Costs of ETV systems

Contribution to the Impact Assessment Report of an EU Scheme for Environmental Technology Verification

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Introduction - The policy context

The concept of Environmental Technology Verification (ETV) has been under intensive scrutiny, in the EU context, since 2004. ETV was first mentioned as a possible option in the 1st communication on ETAP[1] and its relevance consolidated in the two follow up reports[2]. A number of pilot projects have been launched by DG RTD[3, 4, 5] and DG ENV[6]. DG JRC/IPTS has published a report analysing various aspects of ETV systems[7]. DG ENV has dedicated the 3rd ETAP conference on ETV[8], and fruitful opinions exchanges have been done at this occasion. A public consultation whose preliminary results are already available[9] has been conducted by DG ENV. In this public consultation, the ETV Canada model has been proposed as a starting point, among others. A roadmap on impact assessment of ETV has been launched as well (DG ENV).

This report, whose focus is the cost of various alternatives of ETV systems, is meant to be a support to this impact assessment exercise. A brief chapter on the benefits of ETV is included as well, although available data to quantify are scarce. The Roadmap and the public consultation paper is the basis to define the ETV system elements that are relevant in the present policy context, but all the existing literature on ETV together with available results from running ETV projects is used in the following discussion. The EC is considering launching a legislative proposal on ETV in 2008. This report is a contribution to the research work providing support to the preparation of this proposal.

1.1 The Roadmap

Developers of environmental technologies, in particular SMEs, face difficulties when launching innovative technologies in the market. The market up-take of eco-innovation is often hindered by perceived risks, lack of awareness of their economic and environmental benefits or lack of skills or preparation to use them efficiently.
The provision of reliable information on the environmental performance of technologies, verified by an independent third party, could facilitate the market up-take of innovative technologies. There is currently no system at EU level providing this service of technology verification with a high level of recognition both within the EU and internationally. This problem can be addressed partially by the action of Member States, but action at Community level will be more efficient and more coherent with an internal market approach.

The main objectives are:
- to provide technology developers with the possibility to have a reliable third-party verification of the environmental performance of their new technologies, thus increasing their credibility vis-à-vis customers and facilitating their up-take by the market;

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[1] http://ec.europa.eu/environment/etap/pdfs/report_etap_en.pdf
[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0162:FIN:EN:PDF
[3] www.promote-etv.org
[4] www.est-testnet.net
[5] www.airtv.eu
[6] http://www.lifeetv.com/
[7] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504
[8] http://ec.europa.eu/environment/ecoinnovation2007/2nd_forum/index_en.htm
[9] http://ec.europa.eu/environment/etap/pdfs/etv_consultation_statistics.pdf

- to provide technology users, consumers and public authorities with reliable information on innovative environmental technologies, thus facilitating their acceptance by the end-users, allowing to compare and possibly benchmark technologies thus ultimately protecting the environment better;
- to provide the high level of recognition, both within the EU and internationally, allowing technologies to be accepted on different markets on the basis of one verification.

1.2 The public consultation paper

The consultation paper on an EU system for ETV has been developed as a supporting document, helping the respondents to the public consultation to structure their feedback. It contains important information on the characteristics of a possible ETV scheme and as such it can be used as a starting point, providing a commonly accepted definition base for ETV. The paper describes the current policy context making reference to the aforementioned EC proposal, outlines the existing ETV systems and other similar approaches and presents the main features of a proposed ETV system. It is specified that the proposed option (based on the ETV Canada system) is one plausible option among others. The respondents of the consultation were moreover free to propose a different option if they found it better.

1.3 Links with other EU policies

Depending on the future shape of ETV, there may be synergies with other policies in particular with regards to the testing data for technologies. That in turn might contain cost saving potential through synergies. ETV may contribute to the implementation of the IPPC directive mainly by providing feedback for the BREF documents, especially the chapter "Emerging Techniques". Other EU policy instruments concerned could be the Ecodesign directive for energy using products, to the extent that the manufacturer could use ETV provided information to back up his statements on the environmental performance of his product (generally a self declaration by the manufacturer with no third party validation is sufficient). The EU Ecolabel scheme is another candidate, as verified technologies may intervene at the manufacturing, or other, stage of an Ecolabeled product. However, the extent to which ETV may provide input to the implementation of these policies remains to be proven in practice, since these directives target exclusively consumer products. ETV on the other hand concerns products/technologies that are addressed to industry/businesses in general and not consumers. The EU EMAS scheme could also be concerned. For example, ETV could be take into account during the validation/verification process of technology related information that the company wishes to validate by EMAS and include to its environmental declaration. Finally, ETV could also play a role in the attribution of green public procurement.

2 Description of the options – System Boundaries

Main policy options:

> *(a) facilitating the exchange of information, experience and the establishment of joint verification protocols between institutions in member States having the capacity to verify environmental technologies;*

(b) facilitating the setting-up of verification systems by private actors, on a sectoral basis, and ensuring the reliability of these systems through the certification of verification bodies or through a standardisation approach;

(c) setting-up a voluntary EU scheme, building on existing capacities in Member States and involving industry federations and other stakeholders, ensuring the reliability of verifications and international recognition of the system;

(d) setting-up a mandatory EU scheme verifying the environmental performance of innovative technologies before access to the market, based on legislation and/or standardisation and implemented through the certification systems in member States.

General structure of the scheme:

(s1) a centralised scheme with one organisation responsible for all verification procedures and reporting, possibly using sub-contractors to have the necessary experience in the different technology fields covered by the scheme;

(s2) a decentralised scheme with one small secretariat ensuring the overall coordination of the scheme and a number of organisations responsible for the verification procedures and reporting, each organisation being competent for a specific group of technologies for the whole European Union;

(s3) a decentralised scheme with one small secretariat ensuring the overall coordination of the scheme and a network of national or regional organisations responsible for verification procedures and reporting, each organisation being competent for all technologies within a specific geographical area;

(s4) a decentralised scheme with a network of organisation mandated for implementing verification procedures and reporting for one or several group of technologies, within one or several geographical areas, defined on a market basis, with possible overlaps between verification organisations in terms of technologies or geographical areas.

As for the scope and meaning of the verification procedure: several approaches are possible for defining the technical specifications to be verified. These approaches could be summarized along the following lines (numbered for further references):

(v1) the verification may be based on generic protocols defined for a group of technologies, providing guidance for the testing of technologies in this group, ensuring the reproducibility and comparability of test results, and the level of quality required for verification; these protocols may be developed with the involvement of stakeholders, including industry experts, technology users, public authorities, academics and environmental organisations; this approach follows the main lines of the US EAP programme, and can be therefore referred to as the 'US model'.

(v2) the verification may be based on verification claims, prepared by the technology developer in agreement with the verification organisation, defining in details the technical specifications representative of the performance of the technology and the exact conditions of use under which these specifications should be met, as a basis for quantitative tests and verification; this approach follows the main line of the Canadian programme, and can be therefore referred to as the 'Canadian model'.

(v3) the verification may be based on verification claims, prepared by the technology developer and reviewed by the verification organisation before agreement, with a view to check that the claim gives a fair and complete picture of the technology, possibly integrating additional specifications recommended by groups of stakeholders or stemming from a basic and standardised screening of the environmental impacts over the whole life-cycle of the technology; this approach, intermediary between the 'US' and 'Canadian models', can be referred to as the 'mix model'.

3 Qualitative assessment

3.1 Criteria definition

The qualitative assessment aims to compare the options in the light of the main policy objectives (see §1.1), laid down in the form of criteria - conditions, which can be summarized as follows:

- 1st condition: provision of reliable, independent information for technology performance both for technology producers and for technology users.

The producer will use the technology verification system to increase their credibility and consequently the market penetration of the technologies. The technology user will use the information to reach informed purchase decisions, resulting in enhanced environmental protection. Giving the possibility to the end users to compare technologies and eventually benchmark is included in this condition. The possibility to compare can be capitalised as a pre-requirement for the following condition.

- 2nd condition: mutual recognition, that can be implemented in various levels, i.e. within the EU Member States or internationally.

Technology producers will have access to multiple markets economizing resources and efforts. Users will profit from a more diversified offer from technologies that might otherwise not have access to all the relevant markets. International mutual recognition can facilitate the access of new technologies to non-EU markets.

- 3rd condition: adapt to SME specific requirements

SMEs may require some tailor made help to be able to profit fully from ETV. Notably potential barriers to access the system should be low (for example providing help to fulfil the necessary administrative procedures).

- 4th condition: keep the systems expenses at an affordable level for all actors involved

The establishment of a technology verification centre will lead to additional cost. Depending on the shape of the final system, this cost will amount to different levels and will be distributed differently between public and private actors. It should therefore be aimed at striking the right balance between keeping the cost low for all actors and meeting the policy objectives to the maximum extent possible. When comparing the policy options (a) to (d) against this criterion, only an ordinal scaling of the related cost will be made, i.e. a ranking without quantification. A detailed cost breakdown will be carried out for the preferred policy option.

3.2 Assessment of the options

In the following assessment, it is considered that all the best practices, i.e. transparency, independence, quality assurance, scientific excellence etc. are respected and fulfilled by the various actors of each system.

Option (a): BAU

This option partly fulfils the first condition, as through existing research programmes reliable and independent information is provided. However, this information is not thought as a market instrument, targeting specifically the producers and users needs, as with a verification system. Existing research programmes focus, as their name indicates, in research activities, whereas verification targets commercialised technologies[10]. The role of research programmes, community or national, is still very important with respect to verification. The idea, expressed in various workshops of the AIRTV pilot project is the following (suggested as well in the ETV Canada verification protocol): a verification system should use as much available data as possible, to be able to reduce the number of tests thus reducing costs, and also reduce the verification time (i.e. the duration of the whole verification procedure). But often, even if previously established data do exist, they do not conform (or they partly conform) to the quality assurance procedures established by ETV and for that reason they cannot be used. If the verification requirements regarding quality assurance but also other market related requirements, are integrated early enough in the testing process, ideally during the research or demonstration phase, the data generated during these phases will qualify for ETV use. This logic supposes evidently that both research programmes and verification programmes co-exist and collaborate. However, with regard to the functionality of allowing users to choose technologies on the basis of comparable information it appears that data from research programmes alone are not sufficient as they do not directly give the possibility to compare and eventually benchmark the technologies.

Option (a) does not fulfil the second criterion of mutual recognition of technology performance, whatever the level (local, regional, international), for which a more concerted approach is necessary. In the absence of a common and standardised framework the mutual recognition of information on technology performance is theoretically possible but will certainly take longer: the results on performance are not directly comparable since they are based on different evaluation approaches (different protocols, test methods and test conditions, different goals for the evaluator, etc…). Verification on the contrary evaluates technology using predetermined protocols and quality assurance procedures, making

[10] In principle, commercial ready technologies only are accepted for verification. However, the discussions in ETV workshops of some of the EU pilot projects (TESTNET, AIRTV) seem to indicate that some flexibility to this rule could be tolerated in duly justified cases. In that sense some limited overlap between the research phase and the verification phase of a technology might exist. This "nuance" is the same like when distinguishing a commercial ready or commercialised product from an advanced prototype.

comparison easier and more transparent. If the goal is EU-wide recognition then verification is a much more efficient instrument.

With respect to the third criterion, option (a) does not include the opportunity to implement measures for taking into account specific requirements of SME. As the information exchange and the development of verification protocols would be carried out by private actors, it could turn out difficult to develop incentives for them for the integration of SMEs into the verification system. This could even result in an obstacle for SMEs to enter the system.

The additional cost for realising this option as compared to the current situation will be the lowest amongst the different policy options, as (a) corresponds to the business as usual case.

Option (b): private actors driven approach

Through a standardisation approach for (private) verification bodies, and with a sufficiently strong incentive for the verification bodies to make the information on the environmental performance of technologies public, option (b) would meet the criterion of providing reliable information for technology users. This standardisation could be achieved through a certification or accreditation procedure. However, the role of the EU as facilitator would in this option be limited to provide guidelines, which could be done in form of a Commission communication. This would give the EU indirect and therefore limited influence to shape the system according to the policy objectives.

A standardisation approach should encourage the establishment of European wide harmonised verification protocols. The best solution in that respect would be verification bodies at the European level, which would guarantee the harmonization of verification protocols. If that is not possible and verification centers for one sector are geographically distributed, a certification or accreditation of verification bodies should aim at developing test protocols which are harmonised at European level. However, as the international recognition of sectoral verification systems negotiations would have to be carried out on a sectoral basis and with private actors from different EU member states, it could turn out to be difficult to meet the second criterion in this set up.

With regards to the third criterion, the setting up of verification bodies by private actors would not guarantee that the specific needs of SMEs are taken into consideration satisfactorily, as SME do nto have the resources to promote their interest in an organised way. The requirement to take specific SME needs into account could be taken up into the catalogue of criteria for the certification or accreditation of verification bodies.

With regards to the fourth criterion, the transaction cost for private actors would be higher than in option (a), as it involves the development of sectoral verification systems for Europe, the corresponding infrastructure, the development of verification protocols which should ideally be harmonised at European level.

In summary, option (b) could serve to establish a viable form of technology verification centres. However, meeting the criteria mentioned under 3.1 could finally only be accomplished through a detailed set of criteria, which would have to be implemented through a certification or standardisation approach. The interplay between the regulator as facilitator/initiator and private actors which are dispersed across sectors and geographically could lead to significant additional cost while not guaranteeing a satisfactory achievement of the policy objectives.

Option (c): public verification, voluntary

This option entails the establishment of a central verification body at EU which allows for shaping the characteristics of the verification system according to the above mentioned three criteria at the EU level. Verification is envisaged to be voluntary for technology producers.

With regards to criterion (a), the provision of information on the environmental performance of technologies at EU level would be provided by one central entity. This would increase the recognisability of the technology verification system, and through the "one-stop-shop" characteristic search/transaction cost would be lowered for technology users. At the same time a public and independent verification center would appear to have a higher credibility than private actors, as it would be per se not be driven by particular interests.

With regards to criterion 2, one EU verification body ensures the harmonisation of verification protocols at European level. That would be advantageous for technology producers, as one verification would be valid for all Member States and data on the environmental performance of the technology would be made available throughout the European single market. The objective of mutual international recognition of verification systems, which would ease the entry in non-EU markets for new technologies, would be easier to achieve, as it would reduce to agreements with existing non-EU verification systems on a sectoral basis. Also the fact that the negotiation with other verification systems would be channelled through one European organisation would reduce EU internal co-ordination efforts and the related transaction cost.

A public and independent verification center in form of a secretariat at European level could give strong emphasis to taking up specific SME requirements into the verification procedure. That is a key element in the verification system as SME in Europe have a high share in the development of innovative technologies (e.g. in the group of technology oriented university spin-offs). Measures in support of SME could be developed in negotiations with relevant stakeholders. A verification system based on private actors as discussed for options (a) and (b) would not necessarily regard the support of SME as a priority in this context. This potential disregard could result in a entry barrier for SME to the verification system and, subsequently, in a market entry barrier.

With regard to the fourth criterion, option (c) promises to reduce transaction cost for technology users (see above) as well as for technology producers, which would only have to deal with one central verification procedure. At the same time, co-ordination cost for establishing mutual international recognition would be significantly lower if it is organised by one European organisation as compared to sectoral and geographically dispersed verification centers negotiating harmonisation amongst each other and with non-EU organisations. On the other side, option (c) requires the set up of a European secretariat, and the infrastructure of sectoral verification centers attached to already existing institutions. However, the cost of this set up will certainly be compensated through the above discussed cost reductions.

Option (d): public verification, mandatory

This policy option is similar to option (c), but envisages a mandatory verification of the environmental performance of new technologies before access to the market.

As the mandatory character of this option would generate a database of the environmental performance of all new technologies for those sectors taken up into the system, the criterion of providing information for technology users would be met satisfactory. As discussed in the previous option, search cost for technology users would decrease through the establishment of one central verification centre in Europe. However, the obligation to apply for a verification could significantly lower the acceptance of such a system amongst technology producers, as has also been shown by a market survey carried out by JRC IPTS[11]. It would potentially be perceived as an additional burden instead of a way to promote environmental advantages of an innovative technology. That in turn would increase the co-ordination and search cost on the side of the verification centre, which would have to actively screen the market for new technologies and to ensure compliance with the system. This would require a different infrastructure as compared to a voluntary system, with the consequence of significantly higher transaction cost.

As for the second criterion, the organisation of one verification centre at European level would similar as in the case of option (c) ensure the intra-European harmonisation and at the same time facilitate the mutual international recognition of verification systems.

The integration of SME into the system could be supported in a similar way as in option (c), through the involvement of relevant stakeholders from SME to develop tailored measures in order to take specific needs of SME into account.

With regards to the fourth criterion, this option certainly causes the highest cost, for public and private actors as well. In contrary to options (a) to (c) the mandatory character of this policy option would require a more comprehensive policy approach, including the definition what constitutes a technology for each sector and mechanisms to ensure compliance with the systems and a set of sanctions in case of non-compliance. Compared to the higher costs related to this policy option, the policy objectives would probably be met to the same degree as in the less costly option (c).

Table 1 gives a rough overview of the qualitative assessment of options (a) to (d).

[11] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §5, pp.78

Table 1: Option Overview

	Criterion (1) Provision of information	Criterion (2) Harmonisation/ international recognition	Criterion (3) SME support	Criterion (4) Cost efficiency
Option (a) BAU	0	-	-	0
Option (b) Private verification centre, facilitated by regulator	+	-	-	-
Option (c) Public verification centre, voluntary system	++	++	+	+
Option (d) Public verification centre, mandatory system	++	++	+	--

3.3 Assessment of the systems' structure

The various sub-options related to the system's general structure were presented in §2. The two basic structural differences are a centralised scheme versus a decentralised one and a sectorial scheme versus a scheme that would include all technological sectors.

Structure s1: centralised scheme

At a first approximation, a centralised scheme will benefit from a strong coordination since the main actors of the system will be inside the same organisation. On the other hand the system will have to rely on a very efficient network of contact points, otherwise its accessibility will be affected, being the only ETV centre throughout the EU. As it is stipulated in the Roadmap, this scheme would have to sub-contract an important part of the verification activities, since it will be difficult to concentrate all the necessary expertise in a single organisation. In fact, the other options may have to use sub-contracting as well when they are not qualified for a specific, highly specialized verification step, however this should be done at a limited scale. This sub option would be more easily implemented in the versions c-s1-v2/v3 (Canadian and Mix models), where all the steps accessory to verification (i.e. protocol and test plan development and testing) have been already carried out by the vendor. It seems more difficult to implement this option in the version c-s1-v1 (US model), where verification includes the development inside the ETV system of all the above-mentioned steps: it seems improbable that a single organisation will concentrate all the necessary competences for all types of technologies, or systematically delegate the totality of the verification tasks to other organisations (then it would be more a mediator than a verification organisation).

The extensive use of sub-contracting makes the estimation of the running costs of this scheme uncertain. The minimum costs of this scheme should be, for the same amount of verifications, similar to the costs of s2, whereas the maximum is highly dependant on the extent to which subcontracting is used and to the costs of each individual subcontractor.

Structure s2: decentralised sectorial scheme

The public consultation referred to this option as the reference option, while the other sub-options were also examined as possibilities. The sectorial structure of this option gives the possibility to the system to reach a high level of specialization. This should permit to accumulate and use the experience related to specific technological sectors, something that is less straightforward for non-sectorial systems. Moreover, sector specific characteristics that can affect the design of the ETV system can also be taken into account in a more direct manner. The system furthermore shows a higher degree of flexibility, as the adaptation to new technological developments is done at the specialised sectorial verification centre without close monitoring from the central secretariat.

