

Evaluation of the impact of obligatory energy audits for large companies in Germany on improvement of energy efficiency

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ABSTRACT

Following the EU Energy Efficiency Directive of 2012 the German Government implemented a law which specifically targets non-SMEs. All companies and public institutions active in Germany with more than 250 employees or 50 million Euro turnover were obliged to complete an energy audit by the end of 2015 or alternatively to introduce a certified energy management system by the end of 2016. The objective is to improve energy efficiency and to reduce CO₂ emissions. The Ministry assumed that about 50,000 companies or institutions are concerned, but there was no information how many of them met the obligation, which types of measures were implemented, and how much energy was actually saved.

The measure was evaluated recently in order to determine energy savings, reduction of emissions, investment and administrative expenses for the companies as well as effects on the German energy service market. An online survey has been carried out with 900 companies which have completed an energy audit or introduced a certified energy or environmental management system. The results show the quantitative impact of the law in 2015 and 2016 extrapolated to Germany. The questionnaire covered also aspects such as quality of the audits and the audit reports, accomplishment with external or internal experts, elements implemented in management systems, and qualitative impacts, e.g. to attach more attention to energy efficiency in general, to detect main energy consuming equipment or to evaluate energy efficiency measures.

A main result of the evaluation was that most of the companies which have completed an energy audit wouldn't have done it without the law. Companies with management system often had already introduced it before the Act came into force. From a quantitative point of view the law will induce energy savings between 14 PJ and 30 PJ by 2020 which means that the expectations of the German Government have been only partially fulfilled. However it must be taken into account that the evaluation was commissioned at a very early stage after the law entered into force.

Introduction

Within the framework of the EU climate policy the German Government adopted its Energy Concept in September 2010 and decided in June/July 2011 to transform Germany's energy system, the so called "Energiewende" (energy transition). Both have further increased the efforts to improve energy efficiency and reduce CO₂ emissions in all sectors. The ambitious GHG reduction targets aim at a decrease of 40 % by 2020 and 80 to 95 % by 2050 relative to 1990. A further objective is to have an annual increase in energy productivity of 2.1%.

Small and medium-sized enterprises were addressed already in 2008: A program was launched which provides grants for energy audits (Schleich et al. 2015). Large enterprises, so far, were addressed by the European Emission Trading Scheme and the eco-taxation in Germany raising the fuel taxes and a tax on electricity whereby exemptions from this taxation are granted for energy intensive sectors and industries in strong international competition. In addition, some funding programs for energy-saving investments and management systems are available.

In Article 8, the 2012 EU Energy Efficiency Directive established a set of binding measures in order to reach its 20 % energy efficiency target by 2020 (European Commission 2013a). The measures had to be transposed into national law in all Member Countries (Hirzel et al. 2016). In Germany, one of the measures was implemented in 2015 by law (Federal Ministry for Economic Affairs and Energy 2014). It specifically targets non-SMEs according to the EU definition, i.e. companies and public institutions with more than 250 employees or 50 million Euro turnover or a balance sheet exceeding 43 million Euro in total. They are obliged to complete an energy audit according to DIN EN 16247-1 (European Committee for Standardization 2012) by December 2015 and then every four years. The enterprises are exempted from the energy audit obligation if they introduce a certified energy management system according to ISO 50001 (ISO 2011) or EMAS (European Commission 2013b) by the end of 2016.

All large companies active in Germany are obliged, regardless of their legal structure, registered office or their respective business sector. The size of the companies is defined including all sites of the company group, including subsidiaries abroad, but audits are only required for sites which are located in Germany. The energy audit has to cover a minimum share of 90 % of the total energy demand of a company. If companies have a number of similar sites, they can carry out a so-called multi-site audit in a representative number of sites concerning their business and energy usage profile, e.g. supermarkets or banking subsidiaries. A subordinate authority (Federal Office of Economics and Export Control, BAFA) of the Federal Ministry for Economic Affairs and Energy verifies the implementation and can impose a penalty in case of non-compliance.

The German Government assumed that about 50,000 companies or institutions are concerned. However there is a lack of statistics to identify the target group of large enterprises. It was assumed that energy savings of about 50 PJ can be achieved by this measure. The energy audit law was accompanied by many other measures which also concern large enterprises, such as funding schemes for energy efficiency investments, support for cross-cutting technologies and waste heat utilization, Eco tax cap for manufacturing industry if they have introduced an energy management system, Energy Efficiency Networks, and individual energy saving concepts by external energy consultants. This bundle of measures makes it difficult to identify the influence of single measures on increasing energy efficiency.

The audit law does not include an obligation to implement the energy saving measures identified within the audit or by the management system. According to the EU Energy Efficiency Directive the Member States have to provide a comprehensive annual report on energy demand and energy saving. Therefore an evaluation of the effectiveness of the law was commissioned by BAFA in order to provide findings about types of measures carried out as a result of the audit or the management system, achieved energy savings, reduction of emissions, costs and administrative expenses for the companies as well as effects on the Germany energy service market. The paper describes some key results of the study.

