CONCERTED ACTION
ENERGY SERVICES
DIRECTIVE

Measurement and verification for energy services, IPMVP and other approaches

Public report

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Date: 29 January 2013

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Acknowledgements

The authors would like to thank the European and national ESCO associations, for their help in distributing the questionnaire and all the energy services providers and professionals that responded.

Special thanks to M. Theofilidi, C. Tourkolias and V. Venturini for their help with sending, chasing non respondents and elaborating the answers to the ESCO questionnaire.

1 Abbreviations

Table 1: Country codes for the Member States

Country code	Member State
AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia (candidate country)
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

Table 2: Miscellaneous abbreviations

Abbreviation	Full text
CAN	Canada
CMVP	Certified Measurement and Verification Professional
ECM	Energy Conservation Measure
EnMS	Energy Management System
EVO	Efficiency Valuation Organization
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Contract
ESCO	Energy Service Company
FEMP	International Energy Efficiency Financing Protocol
IEEFP	International Energy Efficiency Financing Protocol
IPMVP	International Performance Measurement and Verification Protocol
M&V	Measurement and Verification
RES	Renewable Energy Systems
USA	United States of America

2 Executive summary

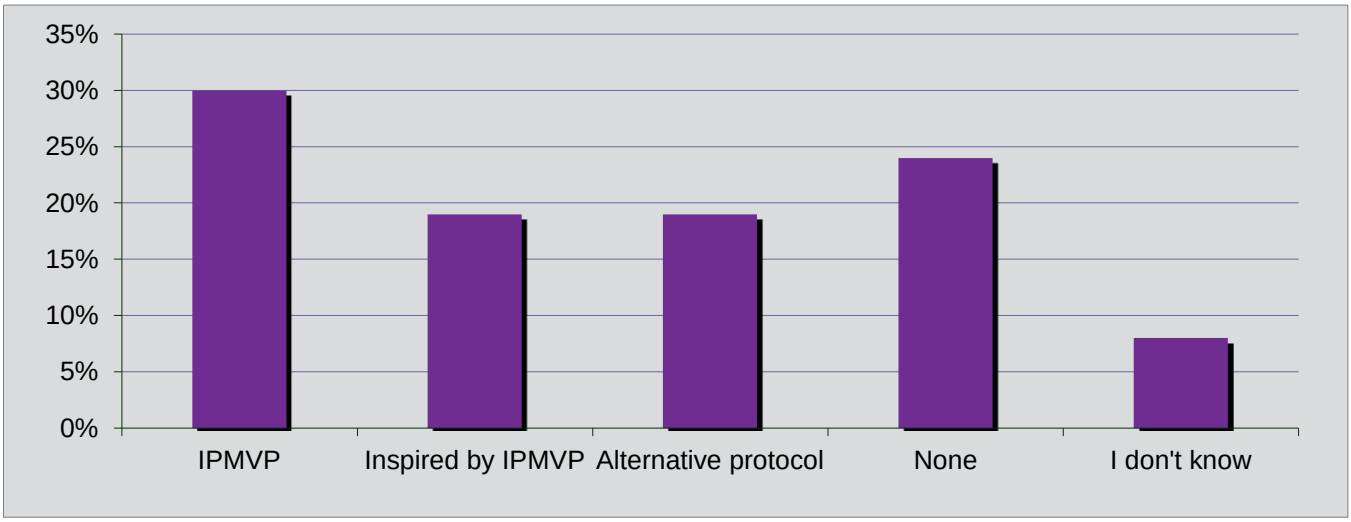
The measurement of energy savings is much more complex than measuring the production of energy (e.g. electricity generated from a cogeneration or renewable plant), because it involves not only the measurement of one or more parameters, but also comparison with the situation before the changes were implemented (e.g. implementation of an energy efficiency improvement), and usually some adjustments. This measurement allows us to evaluate the results of energy efficiency measures (from a single household measure to a policy) and to manage them. The complexity of this measurement is one of the barriers to energy efficiency, especially if dealing with payback time, affordability, etc. It becomes even more of a concern when the payment for the energy service is linked to the energy/economic savings achieved, as with energy performance contracting (EPC).

In order to evaluate energy services providers' approaches to measurement and verification, a questionnaire was distributed to organisations dealing with energy services across Europe (energy services companies, facilitators, services companies not offering performance contracting, etc.).

The results from 100 questionnaires show a variety of performance based contracts in place across Europe. Energy performance contracts are the most common, followed by supply contracts with efficiency/performance clauses. Supply contracts are almost as common as the latter, while contracts complying with EN 15900 are far less common. A measurement and verification protocol is present in almost 70% of the organisations (from single firms to multinational groups with branches in many Member States) and the International Performance Measurement and Verification protocol (IPMVP) is used in almost half of these cases.

The IPMVP was developed at the end of the nineties in the USA to support ESCOs dealing with performance based contracts. In a number of countries it is considered the de facto standard practice for measurement and verification, but it is not so prevalent in Europe (see Figure 1). IPMVP is used in the Eastern European countries as a result of the PERMANENT project, with partners from BG, HR, CZ, PL and RO. In one of these Member States the use of the IPMVP is obligated by law, in others IPMVP has been adopted by the ESCOs or, at least, the project has increased the spread of energy performance contracting.

Figure 1: Measurement and verification protocol utilised



One of the advantages of a standardised measurement and verification protocol at country or European level is linked to financing. Financial institutions tend to evaluate an investment in energy efficiency as a standard asset. Proof of this is the fact that, at the moment, an energy efficiency project asset class does not exist. Evaluation of energy efficiency investments seldom considers the constancy of cash flow guaranteed by the contract with the energy service provider. A more standardised approach to energy efficiency projects could help to change the way investments are evaluated, and a key element of this is a sound measurement and verification plan. A well implemented and maintained plan, shared with the client, strengthens trust and helps to reduce and manage risks, including the risk of litigation. Another instrument aimed at financial institutions is the International Energy Efficiency Financing Protocol (IEEFP), published in 2009. This was used in the PERMANENT project to train employees of financial institutions.

The presentation from IE (www.esd-ca.eu/good-practices/member-state-presentations/energy-services/energy-service-companies-and-monitoring-and-verification-of-energy-savings/initiatives-to-promote-m-v-and-energy-services-in-ireland) showed another interesting application of measurement and verification as a requisite for energy efficiency programmes, grants for energy efficiency measures, and energy efficiency targets for the public sector. This has the potential not only to enhance programme results, but also to diffuse the culture of measurement and verification for all measures and sectors (including small organisations), creating a more favourable environment for the diffusion of energy efficiency services with performance clauses.

2.1 Added value

This report aims to investigate measurement and verification practices, not only for energy services, but also in other fields. Data was gathered from energy services providers via a questionnaire sent out across Europe. Some information, including some from outside Europe, was collected during an informal session organised at the ECEEE Industrial Summer study. Good practice and interesting initiatives on measurement and verification in different Member States were gathered from the participants of the Concerted Action that are participants of the PERMANENT project and/or involved in the work of standardisation groups at European and international level dealing with measurement and verification in various fields (www.esd-ca.eu/good-practices/member-state-presentations/energy-services/energy-service-companies-and-monitoring-and-verification-of-energy-savings/standardisation-in-the-field-of-energy-management-and-m-v).

The executive director of EVO, the organisation that maintains IPMVP and created the IEEFP, was invited to present the protocols in the first session (www.esd-ca.eu/good-practices/member-state-presentations/energy-services/energy-service-companies-and-monitoring-and-verification-of-energy-savings/the-international-performance-measurement-and-verification-protocol). The IPMVP and its possible applications were discussed together with other relevant technical standards dealing with measurement and verification.

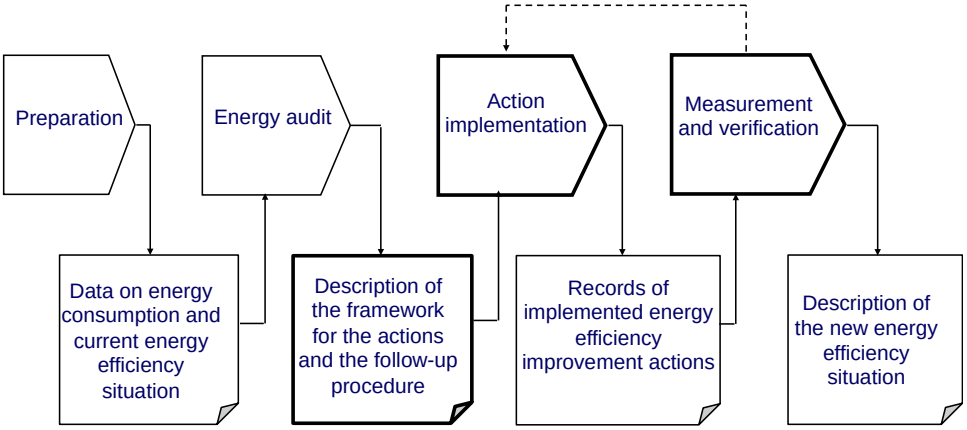
In the second session, the PERMANENT project, its results and lessons learnt were presented and discussed (www.esd-ca.eu/good-practices/member-state-presentations/energy-services/energy-service-companies-and-monitoring-and-verification-of-energy-savings/results-from-the-iee-project-permanent), together with interesting applications of measurement and verification to energy services, incentives and obligation mechanisms in IE (www.esd-ca.eu/good-practices/member-state-presentations/energy-services/energy-service-companies-and-monitoring-and-verification-of-energy-savings/initiatives-to-promote-m-v-and-energy-services-in-ireland).

Both sessions generated numerous questions and concluded with fruitful discussions. The draft report distributed before the sessions, and the presentations and discussions during the session, all contributed to the understanding of measurement and verification protocols, their applications and benefits, and to the sharing of good practice.

3 Measurement and verification

Measurement and verification of energy consumption and performance is a fundamental and necessary part of energy services based on energy performance (energy performance contracting[1], energy efficiency services[2] and in general where performance/savings clauses are present).

Figure 2: Energy efficiency service process



Measurement and verification is also used in energy management systems (e.g. ISO 50001) and in energy planning involving verification and improvement at the local level (e.g. CO_2 reductions achieved within the Covenant of Mayors), at the regional or national level.

A standardised method for the measurement and verification of savings through Europe is considered a critical factor for the ESCOs (Energy Service Companies) market, to ameliorate relationships and confidence between ESCOs and clients and between ESCOs/clients and banks.

3.1 Methodology

The search for information and interesting case studies on measurement and verification in energy services was conducted through an on-line questionnaire distributed via European ESCO associations (EFIEES and eu.ESCO) and national associations where available, or forwarded by national contact points of the Concerted Action to organisations in the JRC ESCO database[3] and other organisations active in the energy service sector in each Member State.

This report analyses the responses to questionnaires, presents a summary of the technical standards and ongoing standardisation work at the European and international levels, describes the International Performance Measurement and Verification Protocol (IPMVP) and the International Energy Efficiency Financing Protocol (IEEFP) and the PERMANENT project.

[1] Directive 2006/32/EC art. 3 letter j 'energy performance contracting': a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement.
Directive 2012/27/EU art. 2.27 'energy performance contracting' means a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, **verified and monitored during the whole term of the contract**, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings;
[2] EN 15900:2010 point 3.7 'energy efficiency services': agreed task or tasks designed to lead to an energy efficiency improvement and other agreed performance criteria.
[3] http://re.jrc.ec.europa.eu/energyefficiency/ESCO/list_esco.htm

3.1 Energy Service Companies responses

The questionnaire (see annex 4.3) was disseminated to organisations active in the energy service sector in AT, BG, CY, CZ, EE, EL, ES, FI, FR, HR, HU, IE, IT, LT, LV, NL, NO, PT, RO, SE, SI, SK. According to analysis of the answers from the services providers, in the field of Member States, all the responses about AT also cover DE, some responses about IE are also valid for UK, and some of those about NL also cover BE and LU. Thus the answers cover 26 Member States (including NO and HR).