All the proposed models (v1 to v3) are easily transferable to this sub option's structure. Model v1 (US) which is the more demanding regarding the necessary in-house expertise, benefits from the sectorial character of this sub-option.

This sub-option, as the previous one, will have to rely to a very efficient contact network to lower the accessibility gap between interested parties and the system.

Structure s3: decentralised national/regional scheme

This scheme is implemented at a regional or national level. However a regional approach (e.g. by geographical sectors) is more realistic to having 27 different systems, one per European country, due to coordination, financing and effort duplication considerations, even if the accessibility of a national implanted system would be stronger.

The structure s3 fits more to the models v2 and v3 because they are not sector bound. Indeed the Canadian and mix models accommodate more easily a non-sectorial approach.

Regarding costs, structures s2 and s3 are directly comparable if they have the same size. Indeed, if the number of sectorial systems is the same with the number of regional systems, the costs will be in principle of the same order of magnitude. However, compared to s2 higher transaction/coordination costs will occur, as it has to be ensured that all regional systems work in a harmonised way across all technologies.

Structure s4: decentralised ad hoc scheme

In this scheme the technological scope and geographical delimitation of the system is variable. The verification systems receive a mandate according to market needs and can enter in competition with each other. This scheme differs from the others in that it allows competition between verification centres. As already mentioned in §2 this may lead to overlaps between systems, meaning the duplication (or multiplication) of effort if similar technologies are verified by different systems.

Practical issues will have to be resolved, as for example the comparability between verifications. Similar technologies will have to follow similar verification procedures, otherwise the information on performance (and the subsequent face value of the ETV logo) will be different.

3.3.1 Structure comparison

The qualitative conditions that are used to assess these sub-options are dictated by the characteristics of each of them (Table 2). The centralised or decentralised structure of the system and its regional or national implementation, affects the system's accessibility, meaning the ease with which companies across the EU can get in touch with the system. The sectorial or not character of the system is reflected on its ability to specialize in a given technological sector. The existence of systems with similar competence influences the capacity to avoid duplication of effort. An additional condition related to the predictability of the system's costs was added as an essential factor for the goals of this report. Finally, the universality of the system, i.e. the capacity to fit to all the examined models (v1, v2 and v3) was also taken into account.

As for the structure s2, this structure can fit to the whole range of proposed models (v1 to v3). It furthermore appears to produce the relatively best results across all dimensions. This structure was chosen for further analysis and cost quantification.

Table 2: Assessment of the general structure

	Accessibility	Avoid effort duplication	Specialization	Universality	Cost predictability
s1	-	+++	+	+	+
s2	+	+++	+++	++	++
s3	++	+	++	+	++
s4	+	-	+++	++	+

4 Cost calculations of the ETV models

4.1 Introduction

The following cost calculation focuses on the estimation of the costs of policy option (c), scheme structure (s2) and its sub-options (v1 to v3). The cost calculation estimates the costs of each ETV model/option, disregarding any costs related to the system's inputs or outputs. For that reason, determining the system's frontiers is capital. For example, testing costs[12] for tests carried out independently by the producer will not be considered as ETV costs.

[12] Regarding testing costs, it can be argued that the total cost of each different system is the same, or at least similar. Once a test protocol is established, it is indifferent (1) if the tests are commissioned by the producer to an independent laboratory and then submitted to ETV, (2) if they are done by the ETV system itself, or (3) if part of the tests are commissioned by the producer and partly executed by ETV. Two remarks could be ventured to counter this view. First, it is probable that the three systems briefly outlined above would result to three different test protocols: the first would be designed mostly by the producer according to his requirements, the second

The main actors, common to each model, are the following:

- the EU ETV team, which ensures the overall coordination of the scheme. The EU ETV team is the only entity that will have to be created from scratch, all the other entities being hosted by existing structures throughout the EU. A description of the duties of this team, together with the detailed cost calculation is given in Annex I.

- the Sectorial Verification Systems, which are the organisations responsible for the verification procedure. Five sectors have been selected (Table 3). The first three have proved to be areas with a certain demand, at least in the US, and can be related to centres of the US ETV system. Monitoring is in fact the sector that has had, also for practical reasons, the biggest number of technologies verified in the existing systems and it can be expected that the same could happen to the EU scheme. Air Emission Abatement is also the sector chosen by the DG RTD pilot project AIRTV. The third system, Energy, could include GHG abatement technologies and possible renewable energy technologies. The last two, correspond to technologies identified in the definition of the DG RTD pilot projects TESTNET and PROMOTE.

- the ETV contact points, who will assure the accessibility of the system and will also be integrated in existing structures (see also Annex II - Cost Calculation of the ETV contact points).

Table 3: Selected sectors for options c-s2

Sectorial Verification System 1 (Monitoring)
Sectorial Verification System 2 (Air Emission Abatement)
Sectorial Verification System3 (Energy)
Sectorial Verification System4 (Clean Production and Water)
Sectorial Verification System 5 (Soil Remediation)

The goal of the calculation is to estimate approximate yearly costs of a running ETV system, structured following different ETV models. A number of factors introduce uncertainties in these calculations. First, the number of verifications that a system would have to undertake is unknown. From historical values of the US ETV and ETV Canada systems, it was assumed that each sectorial verification entity may undertake between 5 (lower bound) and 13 (upper bound) verifications per year, and costs were calculated with respect to these two extremes. Secondly, the verification costs are strongly technology specific. Indeed, each verification

would be edited by the system after a stakeholder consultation (with producer feedback) and the third would be a combination of the previous two. The costs of the tests can then be substantially different. Second, each of the three systems can aspire to different levels of uniformization of the testing for similar technologies. The first is producer driven, the second is stakeholder driven and the third provides some possibilities of uniform testing for the technology performance aspects done within ETV. The rationale of uniformization, understood here as testing similar technologies under similar conditions, is the possibility of straightforward comparison (and even benchmarking) but also the basis for mutual recognition between systems or to facilitate permitting. Uniformization could in this case avoid duplication of tests. The above analysis is valid only for the proper testing costs, since each of the three systems may have different running costs, due to the different actors involved, different processing times etc.

case has its proper "history" and respective verification costs that may vary a great deal, even for similar technologies. For this reason the calculations can only provide *plausible* values based on the data obtained from the various ETV systems that were analysed. The statistical uncertainties in the calculations are treated in more detail in Annex VIII – Uncertainties in the cost calculations.

To estimate the cost of the system two assumptions have been taken corresponding to the estimated maximum and minimum level of activity. In the lower bound, an EU ETV team of five members is set up, and each sectorial verification system carries out five verifications per year, totalling 25 verifications for the whole system. In the upper bound, an EU ETV team of ten members is set up, and each sectorial verification system carries out thirteen verifications per year, totalling 65 verifications for the whole system, to take into account a plausible scale effect in the change towards the upper bound. The costs of the ETV contact points do not change between these two assumptions. These are fixed based on observations on running ETV systems.

The costs estimate the first years of running of the various systems. It is expected that the costs will drop by a learning curve effect when experience is accumulated and the methodologies are mastered. Another tangible factor that influences costs is the need (or not) to develop new protocols. When the system has carried out some verifications and developed the accompanying protocols, these will be then used (with the necessary modifications) for similar incoming technologies. Only for very different technologies will there have to be developed new protocols from scratch. The same will happen also for the systems that use elements of life cycle assessment, in the sense that the preparatory work to define criteria and rules to be applied to distinct groups of technologies (Product Category Rules) will be done only once for a specific group. Consequently, a drop in costs in the follow up years can be foreseen for models c-s2-v1 (to be called **c1** for simplicity) and c-s2-v3 (**c3**). However, when new, innovative technologies enter the system this drop in costs will not appear. This effect has not been taken into account in the following calculations.

4.2 Model c1

Model characteristics		
Policy option	c	voluntary
General structure	s2	decentralised sectorial
Scope	v1	US model

Cost Calculation

Table 4 presents the total estimated costs of model c1. As described before, this model consists of a small secretariat (the EU ETV team) and a group of organisations, one per selected sector, responsible for carrying out the verifications. Five sectors were selected (see Table 4), the first three are directly calculated from data of the US ETV system and the remaining two from adapted data from the pilot projects TESTNET and PROMOTE. The detailed calculations of the various cost elements making up the verification costs under the US model are presented in (Annex III - Cost calculation of the US ETV model).

The differences that appear in the total costs of each of the five systems are mainly due to the different technological sectors. The average cost per verification, taken from the data of each sectorial verification entity, was used to estimate the cost of a typical verification. This cost was then multiplied by five or thirteen, to give the respective upper bound and lower bound values. The lower bound is estimated at 3.6 M€ and the upper bound at 8.4 M€ (Table 4).

Figure 1 schematically shows that, for the verification cases included, the Energy and Soil verification entities present the highest costs, followed by Air Emission Abatement technologies. This means that the average costs behave in this way. However, the costs of individual verifications do not necessarily follow this order. Soil and Clean production and water technologies present the highest cost variations (see Annex VIII – Uncertainties in the cost calculations, for details).

Figure 2 (see Figure 9 of Annex III - Cost calculation of the US ETV model, for details) presents the budget share of the main actors of each sectorial verification system, namely the verification entity, the testing laboratories and the stakeholders. The percentages given are derived from average values of the US ETV model. Table 5 is obtained after the application of the percentages given in Figure 2 to Table 4. It presents the costs of these actors, for the lower and upper bound assumptions. It has to be noted that in the US ETV system the verification entity and the testing laboratories belong to the same organisation, but they are presented here separately, to cover the case of a more general model. The table presents the cost sharing inside the sectorial verification systems. To these costs, the costs of the secretariat and the costs of the contact points have to be added (Table 4).

The vendor/producer of the technology is also a potential fund provider. In the US ETV model there is no standard vendor fee, at least as this has been the case until now in this system. The usual vendor participation has been estimated to between 8 and 13% of the total costs of a verification[13].

Table 4: Costs of model c1

Actors	k€ lower bound	k€ upper bound
EU ETV team (secretariat)	613	1066
Sectorial Verification System 1 (Monitoring)	372	967
Sectorial Verification System 2 (Air Emission Abatement)	539	1402
Sectorial Verification System3 (Energy)	852	2216
Sectorial Verification System4 (Clean Production and Water)	363	944
Sectorial Verification System 5 (Soil Remediation)	561	1459
ETV contact points	370	370
TOTAL COSTS	**3670**	**8424**

[13] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §2.1.4, pp26, Figure 4

Figure 1: Cost estimation for model c1

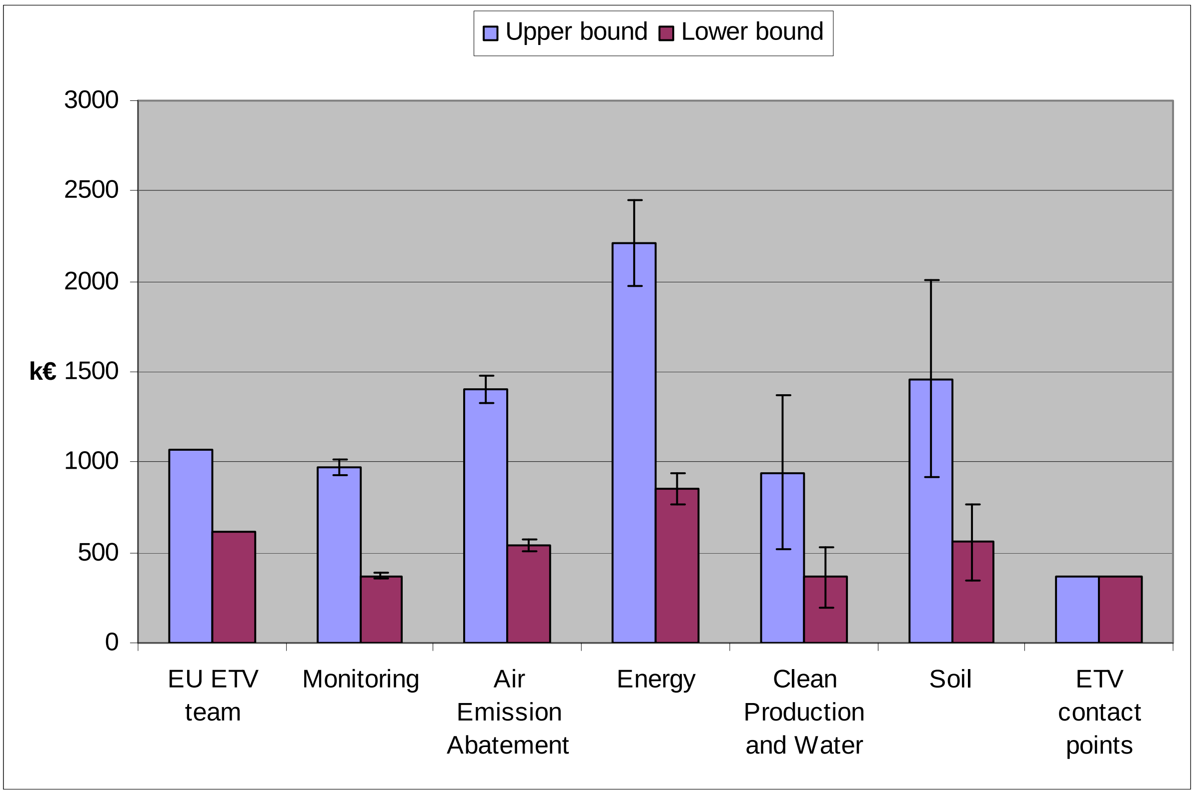


Figure 2: Cost Breakdown of the main actors of the model c1

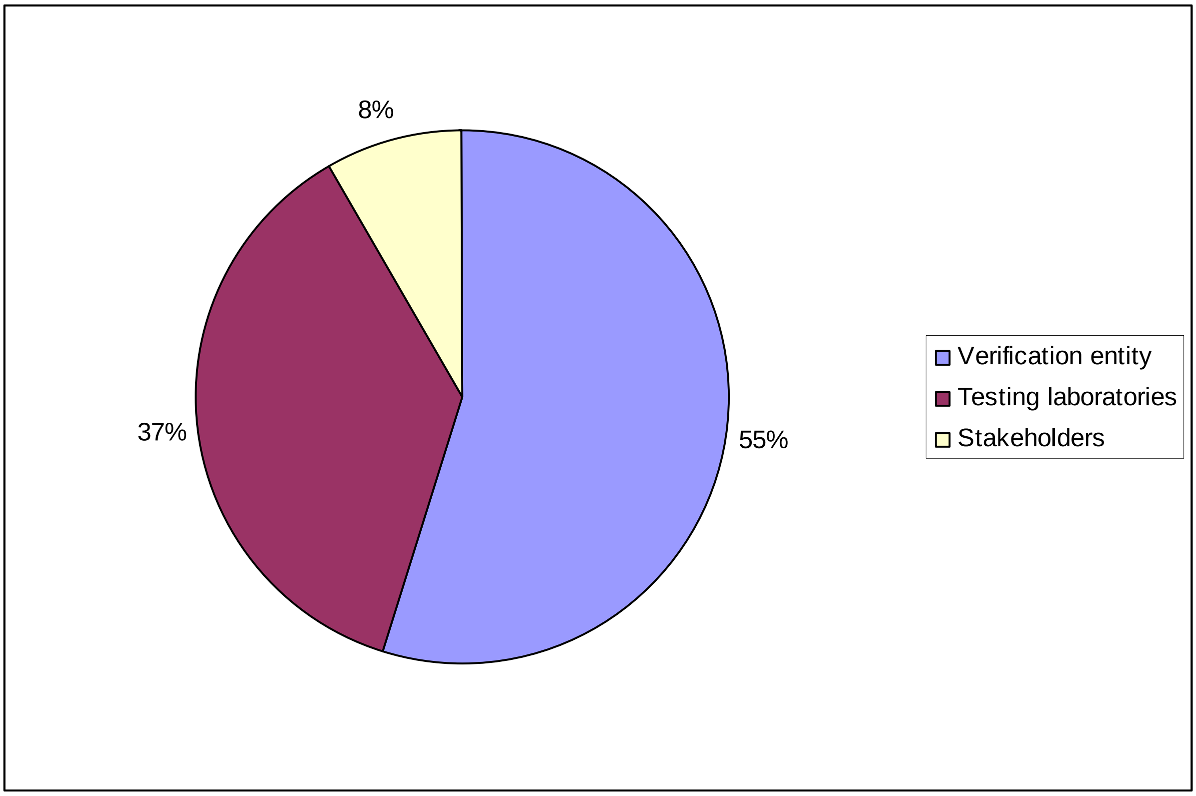


Table 5: Cost breakdown of the main actors of the model c1

Actors	k€ lower bound	k€ upper bound
Sectorial Verification System 1 (Monitoring)		
Verification Entity	203	527
Testing Laboratories	138	359
Stakeholders	31	81
Total for system 1	372	966
Sectorial Verification System 2 (Air Emission Abatement)		
Verification Entity	282	732
Testing Laboratories	227	589
Stakeholders	31	81
Total for system 2	539	1402
Sectorial Verification System3 (Energy)		
Verification Entity	429	1114
Testing Laboratories	393	1021
Stakeholders	31	81
Total for system 3	852	2216
Sectorial Verification System4 (Clean Production and Water)		
Verification Entity	199	517
Testing Laboratories	133	346
Stakeholders	31	81
Total for system 4	363	944
Sectorial Verification System 5 (Soil Remediation)		
Verification Entity	292	759
Testing Laboratories	238	620
Stakeholders	31	81
Total for system 5	561	1459

4.3 Model c2

Model characteristics		
Policy option	c	voluntary
General structure	s2	decentralised sectorial
Scope	v2	Canadian model

4.3.1 Basic calculation

Table 6 presents the total estimated costs of model c2. As described in §2 this model consists of a small secretariat (the EU ETV team) and a group of organisations, one per selected sector, responsible for carrying out the verifications. Five sectors were selected and the costs of each of them is calculated from data of the ETV Canada system. The detailed calculations of the various cost elements making up the verification costs under the ETV Canada model are presented in Annex IV - Cost calculation of the ETV Canada model. The lower bound is approximately 1.8 M€ and the upper bound approximately 3.5 M€.