Methodological approach

The main basis for determining the effect of the law was an online survey of companies concerned. A link to the questionnaire was sent via e-mail to 10,500 companies of which about 800 were made available by BAFA in an address database with companies who agreed on participating in a survey, and randomly selected 9,700 purchased addresses. There was a satisfactory feedback of 900 companies of which 350 came from the BAFA database. As the total number of companies concerned is

not clearly defined statistical representativeness cannot be applied. Therefore the assessment for Germany was not based on the number of companies but the total energy consumption of large companies per sector.

The questionnaire covered many issues in accordance of the information required by the Ministry. Partially detailed data were required concerning energy demand broken down by energy carriers, data on turnover, economic sector, number of employees, number of subsidiaries and other structural characteristics. In case of subsidiaries the respondents were asked to present data for the whole company as well as for a single site for which they had concrete information in hand, e.g. the energy audit report, in order to record measures identified, saving potentials as well as saving measures carried out. The respondents should also report the areas of measures identified and taken and describe the main important measures in detail. Further questions concerned an assessment of investment and administrative costs, and finally an opinion on the law in general, the information about it and the contact with the authority. The questionnaire covered also aspects such as quality of the audits and the audit reports, accomplishment with external or internal experts, elements implemented in management systems, and qualitative impacts, e.g. to attach more attention to energy efficiency in general, to detect main energy consumers or to evaluate energy efficiency measures.

A number of 13 selected energy audit reports have been evaluated with respect to their quality measured by their compliance with DIN EN 16247-1.

It has to be taken into account that the time available between the public notification of the law and the deadline for the completion of the audit was only eight months. The deadline for the introduction of a management system even was only in December 2016. The survey took place between December 2016 and mid-January 2017. Giving consideration to reinvestment cycles not too many effects can be expected up to now, and the questionnaire therefore also included questions about firmly planned energy saving measures.

Many different sources were used to identify the current energy end-use of large companies and their sites in Germany broken down by 24 subsectors (DESTATIS 2014, 2015, 2016a, 2016b, 2016c, Schlomann et al. 2015). Official statistics on energy end-use distinguishing between SMEs and non-SMEs are not available. In the bottom-up analysis, based on 609 cases with complete data on measures taken and savings achieved, separate calculations were made for individual and affiliated companies. A projection to all sites was necessary when companies have more than one site. The data of each case was intensively checked for plausibility and internal validity. The type of business was considered because the questionnaire often was filled in for an energy-intensive production site whereas other sites of the same company are subsidiaries with low energy demand, e.g. sales offices. Finally an extrapolation of energy saving potentials by the end of 2020 was carried out on the basis of the potentials identified in each case and taking into account the autonomous technical progress and the effects of other relevant policy instruments.

Results

Fulfilment of the obligation and characteristics of large companies

51% of the companies surveyed (462) had completed an audit, 45% (403) had introduced an energy or environmental management system, and 4% (35) did not comply with the law mainly because they are not concerned by it.

Most companies commissioned energy audits after the notification of the law in spring 2015 and received the reports just before the deadline in December 2015. However, almost 30 % fulfilled their duty only in 2016.

Almost half of the companies opting for the alternative solution had already introduced the management system before the law came into force. This means that the reason for introduction was

not the law but mainly the eco tax exemption; the earlier they introduced the management system and the higher their energy intensity the more important was the tax exemption as a reason. Towards the end of the year 2015 and even more in 2016 the number increased again (Figure 1).

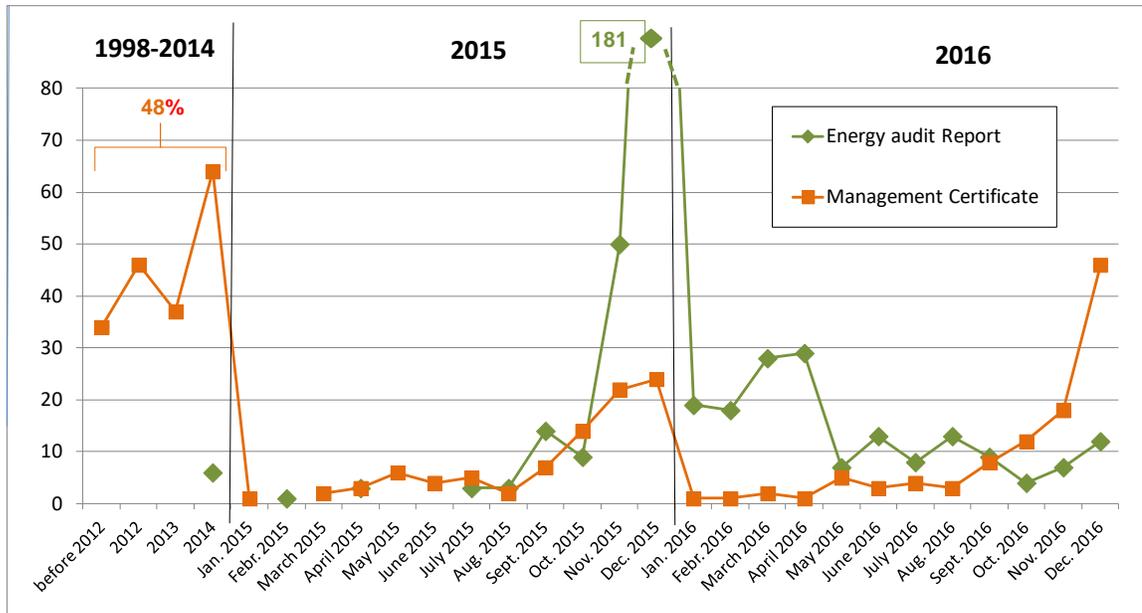


Figure 1. Fulfilment of obligations over time. *Source:* IREES, Survey 2016/2017

Energy-intensive companies, e.g. energy suppliers, paper, chemistry, glass, metal or plastics industries, and other manufacturing industries more often chose the management option. Construction, trade, hospitals and the service sector concentrated more on energy audits (Figure 2).

