Clean Vehicle Procurement

a rear view and guideline

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Target groups: Players in clean vehicle procurement; manufacturers, sellers, public bodies, etc.

Foreword

Within the framework for TRENDSETTER Work-package 12, coordinated technology procurement has been carried out for biogas and electric hybrid vehicles. Experience from the project is shown in this report together with experience from other clean vehicle procurements.

In spring 2004, The Swedish Electric and Hybrid Vehicle Association (SWEVA) took the initiative for a follow-up project of technology procurement for clean vehicles. In addition to the Trendsetter procurement, the follow-up project includes two previous clean vehicle procurements.

The aim of the project has been to study and learn from technology procurement projects for clean vehicles in order to increase the impact of clean vehicle procurement in the future. The main method used for this project has been interviews with various players involved, from manufacturers to users of the vehicles.

The project work has been carried out by Carl Bro AB with Hans Pohl as project manager. He has written this report together with Tove Sandberg. It was completed in May 2005, and is intended as a guideline for technology procurement of clean vehicles.

A steering group and a reference group have acted in support of the project work. The steering group included representatives for the financiers. A number of players and stakeholders participated in the reference group. The reference group was chaired by Mats Nettby of Gatubolaget Göteborg and the steering group by Arne Johansson of Catella Generics.

The project has had financial support from the Swedish Energy Agency, STEM.

Stockholm, December 2005

Sven Alexanderson

Project leader

Trendsetter (WP 12.11 and WP 12.12)

Executive summary

The main objective of the project was to analyse and learn from the previous clean vehicle technology procurement activities. In Table 1 the four studied projects are presented. The City of Stockholm has through its administrations and companies had a leading position in all vehicles procurement projects made to date.

Table 1: Overview of clean vehicle procurement projects

Name	Vehicle types	Key requirement	Selected vehicle(s)	Deliveries within the project	Others
Clio	Passenger car and light commercial vehicle	Electric or hybrid electric	Renault Clio Electrique	150	Pris more than three times conventional Clio. Public subsidy 15 kkr
Berlingo	Passenger car and light commercial vehicle	Electric or hybrid electric	Citroën Berlingo Electrique, (Fiat 600 Elettra, Peugeot 106 Electric)	349 whereof 127 in Sweden	Price as conventional car (excl. batteries). Public subsidy 15 kkr
Focus	Passenger car	Flexifuel (etanol)	Ford Focus FFV	800-900	Price 5 kkr below petrol car (for buyers of a few vehicles)
Hybrids and biogas	Several	Biogas, elhybrid, flexifuel	All	?	Good framework agreement

If the technology procurement projects are compared the Focus procurement has had the largest impact on the market. The flexifuel version of the Focus would not have been developed without the procurement project and now when Saab and Volvo start to deliver flexifuel vehicles the market grows even faster.

Clean vehicle technology procurement activities can in several aspects make use of experiences from procurement projects of other types of products.

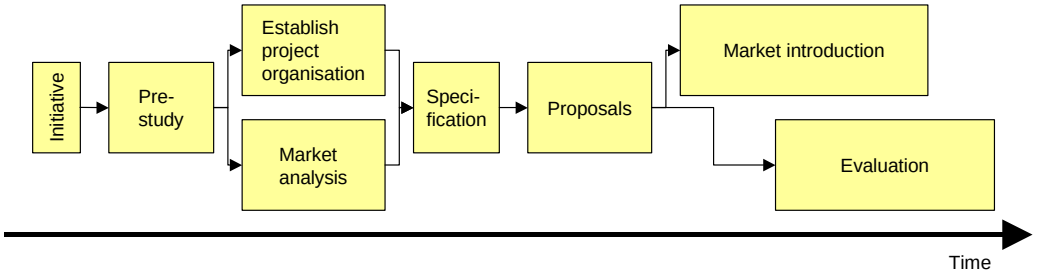


Figure 1: The phases of the technology procurement cronologically

One result of this study is a revised description of the different phases in a typical technology procurement project, compare Figure 1. Important difference is for example the clear purpose of the pre-study to find out if a technology procurement project is the right tool to influence the market.

A sample of in the report given recommendations:

- Handle the group of buyers with the aim to use it in several clean vehicle procurement projects
- Plan the project to allow for pilot deliveries
- Plan the project in a manner that allows for a few years of support to buyers and users after the first delivery has taken place.

Contents

1 Introduction

1.1 Background

SWEVA applied for and received a grant from the Swedish Energy Agency to carry out a project as follows (from the application):

The project will be carried out to further refine the methodology used in technology procurement of clean vehicles. Experience from previous and ongoing technology procurements of clean vehicles will be collected and analysed, mainly through interviews with players involved, from manufacturers to users of the vehicles. One of the key issues for study is the buyers' and users' experience of the procurement process and result. A smaller, parallel study will analyse if, and if so how, technology procurement of vehicles differs from technology procurement of other products. Great emphasis will be put on the dissemination and verification of results.

Carl Bro AB was commissioned to lead and carry out the project with the support of SWEVA members. The Swedish Energy Agency grant was SEK370 000, and the project was carried out during autumn 2004 and spring 2005.

1.2 Aim

The aim of the project was to analyse and learn from previous technology procurement of clean vehicles. The results will be circulated to players that, in one way or another, may become involved in future procurement of vehicles.

1.3 Method

The project has collected information from two main sources:

- Written documentation – reports, brochures, working material, etc
- Interviews with players involved

Appendixes include interview questions and list of interviewees.

In order to supervise the management of the project and to gain approval for conclusions made continually , a steering group with representatives from the Swedish Energy Agency and SWEVA, and a reference group were formed, see Figure 2.

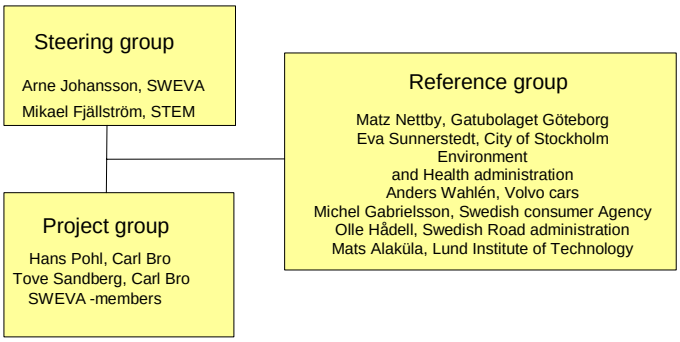


Figure 2: Project organisation

The work was led by Hans Pohl, Carl Bro AB, and was carried out in collaboration with SWEVA members. Great emphasis was placed on dissemination of results, and a special workshop was held to present and discuss the results.

These have also been presented at the Forum for Electric Vehicles in Uppsala, at Energitinget in Eskilstuna and at EVS-21 in Monaco.

All prices in the report are VAT exclusive, unless otherwise stated.

2 Technology Procurement – Methodology

Technology procurement differs from other types of procurement, as it always includes a measure of technological innovation. Ready-made products, already on the market, cannot therefore be subject to technology procurement. There are a number of definitions, but the most prevalent applies to legal texts describing technology procurement in connection with government grants (see 2.2).

The method is not new and was used in the 19th century, and before. Known examples of early technology procurement include navigation equipment, and locomotives in England (Rainhill Trials 1829).

Two central concepts of technology procurement are **innovation** and verifiable **specifications** for the desired product.

2.1 Is technology procurement a competition?

Sometimes, technology procurement is carried out in separate stages. This happens, for example, if there is uncertainty at the beginning of the project as to whether all stages are necessary or meaningful. Sometimes the process is ended before delivery is contracted, and instead the winning tender is publicised and even awarded a prize. This is often called a technology competition, or technology procurement competition, with focus on competition. It is not unusual that such competitions continue as a technology procurement project, followed by market entry.

2.2 Technology procurement in relation to public procurement

Technology procurement can be carried out with or without government grants. However, as almost all previous and ongoing technology procurement projects have been carried out in collaboration between buyers/users and public bodies (municipalities/government agencies), technology procurement has come to be associated with public procurement. To obtain a government grant, the definitions and requirements specified in legal acts must be applied. The current definition of technology procurement is as follows, according to "Statute 2003:564 regarding the support for measures for an efficient and environmentally friendly energy supply":

Technology procurement: the procurement of products or systems that necessitate the development of new technology or a production process for the development of new technology, in order to meet specified requirements from the buyer.

According to the same statute, grants to the buyers can be given for the following stages of technology procurement:

1. Specification of user requirements,

2. Testing of product or system that is being procured,

3. Evaluation of product or system solutions identified in technology procurement, and

4. Investigation of technical prerequisites for meeting identified user requirements.

2.3 How is technology procurement carried out?

Figure 3 below describes a possible technology procurement process that does not conflict with the wording in Statute 2003:564 and the Act on Public Procurement (LOU).

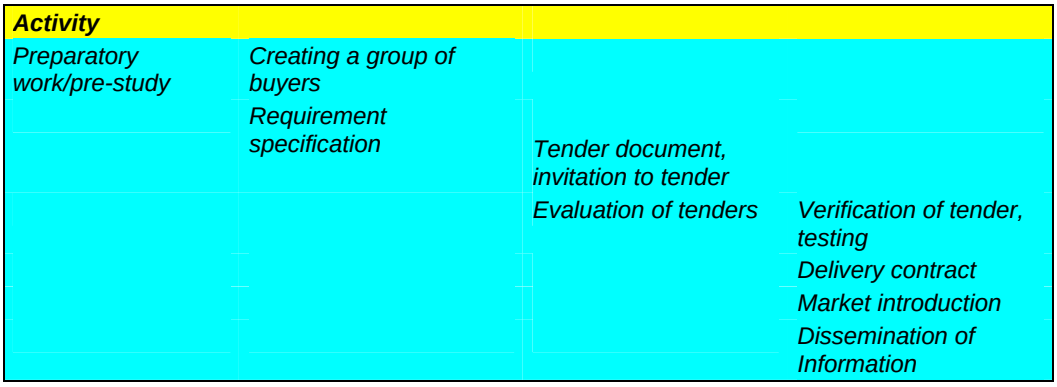


Figure 3: Elements of technology procurement in chronological order

2.3.1 Preparatory work/pre-study

The potential of a technology procurement is investigated in a pre-study. Normally, this includes a survey of demand and technological frontiers through discussions with potential buyers and manufacturers. Often, a seminar is arranged where invited manufacturers are informed about the technology procurement and the advantages this would hold for them. It is difficult to carry out technology procurement without knowledge of ”state of the art” for the sector and approval from manufacturing companies: It is harder to formulate reasonable specifications, and there is also the risk of not receiving any tenders/not sufficiently good tenders.