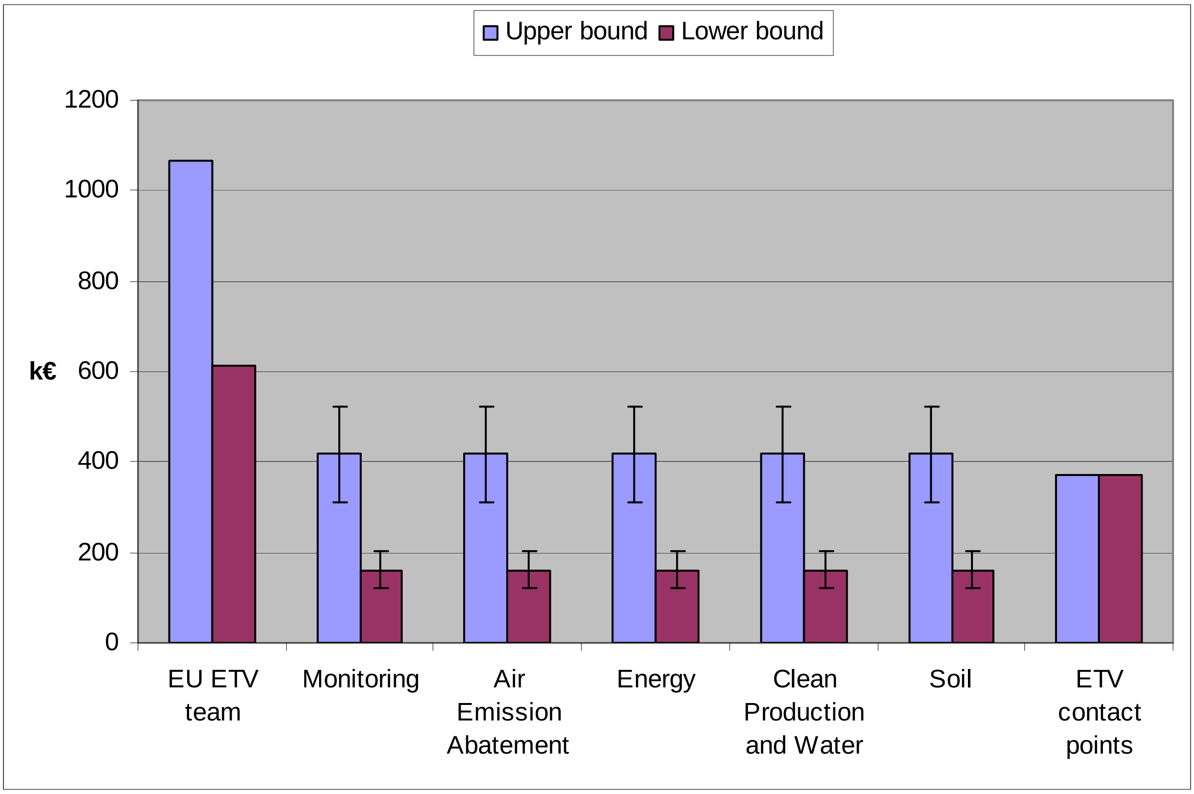
The costs of each sectorial verification entity are identical, since all the cost elements that can vary significantly from one verification case to another (testing, protocol and test plan development) are not included in the calculation, since they do not form part of this model. The testing and accompanying protocol and test plan have been already executed by the vendor, before he enters the system. Or, they are required by the system if the data provided by the vendor do not meet the system's quality assurance requirements, or they do not cover some crucial performance parameter. In that case the vendor has to repeat the tests or execute additional ones, bearing the totality of the costs.

Figure 3 schematically shows the costs of the various entities of the model. The weight of the secretariat and the contact points is relatively more important in the upper bound than in the lower bound (see Annex VIII – Uncertainties in the cost calculations, for details in the calculation of cost variations).

Table 6: Costs of model c2

	lower bound	upper bound
Actors	k€	k€
EU ETV team (secretariat)	613	1066
Sectorial Verification System 1 (Monitoring)	160	417
Sectorial Verification System 2 (Air Emission Abatement)	160	417
Sectorial Verification System3 (Energy)	160	417
Sectorial Verification System4 (Clean Production and Water)	160	417
Sectorial Verification System 5 (Soil Remediation)	160	417
ETV contact points	370	370
TOTAL COSTS	**1784**	**3519**

Figure 3: Cost estimation for model c2



4.3.2 Optional costs

As was mentioned earlier, testing, protocol development and stakeholder costs are not part of this ETV model. However, the vendor/producer of the technology may have to assume the responsibility of a part or of the totality of these costs, to generate the data that will be verified by the system, or to provide additional data if the quality or the scope or the initial data do not respect the system's quality assurance procedures. Information on these costs, qualified as "optional" has been provided by ETV Canada and cover the majority of the verification cases for which these costs were expended by the vendor (Table 7). Testing has the largest variability, followed by stakeholder costs and the development of verification protocols and test plans.

Table 7: Optional costs of the model c2 (per verification)

	min	max
	k€	k€
Stakeholder workshop	24	47
Verification protocols/test plans	31	39
Tests	39	117

However, estimations of the private costs needed to carry out the verifications are difficult to estimate accurately. First because all technologies are accepted and no grouping in technologies by sector that may have similar costs is possible. Second because these costs are expended after a private agreement between the vendor and the independent test laboratory, and are not under the control of the ETV system.

4.4 Model c3

Model characteristics		
Policy option	c	voluntary
General structure	s2	decentralised sectorial
Scope	v3	mix model

Table 8 presents the total estimated costs of model c3. This model is based on the structure of the ETV Canada model, with the addition of an extensive claim review establishing the technology's eco-profile. This eco-profile combines vendor information with elements of life cycle analysis where pertinent (similar to an Environmental Product Declaration) and is carried out using stakeholder advice. The technology eco-profile is used for the review and modification of the vendor's claim and the requirement, if need be, for complementary testing. The detailed calculations are presented in Annex V – Cost calculation of the mix model. The lower bound is approximately 2.1 M€ and the upper bound approximately 4.3 M€.

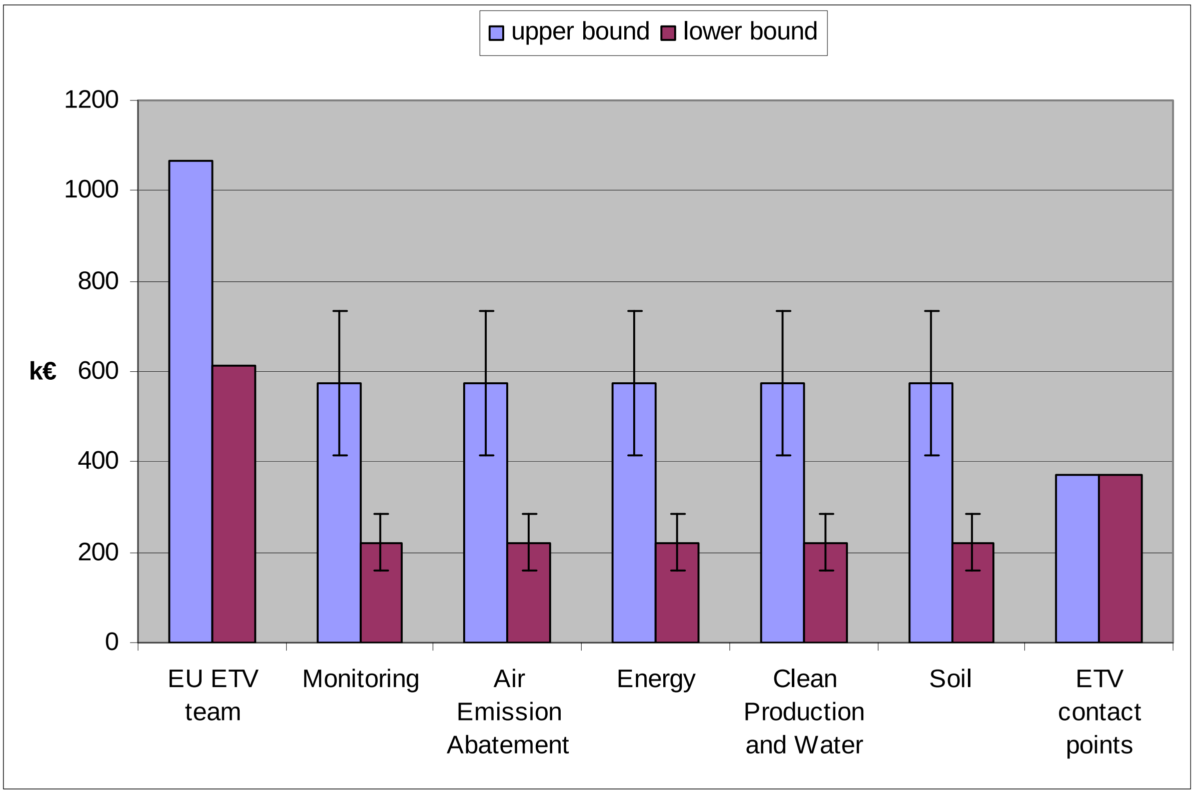
It is expected that this model will include more systematically all environmentally relevant aspects of a technology. Indeed, the ETV Canada model insists on verifying the quality of the established data, and by that the quality of the technology under scrutiny. This model will additionally insist on the completeness, from a performance and an environmental point of view, of the claim. It is expected that this model will require more frequently modifying these claims, resulting in the need for execution of additional testing (or provision of additional data if they are available). The vendors will then have, in comparison with model c2, to expend the related optional costs (§4.3.2) more frequently.

Figure 4 schematically shows the costs of the various entities of the model. All comments referring to the previous c2 model (§4.3) are valid here as well.

Table 8: Costs of model c3

	lower bound	upper bound
Actors	k€	k€
EU ETV team (secretariat)	613	1066
Sectorial Verification System 1 (Monitoring)	221	576
Sectorial Verification System 2 (Air Emission Abatement)	221	576
Sectorial Verification System3 (Energy)	222	576
Sectorial Verification System4 (Clean Production and Water)	222	576
Sectorial Verification System 5 (Soil Remediation)	222	576
ETV contact points	370	370
TOTAL COSTS	**2090**	**4315**

Figure 4: Cost estimation for model c3



4.5 Lower and higher limits of the models

The numbers of verifications per year that were attributed to each verification organisation and to the whole ETV system were based on historical data of the existing ETV systems. These numbers can be considered as a measure of a system's success (other success measures are the impact of the system on the graduate companies translated to sales and ultimately the impact on the environment by the diffusion, due to ETV, of the verified technologies). However, the exact number of the technologies to be verified for the future EU scheme is unknown. But the number of technologies that are verified each year defines the system's size and by a scale effect also the relative costs. It is assumed that the fix costs of the system should drop with the increase in the number of verified technologies. But also the variable costs are likely to drop as well, under certain circumstances. The MCERTS certification scheme (Annex VII), which has many similarities to an ETV system (US model) can be taken as an example of a model towards which an ETV system could trend. In this case, available protocols for all the verification cases exist and can be used with limited modifications and minimum costs. The cost of all the verification steps, with the exception of testing, are minimised.

On the other hand, if no verifications are done, the system will still have to assume the fix costs. An estimation of their amount is given in Table 9. The lower bound is approximately 1.3 M€ and the upper bound approximately 2.4 M€. The upper bound system is conceived for doing a higher number of verifications than the lower bound system and will have to assume more fix costs, in the hypothetical situation that no verifications are performed.

An estimation of the impact on fix costs of a system with a very important number of verifications is more difficult to make. Qualitatively, the fix costs of a model of US ETV type that include stakeholder costs are likely to drop more than the fix costs of a model of the ETV Canada type, that are more incompressible.

Table 9: Fix costs of an idle system

	lower bound	upper bound
Actors	k€	k€
EU ETV team (secretariat)	613	1066
Sectorial Verification System 1 (Monitoring)	72	187
Sectorial Verification System 2 (Air Emission Abatement)	72	187
Sectorial Verification System3 (Energy)	72	187
Sectorial Verification System4 (Clean Production and Water)	72	187
Sectorial Verification System 5 (Soil Remediation)	72	187
ETV contact points	370	370
TOTAL COSTS	1343	2372

4.6 Comparison of the costs of similar ETV "steps" in each model

To compare the four models in a more transparent manner, the similar activities or "steps" in each of them are put in four categories, as far as the available data permit to operate this categorisation. The grey area of Table 10 represents the core verification system, which is complemented by the EU ETV team and the ETV contact points. The activities inside the grey area are going to be examined in more detail. Table 11 presents the various cost elements included in each of the steps (see also the Annexes for details). By the term "Input" is understood the first phase of the verification procedure, resulting in reference documents that are the base of the verification.

In model c1 (US) this input takes the form of the test protocols that are developed with stakeholder input, after a first technology prioritization and subsequent technology selection. Test plans are drawn up according to the protocols and testing is executed following the test plans and respecting the quality assurance procedures of the system. The proper verification step is made up of four interlinked cost elements: General management, Audits and Quality assurance evaluation, Quality management and the final step leading to the verification reports.

In model c2 (Canada) the input takes the form of the vendor's claim. The costs necessary to write out the claim are not quantified here and neither are the costs for the tests, since it is considered that these are outside the system's boundaries. Indications on the probable magnitude of the testing costs are given in §4.4.2[14].

[14] Other additional vendor expenses (also called in-kind contributions) include: staff time, shipping and travel, cost of the testing kit or the technology etc, http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §4.6, pp. 73

In model c3 (Mix) the vendor's claim is enhanced by stakeholder feedback and an Environmental Product Declaration. As for the previous model the cost element "Verification/Reporting/Award" include the verification of the vendor's data, the verification reporting and the final award of the system's logo.

All the models contain costs for general management, quality management and information diffusion. Figure 5 and Figure 6 show the core ETV system costs for each model (corresponding to the grey area of Table 10) for the upper and lower bounds, where the dotted line presents the sum of these core costs. The cost variations corresponding to each system (Annex VIII – Uncertainties in the cost calculations) have been allocated to the different cost "steps" according to their weight in the total ETV system costs. These figures show the funds necessary for the "input" in both the US and Mix models and the testing costs for the US model. It can be seen that the verification cost rises to similar levels for the US, Can and Mix models. Information diffusion costs are considered the same for the whole range of models. Figure 7 and Figure 8 put the core, ETV system costs in the perspective of the total system costs comparing them to the EU ETV team and contact point costs.

Table 10: Overview of the total costs of the models

		k€	k€	k€
Lower Bound		c1 (US)	c2 (Can)	c3 (Mix)
	EU ETV team	613	613	613
ETV system	Input	669		306
	Testing/LCA	1129		
	Verification	707	615	615
	Information diffusion	186	186	186
	ETV contact points	370	370	370
	TOTAL COSTS	**3670**	**1784**	**2090**
Upper Bound		c1 (US)	c2 (Can)	c3 (Mix)
	EU ETV team	1066	1066	1066
ETV system	Input	1740		796
	Testing/LCA	2934		
	Verification	1838	1599	1599
	Information diffusion	484	484	484
	ETV contact points	370	370	370
	TOTAL COSTS	**8424**	**3519**	**4315**

Table 11: Cost items included in the models

	c1 (US)	c2 (Can)	c3 (Mix)
Input	• Stakeholders • Prioritization • Protocols • Solicitation/ selection	• Claim	• Stakeholders • Claim review – technology eco-profile
Testing	• Testing • Test/ QA plans		
Verification	• Verification reports • General management • Audits/QA evaluation • Quality management	• Verification/ Reporting/ Award • General management • Quality management	• Verification/ Reporting/ Award • General management • Quality management
Information diffusion	• Information diffusion	• Information diffusion	• Information diffusion

Figure 5: Costs of ETV system steps (Lower Bound)

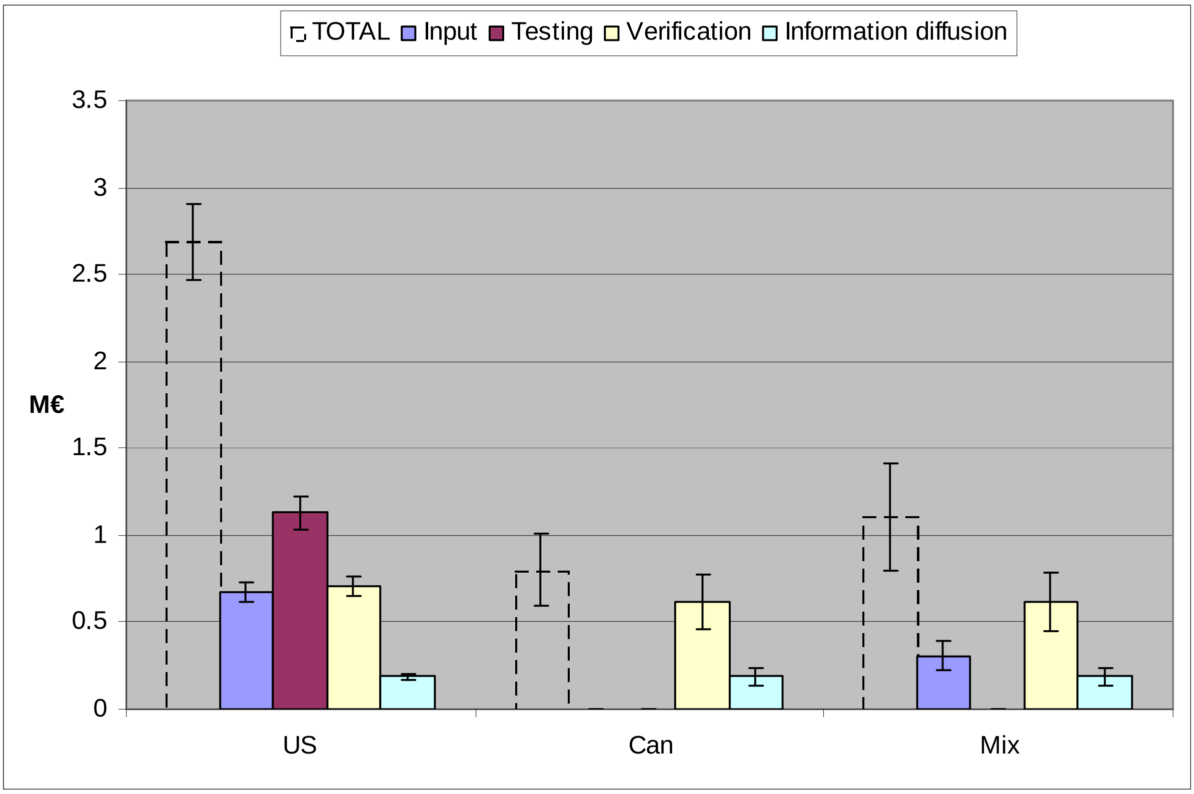


Figure 6: Costs of ETV system steps (Upper Bound)

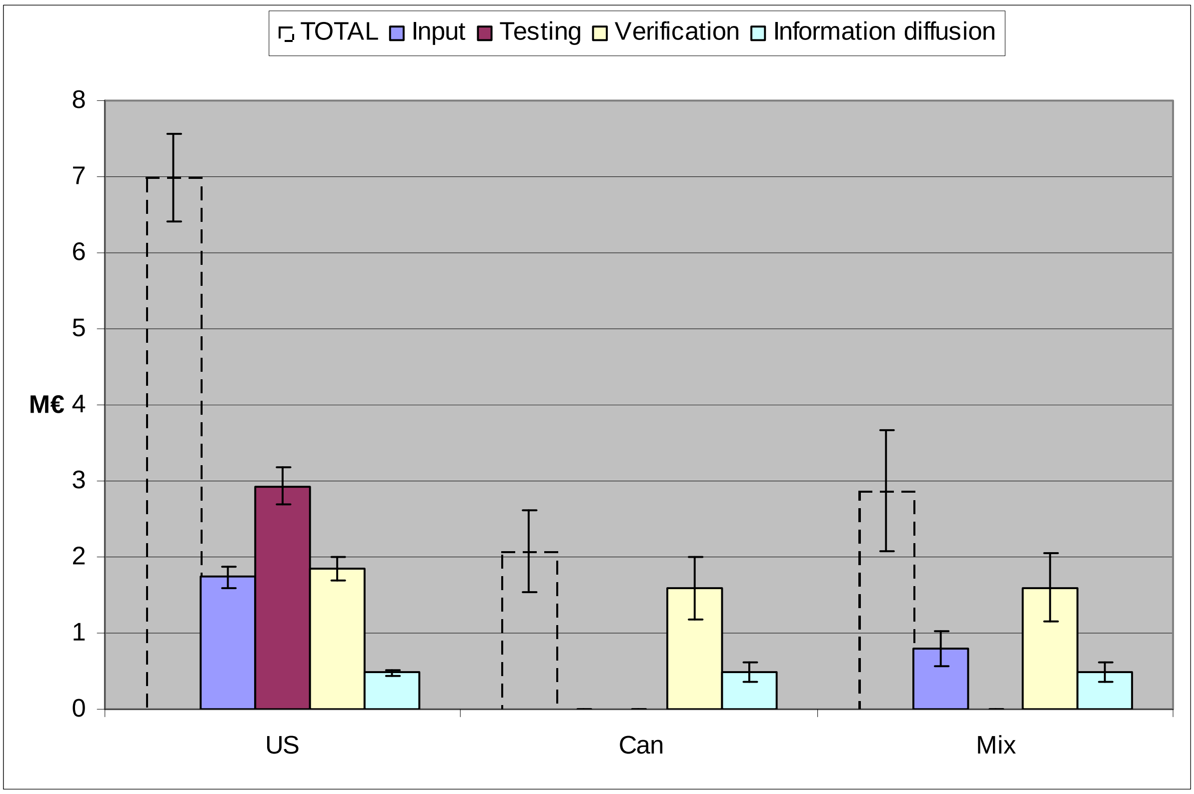


Figure 7: Total costs of the ETV models (Lower Bound)

