurement of eco-innovations are shown in Figure 6.1.

Figure 6.1 Parameters determining choice of product groups



6.5.4 Product groups where the public sector makes up important share of the market

Figure 6.2 shows the product group that the public sector in EU is purchasing, and where green public procurement can be applied.

Figure 6.2 Product and service groups applicable to green public procurement

- Construction
- Chemical products (rubber, plastic)
- Cleaning products and services
- Construction products including heating/cooling/lighting appliance
- Construction work
- Machinery communication equipment
- Energy
- Food products
- Furniture and other manufactured goods
- Horticultural services
- Medical devices and pharmaceutics
- Office machinery (computers/monitors/printers/copiers)
- Paper, printing services
- Sanitation and environmental services
- Sewage and refuse disposal services
- Transport and communication services
- Transport equipment

Source: http://ec.europa.eu/environment/gpp.

Within green public procurement extensive research has been made on identifying the benefits and costs of product categories with the biggest 'green' potential. Figure 6.3 shows the product groups of GPP with the highest environmental potential.

In order to find the product group where the public purchasing power can be most adequately used to develop and commercialise eco-innovation, the product categories shown in Figure 6.2 and Figure 6.3 should be investigated with respect to the analysed parameters shown in Figure 6.1.

Figure 6.3 Product categories that have been identified as the ones representing highest green potential.

- Construction work
- Transport (buses, bus services and passenger cars)
- Cleaning products and services
- Clothing
- Electricity
- IT devices (PC, monitors, printers and copiers)
- Food
- Paper
- Furniture

Source: Rüdenauer et al (2007).

6.5.5 Product groups where the public sector makes up a limited share of the market

The establishment of innovation procurement programmes should not be limited to the product groups where the public sector makes up an important share of the market.

The experiences from the technology procurement programmes from the US, IEA and Sweden show that product groups addressing the private market have successfully been supported. There has been a high potential for the application of technology procurement with respect to improving the energy efficiency of products. In a report from the Swedish Procurement Group for Commercial Buildings (BELOK) the potential for future technology procurement of energy efficiency in commercial buildings is investigated. The report's recommendations for further technology procurement in Sweden are reflected in Figure 6.4. Moreover, there are many energy-efficient products and systems that are invented, but not yet commercialised (Göran Wilke, 4 July 2008). Innovation procurement policy is therefore a suitable instrument to ensure that the best energy-efficient solutions are developed and commercialised.

Figure 6.4 Suggestions for further technology procurement projects

Proposed technology procurement projects

- Energy-efficient food stores. The idea is to form a technology procurement contest among grocery chains in order to develop the most energy efficient food store.
- Energy-efficient catering centre. The idea is to form a technology procurement contest among primarily schools and hospitals in order to develop the most energy efficient catering centre.
- Energy-efficient store lightening.
- Public application of light diodes.
- Energy-efficient medical equipment.
- Energy-efficient climate cooling in offices.
- Energy-efficient office buildings with best indoor environment.
- Technology contest between ESCO on most energy efficient buildings.

Investigation of potential for technology procurement

- Reduced oil and energy consumption in schools by out phasing /conversion of oil-fired boilers.
- Energy-efficient pumps and ventilators.
- Potential for using energy efficient pumps and ventilators in larger systems.

Source: Jagemar and Fahlén (2007).

The relevant product groups are, however, not limited to energy-efficient appliances.

6.5.6 Product and market characteristics

The technology procurement programmes applied in Sweden, the US and under the auspices of IEA DSM Annex III have focused on development of products that are challenging to the companies but where only limited R&D has to be made. In order for the programmes to succeed, the technological capacities of

the companies must be close to the performance requirements of the desired product. Most participating companies have already before the procurement contest considered how to solve the problem. The development of the product has still been a challenge to the company, but the challenge has to a wide extent been associated with combining already known solutions and including non-energy related requirements, e.g. the price of the product.

Market characteristics where technology procurement is adequately applied:

- Large market or lucrative niche markets.

