



A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems

Implementation of national minimum criteria for energy audits, in line with Annex VI of the Energy Efficiency Directive

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1. Introduction

The 2012 Energy Efficiency Directive (hereafter 'the EED' or 'the Directive') establishes a set of binding measures to help the European Union (EU) reach its 20% energy efficiency target by 2020. Under the Directive, EU Member States (MS) are required to use energy more efficiently at all stages of the energy chain, from its production to its final consumption.

Article 8 of the Directive sets out requirements for MS to promote the availability of energy audits to all final energy users, including households, small and medium enterprises (SMEs) and non-SMEs. In line with Article 8(4), MS must ensure that enterprises that are not SMEs are subject to an energy audit by the 5 December 2015 and at least every four years thereafter. Audits may be undertaken as standalone audits or as part of a wider energy management system or voluntary agreement.

Article 8(1), sub-paragraph 3 states that "For the purpose of guaranteeing the high-quality of the energy audits and energy management systems, Member States shall establish transparent and non-discriminatory minimum criteria for energy audits based on Annex VI."

As such, Annex VI of the EED sets out the minimum criteria for all energy audits, including those undertaken as part of energy management systems, required or promoted in accordance with Article 8.

MS were required to transpose the requirements of the EED, including Article 8, into national law by 5 June 2014. Following this, final customers, including those mandated to carry out energy audits, are looking to MS authorities to provide guidance on complying with the new legislation.

1.1. This guidance document

This document is intended to provide practical guidance to MS authorities responsible for the transposition and implementation of Article 8 and Annex VI requirements of the EED, including the establishment of transparent and non-discriminatory national minimum criteria for energy audits. Its specific focus is the application of national minimum criteria for energy audits.

This guidance covers the systems, procedures and applicable, internationally recognised standards, certifications and/or accreditations that MS may implement to meet the minimum requirements.

The guidance document is composed of three principal sections:

- Section 2, "Principles of Annex VI", looks at the requirements of Article 8 and how the Annex VI criteria have been derived within this context.
- Section 3, "Implementation of national minimum criteria", looks at how the implementation of Annex VI national minimum criteria, supports the requirements of Article 8.
- Section 4, "Audit composition", provides practical guidance and best practice examples on the development and implementation of national minimum criteria based on the Annex VI guidelines.

By reading this guidance, MS authorities will better understand how they can develop a framework which will assist end-users of energy in carrying out high-quality and cost effective energy efficiency audits.

1.2 Further information and key documents

The Energy Efficiency Directive can be accessed from EUR-Lex at the following web address:

- <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32012L0027>

The Directorate-General for Energy website page on the EED can be accessed at the following address:

- <https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive>

The website page includes a link to the European Commission's Article 8 guidance note to EU MS officials (SWD (2013) 447). This guidance is supplementary to SWD (2013) 447 and MS officials are encouraged to consult both documents in developing their national approach to implementing the requirements of Article 8.

2. Principles of Annex VI

Annex VI of the EED sets out the minimum criteria for energy audits, including those audits carried out as part of energy management systems. These minimum criteria are set out in Box 1.

Box 1: Annex VI “Minimum criteria for energy audits including those carried out as part of energy management systems”

The energy audits referred to in Article 8 shall be based on the following guidelines:

- a) be based on up-to-date, measured, traceable operational data on energy consumption and (for electricity) load profiles;*
- b) comprise a detailed review of the energy consumption profile of buildings or groups of buildings, industrial operations or installations, including transportation;*
- c) build, whenever possible, on life-cycle cost analysis (LCCA) instead of Simple Payback Periods (SPP) in order to take account of long-term savings, residual values of long-term investments and discount rates;*
- d) be proportionate, and sufficiently representative to permit the drawing of a reliable picture of overall energy performance and the reliable identification of the most significant opportunities for improvement.*

Energy audits shall allow detailed and validated calculations for the proposed measures so as to provide clear information on potential savings.

The data used in energy audits shall be storable for historical analysis and tracking performance.

The minimum criteria in Annex VI have been put in place to support the requirements of Article 8, such that:

1. Energy audits are of **high-quality**
 - a. Based on **transparent and non-discriminatory criteria** (according to Annex VI)
 - b. The quality of energy audits and similar measures is **supervised**
2. Energy audits are **cost-effective**
3. Energy audits are undertaken in an **independent** manner
4. The findings of energy audits are **transferrable**

Table 1 shows how these guiding principles for energy audits can be derived from the clauses contained within Article 8. Practical guidance on how MS can apply these principles is set out in Section 3.

Table 1: Categorised requirements of the clauses of Article 8

Clauses of Article 8 of the EED:	Categorised requirements of Article 8:
1. MS shall promote to all final customers the availability of high-quality energy audits which are cost-effective and are either:	High-quality (general statement) Cost-effective
1a. carried out by independent qualified and/or accredited experts according to qualification criteria	Independent High-quality (qualified/accredited experts)
1b. implemented and supervised by independent authorities under national legislation	Independent Supervision
1. Energy audits may be carried out by in-house experts or energy auditors	-
1. MS shall put in place a scheme to assure and check the quality of energy audits	Supervision
1. MS shall establish transparent and non-discriminatory criteria based on Annex VI to guarantee high-quality energy audits and energy management systems	High-quality Annex VI minimum criteria Transparent and non-discriminatory
1. Energy audit findings shall be transferrable to any qualified/accredited energy service provider	Transferrable
2. MS shall develop programmes to encourage SMEs to undergo energy audits	-
2. MS may set up support schemes for SMEs, including voluntary agreements, to cover the costs of an energy audit and the implementation of highly cost-effective recommendations from energy audits	Cost-effective (energy audit recommendations)
2. MS shall bring to the attention of SMEs examples of how energy management systems could help their businesses	-
3. MS shall develop programmes to raise awareness among households of the benefits of energy audits	-
3. MS shall encourage training programmes for the qualification of energy auditors	High-quality (qualified/accredited experts)
4. MS shall that non-SMEs are subject to an energy audit carried out in an independent and cost-effective manner by 5 December 2015 and every four years thereafter	Independent Cost-effective
5. Energy audits carried out under voluntary agreements are considered as fulfilling the requirements of paragraph 4 where carried out in an independent manner and meet the minimum criteria of Annex VI and supervised by the MS	Independent Annex VI minimum criteria Supervision
5. Access of market participants offering energy services shall be based on transparent and non-discriminatory criteria	Transparent and non-discriminatory
6. Non-SMEs implementing an energy management system certified by an independent body according to the relevant European or international standard shall be exempt from the requirements of paragraph 4, if the EMS includes an energy audit according to the minimum criteria in Annex VI	Annex VI minimum criteria

7. Energy audits may stand alone or be part of a broader environmental audit	-
7. MS may require the assessment of the technical and economic feasibility of connection to existing or planned district heating or cooling network be covered of the energy audit	-
7. MS may implement incentive and support schemes for the implementation of recommendations from energy audits and similar measures	-

2.1. Applicability of Annex VI criteria

2.1.1 Scope

The national minimum criteria to be established based on Annex VI must apply to energy audits promoted by MS and mandatory audits conducted by large enterprises. They apply both to stand alone energy audits and audits carried out as part of energy or environmental management systems.

As stated in Annex VI (b), energy audits must include a detailed review of buildings or groups of buildings, industrial operations or installations, including transportation.

In order to meet the requirements of Article 8 MS must ensure that the minimum criteria they establish, as well as any tools and guidelines issued, cover the complete scope of the Annex VI criteria. In addition they must be applicable and relevant to the full audience of energy end-users set out by Article 8 i.e. all final customers.

2.1.2 Additional or tailored criteria

In establishing their national minimum criteria, MS may choose to add additional elements to a criterion or add additional criteria, beyond those outlined in Annex VI.

For example, MS may choose to specify what constitutes 'up-to-date' data by putting in place a limitation on the use of data that exceeds a given time before the commencement of the energy audit – e.g. the data used to inform the energy audit cannot exceed 24 months from the commencement date of the energy audit.

MS may also choose to tailor their national minimum criteria for particular groups of final customers where they promote energy audits in line with Article 8(1), such as SMEs, public service operators or households.

2.1.3 Energy and environmental management systems

Article 8(6) provides an exemption from mandatory energy audits for enterprises that are not SMEs and are implementing an energy or environmental management system.