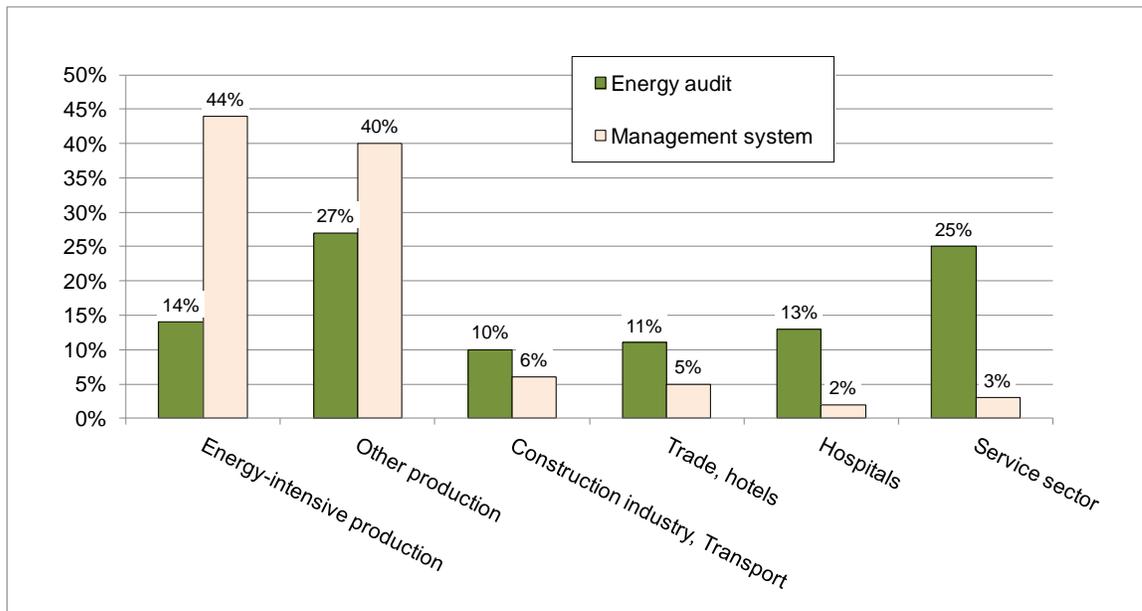


Figure 2. Decision on audit or management system by sector. *Source:* IREES, Survey 2016/2017

Only 8% of the non-SMEs have just one site, on the average the companies have about 30 locations. The greatest number of sites was reported by retailing, hospitality and service companies as

well as by health services. Companies with similar branches often chose the multi-site audit option. Also the business ownership structure of non-SMEs is complex: about 75 % are not independent, but part of a company group. The head offices have been located either in Germany or abroad; in case of companies with audit 92 % are located in Germany, in case of companies with management systems only 55 %. This is relevant not only for the national extrapolation of the results but also partially for the implementation of energy saving measures and corresponding business strategies across all sites. Account should also be taken of the fact that a single energy audit covers only one site, a multi-site audit covers several sites and a management system can cover a whole company with all locations.

94 % of the audit companies would hardly have completed an energy audit to the same extent and at the same time without a legal obligation to do so, whereas almost half of the companies having introduced a management system in 2015 or 2016 would have done it in any case.

10 % of the audit companies and even 30 % of the companies with management system reported a membership in an energy efficiency network. These networks offer exchange of experience, qualified energy consulting which meets the standard required by DIN EN 16247-1 (Rohde et al. 2015).

Performance of the consulting

To find an auditor one third of the respondents used the official energy auditor list provided by the authority. Other companies went back to an already trusted consultant or they received a recommendation from professional colleagues.

With respect to quality the respondents were asked about the process of consulting. Many but not all quality criteria were met (Figure 3). Many consultants did not take economic viability criteria into account sufficiently. Most of them only mention the pay-back period, but did not undertake a life cycle analysis or calculate a rate of return. Further criteria such as the analysis of complete systems, proof of reliability and validity, a clear breakdown of energy used, clear report on calculation methods and assumptions as well as a list of saving potentials were given in most cases. Generally, with regard to almost all criteria internal energy audits – which account for 12 % of all audits – perform better than audits done by an external consultant.