Product characteristics of products that are suitable for *technology procurement* are:

- Products or features are attractive to a large number of motivated buyers.
- Products or features are not already widely available.
- Products are standardised and mass-produced and not custom designed.
- More than one supplier can compete for the procurement.
- Desired changes to products or processes are not so fundamental that they require long lead times for R&D.
- The technology advance the manufacturers strategic goals, e.g. reduced energy consumption.
- The manufacturers of the product perceive the potential market as a promising market.
- The financial risks connected with the scaling-up of the production of the product do not constitute a major risk to the manufacturer.
- The product constitutes a considerable potential for environmental improvements.

Where the desired changes in the product is not easily achieved, and large lead time or high costs are connected with the commercialisation of the product, technology procurement is a less suitable instrument. In these cases other kinds of innovation procurement policy can play an important role.

The proposed innovation procurement policy draw on a broader range of policy instruments than technology procurement programmes. The proposed product innovation policy will be able to target market failures not easily mitigated by the traditional technology procurement approach, and hence the potential product groups and products characteristics are principally wider.

A new pan-European innovation procurement programme should, however, be based on the experiences of the technology procurement programmes. The first projects should start with technologies on component level or single-system level. Subsequently, more complex products could be included.

It is not possible to identify more general product and market characteristics for the application of innovation procurement. The suitability of innovation procurement depends widely on the buyer group's interest and commitment to the project and technological capacities of the industry. A feasibility study should

therefore be prepared to evaluate the potential of innovation procurement for each desired project.

6.6 A role for EU action on innovation procurement policy?

Action by the European Commission on innovation procurement policy has very significant added value, compared to similar actions by Member States (if they are undertaking such policies). These advantages come from the ability of EU policy to convey information to innovators about a much greater potential market – in theory the whole of the single market, and potentially, export markets. This allows EU action to send stronger market signals, about the size of the market and about the international possibilities for innovations. There are other advantages:

- The pool of potential buyers to join a buyer group is much greater – allowing easier formation of large buyer groups with significant market power.

- Investments in innovation policy from each Member State are leveraged by the investments from the other participating Member States, with each Member State achieving its innovation goals more effectively, for a smaller investment.

- Where the initial uptake of an innovation in a national market is needed to overcome market unfamiliarity and mistrust of innovations, buyer groups purchasing innovations in several Member States will open more than one Member State market.

- The European Commission has the role to co-ordinate, or shape, policy instruments to support market initiation across the EU, whether proposed by the EU (e.g. labelling) or needing co-ordination in Member States (incentives).

7 Conclusions and recommendations

1 Eco-Innovation in the EU is being retarded by the uncertainties about the future markets for innovative products. These uncertainties dissuade firms with innovations from the significant economic investments to commercialise those products.

2 These uncertainties are mainly problems of information and could be solved by public policy improving information flows on innovation requirements between innovators and buyers. The markets for innovations each have their own characteristics, and problems. Successful innovation policy needs to tackle all the significant hindrances to market uptake of innovations.

3 Existing international experience, particularly from North America and Sweden, shows that innovation procurement policy involving exchange of information and pre-announced targeted support for market uptake stimulates commercially successful innovation. This provides very good information on the practicalities of using this type of policy.

4 There are several markets for final consumer products where stimulation of commercialisation of innovations would be expected to lead to substantial economic, environmental - and particularly energy efficiency – benefits. Current EU demand-side innovation policy appears not to seize all opportunities to facilitate innovation in these areas.

7.1 Recommendations

- That to achieve the EU's objectives for increased eco-innovation in the EU, the European Commission and Member States uses innovation procurement policy to tackle the blocks retarding commercialisation.

- That the European Commission uses upcoming evaluations of the ETAP and Lead Markets Initiative (LMI) to identify the current scope of EU demand-side innovation policy in tackling blocks to commercialisation and how aspects of existing instruments might be used as part of a wider innovation procurement policy.