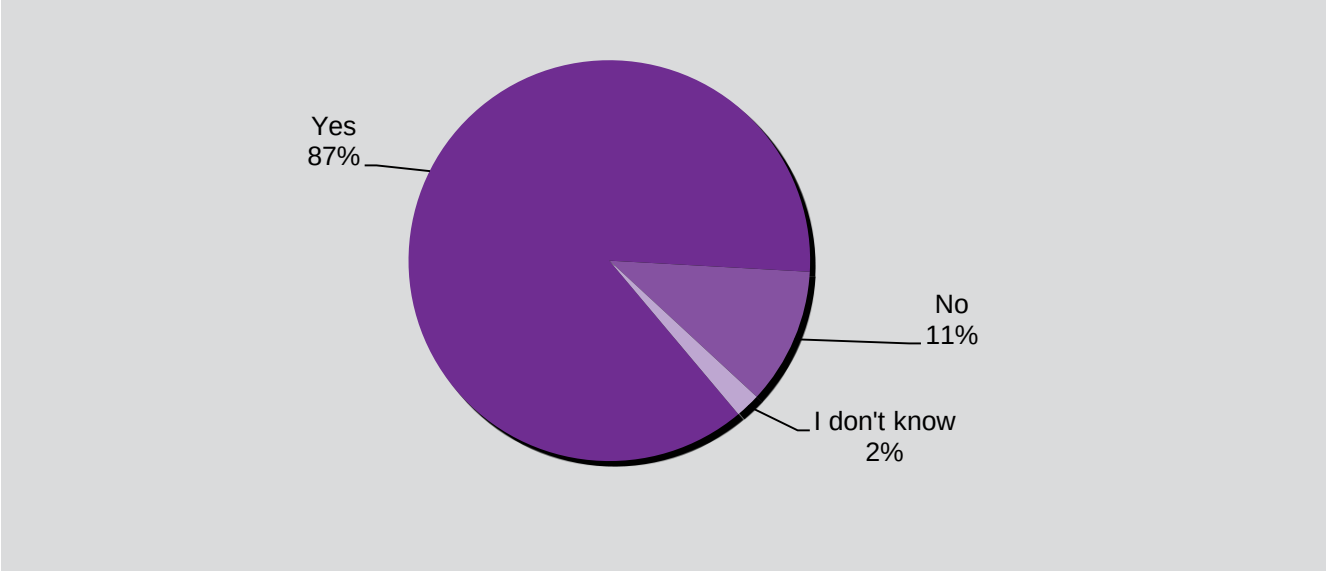
Due to the involvement of the European and national ESCO associations it was not possible to track the exact number of organisations that received the questionnaire, but 100 responses were received. If the distribution were uniform there would be 4 answers from each Member State, but the number of answers varies from 1 to 15.

The responses were collected and analysed to formulate a picture of the ESCO market and specifically, existing practices and views regarding the measurement and verification of energy savings. Analysis of the questionnaire responses is presented in the following section.

Areas of activity and types of contracts

As depicted in Figure 3, 87% of the 100 organisations that participated in the survey recognise their organisation as an ESCO according to the definition of the directive 2006/32/EC, while 11% claimed that their organisation cannot be considered as an ESCO. The latter are consultants involved as facilitators in complex energy performance contracts or service providers not offering energy performance contracting. 2% could not state whether they fall under this definition. In the rest of the text the ESCOs according to the definitions of 2006/32[4] are referred to as ESCO-type companies and the others referred to as non-ESCO-type companies.

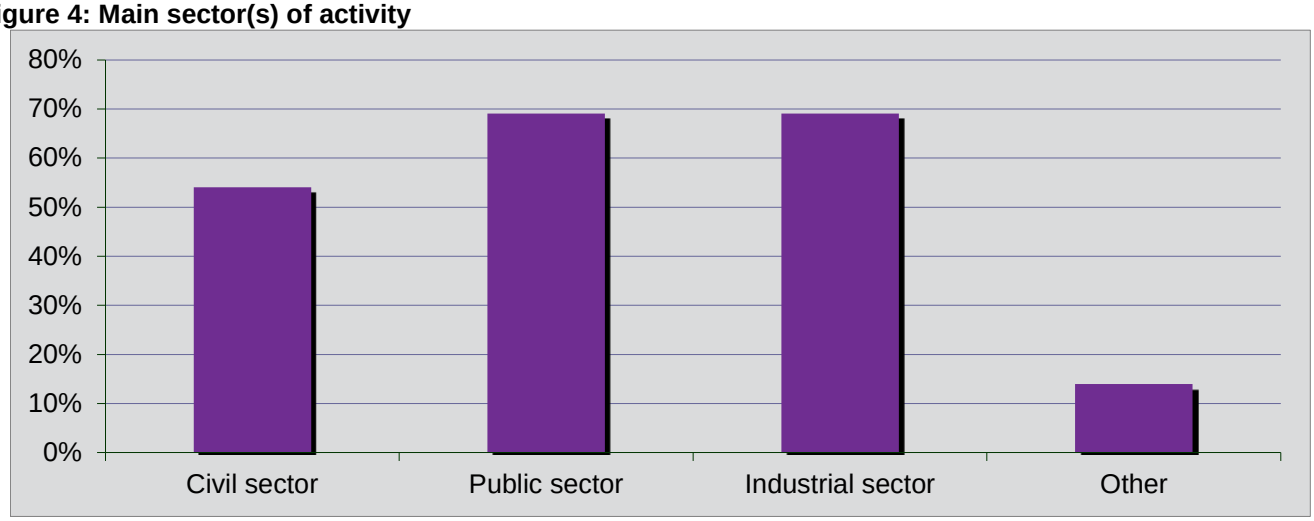
Figure 3: Do you recognise your organisation as an ESCO?



The options presented for sector(s) of activity were civil, public, industrial and others. Although the public sector is a subset of the civil sector, it was presented as a separate option as it usually has different contracting rules and can represent a separate market for energy services providers and market facilitators. As Figure 4 shows, the public and industrial sectors constitute the main field of activity for the majority of the organisations (69% each), while almost half of them are active in the civil sector (54%). 14% of the organisations are also active in other sectors, such as households and the commercial sector.

[4] Directive 2006/32/EC art. 3 letter j 'energy service company' (ESCO): a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria.

Figure 4: Main sector(s) of activity



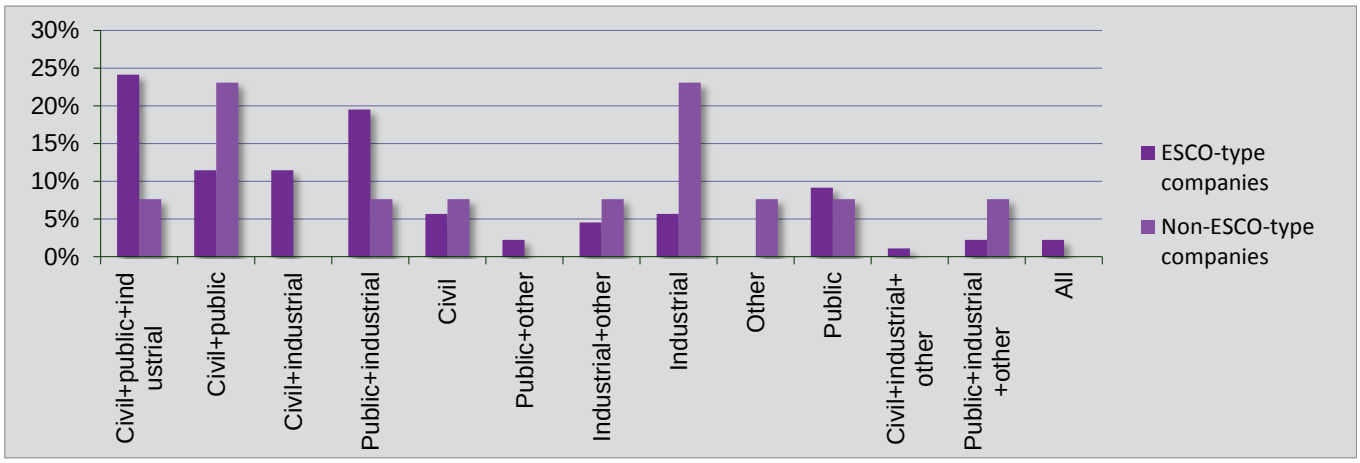
According to the responses, most of the surveyed organisations (over 75%) are active in more than one field, as presented in Figure 5. Approximately half are active in two fields and a quarter is active in three fields.

Figure 5: Activity in more than one sector

ESCO-type companies seem to provide services to multiple sectors (mainly civil, public and industrial) in various combinations, while the non-ESCO-type companies that participated in the survey seem to have either solely the industrial sector or the public and civil sector as their main field of activity (see

Figure 6).

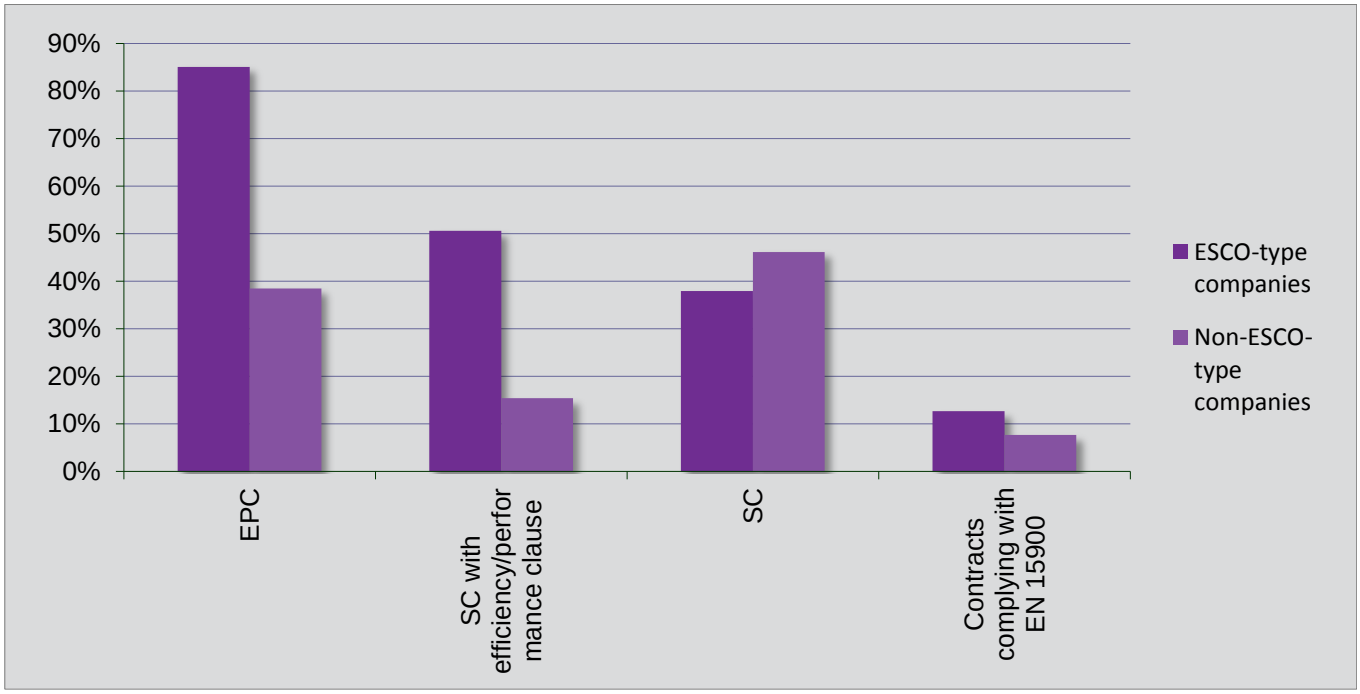
Figure 6: Combinations of sectors



Regarding the type of contracts that the surveyed organisations use with their clients (Figure 7), the vast majority (85% in the case of ESCO-type companies) use Energy Performance Contracts, though many do use other kinds of contract as well. The second most common type is Supply Contracts with some efficiency/performance clause, which is used by 51% of the ESCO-type companies. 38% utilise Supply Contracts, contracts complying with the EN 15900[5] are used by 13% of the ESCO-type companies.

