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Standard Setting for Technology Procurement

Redesigning an Instrument for the Environment

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And not the least, to the reader, as that is where this derives its meaning

Abstract

With the aim of exploring improvement of technology procurement efforts and learning about standard-setting challenges in that context, this study takes up the Swedish implementation of cooperative procurement as an exploratory case. With key interviews, the author gleans the details of the case as implemented over more than a decade and lessons learned in that period. An elaborate explanation appears of the rationale behind the dual-level requirements now commonly used in procurements. Further, the case is used as an instrument to characterise some other prevalent approaches to technology procurement in relative terms, followed by a gap analysis assisted by a graphical representation on a four-dimensional frame. The analysis reveals the distance to the ideal implementation and aids the deduction of remedial policy supplements. One such supplementing instrument is proposed.

Executive Summary

Background

The present research attempts to improve the understanding of Public Technology Procurement, which is a relatively new tool in the panoply of environmental policy instruments, particularly those based on a products approach. The main issue of interest concerns the challenges faced in the associated standard-setting processes, how these are overcome and how standard-setting in general can benefit from that knowledge.

This is perhaps the first documentation of the Swedish trials with cooperative procurement of technologies focussing on the standard setting aspect. To the author's knowledge, it is also one of the earliest attempts to characterise different generic implementation mechanisms of the policy specifically to the end of adapting it as a subset of environmental policy.

The central question has a very broad relevance and hence its exploration can inform a wide range of interests. At its broadest, it can be said to be a study of passage between degrees of excellence. Granted, with technology procurement the passage is more akin to the government pulling the industry sledge as a pack of huskies, than a self-willed industry seagull testing itself to its own limits.

Either way, for any significant leap forward, the uncertainties involved are formidable, not least when one actor needs to guess the potential of another, as with a procurer trying to draft a very progressive yet reasonable tender for producers. When applied with environmental goals in mind, technology procurement is meant to spur the design end of a product cycle, as that is where a bulk of environmental impacts of a product is determined. This thesis investigates the decision-making processes when setting and raising standards in a setting of uncertainty.

Questions

The central question is:

- How may a procurer get into the minds of the producer faced with such a policy as he or she makes the decision to go in, to take the risk and develop technologies and submit a proposal? What is the basis for that decision?

Some related questions are:

- What amount of access to the privileged knowledge of technologies on the producer's shelf does the regulator need for introducing such a policy?
- By what process do they secure that access? Is it at all common that they attempt to? And succeed?
- How do they decide what level of requirements can pass of as 'reasonable'?
- When standards are set for a technology procurement initiative as described, how does the process differ when they look at one parameter versus when trade-offs have to be resolved between several?
- Is it a good instrument to promote innovation at all?

- What, if anything, can be learned from private purchasing processes? Are there parallels where an industry uses bulk or assured orders to motivate suppliers to change or improve technologies? How are standards arrived at then?

Literature

Standards are ubiquitous and indispensable in a globalised, technology-driven world. For the forward-looking firm, they open gateways to new markets and push them to their potential. However, standards are also said to lead an effective race to the bottom to ensure wider acceptability. Furthermore, they discourage continuous improvement by leading firms to believe they have done enough, when the standard itself is not very ambitious to accommodate everyone. Given their importance and faults, the setting of standards is itself increasingly under scrutiny. The hunt is on for a way of arriving at standards such that they fulfil their purpose without stifling improvement. Not surprisingly then, the rules of the game are gradually changing. The European Commission has launched a drive to rewire standard-setting processes. It mandates changes in the very roles of standard-setting organisations. Rather than setting the specifications, they are now expected to focus on standardising measurement of functions and performance and reporting the values. The aim is that with standard measures and reporting, regulators will themselves be better equipped to arrive at harmonised specifications in consultation with stakeholders and with an eye on contextual variables.

This research concerns the standard-setting challenges in the area of overlap between technology procurement and green public procurement. While they can both be seen as subsets of public procurement, the latter is relatively newer as a concept and in practice. The overlap implies using technology procurement for environmental goals. While technology procurement is common around the world, especially in the defence sector and public infrastructure, Europe leads the world in green public procurement by a comfortable margin. Sweden is one the countries where technology procurement has been used for environmental goals with a consistent rate of success.

At the same time, some very distinct issues attend public procurement and related standards in the European context. On the one hand the EU is bent on promoting openness in a *single market* through the directives on procurement and on the other, business swear by the importance of old intra-national buyer-seller relationships. They are important to bear in mind as side-issues, but this study stays clear of the legal and political angles, with a focus on aspects of information deficit, exchange and management.

Method

With scant prior literature devoted to the crux of the research, it was considered best to use the *exploratory case study* method. Sweden has had experience in implementing a unique form of technology procurement which, for the same reason, was chosen as an instructive and *instrumental* case. A key official at the government agency responsible, who had himself been in charge of the program for a decade since its inception, was an obvious choice as a *key informant* for the case interview. Other informants were selected with a view to triangulate the learning from the industry and academia angles.

Interviews and Preliminary Findings

Mr Egil Öfverholm of the Swedish Energy Agency described the Swedish cooperative procurement project in great detail, pointing out the commonalties across the various products procured over the years as also differences in some cases and the few departures from the usual degree of success achieved in the majority of cases.

The interview with Mr Öfverholm served the intended purpose of answering the essential questions regarding the rationale behind the choice of the particular performance levels demanded. It also served the instrumental role of illustrating a host of related issues.

Mr Hans Wendschlag of Hewlett Packard (HP) contributed the perspective of the manufacturing industry. He spoke of the difficulties that HP faced when confronted with ever advancing requirements and the company's mechanisms of response. A crucial insight from this interview was regarding the extent to which industry was consulted about technical feasibilities in the formulation of ultra-progressive standards. It turned out that while eco-labels were increasingly referred to in public tenders and had eased some aspects of the procurement process, the rationality behind standards that were too demanding was not well-founded in some cases.

This interview also served to introduce a wide-ranging typology of efforts that resemble technology procurement in terms of means or ends.

Finally, Dr. Max Rolfstam was interviewed as a voice from academia, his chief research interests being technological innovation and the possible role of technology procurement. He shared his opinion on this author's understanding of issues in innovation and helped clarify a few matters. He also pointed out several instances in literature where experiences had been documented.

Analysis

This study presents a frame of analysis developed expressly for meeting the research purposes outlined above. The frame consists of four dimensions on which the different approaches to procuring advanced technologies are mapped relative to the case studied.

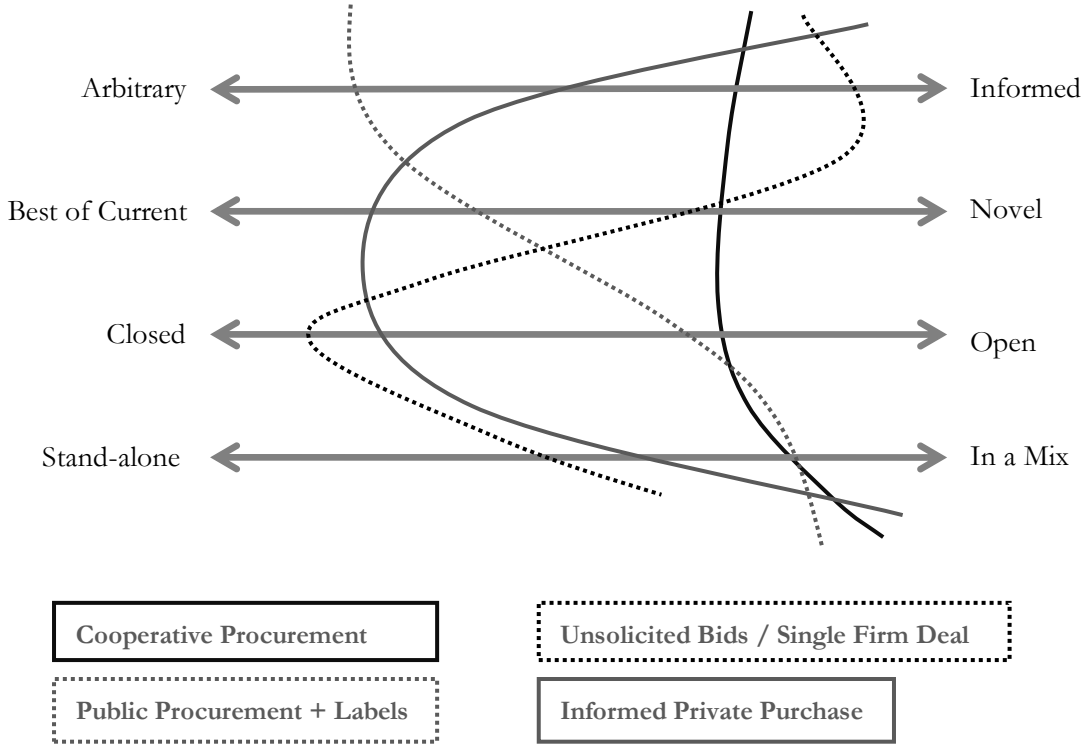

Figure E-1: Application of the Frame of Analysis

The dimensions as shown in the Figure E-1 above are, in order from top to bottom, Rationality, Novelty, Transparency and Policy Design. Mapping the different approaches on this frame helps analyse the nature of deficiencies in each relative to others and identify the elements that could be borrowed from them to arrive at a better approach. In reverse, it helps visualize the gaps in each approach from the ideal and postulate how these gaps may be met.

Conclusion

To close, most of the original research objectives were achieved. The central question regarding the basis behind standards chosen was successfully answered with information from the study case and is contained in section 5.1.3, *The Mandatory and the Desired*. The chief reason for the dual levels with a margin between them is to accommodate the manufacturers' discretion in making choices best suited for production, sales and other business functions. The significance of stipulating two levels and the rationale behind the gap is in itself valuable information for anyone undertaking further research on either standard-setting, technology procurement, innovation policies or even product development. It reveals the need to enhance the competencies within the standard-setting group.

Additionally, with the help of the analysis, it is evident that none of various approaches has quite succeeded in completely mitigating the information deficiency on the procurer's end. Towards solving that issue and the problems associated with long R&D cycles and the buyers' short-term interests, the author proposes a new instrument to complement public technology procurement – an information obligation.

This new instrument would require that as and when new technologies are announced or patented, the company shall intimate the government of the environmental profile of that technology which could be expressed in terms of a product unit or functional units. This is a win-win instrument. The advantage for the firm is that when considering their next bulk order, the public agency is better informed when drafting environmental requirement levels and can issue an open tender clearly favourable to the new technology. A number of objections may possibly arise to this kind of an instrument, but this author feels they can be assuaged by a careful design of the implementation details of actual policy within the scope of applicable laws.

If governments wish tomorrow to arrive sooner that the market wills, there is no alternative to an instantaneous sharing and efficient management of information both ways.

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Abbreviations

ATM – Automated Teller Machine

BBC – British Broadcasting Corporation

BCG – Boston Consulting Group

CBEMA Computer and Business Equipment Manufacturers Association

CRT – Cathode Ray tube

ECEEE – European Council for an Energy Efficient Economy

ETAP – Environmental Technologies Action Plan

GDP – Gross Domestic Product

GPP – Green public procurement

HP – Hewlett Packard

HTML – Hypertext Markup Language

ICLEI – Local Governments for Sustainability

ICS – International Chemical Secretariat

IEA DSM – International Energy Agency – Demand Side Management

JPEG – Joint Photographic Experts Group

LED – Light Emitting Diode

NUTEK – Swedish National Board for Industrial and Technical Development

R&D – Research and Development

SNEA – Swedish National Energy Administration

SSO – Standard-setting Organisation

TFT – Thin Film Transistor (Liquid Crystal Display)

USAID – United States Agency for International Development

1 Introduction

This Master's thesis[1] attempts to unravel a relatively new environmental policy instrument – the processes and actors involved, the roles of the latter and whatever can be learned towards its improvement and spread.

The instrument in focus is Public Technology Procurement. The main issue concerns the difficulties faced in standard-setting processes, how these are overcome and how standard-setting in general can benefit from that knowledge. The questions and initial ideas were first expressed by the supervisors, Thomas Lindhqvist and Naoko Tojo at the IIIEE, as the central issues of this study are in keeping with their established and broader research interest in Product Policies and mixes of instruments in that area.

This is perhaps the first documentation of the Swedish trials with Cooperative Procurement of technologies focussing on the standard setting aspect. To the author's knowledge, it is also one of the earliest attempts to characterise different generic implementation mechanisms of the policy, specifically to the end of adapting it as a subset of environmental policy.