Another important issue is the potential of the technological development regarding economy, efficiency, user-friendliness, etc. If the technology procurement receives public funding, which is often the case, the potential benefit to society by way of environmental sustainability is highly important. Often, this potential is linked to financial incentives, and the savings potential of the new technology can be estimated.

2.3.2 Organisation and role of buyer group

The buyer group should consist mainly of players that are directly intent on buying certain volumes, but could also include representatives that are interested in buying in the future. In some cases, the participation of key players may increase the motivation of manufacturers to submit tenders. When a group of potential buyers has been identified, they are invited to take part in the technology procurement. A large part of the buyer group’s work is to specify re-

quirements for the desired characteristics of the product or service. For the end result to have a real chance to become established on the market, several aspects must be stressed, e.g. efficiency, environmental sustainability, robustness, and user-friendliness. It is therefore highly important that the group also includes representatives for the users (users, operating staff, etc.), technical experts, in some cases buyer organisations, and perhaps other key players, e.g. real estate administrators or other marketing intermediaries. It is also important that the buyers have access to technical expertise in order to specify requirements in the best possible way.

2.3.3 Requirement specification

Specifications should preferably focus on function and be as general as possible. It is usually better to say ”The equipment shall fit approved standard connections under the Electricity Act 19xx:xx”, than to say ”The connection shall have a diameter of 20mm”. This leaves the manufacturers to solve as much as possible of the product’s technical design. As far as possible, requirement specifications should refer to laws and lists of approved materials rather than threshold values; e.g. ”Materials that are not included on the Swedish Chemicals Inspectorate list of restricted substances may be used” or ”In other respects, the product must not lead to limit values being exceeded, according to the Radiation Protection Ordinance”.

Common areas for specified requirements are: function, safety, health, energy/environment, user-friendliness, economy and operation/service friendliness. Requirements may be ranked differently, i.e. some must be met (mandatory) while others are desirable but not obligatory (optional). They are often referred to as “shall” and “should” requirements.

Before the specification of requirements has been established, the project may have quite open contact with manufacturers without conflicting with the Act on Public Procurement. However, as soon as the specifications are underway, this is no longer possible. From then on, the communication must ensure that no manufacturer is given advantage, e.g. more time, compared to others. As long as the same message is communicated to all manufacturers, it is still possible to conduct a dialogue.

2.3.4 Tender document, invitation to tender

The specification of requirements together with the administrative process for technology procurement normally form the major part of the tender document, which is the document sent to manufacturers with the invitation to tender. To avoid any misunderstandings, some contact should be made with the manufacturers during the tender period. The tender document is sent to a minimum number of known manufacturers in the own country, and preferably also to other countries and is published in the ”Official Journal”, if the value of the procurement exceeds the threshold values provided in the Act on Public Procurement (LOU).

The tender period may vary depending on how complicated the product is. During this period, manufacturers can submit queries at official communication

times, normally held twice (in the beginning and at the end), and the questions asked decoded, together with the answers are sent to all possible manufacturers/alt publicised on e.g. web site or trade forum. It is important to explain to the manufacturers that their tender may be made public after the procurement has ended. Manufacturers must therefore ensure that they have patent protection for their inventions, and notify if any parts of the tender should be protected.

It is important to include in the invitation to tender the criteria that will apply to the evaluation of tenders. This requires a special effort from the buyer. It is a great advantage if the criteria enable quantitative treatment (the more complex the product, the bigger the advantage).

2.3.5 Evaluation of tenders

First, the tenders are examined from an administrative viewpoint. All formal criteria must be met, before the technical content is appraised. During the period until the result of the technology procurement is made public, all tenders are treated confidentially. Normally, a technology procurement officer handles all documentation and decodes material for the buyer/evaluation group. The officer also handles the communication with tenderers when questions arise, or when clarifications are required. This means that the company behind the tender is not disclosed to the evaluation panel.

2.3.6 Testing, verification of tenders

If one or several of the tenders meet the criteria in theory, the product/products referred to in the tender can undergo practical testing, often at an authorised testing institute. The tender document should include details of how this is done. This must be considered when specifying the requirements, and it is also important for the manufacturers to be aware of this when they are preparing their tenders.

2.3.7 Delivery contract

When technical testing has been carried out, the tender/tenders that best meet the requirements may be chosen as the winner/s of the technology procurement. This is often publicised in connection with a media event, as part of the process of spreading information about the new technology. The companies behind the successful tender/s are then able to sign delivery contracts with the buyers. Framework agreements are often used with a first option for the buyers involved in the procurement.

2.3.8 Information dissemination, market introduction

A successful introduction of new technology on the market requires information dissemination. This can be done through articles in the press, radio/television features, advertisements and campaigns. In some cases, government grants are also available for information dissemination and market introduction (pre-production grant).

2.4 Results of technology procurement

In many cases, technology procurement has led to much more than the procurement of a new product; in an ideal case technology procurement influences the approach of an entire sector, and initiates a process of innovative thinking among several manufacturers. This was the case with e.g. Nutek's procurement of heat-pumps in the 1990's, and the procurement of fridges and freezers that contributed to energy-efficiency labelling. Experience shows that technology procurement leads to a more rapid development of new solutions

3 Overview of clean vehicle procurement projects

3.1 General

3.1.1 What is a clean vehicle?

The definition of clean vehicles differs from country to country, and even within countries. It also varies over time. Requirements for clean vehicles are relatively strict in Sweden compared to other countries. The main principle is that their use will result in significantly lower emissions that affect local health and the global climate. The main regional difference is that alternative fossil fuelled vehicles are qualified as clean vehicles in some parts of the country and not in others.

The definition, as mentioned, refers to the use of vehicles. However, the opportunities and systems for following up which fuels are actually used are not well developed.

The Swedish Road Administration was commissioned by the government to propose a clean vehicle definition in 2004. The proposal included local emissions, fuel-efficiency, and the use of alternative fuels with reduced greenhouse gas emissions. The proposal was not approved, and a new proposal is being drafted during 2005.

In the technology procurements studied here, there is no attempt to define clean vehicles. The study includes subsets from the clean vehicle population, e.g. battery cars or flexi-fuel vehicles.

3.1.2 Procurement of vehicles

Procurement of vehicles often results in a framework agreement with certain discounts. The choice of vehicle is mainly governed by the intended usage. When it comes to company cars with private use, cars in the segment Volvo and Saab are popular. Other company cars are more often simpler models, delivery vans and pick-up trucks.

Generally, vehicle procurement has developed from being a matter between the local buyer and seller to increasingly being carried out at national or even international level. The administration of vehicle fleets has become more professional and each vehicle is purchased with a pre-defined application. The possibility to purchase additional vehicles has become very limited.

It is common that demands are made on safety-level, e.g. at least four stars in Euro-NCAP. Environmental requirements are sometimes made, usually related

to current European environmental classification. Such requirements on safety and environment clearly signal to the sellers what types of vehicles are in demand. This in itself, however, is not sufficient for technology procurement, (compare section 2 above).

3.1.3 Overview of clean vehicle procurement projects

Table 2 shows the technical procurement projects studied in this report. This is followed by a more detailed description of each project.

Table 2: Overview of clean vehicle procurement projects studied

Name	Vehicle types	Key requirements	Selected vehicle(s)	Deliveries within the project	Other
Clio	Passenger car and light commercial vehicle	Electric or hybrid electric	Renault Clio Electrique	150	Price more than three times conventional Clio. Governement subsidy SEK 15 kkr
Berlingo	Passenger car and light commercial vehicle	Electric or hybrid electric	Citroën Berlingo Electrique, (Fiat 600 Elettra, Peugeot 106 Electric)	349 of which 127 in Sverige	Price as conventional car (excl. batteries). Governement subsidy SEK 15 kkr
Focus	Passenger car	Flexifuel (ethanol)	Ford Focus FFV	800-900	Price 5 kkr below petrol car (for buyers of few vehicles)
Hybrids and biogas	Several	Biogas, electric hybrid, flexifuel	All	?	Economically favourable framework agreement

3.2 Clio

3.2.1 Procurement process

The first pioneering technology procurement of clean vehicles was initiated by the Swedish Agency for Economic and Regional Growth (Nutek) and was led by an executive committee chaired by Stockholm MFO (Equipment and Supply Service Organisation). The pre-study started in 1992, and in 1994 an invitation to tender was sent out. The aim was to procure an electric or electric hybrid passenger car and a light commercial vehicle. Extensive work was done on the specification of requirements as well as on creating a buyer consortium.

The specification has been criticised for being too extensive and complex for vehicle manufacturers. At the same time, e.g. Volvo/Renault said that it showed high vehicle competence among the authors and project members.

Interest from suppliers was high but after the tender evaluation, based on technical, economic and organisational aspects, only two models remained that happened to be similar on paper, Peugeot 106 Electric and Renault Clio Electrique. Other tenders were not financially viable or had other disqualifying shortcomings.

Peugeot withdrew from the process, and contract negotiations were started with Volvo/ Renault. Since the car did not meet all the specified requirements, e.g.

the range per charge was 87 km instead of 100 km and the loading capacity was lower than requested, consortium members were given an option to withdraw their orders. Only a few chose this option.

Twenty pilot cars were thoroughly tested, both in laboratories and by users in the largest municipalities in Sweden. The car narrowly met the required specifications, and deliveries were given the go-ahead. In total, some 150 vehicles were supplied to around 35 different customers. An important part of the project for Renault was to ensure an on-going exchange of experience and information. Therefore several meetings were held with Renault in France, often with the participation of members of the technology procurement.

3.2.2 Infrastructure

According to electricity companies, battery cars do not require a new infrastructure since electricity is available everywhere. In practice, it is not quite as simple since the capacity in existing electrical outlets near parking places is rarely sufficient. The installation of 230V/16A outlets is not normally costly, especially if compared with a new fuel station.

Renault Clio was prepared from the start for charging with 10 or 16 A. In some cases the plug of the charge cable supplied was not adapted to Swedish standards, although it was easily exchanged.

To comply with the need for a fast charger, a Charly 10 kW was brought onto the Swedish market, before it was fully developed, e.g. there was a lack of communication between the vehicle and the charger.