Non-ESCO-type companies seem to more extensively use Supply Contracts (46%) rather than Energy Performance Contracts (38%), Supply Contracts with some efficiency/performance clause (15%) and contracts complying with EN 15900 (8%).

Figure 7: What type of contract(s) do you use?



Measurement and verification

Regarding the measurement and verification procedure, 31% of the ESCO-type companies and 27% of non-ESCO type companies replied that they use the IPMVP protocol (

[5] EN 15900:2010 Energy efficiency services – definitions and requirements

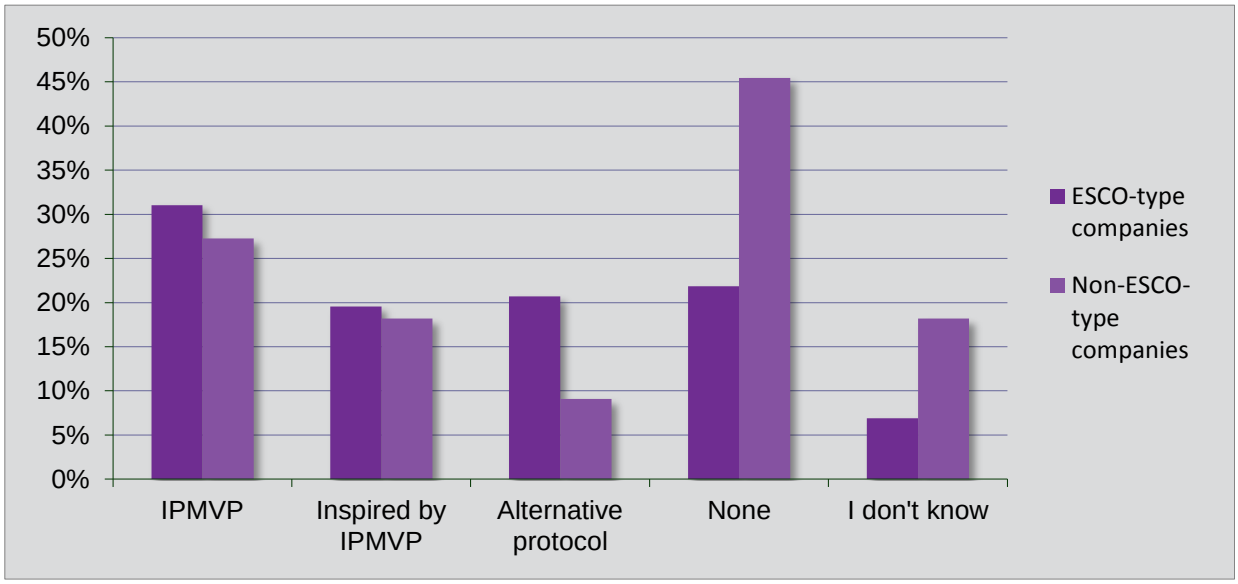
Figure 8).

22% of the ESCO-type companies are not using any measurement and verification protocol. However, the majority of the organisations (68%) do follow a measurement and verification methodology, this may be IPMVP, a method inspired by IPMVP or an alternative method. Specifically, 40% of the ESCO-type companies and 27% of the non-ESCO type companies use a protocol inspired by IPMVP or an alternative one.

Considering the activity fields, 53% of the organisations (ESCOs and non) active in the civil and public sector, only use IPMVP protocols, 20% use protocols inspired by IPMVP, and 13% use other protocols.

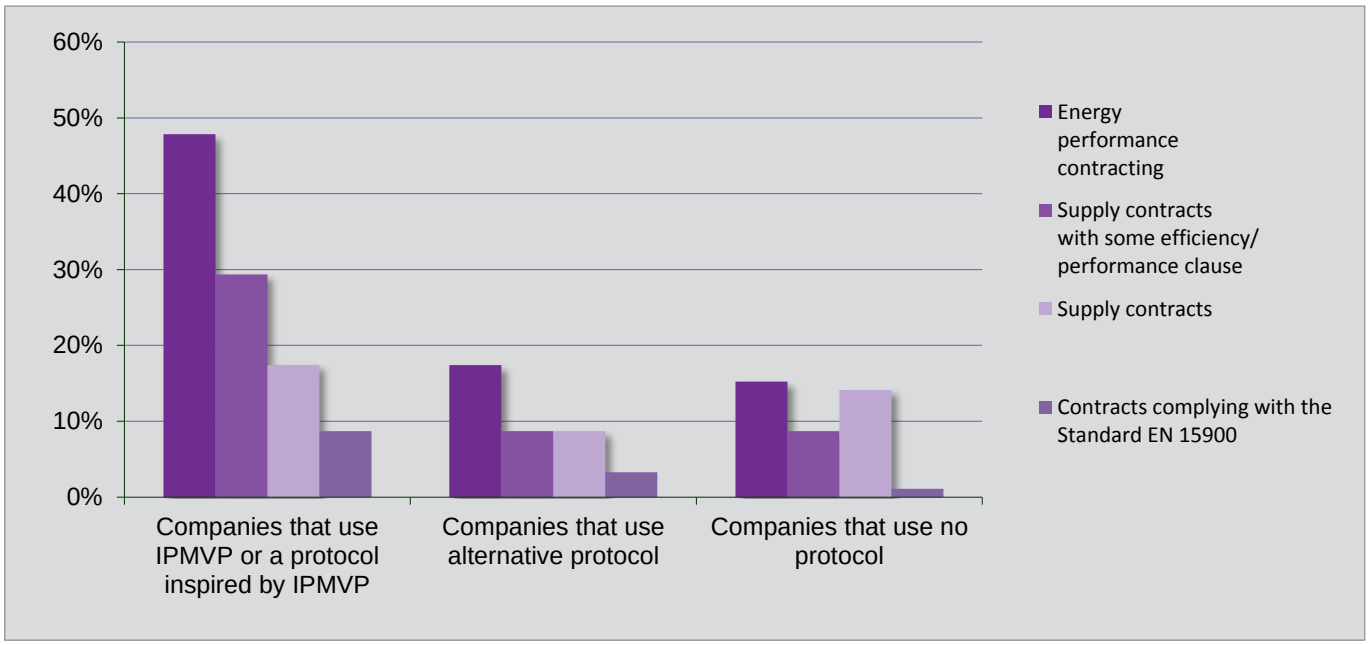
Within the organisations active in industrial sector only, 8% use IPMVP, 31% use protocols inspired by IPMVP and 15% other protocols.

Figure 8: Do you use any measurement and verification protocol?



It is interesting to observe what types of contracts are used by each kind of company alongside the type of measurement and verification methodology they use. Specifically, as seen in Figure 9, companies that use IPMVP or a protocol inspired by IPMVP most often use energy performance contracting, followed by supply contracts with some efficiency/performance clause. They more seldom use contracts complying with the Standard EN 15900. The same trend is observed for companies that use a measurement and verification methodology other than IPMVP. Companies that do not use any protocol, on the other hand, tend to offer energy performance contracting and supply contracts almost equally.

Figure 9: Use of different types of contract according to the use of measurement and verification protocol

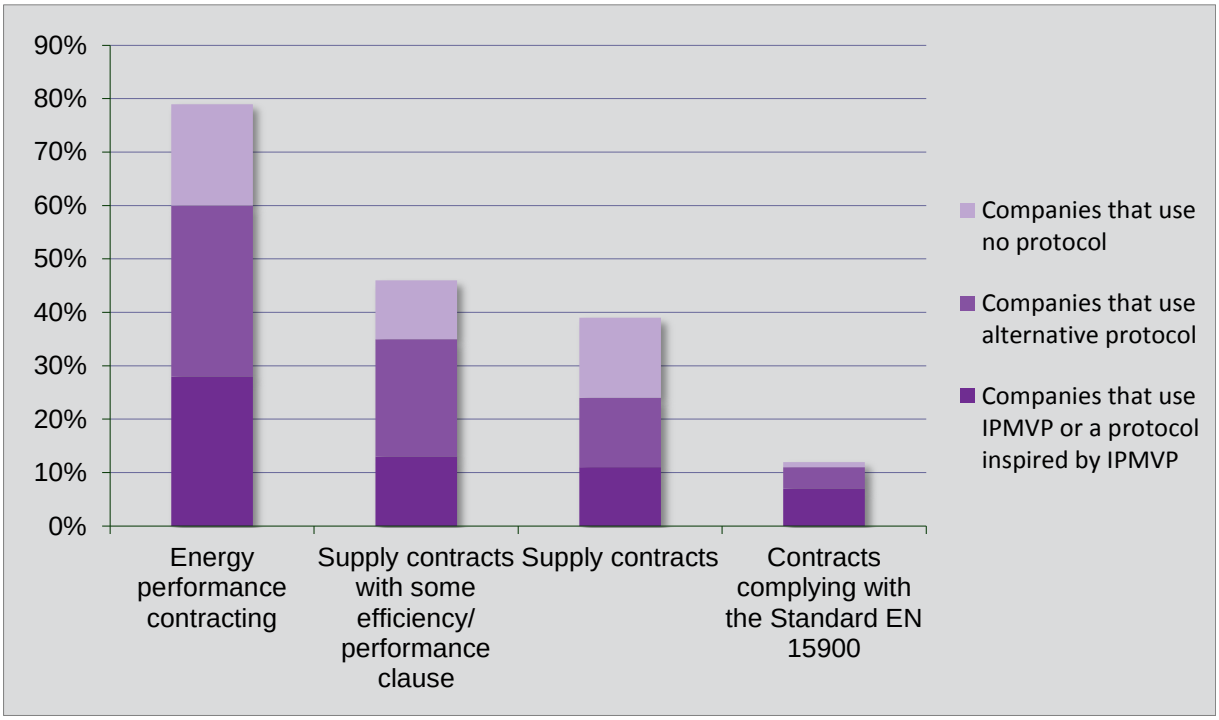


As seen in

Figure 10, responses indicate that it is quite common (76%) for organisations that use energy performance contracting or supply contracts with energy performance clauses to also have some measurement and verification practice (either IPMVP or another kind of protocol). Supply contracts are much more common in organisations using no measurement and verification protocol. It should be highlighted however that contracts that comply with EN 15900 are associated with the highest use of pure IPMVP (58%) or a 92% use of any kind of protocol, emphasising the fact that when a specific energy service standard is followed, the use of a protocol is almost a prerequisite. The EN 15900 does not explicitly require a measurement and verification protocol, but the definition of

a baseline with adjustment factors and the development of a measurement of verification plan is a core part of the Standard (point 4.3). The standardised and comprehensive approach to energy efficiency services described in the EN 15900 was positively considered by financial institutions (as shown by the main findings of the interviews carried out by CEN/CENELEC JWG 3 in annex 4.1).

Figure 10: Use or no use of measurement and verification protocol according to different type of contracts



Nevertheless, less than a third of the organisations employ an IPMVP certified professional (CMVP) or use an external one, as seen in Figure 11. The rest of the organisations do not have a certified person for this protocol..

