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Environmental Technologies Verification Systems

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Foreword

At the beginning of 2004, the European Union adopted the Environmental Technology Action Plan (ETAP) to improve the development and wider use of environmental technologies. These are defined as those technologies whose use is less environmentally harmful than relevant alternatives.

The definition of environmental technology refers to environmentally sound technologies as stated in Chapter 34 of Agenda 21: “environmentally sound technologies protect the environment, are less polluting, use all resources in a most sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes”.

Implementing the ETAP will entail various actions, one of which involves improving testing and performance verification related to environmental technologies. In this respect, the objective would be to provide a European framework for verifying the performance characteristics of new environmental technologies through commonly recognised and transparent protocols.

This report stems from a request from the Environment Directorate General of the European Commission to carry out a research study providing the necessary background for the eventual creation of a European Environmental Technology Verification (ETV) system. The report is based on the results of two consecutive research projects carried out by JITEX on behalf of the Joint Research Centre's Institute for Prospective Technological Studies. The first project focused on the identification and study of existing ETV systems inside and outside Europe. The second project conducted a market survey on users of ETV systems and examined financial and organisational aspects of ETV.

Executive Summary

Early in 2004, the European Union adopted the Environmental Technology Action Plan (ETAP) to improve the development and wider use of environmental technologies, defined as “all technologies whose use is less environmentally harmful than relevant alternatives”. One of the priority actions of the ETAP is entitled "Establishing European Networks of technology testing, performance verification and standardisation".

This report analyses the Environmental Technology Verification (ETV) concept and how it could be applied to Europe. Existing ETV systems worldwide are examined first, followed by the study of related European systems. Information on the verification costs for selected ETV and other systems completes the study of these existing systems. A market survey, targeting the actual and potential end users gives insight on the functional aspects of ETV and advice on how ETV could be applied to Europe. Finally, a generic model for a European ETV System (EETVS) is proposed.

The main results of the report are summarised below.

Study of existing systems

The development of ETV programs is a recent phenomenon originating from North America. Just as ecolabelling provides guidance to consumers seeking to purchase “environmentally friendly” products, verification programs have been designed as a means to accelerate market acceptance of innovative technologies. This is achieved by providing technology users with information about performance, thereby decreasing the uncertainty in purchasing decisions. Verification can be defined as the mechanism or process for establishing or confirming the performance of a technology, product or process, under specific, predetermined criteria or protocols and adequate quality assurance procedures.

The American ETV system and the Canadian ETV system are the pioneer systems in the verification of environmental technologies. Based on these two first systems, which have different characteristics, other ETV systems were developed in South Korea, Japan, Bangladesh, New Jersey and elsewhere. The subsequent systems, which integrate the basic concepts of the first systems, have been adapted to meet specific local or regional requirements.

The objective of the **US ETV** program is to provide credible performance data for commercially-ready environmental technologies to help vendors in selling innovative technologies, and regulators and purchasers in making their decisions. The verification is carried out by public-private partnerships conducted through competitive cooperative agreements with non-profit making research institutes. A broad based stakeholder process helps in choosing technologies, developing protocols and approving verification reports whereas the US Environmental Protection Agency (EPA) has the overall responsibility of the program. The program is structured around a small number (five in 2005) of specialised verification organisations. US ETV follows a dynamic strategy where many different options are tested, modified and improved. In this way, a number of the verification organisations do not continue operation after the pilot phase and new organisations are created.

In US ETV, technology performance is evaluated using generic test protocols developed with independent stakeholder advice. The technology is performed inside the system. The procedure of stakeholder involvement is time consuming but enhances the credibility of the system. All data and reports are publicly available. The system provides no guarantee for performance. It declares that the technologies have been tested under specific conditions and some of their characteristics have been measured. The buyer has to apply specialised knowledge to rank the technologies.

ETV Canada has similar objectives to those of the US ETV. The aim is to provide the market with evidence that a vendor's claim on technology performance is credible and supported by quality independent data. An independent private entity, having received delegation from Environment Canada, is responsible for managing and running the program. This system has developed two options for technology evaluation, namely verification and benchmarking. The verification scheme is technology specific whereas the benchmarking scheme is sector specific (like US ETV).

The verification scheme of the ETV Canada has been studied in more detail. Under this scheme, claim verification is performed. The system does not directly verify the performance of the technology but verifies the vendor's claims on that performance. These claims are based on previously established data, and they must respect minimum standards and guidelines in force in Canada. After verification, ETV ascertains that the data have been examined and have been found sound. Accordingly, the claims provided by the vendor are supported by these data. The testing is done ex-ante by an independent, accredited laboratory. The claims are published but the test protocols and data are not.

In comparison to the US ETV, ETV Canada is a faster system: the data are available for verification and there is no need to develop test protocols and test plans and execute the tests, as this has been already done by the producer and the testing laboratory. However, ETV Canada can propose the execution of additional tests, if the provided data are not sufficient to verify the performance claims. The Canadian system is less costly, since the producer has already financed the tests. ETV Canada prevents the duplication of tests since available data can be used. However, this system does not audit the execution of the tests but relies to the credibility of the data providers. ETV Canada is a vendor-driven, flexible system. Any kind of data and accompanying claims can be used, provided they respect the system's quality assurance requirements. The system does not guarantee the performance of the verified technologies. The buyer has to apply specialised knowledge to judge the technology performance.

The analysis of the US ETV and ETV Canada systems, using two simplified models, shows that the system's design influences various ETV elements like the stakeholder input, the comparison between technologies and the publication of the verification results.

A stakeholder consultation is necessary to a US ETV-type system to develop protocols because the system performs technology testing. In ETV Canada, the testing is not performed inside the system. There, the stakeholders can have a different role, providing advice to the ETV system, but are not needed for protocol development like in the US ETV.

The comparison of technology performance is facilitated in the US ETV: the technologies have been tested under the same conditions and in principle during the same test event. In ETV Canada this is not the case. The performance claims can be based on tests done under

different conditions and using different test methods. Technology comparison is not a primary goal.

In the US ETV, protocols and test plans are developed by the system and are public. In ETV Canada, these "verification tools" are privately developed by the vendor and possibly the testing laboratory, who can seek the advice of ETV if necessary. The ETV system is thus not "entitled" to publish them.

The issue of the **evaluation and impact of ETV** has been addressed by the Japanese ETV and the US ETV by means of surveys and the analysis of outcomes. A survey carried out by Japan ETV on organisations participating in the system showed positive results both for companies and for verification organisations. The US ETV estimated the system's outcomes for concrete verification case studies. These outcomes are estimated based on actual or potential market penetration scenarios. The evaluation showed that sold (or to be sold) ETV verified technologies achieve emission reductions and thus have positive impacts on the environment and on human health. ETV helps firms with regulatory compliance, contributes to technology acceptance by end users and promotes scientific advancement. However, quantitative data on an ETV's impact on sales and subsequent quantified achieved (and not potential) environmental impacts are scarce.

In **Europe**, there are no verification programs like those mentioned above. Partially resembling systems for certification, approval or ecolabelling exist. The systems studied (UK MCERTS, German UBA, French ACIME, Belgian PRODEM, EU Ecolabel, German Blue Angel) present organisational aspects that closely resemble ETV practice. The MCERTS certification and UBA type approval verify technology performance against minimum performance requirements. These systems are de facto mandatory (in the sense that a company cannot easily enter the related market before passing through these systems), pass or fail systems. MCERTS and UBA have implemented a bilateral agreement to achieve the equivalence of testing between the two schemes. This aligned scheme may become the basis for a European standard and a related working group was established by the European Committee for Standardization (CEN). The objective is the mutual acceptance of approval/certification procedures for CEMs within the EU. These harmonisation efforts could provide a basis for the development of a European wide verification system. Moreover, the studied systems possess experience in the evaluation of technology performance. They could serve as verification organisations, testing laboratories or verification centres and constitute, at the same time, a pool of stakeholders and experts.

The analysis of the **technology verification costs** for the US ETV, ETV Canada, MCERTS, UBA, ACIME and PRODEM systems shows that these costs are very technology and system specific and therefore difficult to compare. In the US ETV system, the vendor only contributes towards a small part to the total costs necessary for the realisation of the verification. The rest is supplied by the government and by other stakeholders. ETV Canada is comparatively more vendor-funded, but can also benefit from governmental subsidies for specific technologies. In systems with mandatory characteristics (MCERTS, UBA) the vendor is charged for the total costs. In the voluntary systems, vendors are willing to pay for the verification of their technology, but only an amount corresponding to part of the total cost. To keep the verification cost affordable to the vendors, and at the same time ensure the quality of the system, additional resources need to be found. Moreover, the willingness to pay is directly related to the access to national markets, without having to go through additional national

systems. European vendors are willing to assume the verification costs if the verification enables them to enter any national market in Europe.

The analysis of the **US ETV financial scheme** shows that the majority of the costs are covered by governmental funds, and the program is viable due to the large contribution made by EPA. The contribution of the vendors ranges from 10 to 18% of the verification costs (years 2002 – 2005); these figures drop to between 7 and 13% when compared to total costs (verification and centre support costs together). This contribution is not sufficient to cover the costs of the performance tests, which average 35% of the verification costs. The vocation of the US ETV is to pass to a more vendor-funded system, however, this is far from being achieved although the process is ongoing. The above figures question the feasibility of such a transition. The implementation of a system that would include a similar publicly funded pilot phase followed by a private funded steady state phase should therefore be carefully considered.

Market Survey

A market survey assessed the end users expectations of an ETV system. The survey addressed general questions like the success factors and the usefulness of the ETV, together with more specific questions regarding procedural and funding options. The impact of the ETV was examined with the feedback from vendor companies that had already gone through an ETV system. The most important market survey results are presented below.

A European ETV system is considered a useful tool, provided bureaucracy is kept to a minimum and a high technical level is guaranteed. It is expected to supersede existing, national procedures, e.g. for technology type approval. Through European wide recognition, it should be able to eliminate any need for any duplication of effort and tests throughout Europe. Harmonisation with other non-European ETV programs is also a factor of success.

Priority should be given to innovative, commercially available technologies with a positive environmental impact. Prototypes may be considered inside a limited scope framework.

SMEs are the types of companies that are expected to benefit the most from an ETV system, since they are considered as innovation oriented and at the same time they have limited financial, logistic or testing capabilities. It was however stressed that bigger companies should be welcomed as well.

The different ETV or ETV related systems offer a large range of procedural choices (US ETV-type, ETV Canada-type or verification compared to minimum performance requirements) and vendors' opinions are divided. The meaning of a verification award (logo) that differs in every system and how this is interpreted by potential buyers was mentioned as an important issue that is possible to improve.

The ETV system has to be totally independent. The respondents see it as a public or private organisation, supervised by a public body.

The cost is an issue of the utmost importance for the vendors. As many stakeholders as possible should financially contribute to the system. Financial help is a strong incentive for vendors to go through the verification process.

The ETV system should remain voluntary but strategies have to be developed to motivate the vendors to participate to it, without the system becoming mandatory.

The market survey revealed a contradiction in the way the respondents envisage the ETV system: the vendors did not associate any increase in sales or any additional market penetration to the effects of the ETV system. In spite of this, almost all the respondents declared that the ETV was worth the time and money spent. They did associate the presence of the ETV logo next to their mark as a contribution to the positive image of their company and admitted that they gained in recognition and in credibility.

The reason for this contradiction may be that the effects of ETV verification are difficult to detect. Vendors are reluctant to attribute part of their sales to the ETV logo; they prefer to attribute them to their product's own performance. Plausibly, both the product's performance characteristics and the ETV logo together influence the purchase decision.

EETVS generic model

A generic model for a European ETV System (EETVS) has been developed based on all the gathered knowledge on existing ETV systems, similar European systems and the market survey results. The model supposes that an EETVS is based on existing structures and that only the central coordinating entity, called the EU ETV team, will be created from scratch. The EU ETV team assumes the role of the central coordinating and supervising entity. This team decides on priority areas and appoints verification organisations in relation with priority technologies. The dedicated verification organisations run the system, following the guidelines laid down by the EU ETV team. They appoint testing laboratories (if technology testing is performed inside the system) or verification centres (if the system performs claim verification) to carry out the verification. The verification organisations draw on the experience of stakeholder groups for advice on key elements of the system. The model presents the interconnections between the various system entities like the EU ETV team, the verification organisations, the vendor, the testing laboratories, the verification centres, the stakeholder groups, the network of ETV contact points, and describes each of their roles in the system.

The model presents a range of different implementation possibilities. It can be applied either to a system that performs technology testing or to a system that performs claim verification. The key points of the system, like the degree of involvement and responsibility of the actors, the role of the Testing Laboratories and Verification Centres, the entry point of the vendor and the development of the verification tools, are highlighted. The EU ETV team can have a degree of involvement that varies from a highly centralised system to a system that delegates the majority of its responsibilities to other actors. Regarding the choices for the vendor entry point, the model opts for the implementation of multiple entry points. Finally, the most common verification tools, i.e. the system's general protocol, verification protocol, test plans and quality management plans, are identified and related to the various system entities that develop them.

1 Introduction

Early 2004, the European Union adopted the Environmental Technology Action Plan (ETAP) to improve the development and wider use of environmental technologies, defined as “all technologies whose use is less environmentally harmful than relevant alternatives”. The ETAP consists of a long list of actions grouped in three "areas", namely "Getting from research to markets", "Improving market conditions" and "Acting globally". One of the priority actions of the first area is titled "Establishing European Networks of technology testing, performance verification and standardisation"[1,2,3], including the possibility to set up a European Environmental Technologies Verification System (EETVS). This system would verify the performance characteristics of new environmental technologies through commonly recognised and transparent protocols. In that sense, “to verify” means “to establish or prove the truth of the performance of a technology, under specific predetermined criteria or protocols and adequate data quality assurance procedures”.

The objective of this report is to provide background information for designing a European-level verification program. Based on the study of existing programs worldwide and interviews carried out with stakeholders, the main components of a verification program were identified. For each component, various options are suggested and their benefits and limits are discussed. In addition, the entities that could be involved in the implementation and operation of such a program and the responsibilities that each of them could take on are identified. The report provides a generic model focusing on the two critical elements of a verification program, namely the procedure to test/verify the technology performance and the overall organisational structure that could be adopted for a European-wide program.

1.1 The ETV concept

The development of Environmental Technology Verification (ETV) programs is a recent phenomenon born in North America. Just as ecolabelling provides guidance to consumers seeking to purchase “environment friendly” products, verification programs have been designed as a means of accelerating market acceptance of innovative technologies by providing technology users with information about performance, thereby decreasing the uncertainty in purchasing decisions.

Purchasers of environmental technologies, the consultants that advise them, the financial institutions that fund them or the state and local permitters that approve implementation, make decisions that have an impact on public health and the environment. These decisions are based either on data from past applications of old technologies or on information supplied by technology vendors on the performance of new technologies. Vendor-generated data are quite often viewed with scepticism by all parties. Consequently, high performing innovative technologies that have the potential to protect the environment face a substantial market barrier. Market-based verification processes have been established to overcome those market

[1] Simulating technologies for sustainable development: an environmental technologies action plan for the European Union, Communication from the Commission to the Council and the European Parliament, COM (2004) 38 final
[2] http://ec.europa.eu/environment/etap/pdfs/report_etap_en.pdf
[3] http://ec.europa.eu/environment/etap/pdfs/comm_pdf_com_2007_0162_f_en_acte.pdf

barriers and to assure that data could be accessible, understandable and credible to investors, prospective users, the public, permit writers and enforcement officials.

Generally speaking, verification can be defined as the mechanism or process for establishing or confirming the performance of a technology, product or process under specific, predetermined criteria or protocols and adequate data quality assurance procedures. Verification must not be confused with certification: verification involves the independent assessment of a technology's performance without any judgement of it. Certification usually goes one step further by guaranteeing that the technology, product or process meets specific standards or performance criteria. That is why verification is most useful in areas where standards do not exist yet, in which case it may act as a standard precursor, or in areas where standards are normally not applied.

1.2 Approach and content of the report

Existing ETV systems are examined so as to understand their structure. Simple ETV models are then derived, based on the study of these existing systems. ETV systems have not been identified in Europe, but some selected ETV-resembling systems, like certification and type-approval ones are studied as well, so as to obtain an idea of the type of structures that could eventually be used for the setting up of a European system. The financial scheme of the US ETV system, for which information was available and the "cost of a verification" with the help of a small number of selected illustrative cases are reported. A market survey, targeting the end users of an ETV system has been conducted to gather general information on ETV and to give insight on aspects that remained unclear after the study of the existing systems. Finally, a model for an EETVS is proposed based on all the information gathered above. The model describes the various actors involved in the system and the interactions between them, and gives a range of different system design possibilities for the implementation of the system. The above information is classified in the following chapters:

Chapter 2: Verification systems worldwide

The most important existing ETV systems in the world, their structure, operational procedures and way of functioning are described in this chapter. The US ETV system and the ETV Canada system are the main existing ETV systems in the world. These two systems are different in their philosophy and scope. The newer systems, inspired by one or the other of these two pioneering ones, are also described. Two simple ETV models present in a simplified way the different implementation choices operated by the real systems.

The financial aspects of ETV are also analysed. The available information was however limited, with the exception of the US ETV system for which there is a wealth of financial data publicly available. The contributions of the various actors, US EPA, vendors and stakeholders are reported and compared. The costs of the system, divided in *per se* verification costs and centre support costs are briefly presented and commented.

Chapter 3: Existing European systems for technology approval/certification/ecolabelling

There is no national system in Europe comparable to the existing ETV systems outside Europe. However, a vast range of systems presenting characteristics similar to ETV exists.

Certification, type-approval and even ecolabelling systems include aspects that are comparable to verifications practices. A disambiguation of terms is presented by giving tentative definitions of the various systems. These systems exist in Europe at regional, national or EU level. If ETV were to be transposed to Europe it is cost and time efficient to use existing structures, that possess relevant experience and know how, instead from starting from scratch.

Chapter 4: Cost of verification: illustrative cases

This chapter presents the verifications costs, which are strongly technology specific. For that reason, three case studies are examined: Continuous Emission Monitors, GHG abatement technologies and End-of-Pipe technologies, but even inside these technology categories important cost variations are expected. The contribution of the vendor is examined in detail, reporting additional internal costs, other than the verification fees. The verification time, which indirectly influences costs, is also reported for different systems.

Chapter 5: Market Survey

A market survey, targeting principally the vendors/developers of ETV verified technologies but also including some feedback from other stakeholders (end users, financiers, decisions makers, ETV or other systems etc.) was operated. The survey was carried out in two "waves". At first a questionnaire was distributed to a large pool of recipients. The stakeholders that expressed their interest by replying to the questionnaire were then selected for an interview. The results of this survey are qualitative in nature but provide a valuable insight in the end users expectations of an ETV system. Many stakeholders, especially in Europe, are not aware of the ETV concept and its goals. The impact of ETV is assessed based on the feedback of companies that have already passed through an ETV (or other) system

Chapter 6: A model for EETVS

This chapter proposes a detailed system model for Europe. The model builds on existing ETV systems, proposes different system alternatives and integrates results from the market survey on the end users of ETV. It focuses on an imaginary entity, the EU ETV team, which is the only entity to be created from scratch. For this entity, different degrees of involvement are related to different degrees of responsibility. The other actors of ETV, namely the Verification Organisation, the Testing Laboratory/Verification Centre, etc. are also described. The interactions between all the constituent entities of the system are presented in a simplified manner.

2 Verification systems worldwide

National verification systems have been running for several years in the USA (since 1995), Canada (since 1996) and South Korea (since 1998). Japan started a program in 2002, which is still in a pilot phase. Many other countries, mainly in Asia, have launched or consider launching their own national verification program.

The existing programs belong to either the USA (South Korea, Japan) or the Canadian (China, Bangladesh, New Jersey) model. In the Canadian model, the program managing organisation collects the claims and all the data provided by the technology owner and submits them to a third party verification organisation, which first verifies that the data are reliable and then compares them with the vendor's claim. On the contrary, in the US ETV model, the testing of the technology is performed by one of the partners of the managing organisation, a third verification organisation.

This chapter presents in detail the US ETV and ETV Canada programs and briefly presents the other non European ETV programs, which are to a large extent based on these two pioneering programs.

2.1 The US ETV verification system

2.1.1 Brief description

This pioneering system was launched in 1995 under the auspices of US EPA (Environmental Protection Agency), and the general supervision of an EPA based team dedicated to ETV activities[4]. The objective of the program is to provide credible performance data for commercial-ready environmental technologies so as to aid vendors in selling innovative technologies and regulators and purchasers in making their decisions. This is carried out by public-private partnerships conducted through competitive cooperative agreements with non profit research institutes. These partnerships seek business efficiency and provide third party objective testing. A broad based stakeholder process helps choosing technologies, developing testing protocols and approving verification reports. EPA has the overall responsibility to ensure scientific relevance, fairness and consistency across partner organisations. The program is structured around a small number (five in 2005) of specialized verification organisations (VOs). The biggest part of the necessary funds for running the system comes from EPA. The deliverables of the program include testing protocols and verification reports containing data on environmental performance. All deliverables are available for consultation on the US ETV system web site. Other ETV systems, (Japan, South Korea) have been built on the US ETV system's "philosophy".

[4] http://www.epa.gov/etv/

2.1.2 System Development

The ETV program operated under a pilot scheme from 1995 to 2000. Twelve pilot programs, each focusing on a specific technological sector were initially established and other were added later on. Five of these pilots, now called "Centers", continue operations, and an additional one is still in its pilot phase (Table 1). In 2005 a new program element that enhances technology prioritization, called Environmental and Sustainable Technology Evaluations (ESTE)[5] begun operation. Additional schemes regrouped under the heading of "Homeland security applications" were initially launched within ETV, but were consequently assigned to another EPA entity, the NHSRC (National Homeland Security Research Centre) in the Technology Testing and Evaluation Program[6]. Another feature of the program is EPA's Environmental Technology Opportunities Portal (ETOP)[7], which provides links to programs that help fund the development of new environmental technologies and offers information on existing environmental technologies. The US ETV verification program has put into practice a dynamic operational concept, where changes and modifications are continuously tested so as to improve the program.

All the VOs start operation under a pilot scheme that typically lasts for four years. They then pass to an operational phase and take the appellation "Centre". The pilot phase of the whole ETV program lasted globally from 1995 to 2000, even if pilot activities were still in operation after 2000 as well. The VOs, operate in a flexible way, being able to choose their own operational scheme, provided that they respect the ETV program guidelines and quality assurance procedures (see §4.1 and §4.3 for an example of two US ETV centers with a sensibly different operational approach).

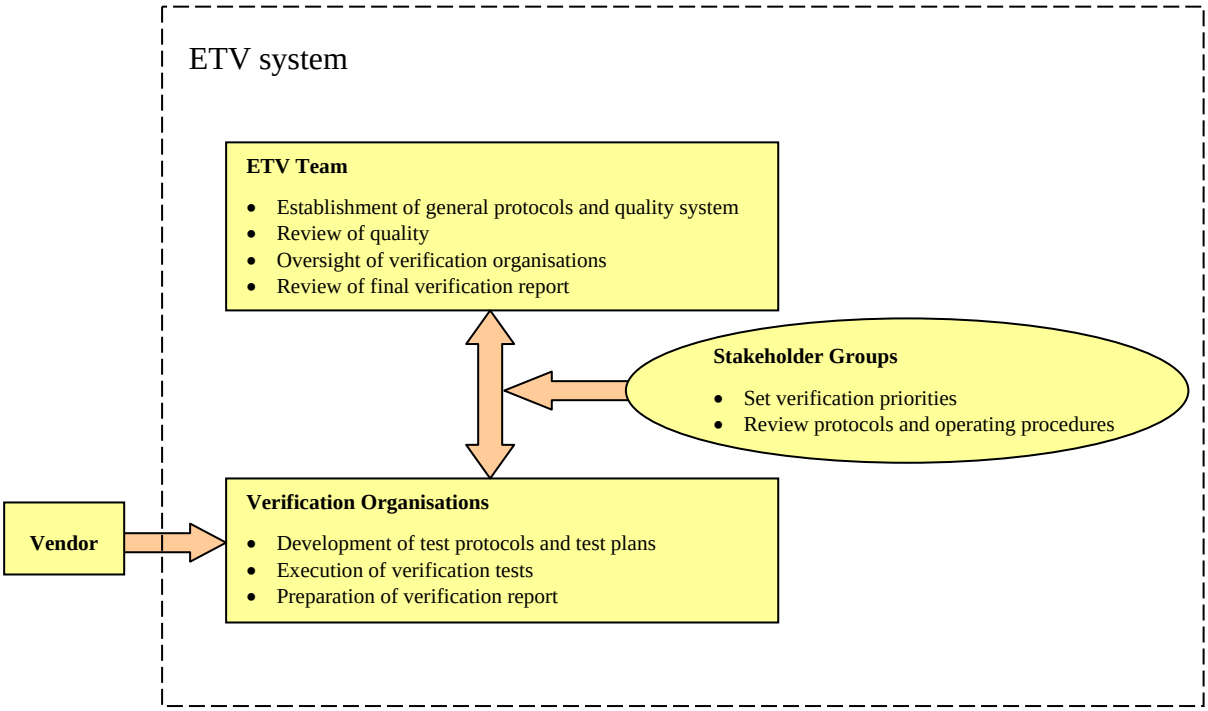
[5] http://www.epa.gov/etv/este.html
[6] http://www.epa.gov/nhsrc/tte.htm
[7] http://www.epa.gov/etop/

Table 1 : History of the US ETV system

ETV Center/Pilot name	VO	Start of Pilot phase	End of Pilot phase	End of project or Continuing	Technologies/Remarks
ETV Air Pollution Control Technology (APCT) Center	RTI International	1997	2002	Continuing	Technologies for stationary and mobile air pollution sources and indoor air pollution activities
ETV Advanced Monitoring Systems (AMS) Center	Battelle	1997	2002	Continuing	Field-portable and stationary monitors for all environmental media
ETV Drinking Water Systems (DWS) Center	NSF International	1995	2000	Continuing	Drinking water treatment technologies for use in small communities and residential treatment units
ETV Greenhouse Gas Technology (GHG) Center	Southern Research Institute	1997	2002	Continuing	Technologies that produce, mitigate, monitor or sequester greenhouse gas emissions
ETV Water Quality Protection (WQP) Center	NSF International	1998	2002	Continuing	Integrated the "Source Water protection Technologies" and "Wet Weather Flow Technologies" Pilots
ETV Pollution Prevention (P2) Coatings and Coating Equipment Pilot (CCEP)	Concurrent Technologies Corporation	1996	–	Continuing, Still in Pilot phase	Coatings and coating equipment that have potential to prevent pollution
ETV Building Decontamination Technology (BDT) Center	Battelle	2002		2004	Technologies that clean-up building contamination from intentional acts. **In 2005 activities assumed by EPA's NHSRC**
ETV Safe Buildings Monitoring and Detection Technology Effort	Battelle	2002		2004	Technologies that monitor and detect chemical and biological agents in buildings and public places. **In 2005 activities assumed by EPA's NHSRC**
ETV Safe Buildings Air Filtration and Cleaning Technology Effort	RTI International	2002		2004	Technologies that can remove chemical or biological agents from building ventilation air
Site Characterization and Monitoring Technologies Pilot	1994: SNL 1997: ORNL 2003: Battelle	1994	–	–	In 2003 was fully incorporated in the AMS center
Indoor Air Products Pilot	RTI	1995		2002	Activities taken over by private industrial associations
Pollution Prevention, Recycling and Waste Treatment Systems Pilot	California EPA DTSC	1995		assumed ending 2001	
Pollution Prevention Metal Finishing Technologies Pilot	Concurrent Technologies Corporation	1998		2003	
Environmental Technology Evaluation Center (EvTEC) Independent Pilot	Civil Engineering Research Foundation	1996		assumed ending 2001	No particular technology focus assigned

2.1.3 System Structure

Figure 1 : Simplified view of the US ETV system



The role of the EPA's ETV team

EPA oversees the verification organisation and has the ultimate responsibility of the system. The so called ETV team consists of EPA employees actively working on the ETV program. Among their tasks are to coordinate the overall program, including multi-year strategies, objectives, operating principles, protocols, implementation activities and annual budgets and to communicate the activities and outputs to EPA, the Congress, customers and the general public and give recommendations on future activities. The ETV staff works with several ETV Centres, one for each technology category (and to which a verification organisation and a stakeholder group is linked).