1.1 Background and Rationale

People and systems are forever driven by the pursuit of excellence, even excellent people and systems. Well, especially excellent people and systems. To steal a quote from my teacher who at a recent meeting quoted his own teacher in turn, "there are degrees of excellence". Anything and everything has degrees of excellence. The people and systems already at one of the degrees are commonly the ones most conscious about the existence or possibility of others. That then, is the way of almost all walks of life. However, it is laced with all the suspense of uncharted territory.

We are increasingly faced with uncertainties involved when breaking through to unprecedented levels of functionality. For instance, a group trying to formulate pre-emptive legislation to deal with advancements in embryonic stem-cell research[2] would be hard put to figure out the endless possibilities of undertaking research in that direction. In a rapidly changing world, where ICT developments are blurring macro boundaries and nanotechnologies are shattering the micro ones, anything - to use a clichéd catchphrase - is possible. The question of addressing the lop-sided distribution of technical knowledge, especially with public agencies on one side, is a very wide one, and any solutions can find relevance in many diverse applications.

However, this study is about a narrower question in that domain – the fact that the passage from one degree to the next is anything but easy. How, after all, would someone or something already the best in their class determine where the next degree is? In other words, how far is the next attainable level, what amount of effort does it involve and is all that effort worth it? Though this sounds precariously close to the murky world of decisions based on

[1] The author has prior experience in Policy Analysis and an academic background shared between engineering and management. The host institution, IIIEE at Lund University, is a premier institution engaged in research and education in environmental management and policy.

[2] A typical dilemma of governments in countries at once at the forefront of such research and faced with a very political colour of questions stirring around it. ("Brown urges embryo bill support," 2008).

costs and benefits, this piece is not about that, at least not mainly and in their traditional sense.

This is about standards and pushing them to the limits of the practically possible and the marketably feasible.

That question, too, applies to a broad array of trades, and hence is of wider academic interest, but we will study it a single context, one where it has recently been applied and probably will be increasingly – that of Public Technology Procurement.

This is an ideal spot for a definition. Granstrand (1984) used the following words (as quoted in Westling, 1991, p. 80) :

> *Technology procurement refers to a case when some part of the seller's R&D work for a new product or process is contracted for by a buyer before the product or process has come into existence. A contractual relation is created between a prospective innovator and the prospective first adopter.*

We can refrain from discussing the definition at this point, to arrive at it further along the text, after we have discussed more about findings relevant to the scope of that definition.

Environmental regulation has come a long way, to the extent that a lot of it no longer even falls under that term. Now the old, the new and evolving versions of government efforts come as a package of environmental policy. The world has gone from emissions standards, to ambient standards, to economic incentives, to information devices and so forth. One school of thinking has championed weaving policies around products, taking a life-cycle approach – right from design to end-of-life. The polluter pays principle was applied since the very beginning. In fact, it has matured enough to have moved on from its mainly 'end-of-pipe' connotation, and has come to be reinvented to extend the responsibility of producers to the 'end-of-life' extreme. On the other hand, efforts to spur the design end kicked in much later in the history and perhaps for that reason, are less common or perhaps yet to take off (Gottberg, Morris, Pollard, Mark-Herbert, & Cook, 2006). It was only in recent times that it was realised and widely recognised that an overwhelming proportion of environmental impacts are determined at the design stage (ECEEE, 2006).

Technology Procurement, then, is a step in the design direction of things and that is where it fits in the environmental sphere. Few have tried it, and even fewer successfully so. Sweden appears to be among the few countries that have consistently replicated successes in this area, judging by the repeated appearance of different Swedish cases in various documents on successful cases. We examine one program in Sweden that was implemented for over a decade for variety of products.

The model on which the Swedish cooperative procurement programme is based has appeared in publication before now. Hans Westling (1991) in his seminal PhD thesis speaks of his experiences in the construction sector and recommends process developed in the course of that experience. Later publications from Swedish National Board for Industrial and Technical Development (NUTEK) (1995) and then Swedish National Energy Administration (SNEA) (1998) report on merits of the process and recommend its wider adoption. Most recently, Olerup (2001) gives an overview of the implementation in two of the products with a wealth of detail on technical specifications.

If the cooperative procurement process has been documented before, why are we taking a second look at it?

For the better part, Hans Westling's book deals more with the technicalities involved in procurement in the construction sector. He has described the interaction and decision processes only in passing. The later publication from SNEA deals with processes but describes examples from several countries and discusses them, finally proposing a process that was followed, more or less in the manner described, throughout the Swedish programme. However, they too do not answer the crucial and tricky questions about the actual standard-setting game - the tug of war, as it were. The NUTEK document clearly states the standards used for one of the procurement projects, but glosses over the deliberations that led to them. Lastly, despite the technical details, Olerup (ibid.) has concentrated on institutional aspects and effects on the markets in comparison to other policy instruments, rather than the nature and reasons for the levels chosen.

Moreover, the main thesis here is that while the agreement on innovative and progressive standards has been possible to meet through the 'Westling type' process, it had largely to do with quality requirements, things that could be characterised as consumer needs. They are often expressed in the market, and can take the form of product offerings. The implied thesis here is that producers are likely to be more interested in pushing the product improvement to meet that type of requirements. When it comes to demanding a purely environmental requirement that neither consumers nor producers have any real interest in, that is likely to not be the case. Hence, this study examines how well the process borrowed from commercial technology procurement with quality based standards serves the purpose of furthering environmental performance. Is there need for a different approach? What, if anything, needs to be done differently or additionally?

Thus, the study has a dual outlook – a better understanding of standard-setting in general and its refinement specifically when adapting the instrument of technology procurement for environmental goals. The research questions are further developed and elaborated in the following section.

2 Problems / Questions

It is known that governments wield considerable influence on markets due to their buying muscle.

When regulators and potential regulatees meet, a tug of war ensues. The regulators wish to raise the bar; that is their main interest and objective. The regulatees cite prohibitive costs, risks and competitive disadvantages; they attempt to lower the bar as far as possible. The questions of how tenable the industry estimates are (ICS, 2004; MacLeod, Harrington, & Morgenstern, 2006) and efforts to remedy the legitimate industry concerns (Haq et al., 2001) have received a fair amount of attention. In the specific case of technology procurement, what are the ex-ante cost estimates to be based on?

Of central interest here is the case where the regulator feels that the existing technologies have reached their limits, but fall short of the environmental aspirations of society. They seek to raise the bar beyond the level possible with existing solutions. To meet the new standards, producers will have to come up with significantly new solutions. The central question is:

- How may a procurer get into the minds of the producer faced with such a policy as he or she makes the decision to go in, to take the risk and develop technologies and submit a proposal? What is the basis for that decision?

A related and very topical issue concerns the technologies that the industry collectively has lying on their shelves – things that are not yet ready for commercial production. The regulator's knowledge of the contents of those shelves is limited. In that respect:

- What amount of access to that knowledge does the regulator need for introducing such a policy?

- By what process do they secure that access? Is it at all common that they attempt to? And succeed?

Referring back to the tug-of-war mentioned earlier, this is a case of higher uncertainties. The regulator needs to decide what would be a reasonable level of requirements. However, unlike other instruments that call for setting standards, they cannot base it on actual market data.

- How do they decide what level of requirements can pass of as 'reasonable'?

It is of some interest to look at Technology Procurement as an advanced case of other processes that involve product standards, such as legal standards and eco-labelling. The difference lies in the range of industry performance that is the target, as Figure 2-1 shows.

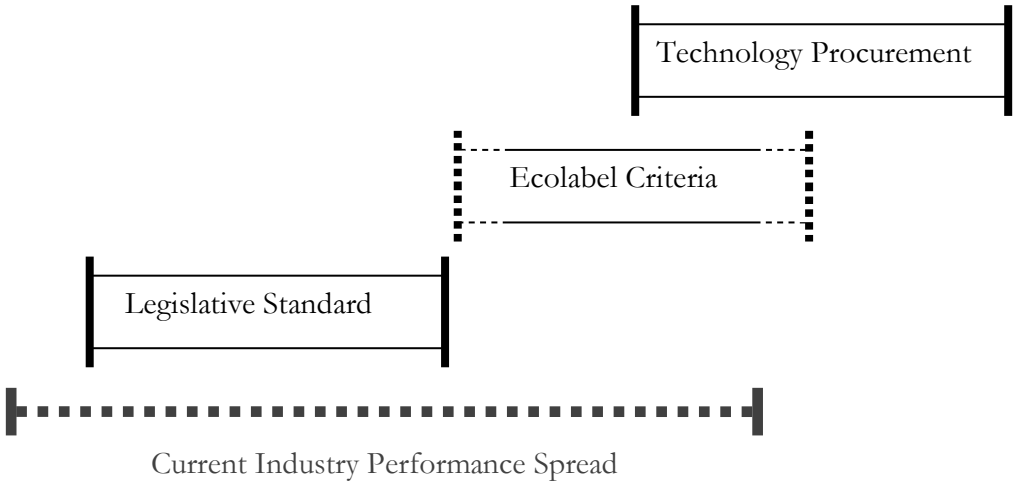

Figure 2-1 Instruments and Progressive Standards

As the objective of a legal standard is to ensure compliance by the whole industry, the level is chosen such that every firm can reasonably meet it. The purpose of an eco-label, as an information instrument by contrast, is to mark out for the consumer the best of the *existing* products in a class. Though given the extant diversity of labels the bounds on either side are somewhat blurred, meaning that some labels could be more accommodating and yet others, very demanding. With technology procurement, the bar is raised even higher. The idea is to take the industry beyond what has been achieved and placed on the market. Often, the standards to be set may be above what even the best in the industry have achieved or are likely to, if the market is allowed to take its own course[3].

In addressing the above questions, we wish to scrutinise cases and qualify their success or failure and examine mutual differences and their effects. This may help us to learn about standard setting processes in general. More specifically:

- When standards are set for a technology procurement initiative as described, how does the process differ when they look at one parameter versus when trade-offs have to be resolved between several?

- Is it a good instrument to promote innovation at all?

Time permitting and circumstances favouring, a number of issue dovetail into these questions:

- What, if anything, can be learned from private purchasing processes? Are there parallels where an industry uses bulk or assured orders to motivate suppliers to change or improve technologies? How are standards arrived at then?

[3] This may not be typical, but it is well recognised that societies do not benefit most if they rely solely on innovation spurred by the market alone. The European Commission too, since recently, identifies inadequate technical innovation among market failures that qualify for state aid (Rolfstam, 2008, pp.17-25).

The author was aware before undertaking the study that it might not be possible to resolve all of the questions to the same degree of clarity. The exploratory case study method was chosen precisely with a view to develop a better understanding of the questions themselves along the way. It also allows for other questions to arise intuitively during the course of case study interviews. These are developed in context in further sections.

3 Literature

3.1 Overview of Standard Setting

Standards are indispensible to the new economic order of the world, globalised and still spreading. ATM machines would be worthless if credit cards around the world were cut to imaginative designs and sizes. The internet and its possibilities would be, well, impossible were diverse computer hardware and browser software not able to interpret HTML and JPEG the same standard way. The more technologies change and evolve, the more we depend on new standards to benefit from them.

> *With standards so frequently the key to winning new business, or gaining entry to lucrative new markets, it is understanding and effectively managing the standards which affect your business that is crucial if you are to fully exploit their potential. (IISD, 1996)*

On the flipside, a common criticism of standards is that they lead companies to a plateau and stifle further improvement (Clifford, 2005). Yet others argue that the levels where the standard is set may itself be the lowest common denominator since everyone everywhere is expected to be able to adopt them (Prakash & Potoski, 2006).

A number of separate standard setting initiatives exist around the world and they involve a variety of institutions and processes. Internationally, the effort is steered by the International Standards Organisation (ISO), which in essence functions as an overarching group of which Standard Setting Organisations (SSOs) around the world are members. Some of these may be government institutions, others industry associations or a hybrid.

The rules of the game, though, are changing. The very nature of SSOs and their roles is currently transforming, faster in Europe than elsewhere. With a view to harmonising European technological standards to facilitate uniform legislations, policy principles and in particular, the Energy using Products Directive, the European Commission has issued a mandate that outlines work expected of European SSOs (EC, 2004a). It delineates the roles of SSOs to be measurement, designing standard procedures to ensure repeatability and the reporting of results. The actual specifications - or 'essential requirements' as termed in that directive - the legislators wish to keep to themselves (in consultation with represented stakeholders, of-course).