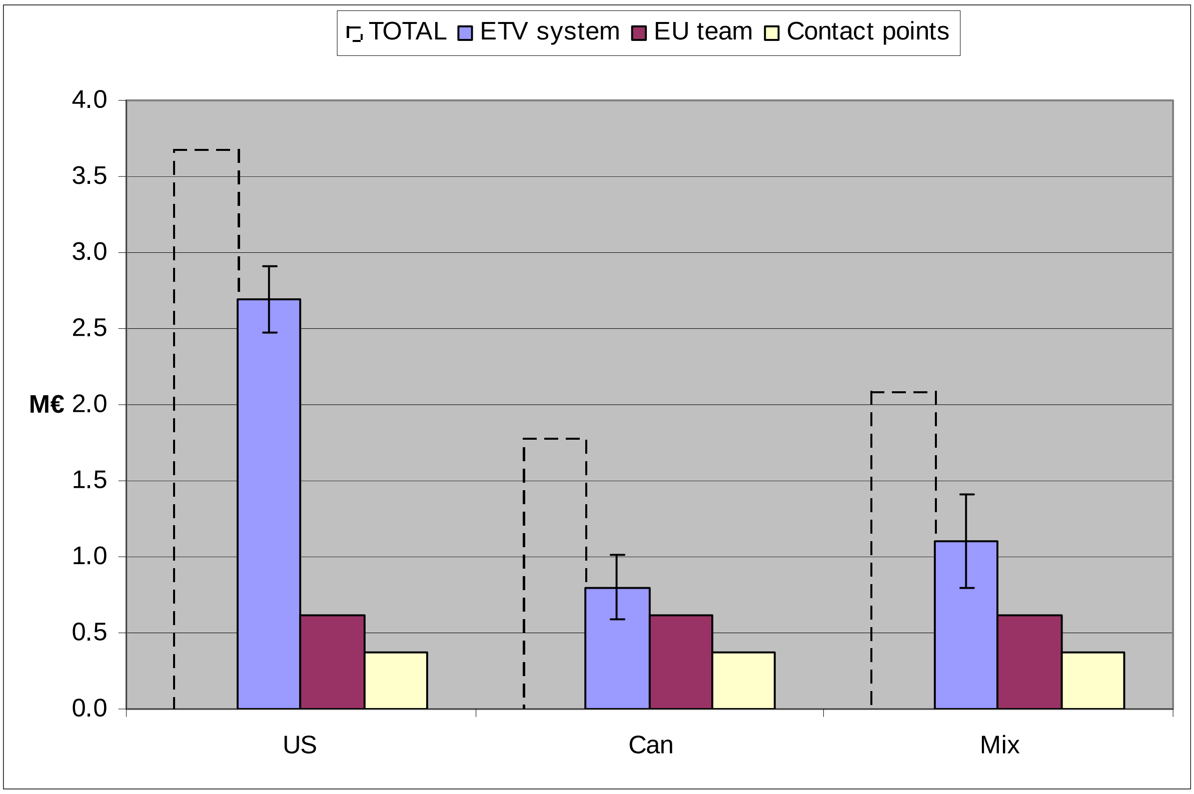
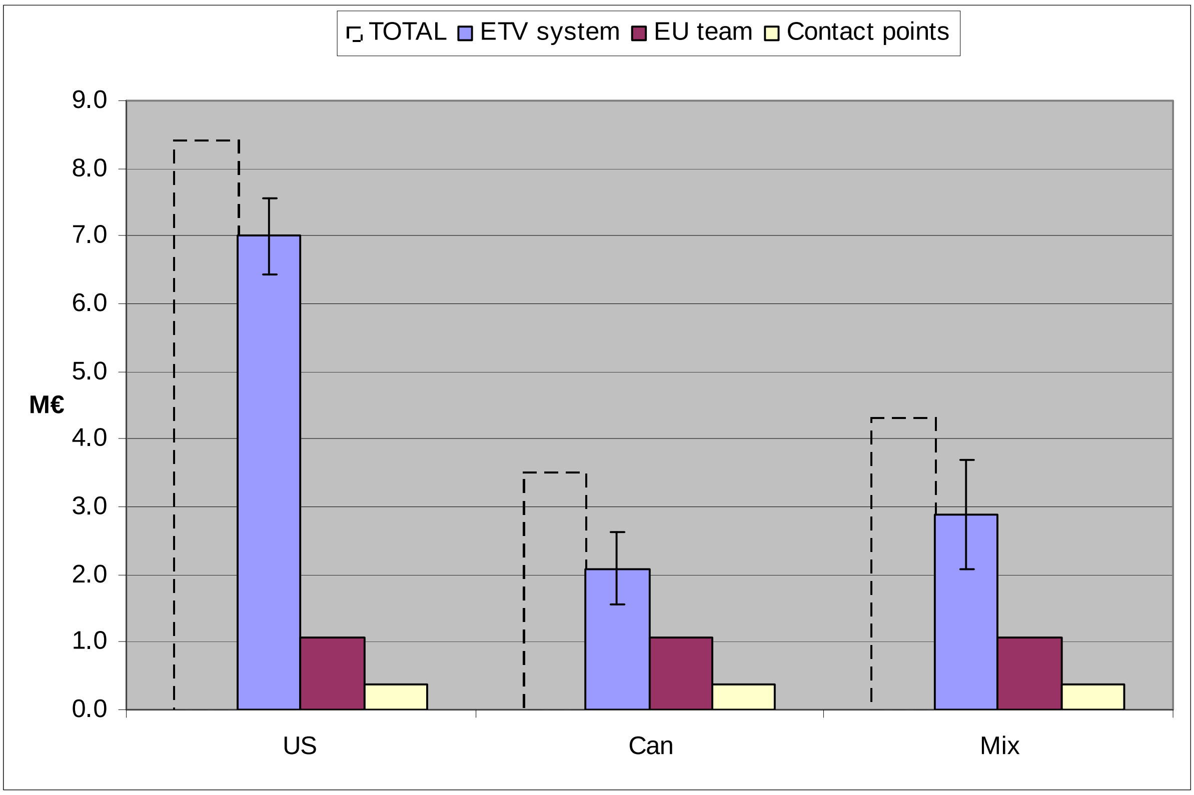


Figure 8: Total Costs of the ETV models (Upper Bound)



4.7 Conclusions

Table 10 (§4.6) shows that under the assumptions presented above (and in the Annexes), model c1 (US model) has the highest costs, followed by model c3 (Mix model). Model c2 (Canadian model) has the lowest costs. The costs of each model directly reflect their respective designs and output.

At the same time, the different models meet the policy objectives to a different extent. The US approach (c1) is advantageous in the sense that through the testing inside the system the same conditions are given for all technology producers. This increases the comparability of the results as well as their reliability**.** From that perspective, the information provision criterion is best met by this model. However, at the same time the need to carry out the testing within the model slows the procedure down. The model is also less flexible as it has to adapt to specific industrial sectors individually through building up the relevant testing infrastructure and developing the necessary protocols together with stakeholders.

In contrast to the US model, the Canadian approach (c3), which is significantly cheaper, does not need to generate all information on the environmental performance of a technology from scratch, but to integrate information provided by the technology producer. That allows at the same time for a more flexible system, as technologies from all sectors can be taken into account, and for a faster procedure, because a lot of testing will in a lot of cases already have been done in advance. The drawback of that model is the reduced comparability and reliability of the information as compared to the US approach. In comparison to the EDP approach the Canadian model is more reliable, as the information on environmental performance is generated context specific and not retrieved from existing databases.

The model c3, which proposes a combination of the ETV Canada model with elements of life cycle analysis, is a novelty model. It aims to enhance the reliability and the comparability of the Canadian model, maintaining as far as possible at the same time its advantages: flexibility, low processing time and cost. This is done with a moderate increase in the model's input by a thorough review, and modifications, to the vendor's claim. The goal of this extended review of the claim is to remediate one of the weak points of the Canadian model. It can be ventured that a vendor can selectively choose to verify some aspects of the technology performance only, provided that sound engineering and scientific principles are used to generate data of acceptable quality. This review would make sure that all relevant aspects of the technology performance are duly taken into account (e.g. cross media effects). During the establishment of the technology eco-profile, LCA elements will be used. The fact that the information is based on given LCA data and the applying technologies are of innovative nature will make it necessary to generate at least partly new LCA data sets in order to meet comparability standards. As in the other models, reliability of given and newly generated data has to be examined.

Table 12: Global model evaluation

	Reliability	Comparability	Flexibility	Affordability
c1 (US)	+++	+++	+	+
c2 (Can)	+	+	+++	+++
c3 (mix)	++	++	++	++

5 Benefits of ETV

The quantification of benefits resulting from environmental technology verification is difficult for a number of reasons. Firstly, the concept of technology verification is relatively young, with the consequence that only limited evidence is available with regards to actual impacts stemming from ETV. Secondly, the impacts of ETV are manifold, they range from environmental and health effects to increased technology sales. However, only part of these are accessible to direct measurement, a large number of impacts is hardly or not at all quantifiable. However, two US ETV reports[15,16] 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.

- Mercury CEMs

The US ETV AMS centre verified seven CEMs (Continuous Emission Monitors) for mercury[17]. 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-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.

According to the US study, ETV verification has in this case resulted in increased sales of mercury CEMs. Several SME reported that through the verification a level playing field with larger companies was created and that they were therefore able to enter the market, which would have been much more difficult without verification.

- Microturbine technologies

[15] 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
[16] 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
[17] http://www.epa.gov/etv/verifications/vcenter1-11.html

The US ETV GHG Center has verified the performance of six microturbine systems[18], 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. For the years to come EPA estimated the potential installation of microturbines up to a capacity of 55MW in five years time.

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, up to a reduction of 150000 t/year of CO_2 and 530 t/year of NO_x. 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.

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

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

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 billion dollars (depending on the performance of the various technologies tested) during a seven year period. Other benefits refer to improved human health, ranging from 680 to 2400 avoided premature mortality cases to reduced respiratory diseases and the related reduction of lost work days.

Annex I - Cost calculation of the EU ETV team

The cost calculation of the EU ETV team is based on data from existing comparable structures within the EC. The cost estimation is based on a number of 5-10 full time members for the EU ETV team (10 was set as a maximum[19] but it can be envisaged that initially the team will work with fewer members and gradually increase in size). The EU ETV team is the only entity that will have to be created from scratch for the establishment of the ETV system. For that reason, a short description of the main duties of the team (not exclusive) is presented below, bearing in mind that some of the duties can be shared with the verification organisations.

Short description of duties of the EU ETV team[20]

The EU ETV team lays the foundations of the verification program (program scope, objectives, strategies and administrative protocols). 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 selects thematic verification organisations, the number of which depends on the priority technology areas addressed by the program. The EU ETV Team is in charge of auditing these organisations 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:

- Supports the Commission in designing the program in implementation of the legal basis: definitions, objectives, eligibility criteria, funding considerations, organisational principles and general strategies
- Makes the assessments and consultation necessary to prepare the Commission's decisions on priority technology areas
- Prepares and runs the competitive selection of thematic VOs in relation with the priority technology areas, ensures the contracting and auditing of the VOs and evaluates their results
- Establishes the general verification protocol of the programme, relevant quality management procedures and implements them in coordination with the VOs
- Establishes the program budget
- Communicates on program activities, progress, outputs and recommendations in coordination with the VOs
- Awards certificates and logos to successful vendors

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[19] http://ec.europa.eu/environment/etap/pdfs/consultation_on_etv.pdf
[20] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §6, pp. 91

Table 13 shows the estimated costs for a team of five people and Table 14 for a team of ten[21]. It was assumed that these sizes will be sufficient to deal with the amount of work generated by the upper and lower estimates of the ETV models described in the main body of the report (§4). Apart from the salary cost of staff, estimations were given for administrative marginal costs and the cost of the workspace. Mission costs (e.g. to designate and evaluate the various actors of the system) and specific credits (e.g. to conduct ex post impact assessments or for communication expenses) were added to the total costs of the project. The total cost for an EU ETV team of five (lower bound) is estimated to a sum 613 k€ and the total cost for a team of 10 (upper bound) is estimated to a sum of 1066 k€.

Table 13: Costs of the EU ETV team (lower bound)

Team of 5 people

	Number of Staff	Cost	Marginal Cost	Cost of the Work Space	Total Cost of the Project
	persons-year	k€	11%	7.5 k€	k€
Staff (per year)					
FO grade AD11/13	1	156	17	8	181
FO grade AD8/11	1	97	11	8	115
FO grade AD+AST5/7	0	0	0	0	0
FO grade AST1/4	1	58	6	8	72
CA function group IV	1	68	7	8	83
CA function group III	0	0	0	0	0
CA function group II	0	0	0	0	0
GH40	0	0	0	0	0
GH20/30	0	0	0	0	0
END/SNE	1	49	5	8	62
Total Staff	**5**	428	47	38	513
		0	0	0	0
Missions (per year)		0	0	0	0
Missions		40	4	0	44
Total Mission Cost		40	4	0	44
		0	0	0	0
Specific Credits (per year)		0	0	0	0
Specific credits		50	6	0	56
Total Specific Credits		50	6	0	56
		0	0	0	0
		0	0	0	0
Total	**5**	518	57	38	613
Total Marginal Cost Charged					**18%**

[21] The US ETV headquarters team is made up of 10 full time staff. Apart from their running costs, approximately 250 k$ are spent every year in contracts for program support, evaluation, and outreach: These activities include collecting data, producing the annual report and the outcomes reports, holding an annual team meeting and outreach, and maintaining the website (source: US ETV personal communication).

Table 14: Costs of the EU ETV team (upper bound)

Team of 10 people

	Number of Staff	Cost	Marginal Cost	Cost of the Work Space	Total Cost of the Project
	persons-year	k€	11%	7.5 k€	k€
Staff (per year)					
FO grade AD11/13	1	156	17	8	181
FO grade AD8/11	1	97	11	8	115
FO grade AD+AST5/7	0	0	0	0	0
FO grade AST1/4	1	58	6	8	72
CA function group IV	3	204	22	23	249
CA function group III	0	0	0	0	0
CA function group II	0	0	0	0	0
GH40	0	0	0	0	0
GH20/30	0	0	0	0	0
END/SNE	4	198	22	30	250
Total Staff	**10**	713	78	75	866
		0	0	0	0
Missions (per year)		0	0	0	0
Missions		80	9	0	89
Total Mission Cost		80	9	0	89
		0	0	0	0
Specific Credits (per year)		0	0	0	0
Specific credits		100	11	0	111
Total Specific Credits		100	11	0	111
Total	**10**	**893**	**98**	**75**	**1,066**
Total Marginal Cost Charged					**19%**

Annex II - Cost Calculation of the ETV contact points

The role of the network of ETV contact points is to establish a relation of proximity between ETV and the vendors, diminishing any geographical distance, language or administrative barriers. The contact points should be active in communicating on ETV, explaining the ETV concept and the advantages that it can bring to its end users. They should be established in all Member States, their hosting establishment being variable: testing laboratories, certification organisations, innovation relay centres[22], Euro-info centres[23], national ministries of the environment etc[24].

Approximately 70 innovation relay centres and 300 Euro info centres are in operation today. The cost of the establishment of a network capable of giving assistance on ETV matters is, in essence, the cost of training the network's personnel to deal with ETV specific requests. It is estimated that 1 training day per year (with an approximate cost of 1000 €) could cover this task. In time, more contact points can be added to the network. This calculation is presented in Table 15.

Table 15: Cost for ETV contact points

Contact point	Number	Cost for training
IRC	70	1000 €
Euro-Info	300	1000 €
Total Costs	**370 k€**	

[22] http://www.innovationrelay.net/ircnetwork/network.cfm
[23] http://ec.europa.eu/enterprise/networks/eic/eic.html
[24] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §6, pp 95

Annex III - Cost calculation of the US ETV model

Introduction

The US ETV verification scheme was taken as a model of a system with sectorial verification organizations which interact with a small ETV team, various stakeholder groups and the vendor. The costs of verifications done through years 1999 – 2005 have been used to estimate the average distribution of all verification cost elements, at the scale of the whole system (Figure 9). During this period, 344 verifications have been completed, with costs ranging from 50 to 200 k€. In order to obtain an idea of the cost per verification (since only global costs or partial costs on specific verifications are available), it is necessary to do some simplifying assumptions, which are described below. On Figure 9, it can be seen that testing is the dominant cost element, followed by costs for reporting and development of protocols and test plans. These costs, together with the costs for technology selection and audits are considered as "variable" costs, because they are technology specific. The remainder, (information diffusion, stakeholders, general management, prioritization and quality management, by order of importance) are the fix costs. Fix costs will have to be incurred even if no verifications are actually taking place.

Figure 10 shows again the percentage distribution of fix and variable costs. The error bars depict the variation of these global costs in the US ETV system from year to year. These yearly variations, apart from being related to technology specific costs, occur because the number of verifications is not the same every year and because many verifications are not completed inside one year. In the following calculations the above variations will be disregarded.

In the US ETV system several equipments that belong to the same technology category (and can be tested using the same test protocol) are verified at the same time, in parallel test sessions. This practice, apart from allowing a more straightforward comparison (even if the goal of the system is not to compare technology performance explicitly), results in cutting down the costs per verification[25]. This effect is not taken into account in the calculations. Vendor in-kind contributions[26] are not considered either.

Fix Costs

Figure 11 shows the fix costs per verification in k€. These costs (which are derived from the so called "Centre support costs" of the US ETV system) are taken to be as 30±5 % of total costs (Figure 10). They were calculated with respect to an average variable cost of 50 k€ which is the average of all the variable verification costs of all verification cases carried out by the US ETV system. The error bars correspond to the applied variability of 5%. The fix costs are assumed as uniform to all verification cases, meaning that variations from one technology to another or from one centre to another are disregarded.

[25] When more than 4-5 technologies are tested at the same time the prices are reduced by 10 – 20 % (source: US ETV).

[26] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §4.6, pp 73

Variable Costs

Variable costs, which are directly related to each verification case are very fluctuant (see introduction to this Annex). For this reason it was decided to take average values of these costs related to a specific sector. These costs are derived from the "Verification costs" of the US ETV system. Four different types of sectors are considered: Monitoring, Air emission abatement, Water and Energy (including renewable energy and ghg technologies), with the costs derived from corresponding centres of the US ETV system.