Verification Organisation

The Verification Organisations (VOs) are the public and private sector organisations that hold cooperative agreements or contracts to assist EPA in implementing the ETV program. They are responsible, together with stakeholder groups and the EPA's ETV team, for the selection of technology categories, which are under continuous review and frequently change to reflect the changes in the marketplace. They manage, supervise and conduct the verification activities, develop, carry out and oversee test and quality assurance plans in cooperation with technology vendors. They solicit vendor proposals, prepare verification reports and verification statements at the completion of each verification. Each verification organisation is contractually required to fully implement EPA's quality assurance (QA) requirements.

Stakeholder groups

ETV relies on the active participation of environmental technology information customers in technology-specific stakeholder groups, one for each technology area. Stakeholders are experts in their fields selected to represent the interests of technology developers and buyers, consulting engineers, industry associations, public interest groups and government, i.e. the end users of verification information in general. They meet several times a year and provide valuable input to the program making sure it serves real market needs. The stakeholders volunteer their time to assist in developing protocols, prioritizing types of technologies to be verified, reviewing documents, and designing and implementing outreach activities to the customer groups they represent. In recent years, stakeholders have also played a major role in developing collaborative relationships to support ETV verifications through cash and in-kind contributions from the organisations they represent and other organisations they are associated with. Cumulatively, ETV has had more than 1200 stakeholders in numerous stakeholder groups. In 2005, ETV had more than 300 active stakeholders that participated in the program.

Technology Vendors

The program is open to all vendors of commercial-ready environmental technologies, both domestically and internationally. The program is open to any technology but as mentioned, stakeholder groups are asked to help setting priorities. After a technology category is selected, all relevant technology vendors are contacted and this can be done in several ways (newsletter, web publication). Vendors can also apply spontaneously. Regarding the outcome of the verification, vendors may choose not to have a verification statement issued or they can even withdraw from the program before testing if they so wish. They can also request a retest at their own expense. It is the responsibility of the vendor to contribute by providing advice to the verification organisation for the draft test/QA plan, paying a participation fee, providing commercially ready units for the testing as well as operation and maintenance support and review of the verification report. Once the verification has been successfully completed, the vendor receives the completed report and statement and from there on, he can use the logo to advertise his product.

Funding

Costs for the verification per vendor range between $5,000 and $100,000 each, depending on the complexity of the test and the number of participants sharing the cost. The original goal when the pilot started was to have a complete private sector sponsorship within three years. This was revised later on and it was considered that, at least in the short term, 10 to 20 % of ongoing costs would have to be paid by EPA to keep the activity viable. By 2001, it was expected that vendors would pay the full cost of testing and possibly the partial cost of quality assurance oversight as well as report writing. However, still in 2003, EPA's contribution of $ 3 million was still nearly three times as large as the vendors' contribution. This issue is discussed in more detail in §2.1.4, §4.1 and §4.3

Selection criteria

During the pilot phase, five different criteria were used in order to prioritize technology categories and at the same time test the system itself.

- address important environmental needs
- present substantial business opportunities for the private sector
- involve multiple developers and vendors
- address the full range of environmental media
- test a variety of verification organisation types

The first three criteria were technology specific and were used as a screen for technologies. The last two criteria were used in a more horizontal manner.

With the completion of the pilot and the move into full implementation, priorities had to be established since it was impossible to address all technologies that vendors may want to have verified. The stakeholder groups assist ETV by representing the marketplace for a given group of environmental technologies in terms of need and feasibility. Three main criteria for selection are considered:

- a legitimate environmental need for the technology
- at least one commercial-ready technology available for testing
- testing protocols available or capable of being developed within a reasonable timeframe and funds available within the constraints of ETV funding

The verification process

Once the definition of priority technologies and pre-screening applications have been done, the development of a generic protocol and test plan follows and this is conducted by the ETV Centres, with the agreement of EPA. The protocols provide testing guidance for a particular technology category but not for a specific technology. However, they should be detailed enough to allow for a testing organisation to duplicate the test and obtain similar results. Experimental design, equipment capabilities, field test sites, laboratory test sites, quality assurance, data handling, health and safety are some of the issues that have to be tackled. Test plans provide detailed instructions for the verification testing of a single technology during a specific test event. These plans must be reviewed and approved by EPA, the vendor, the verification organisation and the stakeholder group in order to have the verification test conducted. Both protocols and plans are publicly available on the ETV web site.

The verification test can then take place under the responsibility of the verification organisation. The results along with the test data are publicly reported. The program does not compare vendors by name but innovative technologies may be compared to standard technologies if appropriate. The same verification organisation drafts the verification statements and reports, which are reviewed by EPA, the vendor, as well as peer reviewers. EPA and the verification organisation sign the report and statement and place them on the ETV web site. The last step for EPA is to revise the generic verification protocol for that particular technology category, so as to take on board lessons learned during the testing procedure.

Lessons learned during the pilot phase

Three major changes were recommended based on the pilot phase experience: simplification of the structure into six ETV Centres that focus on the most attractive market areas, emphasis on conducting more efficient verifications and, lastly, greater involvement and funding

support from participating vendors, states and communities which will benefit from the ETV verification. In total, by February 2007, more than 380 verifications were completed.

Statistics show that about 65 % of the vendors with verified technologies are small business and there are as many as 40 vendors which have had more than one product verified by ETV. Furthermore, care has been taken to check for vendor appreciation and the following has been found:

- 85 % said verification would not be as valuable if EPA was not associated with it
- 73 % were using ETV information in product marketing in 2001
- 73 % believe customers will be impressed by ETV verification
- 92 % would recommend ETV to others
- 37 % said verification takes too long.

The last one is a common negative comment and ETV is regularly seeking methods that will speed up the process, particularly in the data analysis and report development stage. An overview shows that the average for a totally completed verification is 16 months, where typically 3 months are needed for the test plan development, 1 month for the actual testing and 7 months for report writing and approval, but there is a great variation in these numbers. The evaluation of the system with user satisfaction surveys is discussed again in §2.9 and §5.3. Some timing data are given in §4.7.

International cooperation

In total, 48 technologies from international vendors have been verified by the ETV program, 18 from Canada, 7 from Japan and 20 from Europe[8]. Furthermore, ETV training programs have been delivered to Taiwan, Thailand, Malaysia, India and the Philippines. Interestingly, over 10 % of the web site visits are from outside USA. Cooperation between similar programs is desired, for instance between the US and the Canadian ETV but also with different state based programs within the US. Measures have been implemented in order to facilitate and pursue mutual recognition and reciprocity tools have been established between some programs. Nevertheless to date there is not a single US ETV-verified technology that has benefited from a reciprocity agreement.

2.1.4 System Funding

The ETV program has drawn the major part of its funds from EPA. However, after a program redesign the situation in year 2005 was the following: a part of the ETV centres would continue to be funded by EPA while the remainder were given the option of continuing operation, but would have to seek other sources of funding[9]. ETV would continue to provide quality assurance, technical support and signature of the verification statements to these centres.

The analysis of the financial scheme of the US ETV system is based on a number of internal reports[10] that were courteously provided by US ETV[11,12,13,14,15]. These reports cover years

[8] http://www.epa.gov/etv/vendors/map.html
[9] Overall EPA funding is bound to stop in 2007 (personal communication)
[10] These reports are not formally released by the US EPA. Permission by the US EPA ETV program is required before distributing these reports

2001 to 2005, but include information on previous years as well. They contain a wealth of information on financial contributions of the system funding parties, data on how the contributions were allocated and expended by the centres, average verification costs by technology, timing data etc. This chapter examines the various elements that constitute the verification costs and their relative weight[16]. The contribution of the vendor to these costs is also estimated.

Figure 2 : Expenditures and In Kind Contributions in the US ETV system

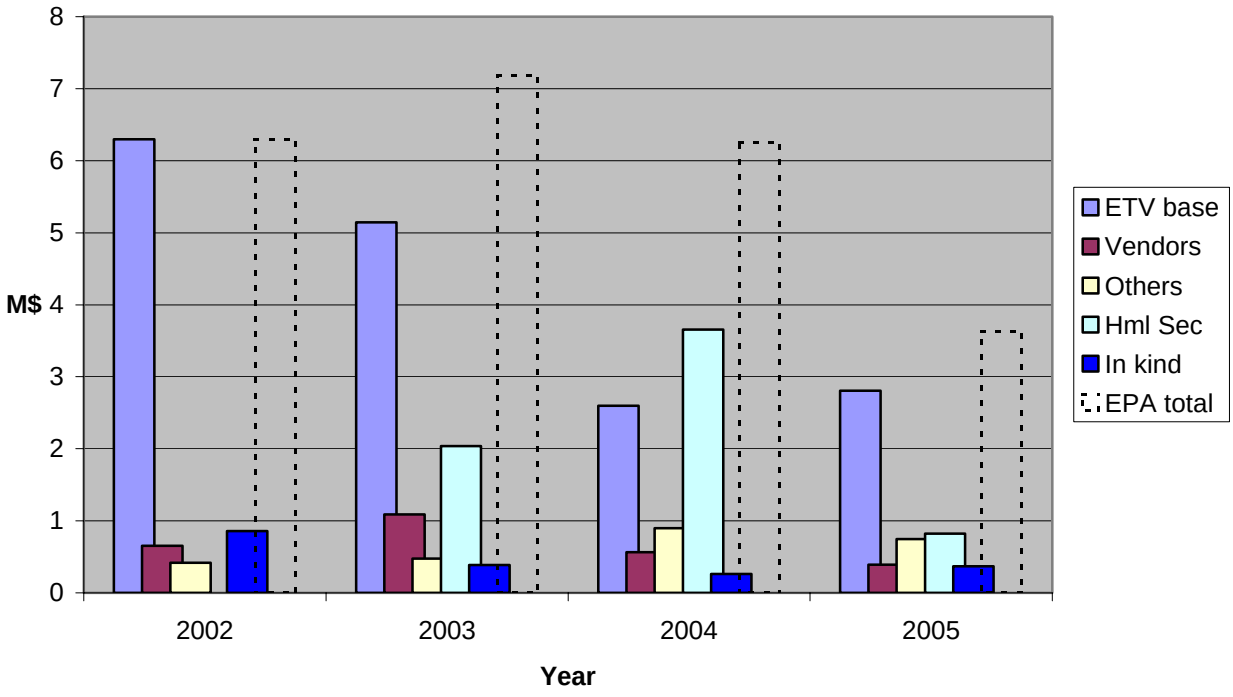


Figure 2[17] shows the expenditures of the system through years 2002 to 2005, related to the various contributing sources. It can be seen that EPA covers the major part of these expenses. EPA total corresponds to the sum of the so-called Base ETV funds and the Homeland security funds, which were calculated separately, given the specificity of the Homeland security program. Base ETV funds experienced a decline during the years 2002 to 2004 but this is less true for the sum of the EPA funds. In fact total funds provided by EPA have decreased only in

[11] Fiscal Year 2001, Annual Environmental Technology Verification (ETV) Program Review Report, Draft May 2002
[12] Fiscal Year 2002, Annual Environmental Technology Verification (ETV) Program Review Report, July 2003
[13] U.S. Environmental Protection Agency Environmental Technology Verification Program, Fiscal year 2003 Annual Report, December 17 2004, United States Environmental Protection Agency
[14] U.S. Environmental Protection Agency Environmental Technology Verification Program, Fiscal year 2004 Annual Report, June 17 2005, United States Environmental Protection Agency
[15] U.S. Environmental Protection Agency Environmental Technology Verification Program, Fiscal year 2005 Annual Report, May 16 2006, United States Environmental Protection Agency
[16] This chapter presents the total costs of the whole system instead of costs of individual verifications. The comparison of the costs of individual verification is of limited value, since they are strongly technology specific.
[17] Data provided by the US EPA's ETV have been used for dressing the following graphs. Absolute values are provided together with relative values. The dollar figures have not been quality assurance checked by US ETV, hence the accuracy of the numbers cannot be guaranteed.

year 2005, when the Homeland security funds were transferred out of the ETV system (Table 1). The figure shows, together with the expenditures, the in-kind contributions[18] of the vendors and other stakeholders. These correspond to non-reimbursed labour hours, testing facilities and analytical support, travel costs etc.

Figure 3 shows the relative expenses allocated to the various fund sources for the same years as Figure 2. Mixed EPA funds amount to an average of 75 % of total funds and this amount rises to 80 % if in kind contribution is not included in the calculation. In kind contribution[18] was broken down to the part corresponding to vendors and to the part corresponding to other stakeholders. Figure 3 shows that in-kind contributions represent a substantial part of non-EPA contributions. For vendors, in between 15 and 40 % of total vendor contribution for the years 2002 to 2005 was in the form of in kind contribution, which is an important percentage of a vendor's ETV budget.

Figure 3 : Expenditures and In Kind Contributions distribution in the US ETV system

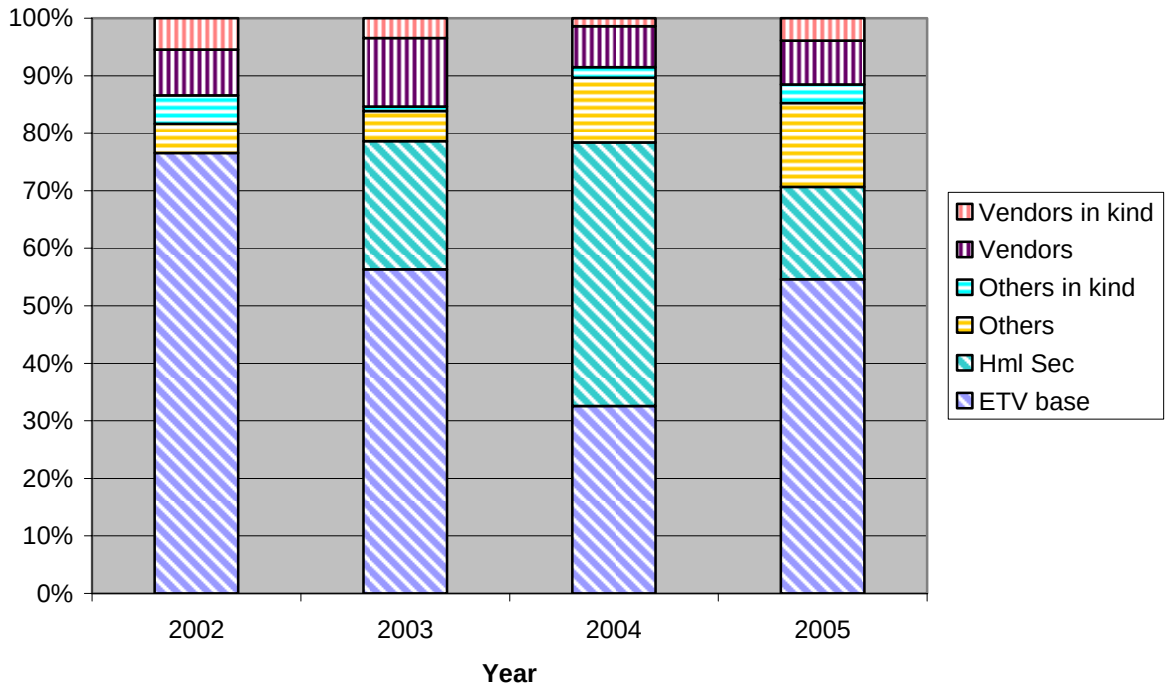
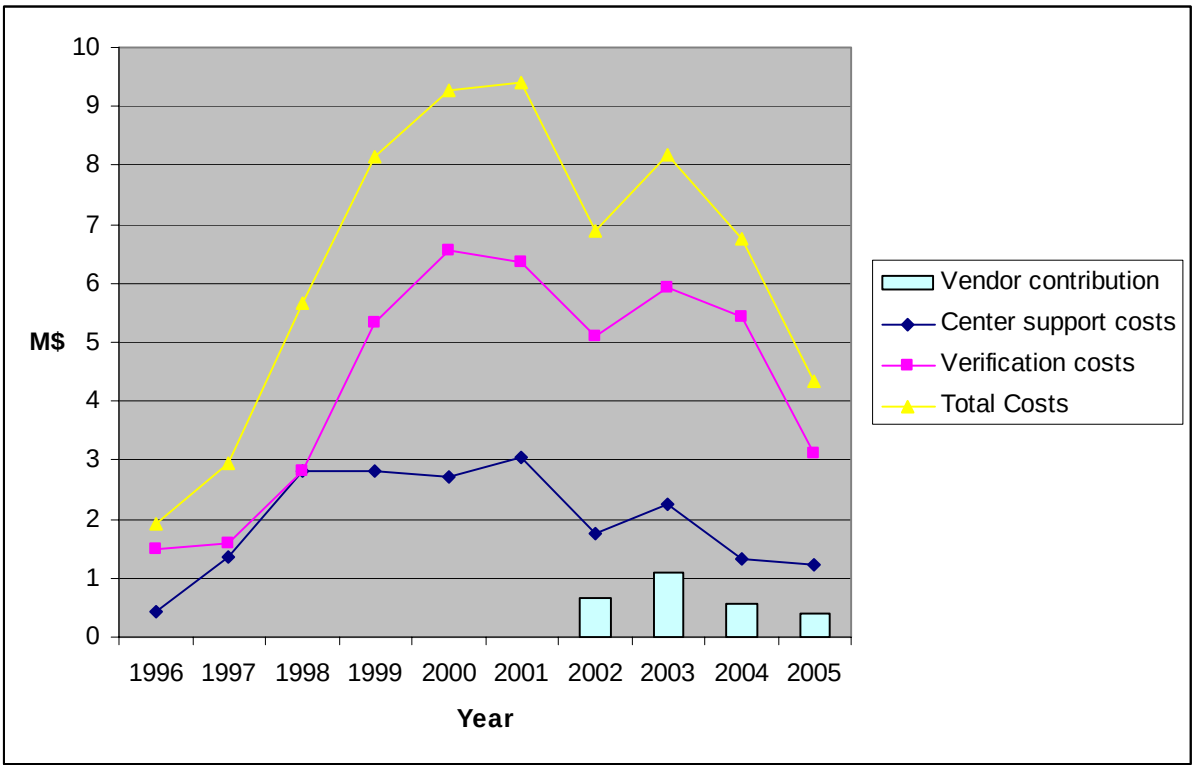


Figure 4 shows the total costs of the system from 1996 to 2005[19]. These costs correspond to the expenditures by year given in Figure 2 (for year 2002 – 2005), but here they are broken down to verification and centre support costs, instead of being related to their source (EPA, vendors etc.).

[18] The in-kind contributions represent costs for the vendors and stakeholders that provide them. They are presented together with expenditures to show the comparative importance of these contributions.

[19] These are the total centre specific costs, generated by the verification organisations. They do not include the program level costs on outcomes and evaluation that are not centre specific. The sum of total centre specific costs and the program level costs on outcomes and evaluation gives the total system costs, which are equal to the expenditures of Figure 2.

Figure 4 : Total Costs and Vendor Contribution in the US ETV system



The verification costs include the following cost elements: technology solicitation and selection, development of technology specific test and quality assurance plans, technology testing, quality assurance and evaluation and development of verification reports and statements.

The centre support costs include the following cost elements: stakeholder activities and meetings, development and maintenance of the quality management system, technology prioritization, evaluation and outreach, privatization (i.e. subcontracting) and other general and management costs. The costs attributed to stakeholders do not include any remuneration, since the stakeholders volunteer their time. In some cases technology prioritization costs are included in the stakeholder related costs. Evaluation and outreach costs include information diffusion costs.

Figure 4 shows a rise in costs can be observed at the beginning, when the system was being set up, followed by a more or less stable period from 1999 to 2004, followed by a fall in costs, linked to the diminution of the system's funds. The costs expended by vendors (excluding in kind contributions), have been taken from Figure 2 and are presented here for the years 2002 – 2005. These expenses, translated to costs, give an idea of the monetary contribution of the vendor to the verification. If they are compared with the verifications costs for this period, they vary between 10% and 18%. If they are compared with total costs, they vary between 8 and 13% only.

In the following analysis of the different costs the focus will be placed on years 1999 to 2004, during which the costs are relatively stable. The goal is to track the approximate distribution of costs related to the various activities of the system.

From Figure 5 it can be seen that for the years depicted, the verification costs are always higher from the centre support costs, the latter varying between 20 and 35 % of the total. These costs varied between approximately 25 and 50 % during the early pilot phase (not shown in the figure), but have stabilised later on. It is obvious that a substantial amount of funds are dedicated to activities that are in a way "accessory" to actual technology verification, but are necessary for the good functioning of the system.

Figure 5 : Cost distribution in the US ETV system

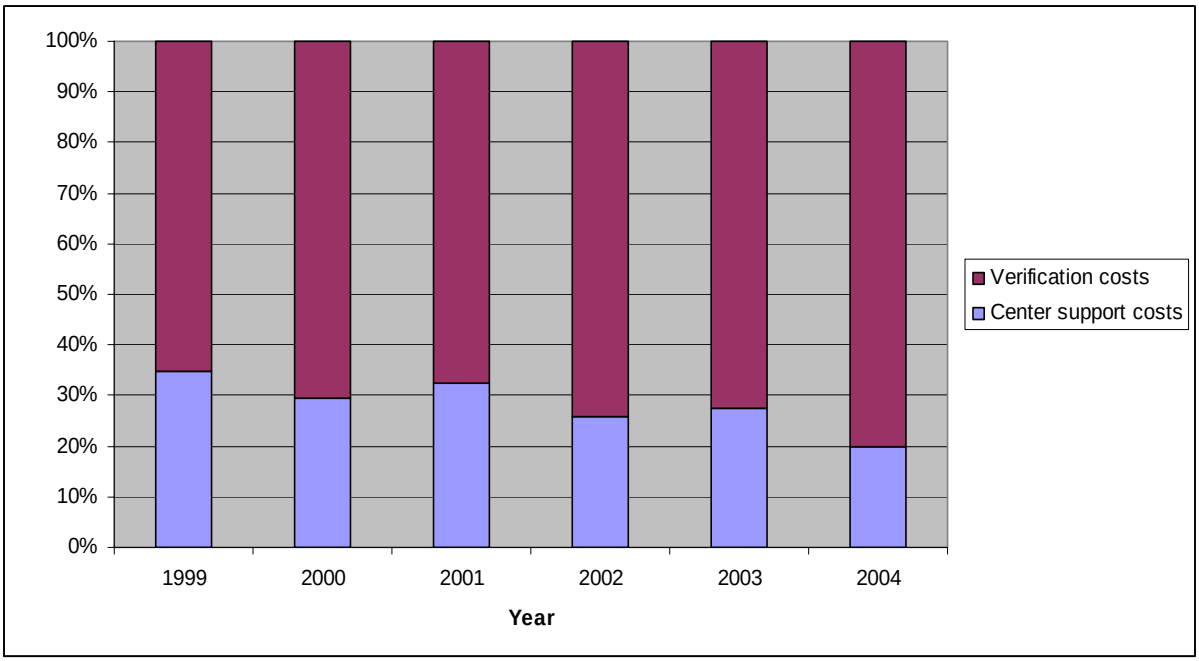


Figure 6 and Figure 7 show the distribution of the centre support costs in the US ETV system. Figure 6 gives an idea of the variation of these costs through the years. These are, of course, relative costs, since the absolute centre support costs were given in Figure 4. However, the percentiles given here can give a good idea, even approximate, of the cost distribution that one could expect in implementing an ETV system similar to the one described here. Additionally, it is normal that the costs vary from one year to another, inside a single verification procedure that lasts more than one year. For example, stakeholder consultation and protocol development costs are bound to occur at the beginning, testing costs in the middle and verification report costs at the end. These differences are levelled out by averaging the costs incurred by the whole system (all the verifications) throughout the years. In average, through the six years, 33% of the costs are dedicated to information diffusion. 28% of the costs are dedicated to stakeholder related expenses. General and management costs amount to 21%, the remaining 18% being shared between prioritization, quality management and privatization (Figure 7).