Further analysis shows that two thirds of the organisations (67%) that explicitly use IPMVP usually do employ an IPMVP certified person. It is interesting to note that an IPMVP certified person is employed by or involved in 37% of the organisations using a protocol inspired by IPMVP.

Figure 11: Do you have an IPMVP certified person in your organisation?

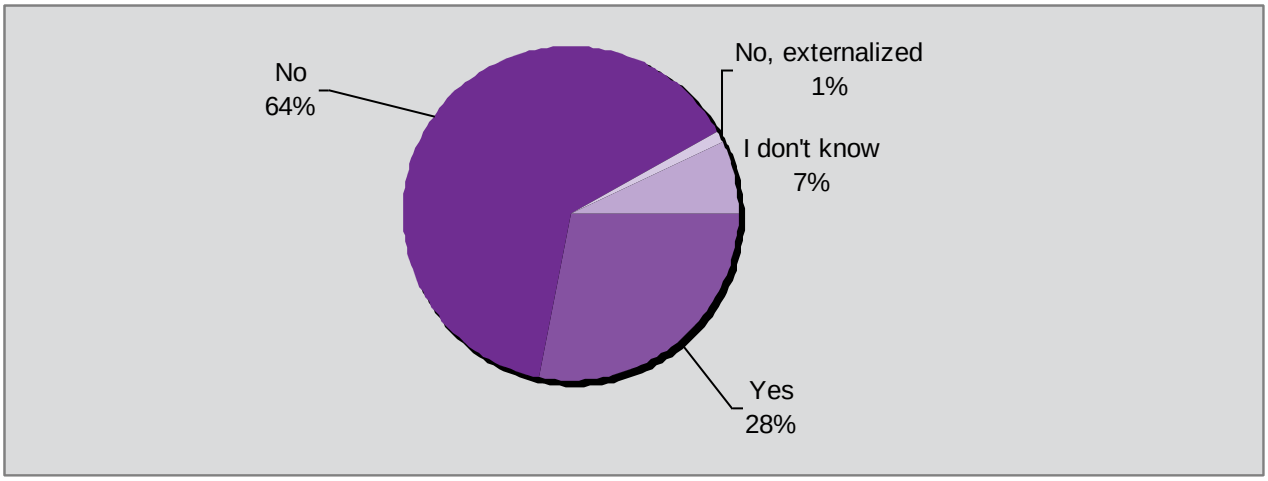


Figure 12 also presents interesting findings on the measurement and verification options (for an explanation of the IPMVP options see page 22) used by the companies that implement measurement and verification protocols. Specifically, from those organisations that use a measurement and verification protocol and implement at least one of the IPMVP options, 71% have utilised the Whole Facility option (C) for the measurement of the savings achieved, while 58% and 63% of them have implemented a Retrofit Isolation option with the measurement of key parameter (A) or all parameters (B) respectively. For the same sample of companies, the Simulation option (D) is

not considered a popular technique as only 10% of the aforementioned organisations have implemented it. Additionally, 4% of these organisations do use the IPMVP but were not aware of which option they use. Probably in some cases the person answering to the questionnaire was not particularly familiar with the measurement and verification protocol and its application.

It is also interesting to note that, taking only the IPMVP and IPMVP inspired protocols and the organisations (ESCOs and non) active only in the industrial sector, option B is the most common (80%), while option A is 40% and option C 60%. Considering organisations active only in civil and public sector, on the other hand, option C is more common (79%), while A and B are around 60%. This could indicate that the option C is utilised more in buildings, while option B is more common when dealing with systems/equipment.

Figure 12: If you use a measurement and verification protocol, which option(s) do you use?

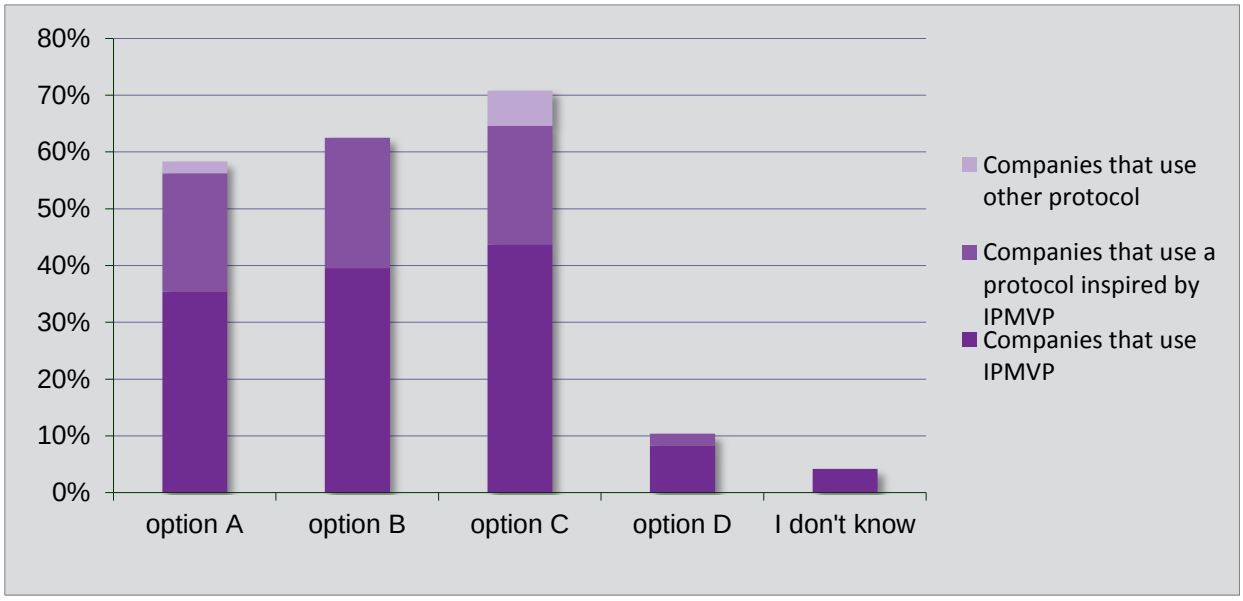


Figure 13 presents the distribution of the combinations of options implemented by all organisations that use a measurement and verification protocol, categorised by type of protocol. Noticeably, 31% of the companies that use IPMVP implement options A, B and C, 21% use only the Whole Facility option, followed by 14% that use all four options.

A similar trend is observed in the companies that use a protocol inspired by IPMVP, with 33% implementing options A, B and C and 17% implementing only option C. However, no company that uses a protocol inspired by IPMVP uses all four options; 17% of them use options A and B, and another 17% use a custom option that is not included in the IPMVP protocol.

Finally, it is worth mentioning that companies that use an alternative protocol most commonly implement a customised option (up to 76%), while only few of them (18%) just use the Whole Facility option.

Figure 13: Combination of options implemented for a measurement and verification protocol
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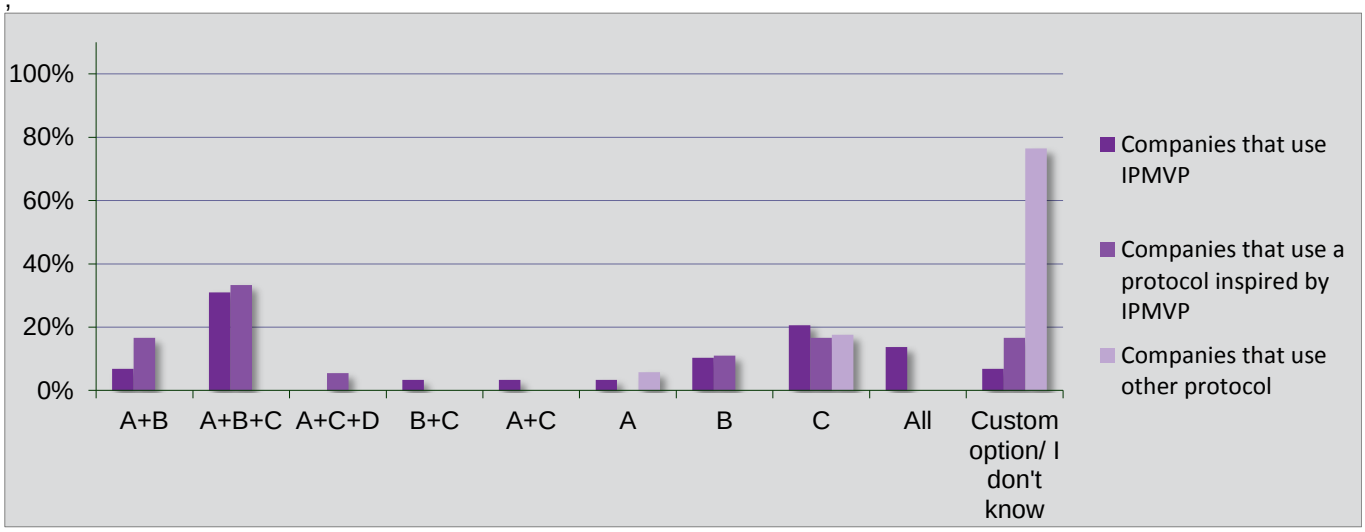
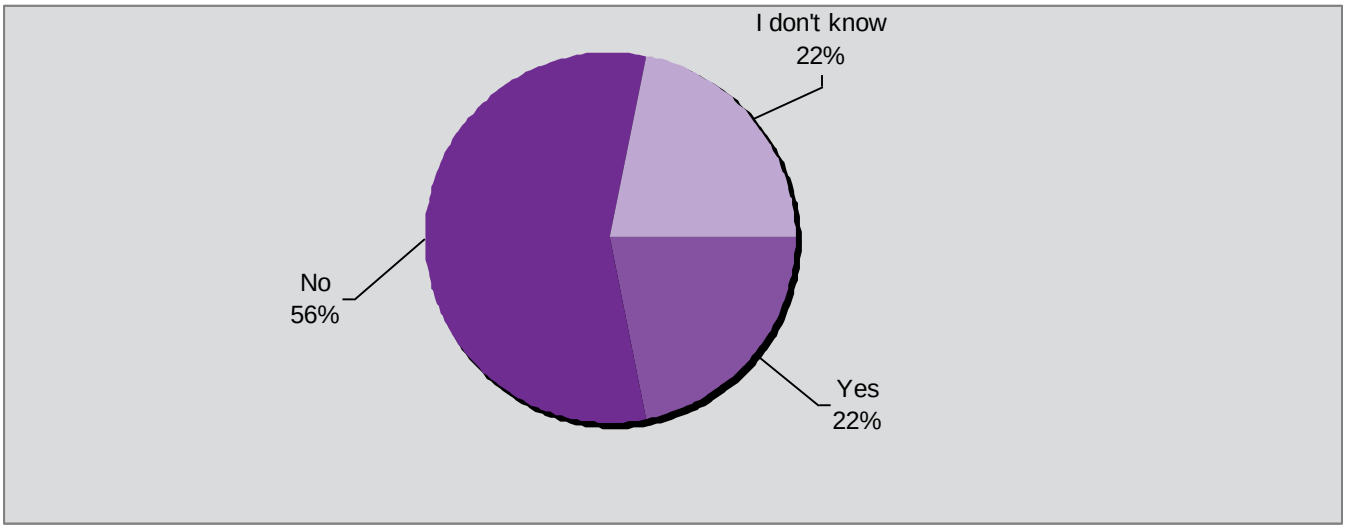


To the question of whether there is an economic threshold over which an organisation uses a measurement and verification protocol, over half of organisations replied negatively (

Figure **14**), while 22% of them stated that there is one. From their free text answers it was deduced that they usually use a protocol when they undertake larger projects.

Figure 14: Is there any threshold over which you use a measurement and verification protocol?