In such cases, the MS must ensure that exemptions are only allowed in cases where the management system is certified by an independent body according to a relevant European or international standard. In addition, the management system must include an energy audit based on the minimum criteria outlined in Annex VI. MS should make this exemption option clear to mandated enterprises, and provide clear and specific guidance on what constitutes a suitable management system.

In line with recital 24 of the EED, the minimum criteria for energy audits outlined in Annex VI are not more far reaching than the requirements of the relevant European or

international standard (such as EN ISO 50001 or EN 16247-1). As such, energy audits adhering to the requirements of a relevant European or international standard are viewed as adhering with the requirements of Annex VI.

Because of their stringent requirements, European and international standards, such as those mentioned above, can provide useful guidance to MS in the development of national minimum criteria based on Annex VI.

3. Implementation of national minimum criteria

The minimum criteria for energy audits are enacted to assure the availability of **high-quality, cost-effective** and **independent** energy audits to all final customers, where the audit findings are **transferrable**. Therefore, it is by setting suitable minimum criteria, MS will enable energy users to conduct audits that meet with the requirements of Article 8.

Sections 3.1 to 3.5 explore the factors that MS should consider when developing and implementing their national minimum criteria.

3.1 High-quality energy audits

In line with Article 8(1) paragraph 3, MS shall establish transparent and non-discriminatory minimum criteria to guarantee high-quality energy audits are undertaken. As outlined within Annex VI, national minimum criteria shall apply equally to standalone energy audits (including those carried out under voluntary agreements) and energy audits carried out as part of an energy management system.

‘For the purpose of guaranteeing the high-quality of the energy audits and energy management systems, Member States shall establish transparent and non-discriminatory minimum criteria for energy audits based on Annex VI.’

In addition to the guidelines provided in Annex VI, Article 8 outlines several requirements aimed at guaranteeing the undertaking of high-quality energy audits. The following sub-sections look at how these requirements can be accounted for by MS within their national minimum criteria.

3.1.1 Use of qualified and/or accredited experts

Article 8 states that energy audits should be carried out by ‘qualified and/or accredited experts according to qualification criteria’. The qualification criteria apply equally to experts undertaking energy audits for large enterprises in line with Article 8(4) and experts undertaking energy audits promoted to SMEs by MS in line with Article 8(1).

As stated in the Commission’s SWD, Article 8 of the Energy Services Directive (ESD) establishes that MS must ensure, where they deem it necessary, the availability of appropriate qualification, accreditation and/or certification schemes for the providers of energy audits. In addition, Article 16 of the EED (on the availability of qualification, accreditation and certification schemes) establishes that where a MS considers that the national level of technical competence, objectivity and reliability is insufficient, it must ensure that, by 31 December 2014, certification and/or accreditation schemes and/or equivalent qualification schemes, including, where necessary, suitable training programmes, are available for the providers of energy audits.

Energy audits must be carried out by either ‘qualified’ or ‘accredited’ experts. In order to ensure that suitable schemes and training programmes are available to generate these experts, it is necessary to understand what these terms mean:

- Accreditation is a public authority activity that ensures the continuous control of the technical competence of conformity assessment bodies. It ensures that energy audits carried out by experts meet the requirements of Annex VI of the EED.

- While there is a possibility to have qualified experts, it may be more difficult to demonstrate their competence through qualification schemes rather than accreditation. This is because many qualification schemes do not include provisions for continuous control.

Regulation 765/2008¹ provides the EU definition of “accreditation”. It should be noted, however, that accreditation according to Regulation 765/2008 is normally provided to legal rather than natural persons – i.e. accreditation is normally provided to an enterprise rather than a natural person. Qualification should therefore apply to those cases where a natural person aims to become active as an expert.

MS may wish to put in place an accreditation system where a national authority certifies auditors or organisations as having the appropriate competencies to carry out audits in line with Article 8. For example, a professional body may be able to fulfil this role, where it can certify its members as suitable auditors, based on its knowledge of their qualifications, obtained through their membership enrolment, and their continued professional development activities. This approach provides a relatively quick route to the establishment of auditor resources within a country.

In order to establish such a system, the MS would need to review the member qualification requirements of any professional body that it wishes to consider as an authority for its accreditation process against the necessary skill requirements to carry out Article 8 compliant audits. Following this review, professional bodies with a match in skill-set could be considered as appropriate accreditation bodies. In cases where there may be a partial gap in the skills required to carry out an audit, MS may wish to encourage their professional bodies to offer training courses which will help their members to bridge this gap (See Section 3.1.2 – Training).

Good practice in guaranteeing high-quality audits through qualification/accreditation requirements

The quality of the accreditation process put in place by a MS is important as it will determine the standard of energy auditors that will be available within the country.

In setting the accreditation requirements for their expert auditors, some MS have demonstrated good practice by defining separate scopes of accreditation applicable to different audit types - for example, buildings, industrial processes/facilities and transport. As such, energy auditors must be accredited against the appropriate scope for the audit type that they are undertaking. In general, auditors may be accredited against more than one scope.

This approach helps to guarantee high-quality energy audits by ensuring that auditors have a high standard of skills and experience that are specifically relevant to the audit that they are undertaking. This avoids the undertaking of audits by more generalist auditors whose lack of specialist knowledge may limit the outcomes of the audit.

This approach mirrors the ‘scope of accreditation’ requirements for verifiers under the EU Emissions Trading System (EU ETS), where verifiers must be

¹ REGULATION (EC) No 765/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93. Official Journal of the European Union, L 218/30.

accredited by their national accreditation body for activities pursuant to Annex I or other activities pursuant to Articles 10a and 24 of the EU ETS Directive².

Qualification criteria

MS must develop or implement qualification criteria that experts undertaking energy audits must meet. These qualification criteria should strike a balance between being suitably stringent to guarantee that high-quality energy audits are undertaken by experts, whilst not being overly onerous and limiting the availability of experts in the MS to undertake energy audits.

The qualification criteria set by the MS must be transparent and non-discriminatory in nature.

Good practice in developing qualification criteria

In defining the qualification criteria for experts, a number of MS have published publically available standards and/or guidelines setting out the competency requirements that must be held by individuals conducting or reviewing energy audits as an expert. For example, this includes Bulgaria³, Cyprus⁴ and Germany⁵. These guidelines include requirements around professional conduct, core competencies and technical and non-technical knowledge.

In making this information available, these MS ensure that the competencies that auditors must achieve are clearly defined and accessible to all parties concerned. This limits the opportunity for audits to be carried out by auditors that do not possess the required skill-set.

Ireland has chosen not to require auditors to provide samples of previous client audits on application; however, in order to help enterprises make an informed decision as to the suitability of an energy auditor for their class of business, the Irish authorities have recommended to enterprises that they request examples with relevant references when procuring the service.

Within this scope, Ireland has created a competence assessment template⁶ in order to assist enterprises with selection of a suitable auditor. A registered energy auditor needs to complete this template and can then share it with a prospective client. This approach aims to help enterprises choose the right auditor and at the same time help auditors sell their services in a more effective way.

² Directive 2003/87/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC

³ Order No. 38/2013 Regarding the Regulation for Energy Auditors Authorisation, Energy managers Certification and Accreditation of Companies Providing Energy Services

⁴ 2012 Decree on the Methodology and Other Requirements for Conducting Energy Audits (RAA 171/2012)

⁵ BAFA, Energieaudits nach EDL-G, Hinweise zur Registrierung vor Energieaudits durchführenden Personen, Bundesamt für Wirtschaft und Ausfuhrkontrolle, available online from http://www.bafa.de/bafa/de/energie/energie_audit/publikationen/hinweise_registrierung_energieaudatoren.pdf

⁶ http://www.seai.ie/Your_Business/Energy-Auditing-Scheme/

Where MS introduce both an auditor accreditation process and a set of qualification requirements, it should be ensured that both systems provide the same standard of auditor and allow for audits in line with Annex VI criteria.

3.1.2 Training

MS are required to “*encourage training programmes for the qualification of energy auditors to facilitate sufficient availability of experts*” (Article 8(3)).

This requirement applies equally to energy audits carried out by independent qualified and/or accredited experts according to qualification criteria (Article 8 (1) (a)) and energy audits implemented and supervised by independent authorities under national legislation.