3.2 Overview of Public Procurement

3.2.1 Wider Green Public Procurement

Governments can push the desired change in society by initiating it closer home. Green public procurement (GPP) stems partly from this ideology. Numerous definitions exist. For the purposes of the Environmental Technologies Action Plan (ETAP), the DG Environment at the European Commission has chosen to define GPP in the following words:

> *Green Public Procurement is the approach by which Public Authorities integrate environmental criteria into all stages of their procurement process, thus encouraging the spread of environmental technologies and the development of environmentally sound products, by seeking and choosing outcomes and solutions that have the least possible impact on the environment throughout their whole life-cycle (Bower et al., 2005).*

3.2.2 Rationale and Advantages

The size of government budgets is often substantial relative to an economy. Public expenses thus wield considerable buying power on the market. The adjacent graph 3-1 shows that across diverse countries, public expenditure tends to remain within the range of 15 to 20% of the GDP. European governments in particular tend to have an even greater share. The public procurement pie alone is around 16% of the GDP in the EU ("Green Public Procurement: how to turn policy into practice!").

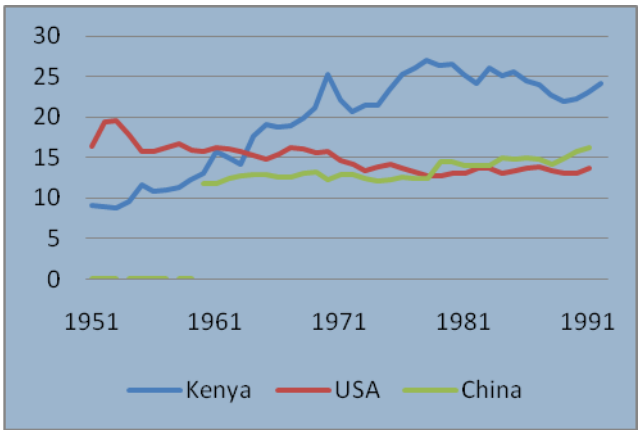

Figure 3-1 Typical Proportion of Public Expenditure

Data Source: (Heston, Summers, & Aten, 2006)

Another advantage is in terms of cost. The closer the changes you mandate are, the lesser the costs. We are talking several kinds of costs – administrative, communication, monitoring and other transactional costs. As a result, the relative benefits are that much greater.

3.2.3 Practice

It is not easy to put a precise timeline to the introduction and spread of GPP. Relevant literature indicates that several countries seem to have been toying with the idea more or less simultaneously. The first actual implementations came from the efforts of networks such as the ICLEI (Local Governments for Sustainability), some of which can be traced to Germany. Indeed, at the 2006 conference in Graz, Austria, Germany was one among the set of countries dubbed the "Green 7" (EC, 2006), as they were the only ones where at least 40% of the tenders were found to consistently have environmental criteria built in. The others were Austria, Denmark, Finland, Netherlands, Sweden and the UK. Formally, though, the EU first introduced the concept through two directives on procurement issued in 2004 (2004/18/EC and 2004/17/EC). The 'Buying Green' handbook (EC, 2004b) released subsequently complemented them by outlining the possibilities for including environmental criteria within the framework of the directives.

There appears to be little by the way of an established process for GPP or even a general theory of how it functions. Although examples from practice are increasingly heard of, the procedural information is often "sketchy" (McCrudden, 2004). Figure 4-2 below shows a rather generalised picture of the procurement process mapped as decision making.

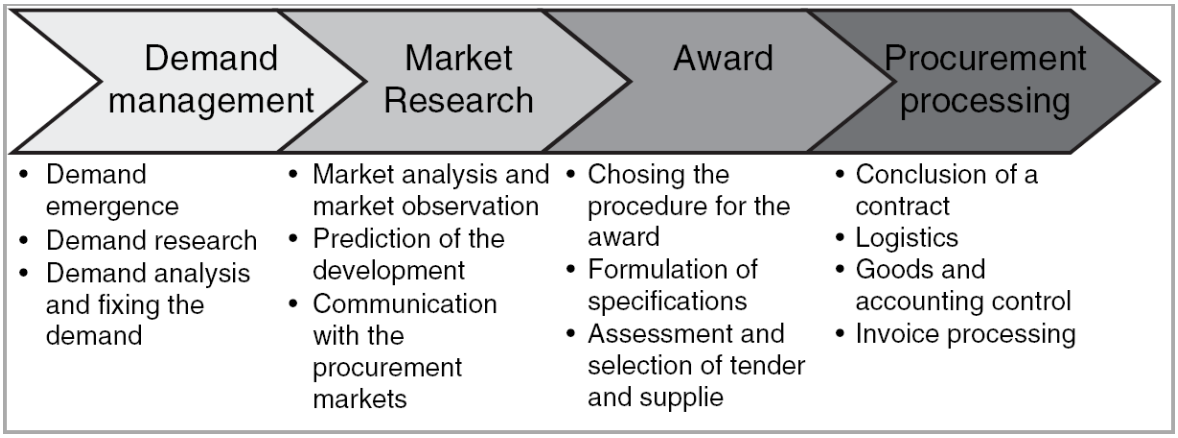

Figure 3-2 Public Procurement as a Decision Process

Source: (Gunther & Scheibe, 2006)

As Figure 3-2 illustrates to some extent, the process involves varied forms of communication between multiple actors. Availability and exchange of information thus becomes crucial to the GPP process.

3.3 Technology Procurement

The use of public procurement to spur innovation in industry is not very new and various approaches have been tried. Arguably, it is a concept older than GPP because of its more commercial origin.

The earliest cases may have been in the realm of state defence expenditure. Military equipment has traditionally been made-to-order according to specifications from the buying agency. At some point, however, the standard setting and prescription implications of the defence procurement processes may have changed. The US Army, for instance, has been known to have switched from the exclusive use of *Milispecs* to commercial procurement at one point ("Going commercial.," 1994). While their reason was to improve the cost-efficiencies of procurement processes, others have spoken against a standard-setting approach specifically for technology procurement for different reasons. There was a time when the Computer and Business Equipment Manufacturers Association (CBEMA), for one, opined that government standard-setting is sluggish and may slow down the pace of industry innovation (Borklund, 1979). They proposed alternative ways such as *multiple contract award* systems that give the government access to the latest technologies from several manufacturers.

While the suggestion may work where the sole objective is to arrive at quality specifications, when it comes to environmental performance, governments may still have to lead the standard-setting (or raising) drive, as we shall also see as this discussion develops.

3.4 The Overlap – SS, GPP and TP

The importance of standard setting processes to green public procurement is not unknown and has often figured on the European political agenda or at least speeches ("Environment - Innovation - Employment," 2007; "Socialdemokraterne - English version - The European Perspective on Green Roads to Growth").

Even so, any processes related to technology procurement would face the larger issues that ail GPP in Europe in general. Some of these problems date from the days of Project 1992 where much of Europe was unified and one of the chief concerns of European businesses was how Public Procurement would be handled ("One Europe, One Economy," 1991). Early observers had noted that European governments had failed to open up their procurement markets to sellers across their borders (Giles, 1991). That may have been for various political reasons, but to this day, producers in the region swear by the advantages of "closer buyer-seller relationships", obvious euphemism aimed against opening up tenders to a wider market. More recent views even hold that the legislative framework in the EU poses obstacles to the full realisation of the potential of technology procurement to stimulate innovation. (Edquist, Hommen, & Tsipouri, 2000). Other views questions whether the emphasis on harmonization of standards in Europe is at all advisable (Faure, 1995).

Related issues revolve around the roles of existing standard setting consortia - formal or informal and strategic ones instituted for specific purposes by the government. In the past, conflicts have dogged procurement processes and call their fairness into question.

Such consortia, or standard setting organisations (SSOs) themselves, display interesting internal dynamics. More often than otherwise, they take the form of industry associations. In other cases they have a significant potent representation of the private sector. Chiao, Lerner and Tirole (2005) analysed 60 such organisations and conclude that relationships among organisations matters to the quality of the standards themselves.

In part of his work on entry barriers, George Stigler (1971) suggested that one of the major reasons why firms may themselves push for standards is to restrict the number of players. The European context presents additional reasons for businesses. They lobby hard for standards at the EU level as opposition is not as well organised at the EU level. Most NGOs know the national context and are limited within their national structure. Moreover, conglomerates based in countries with standards already stringent standards find Europe-wide regulation the easiest way to have the run of foreign turf all to themselves at no extra costs.

3.5 Closer Home[4]

More recently in this region, public technology procurement has often been deployed as a 'demand side' policy instrument. Environmentally preferable technologies are seen as a primary area that public procurement could contribute to (Erdmenger, 2003). The EU itself has identified the environment as a priority area that public procurement policies could contribute significantly to (EC, 2004a).

Rolfstam (2005) goes into a complete review of the genesis and early trials that resembled technology procurement in Northern Europe. One of the projects mentioned there, is the

[4] 'Home', of-course, refers to the host institution and not the author.

focus case chosen for this research. Through the IEA DSM[5] agreement, the Swedish Energy Agency launched the project on cooperative procurement in 1989 that has continued in some form or another to this year. This particular initiative is at the focus of this research to help learn about the process and the nature of challenges.

[5] International Energy Agency – Demand Side Management

4 Method

This study rests on a hybrid of two approaches – Explorative Case Study and Key Informant Interviews.

The term e*xploratory case study* here is applied mostly, but not wholly in the sense used by Yin (2003 p6). Though the research questions were broadly framed before examining the case in depth, the case itself also helped generate more refined questions and develop a concrete hypothesis. In that sense, the research is allowed to take an "intuitive path", which is justified by the ultimate goal of developing the theory by direct observation.

The other sense is what Stake (1995 p3) calls i*nstrumental case study*. The case of Swedish Cooperative Procurement — in the context of broader pertinent policy mixes in the country — has been studied towards better understanding the challenges faced in arriving at standards. The initiative has all the markings of Technology Procurement and was expected to be illustrative of what is typical, at least in Northern and Western Europe. Additionally, when applying the frame of analysis, the details gathered about this focus case are used to map it in the graphical analytical frame (described in section 7), and other forms of implementation are then referenced relative to it on the same frame.

Key Informant are used when a researcher is interested in getting a deeper understanding of information available on a topic or when that information is inadequate to understand the institutional processes and challenges involved (USAID, 1996). The informant selected is usually a knowledgeable person, preferably someone who gained that knowledge from first hand involvement and experience. It is also most useful when the activity of interest has occurred in the past and someone with professional expertise can help connect the realities of the past to relevance in the current context.

Commonly, Key Informant Interviews are also used for research that aims to develop recommendations, which this study can be expected to after analysing the gaps in the current uses and mixes of policy.

4.1 Selection of Informants

The main purpose and design of this research rests on tracking and understanding the limited relevant literature available on the topic and indentifying and investigating gaps in published process documentation. Naturally, authors of the scant literature were the first priority. This fitted well with the chosen case method as one of the prominent authors of journal articles happened to be a senior public official overseeing the project of interest for a decade since its inception. Another such author tracked down is an academic who has recently written a PhD thesis on the topic and works with the author another rare book on Public Technology Procurement. Besides, the government and academia, the third perspective of the producer came in the form of a senior professional at the helm of the environmental department at the Swedish operations of a multinational technology intensive company, with whom the author had been previously acquainted.

After a frame of analysis is developed and described, the elements to be compared are graphically mapped. The frame and relative mapping facilitates a final heuristic Gap Analysis. A simple explanation of the kind of analysis implied here appears in the description by the Department of Engineering at the University of Cambridge ("Gap Analysis", n.d.).

5 The Interviews

As the information learned from the interviews is central to the main thesis, it is best to present it in the body of the text rather than shift the entire transcript to an appendix. It makes for better argumentation and easier reference. This section briefly paraphrases the conversations to reveal the information exchanged. Some of the striking revelations and major issues brought out are formatted with added emphasis.

5.1 Egil Öfverholm

In 1989 the Swedish Energy Agency (hereafter, 'the agency') proposed a cooperative procurement project. The agency was then absorbed into NUTEK, but the program lived on and still lives. The funding has wavered, but continues. Mr Öfverholm worked with it since 1990 to 2000.

A method to push desirable products on the market, and to push their performance in a desired direction was first proposed by the Swedish Royal Academy of Engineering. Hans Westling's thesis (1991) describing procurement of lifts for old buildings and other experiences in the construction industry was a bible for this programme. It stressed the existence and involvement of a strong agent who has resources, funding and is broader and, neutral. It could be one of the major buyers, although competition issues may arise. Westling did not say it should be the government, but in this case, the agency played that role.

The agency put buyers — housing cooperatives — in a group. Some of them were major ones. They constituted large parts of the market and were important to the sellers. The first reaction from sellers was to see this as interference in the normal practice of how they did things. After a while, they realised the advantages of pooled orders.

The first case was white goods – specifically mixed refrigerators. At that time there was one major player in Sweden, Electrolux. Their thoughts probably were, 'if we do not win the competition, then the competitors will steal market share from us'. Once they perceived a risk, they put a lot of effort in R&D. The response from Electrolux was several proposals in the hope that one would fit. They won.