Review and necessity of measurement and verification protocols

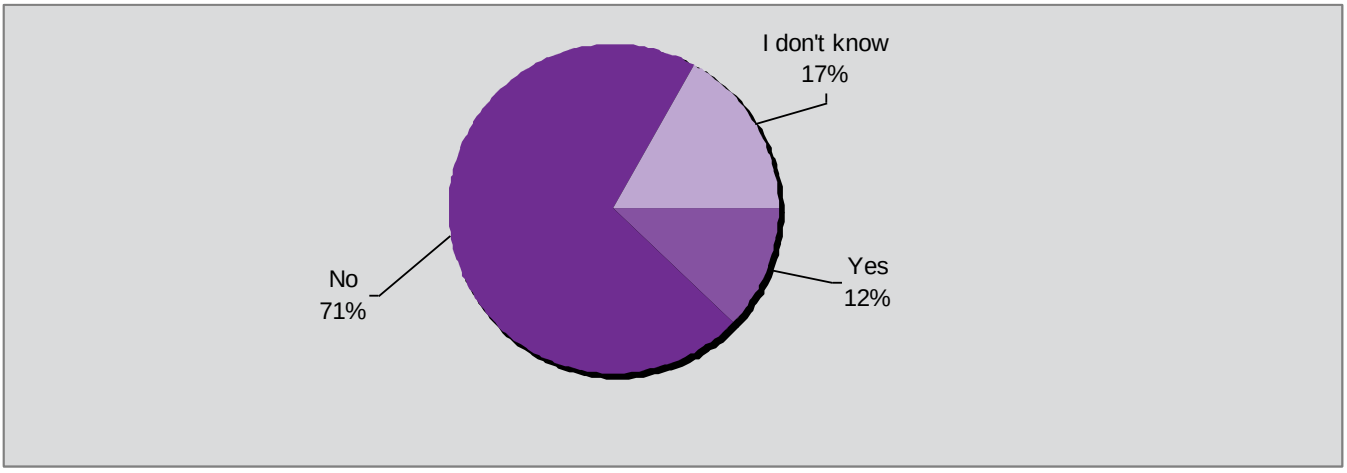
The potential benefits of a measurement and verification protocol for ESCOs, clients and banks were examined to identify the advantages of such schemes in the energy service market, at least as perceived by the ESCOs. According to the main findings summarised from the responses, a measurement and verification protocol can benefit **ESCOs** because it provides all the necessary technical guidelines for the accurate quantification of the achieved savings, increases the effectiveness of projects and the expected income, diminishes the risk of the proposed investments to acceptable levels, provides reliability and professionalism to ESCOs with the standardisation and structure of their projects and procedures, increases transparency regarding the implementation and evaluation of the proposed projects and constitutes a fair mechanism which reduces the risk of conflict between the ESCO and client.

Respondents also outlined that **banks** can benefit from a measurement and verification protocol, because it constitutes an effective tool for the quantification of all crucial figures involved in their financial plans, enhances transparency for the measurement of savings, assures the return of their investments, improves their procedures regarding operation risk management and creates credibility and trust for the financing of future projects.

Finally, it was stated that a measurement and verification protocol can be beneficial to **clients** because it increases clients' trust towards ESCOs and the proposed projects, enhances transparency and confidence in the business models and methodologies for the estimation of the achieved savings, secures the contractual relationship with the ESCO, ensures that the actual savings are correctly determined and guarantees the benefits with no risk, and encourages the ESCO and the clients to accept their obligations with a clear overview of the methods, schedules and parameters that lead to target savings.

Despite the fact that the surveyed organisations believe that banks can also benefit from a measurement and verification protocol, as shown in
Figure **15**, most of the organisations (71%) have not noticed any particular interest from financial institutions in demonstrating the use of a measurement and verification protocol. Only 12% responded positively and they refer to cases of financial institutions that were prior informed on this protocol and/or see it as a project risk mitigation tool.

Figure 15: Are you aware of any interest from financial institutions in a measurement and verification protocol?



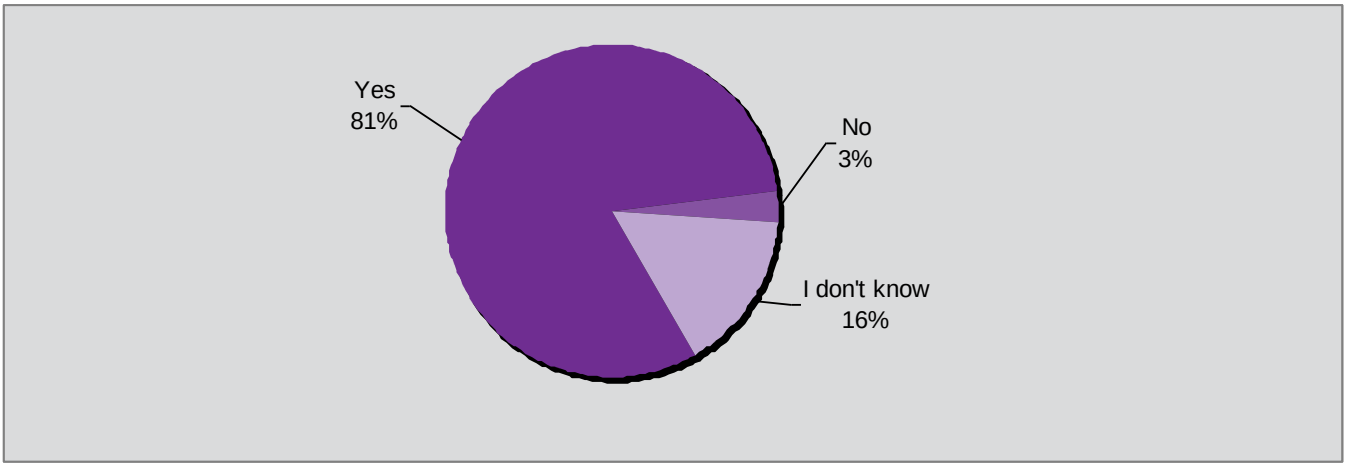
As Figure 16 shows, a large percentage of respondents (81%) positively judge the measurement and verification protocol; this percentage remains for the case of ESCO-type companies (80%). Their responses indicate that they find that the protocol contributes to an improved outcome through a formal, established, understood and transparent process applied to a project or projects, while it also forces contract parties to make better performance contracts. Since it is adaptable to all situations, it also promotes standardisation in the industry.

However, matters of flexibility were mentioned. It was stated that the protocol should not be rigid and complex, as it may create extra costs for projects in relation to the risks involved. Therefore, the level/complexity of a measurement and verification protocol should be decided as far as possible between the ESCO and the customer, depending on a number of specific unique parameters in each project.

Moreover (as shown in

Figure 16), among the responses that view the protocol negatively (approximately 3% of the surveyed organisations), it was also claimed that, by using a measurement and verification protocol, additional effort and expenses for projects would arise and that the IPMVP itself is very lengthy. Some concerns are also linked to the country specific situation, not allowing the use of measurement and verification in contracts.

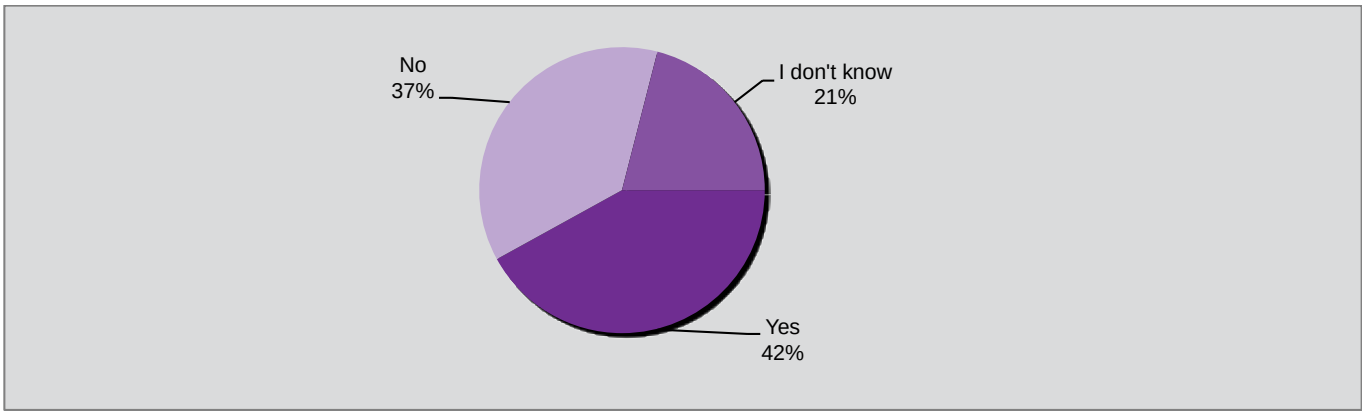
Figure 16: Do you positively judge the measurement and verification protocol?



The surveyed organisations were also asked to express the main concerns within the measurement and verification protocol. Many of the issues raised in responses concerned the complexity of the protocol and the question of applicability to all kinds of projects, which would lead to a more time-consuming process and unnecessary costs. Comments were also made about the reliability of energy consumption data and measurement systems, while some organisations expressed the need for a common and widely accepted protocol used by the public and private sector as well as financial institutions.

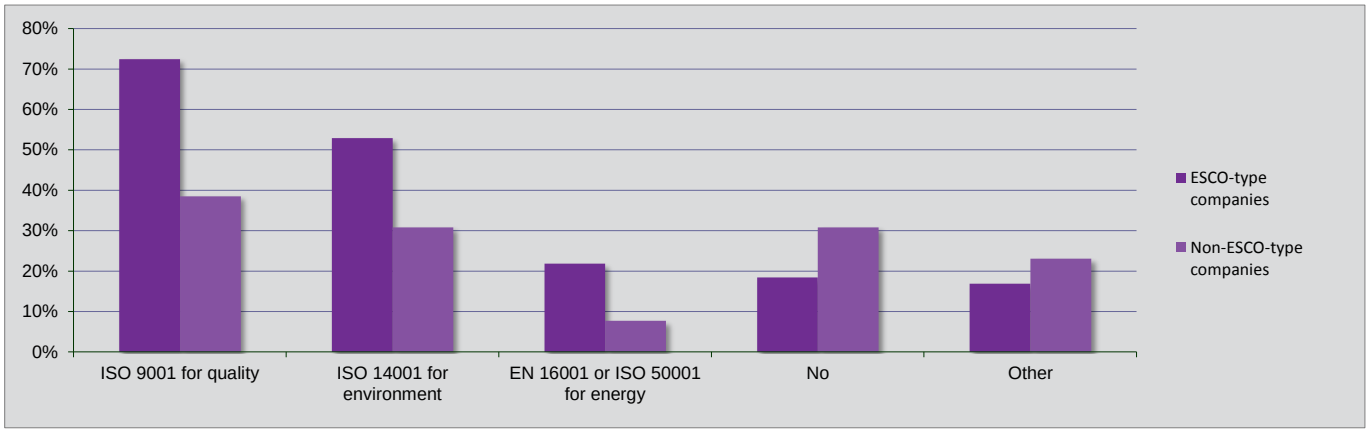
Replies to the question regarding the necessity of a measurement and verification protocol for particular sectors or particular energy efficiency measures were almost equally positive and negative (Figure 17). Specifically, 42% of all respondents replied that the protocol is used or is required in particular sectors or for particular energy efficiency measures, while 37% of them replied that it is not. From the organisations that replied positively, they usually specified it for the public sector.

Figure 17: Is a measurement and verification protocol used or required in particular sectors or for particular energy efficiency measures?