MS may choose to appoint a national authority, or a number of authorities, to commission or provide training programmes directly, or may choose to entrust accreditation/qualification bodies to include specific training as part of the initial and/or re-accreditation/re-qualification; or MS may entrust other third parties to provide the training.

Irrespective of who provides the training, MS should consider setting out minimum criteria around the requirement for, and frequency of, periodic retraining, if deemed necessary to guarantee the technical competence, objectivity and reliability of energy auditors. It is best practice to require professional experts in a subject matter to undertake continual professional development activities to ensure that their skills remain suitable and relevant. MS should therefore set out what form this continued development activity should take (e.g. an assessment, or demonstration of experience) and how often it should be carried out (e.g. annually). Where the assessment of auditor competence is based on experience rather than, or as well as, the achievement of qualifications, MS should consider setting a timeframe around the provision of relevant examples of experience (e.g. audits undertaken in the last three years). Such examples should be provided through reference, as a means to independently confirm their validity.

MS are encouraged to assess the anticipated number of legal or natural persons available to undertake energy audits (‘capacity’) in their country, versus the known or likely demand from all final customers (‘demand’) – including large enterprises required to undertake an energy audit (known demand, see Section 3.1.3 ‘Determining large enterprises’) and SMEs opting to undertake an energy audit – to see if capacity is likely to meet demand. If not, excess demand in the market is likely to lead to higher energy audit costs, making energy audits less cost-effective for the final customer. MS encouragement of training programmes should therefore be aimed at facilitating sufficient capacity in order to maintain the availability of cost-effective audits.

Good practice in guaranteeing the availability of experts through training

In Spain a not-for-profit association⁷ was able to anticipate that the number of energy auditors was not going to be sufficient to cover Article 8 requirements. The association already organised training course for energy auditors and took the initiative to engage with the Spanish authorities to offer to provide the training required to increase auditor numbers.

⁷ <http://www.enace.es/Web/es/formacion.html>

A unique training scheme was developed for individuals wishing to meet the qualification criteria for expert auditors. The training is based on European standards and uses best practices examples from numerous other European MS. The association has also taken the lead in developing a database of trained energy auditors and making this available via its website.

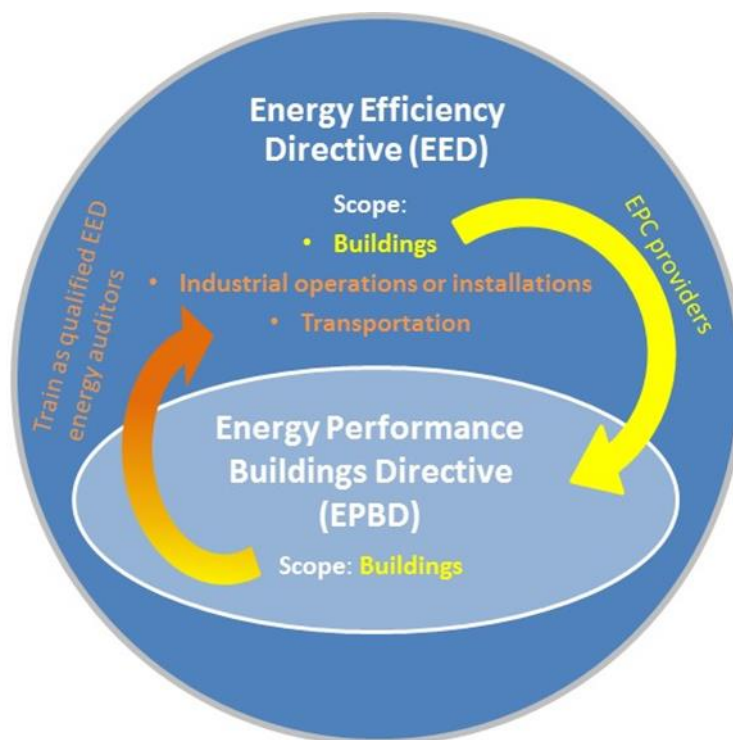
Synergies

Any MS capacity issues around the availability of accredited or qualified auditors could be addressed through the provision of additional training to auditors not currently meeting the national qualification criteria, but identified through synergies with existing schemes/requirements.

The Commission's SWD (recital 13) encourages MS to explore possible synergies between developing the legal provisions for the qualification/certification criteria for experts undertaking energy audits in line with Article 8 of the EED and the MS's transposition of the accreditation requirements under the Energy Performance of Buildings Directive (EPBD).

In seeking synergies, MS should consider the differences in scope between the extent of the EED and the EPBD and the likely differences in the skill requirements of experts under each Directive. However, MS should also consider the benefits that mutual recognition or additional training of experts could bring, as represented in Figure 1.

Figure 1: Possible synergies for the provision of 'experts' in energy assessments



By identifying synergies between the auditor requirements of both Directives, MS will be able to more quickly identify a wider pool of potential auditors, and more easily make available the skill sets required, as less training may be required for individuals that already have skills and qualifications in a similar area.

3.1.3 Supervised by independent authorities

Article 8(1) provides MS with options regarding how energy audits are delivered to all final customers. Energy audits can either be:

1. 'carried out in an independent manner by qualified and/or accredited experts according to qualification criteria; or
2. implemented and supervised by independent Member State authorities'.

Audits carried out by qualified and/or accredited experts

Use of in-house auditors

Article 8(1) paragraph 2 states that energy audits may be carried out by in-house experts or energy auditors. However, if in-house experts or energy auditors are to carry out energy audits, the audit will not be truly independent and the MS concerned must put in place provisions to compensate for this, which assure and check the quality of the energy audits. These provisions should include, if appropriate, an annual random selection for review of at least a statistically significant percentage of all the energy audits they carry out (Article 8(1)).

Statistical significance

The statistical basis for sample size determination is well established (Krejcie and Morgan, 1970⁸) and is commonly used to generate tables from which sample sizes can be derived according to desired values for the following parameters:

The confidence level. This means the chance that the true value for the whole population lies outside of the confidence interval for the sample population. The confidence level is a requirement or target that is set for the audit programme and is determined by how important are accurate results for the purpose for which they are to be used. A higher level of confidence requires a larger sample size. A confidence level of 95% is normally used in many social research activities, corresponding to a 5% chance that the true value lies outside the confidence interval. Values under 90% are rarely used.

The confidence interval ("margin of error"). This means the possible range for the true value of the measured parameter, within the whole population, in relation to the survey sample results. For a given set (i.e. number) of sample results, the confidence interval will be wider for a greater required confidence level (if one needs to be 99% sure the true value lies within a particular range, compared say with 95%, then that range must be correspondingly larger). The narrower the required confidence interval then the larger the sample size must be. The confidence interval required will depend on how important precision in the survey parameter is. Social research values of +/- 1% to 5% are typically used.

The following table indicates the sample population size required dependent on confidence interval (margin of error) and confidence level, taken from Research-Advisors⁹, showing the general relationship between these parameters.

⁸ Determining sample size for research activities, Educational and Psychological Measurement 1970, 30, 607-610. R. Krejcie and D. Morgan.

⁹ <http://www.research-advisors.com/tools/SampleSize.htm>

Required Sample Size [†]								
Population Size	Confidence = 95%				Confidence = 99%			
	Margin of Error				Margin of Error			
	5.0%	3.5%	2.5%	1.0%	5.0%	3.5%	2.5%	1.0%
10	10	10	10	10	10	10	10	10
20	19	20	20	20	19	20	20	20
30	28	29	29	30	29	29	30	30
50	44	47	48	50	47	48	49	50
75	63	69	72	74	67	71	73	75
100	80	89	94	99	87	93	96	99
150	108	126	137	148	122	135	142	149
200	132	160	177	196	154	174	186	198
250	152	190	215	244	182	211	229	246
300	169	217	251	291	207	246	270	295
400	196	265	318	384	250	309	348	391
500	217	306	377	475	285	365	421	485
600	234	340	432	565	315	416	490	579
700	248	370	481	653	341	462	554	672
800	260	396	526	739	363	503	615	763
1,000	278	440	606	906	399	575	727	943
1,200	291	474	674	1067	427	636	827	1119
1,500	306	515	759	1297	460	712	959	1376
2,000	322	563	869	1655	498	808	1141	1785
2,500	333	597	952	1984	524	879	1288	2173

Determining if a sample size is statistically significant for a given population will depend on the desired confidence level and the tolerable margin of error.