The key infrastructure issues for battery cars are access to good service and the adaptation of regulations and conditions for vehicles within different contexts. E.g., the rescue service should be trained to deal with accidents involving battery cars. Generally, it can be said that both government and local authorities included electric cars in rules and regulations relatively quickly. One example is the parking benefit introduced at an early stage in Gothenburg city and Malmö.

One reason for Renault being selected as a supplier was the established network of repair shops. In line with the agreement, key persons at such workshops were trained in battery car maintenance. They performed well, but service suffered significantly due to the lack of back-up during illness or holidays.

3.2.3 User experience

Within the framework for various KFB projects (Swedish Transport and Communications Research Board) usage and user experience were carefully evaluated. Below is a summary of impressions.

Externally, battery cars differ very little from conventional cars. Handling the car was almost like driving an automatic car. Despite this, it was sometimes difficult to gain user acceptance. The limited range and performance of the electric car was difficult to accept by unmotivated drivers. Motivated users, on the other hand, usually appreciated the positive characteristics – silent, zero-emission and energy-efficient.

Motivated users were able to handle the car technically, whereas less motivated users experienced problems at an early stage. The traction batteries initially suffered from a design fault[1]. This led to impaired performance and in some cases total battery breakdown. When complaints were received the battery packs were replaced during service. As batteries have a limited shelf-life this was difficult for Renault to handle, e.g. due to problems and costs relating to stock-keeping. When all was well, a new battery could be obtained in 2-3 weeks, but unfortunately there were occasional hitches that caused significantly longer delivery times. Since the NiCd-batteries required special transport documentation and packaging, handling was more cumbersome than for other spare parts.

Despite Renault claiming a highly ambitious training in service technology and routines for spare parts management, many users experienced that their cars were more often in the workshop than on the road. The established dealer network was an advantage for Renault. Without this, technology procurement would have been more difficult. Today, Renault has no spare parts in Sweden. NIRA/Actia Nordic has taken over any remaining spare and used parts.

In response to complaints over the car's functionality, Stockholm, Gothenburg city and Malmö were offered an exchange option, whereby their battery cars from Renault (Clio and Express) would eventually be replaced by a Kangoo model equipped with range extender. This is in effect an electric car with a small petrol engine and on-board generator, which doubles the range and enables quick recharge for half the range. Gothenburg city and Malmö took up the offer and 25 vehicles were returned. No Kangoos with range extender have, however, been delivered to Sweden, and the municipalities continue to drive the petrol/diesel fuelled Kangoos that were offered in the meantime.

All in all, the cars did not meet buyer expectations. The product was not fully tested and some of the problems have been ascribed to this, i.e. the vehicles were delivered before they were fully developed. The majority of buyers expected a car of the same standard and reliability as a conventional car. Also, not all buyers saw themselves as participating in a pioneering project, but rather as ordinary car buyers, which explains why tolerance over functional shortcomings was limited. If the aim of technology procurement is major technical change, buyers must not be led to believe that everything will function smoothly from day one.

3.2.4 Market development

The model already existed to a limited extent on the French market. The car was not appreciably developed or adapted for the Swedish market. Any modifications were normally made afterwards, in Sweden. Production of the Clio Electrique was fitted into the ordinary assembly line with around 3 000 cars leaving the line every day. When deliveries were due to commence, however, there was already a new Clio version on the way, and it was unclear whether it

[1] Per Jørgensen Møller, Dansk EV Committee has made a study of the batteries

would be battery-driven. Renault Kangoo is still made on a small scale in a battery version, other models are not available as electric cars.

In all, Renault delivered around 200 battery vehicles to Sweden, of which half are in use today. Some vehicles have been sold to Norway and Denmark, around 25 vehicles were shipped to Bordeaux after the exchange deal made with Renault.

In one respect it can be said that technology procurement had the opposite to the desired effect. Negative experience of battery cars contributed to an adverse opinion of this technology in Sweden, Denmark and Norway according to organisations that promote increased use of battery vehicles.

Technology procurement resulted mainly in a completely new type of vehicle being introduced on the Swedish market, and to a lesser extent in technology development. Other contributing factors to the entry of battery cars on the Swedish market were KFB's major demonstration project of battery cars and the agreement made in 1993 between Gothenburg city (Mr. Göran Johansson) and the Managing director of Volvo/Renault (Mr. Pehr G. Gyllenhammar), which included clean vehicles.

An important lesson for Renault is that they should have had set a minimum volume requirement, e.g. at least 10 vehicles per area/town.

The Clio procurement resulted in a network around clean vehicles and, naturally, extensive experience of electric cars. It also paved the way for other technology procurement projects.

3.3 Berlingo

3.3.1 Procurement process

The EU-project Zero and Low Emission Vehicles in Urban Society, ZEUS, led by Stockholm City, included a technology procurement project. The profile was more of co-operative procurement than technology procurement, but expectations on new battery technology was one of Stockholm's motives for the project.

Participating cities were Athens, Copenhagen, London/Coventry, Palermo and Stockholm. All in all, they requested 174 passenger cars and 37 light commercial vehicles, both of zero-emission type. In addition there was an opening in the agreement for third party buyers.

The technology procurement process was similar to that of the Clio procurement. The European dimension entailed certain aspects:

- a major difference was the wider spread of experience among the parties involved
- there was some language confusion and much time was spent on translations
- varying knowledge about procurement among the parties

- national differences regarding vehicle requirements; the specification thus had to include a national perspective for each aspect on the major requirements
- the project was carried out from an environmental protection perspective, i.e. purchasing requirements were not properly supported (e.g. in Copenhagen); the lesson learnt is that projects of this nature must be driven by the activities of professional purchasers.

Despite this, the international cooperation worked well and the procurement was carried out without any major problems.

Nine tenders were received, of which the following were selected: Citroën Berlingo Electrique, Fiat 600 Elettra, and Peugeot 106 Electric for the British market. In total, 133 passenger cars and 78 delivery vans were delivered to the parties in the procurement, according to the ZEUS final report. In addition, four passenger cars and 134 delivery vans were sold to third parties.

In Sweden, Stockholm had expressed interest in 30 passenger cars and 8 delivery vans. Seven passenger cars were delivered, but were later taken back by Fiat. Twelve Citroën Berlingo Electrique delivery vans were supplied and third parties in Sweden ordered a further 115.

Contract negotiations were carried out with the car manufacturer's European organisations. This resulted in varying levels of national interest. Citroën in Sweden showed a great interest, whereas Swedish Fiat was unhappy about the responsibility for seven battery cars. The delivery of Fiat 600 Elettra to Stockholm was problem-ridden, and eventually Stockholm City succeeded in securing vehicle return with full repayment.

The price of the Citroën Berlingo Electrique was SEK92 507, with a compulsory battery leasing charge of approximately SEK1 000 per month. For a limited period, buyers could also receive a government grant of SEK15 000 per vehicle.

3.3.2 Infra structure

Compared with the Renault Clio, the Citroën models only had a 16 A charging facility, which made it a little more difficult to find suitable electrical outlets.

Service and maintenance was carried out quite well under the circumstances by local garages, but battery problems often caused long delays as any spare part requirements were handled in France. Under the battery leasing agreement, drivers had the use of a replacement vehicle during such periods. These vehicles were not normally battery-driven.

3.3.3 User experience

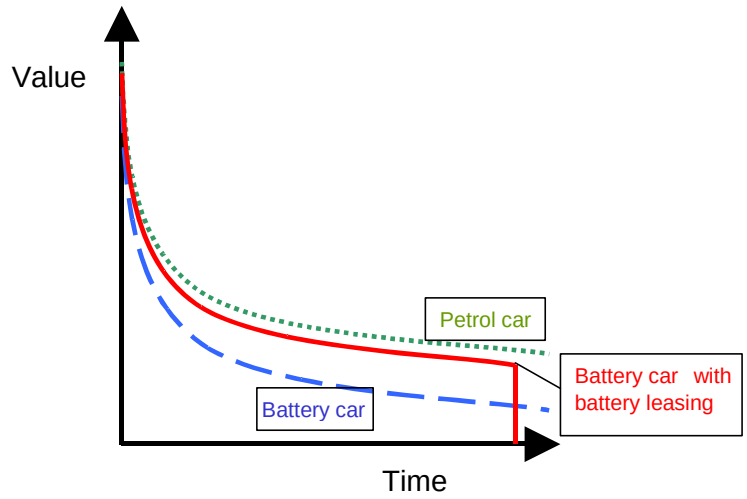
The overall impression is that the Citroën Berlingo Electrique has functioned significantly better than the Renault Clio Electrique. However, the reports on functionality in Citroën vehicles vary. Experience in Malmö, where a total of 28 vehicles have been on the road and 25 are still in use, speaks of relatively extensive battery problems initially, of the same type that afflicted the Renault Clio. There have also been frequent problems with the heating system. Other

users have also reported heater problems, but they have not experienced any particular battery problems.

The evaluation of the vehicles and the procurement were carried out within the framework for ZEUS. A commendable survey was also carried out among all cities included in the project.

3.3.4 Market development

A significant innovative part of the procurement was the battery leasing agreement. This included a function guarantee, which guaranteed at least 80 per cent battery capacity at all times. During repairs, a free replacement car was provided under the agreement. The leasing agreement comes with the car, i.e. if the car is sold the buyer must take over the agreement. The consequences of this have not been closely analysed, but the probable effects are shown in Figur



Figur 4: Effect of battery leasing on resale value

In other words, battery leasing maintains the car's resale value for a while. If the leasing charge together with the cost of electricity for running the vehicle is lower than the cost of petrol for comparative use[2], the resale value of the battery car may be higher than that of the petrol car[2]. For the Berlingo, this is true if the car is driven more than around 1 700 km per month, i.e. around 80 km per working day. Considering that the range is precisely 80 km, this would not be impossible. In practice, it is quite difficult to clock up such mileage over a month. However, using fast charging and pre-determined routes it would be possible to substantially exceed this monthly mileage.

With age, the battery leasing charge forms an increasingly larger part of the running cost. After a few years, there is a time when the condition of the car no longer justifies the monthly cost of the batteries, in addition to other service and maintenance costs. Since the leasing agreement must be transferred when

[2]If the market also includes environmental benefits the value increases further

the car is sold on, the only option will be to scrap the car. The risk is then that a car with a completely new battery pack is scrapped.