The surveyed organisations were asked whether they are certified with any management system and the vast majority (80%) replied that they have one or more management systems, either for quality, environment, energy or other management systems. Figure 18 presents the use of such management systems by type, illustrating that quality and environmental management systems are most common. From the respondents that are certified in at least one management system, 38% are certified with only one, 33% with two, 29% with three and only 1% with four different management systems. The organisations that only have one management system usually refer to a quality management system and more rarely environmental, energy or other management system.

Figure 18: Does your organisation have any management system(s)?



In terms of combinations of system (
Figure **19**), having both quality and environmental management systems is most common (30%), while the combination of quality, environmental and energy management systems is adopted by 18% of the respondents. In general, the vast majority of companies that are certified with an energy management system have also been prior certified with a quality and/or environmental management system.

Figure 19: Combinations of management systems

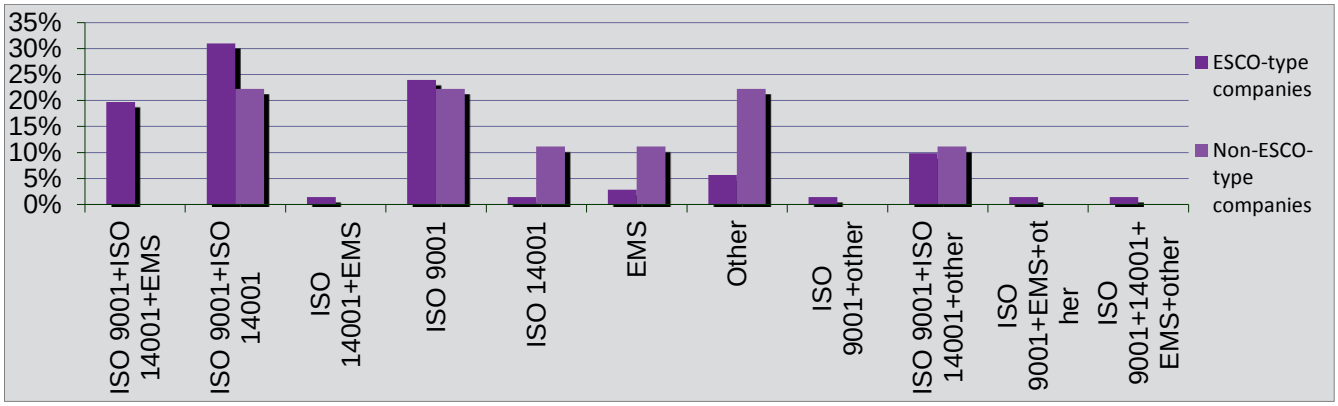
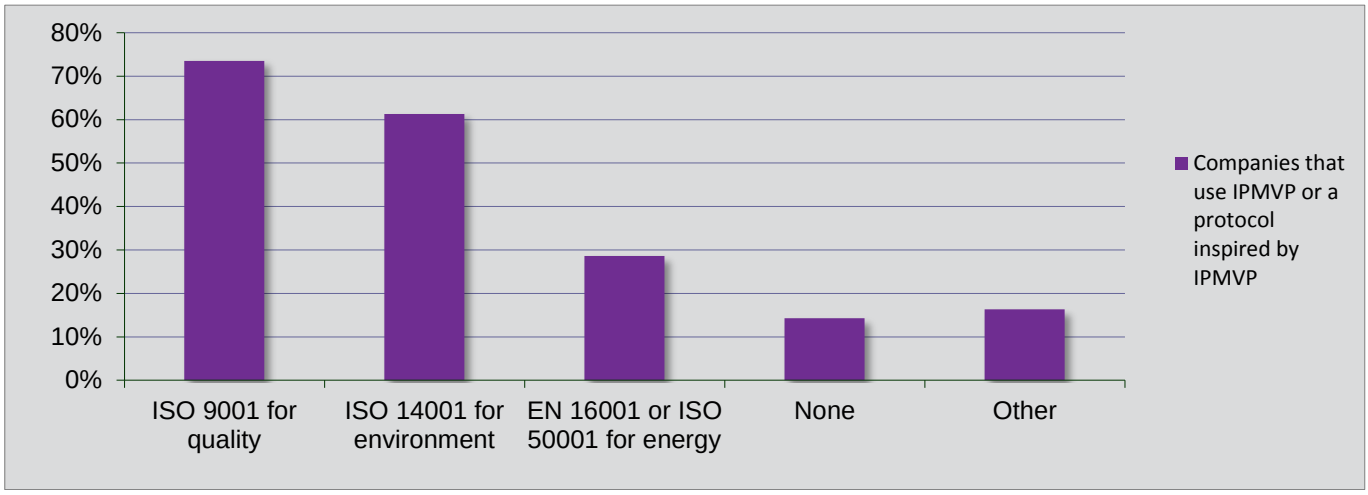


Figure 20 only refers to companies that use IPMVP or a protocol inspired by it and shows a similar trend to the responses for all surveyed organisations. The most common management system is the one for quality (73%), followed by the environmental management system (61%), while the energy management system is adopted less (29%), probably because it is the most recent. However, it is noted that only 14% of the companies that use IPMVP or a protocol inspired by it do not have any management system.

Figure 20: Certification of management systems in companies that use IPMVP or a protocol inspired by it



In summary, the majority of the respondents (81%) view a measurement and verification protocol positively, but it is used or required far less (42%). In few Member States there is a higher penetration of IPMVP or IPMVP based protocols. This penetration does not seem linked with the maturity of the energy service market or the availability of IPMVP in the national language. In fact, in an already mature/developed market, with guidelines/model contracts already present and working, there seems to be less interest/need for new guidelines on measurement and verification.

3.2 Standardisation in the field of energy management and M&V

Directive 2006/32/EC together with other directives within the EU energy framework include definition of energy efficiency and saving targets and reporting of results. Therefore there is a strong need for harmonised monitoring and evaluation methods for energy savings.

Many policies and tools for increasing energy efficiency currently exist and continue to improve, both of a voluntary and mandatory nature. Nowadays, the concept of an ESCO is widely accepted. The concept of energy efficiency services is based on achieving energy savings that can pay back investments designed to achieve these savings. There are many cases of achieving energy savings through aggregating savings from a number of individual projects in households and companies (bottom up approach) and securitizing them into tradable energy savings e.g. white certificates, or emission permits. The other widely applied concept is the implementation of energy management systems according to the ISO 50001 standard in industry and in other organisations. In all these cases the measurement and verification of savings are vital steps in the process. The measurement, calculation and verification of energy savings are established as a cornerstone of effective tools to stimulate technologies and policies for energy efficiency.

There is still ongoing discussion on an exact definition of the term “measurement and verification” from the standardisation point of view. According to draft terminology standard ISO/IEC CD 13273-1-2, def. 3.3.6, M&V means “procedures and methods that identify sources of variability in order to reliably determine energy use and energy consumption compared against an energy baseline for a defined system boundaries”. This concept is applicable to system boundaries for a region, organisation, facility, system, process or equipment etc. In general, M&V allows e.g. building owners, ESCOs and institutions financing energy efficiency projects to quantify and verify the energy savings and performance of energy efficiency improvement measures. It is very important, especially in EPC projects, because M&V increases the transparency and trust between the customer and ESCO on results achieved. It is also important for projects or programmes where reporting of savings is a requirement e.g. Third Party Financing, loans/grants, projects in the public sector using public financial resources. A detailed M&V description and plan is also important for financing institutions where it increases the confidence in a project through information feedback, control and project management and increases the probability of approval of financing. For proper M&V the following aspects should be considered – boundaries of M&V, M&V methods used, adjustment factors, data quality in comparison with costs and purpose and measurement planning.

The purpose of standards for quantifying energy savings differs according to their users. They could be used by:

- Organisations to quantify their energy savings related to an energy saving project, installing energy saving equipment and implementing energy saving programmes
- Investors to evaluate rationality of investment in energy efficiency projects/technologies
- Policy makers to evaluate and quantify the energy savings of energy efficiency policies and programmes

Standardisation work in the field of energy management, including M&V, is ongoing at the European and international level. European standardisation institutions (CEN and CENELEC) created the CEN/CENELEC SFEM – Sector Forum for Energy Management in 2006 as a common platform to exchange information with all stakeholders in order to coordinate standardisation activities in the energy management field and identify new needs for standardisation. With impetus created by requirements set by directive 2006/32/EC, four CEN/CENELEC joint working groups were established:

- CEN/CLC/JWG 1 Energy audits
- CEN/CLC/JWG 2 Guarantees of origin and Energy certificates
- CEN/CLC/JWG 3 Energy management and related services – general requirements and qualification procedures
- CEN/CLC/JWG 4 Energy efficiency and savings calculation

These JWGs prepared and CEN/CENELEC published the following standards prior to the third quarter 2012 (underlined standards contain elements of M&V):

- EN EN16001:2009 Energy Management Systems - Requirements with guidance for use (substituted by ISO 50001:2011)

- EN 15900:2010 Energy efficiency services - Definitions and requirements
- CEN/CLC TR 16103:2010 Energy management and energy efficiency - Glossary of terms
- EN 16247-1:2012 Energy audits - Part 1: General requirements
- EN 16212:2012 Energy Efficiency and Savings Calculation, Top-down and Bottom-up Methods
- EN 16231:2012 Energy efficiency benchmarking methodology

Different aspects of M&V are included in these standards:

EN ISO 50001:2011 – This standard provides organisations and companies with a single framework to help them establish the energy management system and processes necessary to improve energy efficiency on a permanent basis. The structure of the standard follows other similar management system standards e.g. ISO 14001 or ISO 9001. M&V is an integral part of the PDCA process framework and the standard contains the general requirements for M&V steps.

EN 15900:2010 – This standard specifies definitions and minimum requirements for an energy efficiency service and gives an example of activities during the provision of these services. M&V activities are vital part of the process at different stages.

EN 16212:2012 – This standard presents a general approach for energy efficiency and energy savings calculations with top-down and bottom-up methods. In the bottom-up part, it provides general concepts and calculation principles for calculation and evaluation of energy savings of individual energy efficiency improvement measures with implications to M&V and also provides examples of such calculations.

There are other standards currently at different stages of preparation and approval. The following technical standards or technical reports are likely to be published at the beginning of 2013.

- prEN 16247-2 Energy audits - Part 2: Buildings
- prEN 16247-3 Energy audits - Part 3: Processes
- prEN 16247-4 Energy audits - Part 4: Transport
- FprEN 16325 Guarantees of Origin related to energy - Guarantees of Origin for Electricity
- Technical report on energy efficiency obligation schemes in Europe

Some of the international ISO standards in preparation include input from European standards which are already published or are at the preparation stage.

At the international level, energy management and M&V work is ongoing under the umbrella of the International Standardisation Organisation (ISO – www.iso.org), which has two active technical committees: ISO/TC 242 and 257.

'ISO/TC 257 General technical rules for determination of energy savings in renovation projects, industrial enterprises and regions' prepares standards in individual working groups as follows:

- WG 1 General technical rules (France) - Definition of a methodological framework applicable to calculation and reporting on energy savings
- WG 2 Methodology for regions (Netherlands) - General calculation methods on energy efficiency and savings for countries, regions or cities *(input from EN 16212)*
- WG 3 Methodology for projects (China) - General technical rules for measurement, calculation and verification of energy savings of projects

The latter standard would specify the general technical rules for measurement, calculation and verification of energy savings in energy efficient retrofitting and new projects. It would specify the terminology, procedure for M&V

of energy savings in projects, technical requirements, M&V methods, uncertainty of M&V methods and an M&V plan with regard to projects.