Figure 9: Average Cost Distribution in the US ETV model

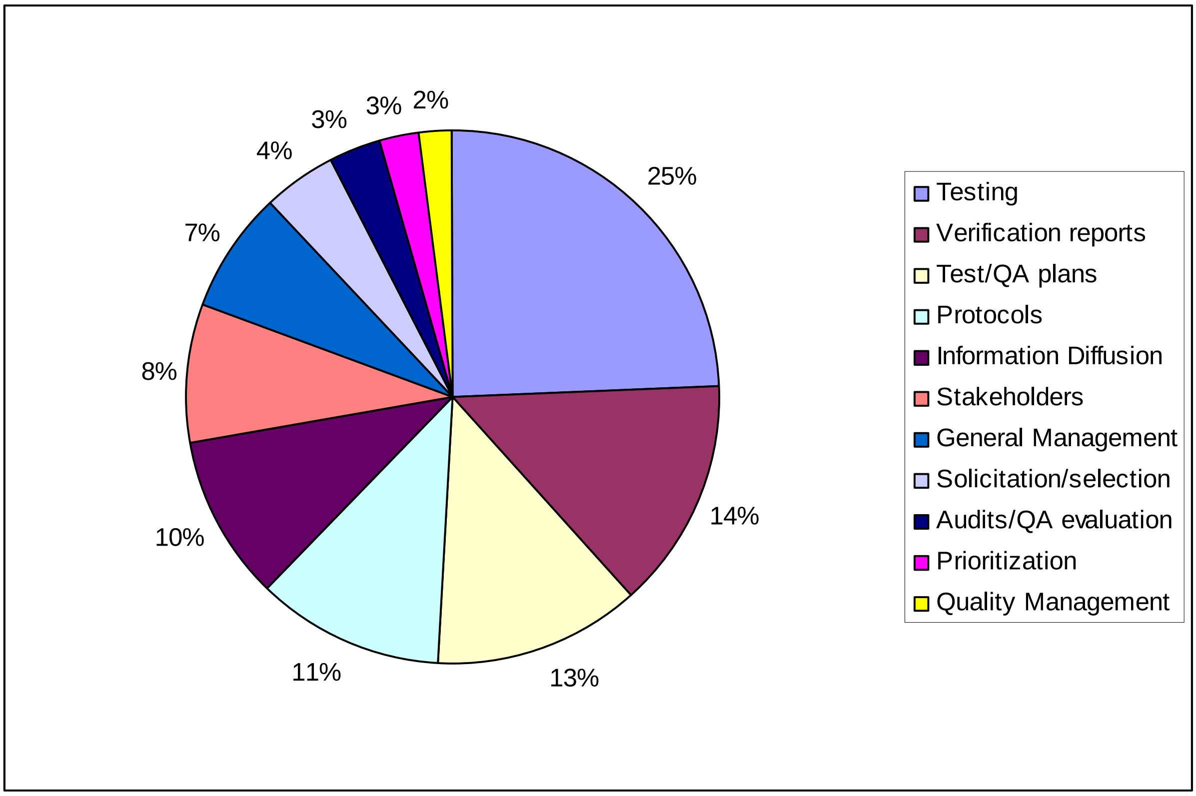


Figure 10: Fix Costs and Variable Costs in the US ETV model (per verification)

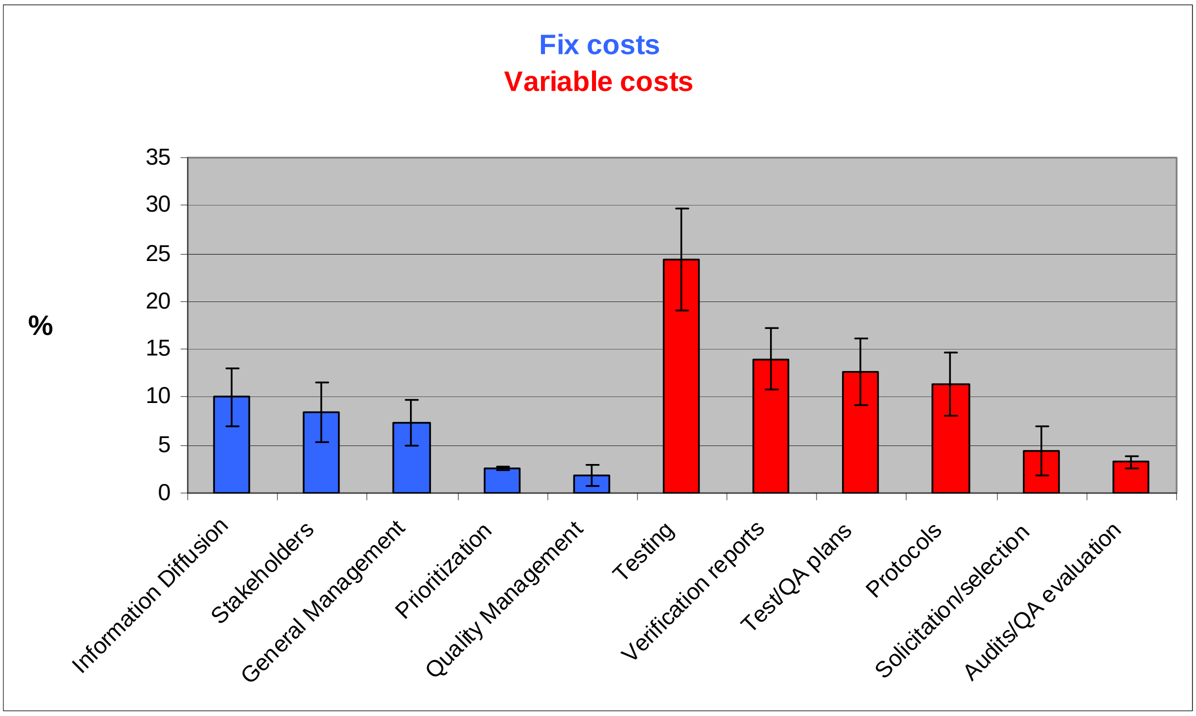
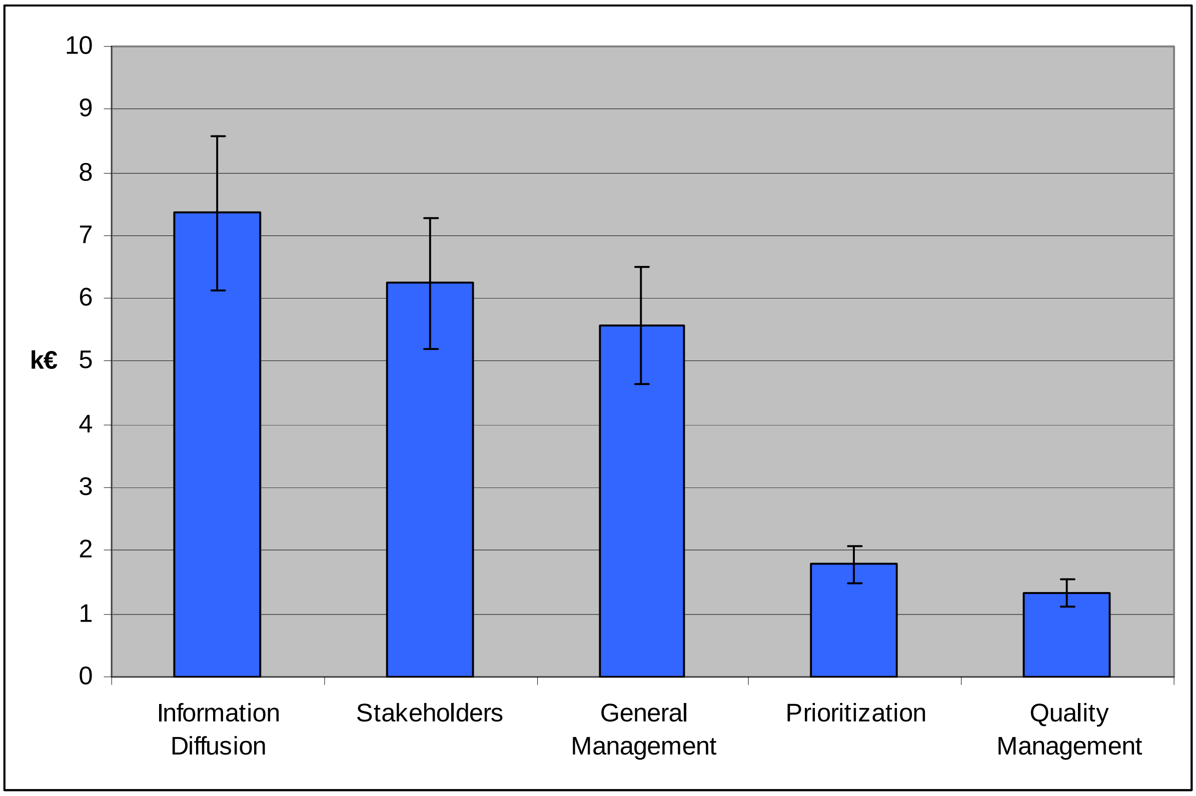


Figure 11: Fix Costs in the US ETV model (per verification)



Monitoring Technologies

Table 16 presents the average fix and variable costs for monitoring technologies. The fix costs are the same for each technology category. The variable costs are derived from average costs of the Advanced Monitoring System's centre[27] of the US ETV system. The technologies concerned are monitoring technologies for air, soil or water contaminants, including mercury emission monitors, ambient fine particulate monitors, test kits for arsenic and cyanide and many others.

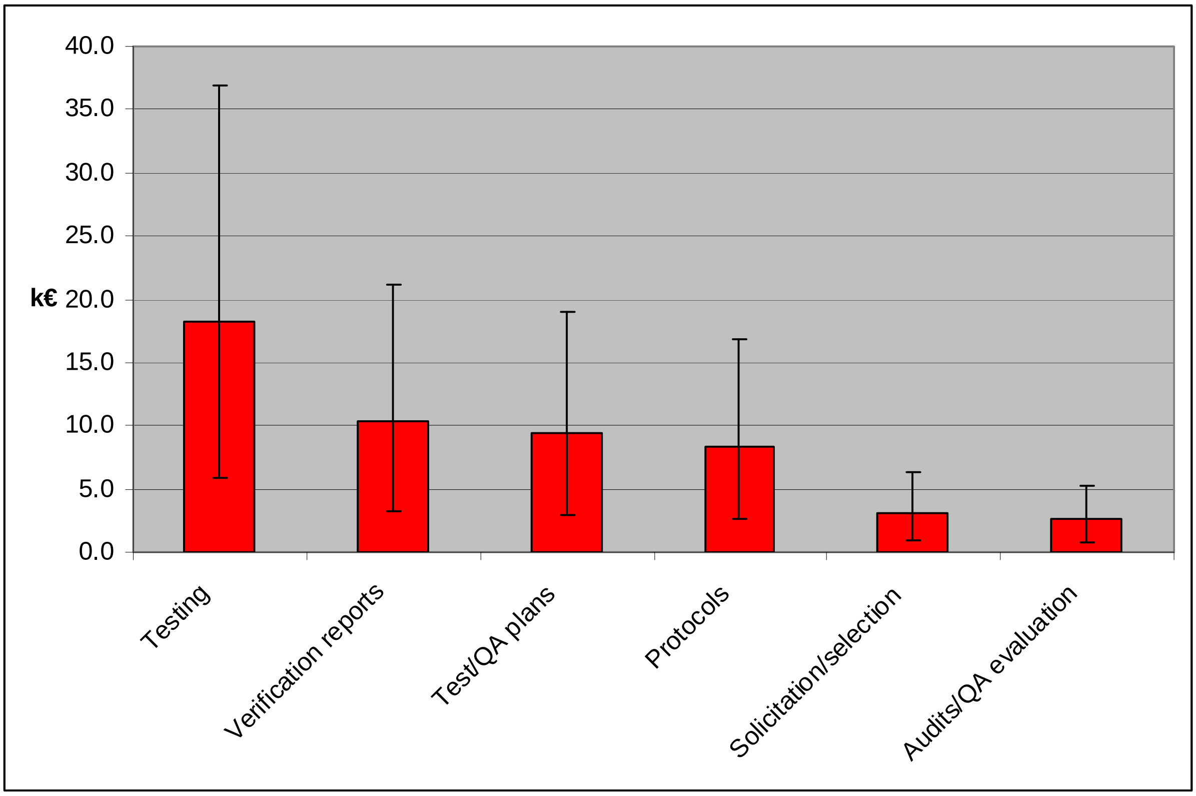
This centre has completed 132 verification cases during the years 2001 – 2005, with an average cost of 52.1 k€ per verification (variable costs)[28]. The more expensive verification case cost 105.7 € and the less expensive 16.6 € (Table 16 and Figure 12).

Table 16: Fix and Variable Costs for Monitoring Technologies (per verification)

Verification Centre 1 (Monitoring)	average	max	min
	k€	k€	k€
Fix costs			
Information Diffusion	7.4	8.6	6.1
Stakeholders	6.2	7.3	5.2
General Management	5.6	6.5	4.6
Prioritization	1.8	2.1	1.5
Quality Management	1.3	1.6	1.1
Total Fix costs	22.3	26.0	18.6
Variable costs			
Testing	18.2	37.0	5.8
Verification reports	10.4	21.1	3.3
Test/QA plans	9.4	19.0	3.0
Protocols	8.3	16.9	2.7
Solicitation/selection	3.1	6.3	1.0
Audits/QA evaluation	2.6	5.3	0.8
Total variable costs	52.1	105.7	16.6
TOTAL COSTS	**74.4**	**131.7**	**35.2**

[27] http://www.epa.gov/etv/center-ams.html
[28] All costs in this report refer to € prices of year 2007.
Exchange rates have been taken from http://www.federalreserve.gov/releases/g5a/ and GDP deflators from http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1073,46870091&_dad=portal&_schema=PORTAL&p_product_code=NA110IDX

Figure 12: Variable Costs for Monitoring Technologies for the US ETV model (per verification)



Air Emission Abatement Technologies

Table 17 presents the average fix and variable costs for air emission abatement technologies. The fix costs are the same for each technology category. The variable costs are derived from average costs of the Air Pollution Control[29] centre of the US ETV system. The technologies concerned control stationary and mobile air pollution sources, and mitigate the effects of indoor air pollutants. Diesel engine emission controls, baghouse filtration products, nitrogen oxides and volatile organic compound emission controls, dust suppression and soil stabilization products, and paint overspray arrestors are some of the examples.

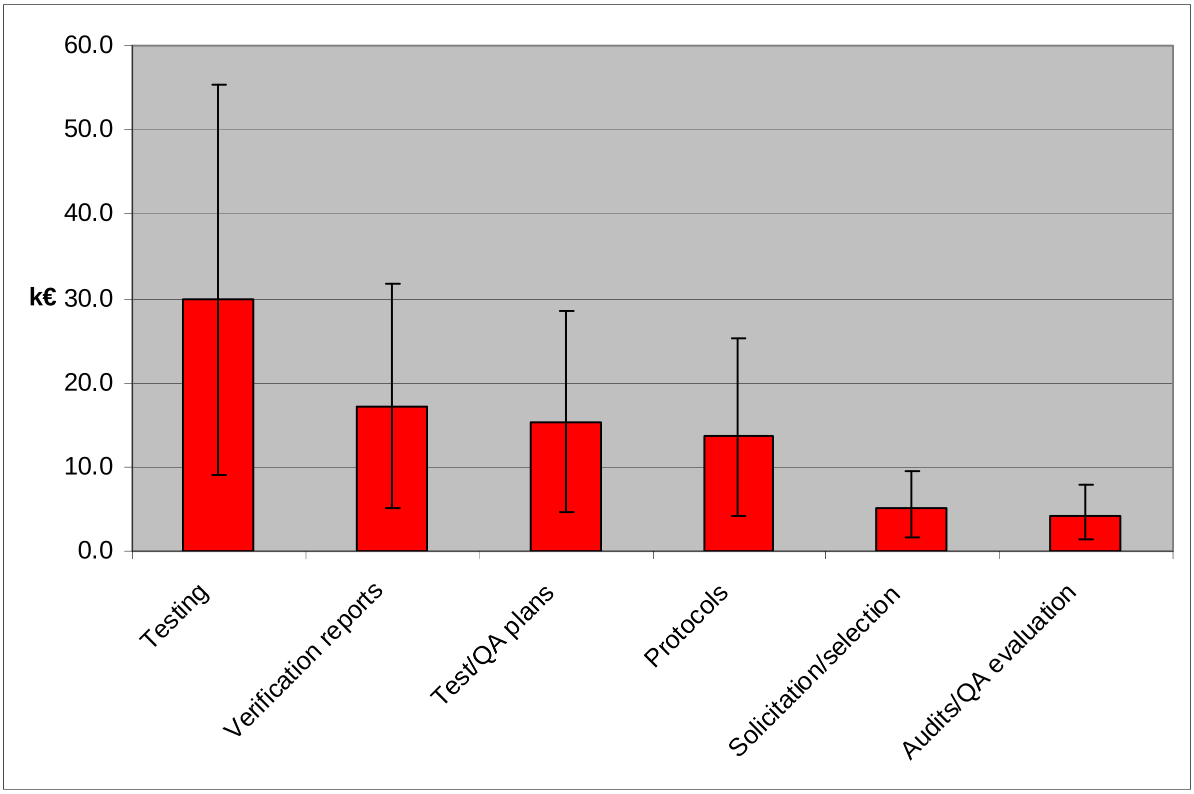
This centre has completed 67 verification cases during the years 2001 – 2005, with an average cost of 68.3 k€ per verification (variable costs)[28]. The most expensive verification case had a cost of 158.4 k€ and the least expensive had a cost of 26.0 k€ (Table 17 and Figure 13).

[29] http://www.epa.gov/etv/center-apc.html

Table 17: Fix and Variable Costs for Air Emission Abatement Technologies (per verification)

Verification Centre 2 (Air Emission Abatement)	average	max	min
	k€	k€	k€
Fix costs			
Information Diffusion	7.4	8.6	6.1
Stakeholders	6.2	7.3	5.2
General Management	5.6	6.5	4.6
Prioritization	1.8	2.1	1.5
Quality Management	1.3	1.6	1.1
Total Fix costs	22.3	26.0	18.6
Variable costs			
Testing	29.9	55.4	9.1
Verification reports	17.1	31.7	5.2
Test/QA plans	15.4	28.5	4.7
Protocols	13.7	25.3	4.2
Solicitation/selection	5.1	9.5	1.6
Audits/QA evaluation	4.3	7.9	1.3
Total variable costs	85.5	158.4	26.0
TOTAL COSTS	**107.8**	**184.4**	**44.6**

Figure 13: Variable Costs for Air Emission Abatement Technologies for the US ETV model (per verification)



Water Technologies[30]

Table 18 presents the average fix and variable costs for water technologies. The fix costs are the same for each technology category. The variable costs are derived from average costs of the Drinking Water System's Centre[31] and the Water Quality Protection Centre[32] of the US ETV system. The verified technologies include membrane filtration systems for reduction of microbiological and particulate contaminants or technologies for reduction of arsenic and inorganic chemicals, disinfection by-products and waste water treatment technologies.