In line with Article 8(1) paragraph 2, if MS deem it appropriate to select a sample of energy audits undertaken by in-house experts or energy auditors for quality review, the selection should be random.

MS must decide whether to allow audits by in-house energy auditors to meet the requirements of their national legislation. If in-house auditors are allowed, the MS may wish to specify certain criteria to maintain a degree of independence – for example, that the auditor must be independent of the particular process or operation to be audited.

Supervision of auditor qualification

Dependent on a MS's decision to permit qualified experts, in addition to or instead of accredited experts, the MS should implement a scheme to check the experts meet, and continue to meet, the qualification criteria.

A MS supervision scheme could include provisions around:

- The observation of in-house experts and energy auditors undertaking an energy audit ('witness audits')
- Provision of references for audits undertaken with a recent. Defined, time period
- Checks on:
 - o Staff / individual qualifications (including validity, scope coverage etc.)
 - o Documentation of, and adherence to, formalised audit processes

- o Record keeping and document retention/storage
- Re-assessment of skills through an exam

'Accreditation', if in line with EU Regulation 765/2008¹⁰, will include a degree of supervision and/or checking of technical competence. Accreditation, by definition, is a public authority activity. Thus MS that permit only accredited experts to carry out energy audits will already indirectly be assuring and checking the quality of energy audits through the initial accreditation and re-accreditation of experts.

However, accreditation according to Regulation 765/2008 is normally provided to legal rather than natural persons. Qualification should therefore only apply to cases where a natural person aims to become active as an expert for the purpose of undertaking energy audits adhering to the MS transposition of Article 8 of the Directive.

Audits implemented and supervised by independent authorities under national legislation

Energy audits may be implemented by independent authorities under national legislation. Supervision of the work and energy audits undertaken by the independent authority, or authorities, should be carried out by a suitably independent supervisory body – i.e. free from outside control or influence – to assure and check the quality of energy audits.

Exemptions to undertaking energy audits in line with Article 8(4)

MS must also supervise the quality of energy audits carried out under voluntary agreements (Article 8(5)) or carried out as part of an energy management system (Article 8(6)), as these provide an exemption for large enterprises to undertake an energy audit in line with Article 8(4). This is clarified in recital 37 of the Commission's SWD on Article 8.

The Commission's SWD, recital 12, encourages MS to look at synergies in utilising the national supervisory authorities empowered under national legislation in transposing the requirements of the EPBD.

Identification of large enterprises

Under Article 8(4), large enterprises (that are not SMEs) must carry out energy audits every four years. Referring to this obligation on large enterprises, the Commission's SWD on Article 8, recital 19, states that '*Member States have to identify the enterprises that fall under this obligation.*'

MS must therefore determine a means of identifying the enterprises located and/or operating within their jurisdiction that meet the EU definition of a large enterprise (non-SME).

The definition of an 'SME' is defined in Title I of the Annex to Commission Recommendation 2003/361/EC of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises:

The category of micro, small and medium-sized enterprises (**SMEs**) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.

¹⁰ Regulation 765/2008 provides the EU definition of "accreditation".

As such, a large enterprise is any enterprise not meeting the definition of an SME according to the European Commission. Examples of this are provided below.

	Company 1	Company 2	Company 3
Number of employees	200	286	345
Annual turnover (EUR m)	57	49	65
Annual balance sheet (EUR m)	46	40	53
Determination	SME	SME	Large enterprise

MS may have a list of large enterprises, or be able to identify large enterprises, by reference to financial / tax reporting records, stock market records, or other reporting by businesses located and/or operating in the MS. This list should ultimately be used to assess which enterprises within the MS should comply, and have complied with, the requirements of Article 8.

3.1.4 European and international standards

MS national minimum criteria for energy audits are not required to be more far reaching than the requirements of applicable European and international standards on energy management or energy auditing. Indeed, such standards can provide a useful basis for the development of national minimum criteria in line with Annex VI. MS may therefore wish to refer to these in developing their national minimum criteria.

Relevant European or international standards include:

- EN ISO 50001 (Energy management) – For energy audits carried out as part of an energy management system
- EN 16247-1 (Energy audits)
- EN ISO 14001 (Environmental management) – Where the management system includes an energy audit

European and international standards represent accepted best practice around energy management and auditing. Thus, the adherence to such standards can assist in assuring the quality of energy audits provided to all final customers in line with Article 8.

The chapters and clauses of relevant European and international standards could be used as the basis for defining national minimum criteria, as they include various provisions and requirements to guarantee the quality of the management system and/or energy audit being implemented. Energy audits should take into account such standards. Examples of this are provided below.

Table 1: Structures of European and international standards

ISO 50001:2011		EN 16247-1		ISO 14001:2004	
Energy Management		Energy Audits		Environmental Management	
<i>Clause</i>	<i>Criteria</i>	<i>Clause</i>	<i>Criteria</i>	<i>Clause</i>	<i>Criteria</i>
-	Foreword	-	Foreword	-	Foreword
-	Introduction	-	Introduction	-	Introduction

1	Scope	1	Scope	1	Scope
2	Normative references	2	Normative references	2	Normative references
3	Terms and definitions	3	Terms and definitions	3	Terms and definitions
4	Energy management system requirements	4	Quality requirements	4	Environmental management system requirements
4.1	General requirements	4.1	Energy auditor	4.1	General requirements
4.2	Management responsibility	4.1.1	Competency	4.4.1	Resources, roles, responsibility and authority
4.2.1	Top management	4.1.2	Confidentiality	4.4.1	Resources, roles, responsibility and authority
4.2.2	Management representative	4.1.3	Objectivity	4.2	Environmental policy
4.3	Energy policy	4.1.4	Transparency	4.3	Planning
4.4.	Energy planning	4.2	Energy audit process	4.3.2	Legal and other requirements
4.4.1	General	5	Elements of the energy audit process	4.3.1	Environmental aspects
4.4.2	Legal requirements and other requirements	5.1	Preliminary contact	4.3.3	Objectives, targets and programme(s)
4.4.3	Energy review	5.2	Start-up meeting	4.4	Implementation and operation
4.4.4	Energy baseline	5.3	Collecting data	4.4.6	Operational control
4.4.5	Energy performance indicators	5.4	Field work	4.4.2	Competence, training and awareness
4.4.6	Energy objectives, energy targets and energy management action plans	5.4.1	Aim of field work	4.4.3	Communication
4.5	Implementation and operation	5.4.2	Conduct	4.4.4	Documentation
4.5.1	General	5.4.3	Site visits	4.4.5	Control of documents
4.5.2	Competence, training and awareness	5.5	Analysis	4.4.6	Operational control
4.5.3	Communication	5.6	Report	4.5	Checking
4.5.4	Documentation	5.6.1	General	4.5.1	Monitoring and measurement
4.5.4.1	Documentation requirements	5.6.2	Content of report	4.5.2	Evaluation of compliance
4.5.4.2	Control of documents	5.7	Final meeting	4.5.5	Internal audit
4.5.5	Operational control			4.5.3	Nonconformity, corrective action and

					preventive action
4.5.6	Design			4.5.4	Control of records
4.5.7	Procurement of energy services, products, equipment and energy			4.6	Management review
4.6	Checking				
4.6.1	Monitoring, measurement and analysis				
4.6.2	Evaluation of compliance with legal requirements and other requirements				
4.6.3	Internal audit of the EnMS				
4.6.4	Nonconformities, correction, corrective action and preventive action				
4.6.5	Control of records				
4.7	Management review				
4.7.1	General				
4.7.2	Input to management review				
4.7.3	Output from management review				

3.1.5 Timeliness of energy audits and data

Frequency of energy audits

Article 8(4), regarding energy audits by large enterprises, states that such enterprises must carry out an energy audit '*at least every four years from the date of the previous audit*'.

Although defining a minimum frequency for energy audits does not assure the quality of a single energy audit, it assures that large enterprises regularly assess their assets and activities to identify possible energy efficiency or energy reduction opportunities. This is particularly important if the nature of an activity or use/construction of an asset changes.