- New proposal from UK: ISO/NP 17747 General calculation methods on energy efficiency and savings for organisations and other enterprises

ISO/TC 242 Energy Management prepares the following standards (with a focus on guidance standards enabling better implementation of the ISO 50001 standard):

- WG 1 Energy Management
    - prISO 50004 Guidance on implementation, maintenance and improvement of an EnMS (US)
    - prISO 50003 EnMS Auditing and Auditor competency (Korea)
- WG 2 Energy Performance Metrics
    - prISO 17578 EnPI - General principles and guidance (Brazil)
    - prISO 17570 Energy Baseline - General principles and Guidance (Canada)
- ISO/TC 242/ISO/TC 257 JWG 3 Measurement & Verification
    - prISO 17580 Monitoring, measurement, analysis and verification of organisational energy performance (South Africa/US)

The latter standard would establish general principles and guidelines for the M&V process of energy performance of, or within an organisation. It would present M&V principles, a detailed M&V plan, data gathering and verification, M&V analysis and verification, and M&V documentation and reporting.

- ISO/TC 242/WG 4 Opportunities for Improvement
    - prISO 50002 Energy audits (UK) (input from EN 16247-1÷4)
    - prISO 50005 Modular implementation of ISO 50001 including the use of energy performance evaluation techniques (Germany)

3.3 IPMVP & IEEFP

History of the Protocols

For efficiency measures to be considered a reliable resource, energy savings, including the persistence of savings, must be verifiable, and project transaction costs must be kept to reasonable levels. If energy efficiency is to realise its full potential, facility owners and operators, service companies, consultants, contractors and financiers should adopt common technical, financial and legal standards that guide the measurement and verification (M&V) of savings and other aspects of energy efficiency business transactions.

Since the 1990s, standardised approaches to energy efficiency M&V were developed to assist developers, owners and financiers of projects. Today, the International Performance Measurement and Verification Protocol (IPMVP) is the leading international standard[6] for measurement and verification of energy saving projects. IPMVP has been translated into 10 languages and is used in more than 40 countries. Five thousand copies are ordered or downloaded annually.

IPMVP is available in the following languages in the different editions:

- 2012: English
- 2010: English, Brazilian, Bulgarian, Czech, French, Croatian, Polish, Romanian, Spanish
- 2009: English, French, Spanish, Portuguese, Catalan, 2007: English, Brazilian, Chinese French, Polish, Portuguese, Spanish
- 2002: English, Chinese, French, Italian, Portuguese
- 1997: English, Czech, Japanese, Romanian, Spanish, Ukrainian

The first edition from 1996 was the North American Energy Measurement and Verification Protocol (NEMVP), available in English, French, Polish and Portuguese.

The **International Performance Measurement and Verification Protocol (IPMVP)** deals with verification of the results of energy efficiency and renewable energy projects. IPMVP was originally applied for EPC projects in North America but has gradually gained ground throughout Europe.

There is also an energy efficiency financing guideline available for project developers and financiers, the so-called **International Energy Efficiency Financing Protocol (IEEFP**) which provides guidelines for local financing institutions around the world to evaluate and finance energy efficiency and savings-based renewable projects.

IPMVP and IEEFP are published by the **Efficiency Valuation Organisation (EVO)**. EVO (www.evo-world.org) is a non-profit corporation with a mission to "*develop and promote the use of standardized protocols, methods and tools (EVO Protocols) to quantify and manage the performance risks and benefits associated with end-use energy efficiency, renewable energy, and water efficiency business transactions.*" EVO is a community of volunteers which came together in 1996 under a US Department of Energy initiative to develop an international M&V protocol that would help determine energy savings from ESCO projects in a consistent and reliable manner. EVO has been an independent volunteer run non-profit corporation since 2001.

Introduction to IPMVP

The IPMVP provides an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects in commercial and industrial facilities. It may also be used by facility operators to assess and improve facility performance. It is especially used in energy performance contracts where savings must be reported to a client and may form the basis of a payment to an ESCO.

IPMVP presents a common terminology to support rational discussion of often contentious M&V issues. A primary purpose of IPMVP is to publish current good M&V practice as reassurance for the public about reported savings. Its global use has helped the EPC industry worldwide.

[6] The term "standard" should not be understood as a legal standard or a technical standard developed by CEN, ISO, etc. IPMVP is more a generally (globally) accepted methodology for M&V of energy savings.

Energy conservation measures (ECMs) covered in the protocol include fuel saving measures, water efficiency measures, load shifting and energy reductions through installation or retrofit of equipment, and/or modification of operating procedures. IPMVP includes the following volumes:

1. Volume I Concepts and Options for Determining Energy and Water Savings

2. Volume III contains specific application guidance manuals for Volume I (current manuals address new building construction (Part I) and renewable energy additions to existing facilities (Part III)

The IPMVP Methodology

The methodology is based on the fact that energy savings cannot be directly measured. They can only be determined by comparing measured use before and after implementation of a project, and making appropriate adjustments for changes in conditions. In a simplified way, it can be said that:

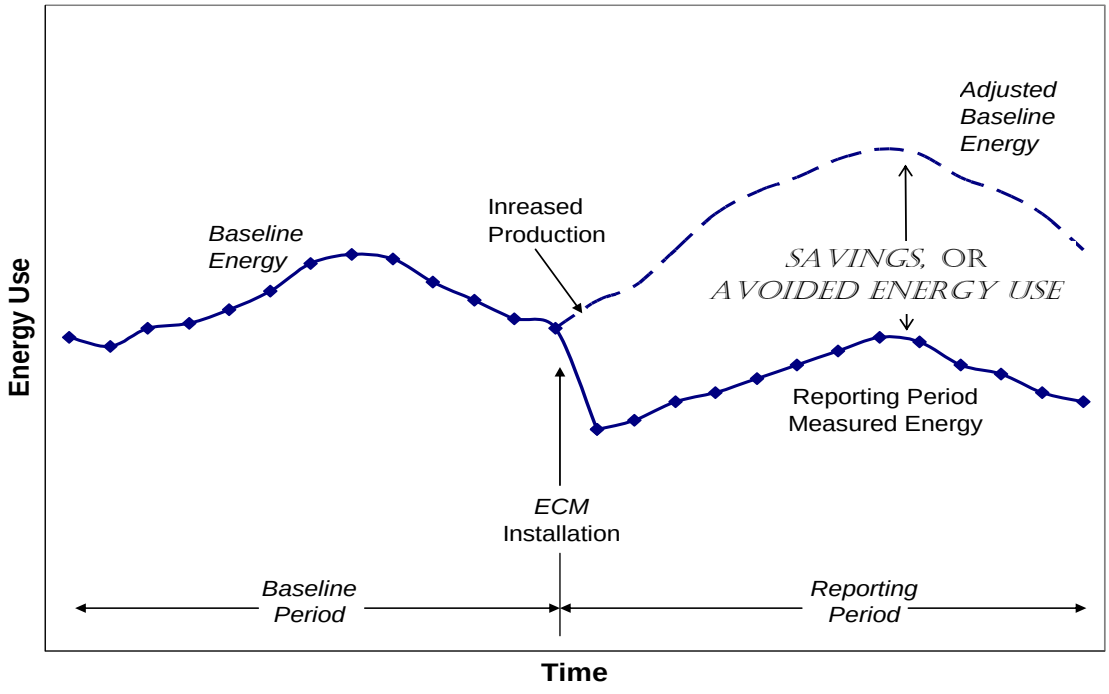
Energy (cost) savings = (Baseline Energy – Reporting-Period Energy) ± Routine Adjustments ± Non-Routine Adjustments

Simple comparison of measured energy use without the adjustments, reports only energy change and fails to calculate the true performance of a project. To properly report "savings", adjustments must account for the differences in conditions between the baseline and reporting periods. Examples when adjustments are needed include:

1. Energy saving projects in an industrial facility where production before project implementation was higher or lower than afterwards

2. Reconstruction of a heating system, annual consumption depends on fluctuations in outside temperature

Figure 21: Determining true energy savings (source EVO/PERMANENT)



IPMVP defines four options for determining savings: A, B, C, and D. These four options enable evaluation of all types of energy efficiency techniques deployed at a building or industrial plant. They provide flexibility in balancing the accuracy and costs of M&V.

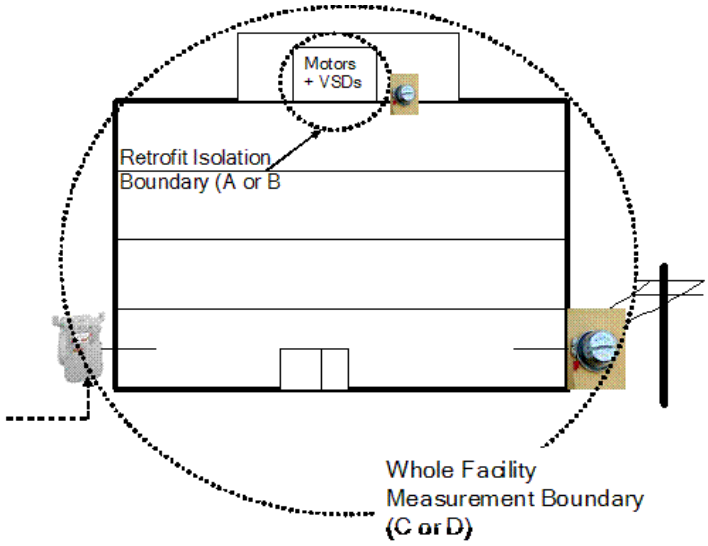
1. **OPTION A** – Retrofit Isolation: Key Parameter Measurement. A typical application is a lighting retrofit where power draw is the key performance parameter that is measured before and after retrofit. Operating hours of the lights are estimated based on building schedules and occupant behaviour.

2. **OPTION B** – Retrofit Isolation: All Parameter Measurement. A typical application is a variable-speed drive (VSD) and controls added to a motor to adjust pump flow. Electric power can be measured with a kWh meter installed on the electrical supply to the motor. In the baseline period, this meter is in place for a week to verify constant loading. The meter is in place throughout the reporting period to record the energy reduction relative to the baseline level. Adjustments are made as needed for changes in the pump flow circuit.

3. **OPTION C** – Whole Facility. A typical application is a multifaceted energy management programme affecting many systems in a building. It involves measuring energy use with the gas and electric utility meters for a twelve-month baseline period and throughout the reporting period. Adjustments are made for weather variations and any other changes in the equipment or occupancy of the building.

4. **OPTION D** – Calibrated Simulation. A typical application is a multifaceted energy management programme affecting many systems in a facility but where no meter existed in the baseline period. Energy use measurements, after installation of whole building gas and electric meters, are used to calibrate a detailed computer simulation. Baseline energy use, determined using the calibrated simulation, is compared to a simulation of reporting period energy use.

Figure 22: Determining the Measurement Boundary (source EVO/PERMANENT)



Choosing between the four options involves many considerations, one of which is the **definition of the measurement boundary** (e.g. a whole building or one energy using system within a plant.) To manage savings at the whole facility level, Option C or D are needed. However, for more detail on the performance of an individual retrofit, a retrofit isolation would be used (Option A or B).

Table 3: Suggested option(s) according to energy conservation measures and project characteristics (source EVO IPMVP vol.1 2012)

ECM Project Characteristic	Suggested Option			
	A	B	C	D
Need to assess *ECM*s individually	X	X		X
Need to assess only total facility performance			X	X
Expected *savings* less than 10% of utility meter	X	X		X
Significance of some *energy* driving variables is unclear		X	X	X
Interactive effects of ECM are signficant or unmeasurable			X	X
Many future changes expected within *measurement boundary*	X			X
Long term performance assessment needed	X		X	
Baseline data not available				X
Non-technical persons must understand reports	X	X	X	
Metering skill available	X	X		
Computer simulation skill available				X
Experience reading utility bills and performing regression analysis available			X	

Measuring and evaluation is done continuously in the long term. A key part of IPMVP is the concept of the measurement and verification plan (M&V Plan), which is created before the beginning of implementation of savings and serves for verification if the expected results have been achieved after they were implemented.