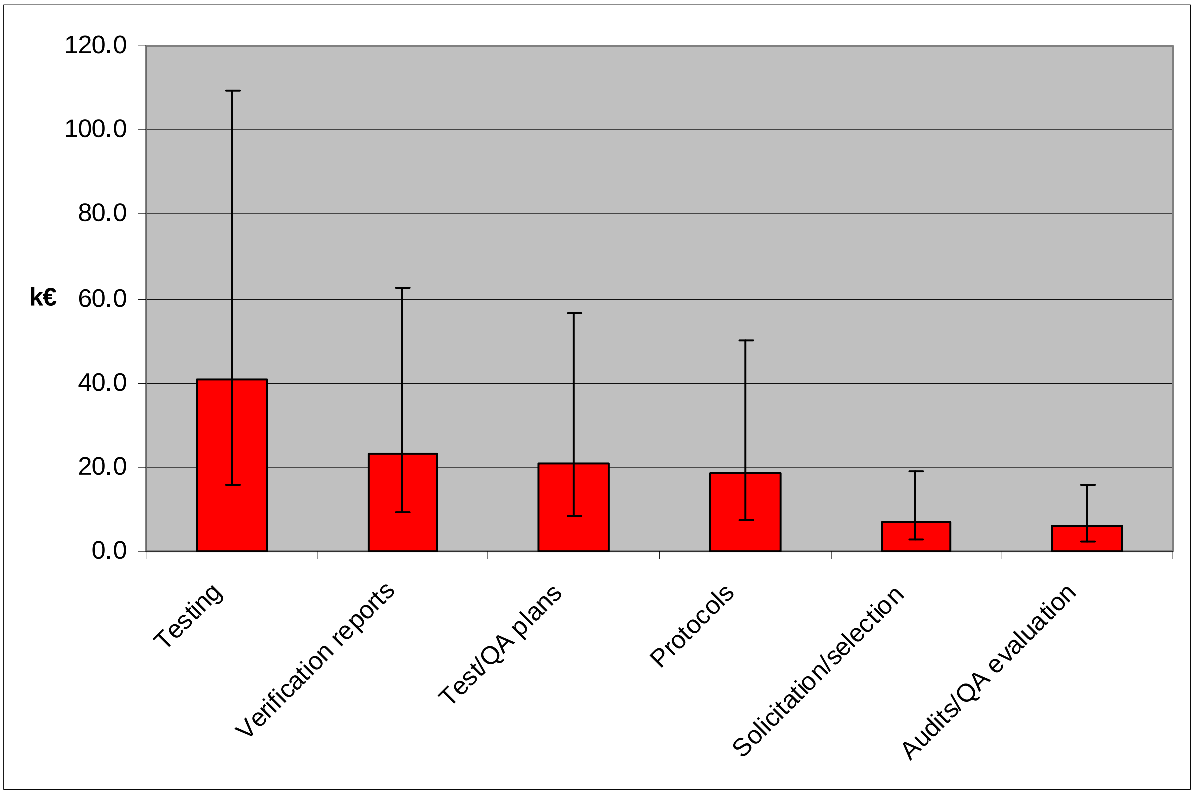
These centres have completed 92 verification cases during the years 2001 – 2005, with an average cost of 108.0 k€ per verification (variable costs)[28]. The most expensive verification case had a cost of 338.9 k€ and the least expensive had a cost of 72.7 k€ (Table 18 and Figure 14).

Table 18: Fix and Variable Costs for Water Technologies (per verification)

Verification Centre 3 (Water)	average	max	min
	k€	k€	k€
Fix costs			
Information Diffusion	7.4	8.6	6.1
Stakeholders	6.2	7.3	5.2
General Management	5.6	6.5	4.6
Prioritization	1.8	2.1	1.5
Quality Management	1.3	1.6	1.1
Total Fix costs	22.3	26.0	18.6
Variable costs			
Testing	40.9	109.5	15.9
Verification reports	23.4	62.6	9.1
Test/QA plans	21.0	56.3	8.2
Protocols	18.7	50.1	7.2
Solicitation/selection	7.0	18.8	2.7
Audits/QA evaluation	5.8	15.6	2.3
Total variable costs	116.9	312.8	45.3
TOTAL COSTS	**139.2**	**338.9**	**63.9**

[30] The chapter on Water technologies is not used in the calculations of the main body of the report but is presented here for information purposes.
[31] http://epa.gov/etv/center-dws.html
[32] http://epa.gov/etv/center-wqp.html

Figure 14: Variable Costs for Water Technologies for the US ETV model (per verification)



Energy Technologies

Table 19 presents the average fix and variable costs for energy technologies. The fix costs are the same for each technology category. The variable costs are derived from average costs of the Greenhouse Gas Technology Centre[33] of the US ETV system. The verified technologies include advanced energy production, waste-to-energy conservation, oil and gas production and transmission, and other energy efficiency technologies.

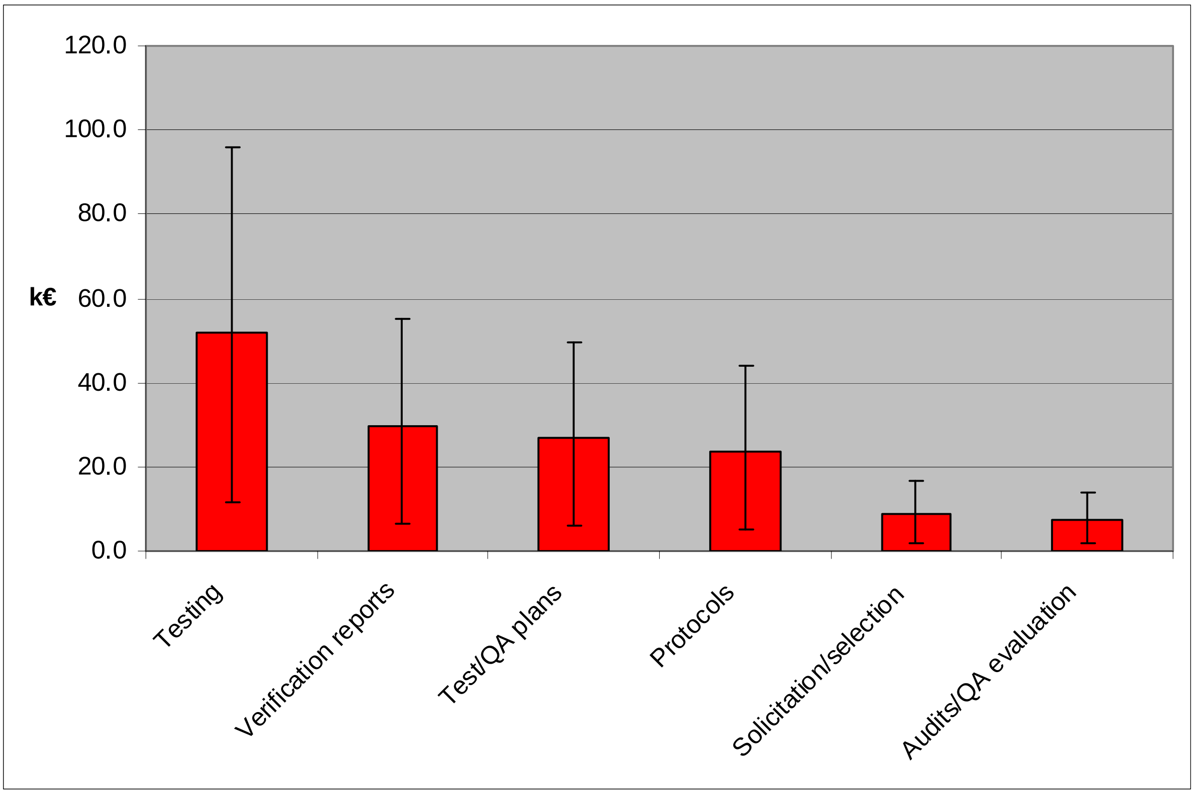
This centre has completed 37 verification cases during the years 2001 – 2005, with an average cost of 167.7 k€ per verification (variable costs)[28]. The most expensive verification case had a cost of 300.6 k€ and the least expensive had a cost of 51.7 k€ (Table 19 and Figure 15).

[33] http://epa.gov/etv/center-ggt.html

Table 19: Fix and Variable Costs for Energy Technologies (per verification)

Verification Centre 4 (Energy)	average	max	min
	k€	k€	k€
Fix costs			
Information Diffusion	7.4	8.6	6.1
Stakeholders	6.2	7.3	5.2
General Management	5.6	6.5	4.6
Prioritization	1.8	2.1	1.5
Quality Management	1.3	1.6	1.1
Total Fix costs	22.3	26.0	18.6
Variable costs			
Testing	51.8	96.1	11.6
Verification reports	29.6	54.9	6.6
Test/QA plans	26.7	49.4	6.0
Protocols	23.7	43.9	5.3
Solicitation/selection	8.9	16.5	2.0
Audits/QA evaluation	7.4	13.7	1.7
Total variable costs	148.1	274.6	33.1
TOTAL COSTS	**170.5**	**300.6**	**51.7**

Figure 15: Variable Costs for Energy Technologies for the US ETV model (per verification)



Annex IV - Cost calculation of the ETV Canada model

The ETV Canada verification scheme was taken as a model of a system, which is not structured in a sectorial basis. All types of environmental technologies can, in principle, be accepted for verification. A small ETV team, various verification entities and the vendor are the main actors of the system. The basic difference with the US ETV model is that testing is not included in the verification system, but is done outside ETV, by the vendor. Approximately 50 verifications have been concluded by the system to date. The range of costs[34] per verification was directly provided by ETV Canada[35]. In the ETV Canada model it is easier to estimate the cost range, since it depends to a lesser extent on technology specific costs, like testing and protocol development.

There was no information available on the fix costs of the ETV Canada model. It was assumed that fix costs, similar in nature and in volume to the fix costs of the US ETV model, could approximate these costs. However, the fix costs elements "stakeholders" and "prioritization" were removed from the calculation. This is because there is not any protocol development using stakeholder advice in this model, and no technology prioritization since the model is not sectorial. Stakeholders (and technology prioritization) will always have a role to play, but this will be mostly done at a program wide scale, (e.g. at the level of the EU ETV team) and not at the level of each individual verification. The assumed fix costs of the ETV Canada model are thus lower than the fix costs of the US ETV model.

Figure 16 shows that verification, reporting and award of the system's logo, i.e. the variable costs, is the dominant cost element, followed by the fix costs, namely information diffusion, general management and quality management. Monetary values for these cost elements are presented in Table 20. The error bars of Figure 17 correspond to the minimum and maximum values of each cost element, meaning that all the verification cases handled by the system should lie between these extreme values.

Table 20: Fix and Variable costs in the ETV Canada model

	average	max	min
	k€	k€	k€
Fix costs			
Information Diffusion	7.4	8.7	6.2
General Management	5.6	6.6	4.7
Quality Management	1.4	1.6	1.1
Total Fix Costs	14.4	16.8	12.0
Variable costs			
Verification/reporting/award	17.6	23.5	11.7
TOTAL COSTS	**32.0**	**40.3**	**23.8**

[34] All costs in this report refer to € prices of year 2007.
Exchange rates have been taken from http://www.federalreserve.gov/releases/g5a/
[35] Personal communication, John Neate, Director, April 2008.

Figure 16: Average cost distribution in the ETV Canada model

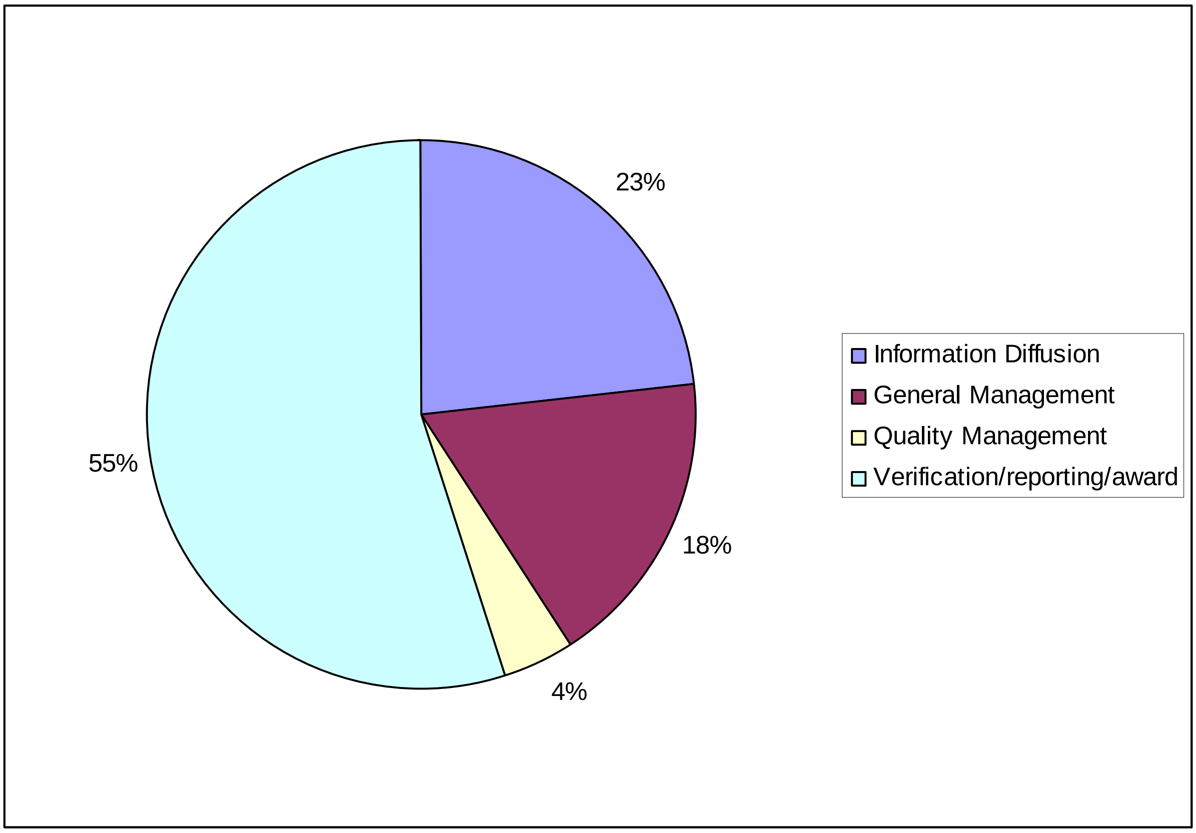
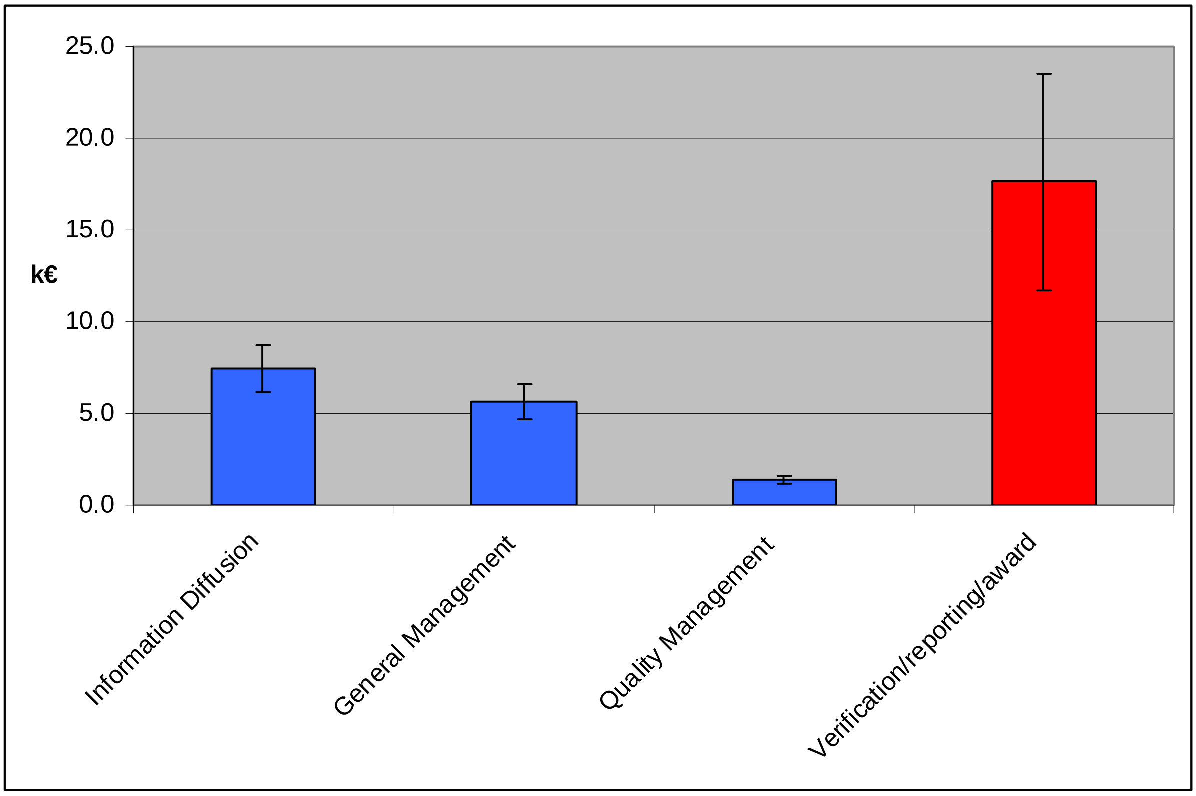


Figure 17: Fix and Variable costs in the ETV Canada model (per verification)



Optional Costs of the ETV Canada model

Table 21 presents the detailed calculation of the optional costs, increased by the additions of fix costs. It has to be noted that Stakeholder costs, which have been counted until now as fix costs, are now considered as variable costs. This is because the stakeholder workshop is now considered as an option. In many cases, the protocols and test plans will be developed by the vendor and the test laboratory, without a formal stakeholder advice. This is not the case of the US ETV model, where all verifications integrate stakeholder costs, since this is a requirement of the system. Moreover, in the US ETV, many verification cases will share the protocol developed by a single stakeholder consultation, decreasing the fix costs per verification. This is not the case in the ETV Canada model, where a stakeholder consultation will address typically 1 verification case. That is why the optional stakeholder costs per verification in the present model are higher than the stakeholder costs per verification of the US ETV model.

Figure 18 shows that testing is, as expected, the most cost intensive element, followed by the stakeholder workshop and the development of protocols and test plans, which have an equal average value but a different variability. Indeed, the available data show that the stakeholder's cost is more technology dependent than the development of protocols and test plans (see also Figure 19).