Figure 6 : Distribution of the Center Support costs in the US ETV system

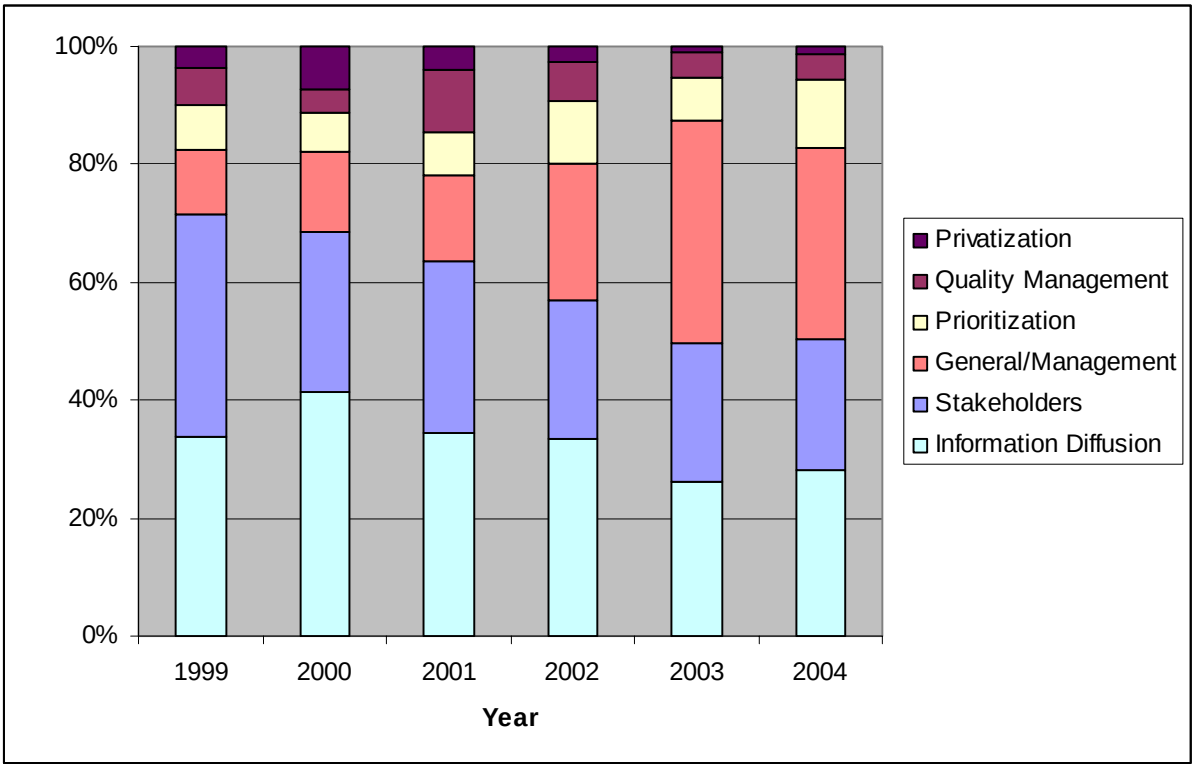
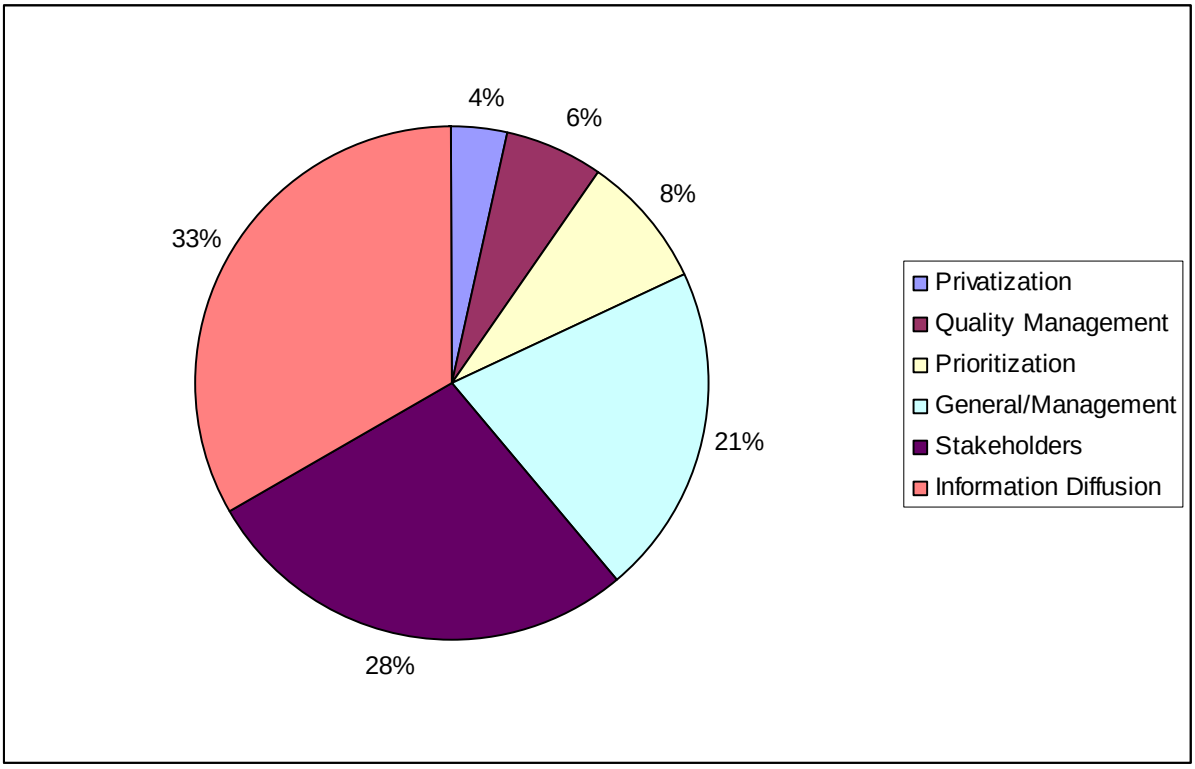
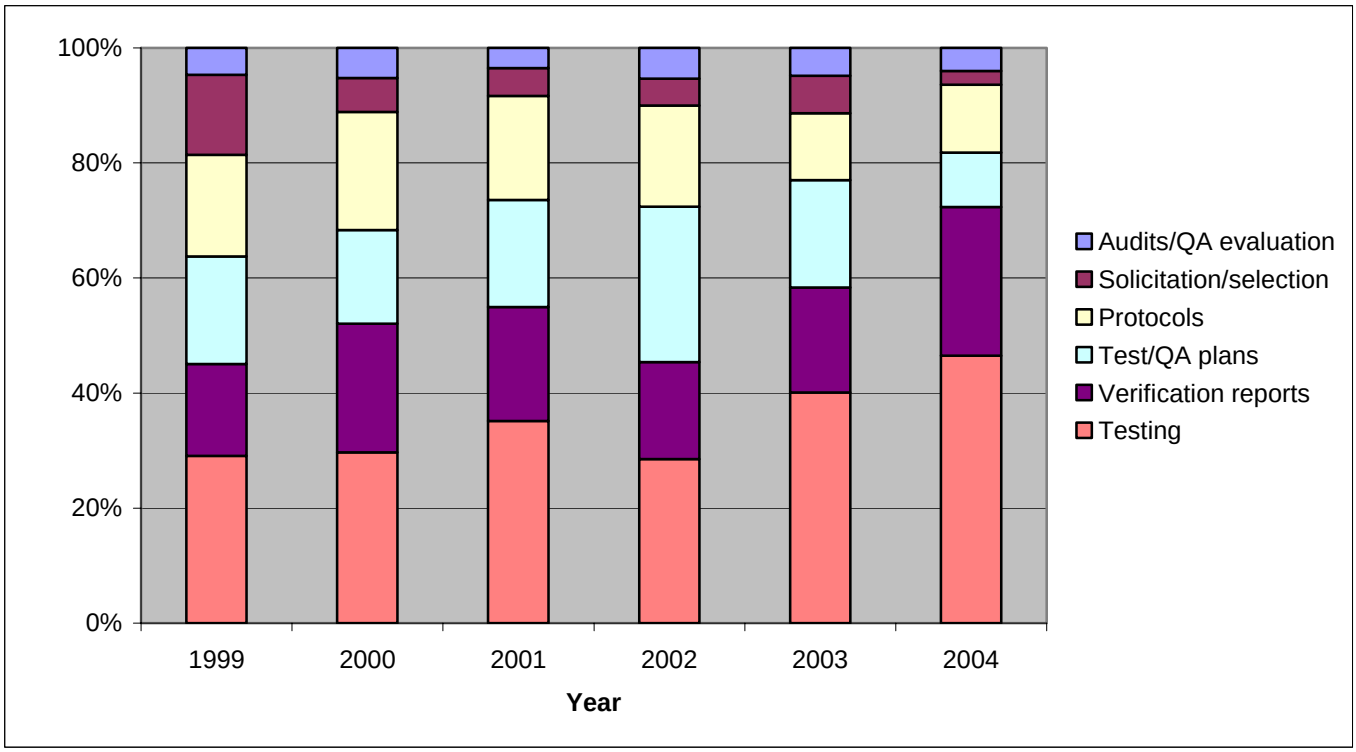


Figure 7 : Average distribution of Centre support costs in the US ETV system



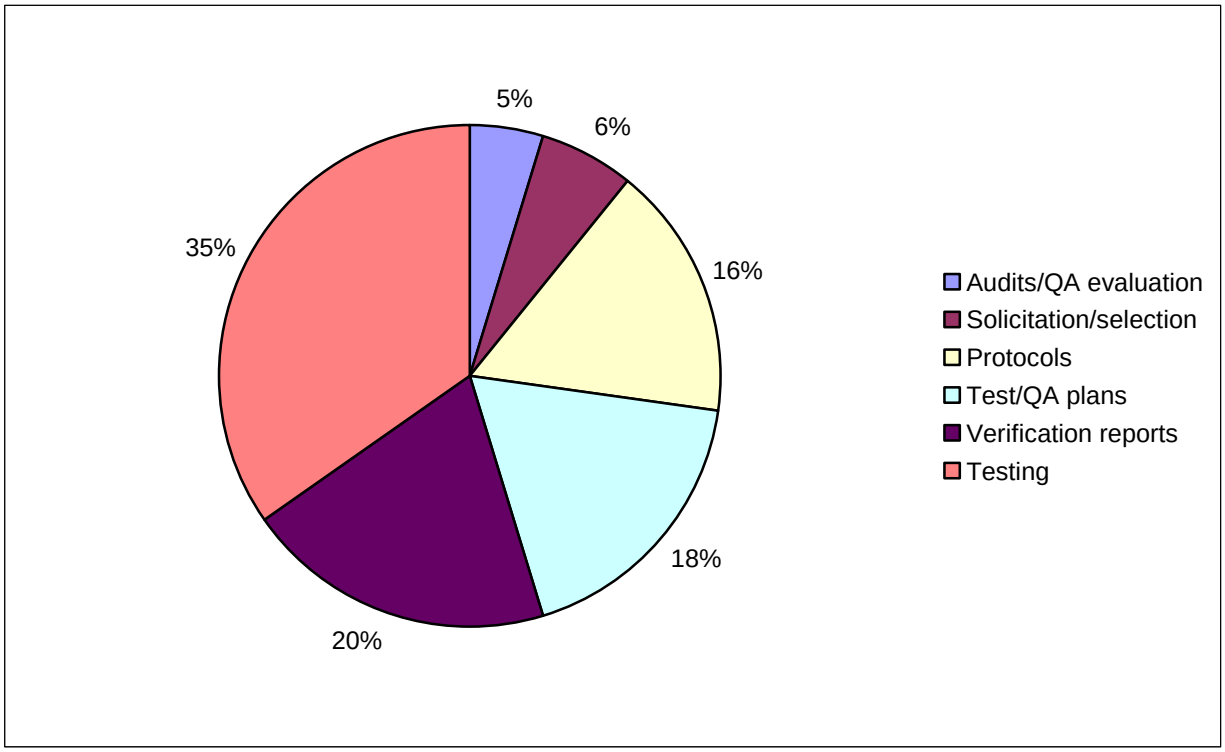
The same exercise is repeated in Figure 8 and Figure 9 for the verification costs. In Figure 4, the vendor contribution was compared with total verification costs and it was found that it varied between 10% and 18 % for years 2002 to 2005. This contribution is not sufficient even for covering the testing costs as can be seen for the whole range of years shown on Figure 8[20]. Figure 9 shows that testing is always the most expense intensive element (35%), followed by the development of verification reports (20%), test plans (18%) and protocols (16%). Technology solicitation and selection, and audit costs occupy the two last positions with 6% and 5% of total verification costs respectively. As it could be intuitively expected, technology testing needs the biggest amount of funds. The development of verification reports follows in the distribution of the costs, and this is a consequence of the design of the system, where very detailed verification reports are edited and published, containing a lot of useful information available for technology users.

Figure 8 : Distribution of the Verification costs in the US ETV system



[20] The comparison of the vendor contribution to the costs of the tests is justified. During the Market Survey of this report (§5) the interviewed vendors conceded that their contribution should be of the order of the costs of the tests and should not cover other costs like e.g. protocol development etc.

Figure 9 : Average distribution of Verification costs in the US ETV system



2.1.5 ETV Environmental and sustainable Technology Evaluations (ESTE)

This program element[5], that begun operating in 2005, is designed to respond more adequately to some prioritization requirements. Under this scheme the technology categories are chosen directly by the EPA Office of Research and Development (ORD). It is mentioned that "sustainability evaluation factors" may be incorporated into the verification process. This is an important element, seeing that if the performance of environmental technologies is typically evaluated under ETV this is less true for the environmental performance of a technology. This aspect could include the evaluation of cross media effects and life cycle assessment.

2.2 The ETV Canada verification system

2.2.1 Brief description

Environment Canada launched the ETV program in 1997, through an agreement with OCETA (Ontario Centre for Environmental Technology Advancement[21]), an independent entity that manages the ETV program. The objectives of ETV Canada are similar to the US ETV ones (see §2.1.1) giving though special importance to the growth and marketability of the Canadian environmental industry by emphasising its capabilities and credibility in the environmental market, helping companies access foreign markets and thereby increase their competitiveness. The approach is to provide the market with the assurance that a vendor's claim of

[21] http://www.oceta.on.ca/

performance for an environmental technology is valid, credible and supported by quality independent test data and information.

ETV Canada has developed two technology evaluation procedures, Verification and Benchmarking (§2.2.3). Under the Verification scheme, the applicants have to submit technology performance claims, supported by previously established data. These claims must be specific, unambiguous, measurable and verifiable and moreover meet minimum standards. Supporting data are collected by an independent third party and analysed by an accredited laboratory. ETV Canada will scrutinize the submitted data and pronounce itself on the validity of the accompanying claims. A verified claim is only valid if the technology is operated within the operating conditions stated in the claim. Under its Verification scheme, ETV Canada does not perform tests nor develops new protocols, unlike the US ETV system. Other ETV systems (New Jersey, China and Bangladesh) follow ETV Canada system's way of functioning[22].

2.2.2 System structure

The ETV program was developed by Environment Canada in the lead role together with Industry Canada and with input from the environmental industry sector. It is managed privately by ETV Canada (owned by OCETA) under a 10-year licence agreement with Environment Canada. Apart from the vendors, accredited laboratories and the verification entities play an important role in the scheme.

Environment Canada

Environment Canada is responsible for program policy and general direction. It provides quality oversight and performance review and is also responsible for negotiating bilateral agreements with other countries and agencies seeking program reciprocity.

ETV Canada

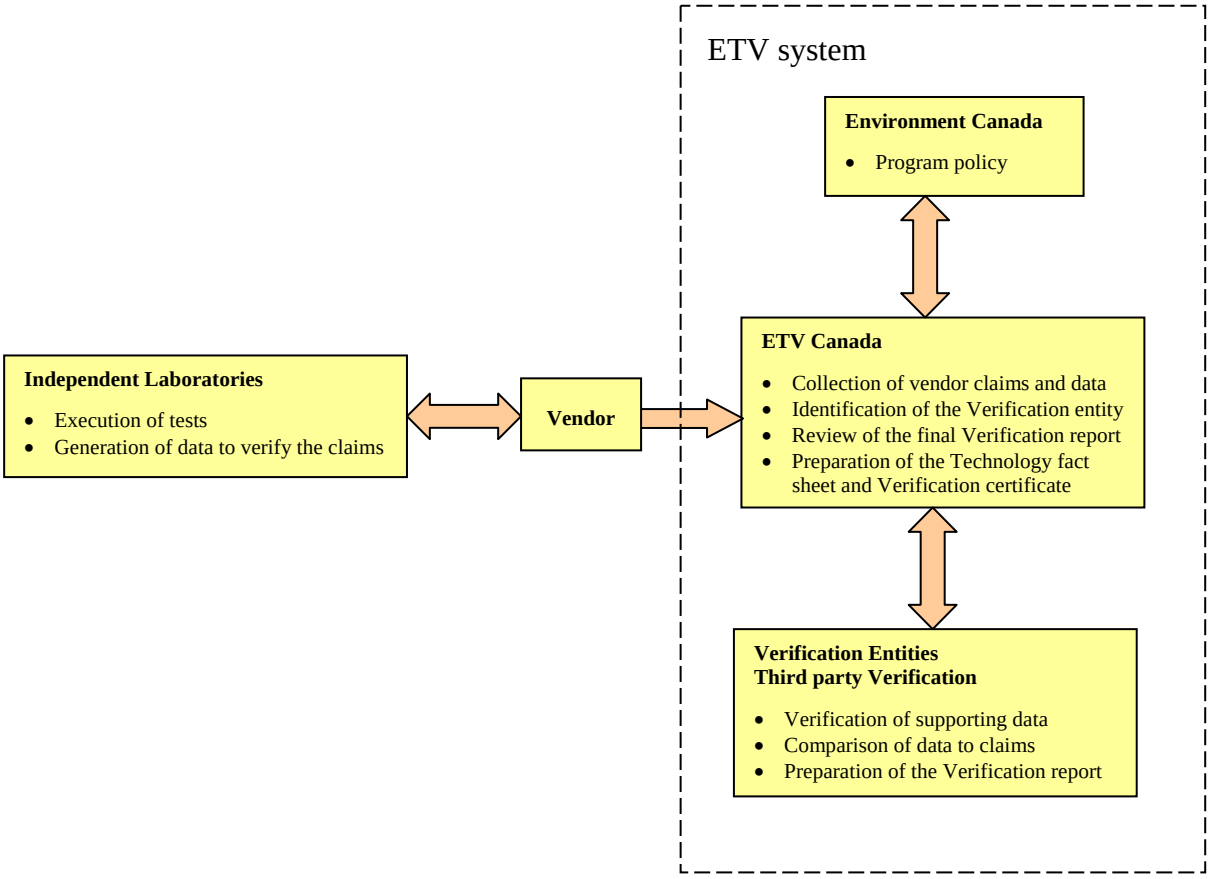
The tasks of ETV Canada are to collect vendors' claims as well as data from independent laboratories, review the applications, identify the verification entities, transmit information to these entities and prepare a final verification report, a technology fact sheet and a verification certificate. Furthermore, ETV Canada proposes an optional service to vendors, the provision of a technology market review and technical assessment, under the Environmental Technology Development Assessment Program (ETDAP)[23]. This program provides assistance and detailed advice on the required technical performance data needed to support quantifiable technology performance claims.

Laboratories

Independent laboratories, accredited by a recognized certification agency, analyse technologies and generate data that can verify the performance claims made by the vendor. The laboratories are directly selected by the vendor.

[22] http://www.etvcanada.com/
[23] http://www.etvcanada.com/ETDAP.asp

Figure 10 : Simplified view of the ETV Canada system



Verification Entities

These entities are private or public organisations in charge of conducting the third party verification and of comparing data to claims. In order to verify supporting data, they examine test relevance, test quality and test adequacy of data, together with test operating conditions.

Technology developers and vendors

Upon entering the program, the vendor company must submit a pre-screening application. Any kind of environmental technology is allowed to undergo the verification process but there are certain prerequisites, which are described later under “selection criteria” and which are checked in the pre-screening phase. If the technology and performance claim are eligible to apply, the applicant submits a formal application and a non-refundable CAD 1,000 application fee. The formal application should contain additional information about the technology, the claim to be verified and the data and information that is available to support the claim. If the application is not considered complete, the applicant may choose to modify and resubmit it.

Funding

The program is in principle fully funded by vendors. However, OCETA, has committed substantial internal financial resources to support the development of ETV as a means of assisting new environmental technologies to achieve commercialisation. The program is

focused on emerging new technologies and these are primarily generated by young or start-up companies with limited financial resources. Such clients pose high financial risks and have had difficulties in financing ETV participation. Nevertheless, the program often benefits from subsidies of Environment Canada, sometimes targeted at specific technologies. In 2003, the government granted CAD 5,000 per verification, irrespective of the technology.

Selection Criteria

To be eligible for the ETV program, a technology must meet the following prerequisites:

- offer an environmental benefit or address an environmental problem.
- be an equipment-based environmental service that can make claims based solely on measurable performance of the equipment.
- meet minimum Canadian standards
- be currently commercially available or ready for full-scale application.

The verification process

When the formal application is submitted, ETV Canada reviews the information and proposes a verification process for the claim, including the identification of a Verification Entity and a cost estimate. The cost will include the administration and management of the application process by ETV Canada as well as the actual validation by the Verification Entity. The cost will vary from application to application and will depend on the effort involved in the verification process. The Verification Entity analyses the data and decides if the claim is adequately substantiated or if additional testing is required, which in that case is conducted by an approved testing agency and paid by the applicant. A report is prepared with the results and submitted to ETV Canada for review, and finally the applicant is provided with a copy. Upon successful verification, the vendor is entitled to a presentation of a verification certificate (for use in marketing), a technology fact sheet which defines the performance claims, a detailed verification report and the use of the ETV logo. The verification is valid for three years after which a license renewal fee will apply should the vendor wish to continue the program.

International dimension

Memorandums of Understanding have been signed between Environment Canada and South Korea, the state of New Jersey and California[24] (the California program is no longer running). Moreover, ETV Canada recently completed the first phase of a Canadian International Development funded project to assist China to develop an ETV program, and a program for verifying environmental technologies for arsenic mitigation has been developed in Bangladesh. The Bangladesh initiative belongs to the ETV Canada Benchmarking scheme, described in the following paragraph.

2.2.3 The ETV Canada Benchmarking scheme

The Benchmarking scheme, distinct from the Verification scheme, is proposed to applicants as a different option. The Benchmarking scheme is *sector specific*. The basic difference with

[24] http://www.arb.ca.gov/eqpr/eqpr.htm

the ETV Canada Verification scheme is the presence of stakeholder involvement resulting to the development of protocols and test methods.

Three projects were initially developed under the benchmarking scheme: the Manure Management Technology Performance Verification Program, the Mercury Amalgam Separation Technology Protocol Development, and the Bangladesh Arsenic Mitigation Program (see §2.6).

Benchmarking is now (since 2006) broadening its scope and the seven following sectors are currently included:

Vehicle Fleet Technologies
Remediation of Contaminated Sites
Water and Wastewater
Energy
Green Infrastructure
Green Procurement
Public Security and Emergency Preparedness

2.3 New Jersey Corporation for Advanced Technology, Verification Program

Introduction

The objectives of this program[25] are to identify innovative technologies which require assistance with regulatory mechanisms and requirements, foster their development and commercialisation, abate or prevent environmental pollution and promote energy conservation in a cost-effective manner. Moreover, encourage new businesses to locate in the State of New Jersey and assist existing enterprises to remain and expand. The approach relies on public-private partnerships and third party objective testing.

Structure of the program

The structure between the different parties involved is similar to that in the Canadian program. In addition, there exists a link to a regulatory body. Therefore, the claims and data are compared to the regulatory performance requirements. If the verification is successful, the technology is awarded a “certificate” valid in New Jersey.

The New Jersey Corporation for Advanced Technology (NJCAT)

NJCAT is the third party verification entity and has a partnership agreement with the New Jersey Department of Environmental Protection (NJDEP) to verify environmental technologies according to an agreed procedure. Its main activities are to identify technology candidates, assist developers of new technologies with the regulatory, commercial, financial and technological support required to bring their product to market, provide third party independent verification of performance claims, assist participants in identifying alternative

[25] http://www.njcat.org/

funding sources, assist in patenting, licensing, sponsor forums and seminars. An advisory team within NJCAT assesses the completeness of the application and a technical expert is selected to perform the actual verification and prepare the report. The expert, together with the technical director, develops an evaluation protocol for each claim. A board of directors finally approves the verification report, and develops and distributes a corresponding fact sheet.

New Jersey Department of Environmental Protection (NJDEP)

The NJDEP prioritises the technologies to be evaluated. After passing this initial screening, the regulatory and technical framework through which the technology will be verified is established. Later on, upon receiving the verification report, the NJDEP shall review the report, ensure once more that the technology provides a net environmental benefit and finally certify that the technology is innovative.

Vendor

The vendor has to send a preliminary application along with the required application fee to NJCAT for evaluation. This application contains target performance claims, which must be specific, measurable and verifiable. NJCAT will discuss with the vendor to ascertain the potential for successful verification. If verification is not recommended, the applicant will get advice for further development of the technology. If a claim during the verification process cannot be verified by available data, the applicant has the option to modify the claim, to generate additional data or to withdraw from the program.

Funding

The program is essentially funded by the vendors. The application fee is $1,000 and upon acceptance to the program, various fees ($20,000 -$100,000), depending on corporate revenue, apply[26]. The average fee is about $20,000.

Selection criteria

All kinds of environmental technologies are eligible, even though some criteria must be met. The technology must provide an environmental benefit and/or resolve an environmental problem without creating a new or alternative environmental problem, and the regulatory framework of the NJDEP must be able to permit the use of the technology.

The verification process

Once an application has been submitted, NJCAT reviews it to assess its completeness and this is done within a period of 30 days. The selected technical expert, together with the technical director of NJCAT decide on an evaluation protocol for each claim. The claim development process is designed to be an interactive process, creating a dialogue between the applicant and NJCAT. Peer reviewers are drawn from NJCAT member organisations, depending on the technology to be assessed. Once the claim has been verified, the NJCAT team further evaluates the relevance and the quality of the data. When having passed this step, the technical expert prepares the verification report, which then goes to a board of directors for

[26] http://www.njcat.org/verification/index.cfm

final approval. The same board issues a report and develops and distributes a fact sheet. It is finally the NJDEP which issues the "certification".

Reciprocal agreements

The NJDEP is in charge of establishing reciprocal agreements with other federal, state or local agencies. New Jersey has signed Technology Acceptance Reciprocity partnership agreements with a number of other states. Moreover, a memorandum of understanding has been signed between Canada and the State of New Jersey. To this date though, no technologies have benefited from this.

2.4 South Korea Environmental Technology Verification Program

Introduction

The objective of the South Korean program is to identify and assess environmental technologies developed or improved in South Korea in order to promote their diffusion and nurture industries in the environment area. This system is the only one that offers two levels of evaluation:

- Certificate of Designation of new environmental technologies, awarded on the basis of document review and field review.
- Certificate of Verification of new environmental technologies awarded on the basis of document review and field verification.

The first is delivered when a developer has sufficient data to prove the performance of his technology, and the second is awarded when such data are not available and on-site testing/field verification is performed by an official assessment organisation.

The South Korea Ministry of Environment (MoE) began operating this system at the request of technology developers. The technologies that demonstrate outstanding functions are designated as “New Technology”, which provides various incentives such as extra points to users at public project biddings. Apart from this program, the MoE has taken other measures to support environmental technologies. It has created an Environmental Venture Fund and has actively identified and supported promising venture companies. It has instituted a Venture Nurture Centre at the National Institute of Environmental Research to assist venture activities for those at the frontier of environmental technology development[27,28].

Ministry of Environment

The role of the ministry is to accept applications, advertise in official journals for the collection and coordination of opinions of stakeholders and finally to issue the certificate of designation of the certificate of verification.

[27] http://www.env.go.jp/policy/etv/pdf/ab/01/ko_e.pdf
[28] http://www.koetv.or.kr/eng/index.html

Environmental Management Corporation (EMC)

This is the control body of the ETV program. It is a non-profit public organisation under the Ministry of Environment. It deals with issues like: reviewing and supporting applications, building and operating an environmental technology assessment deliberative committee, issuing of the verification report, designing of official field assessment organisations.

Environmental technology assessment deliberative committee

The committee disposes of a pool of experts with approximately 600 members from various areas. It is in charge of the review of applications, review of assessment criteria, review of designation of field assessment institutes and the coordination of the stakeholder consultations.

Field assessment institutes

These institutes are responsible for conducting the field assessments for verification. They establish agreements with the applicant, carry out the field assessment according to the assessment criteria and develop a verification report.

Funding

There is a registration fee of 2 million Won (~ 1100 €) for both designation and verification. This is paid by the applicant to the EMC. For the Certificate of Designation, there is obviously no cost of field tests but for the Certificate of Verification there is, and this is paid by the applicant to the field assessment organisation. Loans can be offered for this purpose. There is a special budget allocated to support SMEs for the costs for field assessments and since 2003, the government reimburses 50% of the verification cost for SMEs. The program aims to promote new technologies through incentives. Verified technologies receive points which function as incentives at public procurement bids.

Selection Criteria

The environmental technology should be developed in South Korea for the fist time, or imported from a foreign country and then further improved. It should be recognized as higher state of the art, advancement and validity than other existing technologies. The system has developed verification protocols for the following sectors: Incineration, sewage treatment, waste gas and waste water treatment.

The verification process

The process consists of a notification in an official journal, document review, field survey, field assessment and the announcement of results of the review. The steps naturally vary depending on if the assessment concerns the designation of a new environmental technology or a verification of an environmental technology. The former is scheduled for 90 days and the latter for 120 days. The results are public and the certificate has a validity of three years.

International dimension

South Korea has signed a memorandum of understanding with Canada, on which its ETV model is partly based on. However, according to ETV Canada, no technology in Canada or in South Korea has benefited from this reciprocity.

2.5 Japan Environmental Technology Verification Program

Introduction

The ongoing Japanese pilot project[29] strives to accelerate the dissemination of environmental technologies developed by venture companies and to contribute to the activation of economic activity through environmental protection and the advancement of regional environmental industries.

Structure of the program

The pilot project is carried out by the Ministry of Environment, in cooperation with the Verification Organisations, which are independent organisations that conduct technology verification under the entrustment and contract of the ministry.

The Verification Organisations are environmental entities of local administrations appointed upon a bid process by the MoE and the tests are conducted by research institutes related to the Verification Organisations[30]. Their responsibilities include the general administration of the project, the establishment of Technology Panels, the approval of test sites (can be both a site where the apparatus are already in place or it can be a site where it has to be installed for the purpose of verification) and the audit of the procedure for the verification test. The verification report prepared by the Verification Organisation does not provide any judgment of the technology apart that it has to comply with existing environmental standards. The technology developers must provide a detailed application form, propose a test site, cooperate with the verification organisation on issues like the establishment of the test plan and the preparation of the verification report and they bear the cost and responsibility for transportation, installation and removal, operation and maintenance of the apparatus needed as well as for any material supplies and utilities that might be required.

Funding

At the beginning of the project, the funding was entirely covered by the Ministry of Environment. On year 2003, a fee based system began operation, in parallel with the government sponsored system. The rule followed is that all verifications should begin within the government sponsored system and will pass to the fee based system after two years of operation. The fee based system has an additional organisation added to its structure, called "Verification Management Organisation". This organisation acts as an intermediate between the Ministry of Environment and the Verification Organisations. The Verification Organisations, who are selected by the Ministry of Environment for the government sponsored system, are selected by the Verification Management Organisation in the fee based

[29] http://www.env.go.jp/policy/etv/en/index.html
[30] http://www.env.go.jp/policy/etv/en/01_b.html

system. The Verification Management Organisation is also responsible for collecting the fees from the applicants, the amount of which is established by the Verification Organisation[31].

Selection Criteria

The targeted fields are related to environmental management technology. The selected fields are those where the private sector is the primary developer and technologies are thought to be difficult to assess by users themselves. The verification organisation further selects the technologies to be studied, based on the advice from the Technology Panel and with the approval from the MoE. The technology has to respect the following criteria:

- Belong to a targeted field
- Be in a commercial stage
- Fall within budgetary and organisational possibilities
- Have the principle and mechanism of the technology scientifically explained
- Provide a high environmental positive effect and not cause any side effects
- Be innovative

Technology Categories

The following are the current target categories of the system:

Ethylene oxide waste gas treatment
Organic wastewater treatment for small scale establishments
Treatment of human waste in mountain district
Simplified monitoring
Heat-island effect mitigation (for suppressing heat generated by air conditioning systems)
VOC treatment
Non metallic elements wastewater treatment
Water purification for lakes and reservoirs

2.6 Bangladesh Environmental Technology Verification Program

Canada and Bangladesh governments established a bilateral development assistance project in 2000, the Environmental Technology Verification – Arsenic Mitigation (ETV-AM) Project, followed by a memorandum of understanding known as the Bangladesh Environmental Technology Verification – Support to Arsenic Mitigation (BETV-SAM) Project in 2006[32]. Both concern the verification of technologies for arsenic mitigation for households and small community applications and the capacity building in the Bangladesh scientific and technical institutions, so as to successfully operate the verification program. The need for this type of technologies is strong since the main source of potable water comes from groundwater sources that underlie the whole country. The geology of the aquifer is derived from the Himalayas and contains amounts of naturally occurring arsenic iron complexes.