- The European Commission services should expand its responsibility for the facilitation of EU innovation procurement programmes including the selection of products, the creation and support of buyer groups, and the as-

sessment of products. The Commission services should establish expertise to prepare feasibility studies for potential innovation procurement projects. Particularly in the start-up phase much effort must be devoted to the creation of a framework for the procurement programme and a multi-year commitment given.

- Buyer groups should be formed under the auspices of the programme drawing upon the public procurement networks set up under the Lead Market Initiative, existing green public procurement networks and other Commission groupings, including the Retail Forum. These groups should include private and public procurers representing a sufficiently large share of the potential future market for an innovation meeting a particular need (e.g. to improve energy efficiency of lighting).

- A European demand-side innovation policy should be based on an analysis of the potential market advantages and specific market failures retarding commercialisation of each area of future demand, carried out by the Commission. Analytical support for buyer groups should make use of the product market and technical analysis and expertise being made available by the Joint Research Centre to support EcoDesign, Eco-label and green public procurement policies.

- That the success of an EU innovation procurement policy requires the belief by stakeholders that the policy measures to support the work of the Commission services – e.g. incentives, information campaigns, dynamic labelling, and links to green public procurement – will be applied. This requires up-front commitments by the European Commission and Member States to make such policy measures available. This can only take place in a context of greater understanding of the central role of eco-innovation in meeting medium term economic, energy and environmental objectives and co-operation between policy makers in these sectors.

- To overcome initial unfamiliarity with the potential benefits of innovation procurement policy that would be likely to reduce participation in buyer groups and from innovators, the Commission should allocate upfront funding to the policy programme to be used, as judged appropriate, to support commercialisation, e.g. for purchase subsidies for a limited number of products, incentivising participation of buyers and innovators. These funds should be leveraged with funding commitments from Member States.

8 References

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8.2 Interviews

Organisation	Name and position	Date
Sompfy	Anders Hall	18 June 2008
SAAB	Anna Petre, Manager of government Relations	3 June 2008
e-Traction	Arjan Heinen, Director	14 May 2008; 4 Aug 2008
Coloplast	Birgitte Holm Christensen	9 June 2008
Danisco	Bjarne Nielsen, Senior Application Manager	11 June 2008
City of Copenhagen	Casper Harboe	26 February 2009
Honda Motor Europe	Chris Roger, Head of Corporate Affairs, Public Relations Division	17 June 2008
ABB Motors AB	Christer Holgersson, Strategic Sales Manager	12 June 2008
Elsparefonden	Göran Wilke	4 July 2008
Larmia Control AB	Hans Bolöv, Managing Director	1 July 2008
Wave Dragon	Hans Christian Sørensen, Project Manager	16 June 2008
NUTEK	Hans Nilsson, former Director of NUTEK	7 July 2008
BioLotus	Knud Alleman	2 June 2008
Gustavsberg AB	Matti Weineland, Manager Quality & Environment	5 June 2008
Mercedes-Benz Buses	Michael Goepfart, Executive Managing Director	29 May 2008
H2 Logic	Mikael Sloth, Business Development Manager	17 April 2008
Grundfos	Niels Bidstrup, Chief Engineer	3 June 2008
Borg & Co	Nils Borg	7 July 2008
AEG-Electrolux	Onur Dumos	26 June 2008
Paques B.V	Peter van Leeningen, Director Sales and Contracting	1 July 2008
Think	Richard Waitz, Director of sales	23 April 2008
Toyota Motor Europe	Stephen Stacey, General manager, Government and Technical Affairs	19 June 2008
STEM	Tomas Berggren	25 June 2008 7 May 2009
Electrolux	Tomas Dahlman	4 July 2008
Volvo Buses	Ulf Gustafsson, Product Planner	16 May 2008
Scania Buses	Urban Wastljung, Public and Environmental Affairs	5 June 2008

8.3 Websites

Organisation	Website	Date
European Commision	http://ec.europa.eu/environment/gpp	24 April 2008
European Commision	http://ec.europa.eu/enterprise/leadmarket/leadmarket.html	2 February 2009
HyFLEET:CUTE	http://www.global-hydrogen-bus-platform.com/InformationCentre/FAQ	14 July 2008
hySolution	http://www.hysolutions-hamburg.de/index.php?id=144	14 July 2008
STEM	http://www.energimyndigheten.se	14 July 2008

8.4 EU Directives

Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of the procurement procedures of entities operating in the water, energy, transport and postal services sectors.

Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.

Appendix A Questionnaire for companies potentially involved in PCP

Questionnaire for companies that potentially could be involved in innovation procurement projects

How does innovation normally take place in your company?

What part of the innovation process of eco-innovations constitutes the largest risk for you?

- Are there large costs connected with getting the product approved?

Are there environmental friendly technologies that your company are capable of developing but you refrain from?

If yes: What kind of technologies?

What are the reasons not to develop such technologies?

- Too high entry costs
- Product development very time consuming
- Too high investments in some part of the development
- Lack of maturity on the market
- Lack of internal capabilities to perform the innovation
- Lack of command and control regulation
- Lack of incentive from green public procurement
- Lack of R&D subsidies
- Lack of environmental labelling
- Lack of standards

Do your company use R&D subsidies?

If yes: On what terms are these subsidies given?

Do you see public procurement as a way to mitigate some problems for your company to develop environmental friendly products?

If yes: Why?

How do you think that the tendering and procurement process should be organised in order for you to be interested in bidding on such schemes?

What is the magnitude of investment needed to make the innovation-process feasible?

Appendix B Questionnaire for company involved in technology procurement

Questions for companies involved in technology procurement
What is the basic idea of the technology?
How much innovation has the project lead to?
How large changes did it lead to compared to existing technological trajectories?
What was the reason that you had not made the innovation before?
What were the incentives for you to participate in the design contest? **-** Would you have developed the technology anyway?
What advantages are there for your company in participating in these kinds of projects? • Did you get financial support? • Importance of information dissemination on the technology? • Importance of getting the product tested/evaluated by independent agent?
What are the some risks that are reduced? • What impact did it have on the market? • Was it possible to sell the technology without financial support on the market?
How was the development of the technology financed? • Own financing? • Financing from other stakeholders?
Would you participate in these kinds of programmes again? • Have the market changes? • Have the technology reached a mature level, where further development is incremental?
How could you trickle down the effects of the developed technology to other products?

Appendix C Choice of interview companies

The purpose of this annex is to draw up the purpose of the study and to account for the methodology used to illuminate the objectives set up in Terms of Reference.

A range of companies have been interviewed in order to understand the nature of product characteristics and markets for eco-innovation that the companies have developed or could develop. Based on the sectors that make up the highest potential for green public procurement relevant product groups and market are identified. Some of the interviewed companies do primarily produce products to the public sector, other produce primarily to the private sector. The spread in potential customer group gives the opportunity to investigate different strategies of bundling demand between private and public sector customers.

Both SMEs (Small and Medium-sized Enterprises) and large companies have been interviewed. The companies are chosen according to three different characteristics.

- The first type of company, are companies that have participated in technology procurement programmes where they have developed eco-innovations. These companies have experiences with these kind of procurement programmes and can contribute with knowledge on, what incentives the companies have had to participate, what kind of risks the technology procurement have helped to mitigate, to what extent the innovation has led to a market penetration and evaluate pros and cons for the company by participating in such schemes.

- The second type of company is companies that are in the process of making eco-innovation and where technology procurement could support the commercialisation and market up-take of the technology.

- The third types of company is companies that previously have made or are expected to be capable of making eco-innovation[12]. These companies are interviewed in order to investigate if they refrain from developing eco-innovation they would be capable of developing and how technology procurement could help to mitigate the risks of developing such technologies.

[12] By 'eco-innovation' is understood the development of new environmental friendly products.