Table 21: Fix and Variable costs, including optional costs, in the ETV Canada model

	average	max	min
	k€	k€	k€
Fixed Costs			
Information Diffusion	7.4	8.7	6.2
General Management	5.6	6.6	4.7
Quality Management	1.4	1.6	1.1
Total Fixed Costs	14.4	16.8	12.0
Variable Costs			
Stakeholder workshop	35.2	47.0	23.5
Verification protocols/test plans	35.2	39.1	31.3
Tests	78.3	117.4	39.1
Verification/reporting/award	17.6	23.5	11.7
Total Variable Costs	166.3	227.0	105.7
Total Costs	**180.8**	**243.9**	**117.7**

Figure 18: Cost distribution including optional costs (ETV Canada model)

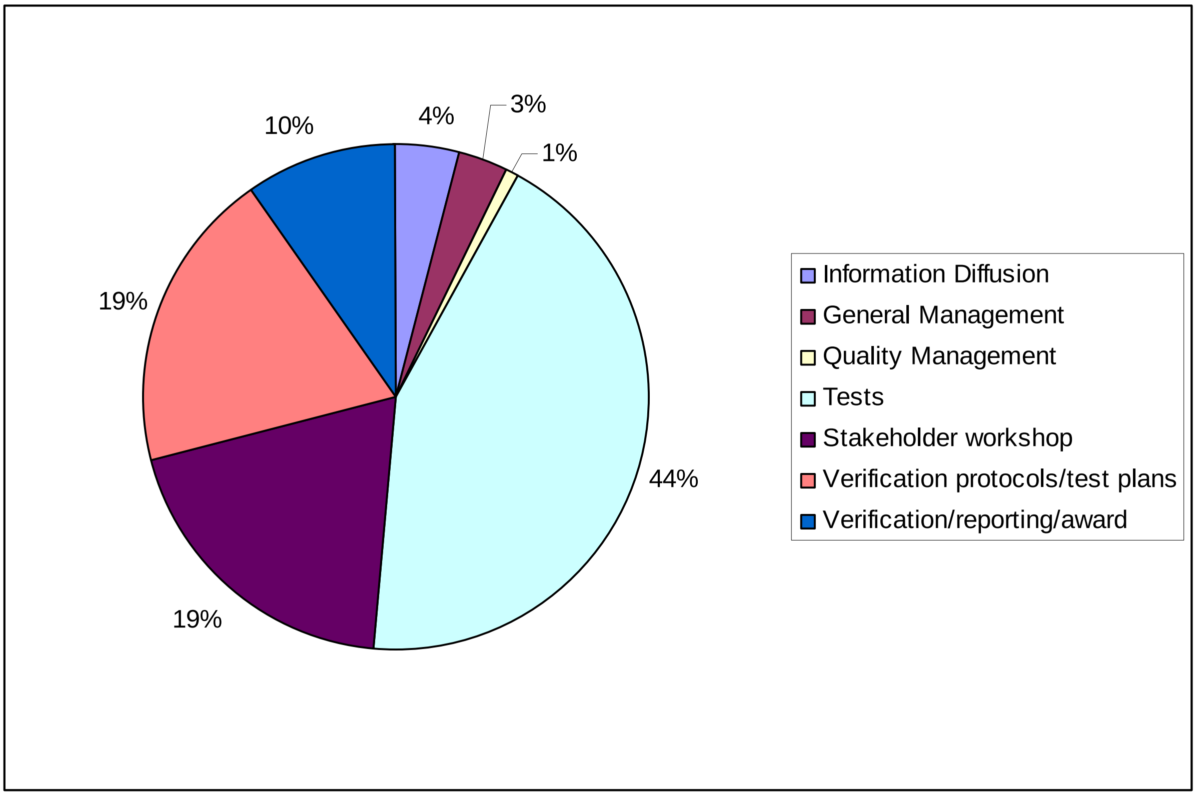
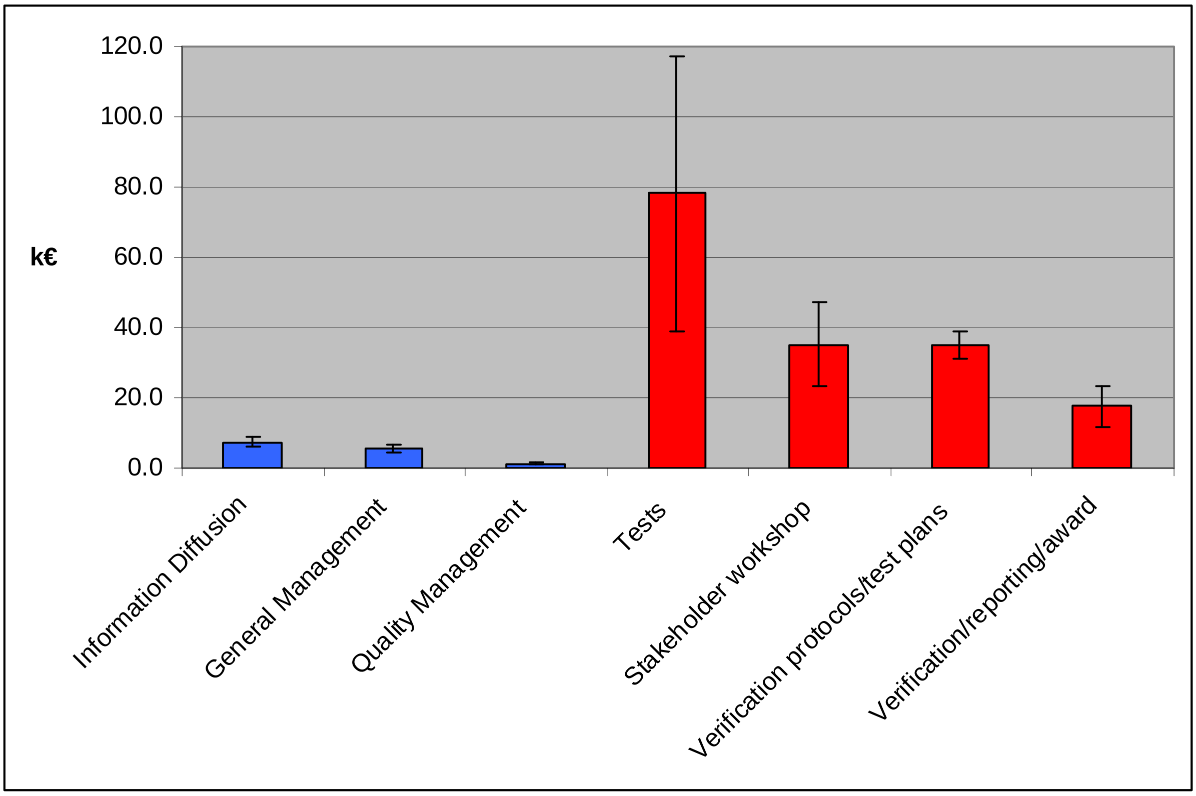


Figure 19: Fix and Variable Costs including optional costs (ETV Canada Model)



Annex V – Cost calculation of the mix model

This model aims to an improved version of the Canadian one. It uses the same structure, but includes a review of the producer's claim, establishing the eco-profile of the technology. This eco-profile will identify the most important factors that will have to be verified by testing, if possible using existing data. The goal is to define the information that the technology verification has to provide and which has to be included in the claim. It may include possible environmental impacts and allow understanding on which part of the product's lifecycle has the most environmental impact. It could be done, stepwise, meaning that a simple version will be drafted at the beginning before deciding if a more detailed analysis is necessary. The information needed for the eco-profile can come from a limited Life Cycle Assessment (LCA)[36] or directly from information provided by the producer. The review of the vendor's claim in the light of the technology eco-profile is carried out with stakeholder advice. The cost for establishing the technology eco-profile is estimated to 6±3 k€[37].

The fix and variable costs of the mix model are presented on Table 22. The fix costs and the variable cost item "Verification/reporting/award" are taken from the Canadian model (Annex IV - Cost calculation of the ETV Canada model). The new variable cost item, "Claim review – technology eco-profile" accounts for 16% of the total costs (Figure 20 and Figure 21).

Table 22: Fix and Variable costs in the mix model (per verification)

	average	max	min
	k€	k€	k€
Fix costs			
Information Diffusion	7.4	8.7	6.2
Stakeholders	6.2	7.3	5.2
General Management	5.6	6.6	4.7
Quality Management	1.4	1.6	1.1
Total Fix Costs	20.7	24.1	17.2
Variable costs			
Claim – technology eco-profile	6	9	3
Verification/reporting/award	17.6	23.5	11.7
Total Variable costs	23.6	32.5	14.7
TOTAL COSTS	**44.3**	**56.6**	**32.0**

[36] The costs of a full LCA can vary a great deal, depending on its scope. The system's boundaries, the level of data aggregation, the data quality requirements, the need for external expert review, are some of the elements that can influence costs. A rough estimation of an average, medium scope, LCA would situate costs at 30±10 k€. The addition of a third party review (as followed in an international standard like ISO 14040), could increase by 20% the costs of the base LCA.

[37] Discussions and first attempts to implement are currently on going inside the AIRTV project.

Figure 20: Average cost distribution in the mix model

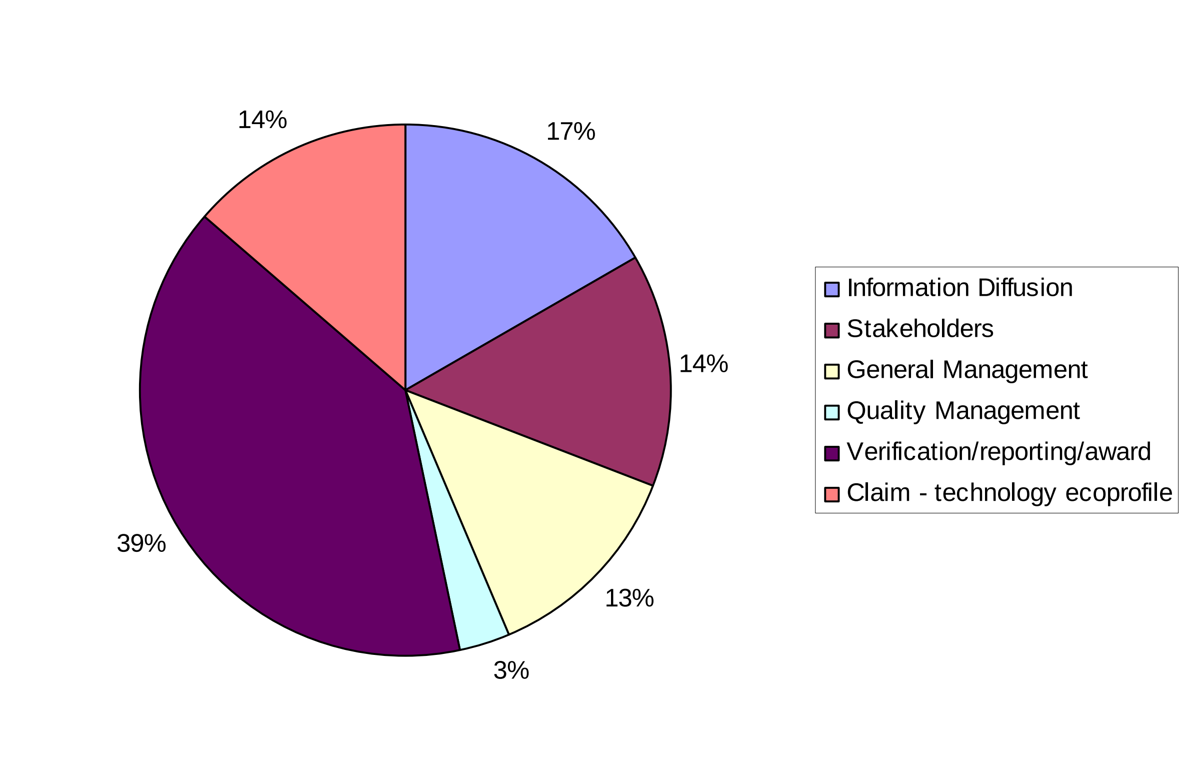
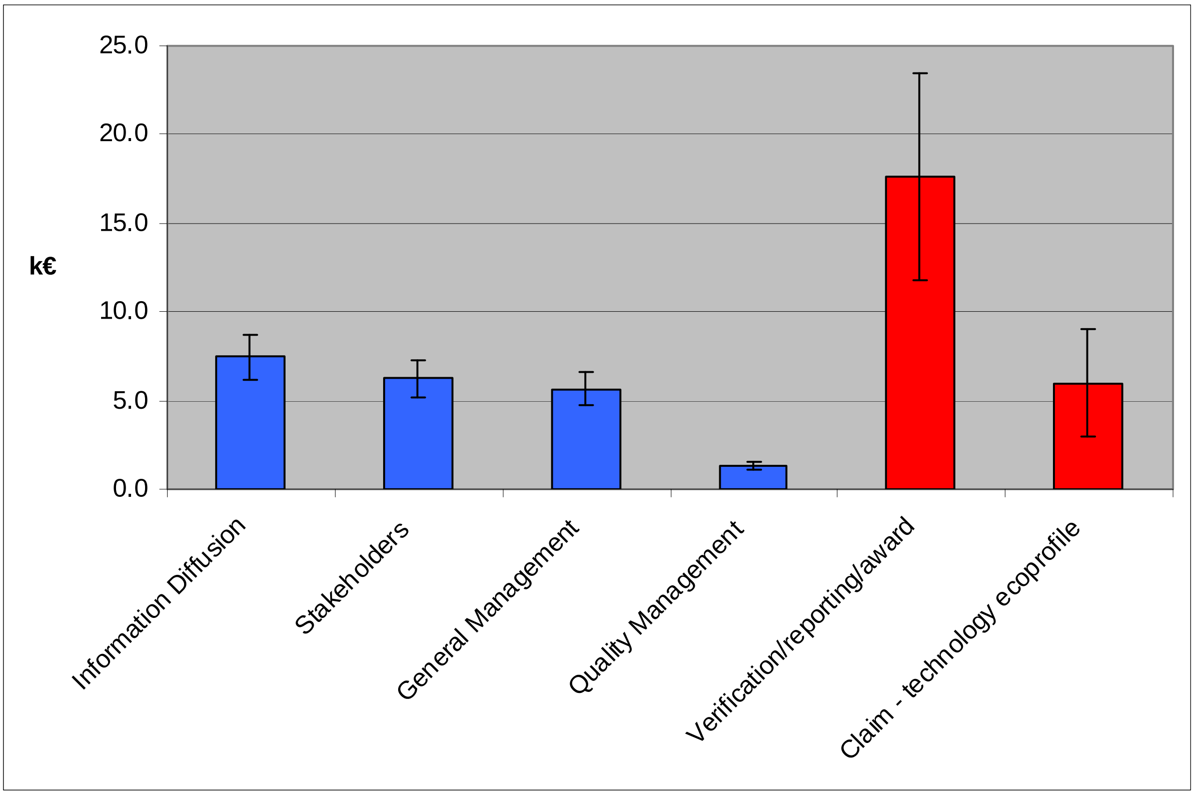


Figure 21: Fix and Variable costs in the mix model (per verification)



Annex VI - Cost calculation of the DG RTD pilot projects, PROMOTE and TESTNET

The EU pilot projects which are in an advanced phase of their development (PROMOTE[3], TESTNET[4]) have collected costs on the ETV schemes that they have developed. These costs do not entirely reflect the costs of a running ETV system for various reasons: in most of the cases the test laboratories and verification centres (and for some cases the technologies) were already known at the beginning of the project. For this reason, the selection costs of these entities (and the screening/application costs of the technologies) are not included in these calculations. In other cases, the stakeholder consultation procedures were done at a limited scale or had to be simulated. Additionally, no ETV logo has been awarded to the graduates of the verification programme and no extensive communication campaign had to be included in the projects' budgets. It is thus considered that the costs presented below are mostly variable costs, which are very technology specific. These costs will have to be increased by fix costs to obtain an estimation of the real costs of an ETV system. Still, the figures provided by the pilot projects are valuable since they are the first estimation of actual verification costs in the EU. The following is a pre-assessment of the costs, based on the results available during the writing of this report. Final results, will be generated inside the pilot projects.

The TESTNET and PROMOTE project models can be schematically compared to the US ETV model, in the sense that the testing is done inside the verification system after protocol development based on stakeholder advice. Procedural differences that may have an incidence on costs do exist, but they are disregarded in the cost calculations of this report.

In many cases, the cost information from the pilot projects is presented in the form of man/hours or man/days. Where no other indication is given a cost of 100 €/hour is taken for the calculations. This cost may be considered high in some countries (e.g. Spain) and low in others (e.g. Denmark, Sweden). Consequently, the variations that may occur from different hourly costs throughout the EU (or different costs due to different seniority levels of the teams that work in the verifications) are disregarded.

TESTNET

Table 23 presents the variable costs for clean production and water technologies. These costs are derived from average costs of the TESTNET project (FP6, DG RTD). This project, whose costs can be assimilated to the variable costs of a verification centre, has verified technologies including water disinfection technologies, plasma waste treatment and drinking or waste water monitoring[4]. Cost information on five of these technologies was available during the writing of this report, and this is presented on Table 23. The average cost was of 50 k€ per verification (variable costs). The most expensive verification case had a cost of 101 k€ and the least expensive a cost of 25 k€ (Table 23 and Figure 22).

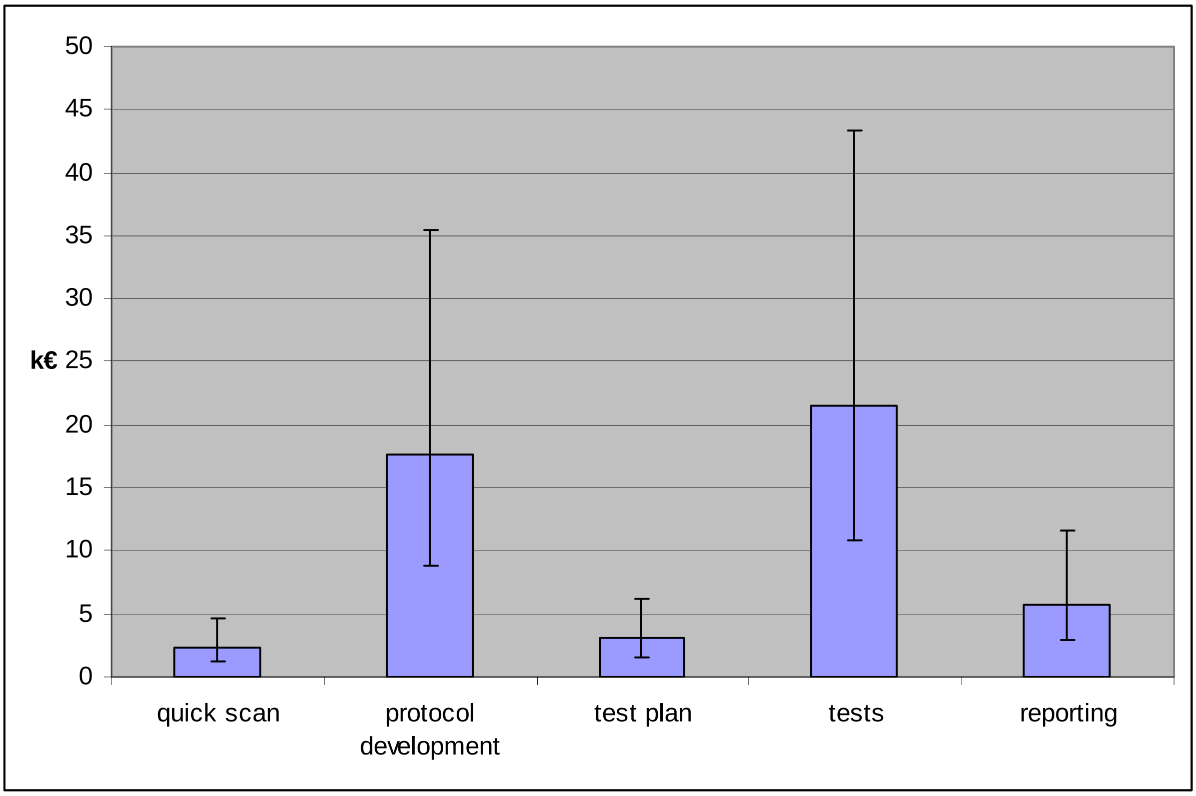
The actors of the TESTNET system are a Thematic Verification Organisation (TVO), the Stakeholders, the Testing Laboratories and the Verification Institute. TESTNET has evaluated two verification models. The first model fits better to technology cases were all the verification tools (test protocols and test plans) have to be developed from scratch, because there is no similar literature available. The second model fits better cases were the verification tools can be developed by modifying existing ones. Since both situations can be presented in a running verification system, the cost values presented average the values from both models[38].

Figure 23 shows the average distribution of the various cost elements. It can be seen that testing is the most cost-intensive element (43%), followed by protocol development (35%), reporting (11%), test plan development (6%) and quick scan (5%).