[31] http://www.env.go.jp/policy/etv/en/pdf/01_intro_a.pdf
[32] http://www.betv-sam.org/index.asp

OCETA[33] and the Canadian International Development Agency (CIDA), the Bangladesh Council of Scientific and Industrial Research and the Department of Public Health and Engineering are partners to the project. The performance verification and the local capacity building program will continue until March 2009.

A big difference with other verification programs is that during the ETV-AM Project, performance verification of arsenic removal technologies prior to its sale in Bangladesh was made a legal requirement. The verification process constitutes of technology screening (based upon a series of technical, social and fiscal parameters specific to Bangladesh, through which a limited number of technologies will emerge. However, it is possible for a proponent to omit the screening stage and proceed directly to the technology assessment and the field verification stages of the process. But then, then applicant has to bear all costs associated with the assessment and field verification himself. The verification process consists of technology screening, laboratory performance evaluation and review, field testing and verification and issuance of a verification report and of a technology fact sheet.

It is important to note that in the ETV Canada terminology, the Bangladesh Arsenic mitigation project is included in the "benchmarking" projects, distinct from the verification projects (see §2.2.3).

2.7 Differences of ETV systems

Outstanding aspects of the US ETV and ETV Canada systems, including the rationale of distinct operational choices are compared in this chapter (§2.7.1).

The US ETV and ETV Canada systems served as models to a range of other ETV systems, which have subsequently developed in different ways. Some basic differentiating points already mentioned before are summarized in §2.7.2.

2.7.1 Comparison of the most important aspects of the US ETV and the ETV Canada Verification systems[34]

In the US ETV system a clear sectorial division is operated through the specialized verification centres. The Verification scheme of ETV Canada is *technology specific* (in comparison to *sector specific*). Meaning that, all technologies (or services) which can demonstrate their environmental relevance can apply for verification.

None of the systems compares or rank technologies. However, the US ETV system is designed to encourage comparison, since technologies of the same type are tested under the same conditions, if possible during the same test event, and resulting data are publicly available. Comparison necessitates though some basic and/or specialized engineering knowledge.

[33] http://www.oceta.on.ca/arsenic.htm

[34] The analysis of this section is based on the comparison of US ETV and the Verification scheme of ETV Canada only (and not the benchmarking scheme)

Testing and data

The most important difference between the two systems is the fact that in the US ETV system, the verification takes place "inside" the system (see also Figure 1 and Figure 10). The verification organisations decide, with stakeholder and producer feedback, the type of tests that will be needed and the operational conditions that will be applied. In the Verification scheme of ETV Canada, the system verifies pre-existing data only, even if the ETV Canada experts can propose the execution of additional tests or the application of quality assurance methods that would enhance the data quality and lead to a successful verification. Then the applicant has the choice of either performing the additional tests or modifying its claim. In this case, the verification system can give advice but does not define the type of tests to be executed. The developer/producer decides, using advice from the ETV Canada experts, on the content of the claims that he will submit to ETV. The system does verify that the tests were done according to sound scientific and engineering practice.

In the US ETV system, all verification related data like test plans, test protocols and verification results are publicly accessible. US ETV is somehow "entitled" to publish because verification data and results were created by ETV. ETV Canada on the contrary does not publish the data which were established and provided by the producer/applicant.

In cases where a technology developer has already a set of data coming from an independent testing laboratory, this data cannot be used by the US ETV system since the ETV procedure imposes that the performance data be generated by a specific verification organisation[35]. This data can be used in the ETV Canada system.

Verification "meaning" and "pass or fail"

The same word, “verification”, is used for different outcomes in the US ETV and in the ETV Canada systems.

The US ETV-type verification would mean: the technology has been tested, possibly together with other similar technologies, and under the same conditions. The achieved performance data are available for the consultation of interested parties, along with the test protocols and test plans that were used so as to obtain this data. There is no guarantee that the technology will perform to the same level under the same, or different, conditions of use.

The ETV Canada verification would mean: technology data submitted by the producer have been examined by the system and have been found sound. Accordingly the claims provided by the vendor are supported by those data. The data have been produced by an independent laboratory, accredited by a recognized certification body. Again, there is no guarantee that the technology will perform to the same level at the same or different conditions.

A "pass or fail" system would compare the performance of the verified technologies against some predefined minimum performance requirements. According to the preceding definitions:

- US ETV is not a pass or fail system: all technologies verified obtain the logo, if the producer, testing laboratories and verification organisations fulfil the quality assurance requirements and accept the different obligations defined by the system.

[35] In fact, US ETV has foreseen a procedure for using previously established data. But this has been done only once since the beginning of the system and seems quite difficult to put in practice (personal communication).

- ETV Canada is not a pass or fail system, at least not in the strict acceptance of this term. This is because the performance level that the ETV is verifying is not defined by some external body or even by the ETV itself but is proposed by the vendor himself. Moreover a modification of the vendor's claims is possible if ETV thinks that the supportive evidence provided is not adequate or if additional testing is required. It is however necessary that the product's characteristics are in line with any Canadian standards or guidelines. A technology may be rejected if the Verification Entity considers the supporting data is not acceptable (not relevant, or quality of data not sufficient).

As a consequence, even a "low performing" technology can enter the verification system and can be awarded the ETV logo, in both cases. A buyer has to apply specialized engineering judgment in order to rank the technologies or compare them to any minimum performance requirements.

Verification duration and applicant fee

The durations and the costs that correspond to each system reflect directly the system's structure. In the Verification scheme of ETV Canada there are no tests performed and therefore the whole procedure is faster. The fee that the producer has to pay is also lower. However, the fee attributed to US ETV only accounts for a small part of the verification costs since it does not include the important governmental contribution (that varies from case to case). This situation was modified in 2005 when some of the VOs were asked to rely exclusively on their own funding sources.

The fee attributed to the ETV Canada does not include any testing. The producer has already paid for the tests (or is going to pay for additional tests) that are not included in the verification procedure.

General Evaluation/Conclusions

The US ETV system creates new knowledge and brings new performance information to the market. The procedure of stakeholder involvement, during which the producer provides advice among other stakeholders and the ETV system experts, is time consuming. But it undoubtedly enhances the credibility of the system. The system necessitates funds to carry out the verifications tests. Until now these funds were mostly provided by governmental contribution, leaving a small part to the producer's charge. Finally the system is transparent, all data and reports are publicly available. US ETV has the advantage of being the most objective when comparing between technologies: they have been tested by the ETV system under the same conditions. The performance that they have achieved is available for the consultation of interested parties. There is of course no guarantee of performance of the technology. The ETV system only declares that the technologies have been tested under specific conditions and a number of their characteristics have been measured. It can be imagined that a very low performing technology enters the verification system and is awarded the ETV logo. A buyer has to apply specialized engineering judgment in order to rank the technologies.

The Verification scheme of ETV Canada, on the other hand, does not perform technology testing but is using previously established data, accompanied by a number of claims that they

should corroborate. ETV ascertains that the data have been examined and have been found sound. Accordingly, the claims provided by the vendor are supported by those data. There is no actual testing of the technology performed inside the ETV system; this has been done ex-ante by an independent laboratory, accredited by a recognized certification body. The system is thus faster since the data are already established and the stakeholder input is replaced by the interaction between the developer/producer and the ETV system. The system is less costly, since the producer has already financed the verification tests. Another advantage is the economy of effort that it promotes. Data that are available can be used and the tests do not have to be repeated, provided these tests have been performed in a way considered acceptable by the ETV system. One possible disadvantage is that ETV does not audit the execution of the tests but relies, at least to some extent to the credibility of the data providers. The claims provided by the vendor should meet minimum standards and guidelines in force in Canada. The claims are published but the test protocols and the data supplied by the applicant are not. This system is more vendor-driven since the verification is adapted to the vendor's claims. In that sense, and from the vendor's point of view, it is also more flexible. A vendor can use any kind of data and accompanying claims, if they respect the system's quality assurance requirements.

2.7.2 Other ETV systems

The ETV programs that have been studied were originally inspired by one of the two pioneering programs, which are US ETV and ETV Canada. They have though developed their structure to adopt it to their own specific preoccupations and requirements. Some outstanding characteristics of these systems are listed below.

The New Jersey system is based on the ETV Canada system. A particularity of the system is that the vendor contribution is dependent on its corporate revenue. Special attention is paid to the fact that a new environmental technology should not create new environmental problems.

The South Korea ETV program is the only one to offer two separate certificates. The certificate of designation is awarded when the vendor can provide sufficient data to support his technology and the certificate of verification when the vendor cannot provide this data and the system has to verify the performance. Verified technologies benefit from a point system to be used in public procurement bids and special attention is paid to SME's with specific funds and loans.

The Japan ETV system was inspired by the US ETV. This program is separated to a government sponsored scheme and a vendor fee financed scheme. Each verification project starts inside the first scheme but has to transfer to the second one after a fixed period of time.

In the Bangladesh ETV program, which targets for the time being only one technology category, the verification is a legal requirement before a company is allowed to sell to the Bangladeshi market.

The harmonization procedures, in the form of reciprocity agreements, memorandum of understanding etc., that have been laid down by the different programs do not seem to bear fruit, at least for the moment.

2.8 Analysis of simplified ETV models

The models presented below have been drawn to illustrate some important aspects of ETV. They were inspired by the US ETV and ETV Canada models but represent them in a very simplified way, excluding much of the complexity of these systems. Some of the ideas discussed in §2.7.1 are repeated here, but are generalized as far as possible.

Figure 11 presents an ETV system where the technology testing is performed by the ETV system. Data previously established by the vendor are not accepted in this system, which is closer to the US ETV one. Figure 12 presents an ETV system where the technology testing and the verification of the testing data are done in two separate organisations, ETV being responsible for the latter. The vendor has the responsibility of collecting this data by independently contacting a testing laboratory and presents the results in the form of a claim. This system is closer to the ETV Canada system. Both options are provided with adequate safeguards prohibiting any conflict of interest between all parties, and endowed with adequate data and testing quality assessment and auditing procedures.

Figure 11 : ETV system with Testing and Verification inside the same entity

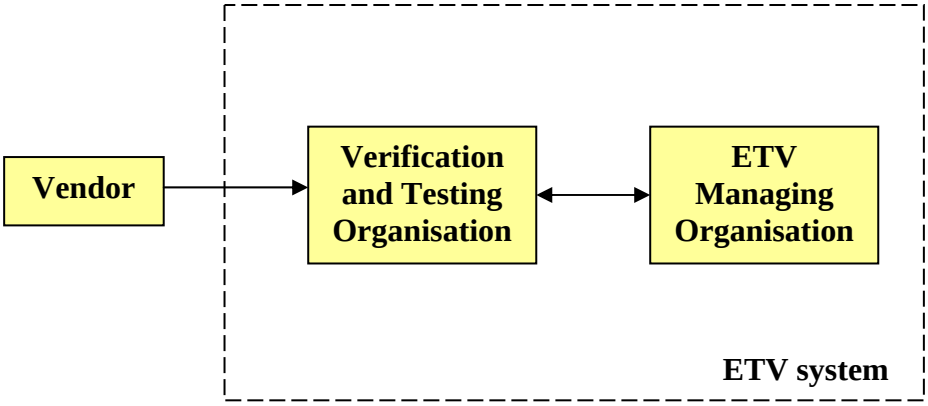
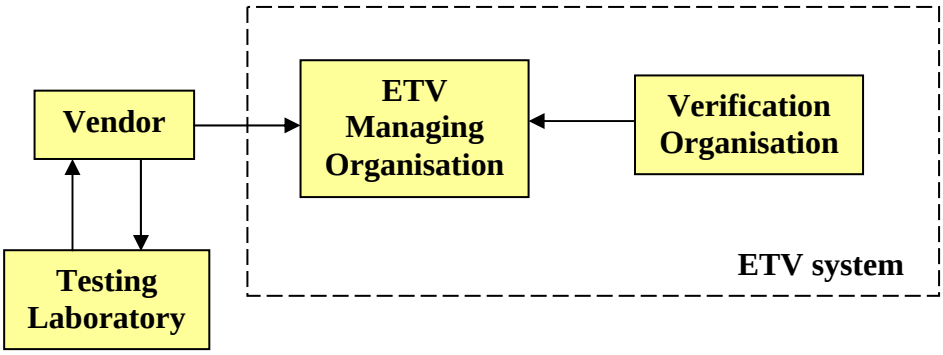


Figure 12 : ETV system with Testing and Verification in separate entities



There are a number of alternatives in the design of the systems, for example to change the entry point of the vendor or have multiple entry points or to separate the Verification and Testing organisation but at the same time keeping both inside the ETV system. Another option could be to entrust the Verification Organisation (or the Testing Laboratory) with the responsibilities of the ETV Managing Organisation etc. However, the most relevant aspects of these systems can be sufficiently highlighted by the two models described above.

Stakeholder input

Stakeholders are more needed for Model 1, where the tests have to be done inside the system. In model 2, the vendor decides beforehand, possibly in collaboration with the testing laboratory and taking advice from the ETV Managing Organisation of the tests that will be necessary. The stakeholder feedback is then reduced to an interaction between these three parties, since it seems improbable that an individual vendor would launch a stakeholder consultation procedure before verifying his technology.

Verification "input"

In Model 2, the objective of the verification is presented in the form of a claim. The vendor has already established the supporting data and will formulate his claim based on them. In Model 1 the vendor, cannot decide how and in what conditions his technology will be tested since this is decided by the ETV system, therefore he cannot formulate precise claims.

Comparison between technologies

Comparison between different technologies is easier in Model 1. The ETV system uses existing protocols, or establishes new ones, to test technologies of the same category. This is not so evident in Model 2 were the vendor together with the testing laboratory will determine the tenure of the tests. This is also related to the use of claims. Comparison between claims that have been formulated by different vendors in different manners is not straightforward (that does not mean that it is impossible). Especially if similar technologies are tested in different conditions and provide performance figures that are not directly comparable. This is why Model 2 is technology specific: comparison is not a primary goal. Model 1 can be sector specific: comparison between similar technologies is easier to put in practice (it necessitates coordination and to apply the same test protocol to technologies of the same sector).

Publication of the results

In Model 1 the technology tests and subsequent evaluation and report writing are all done by the ETV system. Model 1 is generating the performance data by its own means and consequently can freely publish them, respecting of course any confidential information. Model 2 on the contrary does not generate new data: it verifies pre-existing data submitted by the vendor, and which are for that reason the "property" of the vendor. The publication of the results is also much related to the source of funding. If one imagines a Model 1 entirely funded by the vendors, this would certainly influence the amount of published data. However, this configuration is not so easily implemented: intuitively, and this was confirmed during the market survey, the vendors will be reluctant to fund protocols that will be used by other vendors and also reluctant to bare the administrative costs of the Model 1 system that are quite high. In both cases, confidentiality agreements can be signed, but this is not the determining parameter.

Funding

Model 2 is mostly funded by the vendor. He has already paid the biggest amount of money that is necessary for the tests and protocols. He has to pay a smaller amount for the verification of his data. Model 1 is accompanied with a bigger administrative burden[36], necessary to manage the testing of the technologies inside the system, which increases costs.

Duration

Model 1 takes considerably longer to run, since it includes testing and eventually protocol development through stakeholder consultation etc. In Model 2, all this is arranged before the vendor files his application. If the quality of the data is judged insufficient and new tests have to be performed to generate new data, this will of course extend the verification duration also in Model 2.

Conclusions

The previous analysis shows that the various choices, (like the use of the stakeholder input, the testing of similar technologies at the same time, the system's way of funding etc.) put in practice by the different ETV models are a direct consequence of the design of the system. Likewise, the "output" of the system (the publishing of the results, the verification duration, etc.) is predetermined by the system's basic design.

2.9 ETV Evaluation – Outcomes and Impact assessment

Unfortunately, there is no so far a comprehensive evaluation of existing ETV systems. In the US ETV, a number of case studies illustrate the environmental impact of certain verified technologies. The outcomes of some of these case studies are reported below. In Japan, a survey on the impact on sales was conducted in 2005.

The simplest way to evaluate an ETV program is in the form of the program's output, meaning the number of technologies verified and the number of protocols developed, the verification duration and cost or even the number of web site hits. The program can also be evaluated by estimating its outcomes, where the results of the program are compared to the program's intended objectives. This includes the impact on the environment or to human health related to the diffusion of ETV verified technologies. A complementary approach, focusing also on outcomes, consists in evaluating the program based on the end users perception of it, with the use of an end user survey. A survey is a commonly used tool to assess the performance of the system related to the end user satisfaction, and can be focused on different types of end users. A survey targeting vendors, purchasers or permitters will determine the ETV impact on sales, purchase decisions and permitting/regulatory related

[36] To support this affirmation, see §2.1.4 for the US ETV system. The centre support costs that are complementary to verification, account for one third of the total costs. Similarly, a model 1 configuration will require stakeholder related, prioritization and privatization costs that are absent from model 2, and also more important general management costs (so as to manage the tests). Regarding the proper verification costs that account for the remaining two thirds of total costs: model 1 spends funds on the editing and publishing of verification reports, protocols and test plans. Model 2 requires protocols and test plans for the tests that are carried out outside the system, but these are not published. These specific publication costs are thus, absent from model 2. All these costs, summarized in the text under the appellation "administrative burden", are hence increasing the total costs of model 1.

decisions respectively. The surveys can also work out other related issues like the vendor satisfaction from the verification process or ways to improve or redefine the system[37].

Japan ETV

To assess the general impact on participating organisations, including the impact on sales, Japan ETV conducted in 2005 a survey targeting both verification organisations and technology producers[38]. The global results show a positive picture. The verification organisations, which in the case of Japan ETV depend from local administrations, reported that they have obtained the desired results (47% of the respondents), or "more or less" obtained the desired results (53%). Approximately 35% of the participating companies have observed a sales increase related to ETV verified technologies and roughly 72% estimate that a small or large general benefit (sales, R&D, credibility, recognition, general buyer interest) can be attributed to ETV.

US ETV

Two US ETV reports[39,40] address the issue of ETV evaluation, analysing a number of case studies of verified technologies. The outcomes that were examined during these studies were emissions reduction, impact on the environment and on human health, resource conservation, regulatory compliance, technology acceptance and use and scientific advancement. Only in a few cases some information on costs and on economic impact was available. The quantified outcomes were calculated under a set of simplifying assumptions and for the majority of cases they were not based on actual sales data, but on potential market penetration scenarios. Some of the results of three of these case studies are presented below. The two reports contain a total of 15 case studies. The two first cases were selected because information on verification costs were available for this type of technology (§4.1 and §4.3), providing a more complete picture of these verifications. The third selected case study represents a complete quantification exercise, which accounts for the impact of ETV-verified technologies to emissions reduction and human health and ultimately sizes up the related potential economic benefits.

- Mercury CEMs

The US ETV AMS centre verified seven CEMs (Continuous Emission Monitors) for mercury[41]. The verification of this type of equipment helped with the development of a legislative measure, regulating the measurement of mercury emissions from coal-fired power plants. Monitoring data provided by CEMs are required for achieving reductions under a cap-and-trade program implemented in the United States and concerning mercury emission reductions from coal-fired power plants. US ETV estimated the size of the market for ETV-

[37] http://www.epa.gov/cfo/finstatement/2006par/par06report.pdf
[38] http://www.env.go.jp/policy/etv/pdf/ab/03/sys_e.pdf
[39] Environmental Technology Verification Program Case Studies, Demonstrating Program Outcomes, United States Environmental Protection Agency, EPA/600/R-06/001, January 2006 - http://www.epa.gov/etv/pdfs/publications/600r06001/600r06001.pdf
[40] Environmental Technology Verification Program Case Studies, Demonstrating Program Outcomes Volume II, United States Environmental Protection Agency, EPA/600/R-06/082, September 2006 - http://www.epa.gov/etv/pdfs/publications/600r06082/600r06082.pdf
[41] http://www.epa.gov/etv/verifications/vcenter1-11.html

verified CEMs for mercury and used it to represent the potential market for the verified monitors.

This evaluation permitted to identify the mercury CEMs that achieve the performance levels required by legislation (this concerned e.g. measurement accuracy). The ETV verification of mercury CEMs has led to improvements in monitoring technology: Vendors have reported that they have used the results to improve their equipment. ETV results were used by EPA in studies on monitoring technology that contributed to the development of legislation in support to the cap-and-trade program.

- Microturbine technologies

The US ETV GHG Center has verified the performance of six microturbine systems[42], some of which are combined heat and power (CHP) systems. The microturbine/CHP systems can be used at residential, commercial or industrial facilities to provide electricity at the point of use and reduce the need to use conventional heating technologies.

Available sales data indicate that a capacity of 13 MW of ETV-verified microturbines have been installed in the United States, since the completion of the verifications. The individual installations have a capacity of 60 – 70 kW. The ETV-verified performance parameters were heat and power production, power quality and emissions.

Electricity generation in the Unites States accounts for 39% of a total 6.4 billion tons of CO_2 and for 21% of a total of 22 million tons of NO_x emitted in 2002. US ETV calculated that the currently installed capacity results, when compared to emissions generated by conventional technologies, to a CO_2 reduction of between 20000 and 36000 t/year (depending on site) and a NO_x reduction of 120 t/year. Future market penetration scenarios were used to estimate the CO_2 and NO_x reduction for following years. These emissions are related to significant environmental and health effects, but the impact of the reductions achieved by ETV-verified technologies on these effects was not quantified for this case study.

Apart from CO_2 and NO_x reductions, microturbine/CHP technologies can reduce emissions of other greenhouse gases and pollutants like CO, CH_4, SO_2, PM, ammonia, THCs as well as conserve finite natural resources (due to efficiency increases since microturbines avoid losses associated with the transmission of electricity) and use resources that would be wasted otherwise (e.g. biogas).

Finally, the development of a protocol that has contributed to standardization efforts in this field is among the scientific advancement outcomes recorded by ETV. Other positive outcomes like improved regulatory compliance or increased technology diffusion and use are also reported.

- Diesel Engine Retrofit Technologies

This last case study was chosen because the quantification exercise done by US ETV included not only emission reduction estimations but also quantified impact estimations.

[42] http://www.epa.gov/etv/verifications/vcenter3-3.html

This category corresponds to a broad range of technologies like fuel catalysts, crankcase filters, exhaust treatment devices or combinations of them. They target heavy duty diesel tracks, buses and non-road equipment and can reduce PM, HCs and CO emissions. The road equipment of this category accounts for approximately one quarter of PM emitted from mobile sources. US ETV has estimated the size of the diesel track and buses fleet and applied market penetration scenarios to estimate potential emission reductions. As an example, and for PM, in between 9000 and 32000 t of reduction (depending on the performance of the various technologies tested) are estimated after 7 years of use, when a 10% market penetration scenario is applied. This was related to numbers of avoided cases of premature mortality, avoided hospital admissions for various diseases (e.g. pneumonia, asthma) etc. Further on, the economic value of these was calculated and it was estimated that in this relatively low penetration scenario, ETV verified technologies would result to a potential economic benefit of in between 4.4 and 15.5 million dollars (depending on the performance of the various technologies tested) during a seven year period. Many other positive potential outcomes, concerning other pollutants as well are detailed in the report.

3 Existing European systems for technology approval/certification/ecolabelling

3.1 Introduction

There are no verification programs similar to the ones studied in the previous chapter in Europe, even if partially resembling systems do exist[43]. Several ETV pilot scale projects have recently seen the light in Europe[44] in the context of the ETAP implementation initiatives (EURODEMO[45], PROMOTE[46], TESTNET[47], AIRTV[48] and TRITECH ETV[49]).

This section describes the different systems that already exist in Europe to approve, certify or label a product or technology, and identifies the elements and characteristics of those systems on which a European ETV system (EETVS) could be built. The existing systems can be broadly classified in the following categories[50]:

Type approval systems for products that meet a minimum set of regulatory, technical, and safety requirements. Generally, type approval is required before a product is allowed to be sold in a particular country, so the requirements for a given product will vary around the world. For example, the German UBA operates a type-approval system for continuous emissions monitoring systems.

Certification systems which guarantee conformance to standards. Certification schemes include both a type approval of the product, and factory audits carried out regularly to ensure that the product being made and sold is still identical to that which was tested. Certification is often regulation-driven.

Ecolabel is a labeling system for consumer products with a comparatively low environmental impact. Usually both the precautionary principle and the substitution principle are used to define the rules to grant ecolabels. Ecolabels usually cover the whole life cycle of a product, from the extraction of raw materials, through manufacture, distribution, use and disposal of the product. All ecolabeling is voluntary, meaning that they are not mandatory by law.

The systems described below address technologies similar to the ones verified by the known ETV systems, and the procedures that they follow have certain similarities. The MCERTS (UK) and UBA (D) schemes focus on CEMs. Monitoring represents roughly half of the total number of verifications in the US ETV system. ACIME (FR) is a certification scheme which

[43] The word "verify" is used by existing European systems in a different way, in certification systems. These systems "verify" compliance with standards so as to issue a certification. See for example, www.lrqa-view.be (a member 'of the Lloyds Register Group) or Deloitte Cert, www.tgagmbh.de/scopes/index.php?id=0011&idsub=3&cb=190. There are also cases where a "standard" is replaced by a vendor's private declaration in which case it would resemble to a system of claim verification.
[44] http://www.eu-etv-strategy.eu/index.htm
[45] www.eurodemo.info
[46] www.promote-etv.org
[47] www.est-testnet.net
[48] www.airtv.eu
[49] TRITECH ETV is a LIFE funded project
[50] These definitions are generic and are given to clarify some aspects of the examined systems for the purposes of this study. Some actual systems may not fit to the definitions given here, or some definitions will only partially apply to these systems.

targets instruments that measure the quality of the ambient air. Finally, VITO/PRODEM (BE) is a system whose goal and procedure resembles verification, though at a smaller scale.

The analysis of the ecolabeling schemes is out of the scope of this report. In some occasions they do verify technological performance, even if in principle there should be no overlap between these schemes and verification. The word "verification" itself is also frequently found in the vocabulary of the ecolabelling schemes.

3.2 United Kingdom - Monitoring Certification Scheme (MCERTS)

The UK Environment Agency launched its Monitoring Certification Scheme (MCERTS) in 1998[51]. The Agency has appointed Sira Certification Service (SCS)[52] as the Certification Body to operate MCERTS on the Agency's behalf. Sira is independent of all the interested groups, such as the instrument manufacturers, monitoring personnel, test laboratories and end users.

MCERTS provides the quality measurement infrastructure within which environmental monitoring can be carried out to the Agency's requirements. The purpose of the scheme is to ensure that operators, regulators, and the public can have confidence in the data reported on both industrial emissions and the environment receiving those emissions, for compliance purposes.

The MCERTS scheme addresses the following types of monitoring systems:

- Continuous Emissions Monitoring Systems (CEMs)
- Manual Stack Emission Monitoring
- Continuous Ambient Air Quality Monitoring Systems (CAMs)
- Portable Emissions Monitoring Equipment
- Continuous Water Monitoring Equipment (CWMs)
- Self Monitoring of Effluent Flow
- Chemical testing of soil

The case of CEMs (e.g. for air pollution from industrial stacks in power stations, incinerators, chemical factories) was particularly examined in this report. The certification of CEMs by MCERTS has important advantages for the producers of these equipments:[53]:

- The certification is formally recognised within the UK and is acceptable internationally
- It gives confidence to regulatory authorities that instrumentation, once certified, is fit for purpose and capable of producing results of the required quality and reliability
- It gives confidence to users that the instrumentation selected is robust and conforms to performance standards that are accepted by UK regulatory authorities

[51] http://www.environment-agency.gov.uk/business/1745440/444671/466158/
[52] http://www.sira.co.uk/services_mcerts.html
[53] http://www.sira.co.uk/downloads/LeafMCERTSasamanufacturer.pdf

- It provides instrument manufacturing companies with an independent authoritative endorsement of their products, which will facilitate their access to international markets and increase the take-up of their products in the UK.