Battery cars without a leasing agreement gradually loose their resale value, as the time for an exchange of traction batteries is nearing. The difference in cost between petrol cars and battery cars will, in time, equal the cost of a new battery pack. This holds true until the whole pack is changed. Unlike cars with battery leasing agreement, the car will be driven until it breaks down. As new battery packs entail a cost of approximately SEK70 000 kronor, there will quite soon come a time when it is no longer worth buying a completely new pack. On the other hand, the manufacturer (Renault) offered an extensive guarantee covering 100 000 km or five years use.

The battery leasing agreement, third party option, and low price, are probably the most important achievements of the procurement. Apart from this, it did not result in any major market development. The expected battery development was not achieved. On the contrary, Fiat's lead batteries could be said to be a step backwards from development.

3.4 Focus

3.4.1 Procurement process

Stockholm initiated the procurement in 1998. The City saw ethanol-fuelled cars as a possible way of reaching the proportion of clean vehicles that they had committed to (in light of the shortage of battery cars). The first year was spent on a thorough specification of requirements, and a consortium was formed. An executive committee representing consortium members was set up in December 1998.

In the pre-study, potential buyers were shown three car size classes and asked which type/s they preferred. They were also informed that this would be an FFV-type clean vehicle and that emissions and energy efficiency would be as good as or better than for a corresponding conventional car. A paper was drawn up describing the vehicle types in a brand-neutral way. Dealers were approached in the same way. The pre-study showed a high interest from Ford and Volvo. A market analysis carried out by the Environmental Technology Delegation also showed that almost all vehicle manufacturers had looked into the possibility of making flexi-fuel cars.

Volvo chose to withdraw, as they did not feel they had sufficient experience of how the car would function with ethanol in the long run. Life expectancy tests for the engine had not been carried out and were very costly. The risk was seen as too high. French car manufacturers were given a second chance to participate. In May-June 1999, when it was clear that Ford was the only tenderer, the procurement was negotiated.

It is unclear whether a contract was signed with Ford, or if there was only a verbal agreement to deliver provided that there were ”orders” for 4 000 cars. Ford engineers stated this figure based on costs for required development, tests, etc. They did not expect this number to be met, and in other words they did not believe the development project would come off.

In December 1999, the Stockholm LIP-office[3] joined the project and invested a large sum of money on a marketing campaign, which was later stopped largely for political reasons. Suddenly, the City of Stockholm district council did not see it fit to market an individual vehicle manufacturer.

Interest from buyers was promoted through a campaign targeted at municipalities, county councils, and companies with large vehicle fleets. A road-show was carried out to which potential customers and staff from local Ford-dealers was invited for information and test driving (of the Taurus FFV). A special website was also set up. When around 3 000 interest notifications had been received, Ford gave the go-ahead and the development project started.

3.4.2 Infra structure

At the start of the technology procurement, there were already 45-50 fuelling stations with E85 (OK). In February 2005, there were 143, mainly at OKQ8 and Statoil. Low-level ethanol blends offer a direct profit for petrol vendors, while E85 requires a higher commitment.

In 2003, based on certain conditions, E85 was used for around 64 per cent of flexi-fuel car mileage. Then, there were only 70 filling stations. To increase the use of E85, Ford is participating in an ambassador programme, which in the short term leads to enhanced image and in the long term lends credibility to the environmental advantages of E85. The latter is necessary if the economic advantages are to remain.

3.4.3 User experience

Consensus is that the cars have so far met expectations. There have been discussions about fuel consumption, see 3.4.4, but on the whole, users are happy with their vehicles.

Within the framework for some municipal initiatives to promote the use of clean vehicles, more experience is assembled regarding flexi-fuel cars.

3.4.4 Market development - technology

Everything that comes into contact with the fuel must be adapted, from the tank to valve seats. Also, nozzles are bigger and more flexible. The innovative aspect of Ford's solution compared with other ethanol vehicles is that the same sensors are used as in standard petrol cars for emission control and, if the car has been fuelled since the engine was last started, any fuel injection adjustments. This is significantly cheaper than previous solutions.

The engine is not optimised for ethanol use, but rather moderately modified. Therefore, more fuel is needed to e.g. keep the temperature down.

Most of the development work has been carried out in the US. Focus is probably first with this technology. The model is sold both in Europe and in the US.

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[3] LIP = Local investment programme

Even though the technology is new, Ford has had relatively few problems with the car:

- Worries over cold-starting were largely unfounded. In practice, this has only affected a few isolated cars.
- Sensitive timing. To start with, calibration was only initiated with tank volumes exceeding 10 litres. This was found to be unwise, and the limit was changed to five litres. Changes were made to the cars as they came in for routine service.
- In view of e.g. high fuel consumption (see below) a new engine management version was also introduced in the cars during routine service. The new version offers slightly lower fuel consumption.

One mistake that Ford made was to test the car with E85 according to the EU cycle and publish the results in various publications. Since there is no standard for tests of FFV-cars (they are being tested as petrol cars) it was unfortunate to publish these tests, especially since the results were very low compared with user experience in real driving conditions.

3.4.5 Market development - commercial

When the project started, Ford made a production order for 3 000 cars. Orders were apparently slow, which led to an unfortunate situation for the people concerned at Ford and others. However, deliveries eventually picked up and the market development is shown in Table 3 and Figure 5.

Table 3: Market development, FFV-cars

Year	Volyme	Comments
2001	300	Start November
2002	2 500	Poor start and project very nearly called off during spring, but picked up later
2003	5 000	
2004	5 800	Despite five months without production
2005		New car from Ford in June/July Saab introduces FFV-model Volvo introduces FFV-models

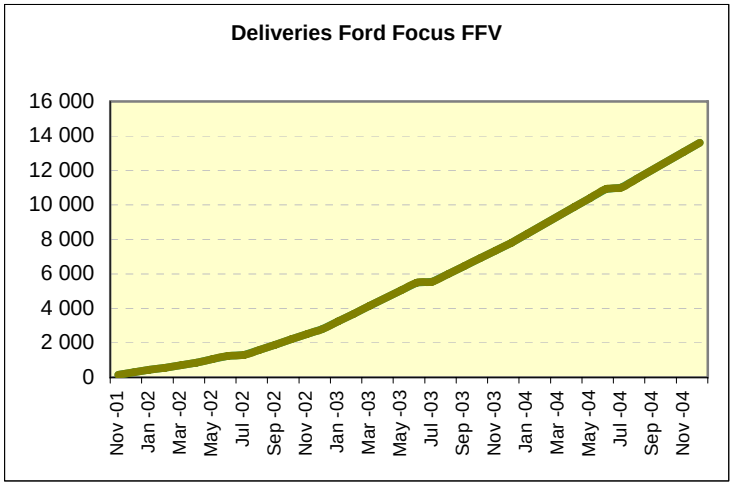

Figure 5: Deliveries of FFV (interpolated data)

The price included a SEK5 000 discount compared to the petrol version. Many felt that the discount was too low. The agreement was valid for three years, and in February 2005 only Borås municipality was still using the agreement.

Ford states that the 3 000 notifications of interest only resulted in 800 – 900 actual purchases. Of the approximately 300 buyers, only around 40 per cent executed the purchase of at least one car. Municipalities were responsible for the largest discrepancy in notified volumes. Stockholm requested 300 vehicles and bought 120. Gothenburg city requested 200 vehicles and bought 30. Ford also emphasises that municipalities are bad clean vehicle purchasers. Gothenburg city, for example, also refused to pay the agreed price, since they had better agreements for all other models.

Overall, Ford points out that without the technology procurement, the Focus FFV-version would not have been introduced in Sweden. The Focus' main competitor, Opel Astra, has during the corresponding period lost a significant market share in Sweden, which according to Ford is largely due to the market introduction of the FFV-model.

Local and national support for clean vehicles has been crucial to the speedy development of FFVs. It is important that market rules are long term. Parking benefits result in e.g. higher resale value in places where such benefits exist. Taxable benefits are not so relevant for Focus customers. The new Focus, available in 2005, could be an option for customers of company cars with private use.

3.5 Hybrids and biogas

The project was initiated by The city of Stockholm. It started as two different technology procurements of biogas vehicles and electric hybrid vehicles. At a later stage, flexi-fuel vehicles were added. The activities were brought together, and Kommentus was commissioned to carry out tender documentation and negotiations.

All distributors were accepted. The result was even better discounts than MFO had previously enjoyed. Framework agreements lasting until 2006 were made with 46 municipalities, and other organisations. No special incentives for clean vehicles were included in the agreements or the procurement. It was therefore up to each buyer to formulate their own principles, like Stockholm, for how many clean vehicles should be included in their respective fleet.

One of the reasons why the procurement took this form was that Stockholm was left without a vehicle framework agreement, since 1 January 2002.

According to the Environment and Health Administration in Stockholm, the effect of the procurements was that Toyota Prius was introduced earlier in Sweden compared with the rest of Europe. The pre-study also showed a demand for Renault Kangoo ERE, but unfortunately, after a long period of consideration, Renault opted not to sell this model in Sweden.

This report only touches briefly on the above procurements as they started as technology procurements but were not completed as such.

4 Analysis – key issues in technology procurement

4.1 Comparison of clean vehicle procurement projects

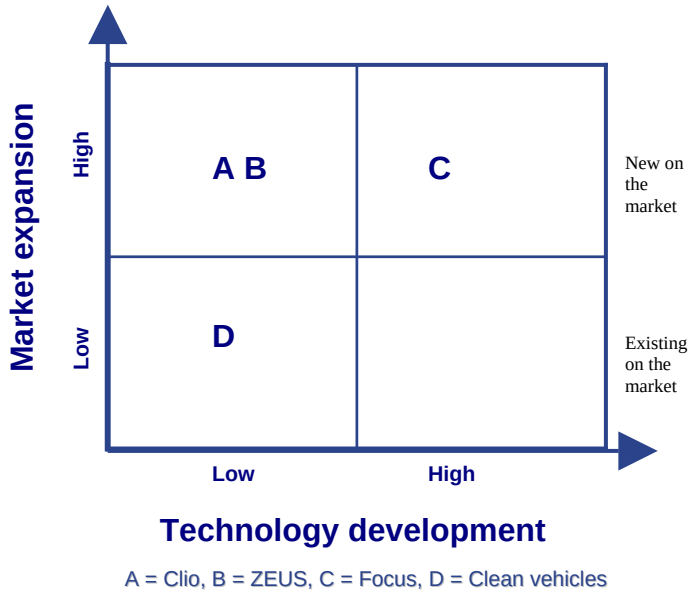

Figure 6: Market and technology development

According to Figure 6, one of four projects has resulted in both the development of new technology and a wider geographic market for the products. The fact that technology procurement is initially based on careful analyses does not guarantee a lasting effect on the market. On the contrary, it would not be relevant to launch technology procurement if the product was already firmly established on the market.