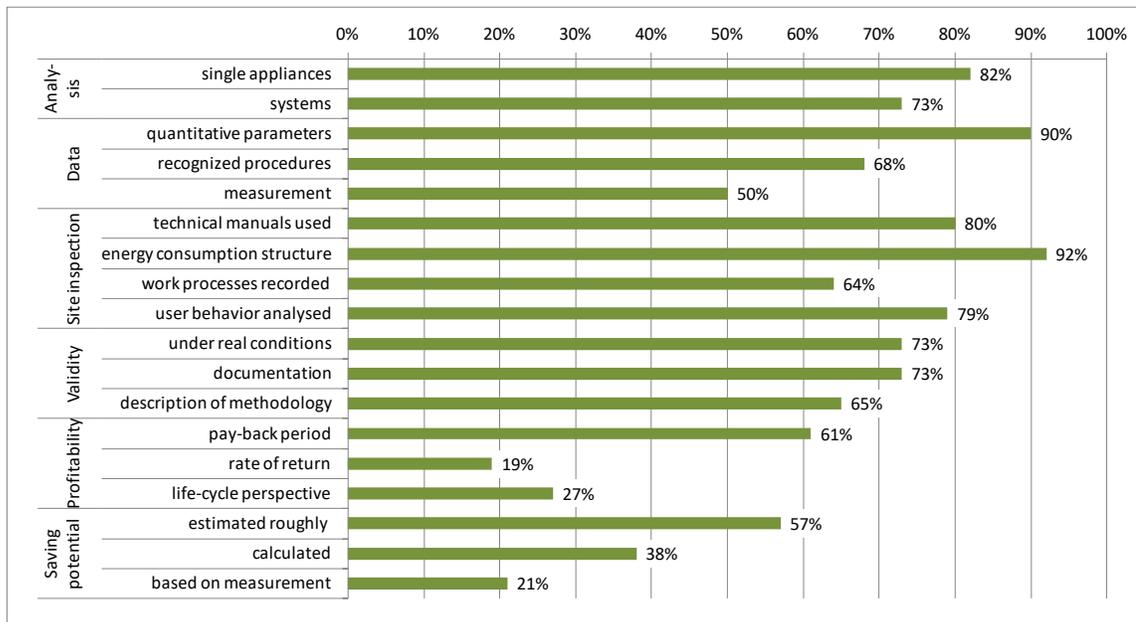


Figure 3. Fulfilment of quality criteria of the audits. *Source: IREES, Survey 2016/2017*

98 % of the respondents confirmed that the auditor made recommendations for energy-saving measures, but not always appropriate ones. In the opinion of 40 % they were directly implementable, further 53 % said they were partially applicable and 7 % considered them to be useless. Implementation plans were provided in 64 % of the companies.

Finally, the audit reports often covered only part of the elements specified in the reference standard. Almost all reports covered a summary, recommendations for measures and a documentation of the auditing process (80 up to 86 %). Two thirds covered documentation and analysis of the present energy status and quantified saving potentials. 58 % described the background. Only 36 % mentioned possible subsidies, 29 % suggestions for recording savings achieved, and 21 % possible interactions between measures. The analysis of selected audit reports by the evaluators revealed a similar result: Very few reports comply completely with all the criteria listed in Din EN 16247-1. Two trained energy engineers of the responsible authority (BAFA) examine a selected sample of reports and reject insufficient reports; the auditors have to remedy defects.

Nevertheless the respondents were very or quite satisfied with the audits including the reports. 73 % would recommend other companies to complete an energy audit, and 83 % would recommend their auditor. Various criteria were used to evaluate the satisfaction; two criteria did not score well: the cost-benefit relation and the internal time spent for the audit (Figure 4).