The Agency has published MCERTS performance standards for CEMs[54,55]. These documents specify the procedures and describe the general requirements for the testing of CEMs for compliance with the performance standards. All testing under MCERTS must be carried out by laboratories and test organisations that comply with the requirements of BS EN ISO/IEC 17025 for these procedures. However, tests performed by the manufacturer and witnessed by SIRA (the certification body operating MCERTS on behalf of the environment agency) can be accepted as well. Performance standards and test procedures are fixed once and for all with MCERTS; they are not revised regularly.

Some features of the test procedures are the following:

- Both the performance standards and the test procedures are based on relevant CEN, ISO and national standards.
- Testing comprises a combination of laboratory and field tests to ensure that instruments perform to the technical requirements and work in real applications.
- The test program and evaluation of results is carried out by SIRA (organisation contracted by the Environment Agency to partly run MCERTS), using a group of independent experts (CEM manufacturers, trade associations, CEM users, the Agency, etc.) known as the Certification Committee.

The test report contains at least the following:

- A description of the CEM under test
- A description of the test program
- A description of the methods and reference tests used in the program
- Any deviation from the standard methods
- The results of the test
- Details of necessary maintenance work and remedial actions required to ensure that the equipment meets the performance standards
- A proposed scope of capabilities to be included on the certificate
- A summary table stating the required performance characteristics for each parameter, a statement of fail or pass, and a reference to the relevant section of the test report.

Certification process

The vendor is directly in contact with the testing laboratory. According to the MCERTS managers, the vendor may have his technology tested by any accredited laboratory, i.e. one of the 5 following laboratories: NPL and AEA Technologies (UK), TÜV (Germany), CESI

[54] http://publications.environment-agency.gov.uk/pdf/GEHO0403BKAB-e-e.pdf
[55] http://www.sira.co.uk/downloads/MCERTS1177.pdf

(Italy), INERIS (France). The tests are fully paid by the vendor. In practice, INERIS has never been contacted to perform tests for an MCERTS certification. The test report is then reviewed by MCERTS (usually rather quickly because they have confidence in the quality of the test laboratories), and the MCERTS certificate is awarded or not. Every two years, the vendor's production site is audited to up-date the certificate and make sure the CEM has not undergone significant changes compared to the instrument that was certified. This manufacturing audit is paid by the vendor. MCERTS verifies that this auditing is done every two years. The certification is valid for 5 years and is then subject to review.

In the MCERTS scheme the technology producer has to perform the required tests by independently contacting a test laboratory. Moreover, existing data, generated by other schemes can be used, if they are compatible with the MCERTS requirements. MCERTS will examine the results provided by the producer, but will not perform the tests by itself. MCERTS performs, in addition, a manufacturing audit in the producer's production unit. This audit permits to certify that every specimen of the producer's technology, and not only the specimen used for the execution of the tests, performs to the same performance levels (manufacturing reproducibility) and also assert that any changes in the product are done without prejudice to its performance. MCERTS can be considered as a "pass or fail" system, in the sense that a technology has to achieve a certain level of performance in order to successfully pass the system's scrutiny. MCERTS publishes performance standards whose requirements are evaluated against the performance of the product under certification. During the interviews it was underlined that even if MCERTS is a voluntary scheme, each success and credibility are such that it can be considered "mandatory in practice".

3.3 Germany – UBA Type approval system

The UBA (German Federal Environment Agency)[56] type-approval system concerns only two types of technologies: CEMs and monitors used by chimney cleaners for monitoring of domestic heating systems. It is compulsory in the sense that the operator of an installation (e.g. a power plant) in Germany can only use CEM equipment that is on the UBA list.

The UBA approval system for CEMs, launched in 1975, verifies the performance of the product and checks that the data provided by the monitoring system meets the minimum requirements defined to be in line with the German regulations. If the performance of a product is better than the minimum requirements, this will appear in the report since the performance data will be indicated. Therefore, the UBA approval proves compliance with regulations, but also provides the performance data if they are better.

The laboratories entitled by UBA to perform the performance tests must be accredited by the National Accreditation Institute. In practice, five laboratories are currently conducting the testing of CEMs in Germany: 4 TUV laboratories (Technischer Überwachungs-Verein: German Technical Control Board, is a German organisation which has many subsidiaries in Germany and worldwide), and a Regional Government laboratory. The following requirements for the test laboratories are enumerated in a circular of the Federal Environment Ministry:

- Tests and expert opinions presented by testing institutes of other EU member states or of the European Economic Area will be recognized as adequate, in particular, if

[56] http://www.umweltbundesamt.de/index-e.htm

- suitability tests were conducted according to the requirements contained in this guideline[57] or according to equivalent procedures involving, in particular, a field test of the measuring system for at least three months and
- the testing institutes proved to have special experience in carrying out emission measurements, calibrating continuous measuring systems and testing instruments, e.g. by nomination of the competent authorities of a member state, and
- the testing institutes shall have been accredited and evaluated by a member of the ILAC (International Laboratory Accreditation Co-operation) for fulfilling respective test tasks according to the standard series DIN EN ISO/IEC 17025 (issue of April 2000).

The reports provided by those laboratories are discussed within the "national group" in charge and, if accepted, they are published. The members of this group are competent experts from the environmental agencies of the states (Länder). In principle approved systems comply with the regulation. But from a legal point of view, the owner of the installation is responsible for fulfilling the regulatory requirements. UBA does not guarantee the performance of an equipment even if it gave approval for it. This is in line with the definition of type-approval, comparing to certification (see §3.1).

3.4 Harmonisation of procedures

Bilateral agreement between UBA and MCERTS

The UK Environment Agency and UBA agreed in 2000 on measures to minimise the burden on instrument manufacturers seeking both certification and approval under these schemes. These measures are focused on accepting the general equivalence of testing under the two schemes, subject to certain safeguards. This agreement is based on a Memorandum of Understanding (MoU)[58] on the product certification/type approval of CEMs; it consists in arrangements for mutual recognition between MCERTS and the UBA scheme.

A document titled "Guidance on the acceptance of German type approval test reports for CEMs"[59] provides the MCERTS Certification Committee with the UK Environment Agency's guidance on how the measures for mutual agreement should be implemented when evaluating applications for certification of CEMs based on existing test reports, which have been accepted by the UBA for type approval in Germany.

According to this document:

- Whereas testing for MCERTS certification shall be performed on a minimum of one instrument, two instruments shall be tested in all cases when the manufacturer requires the MCERTS-certified CEM to be accepted by the German UBA for inclusion on the German Federal Register of approved equipment. Both instruments are required to pass all the laboratory and field tests.

[57] http://www.umweltbundesamt.de/luft/messeinrichtungen/Uniform-Practice-Emission-Monitoring.pdf, pp. 24
[58] http://www.umweltbundesamt.de/luft/messeinrichtungen/mcerts326.pdf
[59] http://www.umweltbundesamt.de/luft/messeinrichtungen/mcerts323.pdf

It should be noted that vendors mentioned that the certificate from the other country is not given automatically, and, for example, an MCERTS certified vendor has to take the necessary steps for a UBA approval by himself (i.e. apply to UBA, provide them with the required documents and test reports, etc.).

Standardisation at European level

The aligned scheme between the UK and Germany may become the basis of a European standard for the testing and approval of analysers for stack emissions and ambient air. A specific working group (WG22, Technical Committee 264[60]) was established within CEN (European Committee for Standardization). The members met for the first time in October 2004, with representatives from MCERTS, UBA and ACIME, and from Italy, Denmark and the Netherlands, and also some technology vendors.

This effort aims to the mutual acceptance of the approval/certification procedures for CEMs within the UE. Apart from a European standard, other, possibly less demanding alternatives are proposed from the CEN under the heading "Conformity Assessment"[61]. Instead of proposing new standards, these schemes promote the mutual acceptance of existing ones, by promoting the collaboration at the level of standardisation organisations. One of the goals of Conformity Assessment is the "market acceptance of products".

3.5 France – ACIME (Association pour la Certification des Instruments de Mesure pour l'Environnement).

This certification body was created in 2003 by AFNOR (French Association for Normalisation)[62], INERIS (French National Institute for Industrial Environment and Risks)[63] and the LNE (National Laboratory for Metrology and Testing)[64], and specialises in instruments for the Environment[65]. It currently concerns instruments measuring the quality of ambient air (among which CEMs), and in the future it is meant to deal with all instruments used to quantify nuisances in the sectors of water, air, noise and soil. Instruments that pass the certification are awarded the NF Mark.

Comments and specific features of this certification:

- The LNE and INERIS are the only two laboratories in France entitled to do the performance tests. They apply the same fees for each stage of the process.
- Test reports provided by other testing laboratories (e.g. TÜV, see §3.3) are accepted as supporting data, as long as those laboratories are properly accredited. In this case, the NF certification process is much shorter (1 or 2 days to review the report) and cheaper.
- Testing time: 6 months for laboratory tests, then 3 months for field tests and another 3 months to write and review the report (total: 1 year).

[60] http://www.cen.eu/CENORM/BusinessDomains/TechnicalCommitteesWorkshops/CENTechnicalCommittees/CENTechnicalCommittees.asp?param=6245&title=CEN%2FTC+264
[61] http://www.cen.eu/CENORM/conformityassessment/index.asp
[62] http://www.afnor.org/portail.asp?Lang=English
[63] http://www.ineris.fr/
[64] http://www.lne.fr/
[65] http://www.marque-nf.com/pages.asp?REF=OM_ACIME&lang=English

- Since the ACIME certification exists, only 3 vendors have had their products certified. As a result of this poor success, ACIME decided not to launch an equivalent certification for water monitoring systems, anticipating that the success would be even lower since the number of vendors on the market is lower than for CEMs.
- Consequently, the ministry of environment is urged by the administrators of the system to make the certification mandatory. Otherwise the continuation of the certification system could be jeopardized, since it does cost time and money to regularly update the test procedures, whereas there are no revenues from it since the vendors are not applying to go through the system.
- According to an ACIME manager, once the European standard on CEMs will come into effect, the ACIME certification will no longer exist.

Table 2 summarizes some of the main features of the schemes examined above.

Table 2 : European systems for CEMs certification/type approval

Country	Name of program	Mandatory	Launching date	Features
UK	*MCERTS*	No	1998	• De facto, all CEM manufacturers apply • Verifies the compliance with the performance standards and audits the production plant • Data generated by 5 labs is accepted: 2 UK labs, 1 French, 1 German and 1 Italian
France	ACIME	No	2003	• 2 labs in France are entitled to do the tests • Data from other labs is accepted (e.g. TUV) • Only 3 vendors have been certified; because of the poor success, the certification may be stopped.
Germany	UBA Type-approval scheme	Yes (to sell on the German market)	1975	• Verifies the performance of the device, i.e. its suitability to meet minimum requirements defined to be in line with the German regulations. • Only data generated by 5 German labs are accepted
EU	CEN standard: Certification scheme for CEMs	No	-	• The standard is still under development

3.6 The Belgian PRODEM system

VITO, the Flemish institute for technological research[66], is a semi-public research centre, in charge of the PRODEM program[67], for performance assessment at plant level. This program is funded by EC-EFRD (European Fund for Regional Development), the regional government, and industry. In 1995, VITO obtained funding from the EFRD and the Flemish Government to encourage SMEs in Flanders to introduce environment friendly process

[66] http://www.vito.be/english/index.htm
[67] http://www.vito.be/english/environment/environmentaltech6.htm

technologies. Typically, SMEs miss the necessary skills, time and money to invest into research in the field of environmental technologies that reduce the impact on air, soil and water. A specific unit was set up in VITO (the so-called PRODEM unit) to support SMEs with the choice of new technologies and/or processes that result in a lower environmental impact.

Performance verification

PRODEM sets up demonstration tests and pilots to investigate the feasibility of selected technologies. This was found crucial to guide SMEs to do the right investments in cleaner technologies. The applicant can either be a vendor who wants his technology to be verified, or a buyer of a technology, who is willing to have substantial, credible data to support his decision before purchase.

Although setting up, for example, a demonstration plant may seem costly, the program, focused on SMEs, is accessible to them thanks to the available subsidies. Demonstration tests can be developed by VITO itself or in cooperation with technology suppliers. Being independent from the technology suppliers, VITO-PRODEM acts as a reliable bridge between technology suppliers and the users, and as a result, also as a catalyst for the market in environmental technologies. Existing protocols are preferentially used, otherwise new protocols are developed in collaboration with experts. The technological fields concerned include effluent water, odour nuisance, waste, energy and soil technologies.

3.7 Ecolabeling schemes

As mentioned before, ecolabeling schemes do not target in principle the same field as verification. They address more final, consumer products, and do not necessarily include the "business to business" relationship that is present in verification. They do verify, in various occasions, technological performance and the word "verification" is present in the ecolabeling vocabulary.

The EU Ecolabel

The EU Ecolabel[68] attributes the flower logo to consumer goods. This European-wide ecolabel coexists with many national labelling schemes which often have different approaches. To improve cooperation and co-ordination between all these labels, the European Ecolabel set up a co-operation and co-ordination group in 2004. The objectives are to:

- progressively co-ordinate product group development in the different labelling schemes in the EU, including reviewing existing product groups and agreeing as far as possible on common approaches
- examine possibilities of mutual recognition and mutual fee reductions
- develop joint marketing activities and information to consumers

Some Member States have started collaborating efficiently.

- Before deciding on new product groups or on revisions, the Austrian ecolabelling Body first examines the possibility of adopting the European criteria. Whenever it is possible to do this, EU criteria are adopted, in which case the producers can choose to

[68] http://ec.europa.eu/environment/ecolabel/index_en.htm

apply for one or the other or for both labels. If a producer decides to apply for both labels he only has to pay one fee – the fee for the EU ecolabel. Even if, in the long term, the EU ecolabel is expected to supersede national level labels, there is a transitory phase during which the producers can continue using the national label – because it is well recognised on their local market – and at the same time use the EU label, mainly for exporting purposes.

- Since 2000 the Nordic Ecolabelling Board follows the strategy to compare the Nordic criteria with the Flower criteria when assessing and revising criteria. As a result, a lot of harmonisation has been achieved in about 15 product groups the two schemes have in common. As a second step, the challenge now is to adjust the timing of the revision work in the two schemes.

The German Blue Angel

This environmental labelling system was created in 1977, and today about 3500 products have the Blue Angel label [69]. There is an annual fee to acquire the right to use the label (€270 to €6000), depending on the annual turnover of the product. Basic criteria for award of the label have been defined (and are regularly reviewed) for around 200 product categories, among which some environmental technologies: solar collectors, small-scale cogeneration modules, low-noise and low pollutant vehicles, heat pumps, etc. The criteria are defined by a jury where the different interest groups meet.

When basic criteria do not yet exist for a specific product category, a manufacturer can submit a new proposal to the Federal Environmental Agency. Such proposals should be well-substantiated and accompanied by supporting documents explaining why a certain product with its environmental properties would distinguish itself from other (competing) products used for the same purpose. The proposal must be accompanied by product descriptions and, possibly, by samples.

If the Environmental Label jury decides the new product category should be created, the UBA draws up a list of criteria that is suitable for the product that is applying for the use of the label, and discusses them with those concerned at all levels of society, such as environmental and consumer associations, trade unions, industry, testing institutes, etc. The jury develops the list of criteria on the basis of either existing standards or requirements under the provisions of German law regarding e.g. hazardous substances, health and safety etc.

If sufficient data and information are not available on a product group, the UBA can launch a feasibility study to compile relevant market data and determine the pollution reduction potential. New proposals are processed free of charge.

3.8 General Conclusion

The technology evaluation systems currently in operation in Europe have certain similarities with the much broader ETV systems described in the previous chapter. The MCERTS certification and the UBA type approval scheme verify technology performance against minimum requirements. They can be considered as "pass or fail" systems, unlike the studied

[69] http://www.blauer-engel.de/englisch/navigation/body_blauer_engel.htm

ETV systems. They can also be considered as mandatory, in the sense that a company which wants to enter their respective markets cannot easily do so before passing through these systems, whereas this is in general not the case for the ETV systems studied (except for the case of Bangladesh §2.6). A mutual recognition bilateral agreement has been created for certification/type-approval of CEMs. This agreement, which has become the basis for a more general harmonization effort in this field, has found a positive response within the vendors of these technologies.

In conclusion, systems that possess experience in the evaluation of the performance of certain technologies are present in Europe. Current efforts of harmonisation and mutual recognition at European level could provide an adequate basis for the development of a European verification system.

4 Cost of verification: illustrative cases

The estimation of the financial elements of a complete verification program, that would involve the overall setting up and running costs, including the determination of funding sources, is out of the scope of this report. Instead, the aim of the present analysis is restricted to the determination of the costs incurred to make one verification. This cost is then compared to the amount that the "customer" of the ETV system, i.e. the vendor, will have to bear. The vendor could cover all or part of the costs allocated to protocol development and actual testing or data verification. The practice followed in the existing ETV systems (US ETV and ETV Canada) is that the vendor does not pay the totality of these costs. In some cases the governmental or other subsidy-providing organisms cover even the majority of the costs. The practice followed by the certification and type-approval schemes that were examined (MCERTS and UBA) is different since they are mandatory, or "considered mandatory" by the market.

Protocol development and testing execution costs can vary to a great extent, depending on the specific technology that is under examination, and the nature of the tests. Because the costs were expected to vary greatly depending on the type of technology, three families of technologies were selected to conduct case studies:

- CEMs (or AMS: Advanced Monitoring Systems)
- GHG abatement technologies
- End-of- pipe technologies

CEMs are subject to certification and type-approval systems in Europe and may provide comparable data on testing conditions and costs. However, environmental technologies, even of the same family, can be very different from each other. The tests associated to those also differ a lot, some including field tests while laboratory tests might be sufficient for others and therefore costs may not be comparable. Consequently, the figures given below should be interpreted as estimates of the order of magnitude of the actual costs.

The case of ETV Canada is examined separately, since protocol development and testing is not included in the costs. The main cost element is, in this case, the verification of the vendor's claims by a specialized verification agent.

The information provided in this chapter has been gathered through direct interviews[70] and literature review. The interviews have highlighted procedural aspects that did not emerge in the literature. The cost structure of a few specific verification cases from the US ETV has been derived from the literature.

[70] For more details on the interviews organisation see §5.1

4.1 CEMs in US ETV – AMS (Advanced Monitoring Systems centre)

Battelle and the stakeholder committees

Battelle hosts the US ETV verification centre, called AMS (Advanced Monitoring Systems) Centre, for air monitoring. The AMS Centre often actively requests vendor participation in an upcoming test by posting a notice in newsletters (ETVoice, the Monitor). Moreover, Battelle generally utilises Internet resources to find vendors of a particular type of technology and contacts them directly by telephone or e-mail to assess their interest in participation. This communication activity (including the organisation of stakeholder committees) represents a significant expense in Battelle's budget.

There is no application fee for vendors. They are all accepted as long as they verify the requirements of the program, i.e. the product should respect environmental legislation and be commercially ready. The cost of verification testing to the vendor varies widely. In cases where multiple technologies are verified at the same time, the amount charged to the vendor may range between 10 to 100% of the total cost of verification, depending upon the level of in-kind/financial support (staff time, travel costs, facilities etc.) received from test collaborators. The costs of the tests vary with the number of technologies that are tested simultaneously. For CEMs, due to the technical difficulty of some tests, the cost is in general of the order of $100,000 *(€79,000)* (includes the testing and the writing of the report). When more than 4-5 technologies are tested at the same time the prices are reduced by 10 – 20 %. The discounts applied as a function of the number of participants are specified in the vendor's agreement. However, Battelle stressed that the price is a function of the external support the vendor gets and the duration of the test (tests can last from 2 weeks to 2 months, which infers on the price).

The test plan

The cost involved in preparation of the test plan does depend on the complexity of a test, but does not usually increase with the number of participating technologies. (This is generally true unless the technologies have very different operating requirements.) Therefore, the test plan's percent contribution to the total cost of a verification can be as low as 15% or higher than 30%. Note that, because of Battelle's verification process, the cost for developing the test plan is included in the total cost of the verification.

Testing phase

Tests may be conducted in Battelle's laboratories, the laboratories of a collaborating organisation or at field locations. Tests may range in duration from a few weeks to several months, depending on the scope of the test. In some cases Battelle follows a simple "accreditation" procedure when tests are entrusted to exterior laboratories: test specimens with known characteristics are examined and the capability of a laboratory to conduct the tests is assessed based on the results provided on the test specimens.

Costs associated to the verification

There are a number of costs associated with a specific ETV test from the point in time when a technology category has been identified and the decision made to pursue the test. Those costs are linked to the following activities:

1. Vendor identification and test collaborator recruitment: 5-10% of the cost
2. Preparation of the test plan: 15-20% of the cost for a single technology
3. Testing: of the order of 50% of the cost
4. Data analysis and preparation of the verification reports and verification statements: 25-30% of the cost

The total cost of a test from start to finish can vary widely depending on the scope of the test, the number of participating vendors, the labour requirements for operating the technologies (e.g. test kits vs. complex (research-grade) instruments), and the level of in-kind support received from test collaborators.

Costs diminishing with the number of participants are the preparation of the test quality assessment plan and the testing, and, to a lesser degree, the recruitment phase. However, data analysis and the writing of the reports have to be done individually and the cost cannot be reduced.

Generic protocol

Battelle does not define generic protocols in advance, but rather generalises the document written for the test plan. That way, they spend only one week to define this generic protocol. It is up to the VO to decide whether they prefer to define a generic protocol first or move directly to the test plan. Battelle has opted for the second option systematically. Consequently, no data relative to the cost for developing a generic protocol is available.

The originality of Battelle is twofold:

- they take the problem of generic protocols the other way round
- they subsidize the testing using collaborators who have an interest in the technology and the result of the tests.

This very dynamic verification centre has already tested 122 technologies/products (projected[71] by September 2006), much more than the other centres. This may be attributed to the type of technology they are interested in as monitoring technologies cost in general less to verify than other types of technologies.

For year 2006, 25 verifications should be completed. Regarding the stop of funding from the federal government, these changes would impact the activities of the AMS Center in the year following the drop in government funding. The number of verifications completed each year has probably been more dependent on the level of interest from their stakeholders and the vendor community than on the exact level of funding they received from EPA on a year-to-year basis.

[71] Projected for completion for the fiscal year that ends in September 2006: verifications are considered complete when the final verification statements and reports have been approved by both Battelle and EPA; it is expected that all of the verifications will be completed by September 2006.

Cost structure of a concrete verification case

The purpose of these verification tests[72,73] was to evaluate the ability of ammonia CEMs to determine gaseous ammonia in flue gas, under normal operating conditions, in a full-scale coal-fired power plant. Figure 13 shows the cost distribution and Table 3 gives the absolute verification costs (these are the average costs from the two instruments tested). US ETV data (not shown in the figure and table) permitted to assess that the vendors' financial contribution was of the order of 6% of the total verification cost. The vendors' in kind contribution was higher, of the order of 60% of his total contribution (sum of cash contribution and in kind monetized contribution). As expected, some of the cost figures do not correspond exactly to the ones provided during the interviews, but are within the same order of magnitude. It has to be noted that the Ammonia CEMs is one of the most expensive verifications made by this centre. The average cost per technology verified was of $50000 for years 2001 – 2005 (for 132 technologies), significantly lower from the case presented here.

Figure 13 : Distribution of Verification costs for the Ammonia CEMs case study (US ETV)

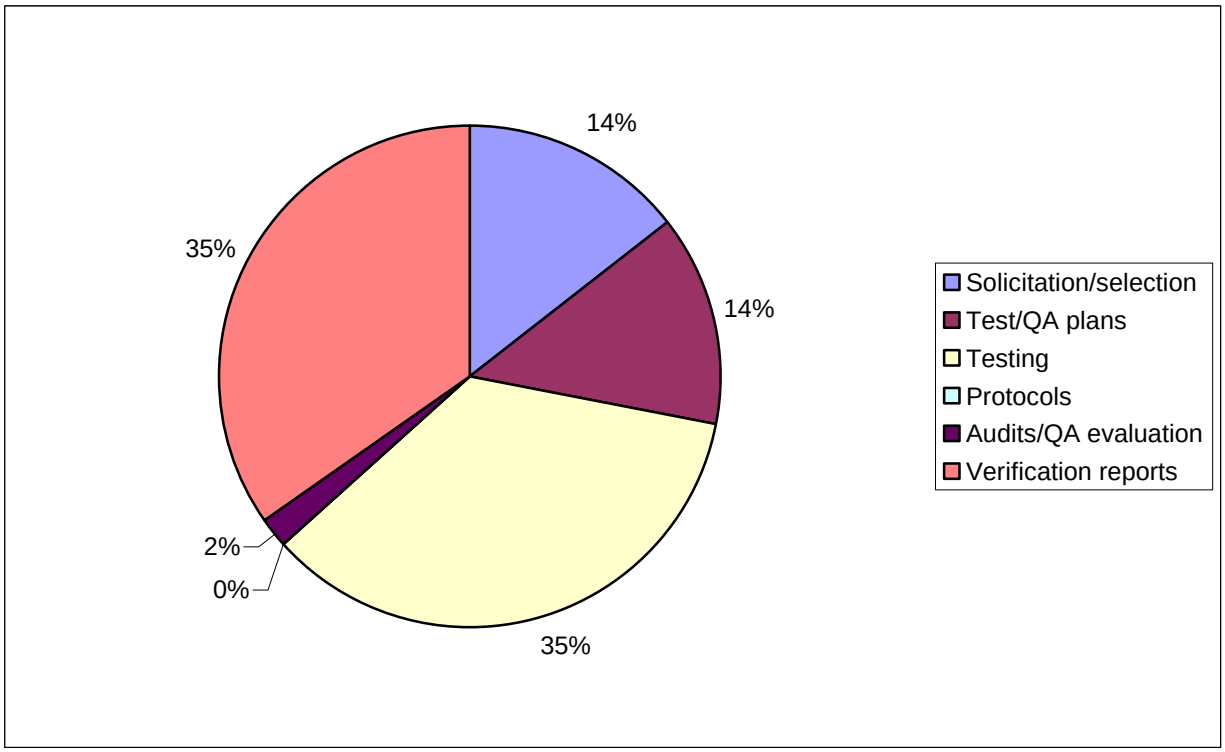


Table 3 : Absolute Verification costs (US $) for the Ammonia CEMs case study (US ETV)

Solicitation/selection	Test/QA plans	Testing	Protocols	Audits/QA evaluation	Verification reports	Total
18200	17150	44100	0	2450	43800	125700

[72] http://www.epa.gov/etv/pdfs/vrvs/01_vs_opsis_ld500.pdf
[73] http://www.epa.gov/etv/pdfs/vrvs/01_vs_siemens.pdf

4.2 CEMs in Europe

At MCERTS, the vendor pays the total cost of the verification and the writing of the report. The protocols have been defined at the creation of the program. Therefore, there is no additional cost to the organisation to determine new protocols. The present experience of the certification (MCERTS, ACIME) and type-approval (UBA) schemes of the CEM sector can give a rough idea of the costs related to application procedures, testing and report writing. For these three programs, only one protocol (or a limited number of protocols) is required and its development is paid for by the verification scheme itself. The data relative to the cost of the various European systems and the US ETV are given in Table 4.

Table 4: Summary of costs for CEMs in different systems[74]

Cost for	US ETV	MCERTS	UBA	ACIME
Total cost	~$100,000 ±10,000 *(~€79,000*±8,000*)*	€55,000±5,000	€100,000	~€31-35,000 (including application fee)
Cost paid by the vendor	Between 10 and 100% of the verification cost. Decreased by 10-20% if 4-5 technologies are tested simultaneously	100%	100%	100%
Application fee	$0	€0	€0	€4,660

ACIME has developed a very detailed fee structure (Table 5) that includes the testing of the CEM instrument and the auditing of the production site for the first time. After that, there will be additional costs to regularly check the instrument, audit the production site and use the NF (Norme Française) Mark.