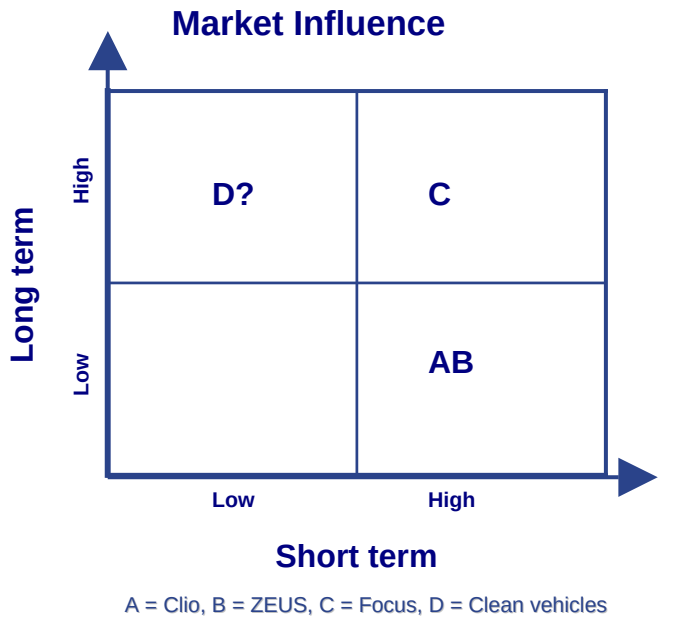

Figure 7: Market development in the short and the long term

Figure 7 illustrates the effects of the four projects. As there is currently no new battery car model in Sweden from established car manufacturers, it is apparent that the Clio and Berlingo projects have not succeeded in having a lasting influence on the market. On the other hand, the short term effect was considerable, and volumes undoubtedly doubled as a result of deliveries within the technology procurement. Regardless of the result, the projects no doubt paved the way for other clean vehicle initiatives, and it is also likely that they influenced decisions on research and development initiatives at Saab and Volvo, compare figure 8.

Figure 8: Volvo 3CC (concept car presented 2004)

It should be noted that even if the battery cars included in this report have not, in many respects, been presented as particularly competitive on the market, there is every reason to monitor the technology. Batteries have developed significantly in the last decade, not least due to the growing use of battery-driven portable products and increased sales of electric-hybrid vehicles.

4.2 How do clean vehicles differ from other products?

4.2.1 Introduction

Beside clean vehicle procurements, a great number of other technology procurement projects have been carried out, especially in the housing sector in the 1980-1990's. Many of these are well documented and can be used to supplement the material from the above vehicle procurements. The comparison below, aims to clarify in what respects, if any, clean vehicle procurement projects differ from technology procurement of other products and services. For those parts where similarities predominate, there are good opportunities for making use of the vast experience contained in the assembled spectrum of technology procurement.

The comparison focuses on:

- buyer terms, their prerequisites for creating and working in buyer-groups
- prerequisites and competitive situation of vehicle manufacturers
- market situation and driving forces for developments on the vehicle market.

Other factors in the comparison include incentives such as regulations, infrastructure and safety.

The technology procurement of heat pumps that Nutek (Swedish Agency for Economic and Regional Growth) carried out in 1993-1995, was chosen as a reference from a sector other than vehicles. This technology procurement is relatively well documented, purchase of the product requires a large investment from the buyer, and it also requires a certain infrastructure. Furthermore, all stages of the procurement were completed, and the project can be followed, from initiative to viable product.

Technology situation and production volumes. When the technology procurement of heat pumps started there was, unlike the vehicle market, very little demand. Government grants had just ended, as the government saw little energy savings with the technology. Compared with vehicles, heat pumps was a new category of products on a market dominated by oil and electric boilers. But as oil prices gradually rose during the 1980's and 1990' while the price of electricity remained relatively low, there was scope for large growth. The potential for a technology shift and market influence through technology procurement was, in other words, much bigger than for the passenger car market.

Suppliers. In the early 1990's, existing heat pump manufacturers in Sweden were small companies with small opportunities for technological development. There was scope for innovation. Vehicle manufactures are large international companies that, moreover, tend to merge into even larger corporations.

Buyers. The technology procurement of both heat pumps and vehicles has had heterogeneous buyer groups comprising both private and public members. Vehicle procurements have had a predominance of public buyers. In the procurement of both vehicles and heat pumps there has been a consensus regarding the importance of environmental/financial requirements, although there have been detailed discussions about how they should be made and their relative ranking.

Technology procurement methodology. The process does not differ between vehicle procurement and other types of technology procurement. The same difficulties arise in the various types of procurement. In all the technology procurements studied, the main difficulty has been to gain initial interest from manufacturers and buyers, something which has required great knowledge of the trade to achieve.

When specifying the requirements, buyers of heat pumps were able to agree. The relative importance of requirements however, was debated. Requirements in vehicle procurements have been specified by a group of experts, and the specifications have then been used as a base for discussion among the buyers. It is difficult to say what effect this has had on the proceedings.

All procurements have included various information initiatives, and all have been mentioned in trade journals and circulated to trade representatives. It seems that vehicle procurements have attracted a wider media interest, and thereby have become better known to the general public. To some extent this may have contributed to more vehicles being sold, although there has been some negative publicity too.

Incentives and economic instruments. A number of interacting factors contributed to the success of the technology procurement of heat pumps. Technology development, market influence, and the favourable balance of higher oil prices and a relatively low electricity cost have led to sales multiplying. The process of aligning the economic instruments for clean vehicles started around the same time as the technology procurements, but this seems to be more complicated for clean vehicles than for heat pumps. More incentives for clean vehicles are gradually being introduced

Other. Another issue that was raised is whether the type-approval process and the construction of necessary infrastructure, etc., is more complicated for vehicles than for heat pumps. The interviews did not reveal any real differences. The type-approval process for vehicles does not seem to have been an obstacle and even if infrastructure, e.g. fuelling and recharging stations, has required careful consideration and planning, it was not been perceived as a particular problem among the interviewees.

4.2.2 Discussion

The impact of technology procurement depends upon a number of factors. For heat pumps especially, political will and support greatly contributed to their popularity. It can be said that successful distribution of a new product is achieved when there is established competition between manufacturers, and when the product no longer depends on supporting measures. This means that the efficiency of technology procurement can vary depending on the stage of market development. The impact of technology procurement is highest for relatively new product categories. On the other hand, it could be dangerous to claim that a certain product has reached maximum development. In the case of heat pumps, recent technological advances had been made before the technology procurement, and it was believed that the technology had been optimised as far as possible, but the development of more efficient heat pumps continued and sales have multiplied.

All companies must adapt to and satisfy customer demands. Nevertheless, it is likely that small companies, at least initially, are more sensitive to fluctuating sales figures during a certain period than large companies. Thus, there is reason to believe that heat pump manufacturers had to be more sensitive than vehicle manufacturers to customer environmental requirements in the technology procurements.

It is argued that there is a relationship between how difficult it is to carry out technology procurement and the complexity of the product or system (Westling 1995). Vehicles are more complex than heat pumps. The possibility of combining components from different manufacturers is also limited. One of the first modern electric vehicle models was developed by IVECO. It was made with components from several manufacturers, and the result was a vehicle with good technological performance that combined the best solutions from several different manufacturers. This type of collaboration seems to be decreasing, not least due to the trend of vehicle manufacturers merging into increasingly larger corporations.

Supporting incentives seem to have given most benefit in the heat pump procurement. It is likely, however, that successful alignment of incentives will eventually benefit clean vehicle procurement. The process of aligning economic instruments for clean vehicles started around the same time as the first technology procurement, but their influence on buyers of clean vehicles in general has not been visible until now (2004/2005).

4.2.3 Conclusions

The biggest differences between technology procurement in various industries are due to the manufacturers, and the incentives visible to them, rather than the technology procurement process as such. In the procurement of heat pumps, the manufacturers were small companies with high technological development potential in a new market. Vehicle manufacturers, on the other hand, were, and still are, large international corporations with technological development characterised by small product modifications.

A key issue in all technological procurement is being able to explain and clarify the incentives for the parties involved. When it comes to the motor industry, it could be that in practice, incentives are not sufficiently valued, mainly for reasons such as company size/maturity, rather than the product itself.

One difference that could be of some significance is that the buyers in vehicle procurement are more often public bodies, than in other technological procurement. This could make it easier to form a group of buyers at the start, and form a natural partnership. Apart from this, the buyer groups have had similar motives and structure.

Something that distinguishes the heat pump procurement is that it resulted in great technological development, which in combination with various government grants and increased energy prices influenced the market.

The special characteristics for any product category must be considered if technology procurement is to work for the category; market situation, development potential, company size, whether the buyers are private individuals or organisations, etc. It is especially advantageous to align the technology procurement method with any other available economic instruments in order to achieve a rapid market introduction of a new product. Public support can be offered to manufacturers, initial buyers (buyer groups) and/or to the buyers of the end-products, and this support has to be optimised for each case. Furthermore, in the case of vehicles, political contacts at an early stage have been crucial to initiate work on tax relaxation, parking regulations, etc. It is important to plan from the start how to align control measures and technology procurement, since this makes it easier for players to see the incentives.

Future technology procurement projects for vehicles can benefit from the experience made in other technology procurements, both when it comes to preparations; how to form and engage a buyer group and how to specify the requirements, and also how the alignment of various incentives and information initiatives can maximise market influence.

Within certain areas, technology procurement requires unique vehicle knowledge, e.g. principles and time perspectives for introducing new technology on

the vehicle market, as well as driving forces for the technology development of vehicles. Understanding the factors that govern decisions by various buyer categories is also necessary in order to motivate manufacturers.

There are also indications that the need for setting up a well-functioning after-market, and other supporting infrastructure where required, is greater when it comes to vehicles. This is illustrated, for example, by the Clio procurement.

4.3 Revised description of technology procurement stages

The different stages in technology procurement are described in Chapter 2, using the traditional Swedish classification and concepts. In this project however, we have found that the description is somewhat halting in relation to the reality of clean vehicle procurement. We have therefore devoted some thought to revising the description of the different stages in technology procurement. The revised version has then been used in the further analysis of the various stages. Even if the proposed division of stages is based mainly on experience from technological procurement of clean vehicles, we believe that it can work just as well for other types of products.