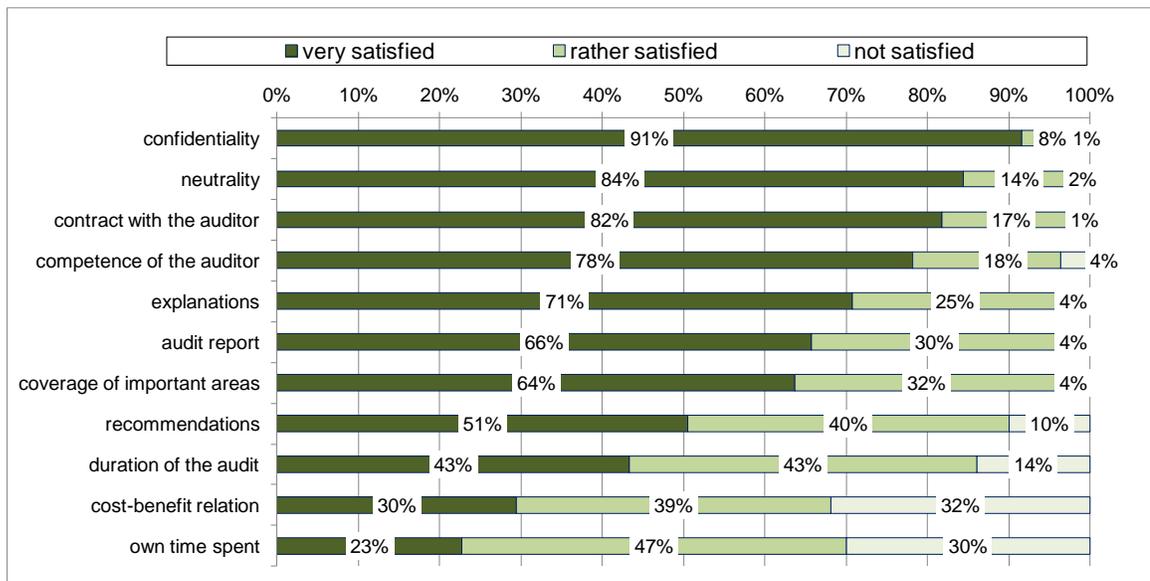


Figure 4. Satisfaction with the audit. Source: IREES, Survey 2016/2017

Introduction of a management system

Company managers who introduced a management system received questions different from those with energy audit. The requirements associated with an energy or environment management system were mostly met: the appointment of an energy or environmental manager, establishment of an energy team, elaboration of an action plan, recording of energy data, defining of saving targets and implementation of energy saving measures (80 up to 92 %). A majority carried out measurement and took measures for continuous saving activities (75 % each). 60 % purchased metering technologies, and 32 % management software, 56 % analyzed work processes and 51 % user behavior. Metering technologies and management software was purchased mainly in the manufacturing industry. 54 % of the

respondents worked together with an external consultant. In 90 % of the companies employees have attended training courses on energy management.

Most respondents were satisfied with the introduction of the management system and would recommend it to other companies (93 %). However, similar to audit companies, they complain about cost and staff expenditure caused by the management system.

Duration and cost of energy audit and management certification

The companies reported a time period of 4.4 months on the average between the commission of an audit and the report delivered. The audit itself took 6.7 days per site on the average. There was a wide range between the statements: in case of waiting for the report between less than one month and two years, the presence of the auditor on site between one day and 60 days.

In companies with a management system the certification audit took 7.1 days on the average with a range between less than one day and almost one year, two thirds of the respondents said that it took less than 10 days.

Remarkable audit costs were reported from companies with audit but even higher costs from those with a management system for its introduction and operation (Figure 5). In the case of audits internal staff was used to compile data on energy demand, technical documents, operational data of plants, etc. Half of the companies carried out the audit exclusively or predominantly with own personnel. When they did it with internal personnel only their costs were below the average. Multi-site audits were more expensive than single audits, but they cover about 10 subsidiaries on the average.

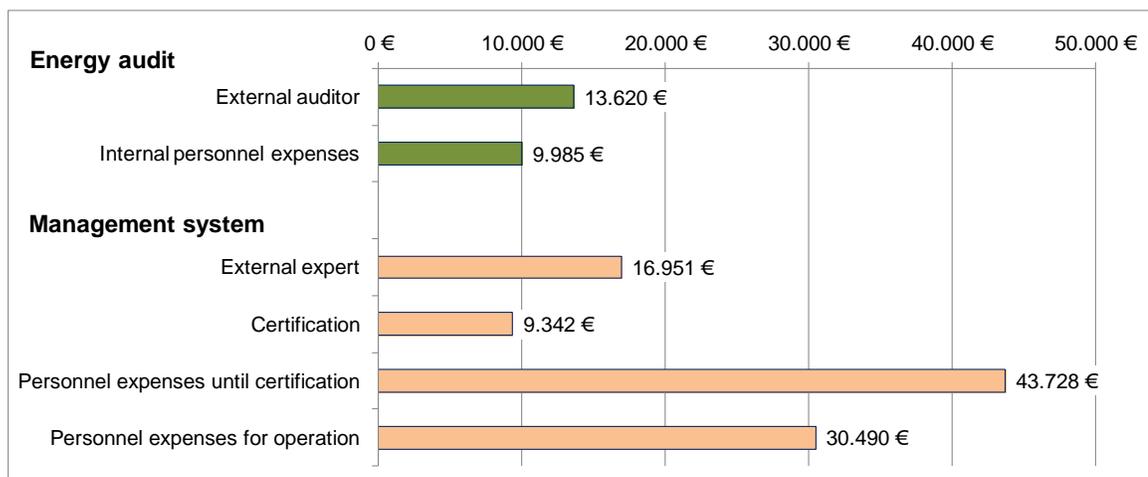


Figure 5. Average cost of audits and management systems. *Source: IREES, Survey 2016/2017*

Experts say that the relatively high average cost correspond to an audit of 10 to 15 days according to the respective daily rate. This should result in a high quality audit with well-founded recommendations of measures. Considering the costs of the introduction of a management system, it has to be taken into account, that in case of multiple sites the expenses mentioned arise for the company as a whole. Companies having introduced the management system since 2015, mention 25 % lower cost than those having introduced it earlier. The certification and operation costs also decreased.

Impacts of energy audits and management systems

70 to 80 % of the respondents agree that the energy audit played an important role because it made a contribution through

- analyzing the energy demand thoroughly
- evaluating possible energy saving measures
- confirming own considerations
- pointing out the economic viability of measures

For almost 60 % was important, that they received information on energy saving potentials for the first time. An indication for a continuous impulse is that 50 % of the respondents “now attach greater importance to energy efficiency in general”. With the latter statement agreed even 80 % of the companies with management system.

A crucial question of the study was the measures undertaken as a result of the audit or the management system respectively. Real data are not available in order to answer this question. The study must rely on information provided by the respondents. An open question would lead to answers with very different degree of precision. Therefore areas were specified where energy efficiency measures can be implemented. These areas were addressed in three respects: measures before the audit or the introduction of the management system, potentials identified and measures implemented including firmly planned ones. Figure 6 shows the results for companies with audit and Figure 7 those for companies with management system.