Then the agency proceeded with other products – with some the process was strictly as described below and in some not so. The Town of Stockholm procured LEDs for traffic lights that had been spotted in Japan in 1993-4. There were only one or two Japanese firms who could produce it, so it was more of a demonstration.

5.1.1 Standard-setting

Firstly, with the group of buyers, it took almost a year before everyone understood the motives and could cooperate. *It is important not to underestimate the time to educate the buyers and producers.* The agency worked very closely with the group. Mr Öfverholm was mostly present in all meetings. The agency entered a contract with the winner and under that umbrella agreement each member of the buying group could buy the product.

The agency soon found that they had other interests. Energy was not high on their priority, for instance, with the refrigerators. These buildings had tenants that paid all inclusive rents. The equipment belonged to the cooperative and the tenants could be quite rough with the

refrigerators. So a major demand was regarding durability and toughness. Homes were getting redesigned. Open kitchens became more common so the unit was visible from the living room. So, it had to be aesthetically appealing and silent. Insides had to be non-toxic, so anything new proposed had to undergo check to meet other regulations. The manufacturers were on the other hand claiming that they were under pressure to reduce and replace CFCs and that was the focus of most R&D then. The resulting technologies consumed more energy, not less. That presented a problem to the agency, because to them energy was the reason to take up the program. Other products like washing machines likewise had demands other than energy efficiency.

Hans Westling's book introduced the hypothesis that the requirements should not specify details of technology, but only functional requirements.

With refrigerators, the main energy criteria was KWh/lt, referring to the energy consumption to cool a unit of inner volume.

One member of the group was the Swedish Consumer Agency. They pointed out that increased insulation reduces the room inside. Though it is energy efficient, the consumer does not prefer it. The compromise was to go upwards. The designs ultimately procured were taller. Another solution was evacuated panels for insulation, mostly in the doors. They had appeared on the market at the time, but in very low volumes.

The group needed knowledge of what was technically possible and what was not. They sourced it in the person from the Consumer Agency. He headed a laboratory and had undertaken many tests on white goods and also participated in international standard-setting. He had had a lot of negotiations with the manufacturers. He knew the market and he knew technology and the possibilities. He was a valuable resource.

In other cases, the agency hired industry experts to have discussions with the buyer group. *One of the advantages was that as a collective, the group could afford to get the best experts. Individual buyers do not have those resources unless they are the railways or the air force.*

Another issue is that within the manufacturing firms, there are various departments – production, sales, research and so forth. Sometimes, the productions personnel are very strong and they do not want any changes. If the person in charge of R&D comes up with something radically new, the production manager will cite many difficulties with additional time on the production line, scheduling, purchases or merely restructuring production processes. The key people were those from sales, because these were the ones in touch with the agency activity, at least initially. When they saw a market, they could and had to put pressure on the rest of the company. When the producers sent people it would either be liaison officials, even CEOs in case of small companies, or sales people. Later on in the process, it would be R&D people.

5.1.2 Which Product?

The idea was to pick a relatively new entrant and procure it to a level of penetration from where it takes off on its own. A 4 to 5 % of market penetration was aimed at, as it is believed that from thereon, the product can establish itself on the market with no further help.

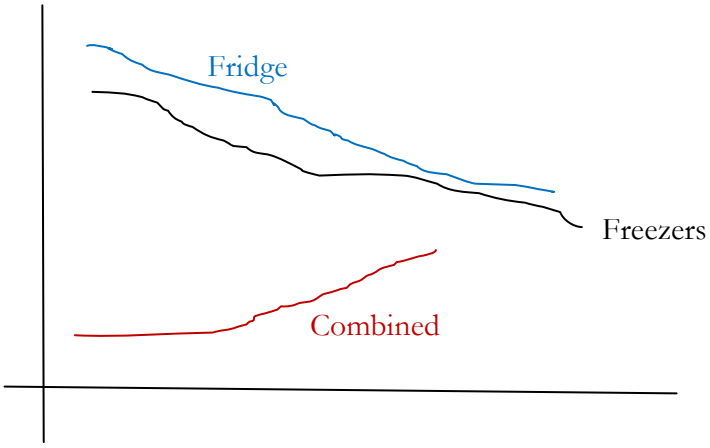

Figure 5-1 Which Product to Focus On?

At the time, independent fridges and freezers were going down and combined models were moving up (see Figure 5-1). That was due to a gradual demographic shift in society to smaller families. The agency decided to pick the combined ones as they were still close to the development stage, not mature products, they were still expanding. And the impacts of intervention would be greater and last longer in the future. It pays, therefore, to study where the market stands.

Choice of Products

The agency chose products (lines) which were projected to grow in the future, the short to middle term. The strategic choice is not dissimilar to application of the popular Boston Consulting Group (BCG) Matrix used to decide on focus units within a large business (depicted below).

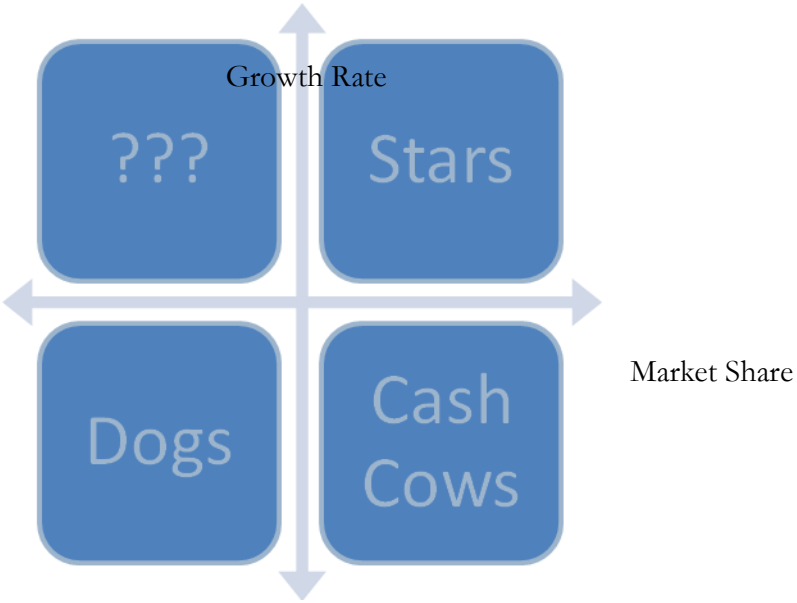

Figure 5-2 The BCG Matrix

With standards, the group mostly discussed functional units, energy to cool a unit volume or to wash a unit load of dirty clothes. With washing, there was some discussion on how dry is dry and what is clean etc. But they used the earlier attempts made at such standards. More difficult with standards were ovens and how to test cooking efficiency. The exciting cases were where standards existed for the actual function but not on the measurement of the function. In these cases, the group had to wait and develop measurement standards themselves and that took longer.

The expert had ideas about the flexibility of technologies, not just insulation, but the cooling apparatus, efficiency of the compressor and how the whole system works. He made numerous calculations for the group so they could discuss how a strict requirement on one element affected others and the trade-offs involved. They finally came up with two levels of requirements.

5.1.3 The Mandatory and the Desired

The desired requirements were tougher than the mandatory ones. The latter, every proposal was required to meet to participate in the competition. Both these levels were such that the group was sure it was technically possible to meet them. Why were they so sure? Firstly, they had the expertise from the Consumer Agency mentioned before. But that was not always enough. In many cases, the group then spoke to individual supplier firm or all together and tried to ascertain their response to a proposed level. The response of-course, varied from the cautious acceptance to outright rejection. An important issue with these discussions, however, was that as a public authority; the agency was required to adhere strict laws regarding procurement. In effect, this means appearing neutral at all times and according no one firm any advantages over the others. Practically, it meant dispatching exactly the same information to everyone at the same time, in the same manner and so forth. *Thus, however much the agency would have liked to have exhaustive rounds of discussions with all participants; it is easier in practice with the buyer groups than with the supplier side because of the legal angle*.

After these talks with the suppliers then, the rest of the group met again to finalize the requirements, which as said before, were stated as two levels. The reason for the gap is that they represent different kinds of technical feasibility. For the desired level, the producer would have to make significant changes, not just design changes in the products themselves but in assembly lines, supply chains – the bigger picture. As already noted, even within the firm there is bound to be some difference across departments regarding how these changes may be handled, how much of a change is acceptable or how much these changes mean in terms of costs. For instance, the production manager decides on "production-friendliness", the salesperson has idea about the "consumer-friendliness". The technologically perfect marvel may be too cumbersome to produce or too ugly to sell. Consumer acceptability was important as the main objective was to ensure that it penetrated the market. Hence, it was best to lave these decisions to the discretion of the manufacturer. It was a problem that their management can best solve and should be best left to solve. The mandatory level could be achieved by changes that did not affect the wider system.

In a sense, the interview suggested that the mandatory levels signified what might be termed *incremental* changes and the desired level, the truly *radical* ones.

The firms, on the other hand, were not used to these kinds of demands. The smaller ones were only used to the routine of researching one issued at a time. Their R&D systems were not geared to dealing with multiple demands of the kind that the group came up with, all the

more because some of them were conflicting demands in design terms. The extra effort brought the added advantages that after procurement, the R&D systems at these firms were reorganised, entire thinking and strategy underwent a change and they were left with a more robust R&D department. Their capabilities to cope with and meet demands were much enhanced.

In larger firms like Electrolux, a related bonus on the side was that the knowledge that they gained with one product lines, later spread to other products within their portfolio and also internationally.

In some cases the response was late (HF Ballasts[6]) or no response came at all (a novel variety of incandescent lamps).With the lamps, the agency even did market surveys to assess the willingness to pay for a product that performed and cost somewhere between the incandescent and fluorescent varieties. With these studies, they approached the manufacturers. The agency was aware of the technology, had seen prototypes and it was even used in other applications such as car headlights. However, the producers failed to respond. The reason was that they were afraid that the new product would cannibalise the current product line and their market shares may dwindle. The older version had a higher profit margin – it could be manufactured in Asia for a dollar and sold here for five.

It is therefore also quite important for the standard-setting players to know their market, the attitudes and drivers.

Whenever the winning product cost more than the commercial alternative – it usually did, but not very much more – the agency topped up the difference. The payment went to the buyers who then made the purchase.

Another example is in the case of ventilation units for schools, in Stockholm and the region. The buyer group was of companies that install these. One of the bids was indeed a very good one, technologically it met the energy specifications and was also very cheap. Through negotiation, the price was brought down to near the same level as the conventional units of the time. When the buyers' group was approached with this bid, they looked the other way, because the agency declined to offer any subsidy for the purchase, citing the already low price. The agency could not force them to buy. The framework agreement only mentioned an intention to buy, not an obligation. However, this was the only case where a successful bid did not work out and the manufacturers lost trust.

Over the years, the agency built good relations with sections of industry and learned a lot.

In yet another case – HF ballasts – the market was very slow because of a steep cost differences compared to magnetic ballasts. When the agency set demands for HF ballasts with requirements higher than available at the time – such as remote control – they got no response that met them, even though it was part of the mandatory level. In this case, the project did not manage to push the technology, but it did push the market considerably. Soon, the HF ballasts were everywhere and today it is very difficult to get illumination without them.

Heat Pumps was another projects that had a major impact on the market. In the 1970s and 80s, the market faltered with oil prices and increasing reports of breakdowns from early users.

[6] High-frequency Ballasts – used in building illumination

The procurement was hence directed more towards increasing the acceptance and bringing the price down, rather than performance. To test durability, the agency carried out a number of field tests. In parallel, they also ran a telephone service to advice consumers. With all these efforts, they managed to change the attitude among the buyers. The impact has been large enough to affect the oil demand in Sweden, because of a shift away from household oil based boilers.

Windows were done in two phases. The first was testing and some entrants did not make it through that phase. Two did (one Swedish and one Norwegian) and they were both equal in performance but differed a bit in design and aesthetics etc. The buyers did not like either design, even though the performance met the requirements. The two were declared as provisional winners, but they were given certain time and expertise – architects serving free for a decided number of hours – to improve the design. The final design was acceptable. However, the Swedish firm was quite small and the Norwegian one though large, was not popular in Sweden. Unless the other Swedish manufacturers turned out similar performing windows, it could not take off. And that is what happened. The aesthetics also played a role and despite engaging architects to promote the winning windows, they did not get very popular. It is only recently that windows of comparable performance level have become the norm in Sweden.

5.1.4 The Award

It was not easy for the typical buyers in the group to forecast their needs a couple of years in the future. So the potential prize for the winner was not a period contract, but a one-time order maximum to the tune of several hundred units – in total of what each buyer could purchase under the framework agreement. This was not large enough to interest the producers. Their interest was the anticipated orders, the assumption that if these buyers specify certain demands today, the product that meets them would continue to be in demand in the future as well and that is the direction to go in.