Technology procurement should in our opinion include the stages shown in figure 9.

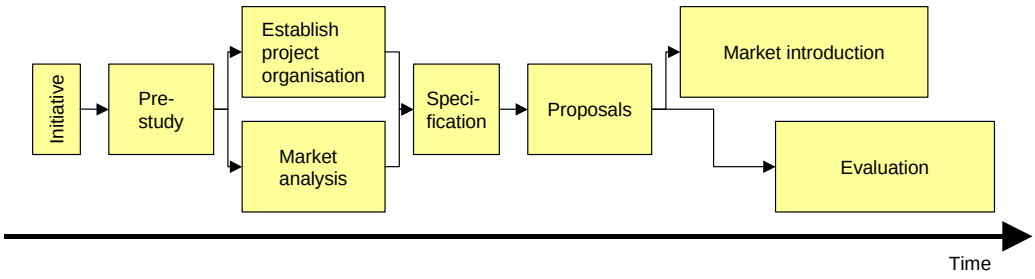

Figure 9: The phases of the technology procurement cronologically

Below is a brief description of each stage, followed by a more detailed examination of most stages, under separate headings.

4.3.1 Initiative

A player sees an opportunity for market development through technological procurement, and outlines the proposed technology's potential in the development towards environmental sustainability..

Example: A person reads in the early 1990's about the stringent regulations for zero-emission vehicles planned in California, and realises that this could well lead to a new world-wide market for battery vehicles. Through technological procurement, this person believes that Sweden could both contribute to and speed up the development towards zero-emission vehicles, and maybe also help Swedish vehicle manufacturers.

4.3.2 Pre-study

This initiative could lead to a pre-study. The key issue for the pre-study is to find out whether a technological procurement with the proposed aim would be effective. To assess this, other possible forms of public support should be considered in comparison. Note that the concept of pre-study has been redefined here, compared to the prevailing description.

4.3.3 Establish project organisation

The technology procurement organisation must be defined, and players involved must be identified. The organisation also includes setting up goals, and strategies for their achievement. A buyer group, and normally also a steering group, is linked to the project group.

4.3.4 Market analysis

A basic prerequisite for technology procurement is market sensitivity regarding functions and singularities. The market analysis makes a more in-depth investigation of issues raised in the pre-study and should include close contact with all key stakeholders taking part in the procurement, not least potential suppliers. An important aspect, apart from gathering information, is to show sensitivity to the views of the players, thereby ensuring a positive commitment to the technology procurement.

4.3.5 Requirement specification

The core of technology procurement is to specify requirements in a comprehensive and well-balanced way, and to describe how they will be verified and appraised.

4.3.6 Tendering

An invitation to tender is drawn up and circulated to potential suppliers. Tenders received are dealt with and evaluated in order to select one or more winners.

4.3.7 Market introduction

Agreements are signed with the winning supplier regarding product delivery. To facilitate the development and introduction of the product, demonstration projects, pilot deliveries and pre-production grants can be used. The project can also contribute with some marketing of the product.

At the same time, the project should offer continuous support to buyers and users, both before and after delivery.

4.3.8 Evaluation

To a certain extent, evaluation starts already when handling incoming tenders. Product evaluation is also an important part of pilot deliveries and demonstration projects. Opportunities for evaluating market influence and any spin-off effects arise some time after delivery, and it is thus important to maintain an organisation for this during a longer period.

4.4 Pre-study

The main aim of the pre-study, as per above, is to make clear whether technology procurement is likely to be the best way of influencing the market. Once the project is off the ground, the desire and ability to objectively question whether the project should be carried out is limited. Players involved naturally tend to want to carry out the project ”at all costs”.

Finding out whether technology procurement is a suitable option requires a comprehensive market analysis. The following aspects should be investigated:

- What are the chances of achieving the desired requirements?
- Can the product be competitive under the current and expected future market situation?
- Are there any special market requirements for an introduction of the product. If so, what are they? For example, fuelling infrastructure, subsidies or change in regulations.
- What are the market volumes, including the desired product, and what potential is there for improving the environment?
- What other products could benefit from the technology development generated through the procurement?
- Which potential suppliers can be expected to submit a tender?
- Who are the buyers? Can they, are they willing to, and are they allowed to collaborate (due to competition regulations)?
- How is conventional products for the same purpose procured today?
- Technology procurement as a tool for market influence should also be put in relation to other possible methods, for example:
- Direct subsidies to buyers or seller of the contemplated product
- Support to research, development and demonstration
- Changed local, regional national or international laws and regulations
- Information campaigns
- Voluntary agreements

These or other forms of public support commonly accompany technology procurement. Since technology procurement should result in a self-driven market, it is important that the need for support is temporary and relatively limited.

Of the four projects studied, none has clearly demonstrated why technology procurement is motivated in the pre-study.

4.5 Establish project organisation

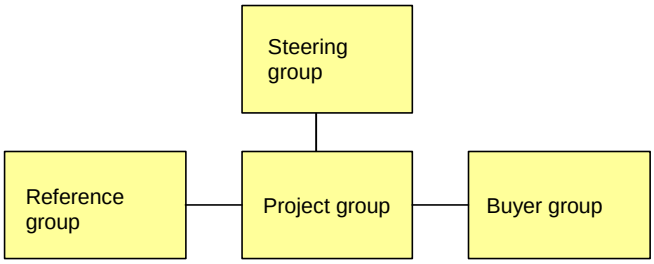

Figure 10: Organisational chart for technology procurement projects

The steering group is responsible for the project's goals and strategies and the overall management of these. The steering group includes financiers and other players that make substantial contributions to the project – monetary or in kind.

The project group should include technical experts, procurement specialists and a project manager. A good understanding of the market in question is also of great importance. If possible, marketing and information expertise should also be included in the project group, at least during the concluding stages of the project. Normally, the project group consists of people from the buyer group, financiers and consultants. The project group is responsible for the greater part of the operative work carried out in a technology procurement.

The buyer group. Credible and leading buyers are a very strong success factor for technology procurement. It is advantageous if they represent a relatively large share of the buying volume on the market. The buyer group gathers potential buyers. By participating in the group, players commit to buying a certain volume of specified products. It is not reasonable that this commitment should be fully binding, but a clear declaration of intent definitely increases the likelihood of successful technology procurement. Players in the buyer group are offered an opportunity to take part in drawing up requirement specifications and the invitation to tender. They are also eligible for any pre-production grants.

The reference group can be used to ensure that a correct and comprehensive specification of requirements is established. A reference group for clean vehicles should include e.g. drivers and users of vehicles, as well as any trade associations and authorities that sooner or later will be affected by the results of the technology procurement, e.g. the Rescue Services Agency. The reference group can also be useful in the market introduction and evaluation stages.

It is important that the organisation is explicit not least to ensure that potential suppliers feel that they have a solid partner to work with, which represents and takes responsibility for tendering, tender evaluation and negotiations.

In the technology procurements we have studied, the project organisation has not been documented in any detail, not even regarding goals and strategies. Reference groups have seemingly not been used. Buyer groups have included a number of players, mainly public buyers of vehicles and also some private owners of vehicle fleets, and have covered the needs of this market segment fairly well.

The tendency has been towards freer types of contract for participants in buyer groups. In the same way, buying commitment has become less specific. One advantage of this development is that it is easier to set up a buyer group. A disadvantage, pointed out by Ford not least, is that confidence in technology procurement is drastically reduced when a buyer group first promises to buy large volumes, but when it comes to the crunch only orders a fraction.

A general conclusion and guidance for future technology procurement of clean vehicles is that a buyer group should preferably be set up and run with the ambition to carry out several consecutive projects. Using the same buyer group several times can save large resources and gradually increase confidence among potential suppliers. Competence and experience built up in the buyer group can then be used and strengthened. In line with this recommendation, it is important to identify at an early stage, any added value that participation in a buyer group brings, and also to consciously try to increase such value.

4.6 Market analysis

The aim of market analysis is to ensure that technology procurement is designed in line with the requirements for a long-term market development in the desired direction. Principally, it is the requirement specification and other related terms in the tendering that call for solid documentation from the market analysis. The results of the analysis are also important however, for the design of the project organisation, especially regarding the composition of the buyer group.

Aspects that are handled in the pre-study should be carefully discussed in the market analysis. To a reasonable extent, the opinions of all stakeholders on the market should be heard, e.g. sellers, buyers, users, authorities and trade associations.

Since the following stages of technology procurement, for competition reasons, do not allow any contacts that could favour a particular supplier, it is important that the market analysis includes a close dialogue with leading suppliers. Normally, it is manufacturers who spend most resources on analysing the market. Much valuable information could thus be obtained through a well-functioning dialogue with them. Another important aim with supplier contact is to market the technology procurement, i.e. ensure that they submit a good tender.

In the projects studied, market analysis has been carried out in various ways. One good example is the sales brochure produced in the Focus procurement to ascertain buyer, and actually even seller, interest. The brochure presented a number of unspecified vehicle types with key facts, excluding price and supplier, but explained that the vehicle could be run on E85 without loss of environmental performance. This was a simple way of investigating genuine interest for each vehicle type.

Study visits and surveys of existing vehicles of a selected type, e.g. electric and hybrid vehicles, as well as studying prototypes is also part of the market analysis. The difficulty of estimating which suppliers will actually submit a tender is illustrated in the Focus procurement. During part of the market analysis period

the project management had a Volvo flexi-fuel model at their disposal. The car functioned very well. When the time came, Volvo still refrained from submitting a tender referring to lack of experience of the technology.

Part of the market analysis should be devoted to assessing and possibly shaping required public support. This could be anything from direct subsidies to measures for facilitating necessary infrastructure. Even if the size of subsidies cannot be determined until the tenders have been evaluated, it could be of significance to include information on planned supportive measures in the invitation to tender.

4.7 Requirement specification

The requirements should refer to product characteristics and function without pointing to technological solutions. Common vehicle procurement documents provide a suitable starting- point for specifying requirements and other parts of the tender invitation.

In the electric and hybrid vehicle procurements, the requirement for a certain battery range was a determining factor. Only a few manufacturers had electric and hybrid in their product range. The range requirement ”at least 100 km, preferably 150 km” was not met by the Clio, which offered 87 km at 20 degrees Celsius. The probably even tougher requirement of 90 per cent range at –15 degrees Celsius was not included in the agreement with Renault.