The rapid advancement in certain energy efficiency technologies and the downward trajectory of unit prices for such technologies means that such solutions can become cost-effective over short timescales and therefore be a viable energy audit finding/recommendation in the near future.

MS must require that their large enterprises carry out energy audits at four year intervals as a minimum. However, they may wish to provide further guidance on the frequency and timing of these audits within the four year period, based on alignment

to business priorities. For example this may include taking into account factors such as building lease length and planned technology refreshes.

Timeliness of energy audit data

Annex VI states, in guideline (a), that energy audits should be based on '*up-to-date*' data.

It is important to use up-to-date data to inform an energy audit. Analogous with the frequency upon which energy audits are undertaken, it is especially important to use up-to-date data if the nature of an activity or use/construction of an asset has changed or changes regularly, to be able to identify technologically and economically viable audit recommendations.

MS should therefore define the lifespan of data that can be used to inform energy audits carried out - See section 4.1.

3.2 Cost-effective energy audits

Article 8 states that all energy audits promoted by MS shall be '*cost-effective*'.

Cost-effectiveness relates the known or perceived value of the outputs with the known or perceived value of the inputs.

E.g. comparing the total cost saving of all energy saving measures identified during an energy audit against the time and capital outlay in undertaking the audit.

The cost-effectiveness of energy audits can have a negative impact on audit quality, where it is allowed to be, or becomes, the primary driver. The requirement for MS to develop transparent and non-discriminatory national minimum criteria based on Annex VI should prevail over the requirement to ensure that energy audits are cost effective, to guarantee the high-quality of energy audits. However, MS should seek to strike a balance between the cost-effectiveness of energy audits and quality.

MS could look at various options to make energy audits cost-effective for all final customers, including:

1. Exploring synergies between the transposition and implementation of Article 8 of the Energy Efficiency Directive and existing national legal provisions, such as for the transposition and implementation of the ESD and/or the EPBD. Synergies may be possible by utilising existing:
 - a. Independent national supervisory authorities
 - b. Qualification criteria for accredited / qualified experts
 - c. Accreditation / qualification schemes

By reducing the costs associated with auditor training in this way, it may be possible to reduce the average cost of an energy audit.

2. Permitting and defining, within the national minimum criteria, acceptable energy audit sampling levels for final customers with multiple assets and/or activities. By reducing the number of audits that are required to be carried out, cost-effectiveness will be improved. See Section 4 for further information on setting sampling levels.

3.3 Independent energy audits

Article 8 states that energy audits shall be carried out by qualified and/or accredited experts in an '*independent manner*'.

In-house experts and qualified and/or accredited experts carrying out energy audits must be free from outside control or influence and able to conduct their work without interference or obstruction.

Energy audits may be undertaken by in-house experts or external energy auditors. Recital 25 of the Directive states that '*Where energy audits are carried out by in-house experts, the necessary independence would require these experts not to be directly engaged in the activity audited.*' As such, MS should require that an in-house expert shall not undertake an energy audit of the industrial process, industrial or commercial operation or installation, or a private or public service they are ordinarily engaged with – e.g. the individual's normal place of work.

The Commission's SWD, recital 12, encourages MS to look at possible synergies between Article 8 of the Energy Efficiency Directive and Article 17 of the Energy Performance of Buildings Directive EPBD regarding *independent experts*.

Article 17, Energy Performance of Buildings Directive¹¹

Independent experts

Member States shall ensure that the energy performance certification of buildings and the inspection of heating systems and air-conditioning systems are carried out in an independent manner by qualified and/or accredited experts, whether operating in a self-employed capacity or employed by public bodies or private enterprises.

Experts shall be accredited taking into account their competence.

Member States shall make available to the public information on training and accreditations. Member States shall ensure that either regularly updated lists of qualified and/or accredited experts or regularly updated lists of accredited companies which offer the services of such experts are made available to the public.

Good practice in guaranteeing independent energy audits

A number of MS have prescribed in their national legislation that energy audits can be undertaken by internal or external experts. For example, this includes the UK, Denmark, France, Ireland, Malta and the Netherlands.

In MS where the use of internal experts is permitted, many have excluded internal experts from conducting energy audits of the asset(s) or activity/activities that they have day-to-day involvement with (e.g. as the site manager of asset 'X') so as to facilitate independence and objectivity in the energy auditing process.

Other MS have specifically stated that the use of internal staff for auditing is not allowed. This is the most effective way to ensure that all audits are undertaken in a truly independent manner.

¹¹ DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings. Official Journal of the European Union, L 153/13

3.4 Transferrable findings from energy audits

The findings from energy audits must be transferrable to any qualified/accredited energy service provider.

This includes any qualified/accredited experts (in-house experts or energy auditors) undertaking a subsequent energy audit, as well as energy service providers acting under the final customers' direction to implement an energy audit finding/recommendation.

Furthermore, energy audits must specifically not include clauses preventing the findings of an energy audit from being transferred, unless the final customer objects.

MS should take steps to facilitate the fulfilment of this requirement. They may consider providing specific training for energy auditors on the requirement for contracts not to include clauses preventing the transferring of energy audit findings and how to handle customer objections or requests to limit the transferring of such findings.

MS authorities implementing and/or supervising the quality of energy audits should undertake checks to confirm that energy audit contracts do not include clauses preventing the transfer of energy audit findings, unless a limitation has been included for a valid reason requested by the final customer. Such checks could be undertaken at the same time as wider quality checks of audits.

3.5 Interactions with other auditing schemes and systems

To meet the minimum criteria in Annex VI energy audits can be provided as 'standalone' audits or as part of broader energy management systems.

3.5.1 Energy and environmental management systems

Large enterprises implementing an Energy Management System (EnMS) or an Environmental Management System (EMS), which includes an energy audit meeting the minimum criteria in Annex VI, are exempt from carrying out standalone energy audits.

As outlined in the Commission's SWD, recital 38, 'the minimum criteria in Annex VI are not more far reaching than the requirements of the relevant European or International Standards.'

As such, audits undertaken in line with recognised European or international standards for energy/environmental management systems are considered to meet the minimum criteria of Annex VI. EN ISO 50001 (Energy Management Systems), and specifically EN ISO 50002 (Energy audits), outline processes to deliver high-quality energy audits.

Although not an energy management system and so not in line with the criteria in Annex VI, audits implemented under EMS certified to the EN ISO 14001 (EMS) standard may be seen as meeting the criteria provided the system includes an energy audit.

MS should provide clear guidance to enterprises to describe the circumstances in which these exemptions can be applied. This should include reference to the proportion of the enterprise covered by the EMS or EnMS. In circumstances where the system does not cover all of the enterprise's operations, additional audits of the operations not covered may need to be carried out in order to comply with regulations.

3.5.2 Voluntary agreements

Article 8(2) and Article 8(5) make reference to voluntary agreements concluded for both SMEs and large enterprises respectively:

Article 8(2) paragraph 2:

*'On the basis of transparent and non-discriminatory criteria and without prejudice to Union State aid law, Member States may set up support schemes for SMEs, including if they have concluded **voluntary agreements**, to cover costs of an energy audit and of the implementation of highly cost-effective recommendations from the energy audits, if the proposed measures are implemented.'*

Article 8(5) paragraph 1:

*'Energy audits shall be considered as fulfilling the requirements of paragraph 4 when they are carried out in an independent manner, on the basis of minimum criteria based on Annex VI, and implemented under **voluntary agreements** concluded between organisations of stakeholders and an appointed body and supervised by the Member State concerned, or other bodies to which the competent authorities have delegated the responsibility concerned, or by the Commission.'*

Energy audits carried out under national voluntary agreement schemes can count as compliance with the requirements of Article 8, if they are independent and meet the minimum criteria outlined in Annex VI. As such, the same criteria and supervision must be applied to audits undertaken under voluntary agreements, where an enterprise is mandated to conduct audits.