Once a winner was announced, the government continued to work with them with information campaigns and promoting the winning product. This was true in the early procurements. However, these campaigns were toned down gradually with products taken up in later years as lawyers within the government warned that it would probably raise issues of fairness. Even though everyone had the same chance to compete and win, it was not seen as tenable that the government should continue to actively promote a particular brand after the competition. Nevertheless, the agency continued to publish lists of the products and their performance levels as this was less contentious.

5.1.5 Process Period

A trade-off exists regarding the time period. Usually the period between finalizing specifications and deadlines for submitting solutions was around one year. If that was kept at five years, then the manufacturer would be in a better position to invest in R&D dedicated to that direction. However, the agency found it difficult to interest buyers in thinking in that long a term. Personally, Mr Öfverholm believes it should be possible to have a project run a longer time and should be tried out, especially if what you want is a big leap forward.

5.2 Hans Wendschlag

About 10 years ago, the Nordic Swan[7] drafted requirements specifying zero mercury in notebook display backlights. Mr Wendschlag from HP — and perhaps other industry insiders —warned them that that was not possible at that time. Apart from the fact that the alternative compromised on the function, another reason was also that they compromised other environmental criteria such as power consumption. However, the Swan stuck its ground and no licences were issued for as long as 3 years. All through that time, not one producer came up with a product or even a prototype, despite several public agencies requiring the Swan as a starting point of environmental requirements in tenders. *This is an obvious case where the knowledge of the shelves was not solicited, or even used in its implicit form, although this can hardly be claimed to be typical for all eco-labels given their sheer number.* After those three long years of unfounded optimism, the Swan conceded and rolled back the zero mercury requirement to a maximum limit. It is only recently that products have begun to emerge that deliver the function without the use of mercury. According to Mr Wendschlag, in 2008, every brand has at least one or two models that meet this requirement.

The central theme of this study could be summed up as "an idea whose time had come" (Weimer & Vining, 1999). The times of "ideas" cannot be forced to come any earlier than it is due. Or can it? Technology procurement is something like a drive to make ideas become reality sooner than due. Or one could say a public agency choosing a particular technology or aiming at certain levels of performance is an indication in itself that its time had come. Nevertheless producers have a major say in deciding the right time, as the Hg case shows.

If the bar is raised too high, firms may opt out, Mr Wendschlag warns. He reckons it quite possible for several major players to collude in such a case and either lend their collective muscle to block arbitrarily high requirements or simply ignore the instrument, voluntary that it is.

Wal-Mart is a very big buyer. They have a huge set of requirements for a range products, that HP decided to meet — to the extent that they even designed a separate line of models for them as the orders were big enough. This is a clear indication that large orders and economies of scale are used just the same in the private sector as is intended with public procurement.

With a large enough order, the government receives a similar level of attention. There is the recent 400 m$ order from the Swedish government (central procurement), that calls for computers with 15-16 environmental requirements. Energy Star is one of them.

Interestingly, the star changed requirements last year. Old star is minimum eligibility for tender application. New star is one of the award criteria. The next level of award criteria is more relevant here: the bidder who exceeds new star by 20% gets extra points. *The 20% figure is apparently without any consultation with manufacturers. It is noteworthy that even in a routine public procurement tender, a dual-level requirement is observed, much in the nature of the mandatory and desired seen before, however arbitrary the higher of the two levels may be.*

A different kind of technology procurement constitutes the case when the customer asks for information of the differential performance of technological variants of the same product on a number of criteria including non-functional, environmental ones. HP has geared up to the task and has spreadsheets ready for quickly calculating the environmental profiles of any

[7] The Swan is an eco-labelling initiative of the Nordic Council of Ministers. More information is at www.svanen.nu .

order mix. These are presented to the client in great detail. They use this data to fine tune the mix of technologies that they order.

Sometimes, the government works with a single producer. Ford Focus, a bio-fuel model from Ford, was promoted by 15-20 municipalities in Sweden. The first committed order from the municipalities was to the tune of 5000-6000 cars. It was also matched by a number of other efforts – financial (tax) benefits for early buyers and obligations for fuel stations to sell a minimum amount of E85 fuel.

Standard setting processes are also undergoing a rather rapid change, particularly in Europe and particularly in the industry that HP is in. Rather than allowing the SSOs to determine the standards, they wish them to draw out standardised methods of measurement and reporting, such that the producers all over Europe can conform to requirements that the regulator will itself set and keep revising (as mentioned earlier in the section 3 on Literature). The regulator would use the standardised methods to characterise the entire product portfolios of major brands to help decide where the actual specifications can be set. This is a very major development for the industry, almost a paradigm shift.

The personnel at HP whose prime work is standard-setting are spread in several divisions - two subdivisions under Environment and the *TechSpec* (technical specifications) people.

5.3 Max Rolfstam

To some extent, it is right to say that there is a divide between technology procurement for commercial reasons and that done for purely or mainly environmental goals. In the former case the requirements translate into quality and efficiency, elements of sustained value for the producers. Environmental requirements are normally seen as a necessary burden and information on possibilities may be harder to extract.

That said, in most cases, even the non-environmental ones, the producers are being shepherded into territory that they have missed. Technology Procurement, like many other policy instruments, is intended to compensate for inadequacies of the market, if not failures. Dr. Rolfstam believes that is not very different from the case of environmental values and desirables. The NUTEK case has shown at any rate that a public agency can "catalyse" innovation by clubbing economical and environmental goals (Edquist et al., 2000, p. 22).

It is important to see that Technology Procurement is just one of the tools from the assortment that might be needed together for everything to work as intended. For instance, developing and promoting fuel cell cars would need not just a prototype and large enough order, but entire infrastructure, associated subsidies, systems for supply and so forth. Admittedly, at times the other tools can be counter-productive. Such as the case of the procurement project for heat pumps. When the government announced a rebate financed by a subsidy, a number of committed orders were cancelled in anticipation! However, in his view it is difficult to predict those kinds of unforeseen public reactions. The key to the success of policy mixes is often plain trial and error.

Regarding the question of eliciting information about technologies on the shelf, that problem is quite well recognised and is currently being discussed at various fora. In fact, the European Commission just established an expert group on 'Public Procurement and Risk', where this will likely be a focus matter.

This author asked Dr. Rolfstam for his suggestions to remedy the information deficit on the procurer's end. More specifically, in the case of emergence of radically new technologies with much higher levels of environmental performance than on offer in the market, could a complementary information instrument be helpful?

In the opinion of Dr. Rolfstam, if a business does not wish to share a particular piece of information, there is no way to get your hands on it. And to begin with, he asks, why would a firm withhold information if it will stands to bring them some kind of benefit? In the case of any single producer having developed a breakthrough technology that is many times better than the existing best on the market, that new product will definitely win a bid, if the procurer places a tender. If a patent has been registered beforehand, there is no real problem. And when there is no clear problem, Dr. Rolfstam feels interventions should be absent or kept to a minimum.

The sad fact is that with public procurement, the rules are not as important as the perception of the rules. In his studies and experience, Dr. Rolfstam finds that most public procurers simply do not take advantage of whatever extent of flexibility is allowed under the procurement directives. Their actions are fairly risk-averse. They normally go for the cheapest offer rather than least total cost, most efficient or wider interpretations of the term "most economically advantageous", just to stay clear of troubles. Procurer phobia of running foul of the European laws will perhaps need extensive training to cure.

If a procurer is well-informed and can shed the notion of perceived risks, there are means available to minimise producer risk in turn. One such is pre-commercial procurement, that are allowed within the EU legislative framework. The basic premise is that as long as something is not commercial, it is exempt from EU procurement directives. As depicted in the figure below, the procurement can be undertaken as a four-stage process, of which only the fourth and final stage invokes the directives. A number of suppliers come together and share the R&D risk with the procurer. The producers can reduce their risk in this set-up. This is because they progressively invest more resources only if they cross the previous stage. The procurer on the other hand, gradually interacts closer and closer with the succeeding suppliers and gets more committed only at the final stage.

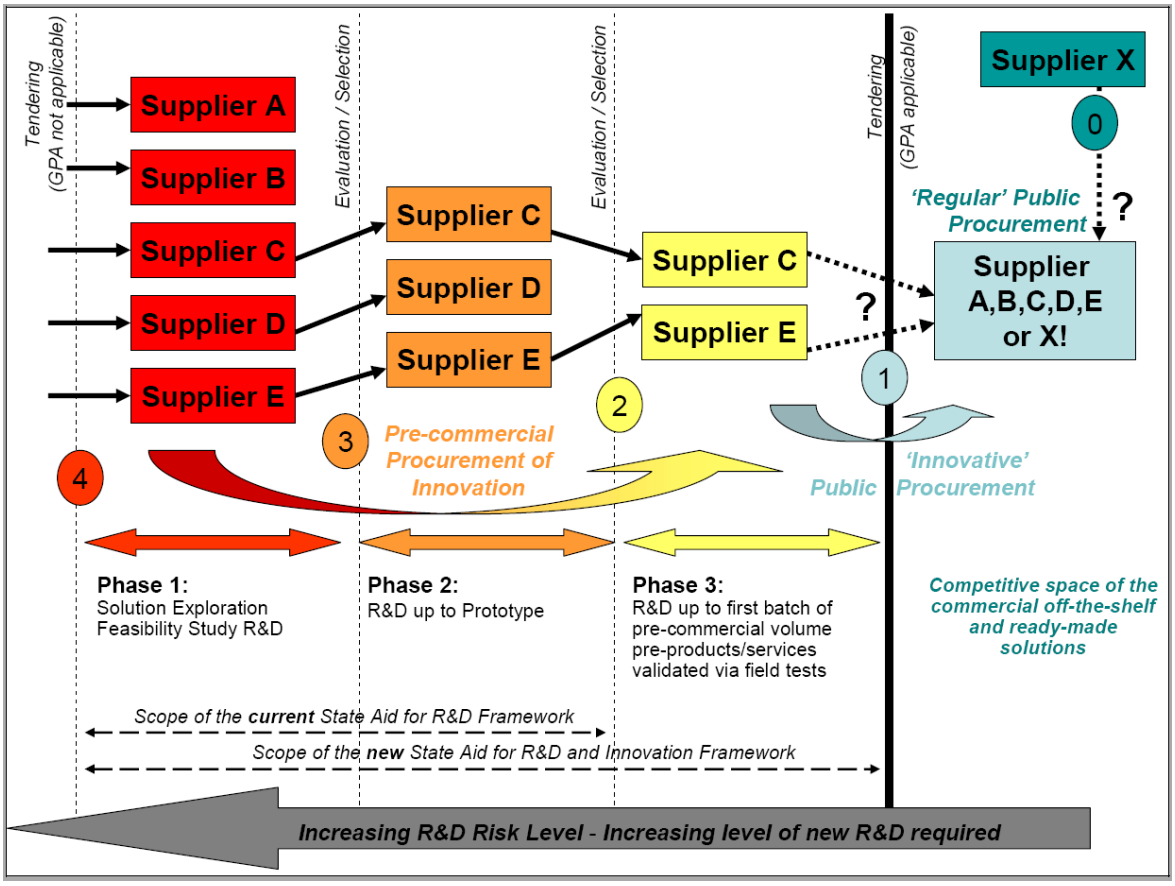

Figure 5-3 Recommended Implementation of Pre-commercial Procurement

Source: (National IST Research Directors Forum Working Group on Public Procurement, 2006)

However, it is easy to see that this process only reduces producer risk, it does not eliminate it. A better wording would be that the producers are given the chance to *optimise* their risks. If a particular producer fails at some stage, they still have given up some inside information, although arguably it was perhaps not worth much as others obviously bettered it. However, the real worth of the information to that same producer is known only to that firm, as outsiders have no knowledge of the others plans that it may have been a part of. It is hence difficult to say how much a failing firm looses, and by corollary, how much risk in absolute terms the process reduces for individual firms.

6 Preliminary Findings

This section summarises the major points learned on combining information gained from the separate interviews. Firstly, we may now revisit the definition of technology procurement and the variety within its scope on the ground.

6.1 Variation in the Terminology

The term Technology Procurement is simple enough to imagine without pondering over a watertight definition of the kind quoted in section 1. However, it turns out that on the field, its implementation varies much in design. To put it in the more correct manner, a large variety of initiatives are being called Technology Procurement. In the following sections, the variants given below are compared on a number of parameters of interest.

6.1.1 Public Procurement of Technology

Let this type represent the ideal procurement process, where a ground-breaking technology is procured by a government through an extended interaction and perfectly open negotiation with a group of producers. There are some examples; some even with environmental goals, such as street lighting or railcars in Germany or other civil amenities elsewhere in Europe (Rüdenauer et al., 2007), but most result in a one-time order which is in itself big enough to interest the producers. This type is merely mentioned as one of the possible means to the ideal being aimed for.