Appendix D Legal aspects of public procurement of innovation

A rather substantial part of innovation procurement is the actual procurement part. Since the contracting authorities who wish to engage in innovation procurement programme are bound by the public procurement legislation, methods for planning the procurement within the existing rules are described in the following.

Depending on the complexity of the technology that the contracting authority wishes to obtain different approaches can be made. Since the contracting authority rarely has the full overview of what technologies the market can offer it may be practical to combine the approaches below. In this way the contracting authority may design the procurement procedure so it takes advantage of already known technologies and makes room for innovation.

It must be noted that the procurement legislation is focused on the procedures leading to public entities' procurement of specific products, works or services. The legislation and jurisprudence is quite comprehensive and for a full insight into the public procurement rules it is recommended to look elsewhere. For the purpose of this annex the possibilities of the public procurement legislation will be described briefly.

Technical dialogue
First of all a contracting authority may wish to explore the market and consult experts on the relevant subject. It is within the scope of the procurement directives to approach the market and conduct a technical dialogue:

"Before launching a procedure for the award of a contract, contracting authorities may, using a technical dialogue, seek or accept advice which may be used in the preparation of the specifications provided, however, that such advice does not have the effect of precluding competition."[13]

This dialogue may help the contracting authority to define the new and unknown aspects of the product or service wanted. The contracting authority must however make sure that the dialogue does not preclude competition in a subsequent tender procedure. The contracting authority may ensure this by making all material and correspondence resulting from the technical dialogue available for all potential bidders.

There are no legislative specifics on how a technical dialogue must be conducted. Therefore the contracting entity can design this dialogue as it sees fit. Whenever the contracting authority has gathered the required information it can continue - or abandon - the procurement procedure.

R&D phase and subsequent public procurement
A different approach for public procurement for innovation can be conducted under the special provision article 16(1)(f)[14] which ensures that the contracting authority can procure research and development services without following a

[13] Recital 8, Directive 2004/18/EC and recital 15 Directive 2004/17/EC.
[14] Directive 2004/18/EC and article 24(1)(e) in directive 2004/17/EC.

set procedure in the procurement directive. This exemption applies for R&D contracts unless the benefits accrue exclusively to the contracting authority for its own use *and* is paid for by the contracting authority as well.

When using this approach the contracting authority must have in mind that it can only procure the R&D services - not the actual end product.[15]

The R&D exemption could, however, also be used for exploring technologies and possibilities and by that paving the way for a subsequent supplies contract for the end product.

Procurement Procedures

In many cases it may very well be suitable for the contracting authority to initiate a public procurement procedure right away and incorporating research and development into the contract. By doing this the contracting authority secures an immediate market for the developed product thus increasing the incentives for the market players to participate.

The public procurement directive allows for different procedures to be utilized for the actual procurement. In the cases of public procurement for eco-innovation the technology or product wished for by the contracting authority may require the use of the competitive dialogue[16] procedure since it is designed to complex contracts. In the public procurement directive it is stated that:

"Contracting authorities which carry out particularly complex projects may, without this being due to any fault on their part, find it objectively impossible to define the means of satisfying their needs or of assessing what the market can offer in the way of technical solutions and/or financial/legal solutions. This situation may arise in particular with the implementation of important integrated transport infrastructure projects, large computer networks or projects involving complex and structured financing the financial and legal make-up of which cannot be defined in advance. To the extent that use of open or restricted procedures does not allow the award of such contracts, a flexible procedure should be provided which preserves not only competition between economic operators but also the need for the contracting authorities to discuss all aspects of the contract with each candidate. However, this procedure must not be used in such a way as to restrict or distort competition, particularly by altering any fundamental aspects of the offers, or by imposing substantial new requirements on the successful tenderer, or by involving any tenderer other than the one selected as the most economically advantageous."[17]

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[15] The definitive distinction between a R&D service contract with delivery of a few prototypes and a supplies contract can be difficult to identify. However according to the definitions in Directive 2004/18/EC article 1(2)(d) it can be concluded that the value of the end product cannot supersede the value of the services in the contract in order for the contract to be exempted from the directive cf. article 16. Since a major part of a contract for developing new green technologies may be attributed to the R&D part, this may lead to rather substantial deliveries of relatively (compared to the R&D part of the contract) cheap end products.