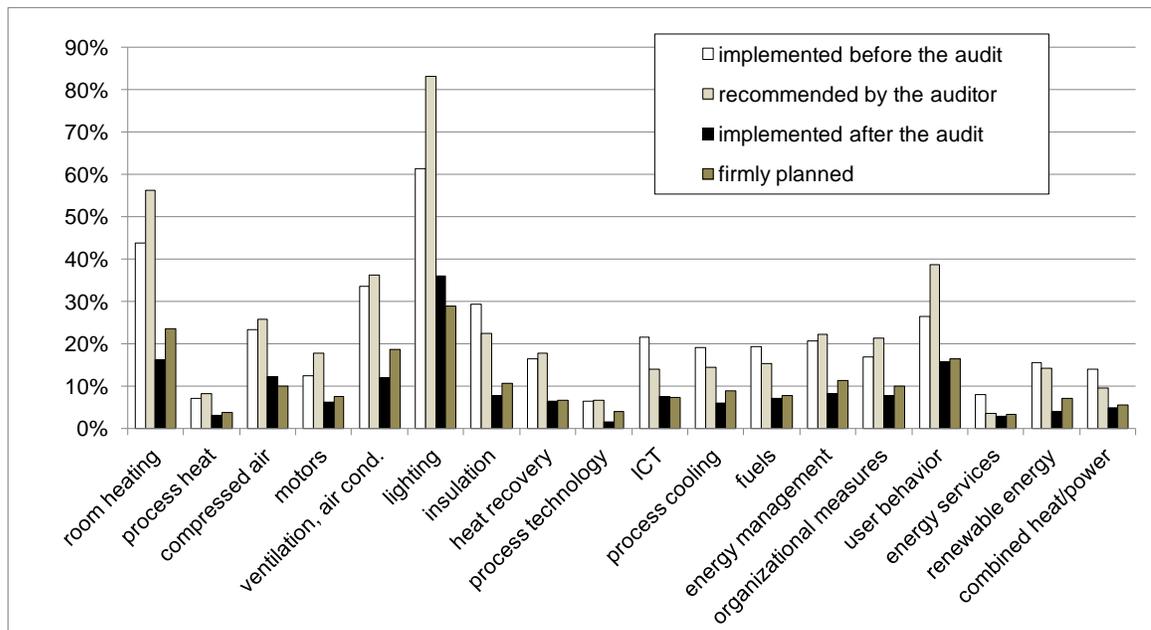


Figure 6. Areas for saving measures – companies with audit. *Source: IREES, Survey 2016/2017*

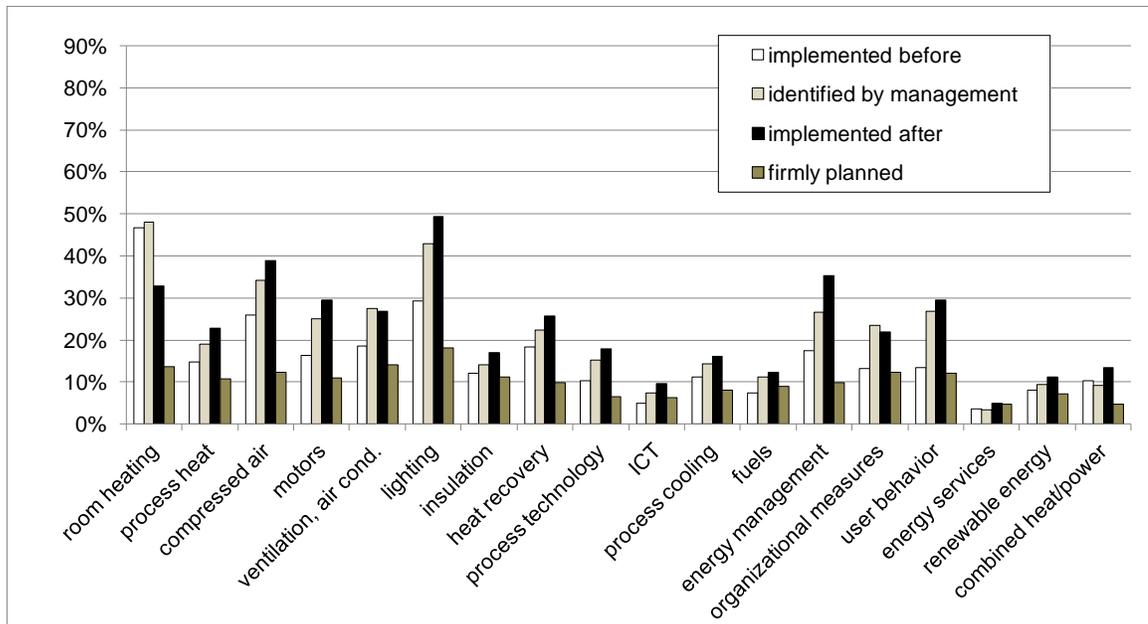


Figure 7. Areas for saving measures – companies with management system. *Source: IREES, Survey 2016/2017*

The focus in audit companies is lighting, followed by ventilation/air condition, room heating and user behavior. Companies with management system also mention lighting most frequently, but process-oriented measures, e.g. in the area of compressed air, motors, heat recovery and process heat, are much more relevant than for audit companies. On the one hand, this reflects the fact that companies with management system mainly cover manufacturing industries whereas audit companies mainly cover the service sector, but on the other hand, companies with management system implement or plan in sum 66 % more measures than audit companies.