6.1.2 Cooperative Procurement (the case studied)

A group of buyers aggregates their demand and requirements to attract proposals for a competition. The winner is assured a certain size of an initial order, part of which can be sold to each individual buyer under the framework agreement with the buyer group. Other policies are be used to supplement the initiative.

6.1.3 Public Procurement Relying on Labels

This is not an established term, but is given here for comparison as it is used to similar ends. It includes a very common scenario when the procurement proceeds by the process as followed in routine government purchases, with the exception that very progressive eco-labelling standards are directly referred to in the tender and serve as basis for the award of points. In Sweden, the Nordic swan and the Energy Star have become increasingly common, both as a mandatory requirement for applications and often with bonus award points for exceeding the requirements as gleaned from Mr Hans Wendschlag (personal communication, 9th April 2008).

6.1.4 Unsolicited Bids

This refers to the case when a producer who has developed a promising technology approaches the government with a proposal in the absence of any expression of interests having been solicited. These have been discussed in Edquist et al. (2000) as forming an important element of public procurement system and laws in several European countries, for instance, Italy and Spain, which have legal provisions for it. The European Commission

Expert Group Report (EC Expert Group, 2005) specifically recommends incorporating provisions to handle such bids. However, these are likely to be most active in industries heavily dependent on the public sector.

6.1.5 Single Producer Engagement

This is the kind of case that covers the Swedish municipalities' engagement with Ford for developing the bio-fuel model mentioned in the second interview (Wendschlag, personal communication, 9th April, 2008). This is another form that is included for purposes of comparison. There are any number of such examples of governments working with a single firm to develop a new solution. However, these have tended to be products dedicated to the public sector.

6.1.6 Informed Private Purchasing

This type is included to describe a sales strategy employed at HP, as learned in the second interview (Wendschlag, personal communication, 9th April 2008). HP informs prospective buyers of the total load of ownership and operation of each technology (options within the HP portfolio with the same function such as CRT or TFT displays for desktops.) They also have a tailor-made spreadsheet where numbers from an order can be punched in and a number of cost and impact categories readily quantified.

6.1.7 Energy Plus[8]

The specification of functional requirements was similar to that of Cooperative Procurement, except that no orders are formally promised. The reward was merely the recognition of having won a prestigious EU-backed competition and a mention on the list of preferable vendors. The program heavily canvased the competition and recruits institutions to commit themselves to buying their supplies from winning vendors.

6.2 The paired standards

In the case studied and many that followed it in time, it is observed that the requirements are always specified in the dual levels – mandatory and desired. The difference between the two, as noted in the first interview (Mr Öfverholm, personal communication, 11th April 2008) was to allow for the manufacturers' discretion for making economic decisions, such as regarding production and saleability.

That is also an indication of lack of information. Since the procurer is not fully competent to take these factors also into account when framing a standard, the cost, in a way, is in terms of the need to specify two levels with a somewhat arbitrary gap between the mandatory and desired levels. The closer the procurer is to perfect knowledge about the new technology and related practicalities, the smaller the gap between the two levels would be.

As the dual-level specification is almost a norm in practice right from routine tenders relying on eco-labels to the European Energy Plus initiative, it is enriching to know the original reasons for the custom. It also helps compare the different approaches above as attempted in the analytical sections to follow.

[8] A European project that closed in 2004. Active website is at http://www.energy-plus.org/english/

7 The Frame of Analysis

Rolfstam (2005) has described an interesting framework in which typologies of Technology Procurement may be pigeonholed. It is a matrix with two dimensions. The first dimension depicts the kinds of social needs that the project aims to meet. This could be anywhere between the public procurer's own interests, that of a third party which rather than the public agency is the final end user or it may be a goal common to the two. The other dimension is the nature of the market intervention. The project may hope to introduce a new technology, to promote and broaden a niche application or to firmly establish a product as mature.

The original matrix is reproduced unchanged in Table 7-1 below:

Table 7-1 Two-dimensional Classification of Technology Procurement

Role in Relation to Market / **Type of Social Need**	**Initiation** (Development)	**Escalation** (Adaptation)	**Consolidation** (Standardisation)
Intrinsic	Computer, radar, sonar technologies	*Vattenfall* off shore wind power plants	24/7 agency
Congeneric	energy-efficient refrigerators	*IEA environmental procurement*	
Extrinsic			*KRAV*

[9]

Source: (Rolfstam, 2005)

While the above frame looks at the objectives of the technology procurement instrument, we look at the design and process. Also, some designs of technology procurement projects we have seen before may be difficult to place in the above matrix. Hence, specific to the purposes of this research, the author developed his own frame of analysis. In line with Rolfstam (2005) and (Edquist et al., 2000) this study uses a multi-dimensional frame as well, but with different dimensions and in a different manner.

[9] The boxes contain some initiatives from Europe and Sweden. KRAV is a Swedish eco-label for food products.

The main element of the analytical frame applied here is a map of where all that has been called Technology Procurement falls along a number of axes of interest (dimensions). The position on each axis is governed by a set of related questions as outlined below.

7.1 Rationality

To what extent is the proposed or prospective standard based on industry information? Were efforts made to assess the feasibility of the technological standard? Does the decision making consider the distance of the standard from the current state-of-the-art and the additional efforts involved? On one extreme of the scale would be a process where all producers share information on the technological options they have on the shelf, cost estimates, design challenges and potentials. On the other, the procurer or coalition of procuring parties will set a demand at what seems reasonable but fairly arbitrary all the same – words to the effect, for instance, "20 % higher than XYZ standards". The XYZ against which the demand is pegged may be either voluntary standards such as eco-labels or based on a market assessment to determine the best available at the time.

In the latter case, a market assessment may not be confused with adequate information. The place on this axis is decided not by how much information is collected, but how the information is used.

7.2 Novelty

This is simpler. How radically new a technological solution is being sought? Is the best hope to improve existing technologies or to push them to their limits, or is it merely another way of promoting and rewarding the existing best in its class. In other words, how challenged does the current best feel? In terms of standard setting challenges, it is evidently easiest to meet, discuss and agree upon incremental requirements in the desired direction. What is by far more difficult is to find out if radically new technologies that take performance to the next level are possible or are at the brink of turning economically attractive.

7.3 Transparency

A measure of how wide open the procurement was — whether or not the process involved an open tender. In other models, the procuring party may have an understanding with a single producer.

7.4 Policy Design

Was technology procurement implemented as a stand-alone measure? Were any other instruments or initiatives launched to supplement them towards the same goal? Did any older or existing instruments help or play any role in the standard setting process itself? How well integrated in general was the technology procurement drive with wider environmental policy and the even wider applicable policy framework?

Since we are interested in more than two axes, we map them not in a Cartesian 3-D form, but on 4 horizontal ones as shown in Figure 7-1. Variants of implementation can be depicted by curves that intersect the axes at points to indicate their position relative to the others. That is the essential content of the next section.

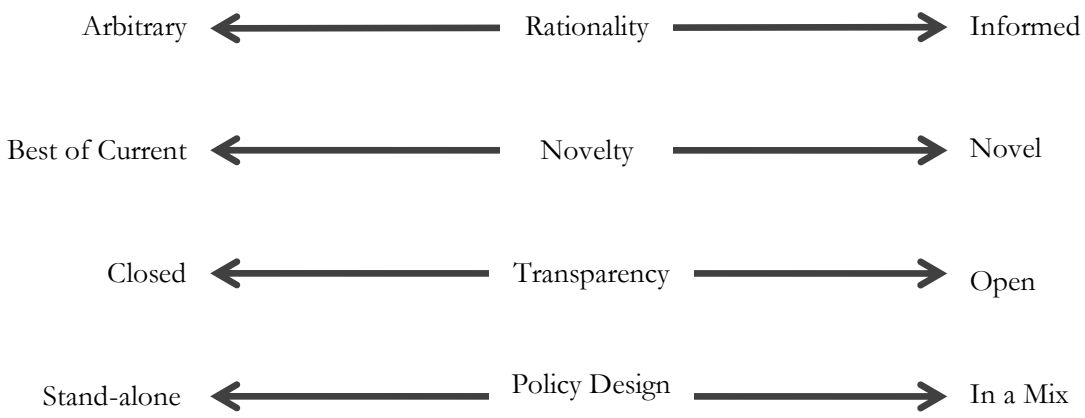

Figure 7-1 Analytical Frame: Graphical Representation

8 Fitting to the Frame

First under consideration, the main case under focus – that of cooperative procurement as implemented in Sweden, and described at length in the paraphrased interview with Mr Öfverholm (Section 5.1).

8.1 Cooperative Procurement

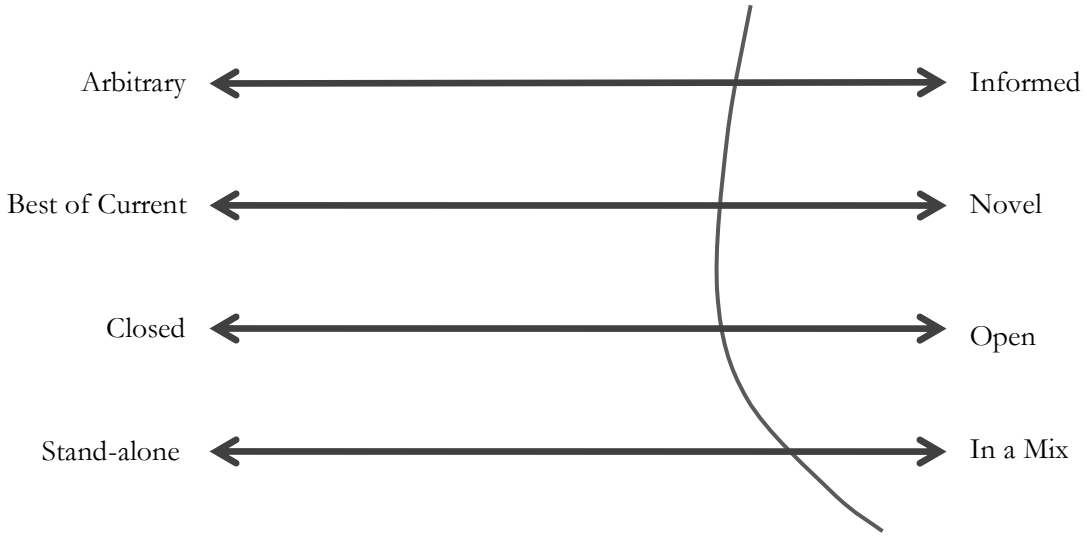

Figure 8-1 Analytical Frame: Cooperative Procurement

The interactive process involved a group of buyers, a private consultant, officials from NUTEK, an expert from the Consumer Agency, who bought the technological knowledge. As learned from the interview (Mr Öfverholm, personal communication, 11th April 2008), the producers side was not constantly represented at all meetings. Intermittently their representatives were invited to join and they variously sent people of different competence, beginning with liaison officials in the early stages, mostly sales people throughout the process, and R&D professionals towards the final stages. The process can thus be said to be informed. However, it did not come out indubitably that the manufacturers always shared detailed information of what performance levels were possible. Their role was more in responding to the demands as they emerged. Also, the participation from the manufacturers end was not uniform across different products procured at different times. Thus, though the standards can be said to be reasonably informed, it does not belong at the perfect extreme, but somewhere near it.

Likewise it is with Novelty and Transparency. The improvements seem to have been incremental in nature. Radically new technologies were proposed and won in a very small proportion of the projects. The competitions were quite open and in some case even foreign firms applied. In some cases, firms that did not win were less than happy about the continued promotion that the winning product received from the government agency. An SNEA study

also mentions "preferred vendor lists" (SNEA, 1998) that some buyer groups in Sweden began with, although it is not clear in which specific projects.

On policy design, however, the scheme merits a perfect score. As described in detail in Neij (2001), in each of individual projects of procurement for different products, the procurement initiative was backed by several other policies, in each case chosen specific to the context as the need was felt. Much of the success as determined in subsequent evaluations (), in fact, can be attributed to the coordination of efforts by several government agency and integrated policy design to begin with. Hence, in Figure 8-1, the curve turns right to the desired end of the axes. Next, we compare a few of the other types mentioned before.

8.2 Public Procurement relying on Labels

As noted from the case of the eco-label (Nordic Swan) requirement for zero mercury in laptop displays (Wendschlag, personal communication, 9th April 2008), in some cases the requirements intended to be progressive can be downright arbitrary. Also, with no basis in current technical know-how, such requirements can range anywhere on the novelty axis. As a routine public procurement system, the process is quite open. Lastly, the extensive reliance on eco-labels is a clear sign of combined use of policies. This line in Figure 8-2, therefore, moves gracefully from one extreme on the top axis to the right extreme on the bottom. Given the multitude of labels, however, the positions are likely to vary greatly. With the new Energy Star procedure, for instance, the levels are much better informed with exhaustive market surveys, so its position shifts rightwards on the first axis.