[16] Article 29, Directive 2004/18/EC, no similar procedure in Directive 2004/17/EC.

[17] Recital 31, Directive 2004/18/EC

Even though the Directive foresees that the procedure may be particular suited for projects involving complex infrastructure, computer networks or legal/financing issues, the Directive does not restrict the use of the procedure to these areas.

The procedure can be used if the contracting authority assesses that open or restricted procedures will not allow the award of the contract and that the contract is considered particularly complex.[18]

A competitive dialogue procedure is essentially carried out as other procedures. The relevant participants in the competitive dialogue is chosen based on economically and technically criteria, and the eventual winning offer is found by applying the chosen sub criteria.[19] However, when using the competitive dialogue procedure the contracting authority may lead a dialogue covering all aspects of the contract with the selected tenders. The dialogue must be carried out with respect to the EU-treaty principle of equal treatment.

One of the characteristics of this procedure is that it can be carried out in several stages with aim to reduce the number of solutions subject to the final evaluation. Furthermore and importantly the contracting authority can decide to specify payments to the participants in the dialogue thus increasing the incentives.

By carrying out this procedure the contracting authority can include the stages of product development as illustrated in Figure 4.2 in the actual procurement phase.

As regards to entities obliged by the Utilities Directive, the use of the competitive dialogue is not possible. Instead the entity may chose to utilize the negotiated procedure.[20] The negotiated procedure does not explicitly allow for phasing out bidders, yet it is not forbidden either. For this reason, entities procuring according to the Utilities Directive should take every possible care not to infringe the principles of equal treatment and transparency if planning a negotiated procedure with built in phasing.[21]

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[18] According to Directive 2004/18/EC article 1(11)(c) a contract is considered particularly complex if the contracting authority 1) are not objectively able to define the technical means in accordance with Article 23(3)(b), (c) or (d), capable of satisfying their needs or objectives, and/or 2) are not objectively able to specify the legal and/or financial make-up of a project.

[19] Please consult "Buying Green! A handbook on environmental public procurement" (European Commission, 2004a) for specific advice on which criteria that is suitable for qualifying applicants for the procedure and which sub criteria that can be used for identifying the economically most advantageous offer.

[20] Directive 2004/17/EC article 40.

[21] Prof. Sue Arrowsmith suggests that phasing out competitors might be possible. If possible it would be more advisable instead to specify higher levels of qualification criteria since the phasing out of competitors without a formal procedure may be difficult cf the principles of equal treatment and transparency (Arrowsmith, 2005).

The contracting authority may sign framework agreements[22] with one or more supplier. This is a contract type where the contracting authority may choose to purchase repeatedly at the same supplier under the framework agreement, or if more than one supplier is attached, renew competition among the participants of the framework agreement and place orders as needed. The public procurement directive specifies in detail how framework agreements are signed whereas the utilities directive is less descriptive. Common for both is that the framework agreement must not be misused in a way that distorts or limit competition.

Summary

A contracting authority may find it sensible to initiate an innovation procurement procedure by extensive contact to the market. By assuring that this 'technical dialogue' does not distort the possible later competition, the contracting authority may decide whether to start a R&D procedure or a regular public procurement procedure, such as a competitive dialogue or negotiated procedure.

Depending on the complexity of the contract, the contracting authority may start a procurement procedure based on the findings from the technical dialogue.

On the other hand the contracting authority may decide that the technologies and specifications of the product are still so unclear that a R&D procedure exempted from the public procurement procedures may be needed. This R&D procedure may eventually lead to a separate public procurement procedure in order for the contracting authority to achieve the products or technologies formed by the R&D.

[22] Article 32 Directive 2004/18/EC and article 14 Directive 2004/17/EC.