The range requirement and its verification is a typical problem for technology procurement of battery vehicles. In the specifications for the Clio procurement, a US driving cycle was used as a basis for testing range per charge[4]. In the agreement with Renault, range information was based on a different driving cycle and test method, developed by an international standardisation group. A generally accepted standardised method for testing range and emissions for electric and hybrid vehicles has not yet (in 2005) been established, despite the fact that more than a hundred thousand electric-hybrid vehicles had been being sold during the eight years since the first commercially viable hybrid vehicles were introduced on the market.

The Focus procurement devoted a lot of thought to emission levels in the specification of requirements. Here too, standardised testing methods for flexi-fuel vehicles were, and still are, unavailable. Both electric-hybrids and flexi-fuel vehicles are to date still tested as conventional petrol cars.

The main aim of technology procurement of clean vehicles is to reduce environmental impact. The electric and hybrid vehicle procurements were mainly concerned with impact on the local environment, whereas the latter two procurements mainly focused on the climate aspect. A possible, but perhaps less clear alternative to the requirements in the electric and hybrid vehicle procurements would be to stipulate very low emission levels and then let the manufacturers determine the technological solution required to obtain this. If a

[4] US requirement levels for emissions were also used

manufacturer chooses an internal combustion engine with extreme exhaust emission control, or fuel cell technology, the range requirements can be easily met. In the same way, the flexi-fuel procurement could have a key requirement of a reduction of ”well-to-wheel” climate impact by X per cent, instead of the ethanol-fuel requirement, and let manufacturers choose between the various more or less renewable fuels and solutions.

Even if such alternative methods of requirement specification definitely represent a more downright approach from a technology procurement perspective, there could be objections. It could, for example, turn out to be almost impossible to make a fair evaluation and comparison of submitted tenders. The difficulties in comparing various clean vehicle alternatives was illustrated in the beginning of this report, where we noted that there is still no national or international definition of clean vehicles.

The key issue in technology procurement is the level of the requirements, i.e. how high to raise the bar. In the Clio procurement, the 100 km range was a mandatory requirement. No manufacturer met this requirement with a commercially credible concept. Therefore, the technology procurement ought to have been terminated. In the Berlingo procurement, interestingly enough, the bar was lowered. Only 80 km range was demanded. Some vehicles on the European market already met this. It is likely that this requirement was consequently more to do with finding technological solutions that could offer at least 80 km range at an attractive price.

The nature of the motor market implies that large technological changes – ”paradigm shifts” – almost require a change in requirements to such effect across the globe. The introduction of the catalytic converter is an example of how requirements in California fairly soon spread across the world. The zero-emission mandate was believed to have a similar effect. In other words, it is unreasonable to expect that technology procurement in itself will contribute to a revolution in the motor market. Either, technology procurement should be used as an ingredient in an already ongoing global innovation process, or it should focus on a limited change of the vehicle. In this respect, the Focus procurement probably came as close as you can get to the maximum change requirements, for a successful technology procurement.

By having more international representation in the buyer group or by prolonging the procurement process, it may be possible to achieve further stages of development. This would have to be weighed against the higher level of effort required to handle such a project and the increased risks carried by longer and bigger projects.

The above line of reasoning refers to the passenger car market. In a wider perspective, there are many other types of vehicles that are not nearly as dependent on a global change of requirements. Working vehicles, trucks and buses are examples of vehicles that are modified for the individual customer or market to a greater extent. Niche vehicles such as mining vehicles, is an example of an area where technology procurement could lead to great technological development.

Put simply, the choice can be between introducing small changes to a great number of vehicles (passenger cars) or significantly bigger changes to a narrow market.

A general recommendation for successful technology procurement of clean vehicles is to keep the requirement specifications short and simple. To devote three pages to a description of user patterns, climate, etc. and then eventually arrive at a requirement regarding annual energy use, is likely to create more confusion than innovation[5]. Technology procurers can probably assume that manufacturers design vehicles that meet current market requirements. On the other hand, requirements related to the anticipated new technology must not be forgotten, for example electromagnetic radiation, which could be a bigger problem in vehicles using strong electric current.

Another general recommendation is to focus the requirements for technology development on as few aspects as possible. In the electric and hybrid vehicle procurements it may have sufficed with advanced requirements regarding emission levels and range associated with these. To also specify low energy consumption significantly increased the risk of problems at a later stage. However, it may have been necessary to specify some form of requirement for energy consumption to avoid the risk of a manufacturer putting forward a vehicle with very large batteries and badly designed charging algorithms. In the same way, the Focus procurement could probably have been limited to a flexi-fuel requirement, refraining from exhaust requirements above current emission standards. Possibly, there may have been a need for requirements regarding some unregulated emission values for E85.

In this context, it should be mentioned that certain safety requirements were included in the Swedish Road Administration's 2004 proposal for a definition of clean vehicles. Needless to say, vehicles specified in technology procurements should also meet certain minimum safety levels, but it is important to set the bar at a level where safety requirements do not seriously limit the main aim of the technology procurement, unless the procurement happens to be about trying to introduce new safety solutions.

4.8 Tenders

The main difference between tendering in technology procurement and general public procurement is the specification of requirements (see above) and the associated model for evaluation of requirements.

As far as possible, the evaluation model should be explained in the tender invitation, based on a numerical total appraisal of stated "facts". Since technology procurement rarely allows practical testing of several proposals in order to select the best alternative, the evaluation has to be based on a theoretical comparison of tenders.

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[5]Refers to the Clio procurement. Was not included in the agreement with Renault. According to the pilot evaluation this requirement would not have been met.

The study of technology procurement projects indicates that it is inefficient to spend large resources on designing advanced evaluation models. In the end, all three completed projects based their final selection on other factors.

Unfortunately, it is probably almost completely unavoidable that technology procurement of clean vehicles leads to specifications that require the introduction of new methods for evaluation of key aspects. Range measurements for battery operation and emission measurements for flexi-fuel vehicles are examples that have already been mentioned.

A clear and active communication with all tenderers should be a priority, especially in connection with the announcement of the preferred tender. If the losing bidders feel they received insufficient information about the reasons for the selection, there is risk for negative feelings about the procurement project. This could result in reduced interest in subsequent procurement projects. Views to this effect have mainly come from the Clio procurement. The number of tenders was relatively large and submitting a full tender involved a considerable amount of time and work.

Below are some questions and answers that would require a more in-depth analysis:

How can you make a total appraisal of environmental requirements and economic aspects?

In certain cases, for example requirements for reduced energy consumption, environmental requirements contribute to lower fuel cost, which in turn can facilitate a total appraisal of requirements.

How do you handle the fact that data from suppliers often cannot be checked until after delivery?

By agreeing on a pilot delivery and evaluation most data can be verified before the main delivery. In case of significant divergence, the procurement could be discontinued. To select the second best bid in this situation is probably unrealistic, not least since the market will have developed since the tender was submitted.

How do you handle the availability requirement, increasingly important for buyers? This is hard to verify until the vehicle has run for a number of years.

One possibility is to stipulate in the agreement that the supplier sticks to promised availability, subject to financial sanctions. Under the battery leasing agreement, the Berlingo procurement included a free replacement car during major service operations[6]. Such solutions work as long as the vehicles are easy to replace, i.e. not especially adapted for a specific application.

4.9 Market introduction

If this hasn’t already been done, the project must now decide on how public support, if any, should be given. Support for a demonstration project with one or a few vehicles could be a way to help suppliers develop and test the new technology. Demonstration vehicles also provide an opportunity for evaluation.

Does the vehicle fulfil the promises in the agreement? Further advantages with a demonstration project at an early stage of market introduction could be that buyers and users are able to get to know the vehicle, time is allowed for the building of infrastructure, and that demonstration vehicles are the best possible marketing tool (provided they work as intended). The main disadvantage with a demonstration stage is the extra time and cost involved. None of the projects studied included demonstration vehicles.

One alternative, that falls between a demonstration stage and direct commercial delivery, is pilot delivery of a small number of vehicles to committed buyers and users. The difference between pilot delivery and demonstration activities is small and most of the advantages remain. Normally, there is no extra support to the supplier for developing pilot models, as this is considered to be included in the agreed price for pilot series and subsequent main series vehicles. The time perspective for pilot delivery and subsequent main delivery is also shorter than for specific demonstration initiatives. The Clio procurement applied pilot delivery and also carried out a thorough evaluation of the pilot vehicles.

The other technology procurement projects chose direct main-series delivery. This worked well, except for the Fiat cars to Stockholm. If the buyers have sufficiently strong confidence in the supplier, and the supplier has equal confidence in the new technology, direct delivery is, of course, the simplest and quickest way of developing the market.

The recommendation is that plans for technology procurement of clean vehicles should at least include time for pilot delivery. If at the agreement stage, it is evident that pilot delivery is unnecessary it is significantly easier to delete this from the plan than to try to squeeze it in at a late stage, if it was not included from the start.

Technology procurement often includes some form of pre-production support. In both the Clio and the Berlingo procurements the government granted SEK15 000/vehicle to buyers that ordered under the technology procurement agreement. Such subsidies may contribute to increased order volumes and satisfied customers. The question is however, whether or not the disadvantages outweigh the advantages, for example through increased administrative load, difficulties in phasing out grants without negative market impact, and the risk of distorted competition. Alongside the Berlingo, the Peugeot Partner, i.e. the same car with a different brand name, was offered at a marginally lower price. When Berlingo customers received a discount of around 15 percent through the government subsidy, it became impossible for Peugeot to remain on the Swedish market. When the delivery contract with Citroën expired, Citroën increased their prices significantly. Probably, this would have been more difficult if Peugeot had remained on the market.

The Focus procurement was carried out without any subsidies to car buyers. Under the contract, the car was already cheaper than a conventional Focus. This discount can be attributed to, among other things, the relatively large notified interest in the car. Major car buyers are used to similar volume discounts, and this type of agreement where all buyers regardless of size pay the same

price, was thus a sort of 'Robin Hood' model, i.e. major car buyers paid relatively more than smaller buyers.

An important form of support normally included in technology procurement is information about the winning product. Since both the government and a number of leading purchasers are behind the choice of vehicle, the message is highly credible and the opportunities for media exposure are good. The Clio procurement in particular, but also the Focus procurement generated a lot of publicity, good as well as bad. In this way, both the parties concerned and a fairly large part of the Swedish population learnt about these clean vehicle models.