“Energy services, contracting” was one of the items in the list of measures identified, taken or planned with the lowest number of responses. Experts often say that ESCOs are important actors for the improvement of energy efficiency, but these services are not very common in German companies.

There are various obstacles which inhibit the implementation of energy saving measures (Figure 8). The most important are reasons concerning profitability, other investment priorities and waiting for a suitable time. The high share of companies with management system who mentioned lacking profitability could indicate that profitable measures have been implemented earlier. 37 % of the companies with audit and 24 % of those with management system have rented their premises, e.g. retail stores or bank branches. In these cases the landlord-tenant dilemma is the most serious constraint. Even some of the manufacturing premises are rented, when real estate subsidiaries are founded. Often the rent includes the whole equipment, lighting, etc. and the tenant is not responsible for any technical energy saving measure.

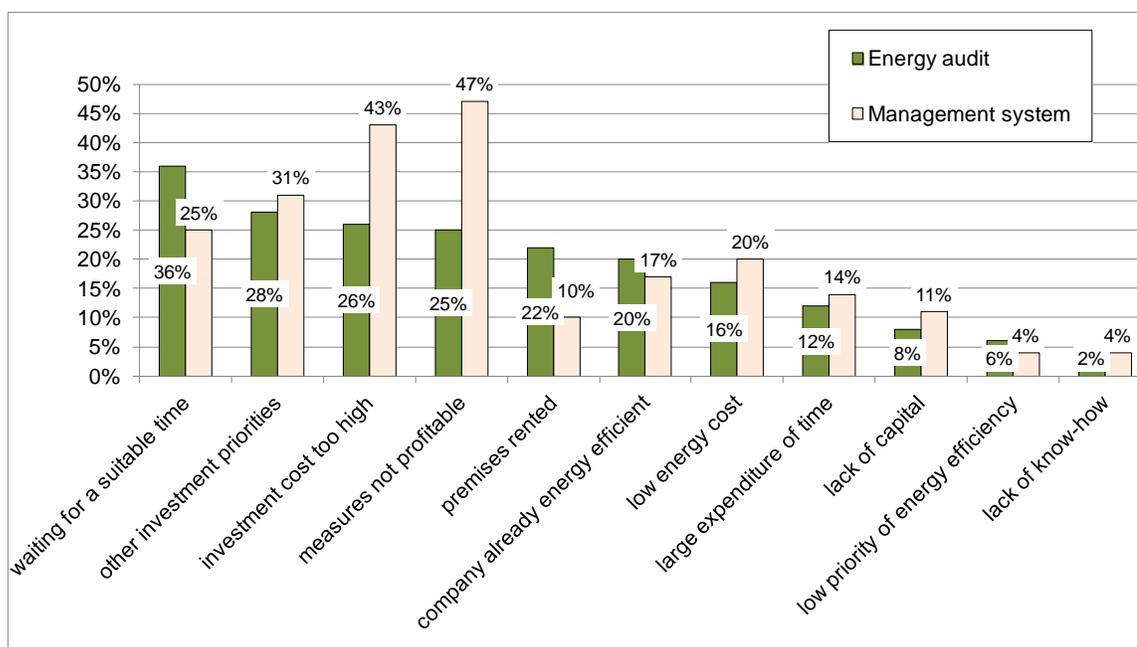


Figure 8. Obstacles to the implementation of measures. *Source: IREES, Survey 2016/2017*

Extrapolation for all non-SMEs in Germany

The total energy end-use of non-SMEs concerned by the audit obligation amounts to 937 TWh (3.373 PJ) per year, of which one third is electricity and two thirds fuels – without vehicle fuels because there are no data available for non-SMEs. The companies of which data were gathered in the survey altogether cover about 5.5 % of the total energy end-use of non-SMEs (52 TWh or 187 PJ).

For the calculation of the quantitative impact two types of data were used: the saving potentials identified by auditors or within the management system, and the actually implemented or firmly planned measures. In sum, the potential is about 3.9 % per year of which 3.4 % are or will be achieved. This would suggest that a large part of the potential is put into practice. Taking into account an autonomous technical progress and an impact of other policy instruments, energy savings of 14 PJ will be achieved by 2020 or even 30 PJ if effects of a further audit are included (Table 1).

Table 1. Extrapolation of the results to German non-SMEs

	2016 – 2020 5 years	2016 – 2020 4 years and next audit 2019
Savings (PJ)	113.06	145.90
./ autonomous progress	84.32	84.32
Result	28.74	61.58
Effects of other policies	14.37	30.79
Final savings (end of 2020)	14.37	30.79

The expectations of the German Government associated with the audit law would then be fulfilled between about 30 and 60 %. The latter figure includes effects of further audits in 2019 and increasing saving activities due to the fact that in the short time the law could not be fully effective.