[74] It is important to note that the verification cost figures given in Table 4 are indicative only and can vary substantially depending on the type of the technology verified. They cannot be directly used to compare between systems since they do not concern exactly the same technologies or the same verification procedure. Only in the case of MCERTS and UBA the technologies can be exactly the same. The disparity in the values given may be due to the fact that UBA systematically tests two specimens instead of one. This cannot explain though the doubling of the price displayed in the table. The prices given in this table were provided through interviews. The values indicated for UBA were given by vendors while the other values were provided by managers of each system.

Table 5: Costs associated to certification of CEMs through the French ACIME program

Component of the total cost	Cost[75]
Application fee:	Total fee for 1 instrument : €4,660 - Fixed fee for application : €3,735 - Fee per instrument : €925
Testing for one instrument and one gas*	€25-29,000
Audit of production site	For non ISO 9000 certified companies: €2,313 For ISO 9000 certified companies: €1,388
Total fee for 1 instrument and one gas manufactured by an ISO9000 company	**€31,048 – €35,048**

* For other cases, estimate on demand, e.g. multigas instrument or several instruments tested at the same time

4.3 US ETV – GHG (Greenhouse Gas technology centre)

Application and selection process

Southern Research Institute (SRI) is the US ETV verification centre for Greenhouse Gas Technologies, including clean energy production solutions. SRI does not accept all applications. To screen out non nearly-commercial technologies, an application fee of $2,000 *(€1,600)* is required. In addition, some preliminary test results are also required by SRI, that prove that the company has already seriously considered the technical and commercial phases of the product to be verified. This fee is refunded completely if the test results are not credible. Following the screening step, the vendor and SRI write a commitment letter that will seal the beginning of the project.

Generic protocols

Over the years, especially when SRI received funding from the federal government, the verification centre has developed a number of generic protocols. However, in the case of an innovative technology, test plans and protocols have to be developed from scratch with high costs. Existing protocols, used worldwide, are usually fit for laboratory tests and not applicable to field tests. SRI conducts field tests only. The use of existing protocols or standards requires an adaptation effort whose magnitude is very dependent on the applicability of the protocol for the laboratory test to the field. According to an estimation provided by an interviewee, two technologies are enough to reach cost effectiveness if they are similar. If they are moderately different, the protocol will be cheaper than if SRI had to start from scratch but it would still be expensive and more technologies would be necessary to reach cost effectiveness. However, the need of funding is upstream to establish new generic protocols. As a consequence of the interruption of federal funding, SRI has to test only common environmental technologies unless the vendors pay for the development of protocols. Another solution for the vendor is to seek subsidizing from the State, like New York State or Texas.

[75] Mean rates for June 2006: 1 USD for 0,79 €, 1 CAD for 0,71 €, 1 GBP for 1,46 €

Report review

Once the test plan has been decided (usually a week – it is also submitted to EPA for approval) and the field tests conducted (about 6 weeks), a report is written and offered for editorial review to the vendor who checks if the technology/product has been properly understood and if there have been some practical issues with the test plan.

Financial data

The manager of ETV activities at this verification centre gave an average cost of $80-100,000 *(€63.2-79,000)* per verification, and $50-75,000 *(€40-59,000)* per protocol (amount that can sometimes reach $140-170,000 *(€111-134,300)* for some technologies). Average verification costs are given in Table 6.

Problems faced by SRI

SRI benefits from a steady flow of vendors, which allows them to be more selective. The oil and gas sector has a lot of financial resources, which pushes vendors to get their technologies verified to get credibility on the market. However, since the government funding stopped, SRI faces a narrower range of technologies, developed less and less by small companies, because few of them can afford it. At the other end of the spectrum, a lot of companies (multinationals) do not require ETV verification because they are already well known on the market. In conclusion, SMEs do not have credibility on the market and need ETV verification in that regard but they cannot afford the high cost of it.

The SRI team responsible for ETV admitted they were surprised the program was continuing and there were still companies asking to be verified, despite the interruption of federal funding. But they are worried about the fact that the ones asking for a verification should be helped. SRI has now 3-4 technologies under test. They have already tested 2 this year, 4 more next year (the ones currently under test should be ready by next year). Since the beginning of the program, they have published about 46 reports (the market survey was carried out in the period 02/2006 – 06/2006).

SRI stressed that, in general, an ETV program should focus on technical and economic performance. ETV should stress that a product/technology's performance is verified under some specific circumstances rather than try to resemble a certification. ETV should present data a purchaser or a regulator can read easily. Besides, the choice of the testing laboratory is also essential. Expertise should be concentrated in one area, one centre, and vendors would be advised for the laboratory, so as to safeguard a high testing quality.

SRI finds acceptable that the vendor pays a substantial percentage of the verification costs, and this is seen as a screening step. The verification centre has to keep in mind that cost effectiveness has to be pursued. A solution would be to create a funding agency that would cover generic protocols and new technologies. The scheme suggested by SRI would be that the vendor of a new technology would be funded at 50%, whereas more common technologies would be funded at a level of 25% of the costs.

Table 6: Summary of the different costs for verification and protocols, US ETV - GHG

Cost for	US ETV
Generic protocol	$50-75,000 *(€40-59,300)* ($140-170,000 for specific technologies) *(€111-134,300)*
Total verification cost:	Average: $80-100,000 *(€63.2-79,000)* FY05 data range: $86-217,000
Verification cost paid by the vendor	From less than 50% up to 100%
Application fee	$2,000 *(€1,600)*

Cost structure of three concrete verification cases

The following concrete verification cases have been examined. Natural gas fired microturbine combined with a heat recovery system[76,77] is a cogeneration installation that integrates microturbine technology with a heat recovery system. QLD (Quantum Leap Dehydrator)[78] is a system that improves the removal of water contained in natural gas, natural gas dehydration being the third largest CH4 emission source in the natural gas production industry. Finally a fuel efficient lubricant for light duty trucks[79], which is realizing fuel economy resulting in smaller CO_2 emissions.

Figure 14 shows the cost distribution and Table 7 gives the absolute verification costs. These data do not include any protocol development costs. It was assumed that in these cases existing protocols were used. Total costs are close to the average ranges provided in Table 6.

[76] http://www.epa.gov/etv/pdfs/vrvs/03_vs_capstone60.pdf
[77] http://www.epa.gov/etv/pdfs/vrvs/03_vs_inger_rand.pdf
[78] http://www.epa.gov/etv/pdfs/vrvs/03_vs_quantum.pdf
[79] http://www.epa.gov/etv/pdfs/vrvs/03_vs_conoco.pdf

Figure 14 : Cost distribution for 3 GHG selected technologies

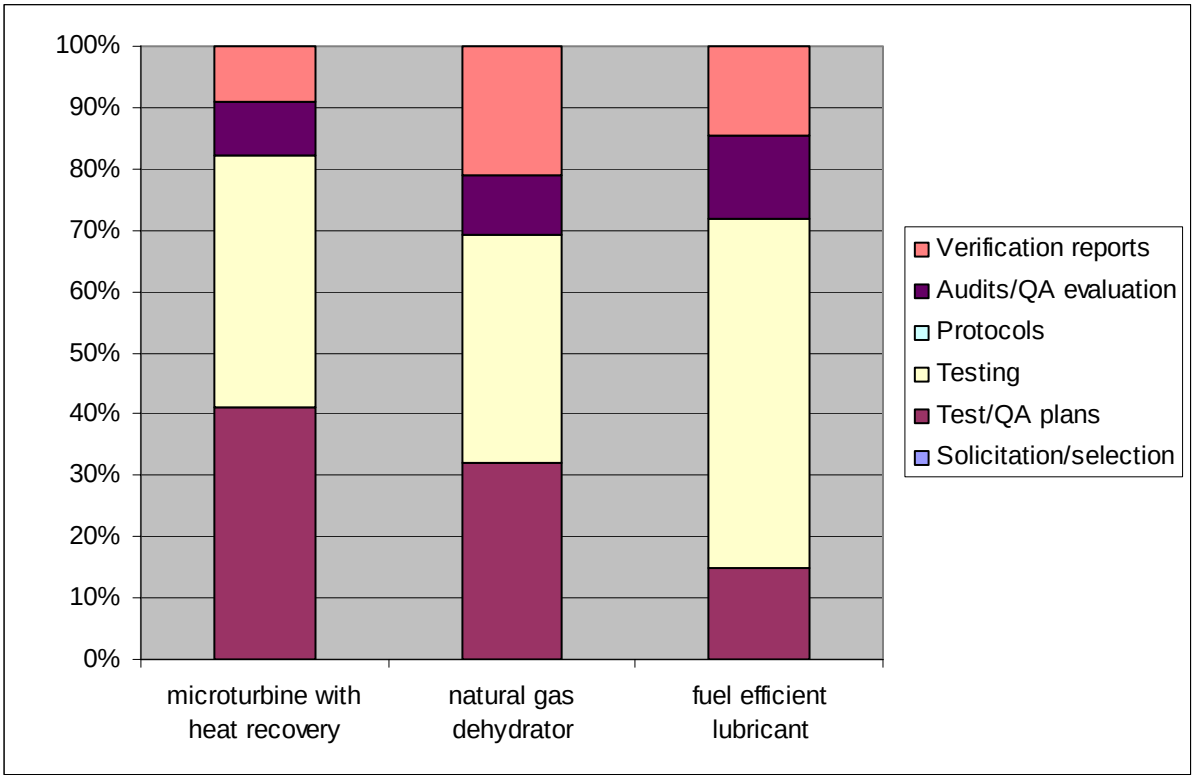


Table 7 : Absolute Verification costs for 3 GHG selected technologies

	Solicitation/ selection	Test/QA plans	Testing	Protocols	Audits/QA evaluation	Verification reports	Total[80]
microturbine with heat recovery	0	60800	61000	0	13000	13400	148200
natural gas dehydrator	0	95000	110800	0	29400	62300	297500
fuel efficient lubricant	0	27200	103800	0	24400	26800	182200

4.4 End-of-pipe technologies - the PRODEM system

As explained previously (see § 3.6), the PRODEM technology evaluation program of VITO concerns all types of environmental technologies.

The end-of-pipe technologies that have been tested in the past are the following:

- a new system of small-scale water treatment, based on the use of plant and natural materials. The verification focused on verification of the purification performance for different compounds (Chemical Oxygen Demand, N, P) over longer term (one year verification test).

[80] The average cost per technology verified in this centre was of $142000 for years 2001 – 2005 (38 technologies).

- a new disinfection technology, an alternative technology for disinfection of swimming water. The verification focused on the disinfection performance for different species.
- a new type of adsorbent oriented to the removal of hydrocarbons out of waste water. The verification focused on the adsorption performance.

It is important to point out that up to date, there is no governmental frame for these verifications. A major consequence is that the final cost for the tests is a result of a negotiation with the respective suppliers. This results sometimes in a more limited verification program compared to what was originally proposed by VITO. Most of the time, this means that a less elaborate measurement campaign is included in the test program.

The cost for the verification of a single end-of-pipe technology generally varies from €20-50,000.

- €20,000 EUR: only possible for 'simple' technologies as e.g. adsorption technology
- €50,000 EUR: more realistic for more complex technologies as e.g. biological treatment and membrane technology.

A more elaborate measuring plan will increase the costs, but of course also the information provided by the tests, especially related to longer-term performance of the technology. Costs might then increase towards €80,000, in some case even €100,000. On the other hand these costs may decrease if more than one related technology is tested at the same time.

The breakdown of the above-mentioned costs is approximately as follows:

- design of the test procedures: 10%
- set-up of a test system: 25%
- testing: 50%
- evaluation and reporting: 15%.

The costs include staff costs and other direct costs. However investment costs are not included, not even partially (investment costs for setting up the VITO test facility were around €10,000,000).

More elaborate long-term testing of small-scale domestic wastewater purification systems (including certification) were reported to be of the order of €150,000 per installation.

4.5 ETV Canada

ETV Canada is a system that differs from the previous ones since it verifies the claims of the vendor and the testing is not part of the verification procedure. The results of the tests only are scrutinized by ETV and used to substantiate the vendors' claims. Therefore it is difficult to include it in the previous case studies, if we consider the claim verification aspect of the system. However, the costs indicated are a good source of information to be able to compare different systems and their related costs.

Preliminary steps to the verification

In Canada, the generic protocol for the basic ETV was defined once and for all, for all environmental technologies, in 1997 and reviewed in 2000. No test plan is established by ETV Canada, but they can however provide a service to the vendor, before the ETV procedure, to conduct a mini-market survey and recommend a test plan. The cost of this service is CAD$5-7,000 (*€3.6-5,000)* (a maximum of CAD$10,000 (*€7,000*) has been reported).

The price of the tests is agreed upon between the vendor and the testing laboratory. The price can be CAD$3,000 (*€2,100)* (very seldom), but most often $100,000 (*€71,000)* or more. According to the ETV Canada manager, the price can reach up to $250-500,000 *(€178-355,000)*. It seems that the testing laboratories are the first beneficiaries of the system, followed by the verification agent (see below). On the contrary, ETV Canada organisation is presenting a budget deficit.

Verification of the claims

The verification done by this program is a vendor claim verification. A verification agent/entity is subcontracted for that task. The ETV procedure fee is $15-20,000 *(€11-14,000)*. Approximately 30% of this amount covers the expenses of the verification entity, who has more or less agreed on fixed rates for the verification of the data. That fee is rarely higher than $12,000 *(€9,000).*

Table 8: Summary of the different costs for verification and protocols with ETV Canada

Cost for	ETV Canada
Service for mini-market survey	CAD$5-7,000 *(€3.6-5,000)*
Verification cost paid by the vendor	CAD$15-20,000 *(€11-14,200)*
Verification agent	CAD$10-12,000 *(€7-9,000)*
True verification cost	CAD$25-30,000 *(€18-21,300)*
OCETA contribution	50% of the true verification cost
Tests (not included in the verification)	CAD$100,000 *(€71,000)*

According to an ETV Canada manager, the true cost of the verification is about $25-30,000 *(€18-21,000)*, i.e. roughly 50% higher than the amount charged to the vendor. The difference is paid by OCETA, which is based on other revenues enabling to compensate for the ETV deficit. Some vendors who went through the program are aware of this subsidizing by a private organisation. They know they are not asked to pay the full amount. However, others do not know about this financial aspect. This smaller amount the vendor has to pay has been defined as such because a market study has showed that this was an acceptable amount for vendors. However, some vendors have difficulties in collecting even this lower amount. Moreover, up to now, ETV was not in a strong enough position to charge more since it was not enough widely recognised. A summary of the various costs is given in Table 8.

4.6 Fees and costs assumed by vendors

Vendors' willingness to pay

The interviewees were asked how they would estimate a reasonable amount that they would accept to pay to have their technology verified. The replies were based on the vendors' experience, related to (1) having one of their technologies tested by a third party, or (2) referring to the marketing budget they have, or (3) as a percentage of the technology development cost or, (4) in most cases, referring to the amount they paid to have a technology ETV verified (or type-approved or certified). In this latter case, the amount they actually paid for ETV may be higher (or lower) than the amount they are willing to pay for a future ETV.

Several vendors mentioned they are willing to pay higher amounts compared to what they currently pay for a verification/approval if the verification enables them to enter any national market in Europe without having to go through each national type-approval/verification system.

The vendors usually sustain that their financial contribution should cover, at the maximum, the "performance test" component of the verification, since they believe that the generic protocol should not be charged to them. Indeed, their argument is that one single vendor would have to pay for it (the one who applies for the verification first), whereas others, with similar technologies who would apply later on, would not have to pay. They suggest that it is not fair to the first vendor to pay 100% of this generic protocol cost. It should either be paid by the program or spread among several vendors. The general opinion is that the protocol, which will be the property of the EETVS, should be paid for by public funds or other contributors.

However, certification practice has avoided this problem by charging the subsequent "users" of the protocol, fees that are returned to the first user. With this system all the users pay the same amount of money and this amount diminishes with the increase in the number of users.

Amounts currently paid for a verification

When asked how much they paid for the verification of their product, the vendors usually split the cost in two items:

- the official fee paid by the vendor to the verification program they went through
- the total cost, including internal costs

Fees associated to the verification directly

Costs associated with ETV and paid by the vendor vary from one system to the other. Since most of the persons interviewed had been through US ETV or ETV Canada, we will mostly conclude on these two systems and add some extra comments on MCERTS and UBA.

The direct cost associated to ETV Canada is usually much lower than the one charged by US ETV, the main reason being that ETV Canada requires that the vendor provides the supporting performance data for the verification. However, to obtain that data, the tests

usually cost the vendor about CAD$100,000 *(€71,000)* (the range extends from $30,000 to $250,000 (*€21,300 to 177,500*), according to ETV Canada managers). So the total cost for the vendor ends up being comparable to the one spent by US ETV.

For instance, according to the ETV Canada managers, the price charged to the vendors for a verification report is usually around $15,000-$20,000 *(€11,000-€14,200);* ETV Canada may however provide subsidies to some vendors, hence decreasing the cost to the vendor. US ETV-verified vendors we interviewed were charged from US$5,000 to $30,000 *(€4,000 to €23,700),* although the cost of a verification can reach $100,000 *(€79,000).* It is important to note that this cost includes the testing fees in the US ETV system.

There is a net evolution in time of the fees billed by US ETV to the vendors. The first verifications done during the pilot phase of the program were free. The cost then increased gradually, as the federal government was reducing its financial participation. From now on, the VOs will have to be self-sufficient, since in 2005 the federal government unexpectedly decided to stop financing the program, starting from 2007.

MCERTS is usually charging amounts of the order of €50-60,000. However, in the case of an innovative technology that MCERTS considers as interesting to be tested by the program, MCERTS may decide to pay for part of the testing cost. In this case, the amount of subsidising by MCERTS may vary from one technology to another. For instance one vendor only paid €5,000, while another one ended up paying more than £30,000 *(€44,000*) because testing that innovative technology was more complex than expected.

Few interviewees have experienced UBA. However, the price to pay to get certified by UBA is rather high: on the order of €100,000 for the people interviewed. Table 9 gives a summary of these costs. These values are of course rough approximations since they are very technology dependent and can vary enormously between different cases. They are provided just to give a vague idea of the costs that a vendor will have to endure if he goes through the verification process in these different systems.

Table 9: Fees charged to the interviewed vendors by the different programs

ETV Canada	US ETV
CDN$15,000-20,000 *(€11,000-14,200)* (no testing)	US$30,000 *(€24,000)*
MCERTS	UBA
€50-60,000	€100,000

Additional expenses

In addition to the administrative and test fees, it is important to take into account the time and effort needed by the vendor to go through the process. When testing is required, this implies that the vendor has to provide one testing kit/product (two in the case of UBA), which has a cost. In the US ETV system these costs are monetised under the heading "in kind contributions".

Here is a list of possible additional costs:

- testing kit/technology
- shipping
- staff time (training of ETV staff)
- travel to the field
- equipment rental
- report writing/review
- test plan review.

Here is a typical example of the order of magnitude the interviewed vendors had to expend as additional costs. Shipping could amount from $200 to $2,000 *(€160 to €1,600)*, staff time about $3,000 *(€2,400)*, travel to the test field $1,000 *(€800)* per flight, equipment rental about $500/month *(€400/month)*, effort for review about $3,000 *(€2,400)*. So the additional fees can easily add up to $10,000 *(€8,000)*. Regarding the cost of the testing kit/technology, the cost varies greatly: an analyser can cost about $25,000 *(€19,800)*, whereas an engine can reach up to 2 million dollars *(€1.6 million)* – according to the vendor.

The amount paid was the maximum these companies could afford; especially taking into account the increase in sales was not high. When asked again to participate in the program for another technology/product, they usually refused because the prices for verification went up (US ETV). Besides, regarding ETV Canada, the renewal of the verification was considered by the vendors as a "money machine" only. An additional cost of CDN$2-3,000 *(€1.4-2,100)* has to be considered if the vendor seeks renewal of their certification in Canada, every two years (another payment occurs every 5 years).

4.7 Time needed for verification

Time has an influence in businesses as it prevents the company from getting the verification report and compete in the market place, and it keeps staff busy on some projects, whereas they could work on other things. If it takes too long to be verified, the vendor may lose some market share or their product might be improved meanwhile, which makes the verification results useless.

US ETV has been reported to be a long process, taking up to 18 months on average. The verification report seems to take a long time (up to 6 months), whereas tests are usually fast to carry out (a few days or weeks), once a time window has been agreed upon. Tests can be more time-consuming when they include a field test and/or when a staff member is sent to explain the operating conditions of the product. A big issue is to decide on the test plan, which can take several months. Indeed, the vendor may ask for specific tests that would prove the originality of their product/technology. Moreover, innovative technologies usually do not have a protocol associated to them and these are generally very long to establish.

ETV Canada has been reported to be quick (6 months) as there is no testing required. However, the difficult part, which is prior to the verification itself, may be the writing of the claims, for which ETV Canada can assist the vendor (this can take 1-2 months), and the search for a verification agent/entity. This last step has sometimes been a real effort for innovative technologies.

MCERTS includes some laboratory tests (quick to run in general) and field tests. MCERTS is very popular among buyers. Therefore, a lot of vendors decide to have their technology certified. As a consequence, there may be delays, in addition to other problems inherent to such a system (administrative issues, problems with data at the testing facility, malfunction of the vendor's product). The whole process should take about 6 months but many vendors had to wait for 10 months. One extreme case of a vendor who spent 4 years to have his technology verified was reported as well (for the special case of a very innovative technology). This time issue is particularly important as MCERTS verification is in reality almost "mandatory". Table 10 summarizes the average times mentioned during the interviews.

Table 10 : Average time needed for verification/certification

ETV Canada	US ETV
6 months	12-18 months
MCERTS	**UBA**
10 months – in theory limited to 6 months	NA

5 Market Survey

5.1 Introduction

The market survey has addressed, in particular, the expectations of the end users from a European ETV system and their willingness to participate to it, including in financial terms. The sound management of the system and related operational procedures were also addressed. The results represent strongly the vendors' point of view, since very few technology buyers provided replies. Representatives from existing ETV systems, public authorities and other stakeholders have also participated to the survey.

The market survey was carried out in the period 02/2006 – 06/2006. The survey was done using questionnaires and telephone interviews. 34 questionnaires[81] were received and analysed out of 180 sent. 75 interviews[82] were conducted.

Some of the European vendors contacted had already been through existing ETV-type programs and were able to assess the advantages and drawbacks of these systems for vendors. The market survey was completed by interviewing vendors, mostly from North America, who went through existing ETV-type systems, so as to assess the impact of such programs on these companies[83].

Table 11 : Type of interviewees and country of origin

	Europe	USA	Canada	Total
Vendor	17	13	8	38
Buyer/User	4	0	0	4
Public Authorities	10	0	0	10
Other Stakeholders	10	0	0	10
ETV-related programs[84]	8	4	1	13
Total	49	17	9	75

Finally, managers of these existing programs were also interviewed. Table 11 details the distribution of interviews with respect to their type (vendor, buyer/user, public authority, other stakeholders, existing ETV program) and their origin (Europe, USA, Canada). The full list of interviewed stakeholders is given in Appendix D.

[81] Appendix A: European ETV survey questionnaire
[82] Appendix B: Guideline for interview: Stakeholders
[83] Appendix C: Guideline for interview: Impact assessment
[84] The expression « ETV-related programs » refers to certification/labellisation or ETV programs that already exist, such as US ETV, ETV Canada, MCERTS, UBA, systems in California etc.

The interviewed vendors went through the following systems:

- US ETV: 21
- ETV Canada: 6
- MCERTS: 6
- UBA: 2

It should be noted that some vendors went through more than one system whereas other interviewed vendors have not been through any system. Besides, some Canadian vendors went through US ETV instead of ETV Canada.

5.2 Key findings/General questions

The first part of this chapter (§5.2.1) is epigrammatically enumerating the most frequent answers in standard interview questions. In the second part (§5.2.2) these trends are re-examined and the findings considered as the most important are detailed. These findings are commented and interpretations of the interviewees' replies are proposed, where pertinent.

5.2.1 Trends arising from the interviews

The outcome of the interviews is sorted by topic. For one specific topic, only the opinions cited very often (over 50% of respondents to that question) are presented here.

General questions regarding the program

- Usefulness of the ETV program: The European program will be useful if:
  - ✓ It represents a guarantee for quality of information on a technology
  - ✓ It enables to have access to the market in each Member State, without having to go through additional local/national approval programs
- Prerequisites for an effective ETV program:
  - ✓ The program should be simple, low cost/affordable and fast
  - ✓ The technical level of the verification has to be high
  - ✓ The program should be voluntary
- Should ETV be a fully public or a public/private initiative?
  - ✓ ETV should be a public/private initiative: the private sector will provide the funds and the public sector will help for recognition of the ETV system on the market. In its pilot phase however, involvement of the public sector (mainly for funding) should be significant.
- Eligibility criteria:
  - ✓ Opinions are divided on whether the ETV program should accept all technologies or if priority should be given to some technologies.
  - ✓ Prototypes and commercial products should both be accepted for ETV verification. In this case, a distinction needs to be made for the buyer to easily know which one has actually been verified.

- ✓ The program should be open to all companies, small and large, European or not.

Procedural options

- Definition of a "verification" of an ET:
  - ✓ The three options are equally cited: US ETV-type verification, ETV Canada-type verification, and verification of compliance with minimum requirements. Advantages and drawbacks of each option were cited.
  - ✓ Several two-level systems were suggested: for instance, having an ETV logo for prototypes and another one for commercially ready products; having an ETV logo for conventional ETs and another one for innovative ETs. Besides, some interviewees mentioned a multi-level system that would judge the performance of the ET and therefore award logos referring to higher or lower quality (categories A, B, C that already exist for refrigerators for example).
- What a verification should (not) be (irrespective of the definition chosen)
  - ✓ Verification results should be easy to understand. It is important that a buyer does not need a specialist's knowledge to understand and evaluate the performance report of an ET.
  - ✓ The verification procedure should be simple and transparent

Financing the EETVS

- Is the cost of a verification procedure a major factor of success?
  - ✓ The cost of the verification procedure is a very important factor and should be kept low
- Should there be specific public support for SMEs, to prepare for going through the verification process?
  - ✓ There should be specific public support for SMEs. This is essential, as SMEs would be driven out of business otherwise.
  - ✓ The vendors should however pay for at least part of the verification.
- At what level should the stakeholders contribute, and what should their role be?
  - ✓ Everybody should play a role, whether it takes the form of guidance or the form of financial support.
  - ✓ Member States should play an active role: they should contribute financially to ETV and should help identify other sources of funding.

Organisational structure

- Accreditation of testing laboratories
  - ✓ The testing laboratories (TL) must be accredited for a specific technology area.
  - ✓ Accreditation criteria: the TL should be an independent body (no in-house testing).

- Developing the evaluation tools

- ✓ Test protocols: their development should be paid for by the public part of EETVS, and if a protocol is used by another ETV program, it should be used at least as a basis, when developing the EETVS protocol.

Factors of success

- Criteria to ensure the credibility of the system on the market
  - ✓ Gain broad recognition by being recommended and promoted by public authorities.
  - ✓ Credible verification results, by giving priority to technical excellence.
- Criteria to ensure the system is useful to the market
  - ✓ Useful to the Vendor: simple procedure, with as little bureaucracy and formal procedures as possible.
  - ✓ Useful to the buyer: a public database that enables to compare main performance data.
- Criteria to ensure the system is accessible to the vendors
  - ✓ Accredited TLs should be located in as many countries as possible so as to reduce distance and cost for the vendor
  - ✓ The fee paid by the vendor for verification should be low.

5.2.2 Key findings from the interviews

The comments of the interviewees are given in plain letters, whereas interpretation of these comments is in italics.

General questions regarding the program

Usefulness of ETV in relation to existing systems - harmonization: A European ETV system is widely considered as a useful tool provided bureaucracy is kept to a minimum and high technical level is guaranteed. Thanks to this European wide recognized system, the existing procedures for technology type-approval required in each country are expected to become unnecessary. However, vendors fear there will be a duplication of systems in Europe because of the creation of EETVS and in the end, will have to pay more for the same service.

Some confusion with current type-approval, or certification processes is noted; therefore the meaning of verification and of the ETV logo (or label) will need to be clearly communicated.
In fact, most vendors were vague about these existing systems, and only few vendors were able to cite the names of the type approval systems they supposedly have to go through to be able to enter a certain country's market.
Nonetheless, the designers of a potential EETVS should be aware of the existence of numerous national, and sometimes local technology approval systems around Europe.

Harmonisation of the EETVS with the existing verification programs in the world is necessary (USA, Canada), as well as mutual agreements.