Introduction to IEEFP

The IEEFP (International Energy Efficiency Financing Protocol) provides guidelines for Financing Institutions ("FIs") around the world to evaluate and finance energy efficiency and savings-based renewable projects ("Energy Savings Projects").

The IEEFP's objective is to create a better understanding by FIs on how energy users' well-documented energy savings equate to new cash flow and increased credit capacity for end-use consumers to repay loans.

Among the main reasons for developing the IEEFP is overcoming one of the most significant barriers to energy efficiency projects: the lack of commercially viable financing. This lack of financing is not caused by a lack of available funds per se, but rather by an inability to access existing funding capacity at FIs on commercially attractive terms. This lack of access is caused by a "disconnect" between the traditional lending practices of FIs and the financing needs of energy efficiency projects.

FIs typically apply their traditional "asset-based" corporate lending approach for energy efficiency projects that is limited to their lending a maximum of 70%-80% of the value of assets financed (or collateral provided).

Unfortunately there is often little or no collateral value in the energy efficiency equipment once installed in a facility; rather, the value is the cash flow generated from the equipment after installation. To date, most FIs (due to lack of knowledge) have not recognised nor appear to believe that meaningful cash flow can be generated from energy efficiency projects, or that such cash flow can be relied upon to repay the related loans.

IEEFP is an international standardised methodology for evaluating the risks and benefits of financing energy efficiency projects. It focuses on the "Savings Value" of projects for loan repayment and credit capacity analysis. It provides, in non-technical terms, guidelines on:

1. The overall investment opportunity presented by energy efficiency

2. Assessing risks of different types of projects
3. Assessing investment grade energy audits
4. Appropriate financing structures
5. Key elements of ESCO contracts
6. Key elements of the M&V process
7. Risk mitigation techniques
8. Loan applications

3.4 Permanent project

The PERMANENT project (www.permanent-project.eu) addressed one of the key barriers to the implementation of energy saving projects in both the public and private sectors: the perceived risk of achieving project results and the disbelief that planned project results (project performance) will be achieved and can pay back the investment in a sustainable manner.

PERMANENT has trained energy end users, energy efficiency professionals and financiers in performance risk management and measurement & verification techniques in energy saving projects. The International Performance Measurement and Verification Protocol (IPMVP) and the International Energy Efficiency Financing Protocol (IEEFP) of EVO (Efficiency Valuation Organisation) were used as basis for the training activities. Five project teams from Bulgaria, Croatia, the Czech Republic, Poland and Romania were trained as approved instructors in the IPMVP and IEEFP protocols and subsequently carried out training in the respective countries.

Every country team translated both Protocols into national languages and - due to different levels of market maturity for energy services and different backgrounds for measurement and verification - adapted the original training materials of EVO to their national situation. The national versions of the Protocols were printed and distributed at the training courses and also made available free of charge at the webpage of EVO.

Technical training in IPMVP and financial training in IEEFP was carried out during 2011. The training was well attended in all five countries and resulted in better understanding of energy efficiency measurements, project financing and the energy services market. 56 awareness-raising presentations were planned and delivered (1780 participants) and 72 half-day to two-day training events were planned and organised, attended by a total of 1360 participants. During these training sessions, participants received more detailed information about the project, measurement and verification techniques and methods, reliability of energy savings, measurement and verification plans, energy efficiency project risks and their mitigation, energy performance contracting (EPC) and energy services in general.

At the beginning it was challenging to get enough attendants to the IPMVP and IEEFP training, but the feedback from attendees at the one or two day sessions were generally very positive and the methods of measurement and verification attracted a lot of interest. For shorter awareness-raising presentations, the reactions were also positive, although some of the attendees did not grasp the importance of measurement and verification, probably reflecting the need for more information.

Recognition amongst key policy makers created by PERMANENT has helped to ease the barriers to financing of energy efficiency projects. Several countries recently explicitly mentioned the ESCO mechanism and/or the wisdom of following IPMVP in public buildings, in specialised EE funds, and in their National Energy Efficiency Action Plans. Such public endorsement can only help reticent private sector players to employ ESCOs more fully across the economy.

Follow-up activities include the following:

1. In the Czech Republic, the Association of Energy Service Providers (APES) decided to adopt IPMVP as the official methodology for measurement and verification of Energy Performance Contract results.

2. In Bulgaria, energy auditing and ESCO companies have shown real interest in incorporating the IPMVP principles in their contracts, methodology and practice.

3. In Croatia, Recent developments in energy efficiency (National EE action plans, Preparation of a Law on Energy efficiency and sub-laws, implementation of national programmes such as ‘House in Order’ etc.) clearly show that measurement and verification should be part of every energy efficiency strategy and projects.

4. In Poland and Romania, the PERMANENT project led to an increase the interest in EPC projects, and more new projects are expected to be developed in the near future.

Although PERMANENT cannot claim to have eradicated the financing barrier, the project has actively promoted an independent view and discussion forum for both private and public players to learn about IEEFP and IPMVP methods. It has created an ‘awareness shock’ from an unbiased source, raising understanding so that local market influencers realise important steps to clear common financial barriers to energy efficiency projects.

4 Annexes

4.1 Good practice factsheet
1- IPMVP obligation for public energy performance contracts in Croatia
2- Good practice factsheet – Qualification System of Energy Services Companies in Portugal

To be published in the public section of CA ESD CA EED website (www.esd-ca.eu), under “good practice”.

4.2 Benefits of EN 15900 identified by financial institutions

The following points are taken from the work of CEN/CENELEC JWG 3 and summarise the views of a number of financial institutions on the possible benefits of using EN 15900 in the development and supply of energy (efficiency) services.

- EN 15900 allows simple third part financing evaluation and shortens the evaluation time
- Customer credit rating for the project is grounded
- Service Provider Credit default is grounded
- The cash flow projections are defined and possible deviations or risks are identifiable
- The financial structure (e.g. tenor, grace period, repayment schedule) can be designed around project requirements
- EN15900 provides a solid foundation for developing more sophisticated products to control risks (e.g. derivatives)
- It introduces management procedures which can activate early warning indicators and trigger corrective actions (risk management)

4.3 Questionnaire

Questionnaire on "measurement & verification" for the Concerted Action for the Energy Services Directive

CT4 – Energy companies and energy services

WG 4.3 – Monitoring and verification, IPMVP and other approaches

Questionnaire prepared by:

Michael ten Donkelaar, Enviros, Czech Republic

Jan Magyar, SIEA, Slovakia

Yannis Vougiouklakis, CRES, Greece

Daniele Forni, ENEA/FIRE, Italy

Concerted Action on Energy Services Directive

The Concerted Action for the Energy Services Directive (www.esd-ca.eu) provides a structured framework for the exchange of information between the 27 Member States plus Norway and Croatia during their implementation of the Energy Services Directive. The objectives of the Concerted Action are to:

a. Enhance and structure the sharing of information and experiences from national implementation whilst promoting good practice concepts in activities to improve and strengthen Member State implementation of the Energy Services Directive.

b. Create favourable conditions for an accelerated degree of convergence of national procedures in Energy Services Directive related matters.

c. Complement the work of the Energy Demand Management Committee.

Description and objectives of WG 4.3

Monitoring and verification of energy consumption and performance is a fundamental part of energy services based on energy performance (energy performance contracting, energy efficiency services, etc.) and energy management systems (e.g. ISO 50001). It is also essential in energy planning involving verification and improvement at local (e.g. CO_2 reduction of covenant of mayors), regional or national level.

The availability of a standardized method for the measurement and verification of savings standardized through Europe is a critical factor for the ESCO market, to ameliorate the relations and confidence with the clients and the banks.

Case study examples will be collected based on the responses from this questionnaire and will be presented and discussed in the Working Group 4.3 parallel sessions in the 3rd Plenary Meeting in Cyprus.

Please **fill only the online questionnaire** at the following address:

https://response.questback.com/energysavingtrust/4yyhjxqm0c/

Contact information for the respondent

-Name:

-Surname:

-Position:

-Mail address:

-Telephone:

Organization

-Name of the organization

-Member State (if multinational organization, please specify to which Member States the answers are referred to)

QUESTIONNAIRE

Q1 Do you recognize your organization as an ESCO according to the definition of the directive 2006/32/EC[7] ?

- Yes
- No
- I don't know

If not, specify why: …

Q2 Main field(s) of activity: [multiple answers]

- Civil sector
- Public sector
- Industrial sector
- Other: …

Q3 Which kind of contract(s) do you use? [multiple answer]

- Energy performance contracting[8]
- Supply contracts with some efficiency/performance clause
- Supply contracts

[7] energy service company' (ESCO): a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria.
[8] In the 2006/32/EC, an Energy performance contracting is a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement.

- Contracts complying with the Standard EN 15900
- Other: …

Q4 Do you use any measurement and verification protocol?

- Yes the IPMVP[9]
- Yes inspired by IPMVP, but with some modifications (please specify in the free text below)
- Yes (please specify in the free text below if it is internal to the company, local, national, etc.)
- No, we do not have anything like this (please explain briefly in the free text below how you evaluate savings)
- I don't know

Free text: …

Q5 Do you have an IPMVP certified person in your organization?

- Yes
- No
- I don't know

[if Q4 answer is "No", after Q5 jump to Q12]

Q6 If you use the IPMVP, which option(s) do you use? [multiple answer]

- A (estimation)
- B (retrofit isolation)
- C (whole facility)
- D (simulation)
- I don't know

If more than one, please indicate the share of each option: …

[9] IPMVP International Performance Measurement and Verification Protocol is a protocol for measurement and verification developed in North America in 1997.

Q7 Is there any threshold over which you use a measurement and verification protocol?

- Yes
- No
- I don't know

If yes, please specify the threshold: …

Q8 What are the benefits of a measurement and verification protocol?

For ESCO: …

For clients: …

For banks (if involved): …

Q9 Did you notice any interest from financial institutions in measurement and verification protocol (e.g. banks may see this as a way to manage risks and be more willing to finance such a project)?

- Yes
- No
- I don't know

If yes, please specify why: …

Q10 Do you judge positively the measurement and verification protocol?

- Yes
- No
- I don't know

Please specify why: …

Q11 What are the main concerns within the measurement and verification protocol?

…

Q12 Is a measurement and verification protocol used or required in particular sectors (e.g. public sector) or for particular energy efficiency measures?

- Yes
- No
- I don't know

If yes, please specify the sector and/or the energy efficiency measures: …

Q13 Does your organization have any management system(s)? [multiple answer]

- ISO 9001 for quality
- ISO 14001 for environment
- EN 16001 or ISO 50001 for energy
- No
- Other

If other, please specify in the free text below: …

If you have information of good examples or good practice of measurement and verification or any comments, please do share them with us: …

Thank you for completing this questionnaire!

Your response is very important to the collection of information for Working Group 4.3 of the Concerted Action for the Energy Services Directive.

If you have any questions, please do not hesitate to contact Daniele Forni.

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+39 06 30483947

For more information please email
forni@fire-italia.org

Legal Disclaimer

The Concerted Action for the Energy Services Directive II (CA ESD II) was launched by Intelligent Energy Europe (IEE) in May 2011 to provide a structured framework for the exchange of information between the 29 Member States during their implementation of the Energy Services Directive (ESD).

For further information please visit **www.esd-ca.eu** or contact the CA ESD Coordinator Lucinda Maclagan at**lucinda.maclagan@agentschapnl.nl**

CONCERTED ACTION
ENERGY SERVICES
DIRECTIVE

INTELLIGENT ENERGY
EUROPE