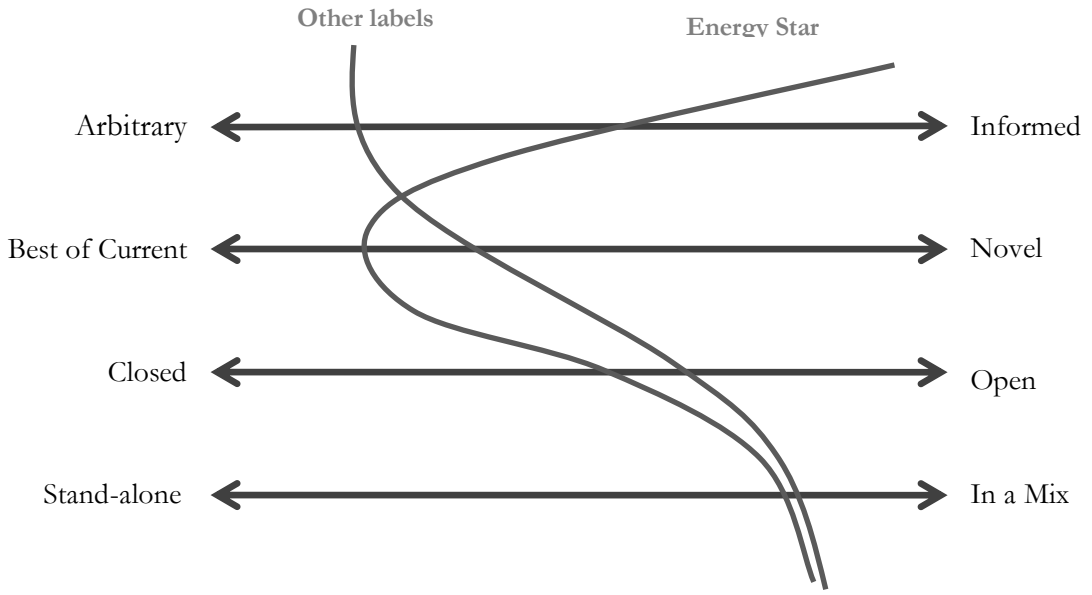

Figure 8-2 Analytical Frame: Public Procurement with Ecolabels

8.3 Informed Private Buyer

When HP makes those presentations to a client, naturally there is a crucial flow of information. Yet, it is not at the best end of the first axis as the client does not use that information to decide any standard, rather to make a choice. That choice, moreover, is

unlikely to be anything that the market has never seen before. The informed decision will only promote the best – in terms of energy efficiency – of what HP has to offer. The information exchange is quite closed as it occurs between HP and one client at a time. However, it is definitely better than a routine private purchase. Though there are no additional public policy instruments at work here, HP's proactive information sharing strategy must count as a supplementing effort. We get a nice, symmetrical parabolic curve (Figure 8-3), indicating the fact the deficiencies are somewhere in the middle.

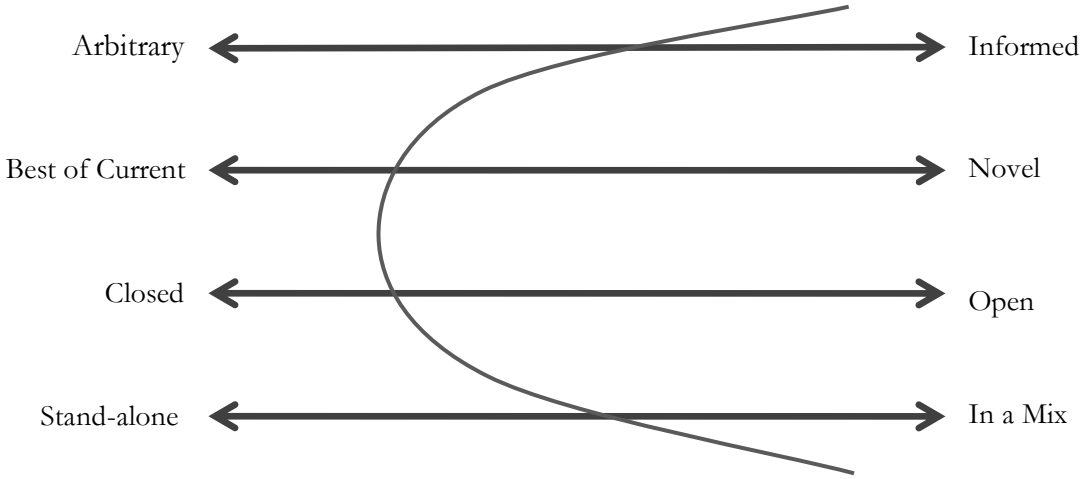

Figure 8-3 Analytical Frame: Informed Private Buyer

8.4 Unsolicited Bids and Single Producer Engagement

In terms of information exchange, these situations are perfect as the producer might be willing to share a bulk of confidential technological details. For the same reason, the potential for churching up a radical new solution is also high. Obviously, either mechanism is anything but open to all, relying on the exclusivity to rid of some of the tricky problems discussed above. There may or may not be other instruments at work. In case of Ford Focus, for instance, the government brought in a slew of measures including incentive for fuel suppliers and rebates for early purchasers. The scope of variation is depicted in Figure 8-4 by an alternative dashed curve.

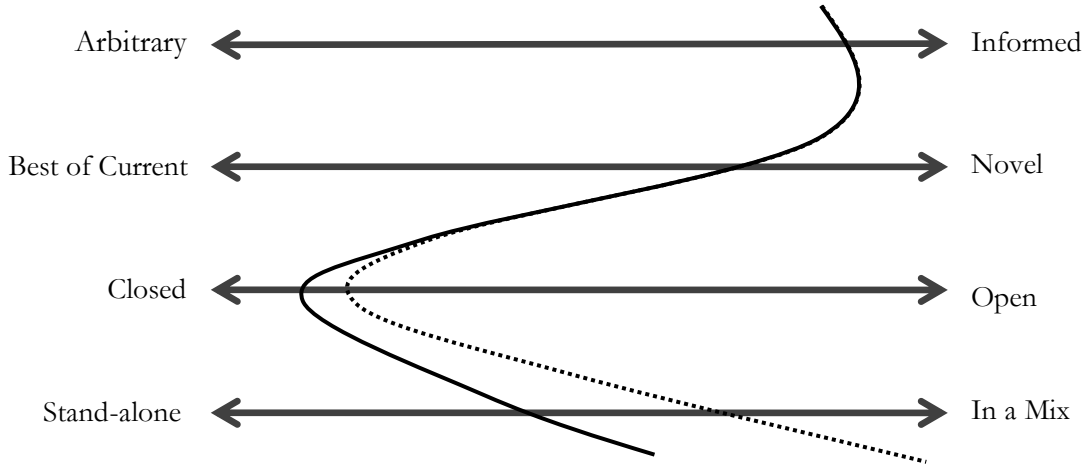

Figure 8-4 Analytical Frame: Unsolicited Bids or Single Producer Engagement

An immediate outcome of juxtaposing the typology of this instrument is that one can now discuss alternative designs and processes in this light. One such design is proposed in the latter of the next section.

9 Concluding Discussion

Finally, to take stock of the objectives and the degree to which they were achieved and to formulate outcomes.

The most fundamental question of all concerned the basis of decision regarding standard and levels of requirements. That was successfully gleaned from the study case and appears succinctly documented in section 5.1.3, *The Mandatory and the Desired*. The significance of stipulating two levels and the rationale behind the gap is in itself valuable information for anyone undertaking further research on either standard-setting, technology procurement, innovation policies or even product development.

The fact that the gap reflects one part of the information deficiency on the procurer's side points to the obvious need for enhancement of expertise on that side. While training has been proposed before, the case suggests that with an aggregate procurement such as in cooperative procurement, **the group can be expanded to include professionals from wider spheres, beginning with production and marketing**.

The subsequent frame-fitting analysis also helped in characterising and comparing various approaches to technology procurement. The gaps noticed on the analytical frame indicate that the above is only part of the information deficit. The two following main issues stand out in balance.

An unresolved problem that clearly emerges from the above analysis is that of *new information* imbalance. The bulk of key information of path breaking technologies is with the manufacturer. The reader will recall one of the research questions pertained to this angle and the answer seems to be that the variety of implementation has not quite perfected a solution yet. In all the above "maps", none of the lines begins somewhere on the far right of the first axis that we called 'rationality'.

The other problem is simply that of *time* and *timing*. *Time* refers to the issue that Mr Öfverholm (personal communication, 11th April 2008) brings out. For pushing R&D in a desired direction for eventual procurement, the project cycle has to be considerably longer than the typical that they tried. Buyers in the group were not prepared to plan ahead in those terms. However the government could. In some cases, it could persuade a group of buyers to.

On the other hand, the *timing* issue is the trickier one of determining and cashing on opportune windows of innovation. On top of the information burden discussed above, even the rich information at the side of the industry occurs in spurts and pulses. That, incidentally, is also the case with large bulk orders or coordinated buyer requirements. The two cycles will coincide only rarely (see Figure 9-1) and it is not the best policy design to work with these fortuitous events.

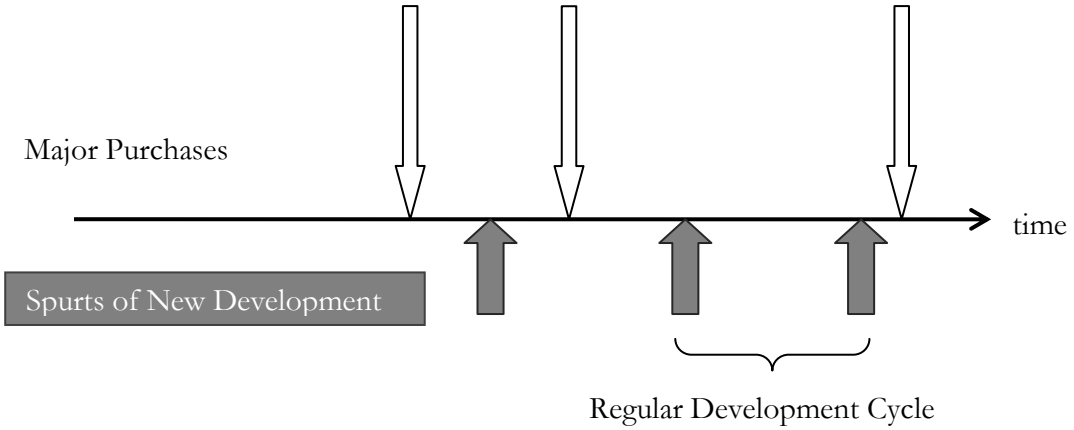

Figure 9-1 Purchase and Development Cycles 'Out of Phase'

There is a clear need for an instrument that will help bridge gaps – both in terms of information and between mismatched cyclic events.

9.1 Procurer-Pull Technology Procurement

A possible solution (at the very least a direction) came to this author in one stroke on reading a recent piece of news in the Technology section on BBC website ("Electronics' 'missing link' found," 2008).

Hewlett Packard recently announced trials of a breakthrough technology that may replace transistors – the components that were at the core of computer technologies for the last 25 years . All development in computing was hitherto driven by perfecting and shrinking them. It had begun to look like we were approaching the limits of how many transistors could be packed onto a single chip. What is more, the new device has not one but two functions – as a single unit it can serve as a memory cell and as two, replace a transistor. The industry is now looking at a whole new scale of miniaturisation. This would directly translate into environmental advantages in terms of both energy and materials.

HP will soon be able to manufacture computers with an unprecedented environmental impact profile. Public procuring agencies could give them the initial boost needed to get the production line running and start paying back R&D. A crucial question is, how would the twain meet in keeping with application tender and procurement regulations?

If only firms could regularly update the government of their capabilities. This is to suggest a kind of an information policy instrument, to complement the technology procurement instrument. This is not to suggest that companies should share all future blueprints and patents with the government. But they can be asked to share the levels that they can potentially meet on a number of functional desirables, such as, say, standby energy consumption, total content of a bundle of heavy metals and so forth. The information

instrument can make it mandatory to update the government on an as-and-when basis about these levels – as and when the companies test marketable prototypes.

This new instrument would require that as and when new technologies are announced or patented, the company shall intimate the government of the environmental profile of that technology. This could be in terms of a product unit or functional units.

The advantage for the firm is that when considering their next bulk order, the public agency is better informed when drafting environmental requirement levels and can issue a tender clearly favourable to the new technology.