During the interview, a manager of the ETV Canada said they are willing to collaborate with the EU in developing its EETVS, and share the generic protocol which is the basis of the ETV Canada program. A Verification Centre of the US ETV reacted in the same way.

Factors of success – requirements of ETV: For the program to be effective, it should be simple, fast and affordable for the vendors. It should also be widely recognised, both in Europe and worldwide, as a reliable tool to assess the quality and performance of an environmental technology and should be based on a procedure of technical excellence. The European vision of the program is important to vendors, although they are aware of the difficulties and the time needed to harmonise all national practices and regulations in Europe.

Most stakeholders see the system as a public/private initiative, the public part helping for recognition and the private part providing the funds and assuring that the system is close to the market. The system should however start off as a public initiative in which the EU and Member States take part.

Examples of programs that use a private organisation to run them exist (MCERTS through SIRA, ETV Canada through OCETA) and comments about them were mixed.
The US ETV program, that is run by a public structure, started with a 5 year pilot project involving 12 Verification Centres, and the vendors were invited to have their technologies verified for free, at least during the first couple of years.

Prioritization of technologies and the question of prototypes: The program should be open to all technologies, but priority should be given to some ETs chosen because of their bigger environmental impact or because they are needed on the market. However, heterogeneity in Europe should be taken into account when defining the priority technology areas. New and innovative technologies should also have priority. The need of an ETV program is particularly strong for technologies that are not covered by standards of regulations.

Prototypes and commercial products should both be accepted, but some distinction in the awarding process will need to be made (e.g. keep the ETV logo for commercial ETs). Although ETV Canada and US only accept commercially ready products, the interviewees considered the case of prototypes for the EETVS. Indeed, small companies that cannot perform their tests in-house can learn about their product through testing done by a third party using well-recognised ETV test protocols. They would gain a lot of knowledge from that experience. It seems difficult and confusing to set up different levels of awards. This implies a lot of communications and testing facilities that can adapt to such a range of different products.

Testing prototypes is out of the scope of existing ETV programs, mainly because a prototype is bound to evolve and therefore the performance data at a certain stage of the prototype development would be meaningless for a buyer of the future commercial product.
However, if the technology developer is willing to pay for the verification, it could be useful to the developer to evaluate the prototype on the basis of established protocols that are recognised on the market, thus enabling him to compare with the future competitors and decide if the technology is ready for commercialisation. A verification of a prototype should not, however, lead to awarding an ETV logo, and the verification report should not be published. The verification of a prototype can be even more difficult to implement if it would necessitate the development of a dedicated protocol. In any case it should be born in

mind that the frontier separating a prototype from a fully commercial product can be a blurred one.

SMEs versus large companies: The program should be open to all companies, SMEs or large groups, whether European or not. However, specific treatment should be applied to SMEs (through financial support and guidance) and to non-European vendors (who should not receive public funds). The program seems better targeted toward SMEs than toward multinationals. The benefits gained from the verification by these large groups are very small and they may not be interested in paying what could still be considered an important amount of money by them for a limited reward.

Discrimination rules may have to be examined closely. Some measures suggested by the interviewees may not be compatible with EU competition rules.

Procedural options – organisational structure

Different verification systems: The US ETV-type verification, the ETV Canada-type verification (or claim verification) and verification compared to minimum requirements, are equally cited as the most relevant definition to adopt for the EETVS. Some suggest that the system should offer several types of verification, e.g. US ETV-type verification or verification compared to minimum requirements. This latter alternative would be appreciated by the market (and the public authorities) since it would enable to point out the environmentally sound technologies, whereas a simple verification (i.e. US ETV-type verification) of the performance requires that the buyer has a sound knowledge of basic engineering principles in order to be able to evaluate the results.

These three different options have both advantages and disadvantages. The US-ETV scheme requires the testing to be done inside the ETV system. Data, referring to similar technologies are thus generated (ideally during the same testing "event") and published. The technologies are not ranked in any way and the end user is invited to compare them based on the publicly available data. The Canada-ETV scheme is based on the verification of the data provided by the vendor and does not include the execution of tests inside the system. This system, like the previous one, does not compare technologies to each other. However the information is now provided in the form of a verification statement, or claim that is submitted by the vendor, together with the experimental data. The adequacy of the data to support this claim is then verified.

The US-ETV system is more complex to put in practice, since it involves the actual execution of the tests by the ETV system, through accredited laboratories. The advantage is that ETV has control over the way the tests are carried out and verifies not only the results but the application of sound scientific principles during the execution of the tests. On the other hand, ETV Canada is verifying claims based on previously established data, since the tests are done outside the system. An obvious advantage of this option is costs and processing time.

A choice between different options is thus presented to the EETVS. None of them however, at least in their actual form seems to satisfy all the stakeholders. In both systems presented above, there is a possibility for a very low performing technology to be successfully verified by the system.

Credibility – Market recognition: The best ETV Team is generally considered to be a public body. A private body playing the role of the ETV Team could be credible provided it is totally independent, and it would have the advantage of being more reactive.

> *Recognition of the ETV scheme from the market is a crucial issue. Even if he may not be familiar with the logo, a buyer will tend to be more confident if he sees it is backed by a public body.*

The testing laboratories must be accredited by the EETVS, an essential criteria being their independence. For each technology group, there should be more than one accredited laboratory to avoid monopoly and delay in producing test data.

For the verification organisation (VO), to be credible, it should not be directly involved in the performance testing itself, and it should have a very good expertise in the technology area it is in charge of.

> *Ideally the VO and the TL should not belong to the same structure. However, practical considerations or the availability of the adequate expertise may justify the merge of the VO and the TL in one entity, duly audited by the ETV supervising organisation.*

Besides the vendors, it is important that the most relevant stakeholders of each technology category take part in the system: Member States, buyers, users, academics, trade associations, etc.

Test Protocols: The test protocols should be established by independent experts (not by bureaucracy), using existing protocols as a starting point when possible. Their development should be paid for by the public part of the system (i.e. not by the vendor).

> *This issue has to be taken into account in the financial scheme of EETVS because the system can be very expensive for innovative technologies, especially because those are the technologies that would be expected to benefit the most from EETVS.*

Financing the EETVS

Cost is of course a major issue for vendors who may go through the ETV program, but also for all stakeholders that would enable the program to run properly. It is obvious that the cost of verification should be kept as low as possible.

> *The difficulty is to define how much "low cost" actually means; to quantify what "low cost" could be, a vendor will put into the balance factors such as the technology type, the selling price of the ET on the market or the volume that can be sold. Besides, some technologies are very expensive to test because they require elaborate field tests or even dedicated equipment.*

Willingness to pay: A suggested price range between € 5,000 (not including tests – ETV Canada type of verification) and € 25-30,000 (including tests – US ETV type of verification) has often been cited. But it is a function of what the buyer would be ready to pay for guaranteed quality and whether it is mandatory to go through ETV or not. A large source of the cost of verification for vendors is linked to the TL.

To some vendors, the verification appears to be moved by political reasons: it serves to define new regulations since the program can gather information about the state of the art of a technology. In that case, vendors think the verification should be highly subsidized. Others think that very innovative technologies should be highly subsidized since they contribute to the improvement of the environment. However, a deeper problem is to motivate vendors to go through the verification process, without its becoming mandatory. Vendors should have a good reason to spend such an amount of money and ETV's role on the market has to be clear and useful.

The choice of the testing laboratory: Two views are opposed regarding TLs: the vendor should / should not be able to pick the TL of his choice to do the testing. In the case of US ETV, the verification centre may be the one that often conducts the tests, at the risk of a monopoly. Besides, if the vendor is free to address any TL, the next question is whether all TLs should charge the same amount for the same tests or should they be allowed to fix their own price.

Behind this problem is the question of not only accrediting the TLs but also making sure they are keeping the same high standard of testing. It seems fair that the vendor can contact any TL that has been accredited by EETVS and competition play a role in the price. However, the quality of the results should not be compromised. Therefore it seems important to regularly audit all the TLs. A strong position of the VO (like the US verification centre that sometimes performs most of the tests) is another possibility. However it may give some weight to some countries, to the detriment of maybe smaller ones.

Subsidies – financial support: Whether SMEs should benefit from special public support to go through ETV is debatable. Financial support to any company is usually widely accepted, taking different forms such as subsidiary, special term payments or special loans. But although some interviewees stressed that SMEs need public support (and may not even need to pay anything) to get ETV verification, other suggested that other factors should be taken into account, independently from the size of the company. For instance, the environmental impact of the technology should be one of the strongest arguments for a company to get financial support. The innovative aspect, the sustainable development quality of a technology are other factors mentioned by the interviewees. Considering this, all companies could be eligible to financial support.

Financial help is a strong incentive for vendors to go through the verification process. This help could intervene at different levels: business angels, regions, Member States, European Commission. SMEs are the target of ETV in the sense that they are usually innovative but once they have spent their budget in R&D, it is difficult for them to pay for the verification. This is linked to a previous comment stating that ETV's role and advantages have to be clear.

Mandatory versus voluntary schemes: It has been stressed that any action by Member States that would give an advantage to verified ET would in a way make the process look mandatory and would justify some financial help. MCERTS, for example, has reached that level over the years.

The mandatory aspect of EETVS could be similar to what happens with MCERTS for instance. This UK scheme is running on a voluntary basis. However, throughout its

implementation it has gained such credibility that producers who wish to enter the CEM market systematically opt for having a MCERTS certificate, under pressure from the users who are fully convinced of the benefit of MCERTS. The market is behaving in such a way that the scheme resembles to a mandatory one. Some vendors stressed that EETVS should not reach that level of compulsoriness. They are afraid that the verification would then become banal and it would, in the end, make people pay for something that resembles a certification without being one. If EETVS becomes mandatory, vendors think it should be fully subsidized, whereas type-approvals are not. Countering this line of thinking one could argue that first of all the MCERTS scheme is a certification scheme and secondly, most certification schemes are strictly voluntary. If now an ETV scheme gains such success that it becomes necessary to the majority of the vendors of a specific market, then this could be interpreted as a sign meaning that the system is ready to move towards certification.

Financiers: Finally, all stakeholders should contribute financially: not only the Member States, the EC and the vendor, but also trade/industrial associations, users, regulators, environmental groups, public authorities etc. Venture capitalists may not be allowed to participate in ETV because of some potential conflict of interest but they could play a role when investing in innovative vendors.

The contribution of the stakeholders may take different forms: they could finance the verification, of course, but they could also, for instance, provide the facilities, equipment and staff for the tests. Test results have to be fair, still, but a problem of conflict of interest is rather mentioned in the global organisation of EETVS rather than with stakeholders and testing.

5.3 Impact assessment

The opinions below present the trends observed during the interviews with the vendors that have already gone through other[85] ETV programs in Europe and in North-America (MCERTS, UBA, US ETV, ETV Canada). They have been collected and analysed during 30 interviews. The interviewed vendors have not, as a general rule, conducted an impact analysis in their own company, of the impact of the ETV system, so as to apprehend what percentage of their sales can be attributed to ETV or to what extent did ETV permitted them to enter a new market. Moreover, a handicap of this impact analysis is the difficulty to evaluate the relative influence of the ETV logo and the products own characteristics on the purchasing decision. This means that the answers obtained are based on a general appreciation of the ETV system or better the general "impression" that the ETV system has left to the participants, and this includes apart from the impact on sales, factors as flexibility, costs, reaction time, presentation of test results, use of the logo etc.

The presentation of the results is organised in the following way. As in the previous chapter, at first, the "raw" results/replies are given, accompanied with some brief conclusions (§5.3.1) At the following chapter (§5.3.2) an analysis of these results is proposed and some interesting (or anecdotic) contributions from interviewees are cited in detail.

[85] MCERTS is a certification scheme and UBA is a type-approval one. They were chosen though since many of their functioning aspects can be found in the ETV programs of US and Canada. See §3.1 for a tentative definition of these schemes.

5.3.1 Answers of the interviewees

- Description of the process of going through a verification program:
  - ✓ The vendors were often solicited by the US ETV program: this is a way for US ETV to gather several technologies and know the state of the art in one domain. The results can help define new legislations. If, for instance, no ET has been able to achieve a satisfying performance level in a specific field, no regulation will be decided until some performing ETs are available on the market.
  - ✓ The process was slow and time-consuming.
  - ✓ The Germany UBA was particularly praised for its scientific quality
- Was the outcome of the verification worth the investment (in terms of time and money)?
  - ✓ The verification was generally worth the investment.
  - ✓ In some cases, for some markets, verification was essential to do business.
- Did the verification accelerate the entrance of the vendor's ET into the marketplace?
  - ✓ Verification did not accelerate the entrance of the ET on the marketplace. About 90% of the interviewees agreed on this. However, this was not based on information from the sales department. It was rather the general feeling of the interviewees. Nevertheless, this answer should be weighed carefully in our analysis because, although most of them did not see any acceleration of their entrance on the market thanks to ETV, they did admit that ETV helped them gain their first clients (in the case of start ups for instance) thanks to the recognition they gained from the verification. It may be closer to the truth to say that it is not trivial to estimate the impact of ETV since a sale will not depend solely on ETV but the program will play a role to finally convince the buyer.
- What was the impact of the verification on the vendor's overall business?
  - ✓ There was no real impact on the overall business in general. As in the previous case, this comment made by the same vendors who did not see any improvement in their entrance on the market thanks to ETV, is to be considered carefully. There is, once again, an apparent contradiction in the sayings of the interviewees.
- Advantages and drawbacks of the program:
  - ✓ Advantages:
    - Testing several ETs at the same time is interesting technically and financially (US ETV). The buyer can also compare the products more easily.
    - Testing: It is helpful for people who cannot do tests in house, by enabling them to learn about their product.
  - ✓ Drawbacks:
    - The tests are not always done in the right conditions or by sufficiently competent personnel.

- It is expensive, especially when an engineer is sent to the test site or the organisation of the ETV system is not optimised.
- It is slow.

- How could the program be improved?
  - ✓ Time is an important issue
  - ✓ Publishing the results is a big concern
  - ✓ Testing: the flexibility with the test results has to be improved. It may be needed to do more tests. Several vendors mentioned additional tests would have emphasized specific qualities of their technology/product. The difficulty of ETV, according to the vendors, is to be flexible enough to adapt to individual ETs. The program is regarded as being too rigid.

5.3.2 Analysis of the results

Impact on sales

No direct increase of sales has been observed by the interviewees, either because it is difficult to differentiate if the customer has been attracted mainly by the ETV logo or by the product characteristics, or because ETV truly had no impact. As several companies interviewed were small at the time of ETV, their sales increased as part of the development of the business. For larger companies that were already selling their product on the market, there was no sign of improvement of their sales. Besides, the people interviewed were often technical employees responsible for certifications: the marketing or sales department had not informed them of any sales increase regarding the ETV-verified products. Additionally, for some vendors, it was too early to see the impact of the verification as they had just been through the process.

ETV was thought as a means to accelerate the entrance of a technology on the market. Since no increase in sales was associated to the US or Canadian logo, there was no real acceleration of the entrance on the market, despite a broader recognition and credibility. It is important to note that in the UK, certification by MCERTS is highly recommended and in Germany, type-approval by UBA is mandatory. Therefore there is no point in estimating an increase in sales since the product would not be sold otherwise. However, because of this mandatory aspect, MCERTS-like systems may have the tendency to slow down the entrance of new innovative products on the market in general. The case of US ETV or ETV Canada is slightly different as was mentioned earlier. However, some vendors complained that if they choose to go through the verification process, their business is slowed down. This is because they spend a lot of resources on the verification process and they lose time since they have to wait for the issuance of the logo. At the same time their competitors may market their competing product earlier, without any control over the product's performance characteristics that they have to declare.

The general trend is that the vendors are not completely satisfied with their experience. They felt somehow pressurized to participate (whether by the market or by the way the program's advantages were sold to them). The results have not translated into a big increase in sales for their company. Besides, the vendors often complain of a lack of communication, mostly

concerning buyers who do not know about the system and the meaning of the logo. Still, "in some cases it is essential to do business".

Advantages of being ETV-verified

Notwithstanding the opinions expressed in the previous paragraph, in almost all cases, the interviewees thought US ETV was worth the time and money spent. One person underlined the fact that ETV is particularly useful when there is no regulatory framework for the ET. Although there was no visible improvement in the sales department, they did gain credibility and recognition. This is particularly true for start ups who gained their first customers thanks to the ETV logo that proved they were recognised by a public authority. Although the vendors did not make this association, we thought that this could be seen as an impact of ETV on sales. Therefore it contradicts their previous affirmation on sales. This is reflected on the whole company. Despite the lack of increase in sales, the company benefited from the broader recognition and credibility. This gave the marketing department a useful tool to convince potential clients.

The logo can be posted on the Web site of the company or at trade shows. It does help the company in the sense that it can bring a little advantage compared to a competitor. It is then up to the company to make use of this new marketing tool. However, a lot of interviewees recognised they did a mediocre job at marketing their verification: they acknowledged they did not make use of the logo efficiently.

In the case of ETV Canada, being verified was very useful to vendors who targeted public markets, as the verification was recognised in all provinces. However, they faced a lack of recognition toward the private sector.

The advantage of being certified through UBA or MCERTS is obvious as it is mandatory (UBA) or considered as mandatory by the players (MCERTS). Besides, as British users are strongly encouraged to buy MCERTS-certified products by MCERTS itself (MCERTS has decided to direct its “marketing” activities toward the users to promote the value of the certification system), having the certificate is crucial for the vendors.

Drawbacks of the verification

In the case of US ETV, since all results are published, a bad result can become an issue for some companies. For instance, it has happened that a technology tested on invitation of the US ETV was not used in the right conditions (according to the producer: much higher concentrations for a membrane, cold environment). Therefore, the product did not perform as well as expected. The report issued and published on the web site ended up having a bad influence on the sales of the company. In a different case, one interviewee went through several tests, with the same category of products. The first ones went very well and the company was the best among the little group that got tested simultaneously. Their sales increased slightly, supposedly as a result of this. However the last test results were not good and since this result is the last one published on the web site, this one has the worst influence and the company admits they lost some clients because of it. Needless to say that in this case, the company did not do any marketing based on the logo.

Note that when the vendor recognised there was a slight increase in sales, this may appear in contradiction with other statements saying there was no increase whatsoever. This may be due

to the fact that the vendors expected a whole increase in sales, a much bigger impact on their company that what ended up happening. It is important to keep in mind that those comments were gathered during interviews and the interviewees, who nevertheless, received the interview guidelines in advance, answered sometimes subjectively. They all mentioned that no estimates of sales and the impact of ETV were available to back up their statements.

In the case of MCERTS, the long period of time needed to go through the administrative steps and the testing has been an obstacle to sales. Some clearly estimated the loss that created, taking into account their competitors got through the certification faster. Indeed, their customers were willing to wait for the certificate to buy their products. But they could not wait longer than two years and since MCERTS is mandatory in a way, they finally had to purchase the competitors' product. The reason why the competitors went faster is the following, according to the interviewee: as this innovative technology was complex to get tested for a reasonable amount (several test laboratories refused to do it for the amount indicated), MCERTS realised the certification process had to be simplified for a similar technology. Therefore the interviewee went on with the certification process (since some tests had already been started) while their competitors benefited from the simplified procedure. In the end, it took about four years for the interviewee to become MCERTS-certified, while it was faster for the competitors. This case is however, unusual. The most often mentioned duration for certification was about 10 months, a few months longer than the expected one.

In the case of US ETV, the fact that a technology has obtained worse results from other technologies can be used by the competitors as a marketing tool. This can have a really bad influence on the "victim" company. US ETV does not provide a direct comparison of the technologies since results are published individually on the web site. Nevertheless, it is easy to identify the technologies tested simultaneously, based on the date, and compare them. Moreover, recently, the US ETV did publish a report comparing the different technologies they tested, without mentioning the names of the companies. Reading this report, it is easy to link it to the results available on the web site to identify the vendors compared. However, it is forbidden by US ETV to inform a potential user that the tests have been carried out simultaneously and the individual reports are a comparison certifying one vendor is better than another (the vendors are told the proper use of the logo when they sign for the verification). Therefore, a vendor filed a suit against a competitor who acted in such a way, which was accepted. As a consequence, it was publicised by US ETV that the first vendor did not act properly.

The possible malfunctioning of the system, especially regarding processing time, and worse than anticipated performance results are two major sources of concern for the vendors. Generally speaking, the fact that the performance levels of competing technologies are freely available might constitute a disadvantage for some vendors but it is certainly a considerable advantage for the buyers. Apart from being a market instrument in the hands of the vendors ETV is also a means for the buyer of making informed purchase decisions.

Social impact

The increase of sales could lead to hiring more employees. It happened to some vendors who grew from less than 10 people to a few tens of employees. However, none of them could certify this was due to ETV verification. They rather mentioned the fact that the company was a start up at the time of the ETV verification and it was part of the natural evolution of their

business. Larger companies, on the other hand, did not hire more people. However, no loss of jobs has been reported.

An often cited problem, related to the creation of EETVS, has been the question of the future of existing verification programs, such as type approval, certification or labelling and their relation with ETV. Vendors fear that EETVS might just be another certificate that will duplicate what exists already and that will force them to spend even more money to get their products marketable. To make EETVS successful, vendors suggest it should take into account the existing certification/verification systems in Europe. That way, the testers will not suffer any job loss in their sector, because of the creation of a new system. Vendors will also not duplicate all their testing efforts.

6 A model for EETVS

This chapter presents the structure of a model that could serve as the basis for the implementation of a European Environmental Technology Verification System (EETVS). It is based on existing ETV models and takes into account the results of the market survey on actual and potential users of an ETV system. The study of ETV systems permitted to identify all the entities that constitute an ETV system, which have been adapted to the specificities of the EU. The market survey permitted to take into consideration the opinion of the end users on some critical aspects of the system. The model does not propose a unique solution for ETV, but a range of possibilities, each one having strong and feeble points. The model describes the overall organisational structure of the system and details the responsibilities of each one of the system constituting entities. The common tasks, which need the collaboration of more than one entity to be carried out, are also described. It is certain that a running ETV system will have to draw up more specific rules on how the different entities collaborate, interact, decide and solve eventual conflicts, but this is out of the scope of this report.

The general idea is that EETVS will rely principally on existing structures that will assume the role of the different entities of ETV. Only one entity that will take the role of the central organising and supervising unit, called the “EU ETV Team”, will have to be created from scratch. The degree of involvement and responsibility of this dedicated "EU ETV Team" can change keeping the general model structure, and this is also discussed below.

6.1 Description of the various ETV actors

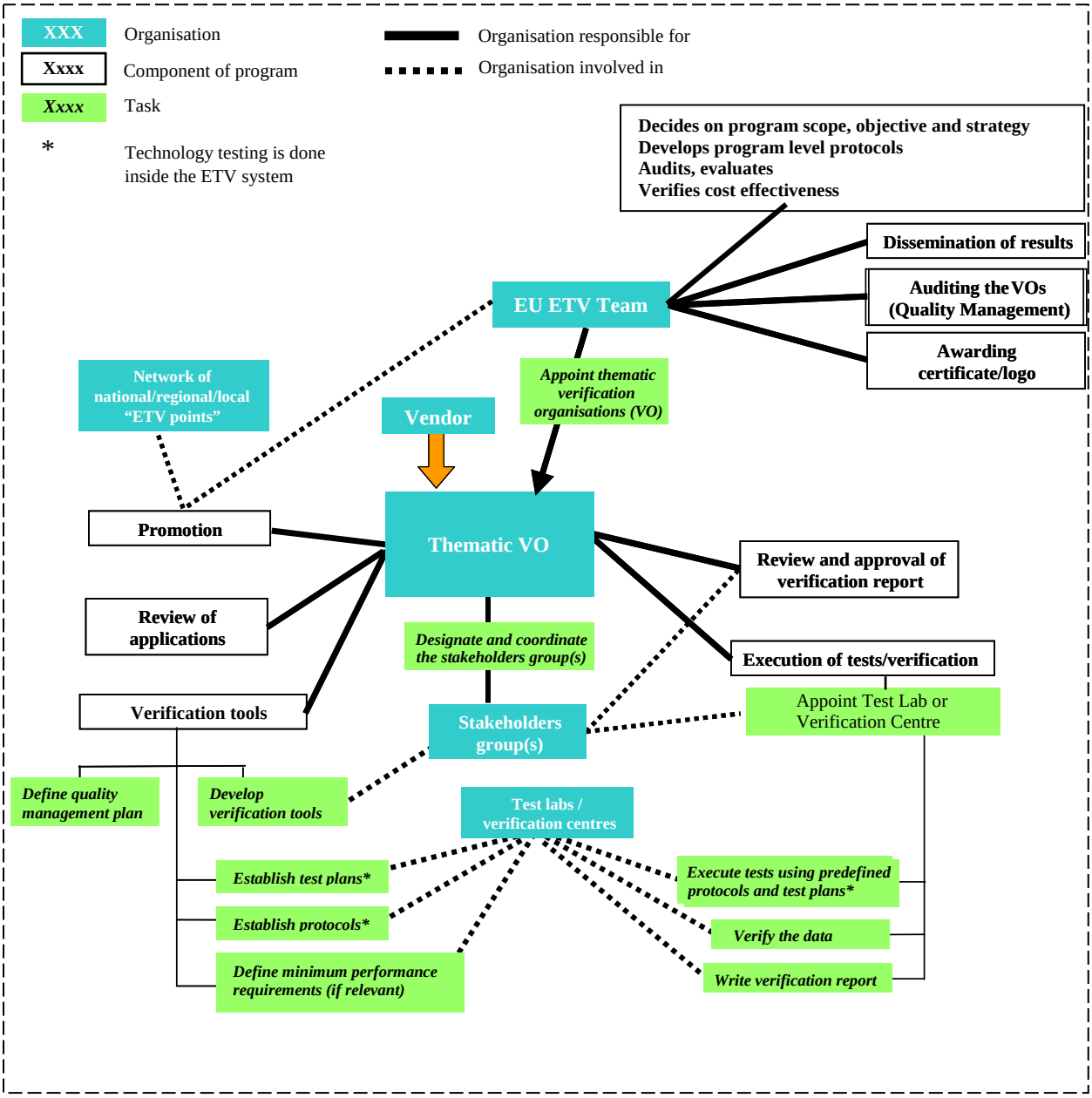
The following assumptions were made before elaborating the model:

- The objectives, scope, and definitions for the program are considered to be set
- The model is applicable, irrespective of the alternatives chosen for the program, whether the system performs technology testing or claim verification

The EU ETV team

The EU ETV team lays the foundations of the verification program (program scope, objectives, strategies and administrative protocols). The way this team is selected, as well as its status (private or public), are not examined here. The market survey results on this point indicate that a public entity would enhance the credibility of the system.

Figure 15 : The EETVS model



The EU ETV Team's role is to coordinate and supervise the verification process. It is responsible for the compliance with the objectives and quality management procedures. It designates thematic verification organisations (VOs), the number of which depends on the priority technology areas addressed by the program[86]. The verification organisations are public or private research or test organisations that are contracted to, or have an agreement with the EU ETV Team to assist in implementing the ETV program.

The EU ETV Team is in charge of auditing the VOs and verifying that their procedures and outcome comply with the program requirements.

The responsibilities of the EU ETV team can be enumerated as follows. The team:

- Lays the foundations of the program: definitions, objectives, eligibility criteria, funding considerations, organisational principles and general strategies
- Decides on the priority technology areas and appoints the thematic VOs in relation with the priority technology areas (if relevant)
- Establishes quality management procedures
- Establishes program-level protocols
- Establishes the program budget
- Communicates on program activities, progress, outputs and recommendations
- Creates and maintains a means to communicate the program opportunities and results (website, large scale publication, specific newsletters, etc.)
- Awards certificates and logos to successful vendors
- Audits the VOs, in terms of compliance with the objectives and quality management procedures
- Assesses the output of the VOs and redefines their objectives if necessary

The Thematic Verification Organisation (VO)

The VO implements the verification process, except for awarding the certificate and logo, and disseminating the results of the program. It is in charge of developing test plans and protocols. The VO carries out directly the tests, appoints other test laboratories to perform the tests, or designates verification centres to verify the vendor claims when they are not qualified themselves or if this is required by the system's design. In that case, the VO is responsible for verifying the accreditation of these organisations or providing for an ETV specific accreditation system. The VO processes the vendor applications and the vendor is directly in contact with the VO who regulates the vendor participation in the process. The vendor is only

[86] It is assumed that a number of different by sector, called thematic, verification organisations are needed for an ETV system who wishes to cover different technology sectors. A technology specific system as the one described by model 2 of §2.8 will necessitate only one verification organisation.

in contact with the EU ETV Team at the end of the process, when awarding the certificate/logo.