MS should review the scope and requirements of national voluntary agreement schemes against those of Article 8 and Annex VI to identify possible areas of misalignment or shortfall on the part of the voluntary agreement, such as around:

- **Confirming compliance:** For large enterprises under a voluntary agreement, how will compliance with Article 8(4) and the minimum criteria in Annex VI be assessed?
- **Scope:** Does the voluntary agreement define energy in the same way as the EED? Article 2(1) of the EED defines energy as meaning “*all forms of energy products, combustible fuels, heat, renewable energy, electricity, or any other form of energy, as defined in Article 2(d) of Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics*”
- **Audit frequency:** If the voluntary agreement includes large enterprises and an existing requirement to undertake energy, does the required frequency meet the minimum requirement for audits to be undertaken every four years from the date of the previous audit?
- **Transfer arrangements:** What happens if an enterprise enters or leaves a voluntary agreement? How will large enterprises leaving a voluntary agreement be made aware of the requirement to undertake energy audits in line with Article 8(4)?
- **Penalties:** Is the penalty regime implemented under the voluntary agreement sufficient to act as a deterrent and encourage compliance?

In cases where voluntary agreement audits do not meet the requirements of Annex VI, they cannot automatically be used to comply with Article 8. In these cases MS may wish to consider whether arrangements can be put in place to bridge the gap in audit

criteria. For example, this may include amending legislation to increase the frequency at which audits under the voluntary agreements are required to at least four years.

3.5.3 Industrial emissions schemes

Participation in national or international schemes, either on a voluntary or mandatory basis, on the monitoring and/or reporting of industrial emissions does not exempt a large enterprise from the requirement to comply with Article 8(4) of the EED and from undertaking energy audits meeting at least the national minimum criteria based on Annex VI.

Such schemes would include, for example, mandatory schemes such as the EU Emissions Trading System (EU ETS) or the UK's CRC Energy Efficiency Scheme (CRC) and voluntary reporting schemes such as the Carbon Disclosure Project (CDP).

However, energy data collected under such schemes may be a useful source for informing energy audits undertaken in line with Article 8. As such, MS may wish to consider developing national minimum criteria for energy audits that, whilst meeting the minimum requirements of Annex VI, also seeks to take advantage of possible synergies with existing national or international schemes. This will help to streamline national legislation, as well as improving the cost-effectiveness of audits for enterprises that are required to participate in more than one national scheme. In order to help enterprises to take advantage of such circumstances, MS may wish to issue guidelines.

4. Audit composition

Annex VI of the EED sets out the minimum criteria for energy audits and so prescribes the audit 'composition'; the composition referring to both the required scope and content of energy audits.

This section explains each of the criteria of Annex VI, and how MS should account for these when setting their national minimum criteria for audits.

4.1. Up-to-date, measured and traceable data

Guideline (a) of Annex VI states that energy audits shall "be based on up-to-date, measured, traceable operational data on energy consumption and (for electricity) load profiles". The following sections look each of these aspects in turn and what they mean for setting MS criteria.

Up-to-date

The energy consumption data used as the basis of an energy audit should be representative of the current and recent operation of the audited operation. What constitutes up-to-date data is dependent on the rate of change of the operation. For example, if a building was upgraded 18 months prior to the proposed date of an energy audit, and new energy using equipment or insulation/building materials were installed as part of that upgrade, energy consumption data from between 36 and 24 months prior to the audit date cannot be considered as being up-to-date. This is because it is not representative of current operations, which would limit the applicability of the audit findings.

MS should define criteria around what constitutes up-to-date data, in line with the guidance provided in the Commission's SWD on Article 8¹².

Good practice in defining 'up-to-date' data

It is considered good practice for MS to put in place some form of limitation on the use of historical data for energy audits, due to the rate of advancement of energy saving and data technologies that may make such data less representative and/or less reliable.

For example, the UK has implemented a limitation on the use of data that requires that data must not be greater than 24 months old on the commencement of the energy audit. This requirement was put in place to ensure that the data used in energy audits is up-to-date; in line with guideline (a) in Annex VI.

Measured

The energy consumption data used as the basis of an energy audit should be measured, where the data is either obtained directly from a measurement instrument

¹² European Commission's Article 8 guidance note (SWD (2013) 447) to EU MS officials: <https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive>

or calculated from readings displayed on a measurement instrument. As such, data should **not** be calculated solely without reference to measurements taken from a measurement instrument, for example an electricity meter or fuel gauge.

The Directive does not specify a list of accepted measurement instruments for the measurement of energy consumption data. However, in line with good practice, energy consumption data should be measured in a consistent way to determine an accurate and true picture of energy consumption over a given period of time.

MS may choose to add additional criteria around what constitutes measured data, in line with the guidance provided in the Commission's SWD on Article 8. This might include, for example, specific requirements regarding measurement instrument types.

What if measured data is not available?

Final customers may not have a continuous period of measured data on energy consumption, due to interruptions such as meter errors / failures or lost records (e.g. invoices or delivery notes). A period without measured data is often referred to as a 'data gap'.

It is good practice for MS to consider defining a permissible option, or number of options, for addressing data gaps, such as through the use of estimation techniques or contacting the energy supplier for the missing data.

If a MS chooses to allow the use of estimated data to inform energy audits, MS should consider whether to allow the unrestricted use of estimated energy consumption data. It is good practice to define the techniques that can be used to estimate data to safeguard that, overall, data are broadly representative and accurate. Such techniques may include:

- **Direct comparison** – The use of data from a historical and equal time period to estimate the data for the data gap (e.g. using last months' consumption).
 - *Considerations in using this technique:* Seasonal and/or other variations impacting the rate of energy consumption need to be considered in selecting a suitable historical time period to use. MS may wish to also consider a limitation of the use of historical data that exceeds a given timeframe from the audit date (e.g. the start/end date of the historical period cannot be greater than 24 months from the start/end date of the data gap).
- **Pro-rata** – The extrapolation of measured data from a time period that is shorter than the data gap to estimate the data for the data gap (e.g. using an average daily energy consumption, calculated from measured data and multiplied by the number of days for the data gap, to determine a total consumption for the data gap)
 - *Considerations in using this technique:* Seasonal and/or other variations impacting the rate of energy consumption need to be considered in selecting a suitable period to calculate the daily average.
- **Energy benchmarks** – The use of data for a known parameter to construct an energy intensity ratio to calculate the data for the data gap (e.g. kWh per unit of floor area)
 - *Considerations in using this technique:* This technique requires the calculation of an energy intensity ratio. This could be constructed from the asset/activity for which there is a data gap or another assets or activity, or number of assets/activities. If the latter, the

suitability and representativeness of the other assets or activities should be evaluated to ensure accurate data for the data gap.

It is also good practice to implement a time limitation on the use of estimated data – i.e. the permissible size of data gaps – to ensure that the majority of a data set is based on measured data.

Traceable

Energy consumption data must be traceable; meaning that the energy consumption data must be supported by verifiable, formal records that document the energy used.

The Directive does not specify what constitutes traceable energy consumption data and records or how long the records must be retained.

Data used to inform energy audits, such as summaries of energy consumption, should be traceable back to its primary source and the measurement device it was recorded by. For example, this might be an invoice for gas that documents the associated meter number. As outlined in section 3.1.2, energy audits must be supervised by MS authorities including, if appropriate, an annual random selection of energy audits carried out by in-house experts or energy auditors for review. Such a review would be expected to include cross-checking of energy data against its primary source.

Traceable records would not be expected to include aggregated data on energy consumption representing more than one point of supply, where the aggregated data is not substantiated by the actual primary data at the time of measurement.

MS may choose to add additional criteria around what constitutes traceable data, in line with the guidance provided in the Commission's SWD on Article 8.

Tracing data during a check on energy audit compliance

If a MS decides it is appropriate to undertake an annual random selection of energy audits carried out by in-house experts or energy auditors to check compliance with the national minimum criteria, it is good practice for the authorities involved to undertake a sample check of energy consumption data. This would include tracing back to the primary data source if the data is first provided in a summary / aggregated format.

For example, initially the MS may request a summary of the energy consumption data, which may be retained electronically in Microsoft Excel or a similar program. To ensure the MS check is not overly burdensome on either the final customer or energy auditor, the MS authority may then wish to select a sample of energy supply points (e.g. electricity or gas measurement devices) and request the associated primary data sources used to construct the Excel summary. These may be the invoices from the energy supplier in non-editable electronic copy (e.g. PDF) or hard copy.

In this example, the retention of the Excel summary and the invoices means that the data is traceable and can be cross-checked for accuracy against its original source.

4.1.1 Load profiles for electricity

A load profile (or load curve) is a chart illustrating the variation in demand/electrical load, typically in kW, over a specific period of time.