Table 23: Variable Costs for Clean Production and Water technologies for the TESTNET project (per verification)

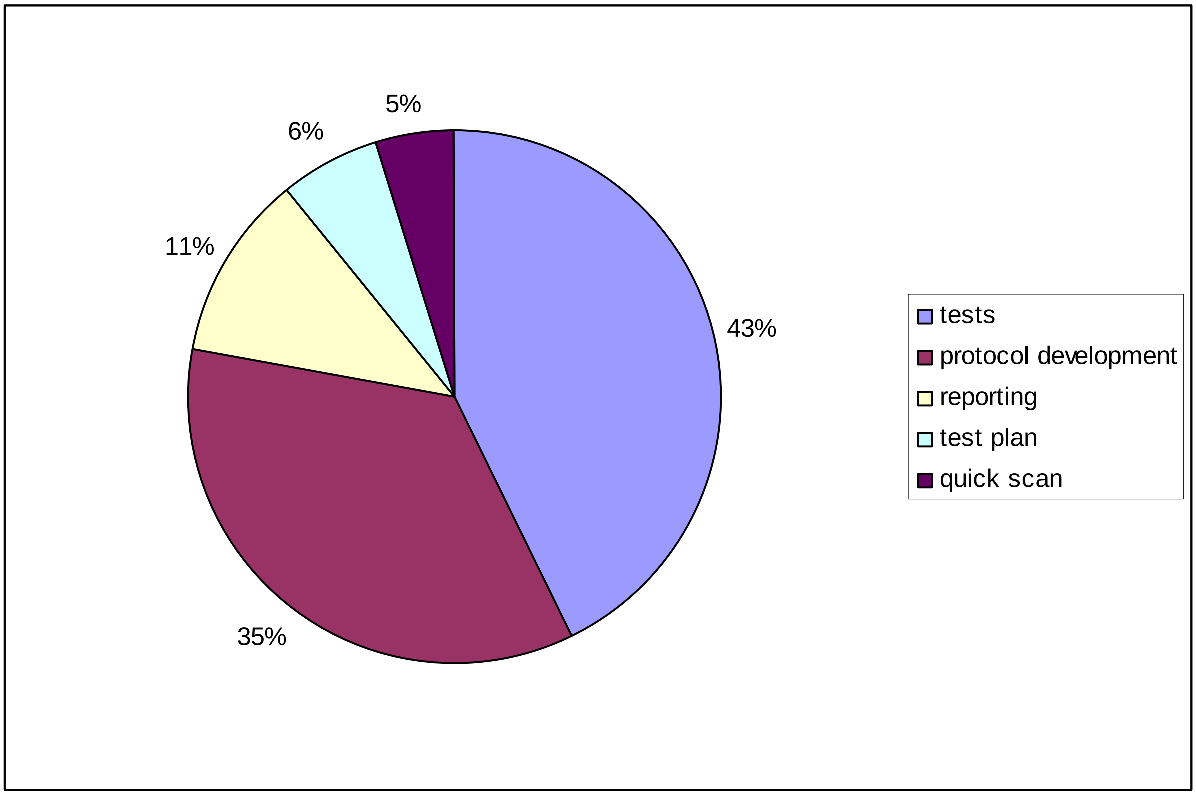
	average	max	min
	k€	k€	k€
Quick scan	2	5	1
Protocol development	18	35	9
Test plan	3	6	2
Tests	22	43	11
Reporting	6	12	3
Total	50	101	25

Figure 22: Variable Costs for Clean Production and Water Technologies for the TESTNET project (per verification)



[38] http://www.est-testnet.net/servlet/KBaseShow?m=3&cid=16042&catid=16068

Figure 23: Average distribution of Variable Costs for Clean Production and Water Technologies for the TESTNET project (per verification)



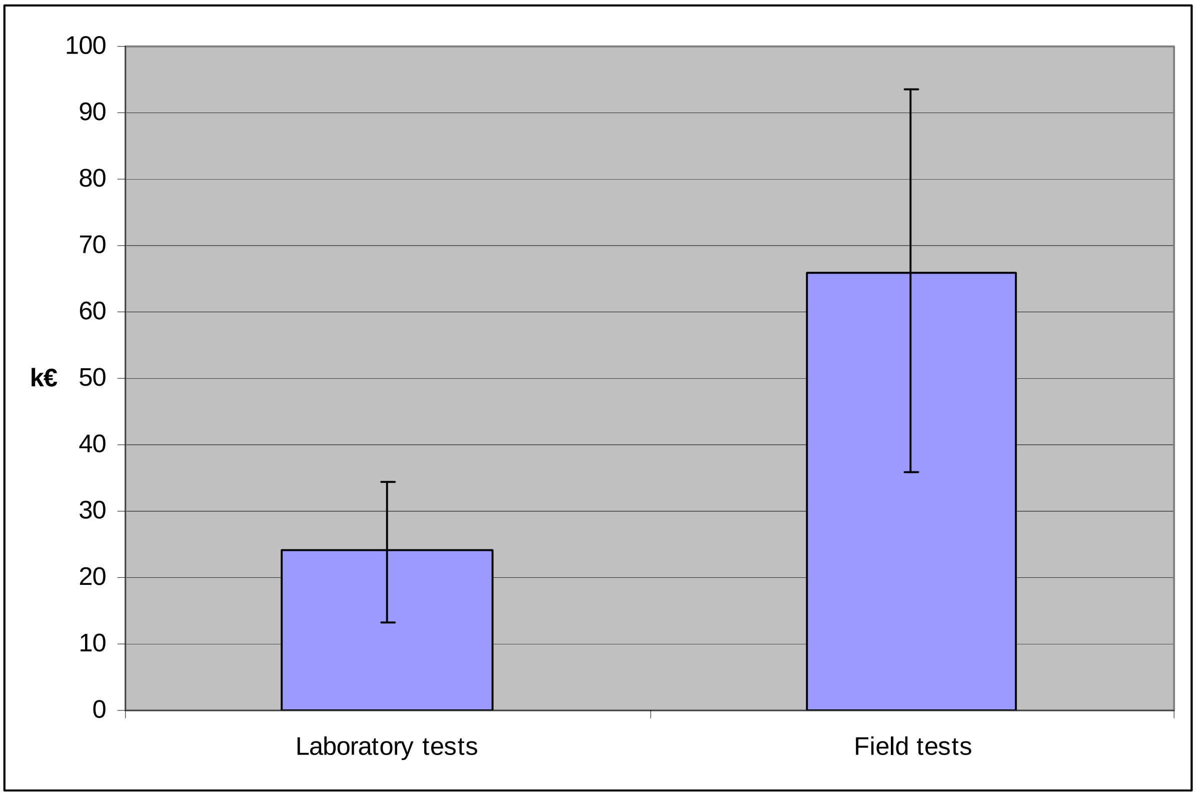
PROMOTE

Table 24 presents the variable costs for soil remediation technologies. These costs are derived from average costs of the PROMOTE[3] project (FP6, DG RTD). This project, whose costs can be assimilated to the costs of a verification centre, has verified technologies including photometers, fluorometers and metal oxide sensors. Cost information on five of these technologies was available during the writing of this report, and this is presented on Table 24. The average cost was of 90 k€ per verification (variable costs). The most expensive verification case had a cost of 128 k€ and the least expensive a cost of 49 k€ (and Figure 24). In this type of technologies it is necessary to execute laboratory tests (reference tests) complemented by field tests, something that is not systematically done in other types of verifications. The field tests cost typically 2 – 3 times more than the laboratory ones (Figure 24).

Table 24: Variable Costs for soil remediation technologies for the PROMOTE project (per verification)

	average	max	min
	k€	k€	k€
Laboratory tests	24	34	13
Field tests	66	93	36
Total	90	128	49

Figure 24: Variable Costs for Soil Remediation Technologies for the PROMOTE project (per verification)



Annex VII - Cost calculation of the MCERTS scheme

MCERTS, the UK Monitoring Certification Scheme is a model that has many similarities with ETV[39]. It is given here as an example of what could look like a very specialized ETV model. MCERTS is focusing on very specific technological sectors (e.g. CEMs: Continuous Emission Monitors) and is able to use existing verification protocols with slight modifications. In this way the bulk of the variable costs of the system is dedicated to testing (an average of 85% of the costs, more than all the ETV systems) as can be seen in Figure 25. The other cost elements, are the start up costs, which correspond to the definition of the test criteria and the review of the manufacturer's claims, the development of the protocols and test plans and reporting, just like in a verification system (monetary values are given in (Table 25). An additional cost element, absent to verification is the manufacturing audit. Indeed, a certification system makes sure that all the specimens of the producer's equipment are of the same quality (and have the same performace) like the tested specimen and that no design changes that affect performance are done in the technology/product.

Table 25: Variable costs of the MCERTS scheme (per certification)

	average	±margin
	k€	k€
Start up	1.2	0.1
Protocol/test plan	1.2	0.1
Testing	51.0	4.3
Reporting	3.6	0.3
Manufacturing audit	3.0	0.3

[39] See: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1504, §3.2 and references herewith.

Figure 25: Average cost distribution of the MCERTS scheme

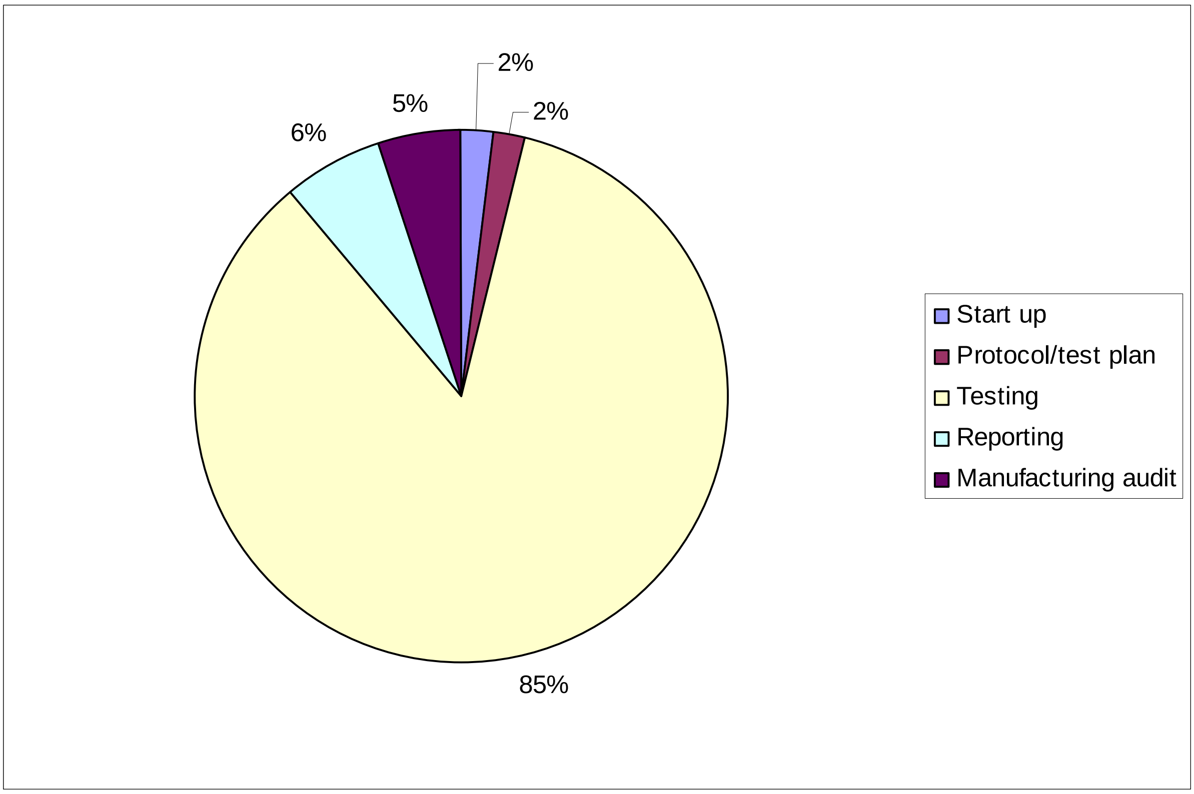
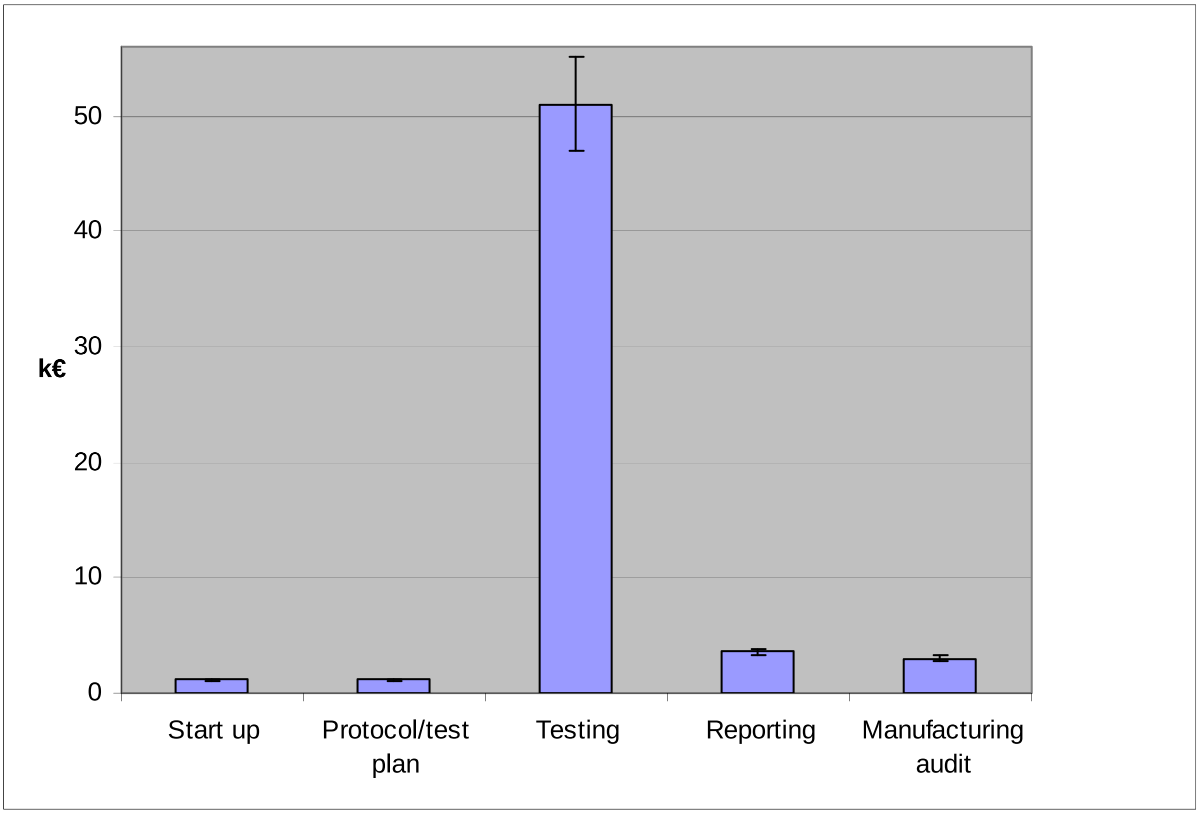


Figure 26: Variable costs of the MCERTS scheme (per certification)



Annex VIII – Uncertainties in the cost calculations

The following tables show the detailed calculations of the costs of the sectorial verification systems of the four models. The following signs are used:

m: mean
s: standard deviation
n: number of observations
z: 95% percentile of the standard normal distribution
t: 95% percentile of the t-student distribution
w: width of the amplitude of the confidence interval

For the model c-s1-v1 (US model), the costs of individual verification cases which correspond to the five sectors are available. When $n > 30$ the standard normal distribution is used. When $n \leq 30$ the t-student distribution is used. The significance level (or error margin) of the distributions was fixed to 5%. The costs of the lower and upper bounds of the systems are then calculated by multiplying the number of expected verifications by the mean costs per verification and the respective margins from the width of the amplitude of the confidence intervals. Table 26 shows that very low margins are calculated for the Monitoring verification system where the number of observations is very high ($n = 132$) and the distribution is less spread (lower s comparing to the other cases). For the last two cases (Clean production and water and Soil remediation), only 5 observations were available for each. The t distribution was used, yielding a much higher margin for the verification systems. These margins appear as error bars in Figure 1. The calculation of the total costs is done by simple summing of the costs of each sectorial verification system. The total margins of the whole system are estimated on Table 27, taking the verification system as the population for the lower and upper bounds respectively and applying the t-student distribution with $n = 5$. For the US system, the total margins correspond to the error bars of the Total costs in Figure 5 and Figure 6, which are identical to the ETV system costs of Figure 7 and Figure 8.

For the remaining models only a range of maximal and minimal values were available and not a cost population as such. For that reason, it is not possible to perform a statistical analysis to reach the 5% confidence interval as was done for the previous model. The tables give the minimum, maximum and average values per verification. These are then multiplied by 5 or 13 to give the corresponding values for the lower and upper bound. The lower and upper margins are schematically presented in Figure 3 and Figure 4 of the main text. The total costs for the whole model are then calculated by simple addition of the costs constituting each of them. The corresponding total margins are schematically given in Figure 5, Figure 6, Figure 7 and Figure 8. As explained in the main text of the report, in these cases it is considered that all the verification cases have the same cost characteristics (i.e. the sectorial variations are disregarded).

Table 26: Statistical uncertainty in model c1 (US model)

	Per verification						lower bound	±margin	upper bound	±margin
	m	s	n	z/t	w	sign. level	m x 5	w x 5	m x 13	w x 13
Monitoring	74	23	132	1.6	3.3	5%	**372**	**17**	**967**	**43**
Air Emission Abatement	108	29	67	1.6	5.9	5%	**539**	**30**	**1402**	**77**
Energy	170	67	37	1.6	18.2	5%	**852**	**91**	**2216**	**236**
Clean Production and Water	73	26	5	2.8	32.7	5%	**363**	**164**	**944**	**426**
Soil Remediation	112	34	5	2.8	42.1	5%	**561**	**210**	**1459**	**547**
Totals							**2687**	**220**	**6987**	**573**

Table 27: Margins of the model c1 (US model)

	s	n	t	w
lower bound	177	5	2.8	**220**
upper bound	461	5	2.8	**573**

Table 28: Range of values in model c2 (Canadian model)

	Per Verification			lower bound	lower margin	upper margin	upper bound	lower margin	upper margin
	min	max	m	m x 5	min x 5	max x 5	m x 13	min x 13	max x 13
Monitoring	24	40	32	**160**	**119**	**202**	**417**	**309**	**524**
Air Emission Abatement	24	40	32	**160**	**119**	**202**	**417**	**309**	**524**
Energy	24	40	32	**160**	**119**	**202**	**417**	**309**	**524**
Clean Production and Water	24	40	32	**160**	**119**	**202**	**417**	**309**	**524**
Soil Remediation	24	40	32	**160**	**119**	**202**	**417**	**309**	**524**
Totals				**801**	**595**	**1008**	**2083**	**1547**	**2620**

Table 29: Range of values in model c3 (Mix model)

	Per Verification			lower bound	lower margin	upper margin	upper bound	lower margin	upper margin
	min	max	m	m x 5	min x 5	max x 5	m x 13	min x 13	max x 13
Monitoring	32	57	44	**222**	**160**	**283**	**576**	**416**	**736**
Air Emission Abatement	32	57	44	**222**	**160**	**283**	**576**	**416**	**736**
Energy	32	57	44	**222**	**160**	**283**	**576**	**416**	**736**
Clean Production and Water	32	57	44	**222**	**160**	**283**	**576**	**416**	**736**
Soil Remediation	32	57	44	**222**	**160**	**283**	**576**	**416**	**736**
Totals				**1108**	**800**	**1415**	**2880**	**2080**	**3679**