The VO collaborates with thematic stakeholders groups, for scientific or technical support, for guidance on market needs or selection of qualified testing laboratories, or for promotion or review purposes. The stakeholders are selected among technology developers, technology buyers, consulting engineers, financial interest groups, industry associations, public interest groups etc. The VO can also call upon national or regional organisations/contact points, to locally act as an intermediary between the vendors (often small SMEs) and the ETV system.

The responsibilities of the VO can be enumerated as follows. The VO:

- Promotes the program at EU level and identifies the technology vendors potentially interested in the program
- Reviews the vendor applications
- Reviews the accreditations of the testing laboratories and verification centres
- For each technology to be evaluated the VO:
    - For systems that perform technology testing the VO:
        - Establishes the specific protocol and the test plan
        - Performs the testing or selects the appropriate testing laboratory
    - For systems that perform claim verification, the VO performs the verification or selects the appropriate verification centre to verify the claims and supporting data
    - Defines minimum performance requirements (if relevant)
- Reviews and approves the verification reports
- Designates and coordinates the stakeholder groups and their activities

The Testing Laboratory

A testing laboratory is used when the testing is done by the ETV system. When the Thematic VO does not have the expertise or if this is the strategic choice of the system, it appoints a specialised testing laboratory to help in developing the specific protocols and test plans and to execute the tests. The testing laboratory respects the protocols and the quality management procedures; implements the test plans when provided by the VO, and writes the verification report. The testing laboratory should be accredited, but the accreditation procedure is to be defined (e.g. ISO, case by case ad-hoc accreditation).

The Testing Laboratory:

- Participates in the drafting and updating of the test protocols
- Establishes the test plans
- Executes the tests

- Writes the verification report

The Verification Centre

A verification centre is used when the system performs claim verification. It will examine the vendor data and verify if they support the accompanying claims. The verification centre proposes to the vendor to repeat the tests if it thinks that the quality of the data is not sufficient. The verification centre respects the quality management procedures of the system and writes the verification report. The verification centre should be accredited, but the accreditation procedure is to be defined (e.g. ISO, case by case ad-hoc accreditation).

The Verification Centre:

- Examines the supporting data
- Verifies the vendor's claims
- Writes the verification report

The Stakeholder Groups

The role of the stakeholder groups is essential, at first by assuring the credibility of the ETV system. They are involved in the development and review of the system's verification tools like test protocols, test plans and quality management plans. They closely collaborate with the VO regarding technology prioritization and testing laboratory/verification centre selection.

The responsibilities of the stakeholder groups can be enumerated as follows. The stakeholder groups:

- Participate in identifying the vendors of targeted technologies
- Guide the VO in selecting the appropriate test laboratories or verification centres.
- Participate in defining the minimum performance requirements (if relevant)
- Are involved in drafting and updating the test protocols

The Vendor

The entry point for the vendor has been placed at the level of the Thematic Verification Organisation, but multiple entry points can be also envisaged as discussed later in this chapter. The vendor contacts the ETV system by its own initiative or is asked to participate if the system follows a proactive approach. The input of the vendor can take either the form of a claim, accompanied by supporting data, or, the technology in question, accompanied by his advice on how to test it. The vendor has to collaborate actively with the other ETV actors, depending on the specific design of the system, including the test laboratories/verification centres, stakeholder groups and verification organisation. A description of the vendor's various required inputs has been provided in §4.6.

The Network of ETV contact points

The network's goal is to establish a relation of proximity between ETV and the vendors, diminishing any geographical distance, language or administrative barriers. It would also be

active in communicating on ETV, explaining the ETV concept and the advantages that it can bring to its end users. This contact points should be established in all Member States, their hosting establishment being variable: testing laboratories, certification organisations, innovation relay centres, national ministries of the environment etc.

Member States

The Member States are involved at various stages of the process: promoting the system and disseminating the list of awardees, soliciting the vendors and assisting them through the application procedure, establishing the network of ETV contact points etc. One of the most important added values that ETV could bring to the market, as was underlined during the market survey, is to become a doorway to the markets of the different Member States.

6.2 General considerations

Degree of involvement of the actors

The model described above is not directly applicable; it provides an idea of the whole range of choices and implementation possibilities offered by an ETV system. The degree of involvement of the various actors can notably change and some of them can be removed from the system. In particular, the EU ETV team can be merged with the thematic VO or the thematic VO can assume the responsibilities of the Testing Laboratories or Verification Centres. In both cases the resulting system would be highly centralised, probably achieving a high degree of harmonisation across Europe, guaranteeing that the value of the verification is equivalent, irrespective of the testing laboratories or the verification centres involved in the process. At the same time, a highly centralised structure would take less into account local conditions and specificities. The corresponding EU ETV team would require more staff and budget, and the accessibility, especially for small equipment producers, would be lower.

Another alternative could be a very decentralised system where the EU ETV team delegates a substantial part of the process to sectoral verification organisations, or to a thematic network of organisations. These will have the flexibility to implement their own ETV system, with their own program structure, stakeholder groups and other system entities, operating procedures and quality management procedures. The EU ETV team would only define the broad outline of the system. This flexibility would enable the system to adapt more easily to the specific needs of each market/technological field. The various technologies would receive the same ETV logo, but the value of the awarded certificate could differ from one thematic network to another, given their autonomy in the implementation of the program. The thematic networks could also have a short to medium term commitment (as is done in the Japan ETV) and could end operations after the expiration of this commitment. This would enhance even more the flexibility of the system and its capacity to address specific verification problems.

For transparency reasons, the organisation that audits the system would better be separate from the organisation that runs the system. Following the same logic, the EU ETV team, the thematic VO and the Testing Laboratories/Verification Centres should not be merged to one organisation.

Another important point relates to the role of the stakeholder groups. An option to lighten the system and reduce the ETV processing time would be to replace them with the interaction between e.g. the Thematic VO, the Vendor and the Testing Laboratory/Verification Centre.

However, the results from the market survey (§5.2) show that this might impair the credibility and transparency of the system. The feedback of the stakeholder group acts as an additional guarantee of the independence of the system.

Testing Laboratories versus Verification Centres

The Testing Laboratories and the Verification Centres appear in the model as a single organisation. In the description of the model, it was assumed that the system would either test the technologies using Testing Laboratories, of verify the vendor's claims based on previously established data using Verification Centres, but not both. A complementary option would be to allow the vendor to provide "supporting data", obtained by the vendor either through an independent laboratory or in the vendor's own facilities. This data would complement the data generated by the tests done within the ETV system. The advantages include savings in costs, since some tests will not be repeated and the possibility for a vendor to apply to more than one verification system with the same set of data. The study of the existing ETV systems shows that this option is not implemented in practice in the current systems (i.e. US ETV and ETV Canada). The only system that does both testing and verification of data is the Korean system (§2.4), however it attributes two different certificates depending on the procedure followed. Moreover, the analysis of simple ETV models presented in §2.8 highlighted the differences and incompatibilities of a verification system based on technology testing and a verification system based on claim verification.

Entry point for the vendor

Two options can be considered regarding the entry point of the vendor into the system. Entry at the level of the VO (or EU ETV team) and entry at the level of the testing laboratory/verification centre.

- Entry at the level of the VO (or EU ETV team)

The vendor contacts the VO who manages the entire process. The VO examines the application, develops the test protocol (if needed), executes the tests or subcontracts them to a qualified testing laboratory, (or identifies a suitable verification centre for claim verification) etc. In this case, the vendor only contributes when solicited by the VO (approval of test plan, training of testing staff, etc.).

The advantages are a better control of the process according to the established rules, thanks to an experience effect (e.g. dedicated staff who deal with all the ETs verified by the VO). Additionally, any technologies that do not fit inside the scope of ETV are screened out at an early stage.

- Entry at the level of the Testing Laboratory/Verification Centre

The vendor may enter the system by contacting directly an accredited testing laboratory, who informs the VO that a verification is being started. The VO then checks that the technology is within the scope of the ETV system and that the testing laboratory complies with the requirements to conduct the test. The VO will have to verify that the testing laboratory is

accredited, if relevant, that it is competent (in terms of staff, knowledge and test facilities) to test the technology, and that it is truly independent from the vendor's interests.

The main advantages of this solution is that the vendor independently chooses the test laboratory, hence competitiveness rules apply and the vendor can seek for the most convenient laboratory (taking into account the geographical proximity and language issues, the reputation or high technical level of the laboratory, the appropriateness of the test equipment) or for the less expensive one.

The main disadvantages of this option is that since it is only solicited for a verification once in a while, the test laboratory may lose a lot of time on the administrative procedures it is not very familiar with. However this burden can be born by the VO if the procedure is adequately well engineered.

As a conclusion, both options have advantages and disadvantages. Having a system with multiple entry points seems to be the best solution.

Evaluation tools

Different types of evaluation tools need to be developed, for different purposes and at different levels of the process as shown in Table 12. In the column "Developed by", the main entities responsible for the development of the corresponding tool are included. For example, stakeholder input could be requested for the development of all the tools, the VO could be involved in the development of the quality management plan etc.

The strategy for developing the protocols and test plans can vary, as shown from the information on the US ETV system (§4.1 and §4.3). Either a verification protocol can be developed first and then translated to a test plan or the opposite. In any case, the development of these tools is an iterative process, where knowledge gained is gradually integrated and the documents are improved with the experience gained.

Table 12 : Evaluation tools of an ETV system

Evaluation tool	Purpose	Developed by
System-level General Protocol	Guidance and rules to EETVS in general (quality assurance, testing, responsibilities, etc.)	EU ETV Team
Generic verification protocol[87]	Testing guidance for a particular technology category	Thematic VO with the feedback of the stakeholders group
Test plan[87]	Based on the generic protocol, it details the test conditions adapted to a specific test event.	Thematic VO and Test Laboratory with the feedback of the vendor
Quality management plan	The specific policies and procedures for managing quality related activities in the ETV program.	EU ETV Team

[87] The generic verification protocol and the test plan are not needed in a system that performs claim verification.

Appendix A

Questionnaire and outline of the ETV system, sent to a large panel of stakeholders

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

EUROPEAN ETV SURVEY

Questionnaire

Institute for Prospective Technological Studies

Name:
Organisation: Job title:
Address:
Country:
Phone: Email address:

Organisation type

- ☐ Environmental Technology developer or vendor
- ☐ Environmental Technology user/buyer
- ☐ Professional/industrial association
- ☐ National or regional public authority
- ☐ Testing organisation
- ☐ Other: _____

Verification of environmental technologies

	1	2	3	4	0
1. Were you familiar with Environmental Technologies Verification programmes before reading the attached "background document"? *(1 - not at all to 4 – strongly; 0 – Do not know)*	☐	☐	☐	☐	☐
2. What would you expect from a European ETV System (EETVS)? *(1 – not at all important to 4 – very important; 0 – no opinion)*					
• It would provide technology users with reliable data enabling them to compare technologies	☐	☐	☐	☐	☐
• It would accelerate the introduction of a new product on the market thanks to a widely recognized logo or certificate	☐	☐	☐	☐	☐
• It would give a judgement on the performance of a new technology	☐	☐	☐	☐	☐
• Can you think of another advantage in buying/using an EETVS verified technology? Please specify:_____	☐	☐	☐	☐	☐
• The performance verification should include an economic assessment	☐	☐	☐	☐	☐
• The performance verification should integrate Life Cycle Assessment considerations	☐	☐	☐	☐	☐
• The technology vendors should be supported to go through EETVS	☐	☐	☐	☐	☐
• Other: _____ _____	☐	☐	☐	☐	☐
3. Requirements for the EETVS to be well recognized on the market, by both the supply and demand sides: *(1 – not at all important to 4 – very important; 0 – no opinion)*					
• The EC (or an EC-related organisation) supervises the verification process	☐	☐	☐	☐	☐
• All stakeholders (vendors, buyers, regulators, etc.) play a role in the verification process	☐	☐	☐	☐	☐
• Verification is done by a test lab having expertise in the technology tested	☐	☐	☐	☐	☐
• Verification is done by an independent testing entity	☐	☐	☐	☐	☐
• Verification is done by a testing entity accredited by the EETVS Team (or a TVO)	☐	☐	☐	☐	☐
• For performance data to be comparable, similar technologies must be tested by one same lab	☐	☐	☐	☐	☐
• The Member States and regional public bodies promote the system locally	☐	☐	☐	☐	☐
• All verification reports are made public, whether successful or not	☐	☐	☐	☐	☐
• Other: _____ _____	☐	☐	☐	☐	☐

4. Key factors for the success of the programme (e.g. related to economic, technical, organisational aspects): (*in descending order*)
   1. _____

	YES	NO
1. Your organisation:		
• has had its technology verified (by US-ETV, Canada ETV, Korea-ETV, MCERTS, UBA, etc)	☐	☐
• has had the opportunity to purchase a verified technology (US-ETV, Canada ETV, Korea-ETV, MCERTS, etc)	☐	☐
• is somehow already involved in the development of the EETVS (how? _____)	☐	☐
2. If you are a technology vendor/developer:		
• Would you accept to test your technology against minimum performance requirements?	☐	☐
• Do you consider the lack of geographical proximity (of laboratories or other testing centres) a major obstacle for the system?	☐	☐
If YES, for what reason? ☐ language barrier ☐ distance barrier ☐ other:		
• What would be the maximum duration that you would consider acceptable for the completion of the verification process?		
☐ < 1 month ☐ < 3 months ☐ < 6 months ☐ < 12 months ☐ < 24 months		
• Which testing organisation do you consider trustworthy and best qualified to conduct the testing of your technology's performance? *(please rank from 1 to 5, in descending order)*		
_ *An ISO 9001 certified lab*		
_ *A testing lab or university, provided it has specific expertise and facilities*		
_ *Any laboratory referenced by the EETVS*		
_ *A partner laboratory*		
_ *Using my own testing facilities* _ *Other:*		
Would the cost of the testing affect your decision when choosing the test lab? ☐ strongly ☐ slightly ☐ not at all ☐ no opinion		
	YES	NO
3. The EETVS is currently in a phase preliminary to the designing of the system. Are you interested in contributing to the designing and setting up of the system by:		
• Taking part in a Stakeholders Group?	☐	☐
If YES, in which technology area: _____		
• Giving your input to a market survey aiming at defining the factors of success of the system?	☐	☐
4. Would you or one of your colleagues be willing to be interviewed by phone to give your opinion on the system?	☐	☐
Contact details of the person *(name, phone, email)*: _____		

5. Could you give us the contact details *(name, phone, email)* of other stakeholders who may be interested in the development of the EETVS?

Contact 1: _____

Contact 2: _____

Contact 3: _____

For further information, please contact: *JITEX Paris Office*
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Fax : 33 1.45.15.05.11
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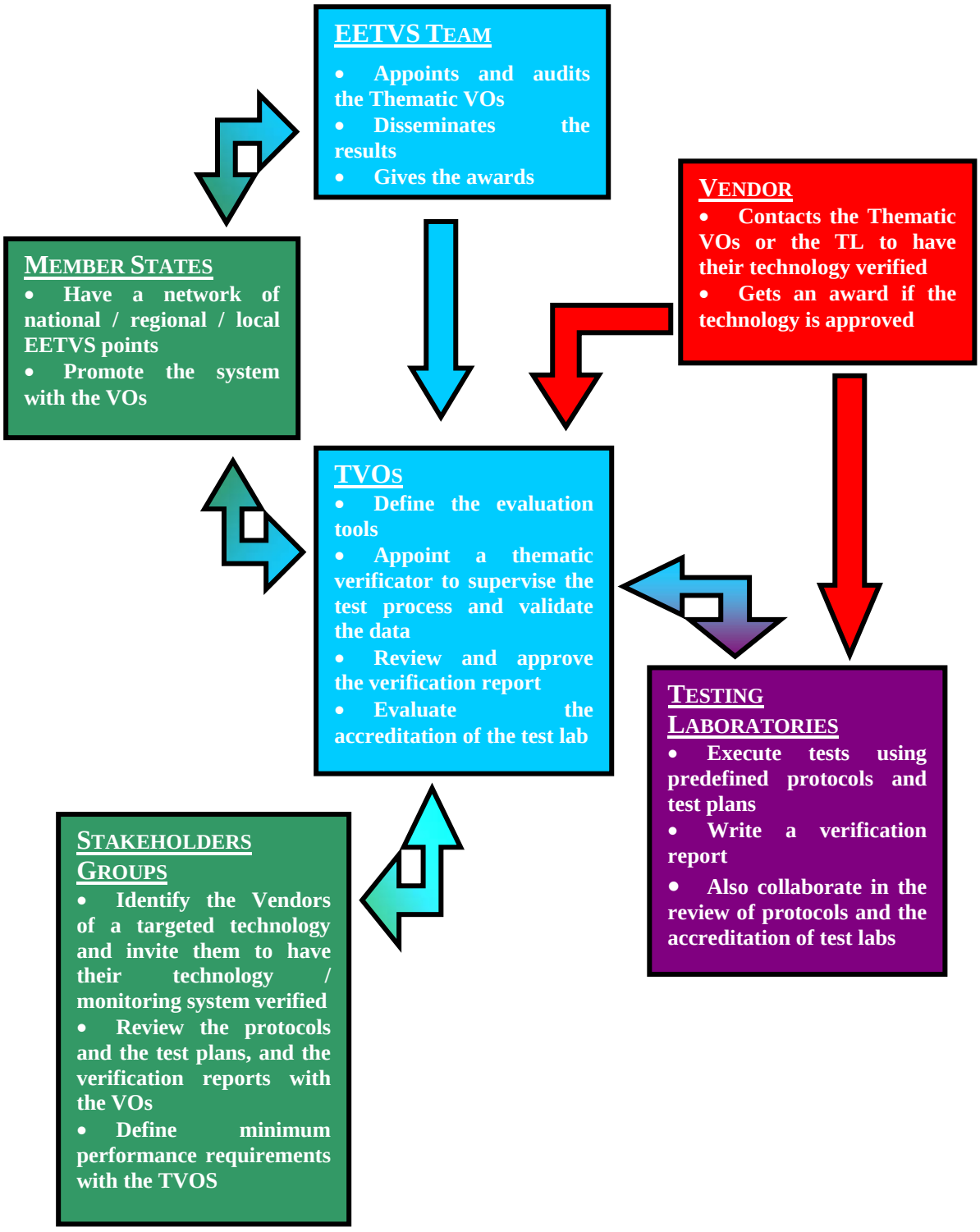
EETVS TEAM
• Appoints and audits the Thematic VOs
• Disseminates the results
• Gives the awards
VENDOR
• Contacts the Thematic VOs or the TL to have their technology verified
• Gets an award if the technology is approved
MEMBER STATES
• Have a network of national / regional / local EETVS points
• Promote the system with the VOs
TVOS
• Define the evaluation tools
• Appoint a thematic verificator to supervise the test process and validate the data
• Review and approve the verification report
• Evaluate the accreditation of the test lab
TESTING LABORATORIES
• Execute tests using predefined protocols and test plans
• Write a verification report
• Also collaborate in the review of protocols and the accreditation of test labs
STAKEHOLDERS GROUPS
• Identify the Vendors of a targeted technology and invite them to have their technology / monitoring system verified
• Review the protocols and the test plans, and the verification reports with the VOs
• Define minimum performance requirements with the TVOS

Appendix B

Guideline for interview: Stakeholders

A. General questions	
1	Do you consider it would be useful to have an ET evaluation/verification program operating in Europe? Why?
2	What are the prerequisites to make such a program effective (simple and quick procedures, low cost, good recognition of the program Europe-wide, etc.)?
3	Should the program be a fully public initiative or should it be a public/private initiative?
4	Eligibility criteria: • Type of technology • Technology development stage (commercial, prototype, demonstration) • SMEs and/or large companies • Available to non-European technologies?
B. Procedure options	
1	What should a "technology verification" consist in? e.g. claim verification,
2	Opinion of the future EETVS users on accreditation of the testing labs
3	Do similar tests need to be done by one same lab for the results to be comparable?
C. Financing the EETVS	
1	Is the cost a major factor of success for the program? For example, in the US ETV program, the cost of verifying one technology ranges from $5,000 to $100,000.
2	Should SMEs benefit from a specific public support to prepare going through the verification process?
3	At what level should the stakeholders contribute, and what should their role be?
D. Organisational structure	
1	What type of structure would be credible to the market?
2	Who is the ETV Team? Would a private organisation be credible?
3	Should the test labs have some type of accreditation to carry out the performance test? What type of accreditation?
4	Can the VO and the TL be one same organisation?
E. Factors of success	
1	Ensuring **credibility of the system** on the market: which are the most important criteria? e.g. broad recognition of the system, quality of the test procedures and test data, transparency of the results, incentives (public procurement, compulsory through regulations)
2	Ensuring that **the system is useful** to the market: which are the most important criteria? e.g. rapidity of the procedure, comparison of performance with minimum requirements , etc.
3	Ensuring **that the system is accessible** to the vendors: which are the most important criteria? e.g. affordable, simple, providing support (money, guidance) to vendor, accessible locally, etc.

	What timeframe would you consider as acceptable for the completion of the verification process?
4.	Does a regulatory framework need to be set up for the ETV system to run efficiently? What type?
F. Impact assessment *(for vendors having been through US ETV, ETV Canada, MCERTS, or for users having bought verified technologies)*	
1	How would you describe the process of going through a verification program?
2	Was a financial contribution required to have your technology verified?
3	Was the outcome of the verification worth the investment (in terms of time and money)?
4	Did the verification actually accelerate the entrance of your environmental technology into the marketplace?
5	What was the impact of the verification on your overall business?
6	Is the verification program well recognised on the market? (by buyers, users, public authorities, etc.)?
7	Advantages and drawbacks of the program
8	How can the program be improved?

Appendix C

Guideline for interview: Impact assessment

Feedback on your experience of the US/Canada ETV program

Guideline for the interview	
1	How would you describe the process of going through a verification program?
2	Was a financial contribution required to have your technology verified? Was the cost an important factor when deciding to go through the ETV process?
3	Was the outcome of the verification worth the investment (in terms of time and money)?
4	Did the verification actually accelerate the entrance of your environmental technology into the marketplace?
5	What was the impact of the verification on your overall business?
6	Do you believe the stakeholders groups play a major role in the process? Did your company participate in an ETV-related Stakeholders Group?
7	Is the verification program well recognized on the market? (by buyers, users, public authorities, etc.)?
8	Advantages and drawbacks of the program
9	How can the program be improved?
10	If a European ETV system is implemented, would you be interested in having your technology verified? Would you expect the US ETV certificate/logo to be recognized as equivalent to the European ETV logo on the European market?
11	What are the main criteria for and ETV to be credible **o**n the market?
12	What do you think of the ETV Canada Program?
13	Would you recommend the European Commission to set up an ETV program?

Appendix D

List of Interviewed Stakeholders

Name	Organisation	Country of origin	Experience in ETV-like systems
Vendors (39 contacts)			
Juha Lappalainen	Aboatox	Finland	US ETV
Mike Swink	Air Purator Corp	USA	US ETV
Matteo Dadati	Aquaria srl	Italy	
Mark Moreano	BHA group	USA	US ETV
Jeremy Wickins	Biobubble	UK	
Hamish Adam	Boreal Laser	Canada	US ETV
Dennis Gregor	Candetec	Canada	ETV Canada
Tony Hayes	Capstone	USA	US ETV
Chuck Solt	Catalytica Combustion	USA	US ETV & ETV Canada
John Cooper	Cooper Environmental	USA	US ETV
Juha Kaartinen	Dekati Ltd	Finland	US ETV
Dr. Cullimore	Droycon Bioconcepts, Inc	Canada	ETV Canada
Tracey Fraser	EcoWaste Solutions	USA	US ETV
Terry Mocherniak	Encelium Technologies, Inc	Canada	ETV Canada
Daniel Moulenne	Environnement SA	France	MCERTS, UBA, US ETV
Bob Coak	Greenland Corporation	Canada	ETV Canada
Hans Jensen Holm Frederik Soby	Haldor Topsoe A/S	Denmark	
Risto Juvonen	Hidex Oy	Finland	US ETV
Dick Bates	Horiba Instruments	USA	US ETV
Steeve Gilchrist	Hydrogen Fuel Injection System Canadian hydrogen energy Co.	Canada	ETV Canada
Michael Vecht	Innova Air Technologies	Denmark	US ETV
Dolores Maillo	Isofoton	Spain	
Richard Whiteside	Land Instruments	USA	MCERTS, UBA, US ETV
Rolf Schleicher	Maxxtec Benelux	Belgium	
René Otjes	Mechatronics	The Netherlands	US ETV
Thomas Steiner	MonitoringSystems GmbH	Austria	MCERTS
André Bals	Omnisens	Switzerland	US ETV
William Averdieck	PCME	UK	MCERTS
David Rollins	Plug Power	USA	
Robin Hutchinson	Procal	UK	MCERTS
Warren T. Corns	PS Analytical, Ltd	UK	US ETV
Mike Meyer	Rupprecht & Patashnick, Co	USA	US ETV
Susannah Clements	Signal Group	UK	MCERTS
Toby Wiik	Standard Filter Corporation	USA	US ETV

Martin Plum	Terreco BV	Belgium	
Craig McKim	Testo Inc	EU	US ETV
Gert Jan Bakkenes	Thermo Electron Corporation	USA	US ETV
Peter Demeter	Trans-Cycle Industries	Canada	ETV Canada
Doug Beynon	Unisearch Associates, Inc	Canada	US ETV & ETV Canada
Member States representatives (10 contacts)			
Jean-Marc Merillot	ADEME	France	
Niels Henrik Mortensen	Danish Environmental Protection Agency	Denmark	
Maria Halmi	RABA AG *Via* : Hungarian Ministry for Environment and Water, Division of Technology	Hungary	
Ander Elgorriaga	IHOBE	Spain	
Francis Farrugia	Malta Council for Science and Technology	Malta	
Marie-Christine Le Picard	Ministry of Economy and Industry	France	
Juri Truusa	Ministry of Environment	Estonia	
Dimitrios Tsotsos	Ministry of Environment, Physical Planning and public works	Greece	
Samo Kopac	Ministry of the Environment and Spatial Planning	Slovenia	
Elena Bodikova	Slovak Environmental Agency	Slovakia	
Stakeholders (10 contacts)			
Agnes Czibók	Association of Environmental Enterprises	Hungary	
Christelle Demaretz	CD2E	France	
David Francis	Centrim	UK	
Thomas Track	Dechema	Germany	
Eric Marty	Emertec	France	
Olagnier	Enhesa	Belgium	
Dutruge	Enviropea	France	
Heikki Sundquist	Foundation for Finnish Inventions	Finland	
Philippe Chartier	Syndicat des Energies Renouvelables	France	
Gabriel Berry	TV Energy Ltd.	UK	
Users (4 contacts)			
Hans Van der Stelt	Heijmans Milieu, Sloop en Recycling BV	Netherlands	
Kjell Oren	Norsk Hydro	Norway	
Guillaume Prévot	Silex International	France	
Josep Bernat	Uniland	Spain	
Organisations involved in ETV-like programs (12 contacts)			
Ann Louise Sumner	Battelle	USA	
Franck Cheutin	CSTB	France	
Rodolphe Morlot	CSTB	France	
Richard Gould	Environment Agency	UK	
John Neate	ETV Canada	Canada	
Jean Poulleau	Ineris	France	
Andrew Trenholm	RTI	USA	

Richard Adamson	SRI	USA	
Hans Joachim Hummel	UBA	Germany	
Chris Roberts	UK - Clear skies	UK	
Teresa Harten	US EPA	USA	
Roger Dijkmans	VITO	Belgium	

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Abstract

This report examines the environmental technology verification (ETV) systems in the context of the Environmental Technologies Action Plan (ETAP) implementation strategy (European Commission). The organisational structure of existing ETV systems and related European ones is studied and financial aspects of these systems are analysed. A Market Survey was carried out to collect the opinion of the end users related to various implementation choices of ETV. An ETV model, describing the various ETV constituting entities and proposing a structure for a European Environmental Technology Verification Systems (EETVS) is presented.

Keywords: Environmental Technology Verification (ETV), Environmental Technology Action Plan (ETAP)

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