At the macro-scale, power generation companies use this information to plan how much power they will need to generate at any given time. On a smaller-scale, the

load profile of a specific asset shows how electrical demand changes over time, partly driven by the combined electrical rating of all equipment within the asset (often referred to as base load) and partly driven by the nature of the operation of the electrical equipment.

If constructed and analysed correctly, electrical load profiles are useful tools to use during an energy audit, as they allow for the identification of trends in electrical demand.

4.2. Energy consumption profiles

Guideline (b) of Annex VI states that energy audits shall “comprise a detailed review of the energy consumption profile of buildings or groups of buildings, industrial operations or installations, including transportation”.

Patterns of energy usage, derived from interval energy data, are often referred to as energy consumption profiles. Understanding patterns of energy consumption within a building or group of buildings, industrial operations or installations and transportation can assist in the identification of energy wastage and therefore the identification of energy saving opportunities.

The granularity of the energy consumption profile is driven by the temporal resolution of the energy data. To be able to identify patterns in energy usage over time and understand what equipment, action or behaviour is driving the energy demand, the temporal resolution of the energy data (e.g. half hourly electricity meter readings) must be greater than the frequency of change in energy demand (e.g. a production process lasting several hours). If the energy data is available on a less frequent basis than the change in energy demand, the energy data may mask a trend in the energy data and hide an energy saving opportunity. As such, improving the temporal resolution of energy data is itself a common recommendation and outcome of energy audits.

Energy wastage can be a constant issue or occur over a defined and varied time interval, from a few seconds to several months or longer. As such, it is good practice for energy auditors to look at energy consumption profiles over a suitably long period of time to take into account changes in energy demand – e.g. such as seasonal changes in heating, ventilation and air conditioning (HVAC) energy demand that are largely driven by changes in the outside air temperature.

As such, MS may choose to add additional criteria around what constitutes an acceptable energy consumption profile for the basis of an energy audit.

4.3. Life-cycle cost analysis

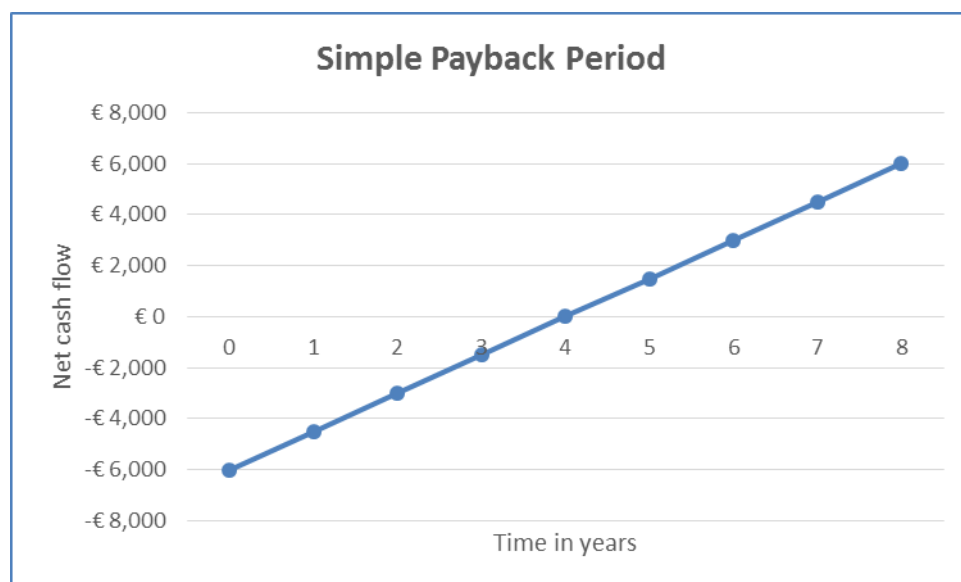
Guideline (c) of Annex VI states that energy audits shall “build, whenever possible, on life-cycle cost analysis (LCCA) instead of Simple Payback Periods (SPP) in order to take account of long-term savings, residual values of long-term investments and discount rates”.

Life-cycle cost analysis (LCCA) is a tool to determine the most cost-effective option when comparing the business as usual (BAU) case against different and competing alternative measures to purchase, own, operate, maintain or dispose of an energy using asset or process.

LCCA should be used when each alternative option is equally appropriate to be implemented on technical grounds. Energy audits should, whenever possible, build on LCCA over simple payback periods (SPP). A simple payback period calculation

typically only considers the initial capital expenditure (CapEx) of the energy saving measure being considered and the rate of return on investment, usually expressed as a financial saving over a chosen time interval (e.g. € per annum), to determine the cumulative cash flow and financial break-even point.

Figure 2: Example of a simple payback period (SPP) calculation



CapEx cost:	€ 6,000
Saving (per annum):	€ 1,500

Year:	0	1	2	3	4	5	6	7	8
Cumulative cash flow:	-€ 6,000	-€ 4,500	-€ 3,000	-€ 1,500	€ 0	€ 1,500	€ 3,000	€ 4,500	€ 6,000

It may be more appropriate to use LCCA when there are other financial variables and other considerations to take into account in determining the rate of return on investment and the break-even point. The financial variables are likely to include both costs and benefits, such as installation costs (including the possible disposal of redundant equipment), on-going maintenance costs, subsidies due or taxes payable, interest charges on financial loans and the residual value of any equipment. Other considerations may include the lifespan of any new equipment.

LCCA takes into account all of the cost and benefits of the BAU case and the alternative measure case being analysed and determines the net present value (NPV) of both. The NPV is the sum of all future cash flows, both incoming and outgoing. By comparing the NPV of both cases, you can assess the net benefit of the proposed alternative measure.

For long term investments, it may also be important to consider discounting and the discount rate. Discounting is used within investment finance and LCCA to understand "How much money would have to be invested currently, at a given rate of return, to yield the cash flow in the future?" The discount rate is generally the appropriate weighted average cost of capital (WACC) and will vary from company to company depending on how they typically fund investments, either through debt (e.g. loans) or

equity. The discount rate is expressed as a percentage and applied to the net cash flow over the lifespan of an investment.

By applying a discount rate, it is possible to determine the net discounted benefit of the proposed alternative measure, which is considered a better indicator of the overall benefit of an investment.

Table 3: Scoping of an LCCA

Scenario 1 - Business as usual	Unit	Scenario 2 - New investment	Unit
Analysis Lifespan		Analysis Lifespan	
5	years	5	years
Operating Energy Demand		Operating Energy Demand	
200	kW	200	kW
Utilisation		Utilisation	
30%	Percentage	30%	Percentage
Efficiency		Efficiency	
78%	Percentage	94%	Percentage
Capital Cost		Capital Cost	
0	€	€ 18,000	€
Installation Cost		Installation Cost	
0	€	€ 4,000	€
Maintenance Cost		Maintenance Cost	
15	€ per kW	10	€ per kW
Fuel Cost		Fuel Cost	
0.03	€ per kWh	0.03	€ per kWh
Energy Tax		Energy Tax	
0.002	€ per kWh	0.002	€ per kWh
Subsidy Received		Subsidy Received	
0	€ per kWh	0	€ per kWh
Residual Value		Residual Value	
0	€	10,000	€

Table 2: Analysis by year over the investment lifespan

Analysis by year						
Years	0	1	2	3	4	5
Scenario 1: business as usual						
Capital	-	-	-	-	-	-
Installation	-	-	-	-	-	-
Maintenance	-	€3,000	€3,000	€3,000	€3,000	€3,000
Fuel	-	€20,215	€20,215	€20,215	€20,215	€20,215
Energy tax	-	€1,348	€1,348	€1,348	€1,348	€1,348
Subsidy received	-	€0	€0	€0	€0	€0
Residual value	-	-	-	-	-	-
Total	€0	€24,563	€24,563	€24,563	€24,563	€24,563
Scenario 2: new investment						

Capital	€18,000	-	-	-	-	-
Installation	€4,000	-	-	-	-	-
Maintenance	-	€2,000	€2,000	€2,000	€2,000	€2,000
Fuel	-	€16,775	€16,775	€16,775	€16,775	€16,775
Energy tax	-	€1,118	€1,118	€1,118	€1,118	€1,118
Subsidy received	-	€0	€0	€0	€0	€0
Residual value	(€5,000)*	-	-	-	-	(€5,000)
Total	€18,000	€19,893	€19,893	€19,893	€19,893	€19,893

* The residual value in Year 0 under the new investment scenario (scenario 2) is the residual value of the old equipment being replaced.