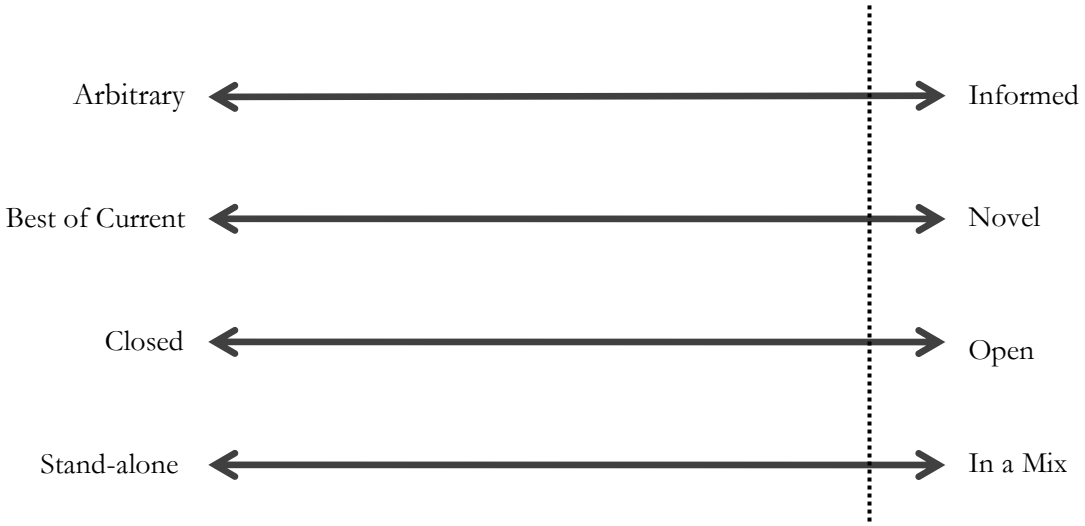

Figure 9-2: Analytical Frame: The Proposed Mix

Using the same frame as for analysis, Figure 9-1 attempts to represents what might be possible to achieve with the proposed additional policy instrument.

Though the opinion of Mr Wendschlag of HP on this particular kind of producer obligation, could not be ascertained before the time of submitting this draft, the author can attempt an educated guess based on the conversation in Stockholm. If he can painstakingly produce presentations for every individual purchaser detailing the environmental profile of their order, complete with calculations specific to that order mix, it is unlikely if he or the company would mind sharing with the government the generic environmental profile of a technology that they have recently patented and are eager to commercialise. It is even less likely when it means anticipating an open, yet very favourable tender that is nevertheless perfectly in keeping with the law.

Also, it is likely that the proposal will encounter Dr. Rolfstam's question (personal communication, 22nd May 2008) - "Why would a producer not benefit from a breakthrough technology when applying for a tender (without any additional interventions)?"

Firstly, as in the case of the latest device that HP has developed, even a prototype of a complete computer is probably not available yet. The product is far from ready for the

market. Given the time frames of development discussed above, the producer will only start acting on tenders at a much later stage. More importantly, the terms of relative advantage in public procurement are specified in tender documents, drafted by people on the procuring side. As discussed, they are in the dark regarding the differentiating levels of environmental performance that sets the new technology apart. If well and pre-informed of the new potential, they would be in the position to include in the text of the tender, clearer award points for meeting or exceeding those levels of requirements. The anticipation of winning tenders will considerably curb producer risks, shorten development cycles and provide a ready market, without any advertising overheads, for the first line of manufacture.

That is what the information instrument would achieve. Somewhat reverse in principle to the *unsolicited bid*, the procurer will constantly stay wise to the latest levels of requirements that just-patented technologies can meet. He or she will draft more efficient tenders truer to the real potential of society at the time.

The intricacies of the design of this instrument mix would, of-course, have to be written with due care not to run foul with the law. Combined with either pure public procurement or with the Swedish styled cooperative procurement, this policy mix is sure to give a much needed initial boost to emerging technologies. That and the *twenty dollar bill test* (Bardach, 2005)[10] are beyond the scope of this study and would be excellent topics for further research.

As mentioned on the opening page of the first section, this is the age of rapid technological advancement. The old Sanskrit adage - 'change is the only constant' - was never truer. This has also been called also the knowledge age. Managing information is crucial to success in almost every field; so also in public policy. The best results will be seen when governments, citizens and businesses instantly and efficiently share new information with governments as and when it appears, in all mutual directions.

[10] From the common joke about two economists taking a stroll, one of whom suggests that if it is lying in the middle of the road, it is unlikely to be a twenty dollar bill. Bardach likens the situation to untested policy options to ask: why if the suggested alternative is such a great idea is it not already in place?

Bibliography

Bardach, E. (2005). *A practical guide for policy analysis : the eightfold path to more effective problem solving*. Washington, D.C.: CQ Press. Retrieved June 4, 2008, from http://www.loc.gov/catdir/toc/ecip0422/2004020091.html.

Bower, M., de Jong, K., Jonk, M., Berman, T., Bersani, R., Lusser, H., et al. (2005). Green Public Procurement in Europe 2005 - Status overview. . Virage Milieu & Management. Retrieved March 9, 2008, from http://ec.europa.eu/environment/gpp/pdf/report_facts.pdf.

Brown urges embryo bill support. . (2008, May 18).*BBC*. Retrieved June 4, 2008, from http://news.bbc.co.uk/2/hi/uk_news/politics/7406773.stm.

Chiao, B., Lerner, J., & Tirole, J. (2005). The Rules of Standard Setting Organizations: An Empirical Analysis. *National Bureau of Economic Research Working Paper Series*, *No. 11156*. Retrieved from http://www.nber.org/papers/w11156.

Clifford, S. (2005). So many standards to follow, so little payoff. *Inc*, *27*(5), 25-27.

EC. (2004a). Mandate to CEN/CENELEC/ETSI for Programming of Standardization Work in the Field of Eco-design of Energy-Using Products M 341 - EN. . European Commission.

EC. (2004b). Buying Green! A handbook on environmental public procurement. . European Commission. Retrieved December 4, 2007, from http://ec.europa.eu/environment/gpp/pdf/buying_green_handbook_en.pdf.

EC. (2006). Green public procurement: Turning Policy into practice. In . Graz, Austria. Retrieved December 3, 2007, from http://www.iclei-europe.org/fileadmin/user_upload/ITC/gpp_2006/graz_report_final_small.pdf.

EC Expert Group. (2005). Public Procurement for Research and Innovation - Expert Group Report: Developing procurement practices favourable to R&D and innovation. . European Commission.

ECEEE. (2006). The Eco-design Directive for Energy Using Products (2005/32/EC). . European Council for an Energy Efficient Economy. Retrieved December 19, 2007, from http://www.eceee.org/european_directives/Eco_design/eceeeBrief_Eco_design.pdf.

Edquist, C., Hommen, L., & Tsipouri, L. J. (Eds.). (2000). *Public Technology Procurement and Innovation* (p. 322). London: Kluwer. Retrieved from http://books.google.com/books?id=I9_IbH37N94C.

Electronics' 'missing link' found. . (2008, May 1).*BBC*. Retrieved May 2, 2008, from http://news.bbc.co.uk/2/hi/technology/7377063.stm.

Environment - Innovation - Employment. . (2007, June 1). Retrieved from www.eu2007.de/en/News/download_docs/Juni/0601-U/035Arbeitspapier.pdf.

Erdmenger, C. (2003). *Buying into the environment : experiences, opportunities and potential for eco-procurement*. Sheffield: Greenleaf Publishing.

Faure, M. (1995). The Future of Socio-Legal Research with Respect to Environmental Problems. *Journal of Law and Society*, *22*(1), 127-132.

Gap Analysis. . (, n.d). Retrieved May 19, 2008, from http://www.ifm.eng.cam.ac.uk/dstools/choosing/gapana.html.

George J. Stigler. (1971). The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science*, *2*(1), 3-21.

Giles, M. (1991). Market failure. *Economist*, *319*(7710), 6-9.

Going commercial. . (1994).*Economist*, *332*(7879), 13-15.

Gottberg, A., Morris, J., Pollard, S., Mark-Herbert, C., & Cook, M. (2006). Producer responsibility, waste minimisation and the WEEE Directive: Case studies in eco-design from the European lighting sector. *The Science of The Total Environment*, *359*(1-3), 38-56.

Granstrand, O. (1984). Technology Procurement as a Special Form of Buye-Seller Interaction in Industrial Marketing. In (Vol. 84). Stockhom School of Economics.

Green Public Procurement: how to turn policy into practice! . (, n.d). Retrieved December 3, 2007, from http://www.eu2006.gv.at/en/News/information/0304GreenPublicProcurement.html.

Gunther, E., & Scheibe, L. (2006). The hurdle analysis. A self-evaluation tool for municipalities to identify, analyse and overcome hurdles to green procurement. *Corporate Social Responsibility and Environmental Management*, *13*(2), 61-77.

Haq, G., Bailey, P. D., Chadwick, M. J., Forrester, J., Kuylenstierna, J., Leach, G., et al. (2001). Determining the costs to industry of environmental regulation. *European Environment*, *11*(3), 125-139.

Heston, A., Summers, R., & Aten, B. (2006). Penn World Table Version 6.2. . Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

ICS. (2004, April). Cry wolf – predicted costs by industry in the face of new regulations. . International Chemical Secretariat. Retrieved January 3, 2008, from http://www.chemsec.org/downloads/?filename=Cry_wolf_report.pdf.

IISD. (1996). Global green standards: ISO 14000 and sustainable development. . International Institute for Sustainable Development. Retrieved December 11, 2006, from www.iisd.org/pdf/globlgrn.pdf.

MacLeod, Harrington, W., & Morgenstern, R. D. (2006, March 14). Comparing the Ex ante and Ex post Costs of Complying with Regulatory Changes. . DEFRA. Retrieved from http://www2.defra.gov.uk/science/project_data/DocumentLibrary/SD14011%5CSD14011_3366_FRP.pdf.

McCrudden, C. (2004). Using public procurement to achieve social outcomes. *Natural Resources Forum*, *28*(4), 257-267.

National IST Research Directors Forum Working Group on Public Procurement. (2006). Pre-commercial Procurement of Innovation: A Missing Link in the European Innovation Cycle. . European Commission. Retrieved from http://ec.europa.eu/information_society/tl/research/key_docs/documents/procurement.pdf.

Neij, L. (2001). Methods of evaluating market transformation programmes: Experience in Sweden. *Energy Policy*, *29*(1), 67-79.

NUTEK. (1995). Technology procurement as a policy instrument : a comparative study. . Swedish National Board for Industrial and Technical Development.

Olerup, B. (2001). Technology development in market networks. *Energy Policy*, *29*(3), 169-178. doi: 10.1016/S0301-4215(00)00118-X.

One Europe, One Economy. . (1991).*The Economist*, *321*(7735), 53-55.

Prakash, A., & Potoski, M. (2006). Racing to the Bottom? Trade, Environmental Governance, and Iso 14001. *American Journal of Political Science*, *50*(2), 350-364. doi: 10.1111/j.1540-5907.2006.00188.x.

Rolfstam, M. (2005). Public Technology Procurement as a Demand-side Innovation Policy Instrument – an Overview of Recent Literature and Events. . Danish Research Institute for Industrial Dynamics. Retrieved March 10, 2008, from www.druid.dk/uploads/tx_picturedb/dw2005-1635.pdf.

Rolfstam, M. (2008). *Public Procurement of Innovation*. Lund: Lund University.

Rüdenauer, I., Dross, M., Eberle, U., Gensch, C., Graulich, K., Hünecke, K., et al. (2007). Costs and Benefits of Green Public Procurement in Europe. . Öko-Institut. Retrieved March 21, 2008, from www.iclei-europe.org/fileadmin/user_upload/Procurement/GPP_Costs_Benefits/GPP_EU_Final_Report_all_small.pdf.

SNEA. (1998). Pocurement for market transformation for energy-efficient products. . Swedish National Energy Administration.

Socialdemokraterne - English version - The European Perspective on Green Roads to Growth. . Retrieved February 1, 2008, from http://socialdemokraterne.dk/default.aspx?site=english&func=article.view&id=154788.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, Calif. ;: Sage.

USAID. (1996). Performance Monitoring and Evaluation. . USAID Center for Development Information and Evaluation. Retrieved February 12, 2008, from http://www.usaid.gov/pubs/usaid_eval/pdf_docs/pnabs541.pdf.

Weimer, D. L., & Vining, A. R. (1999). *Policy Analysis: Concepts and Practice* (p. 486). Prentice Hall.

Westling, H. (1991). *Technology Procurement for Innovation in Swedish Construction*. Stockholm: Swedish Council for Building Research.

Yin, R. K. (2003). *Applications of case study research*, Applied social research methods series, 99-0497898-0 ; 34. London: SAGE.