The potential resulting from the survey appears to be relatively small in comparison with findings from Energy Efficiency Networks in Germany. In about 360 participating companies, mainly non-SMEs, between 2010 and 2012 external consultants identified a potential of 10 % and reached savings of 6 % on the average (Rohde et al. 2015). The audits were also based on the standards of DIN EN 16247-1.

Discussions and conclusions

The study revealed that the audit obligation led to significant effects. The findings suggest that audits or the introduction of a management system also have a sustainable impact in terms of strategic importance of energy efficiency and priority setting. The quantitative expectations of the German Government regarding the impact of the energy audit law have not been realized completely. However the evaluation took place at a very early stage. Larger investments in energy-saving measures often depend on reinvestment cycles of two or more years.

Although most companies were satisfied with the audit, objectively seen there are some doubts about the quality of many audit reports and of the performance of the audit. Various deficits are apparent, e.g. in the profitability analysis. Lacking quality of audits may be one reason for the relatively low energy saving potential identified.

Numerous respondents suggested that other criteria should be relevant for the definition of the target group of the law instead of number of employees or turnover, e.g. the yearly energy used. This would mean that administration services, sales offices or very small subsidiaries would not have to make the effort of an audit. Some said the whole service sector should be exempted from the obligation, or the law should provide a less extensive procedure of data recording. Above all, personal services and facility management companies have a very low energy demand because their employees work in premises of the clients.

Another problem is rented premises. The law does not address landlords specifically. Tenants have restricted possibilities to improve energy efficiency. For example, when the auditor recommends insulation of exterior walls or replace the heating plant, tenants can only try to motivate their landlords to implement the measure.

An important point is the quality of the audits and the audit reports. In half of the cases it appears not to be satisfactory and does not comply with the standards of the DIN EN 16247-1. Experts say that the energy audit law created a high demand for energy consultants and many micro-enterprises and newcomers came into the market. Many consultants offered energy audits at low prices. However this observation is in contradiction to the relatively high prices reported by the respondents. The authority responsible for the check of the reports rejects unsatisfactory reports and examines carefully the qualification of consultants for the official auditor list. However it is impossible to remove a person having delivered insufficient reports from the list.

From a methodological point of view the evaluation was faced with some challenges. The survey was conducted online (for financial reasons) and had to be strictly anonymous so that queries relating to unclear answers were not possible. The questionnaire itself was very long and detailed. For an extrapolation exact data on energy used, potentials and savings, as well as on energy and investment costs were necessary. Many companies have cancelled the interview because the search for data required too much effort as expressed in phone calls with the research team. Others considered the questions to be not sufficiently specific and therefore their company could not be adequately portrayed. This is certainly true, but more details would have enlarged the questionnaire even more. A further problem is that effects cannot be measured physically but only indirectly through the statements of the responding companies. However the returned questionnaires finally included in the evaluation show great efforts of the respondents and a high precision of answers.

Citations and References

European Commission 2013a. *Guidance note on Directive 2012/27/EU on energy efficiency, Article 8: Energy audits and energy management systems*. Brussels, 6.11.2013, SWD (2013) 447 final.

European Commission 2013b. *EMAS – Eco-Management and Audit Scheme – User’s Guide*. 2013/131/EU. Brussels, 4 March 2013.

European Committee for Standardization 2012. *DIN EN 16247-1 Energy audits – Part 1: General requirements*. Brussels.

DESTATIS, Federal Ministry for Economic Affairs and Energy 2014. *Making more out of energy. National Action Plan on Energy Efficiency*. Berlin, December 2014.

DESTATIS, Federal Statistical Office Germany 2015. *Volkswirtschaftliche Gesamtrechnungen*. Fachserie 18 Reihe 1.5. Wiesbaden.

DESTATIS Federal Statistical Office Germany 2016a. *Produzierendes Gewerbe. Kostenstruktur der Unternehmen des Verarbeitenden Gewerbes*. Fachserie 4 Reihe 4.3. Wiesbaden.

DESTATIS, Federal Statistical Office Germany 2016b. *Betriebe, Tätige Personen und Umsatz des Verarbeitenden Gewerbes nach Größenklassen*. Fachserie 4 Reihe 4.1.2 Wiesbaden.

DESTATIS, Federal Statistical Office Germany 2016c. *Unternehmensregister*. Status 31.5.2015 WZ08. Wiesbaden.

Hirzel, S. et al. 2016. *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems*. Report on the fulfilment of obligations upon large enterprises, the encouragement of small- and medium-sized companies and on good-practice. Brussels: EU, April 2016.

ISO, International Organization for Standardization 2011. *ISO 50001 Energy management systems – Requirements with guidance for use*. Geneva.

Rohde, C. et al. 2015. “Learning Energy Efficiency Networks – Evidence based experiences from Germany”. *ACEEE Summer Study on Energy Efficiency in Industry*, Buffalo, NY, 2015, August 4-6, p. 6-1ff.

Schleich, J. et al 2015. “Effect of Energy Audits on the Adoption of Energy-Efficiency Measures”. *ACEEE Summer Study on Energy Efficiency*. Presqu’île de Giens, June 2015.

Schlomann, B. et al. 2015. *Energy consumption of the tertiary sector (trade, commerce and services) in Germany for the years 2011 to 2013*. Karlsruhe, Munich, Nuremberg.