Table 5: Net present value and the net discounted benefit

Net present value	
Discount rate	6%
Business as usual scenario	£103,469
New investment scenario	£97,059
Net discounted benefit of new investment vs business as usual	£6,409

4.4. Proportionate and representative audits

Audit coverage

Guideline (d) of Annex VI states that energy audits shall “be proportionate, and sufficiently representative to permit the drawing of a reliable picture of overall energy performance and the reliable identification of the most significant opportunities for improvement”.

Annex VI prescribes that energy audits should be proportionate to the enterprise concerned and its assets and operations. As such, and in line with the requirements of Article 8, MS should consider appropriate national minimum criteria for audits carried out by or on behalf of large enterprises and, separately, audits carried out by or on behalf of SMEs.

To safeguard that energy audits are proportionate to both the enterprise and the scale of the possible energy savings, MS may choose to add additional criteria around the optional exclusion of some energy as part of a de minimis.

Choosing whether to set a de minimis

Some MS have included provisions, within their transposition of Article 8 into national law, to allow enterprises to exclude a proportion of their energy use from audit. This is known as the de minimis. For example, the UK has allowed for up to 10% of a large enterprise’s energy consumption not to be subject to an energy audit.

Large enterprise have a high degree of flexibility in how they apply the de-minimis. It may choose to omit energy consumption at a group level (if applicable), organisational level, fuel level or supply point level. This flexibility ensures that large enterprises are not overly burdened in having to account for energy consumption that may be immaterial or difficult to quantify / measure. It may also allow for the exclusion of certain operations where it is known that there is minimal opportunity to reduce

energy consumption, thereby improving the cost-effectiveness of the audit.

Other MS have chosen to encourage enterprises to improve their data records and audit coverage over time, by implementing a progressively more stringent de minimis e.g. France allows a 35% de minimis in the first part of the national scheme and 20% thereafter.

MS can also choose not to provide for any de minimis, setting a practice that requires all operations to be included in an audit. Whilst this option appears to maximise the potential to identify energy saving opportunities, it may be at the expense of creating a framework for cost-effective audits.

Representative sampling approaches to audits

Energy audits must be sufficiently representative to permit the drawing of a reliable picture of overall energy performance. As such, the national minimum criteria implemented by MS should clarify that, at the highest level, an enterprise is required to systematically undertake energy audits of all of its energy related aspects including buildings or groups of buildings, industrial operations or installations and transportation.

As stated in guideline (b) of Annex VI, an energy audit may be undertaken for a *group of buildings*. This may include allowing enterprises to audit a sample of their operations and scale-up the findings across a wider group of similar operations e.g. auditing 3 out of 10 office buildings that are all of a similar size, age and construction type. In this example, it could be assumed that audit findings would be applicable across all ten offices and total savings potential for the approaches could be determined by scaling up the results of the three audits. This approach reduces the effort required to audit operations and improves cost-effectiveness of auditing.

Enterprises may have several identical or largely similar assets or undertake similar operations in differing geographical locations. MS may therefore wish to consider putting in place guidelines regarding how sampling assets or operations as part of an energy audit, or number of audits, can be used to ensure that the energy audit(s) are representative of the overall energy performance of the enterprise through the extrapolation of the audit findings and recommendations. Using sampling, an energy audit may include a statistically significant and representative number of detailed audits of the sampled assets/operations (including or excluding a visit to the asset) and a higher level overview of all the assets or the full scope of the operation.

Good practice around representative sampling for audits

MS such as Finland¹³, the UK¹⁴ and France¹⁵, have put in place guidelines around appropriate approaches to sampling, including defining what constitutes an appropriate sample size. This helps to define a minimum standard for auditing, but also increases the risk that enterprises will only ever audit the minimum number of operations in a sample group. In cases where sampling is allowed, but no minimum sample size is defined, MS should require that enterprises are able to supply justification to support their chosen sample size.

¹³ Ministry Of Justice (2014): Government Regulation of Energy Audits 20/2015 Section 3. <https://www.finlex.fi/fi/laki/ajantasa/2015/20150020>

¹⁴ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/435845/DECC_Approaches_to_ESOS_audits_guide_FINAL_20_03_15_amended.pdf

¹⁵ Decree 2014-1393 (2014): Rules for implementation of the energy audit. <http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000029799204&dateTexte=&categorieLien=id>

The UK guidance provides examples, on the parameters that large enterprises in certain sectors should take into consideration when creating an audit sampling plan for site visits, to ensure that the findings from the audit site visits undertaken are representative of all the enterprise's assets and activities. This guidance is designed to help enterprises to create sample groups of similar operations. Parameters to consider may include the size, age, and nature of a particular building, operation or process. Other factors to consider include building fabric, vehicle type and usage patterns.

The guidance directs large enterprises to consider the uniqueness of, or commonality between, assets and activities, which should lead them to defining their own representative sample of audit site visits.

4.5. Detailed and validated calculations

Annex VI states that *"Energy audits shall allow detailed and validated calculations for the proposed measures so as to provide clear information"*.

In undertaking an energy audit, the energy auditor or in-house expert should undertake and retain detailed calculations of the financial costs/benefits and energy saving potential of identified and proposed measures presented as an outcome of the energy audit. Detailed in this case refers to documenting all steps of the calculation process as well as recording the data sources used and any assumptions that may have been applied. MS may wish to provide example calculations in their own guidelines to demonstrate the level of detail that is expected to be recorded.

The auditor or in-house expert should also validate the calculations undertaken. MS may choose to add additional criteria around what validation checks are undertaken, and who does them. For example, whether validation checks should be carried out by an independent third party, and what the qualification requirements of that third party should be. The extent of the validation checks to be carried out should also be defined e.g. whether calculations should be validated against primary data sources.

In line with Article 8(1) paragraph 4, energy audit findings shall *"not include clauses preventing the findings of the audit from being transferred to any qualified/accredited energy service provider"*. As such, it is important that the energy service provider has provided the enterprise it is acting on behalf of with access to detailed calculations and all other data used as part of the audit. This will allow the enterprise to retain the ability to freely select an alternative energy services provider in the future, without being dependent on the services of its original provider.

In defining national minimum criteria, MS should consider:

- What are the minimum requirements for audit calculations?
 - Should the calculations be required to be included in energy audit reports?
- What should the calculations cover?
- What level of depth in the calculation workings is required?
- How should the calculations be validated?
 - How might validation through voluntary agreements and/or energy management systems apply?

4.6. Data storage

The final recital in Annex VI states that *"The data used in energy audits shall be storable for historical analysis and tracking performance."*

As it may be important to check the traceability of energy audit data as part of MS supervision of energy auditing schemes, MS should put in place minimum requirements around the length of time that data used to inform energy audits must be stored for.

Data records may be expected to be in electronic or hard copy format and present the actual data at the time it was measured. MS may wish to define that best practice is the retention of records in an electronic format – this provides a more transferrable data source and protects against issues of damage or degradation.

Requirements around the retention of energy consumption data may be expected to be in line with existing national legislation or requirements laid down by the independent authority/authorities e.g. in accordance with national standards for accounting. MS should also consider whether any national requirements for data security may apply, and what this means in terms of energy data records e.g. do files need to be password protected. Enterprise should also be encouraged to consider their how their own policies on this topic will apply.

As part of good practice, MS should consider setting requirements for the storage of data covering:

- **What data should be stored?** – E.g. is summary data acceptable?
- **What formats are permissible for storing data?** – E.g. is only electronic format acceptable because it must be available remotely?
- **How long data should/must be retained for?** – E.g. is there a national requirement or other accepted minimum for the retention of such data?
- **What data security measures apply?** – E.g. protection of files.

Good practice in setting data storage requirements

The UK requires that data must be retained for the four-year period in which the energy audit was undertaken (linked to the requirement for large enterprises to undertake energy audits every four years) and the following four-year period. As such, data may need to be stored for a maximum of 8 years. This requirement is designed to ensure that in any given four year period, enterprises will always have data available to support their compliance with Article 8.