Perhaps the most important lesson learnt from the study of technology procurement projects is that qualified support to buyers and users must be ensured for quite a long period of time after the first delivery has been made. Unfortunately, technology procurement projects are very often considered to be completed once a contract has been signed with one or a number of suppliers. In the clean vehicle procurements commitment was extended over a slightly longer period to include, for example, an evaluation of the Clio pilot delivery, but this was still far from enough. Motives for offering support to buyers and users during the first years of "running-in" include:

- When general problems arise, concrete advice on how to deal with them can be offered to all vehicle users. Furthermore, it can be valuable for users to share experience.
- It is much easier for buyers in a consortium to make themselves heard than if they act individually. This position of strength can be useful for example in a dialogue with car suppliers and their service organisations, or with insurance companies.
- An on-going dialogue with users considerably facilitates the evaluation process.
- Information and data from a reliable source is the only way of stopping rumours that, for better or for worse, tend to start when innovations that threaten established technology are introduced. Supplying vehicle users with facts and in other ways keeping them satisfied ensures the probably single most important success factor for continued market growth. The users are the best ambassadors for the new technology.

Concrete solutions for ensuring a continued support to buyers and users include:

- Plan for financing the project during a few years after delivery.
- Establish and regularly up-date mailing lists of buyers, and not least users of the vehicles.
- Create a website for information, shared experience, etc.
- Include some form of requirement for participation in the evaluation process in all contracts with buyers.
- Follow up how each buyer has fulfilled their buying commitments.

The above suggestions are in line with the recommendations made earlier in this report on the “reuse” of buyer groups in future technology procurement projects.

4.10 Evaluation

The foundation for meaningful evaluation is laid at an early stage in the project, when goals and strategies are formulated. One of the main aims of evaluation is to compare the outcome with the intentions and to analyse any divergence.

Another purpose of evaluation is to seek to further develop the methodology of technology procurement. A spirit of constant learning is vital. In this context, we are forced to point out that a couple of people that held central positions in the technology procurement projects we have studied were not been willing to share their experience. In one case a person demanded payment for being interviewed and in another, a person refused to be interviewed at all.

An evaluation is expected to show whether the procurement was a success or a failure. Since technology procurement, according to reasons put forward earlier in this report, is never the sole factor for influencing the market in a certain direction, it is very difficult to determine what aspects of an accomplished change can be attributed to technology procurement.

It is relatively easy to assess how many vehicles the buyers actually bought within the technology procurement project, and the difference in performance between the procured products and their main alternatives. Furthermore, it is usually possible to establish whether the market shows signs of growth or stagnation. Battery cars have suffered a number of difficult years in Sweden, with essentially no new registrations. If the market does not pick up soon, a large part of the lessons learnt from the development of this technology will soon be forgotten. Ethanol cars on the other hand, have shown an almost straight upward trend since the technology procurement, and as new manufacturers are joining, volumes are likely to continue to grow.

Even when technology procurement does not lead to the expected market development, effects can be reached within other areas. Tangible “spin-off” effects from clean vehicle technology procurement by way of new products are hard to find, but on the buyer side it is likely that the procurement projects have contributed to a more extensive and active collaboration and networking that we see today.

When should the evaluation be carried out? Since there is normally no time limit for when technology procurement is considered to finish affecting the market, there is no set date for when results can be read. A natural time for the big summing-up and evaluation of technology procurement is probably when the project is nearing the end, i.e. a few years after the first delivery. Needless to say, evaluation is a continuous process throughout the project. It is important at all times to gather and document key data and to analyse whether proposed goals and strategies still apply.

5 Recommendations

Based on this study of four clean vehicle technology procurement projects, we offer some recommendations for future activities. The structure follows the proposed stages of technology procurement, see Figure 11. More details and background to the recommendations are found mainly in Chapter 4.

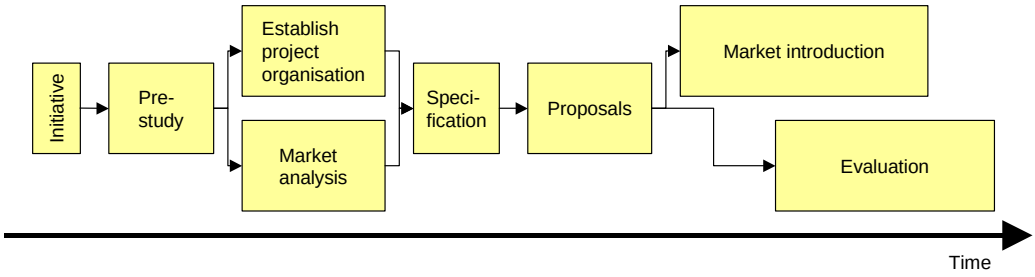

Figure 11: Stages of technology procurement

An initiative can lead to a **pre-study**. The key issue for the pre-study is to find out whether a technological procurement with the proposed aim would be effective. To assess this, e.g. other possible forms of public support should be compared.

A recommendation regarding **project organisation** is that the buyer group should preferably be set up and operate with the ambition to use the same group in future technology projects. This is cost effective, creates confidence and increases the long-termness of commitments.

Market analysis provides basic documentation for the specification of requirements, but should also be allowed to influence the composition of the buyer group. The Focus procurement came up with a good way of investigating market interest for a proposed vehicle, i.e. produce a fictive sales brochure for the new model/models.

Requirement specification should if possible avoid pointing out specific technological solutions. In this respect, all the clean vehicle procurements have to some extent missed this point, but it could be that more detailed requirements would have further complicated the procurement project. The nature of the passenger car market makes it unrealistic to expect major technological change to result solely from technological procurement. To achieve major change, technology procurement must be well timed. It should thus be part of an extensive, preferably global, innovation process. The conditions for proper technology procurement are considerably better for other types of vehicles. The choice is between introducing small changes to a great number of vehicles (passenger cars) or significantly bigger changes to a narrow market.

Requirement specification should be kept short and simple. In line with this, it is important to focus requirements on as few aspects as possible. Unfortunately, it is easy to end up with a complete list of desiderata, which significantly limits the chance of success.

Tender evaluation, unfortunately, normally seems to require the introduction of new methods for testing. As far as possible, this should be avoided, not least to facilitate the work of the manufacturers and to avoid problems of interpretation.

The market introduction plan should leave space for pilot deliveries, which could then be taken up or not, depending on the character of the winning product. Furthermore, when planning technology procurement a significantly longer period of active involvement by the project should be allowed, than has hitherto been the case. The organisation should remain in place for a few years after the first delivery, in order to offer support to buyers and users. Keeping buyers and users satisfied and well informed ensures the most effective channel for marketing of the new technology.

The foundations for a correct and useful **evaluation are** laid when the project objectives and strategies are drawn up. The main evaluation for the entire project should be carried out at the end, i.e. a few years after the first delivery.

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Appendices

A. Interview questions

B. Interviewees

Appendix A Interview questions

Pre-study

Why/on whose initiative was the pre-study, and thereby the procurement, initiated?

How were the respective pre-studies carried out and what were the results?

What are the key issues in a pre-study?

Buyer group

How should the buyer group be organised ? Which companies, administrations and other organisations should/should not be included? Can various buyers be given different roles?

How binding should notified interest for purchase of the product be?

How do you ensure long-term commitment to the procurement from the buyer group?

Requirement specification

How should requirements be specified? Are there any good/bad examples?

What were the crucial differences between the required specifications and the technology available on the market (in Sweden, the world)?

What was the result of the procurement in relation to the required specifications? Major differences?

Tender procedure

How was the tender invitation carried out (in respective procurement)?

How should it be carried out?

How do you ensure many and more importantly, good tenders?

Tender evaluation

Formal requirements – anything especially worth noting?

What additional mandatory requirements were made?

How was the relative importance of various optional requirements clarified?

Were practical tests carried out as part of the evaluation?

What is the experience of objective methods (points, calculations, etc) used for comparison of tenders? Which parts of the comparison were based on subjective methods?

Negotiations and contracts

Experience gained from respective procurement?

What is important at this stage?

Dissemination

Actual purchases generated by the procurement? Number of buyers? Type of buyers?

Information initiatives? Campaigns, demonstration projects, etc.

Was there a pilot project?

Were there any supporting incentives? If so, which? During what stage were these defined?

How were any requirements for new infrastructure dealt with?

Further development

What forms of support was offered to the buyers of the vehicles?

What forms of support was offered to the sellers of the vehicles?

Evaluation

How was the procurement evaluated?

What lessons have been learnt?

What are the major effects attributed to the procurement? In the short-term? In the long-term?

What outcome did you expect when you decided to participate in the project?

What was the actual outcome?

Appendix B Interviewees

Most people were interviewed in-depth. In some cases however, only limited aspects were dealt with.

Anders Lewald, Swedish Energy Agency (project manager Clio, financier)

Anna Sörenson, Östersund Municipality (user)

Arne Lögdberg, Svenska Energi- och Värmepumpsföreningen, *Swedish Energy and Heat Pump Association* (project manager, heat pump procurement)

Benny Dahlström, Toyota (manufacturer, did not participate)

Björn Olsson, Telge Energi (user)

Carl-Göran Bergstrand, Kommentus (electric hybrid and biogas procurement)

Carl Naumburg, VINNOVA (participated in the Focus procurement)

Einar Nome, Renault (responsible for service, Clio)

Eva Sunnerstedt, City of Stockholm Environment and Health Administration (buyer in most of the procurement projects, project manager ZEUS)

Gregor Hackman, City of Stockholm (director for the Local Investment Programme (LIP) financier)

Lars Ahrenberg, Volvo Cars (supplier in the Clio procurement)

Lars G Örtegren (expert support in most of the procurement projects)

Mats Alaküla, Lund Institute of Technology (responsible for evaluations, etc.)

Matz Nettby, Gatubolaget Göteborg (buyer, etc.)

Mikael Fjällström, Swedish Energy Agency (financier, etc)

Nils Lekeberg, Ford Motor Scandinavia (supplier, Focus procurement)

Sven Alexandersson, Environment and Health Administration in Stockholm (buyer/project member in most of the procurement projects).

Thomas Hammarlund, City of Göteborg Environment Administration (user, etc.)

Thomas Landqvist, Vagnparken i Skåne AB (buyer and user)

Åsa Aspelin, Örebro Municipality (user)

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